Landslides

What Causes a Landslide?

Hazard Description

Landslides are the movement of rock, soil, or other debris, down a slope. In general, the term landslide includes a wide range of ground movement, such as rock falls, and shallow or deep failure of slope.

Debris or mud flows are a combination of rock, earth, and other debris saturated with water. They develop when water rapidly saturates the ground from precipitation or a sudden influx of water that destabilizes the ground. As materials give way to gravity and move down a slope, a flowing river of mud or "slurry" can reach avalanche speeds and grow as it picks up trees, rocks, and other materials along the way.

Landslides occur naturally from heavy rain or snowstorms, earthquakes, and volcanoes. However, a landform's stability can be compromised by human activity such as construction of buildings or other infrastructure, logging, and mining near or along steep slopes.

Historical Occurrences and Impacts

The State of Washington rates landslide losses second to flood losses for the state as a whole with the Puget Sound area having the greatest vulnerability. While Whitman County has never received a disaster declaration specifically for a Landslide, four (4) of the declarations listed as a *Flooding* or *Severe Storm* event which occurred in the County included landslides.

Nationwide, our state has also experienced one of the worst slides in U.S. history. One example of this is the March 22, 2014 incident occurring in Snohomish County, Washington. Recorded as Federal Disaster #4168: Washington Flooding and Mudslides, Oso also known as the "SR530 Landslide" A massive landslide occurred 2 miles east of Oso along State Route 530. Higher than normal rainfall contributed to the collapse of an unstable slope north of the Stillaguamish River. The landslide generated a massive debris-avalanche flow that crossed the river and covered nearly one-half square mile. The landslide killed 43 people and buried over 40 homes and other structures in a rural neighborhood known as Steelhead Haven.

Factors Contributing to Landslides

All mass movements are caused by a combination of geological and climate conditions, as well as the encroaching influence of urbanization. Vulnerable natural conditions are affected by human, residential, agricultural, commercial, and industrial development and its supporting infrastructure.

The occurrence of a landslide is dependent on a combination of site-specific conditions and factors. Most commonly, the factors that contribute to landslides fall into four broad categories:

1. Climatic or hydrologic (rainfall or precipitation)
2. Geomorphic (slope form and conditions, e.g., slope, shape, height, steepness, vegetation and underlying geology)
3. Geologic/geotechnical/hydrogeological (groundwater)
4. Human activity.

Change in slope of the terrain, increased load on the land, shocks and vibrations, change in water content, groundwater movement, frost action, weathering of rocks, and removing or changing the type of vegetation covering slopes are all contributing factors. In general, landslide hazard areas are where the land has characteristics that contribute to the risk of the downhill movement of material, such as the following:

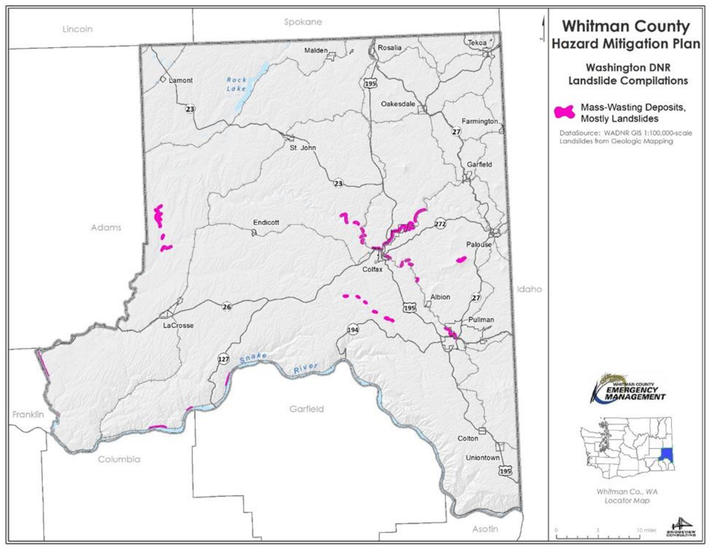
- Areas identified as having slopes greater than 33 percent;
- A history of landslide activity or movement during the last 10,000 years;
- Stream or wave activity, which has caused erosion, undercut a bank or cut into a bank to cause the surrounding land to be unstable;
- The presence of an alluvial fan, indicating vulnerability to the flow of debris or sediments;
- The presence of impermeable soils, such as silt or clay, which are mixed with granular soils such as sand and gravel.

Delineation of a Landslide Hazard Area

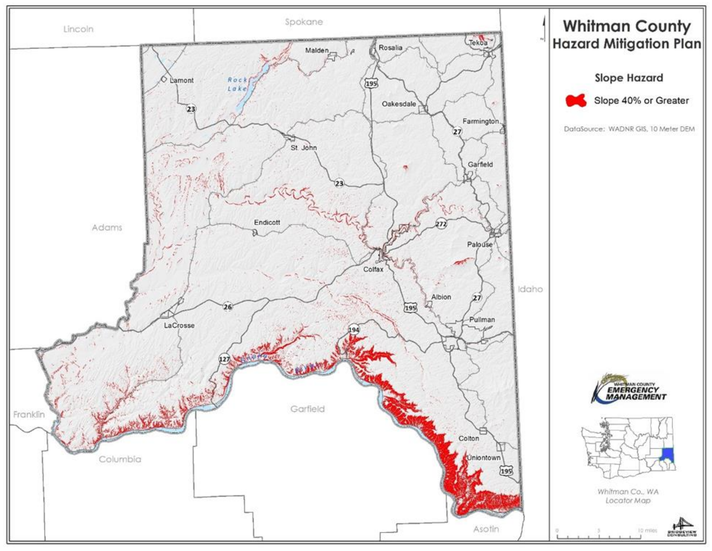
Flows and slides are commonly categorized by the form of initial ground failure. The most common slide is the shallow colluvial slide, occurring particularly in response to intense, short-duration storms, where antecedent conditions are prevalent (Baum, et. al, 2000). The largest and most destructive are deep-seated slides, although they are less common. Map 1 illustrates the various types of landslide hazards in the County as identified by Washington State Department of Natural Resource. Map 2 illustrates the slopes within the county which have been determined by Washington State Department of Natural Resources as having a 40 percent higher (~21 degrees) slope.

Vulnerability

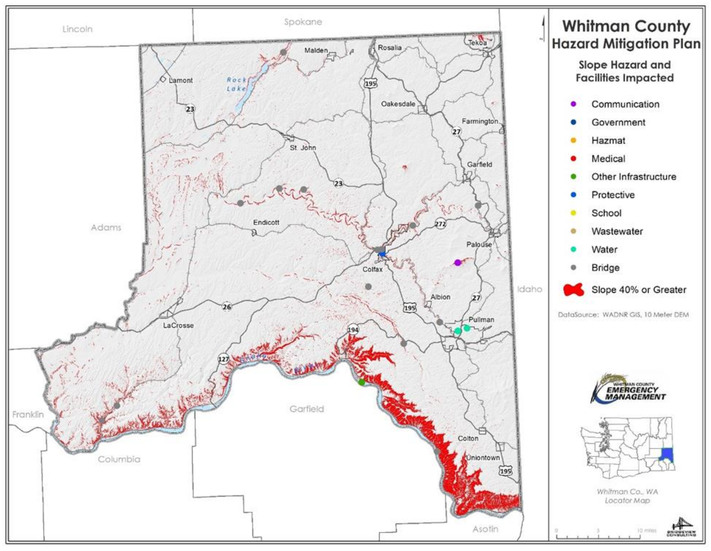
Whitman County has little history of landslides, and none which suggest anyone has been injured or killed. That does not, however, suggest that landslides have not, nor can continue to occur when weather conditions support landslide activity. Based on an exposure analysis of slope and proximity to previous landslides known to have occurred (as illustrated in Map 1 utilizing data compiled by Washington State Department of Natural Resources), Map 3 identifies those critical facilities which intersect the 40 percent slope, and which may be at risk for future landslide.



Map 1 – Landslide Categorization



Map 2 – Slopes 40 Percent or Higher



Map 3 – Slopes Intersect with Critical Facilities