3.7 Risk Assessment: Landslide

Description

According to the U.S. Geological Survey (USGS), the term landslide includes a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over steepened slope is the primary reason for a landslide, there are other contributing factors. Among the contributing factors are: (1) erosion by rivers, glaciers, or ocean waves which create over-steepened slopes; (2) rock and soil slopes weakened through saturation by snowmelt or heavy rains; (3) earthquakes which create stresses making weak slopes fail; and (4) excess weight from rain/snow accumulation, rock/ore stockpiling, waste piles, or man-made structures (USGS 2017).

Landslides may be classified by both type of movement and material. An understanding of the types of landslides that occur is fundamental to assessing the landslide hazard and evaluating potential mitigation measures. The following list is a simplified differentiation based on the type of movement.

Figure 3.7.A. U.S. Highway 95, Bonners Ferry Landslide, 1998

Source: www.landslidetechnology.com/landslides/bonnersferry.htm

Falls: Free falls of soil and rock with local rolling, bouncing, or sliding.
Slides: Lateral and downslope movement of partially intact masses.
Flows: Viscous flows of completely fragmented material, saturated with water.
Landslides can also be differentiated based the type of material involved.
Rock: Bedrock
Debris: Predominantly coarse material.
Earth: Predominantly fine material.

Together, movement and material produce a composite classification scheme. For example, a free fall of bedrock is referred to as a "rock fall," while a viscous flow of predominantly fine material is referred to as an "earth flow." The wettest flows are referred to as "mud flows." These events may be very difficult to distinguish from heavily debris-laden flash floods and functionally are essentially the same.

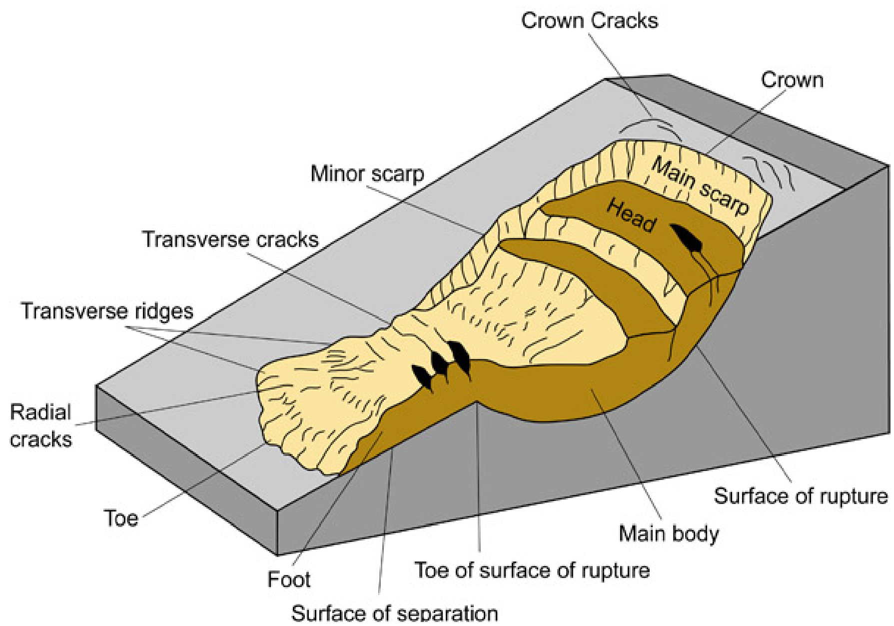
Factors Contributing to Landslides

Natural Factors: Natural factors contributing to landslides include slope morphology (shape), slope material (soil), bedrock geology, vegetation, and climate. Generally, the steeper a slope is, the more prone it is to landslides (except when the slope is so steep that loose material does not accumulate). A study of landslides in central Idaho has shown that most slides occurred on slopes of about 30 degrees and that landslides were rare on slopes steeper than 41 degrees. The general shape of a slope also influences the likelihood of a landslide. On a concave slope (e.g., hollow, swale, gully), water and debris tend to concentrate, making landslides more likely. Conversely, on a convex slope (e.g., ridge, nose), water and debris are less likely to accumulate.

The slope surface materials and their underlying geology also determine landslide risk. A landslide event is generally dependent on a material weakness. For example, if an impermeable layer exists, subsurface water will accumulate there, leading to reduced slope strength and a potential failure plane. The underlying and adjacent geology often influence the risk of landslides by controlling the movement of groundwater.

Vegetation contributes to slope stability in two ways. First, roots increase the shear strength of the slope material. Second, vegetation removes water from the hill slope by evapotranspiration. Therefore, burned watersheds are particularly vulnerable to landslides.

Figure 3.7.B. Landslide Terminology



Source: www.idahogeology.com

The climate of a region determines the frequency and magnitude of precipitation events. The amount of precipitation in Northern Idaho is higher than the statewide average. This, along with the topography of the region, increases the likelihood of landslides in this part of the State. The size and timing of precipitation events also has a great impact on landslide risk. They influence the processes of rock weathering (important in influencing soil depth and strength), the type of vegetation that occupies the hill slopes, and the fire regime of the region. Most wildfires occur in mid- to late summer, the same season that severe thunderstorms are most likely to contribute to landslides. Further, the transition into fall often sees higher precipitation amounts that can impact recently burned areas. Fire destroys the plants on a hillside that hold the soil together and limits the amount of water that can be infiltrated and instead it runs off. As the rains run off it gathers more and more sediment. This was a major concern in the Sun Valley area following the 2007-fire season, and in Blaine County after the Beaver Creek Fire in 2014 that led to floods.

Human Activities: Some human activities and land uses can increase the potential for landslides. These include road construction, timber harvesting, and grazing, mining, and long-term fire suppression. Such activities can contribute to slope instability by changing infiltration rates and groundwater movement, removing vegetation, and/or over-steepening slopes. In a study of 700 landslides in the Payette River drainage, less than 3 percent of observed recent landslides occurred on undisturbed sites; the rest were associated with forest disturbances including wildfire, timber harvesting, and roads.

Irrigation and others ways that additional water is introduced (e.g., sprinklers, injection wells, and even septic systems) may also contribute to local slope instability. This may be critical along the Snake River canyon in Bonneville, Jerome, and Twin Falls Counties and near urban centers. In July 2006, a landslide in Washington County, Idaho, is thought to have been caused, at least partially, by the presence of irrigation water. This landslide damaged one home and blocked the irrigation canal, depriving a large area of irrigation water. A State Disaster Proclamation was issued for this landslide. Placing roads on steep slopes has been widely identified as the single human activity most likely to increase the landslide hazard on a site. Roads increase the amount of bare soil and, if constructed across steep slopes, result in a portion of the road fill being steeper in gradient than the natural slope. Road construction on slopes also diverts groundwater to the surface, where it is concentrated and can obtain a higher flow velocity. Mining activities can have similar impacts.

Landslide Triggers

An unstable slope will remain in place and intact until a landslide is triggered. Typical triggering events include (alone or in combination): water, seismic activity, volcanic eruptions, and the rapid erosion of the slope toe material (e.g., by stream down cutting or road excavation). The most frequent landslide-triggering mechanism is water from intense rainfall, rapid snowmelt, or human-introduced sources.

A common cause of failure is the infiltration of water into the slope, which usually leads to an increase in ground stresses and a reduction of the soil's strength. Late spring and early summer comprise “slide season”, particularly after days and weeks of greater than normal precipitation. When water accumulates on the surface as runoff, a flow may be triggered. Flows in mountainous terrain are a year-round threat and may be triggered by a heavy, brief rainfall during summer thunderstorms.

Seismic activity and volcanic eruptions, due to their infrequent natures, play a relative minor role in triggering landslides in Idaho. However, these events can affect a large area and may trigger numerous unstable slopes. Floods are often accompanied by numerous landslides due to toe cutting and the introduction of large amounts of water.

Landslide-related Damages

Landslides threaten residences, businesses, transportation corridors, fuel and energy lines, and communication facilities. Landslides range from very small to massive, and they may affect only a single property or slope or an entire drainage area. A landslide event may be composed of a single discrete landslide or numerous landslides over an entire region. Landslide hazards may be classified as “onsite” and "offsite." Onsite hazards correspond to landslides that originate on or near the development site. These are typically the slower moving and spatially limited falls and slides. Offsite hazards begin on slopes away from the development and travel great distances or cover large extents. These are typically flows or, in some cases, massive slides. Both onsite and offsite landslides may impact lives, property, and the environment.

A possible secondary hazard in Idaho is a "seiche," a damaging wave triggered by landslide into lakes. Seiches, similar in effect to tsunamis, can damage or destroy shorefront property, docks, and boats. Seiches are uncommon but do occur. They damaged docks and some boats around Lake Pend Oreille (at Bayview and Sandpoint) in 1946 and 1963. A seiche triggered by the 1959 Hebgen Lake earthquake caused water to slosh over the top of the dam, resulting in cracks and erosion. Another secondary hazard is when landslides and debris flows block culverts and other flow routes, creating drainage and flooding hazards.

Figure 3.7.C. Earth Flow Damage to U.S. Highway 95 near Bonners Ferry

Source: Idaho Geological Survey

While landslide events are undoubtedly costly, losses in Idaho are difficult to estimate because of landslide frequency and the fact that many smaller events are handled locally or privately, without State involvement. For example, ongoing landslide problems magnify the challenges of maintaining U.S. 95, the primary north-south link in the Panhandle region. It is often impossible to redirect traffic on this heavily traveled road, as alternate routes do not exist, and detours in steep terrain are difficult or impossible to construct. Landslides here disrupt emergency functions and commerce, as well as personal lives. Some of these impacts can be quantitatively measured (e.g., lost business) while others, such as the disruption of families, is impossible to quantify.

Location, Extent, and Magnitude

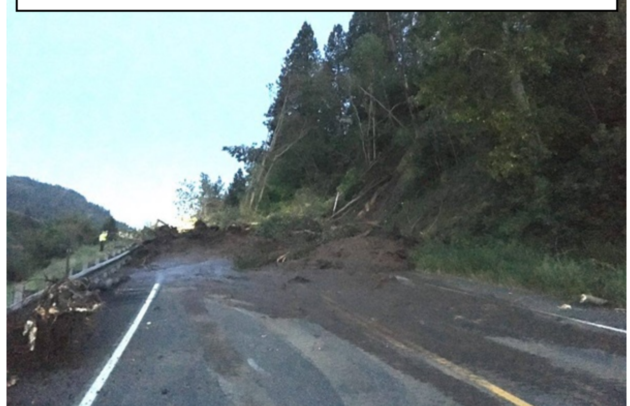
The entire United States experiences landslides, with 36 states having moderate to highly severe landslide hazards. According to the USGS, a majority of Idaho has low landslide potential; however, there are areas in central and southeastern Idaho with moderate to very high potential (USGS 2005). Landslide activity is considered to be localized in the State. The USGS is currently updating its research on hazardous landslide processes, including their mechanisms, recurrence, distribution, and probability (http://landslides.usgs.gov).

CHAPTER 3.7
RISK ASSESSMENT: LANDSLIDE

Landslides are typically a function of soil type and steepness of slope. Soil type is a key indicator for landslide potential and is used by geologist and geotechnical engineers to determine soil stability for construction standards. The best available predictor of where movement of slides and earth flows might occur is the location of past movements. Past landslides can be recognized by their distinctive topographic shapes, which can remain in place for thousands of years. Most landslides recognizable in this fashion range from a few acres to several square miles. Most show no evidence of recent movement and are not currently active. A small proportion of them may become active in any given year, with movements concentrated within all or part of the landslide masses or around their edges.

The recognition of ancient dormant mass movement sites is important in the identification of areas susceptible to flows and slides because they can be reactivated by earthquakes or by exceptionally wet weather. In addition, because they consist of broken materials and frequently involve disruption of groundwater flow, these dormant sites are vulnerable to construction-triggered sliding.

Figure 3.7.D. Landslide Closes State Highway 3, May 29,



Source: Lewis-Clark Valley News, 2017. Photo courtesy of Idaho State Police.

Idaho Department of Transportation Projects

Table 3.7.E shows the mitigation projects completed by the Idaho Department of Transportation along state managed highways from landslide-prone areas starting in 2013 through 2018 and the projected mitigation work-in-progress for program years 2018 and 2020. The completed landslide area projects totaled over $15.8 million and the mitigation work-in-progress is projected to total $17.1 million. As seen in this table, a majority of the work has been done in Boundary and Clearwater Counties.

Table 3.7.E. Idaho Department of Transportation Landslide Repair Projects

Program Year	DOT District	County	Location	Segment	Beginning Mile Post	Ending Mile Post
			DOT Work Completed			
2013	1	Boundary	Stc-5804, Old Us-2 / Deep Cr Loop	004450	1.1	1.2
	1	Boundary	Stc-5804, West Side Rd / Lions Den	004450	6.6	6.66
	2	Clearwater	Stc-4783, Dent Bridge Rd MP 1, Clearwater Co	005250	0.931	1.031
	2	Clearwater	Stc-4783, Dent Bridge Rd MP 13, Clearwater Co	005250	13	13.06
	2	Clearwater	Stc-4782, Grangemont Rd, Clearwater Co	005260	4.6	4.9
2014	1	Bonner	Stc-5783, Eastriver Rd MP 11.3, Bonner Co	003800	11.3	11.4
2017	2	Idaho	SH 14, Slide Repair Nr Elk City, Idaho Co	001970	39	39
	1	Boundary	Stc-5810, Cow Creek Rd MP 100.1, Boundary Co	002545	100.1	100.1

Program Year	DOT District	County	Location	Segment	Beginning Mile Post	Ending Mile Post
	1	Kootenai	Stc-5742, Greensferry Rd MP 100, Worley Hd	002013	100	100
	1	Boundary	Stc-5801, Crossport Rd MP 9.5, Boundary Co	004480	9.5	9.5
	1	Boundary	Stc-5804, Lions Den/Westside Rd MP 7.0, Boundary Co	004450	7	7
	1	Boundary	Stc-5804, Westside Rd MP 11.0 – 19.0, Boundary Co	004450	11	19
2018	3	Elmore	Stc-3809, Middle Fork Boise River Rd, Elmore Co	000443	34	40
Dot Work In Progress						
2018	3	Elmore	Stc-3809, Middle Fork Boise River Rd, Elmore Co	000443	34	40
2020	1	Boundary	Stc-5804, Deep Cr Loop MP 1.1, Boundary Co	004450	1.1	1.1
	2	Clearwater	Stc-4782, Grangemont Rd MP 4.75, Clearwater Co	005260	4.75	4.75
	2	Clearwater	Stc-4782, Grangemont Rd MP 22.2, Clearwater Co	005260	22.2	22.2
	2	Clearwater	Stc-4783, Dent Bridge Rd MP 1.1, Clearwater Co	005250	1.1	1.1
	2	Clearwater	Stc-4783, Dent Bridge Rd MP 1.8, Clearwater Co	005250	1.8	1.8
	2	Clearwater	Stc-4783, Dent Bridge Rd MP 31.3, Clearwater Hd	005250	31.3	31.3
	2	Clearwater	Stc-4783, Dent Bridge Rd MP 32.5, Clearwater Hd	005250	32.5	32.5
	2	Clearwater	Stc-4786, Upper Fords Creek MP 103.2, Clearwater Co	002675	100.32	100.32
	2	Clearwater	Stc-4786, Upper Fords Creek MP 107.4, Clearwater Co	002675	100.74	100.74
	1	Benewah	SH 5, Emergency Repair MP 5.8, Benewah Co	001820	5.8	6
	1	Boundary	US 95, Emergency Slope Repair MP 498, Boundary Co	001540	497.85	498.05
	1	Bonner	SH 57, Emergency Repair MP 1.9, Bonner Co	001620	1.9	2
	1	Boundary	US 95, Emergency Repair MP 518, Boundary Co	001540	518.35	518.5
	1	Kootenai	SH 97, Emergency Slope Repair MP 67.4, Kootenai	001790	67.4	67.6
	1	Kootenai	SH 97, Emergency Repair MP 76.90, Kootenai Co	001790	76.9	77.05
	1	Bonner	Stc-5783, Eastriver MP 10, 11, 11.2, Bonner County	003800	10	10
	2	Lewis	Stc-4747, Central Ridge Rd MP 15.3, 16.7, 17.4, North Hd	006500	15.33	15.33
	2	Idaho	Stc-4730, Glenwood Rd MP 100.8, Idaho County	001841	100.606	100.606
	3	Washington	Stc-3878, Farm To Market Emergency Repair, Washington Co	007920	3.6	3.789

Program Year	DOT District	County	Location	Segment	Beginning Mile Post	Ending Mile Post
	3	Washington	Stc-8217, Cove Rd Emergency Repair, Washington Co	007880	0.76	1.37

Source: Idaho DOT

Landslides can be classified by their velocity as proposed by Cruden and Varnes 1996. The more rapid the movement, the more dangerous the slide (Table 3.7.F).

Table 3.7.F. Landslide Velocity Classification

Description	Velocity Range
Extremely Rapid	> 5 m/sec
Very Rapid	3 m/min – 5 m/sec
Rapid	1.8 m/hr – 3m/min
Moderate	13 m/month – 1.8 m/hr
Slow	1.6 m/yr – 13 m/month
Very Slow	16 mm/yr – 1.6 m/yr
Extremely Slow Negligible	16 mm/yr

Source: Cruden and Varnes 1996

Impacts

Severity

Landslides destroy property and infrastructure and can take the lives of people. Slope failures in the United States result in an average of 25 lives lost per year and an annual cost to society of about $1.5 billion. There are no records In Idaho of fatalities attributed to landslides. The biggest assets at risk to landslides are roads and infrastructure in landslide-prone areas. Landslides can isolate populations due to road closures.

Landslides are often triggered by other natural hazards such as earthquakes, heavy rain, floods or wildfires, so landslide frequency is often related to the frequency of these other hazards. Throughout Idaho, landslides typically occur during and after major storms, so the landslide potential largely coincides with the potential for sequential severe storms that saturate steep, vulnerable soils. Until better data is generated specifically for landslide hazards, this severe storm frequency is appropriate for the purpose of ranking risk associated with the landslide hazard.

Landslides are most likely during periods of higher than average rainfall. The ground must be saturated prior to the onset of a major storm for significant landslides to occur.

Warning Time

Landslide velocity can range from inches per year to many feet per second, depending on slope angle, material and water content. Some methods used to monitor mass movements can provide an idea of the time prior to failure. It is also possible to determine areas at risk during general time periods. Assessing the geology, vegetation and amount of predicted precipitation for an area can help in these predictions. However, there is no practical warning system for individual landslides. The current procedure is to monitor situations on a case-by-case basis and respond after the event has occurred. Generally accepted warning signs for landslide activity include:

- Springs, seeps, or saturated ground in areas that have not typically been wet before
- New cracks or unusual bulges in the ground, street pavements or sidewalks
- Soil moving away from foundations
- Ancillary structures such as decks and patios tilting and/or moving relative to the main house
- Tilting or cracking of concrete floors and foundations
- Broken water lines and other underground utilities
- Leaning telephone poles, trees, retaining walls or fences
- Offset fence lines
- Sunken or down-dropped road beds
- Rapid increase in creek water levels, possibly accompanied by increased soil content
- Sudden decrease in creek water levels though rain is still falling or recently stopped
- Sticking doors and windows or visible open spaces indicating jambs and frames out of plumb
- A faint rumbling sound that increases in volume as the landslide nears
- Unusual sounds, such as trees cracking or boulders knocking together.

Relationships to Other Hazards

Secondary Impacts

Landslides can cause several types of secondary effects, such as blocking access to roads, which can isolate residents and businesses and delay commercial, public, and private transportation. This could result in economic losses for businesses. Landslides have the ability to block stream channels and waterways, which could result in localized flooding. The eventual release of these blockages would also mirror the effects of a dam, levee or canal breach. Landslides are also known to trigger seiches, which can cause waves in larger bodies of water. This has the ability to negatively affect dams, levees, and canals. A seiche triggered by the 1959 Hebgen Lake earthquake caused water to slosh over the top of the dam, resulting in cracks and erosion. Locations of past landslides do have the ability to increase the immediate area's susceptibility to future landslides and flooding, due to the removal and transport of tree, vegetation, and other ground materials.

Other potential problems resulting from landslides are power and communication failures. This may affect energy transmission and communication lines, possibly resulting in energy shortages or cyber disruptions. Vegetation or poles on slopes can be knocked over, resulting in possible losses to power and communication lines. Landslides also have the potential of destabilizing the foundation of structures, which may result in monetary loss for residents. From a human-caused perspective, landslides do have the ability to affect energy transmission and communication lines, possibly resulting in energy shortages or cyber disruptions.

Additionally, landslide are more prominent in areas that have been affected by and experienced wildfires. Wildfires, particular large-scale fires, can dramatically alter the terrain and ground conditions,

making land already devastated by fire susceptible to mudflows. Normally, vegetation absorbs rainfall, reducing runoff. However, wildfires leave the ground charred, barren, and unable to absorb water; thus, creating conditions perfect for slides (FEMA 2013).
At this time, there is no magnitude scale for landslides.

Past Occurrence

Idaho's geology, landscape, climate, soils, and other factors are locally conducive to landslide activity, and numerous landslides occur each year in Idaho. Many of these, though, are small events without well-documented impacts. The Idaho Geological Survey has identified and plotted over 3,000 major landslides in the State. Landslides are also included on local and regional geologic maps and other geologic sources.

For the 2018 Plan update, landslide events were summarized between January 1, 2012 and October 1, 2017. Table 3.7.G includes events discussed in the 2013 Plan and events that occurred between 2012 and 2017. Loss and impact information for many events could vary depending on the source. Therefore, Table 3.7.G may not include all events that have occurred in the state and the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP update.

Table 3.7.G. Landslide Events in Idaho, 1974 - 2017

Date(s) of Event	Event Type	Counties Affected	Description
January 27, 1974	Landslide	Idaho	Hat Creek Landslide, located on U.S. Highway 95 near the town of Pollock, Idaho, started moving on January 27, 1974. The slide closed U.S. Highway 95 and the toe impinged into the Little Salmon River. The slide was about 2,300 by 500 feet and involved about one million cubic yards of material. Investigation and analysis centered around four alternatives: complete removal, lower slide removal, upper slide removal, and stabilization of the upper slide with groundwater control. The stabilization of the upper slide by groundwater control was selected as the most cost-effective alternative. A construction dewatering system, consisting of 45 eductor well points, was installed to provide a stable trench excavation. A drain trench, 700+ feet long, was constructed across the head of the slide. The drain trench contained 6-inch perforated pipe and 10-inch collector drainpipe covered by 4-1/2 feet of filter material. The stabilization work was completed in November, 1977 and realignment of U.S. Highway 95 in the fall of 1978 for a total cost of $770,000.
1979+	Landslides	Gooding	A series of major landslides has struck the plateau along the Snake River located in Hagerman Fossil Beds National Monument since 1979. These large slope failures have occurred approximately every two years, and typically affect areas ranging from 300 to 800 feet wide and up to 1,000 feet long. The 1987 event destroyed a $1 million irrigation pumping facility and nearly killed two workers.
July 1982	Landslide	Boise	unknown
February 1986	Landslide	Boise	unknown

Date(s) of Event	Event Type	Counties Affected	Description
March 1986	Landslide	Boise, Elmore, Lewis, Nez Perce, Owyhee	unknown
April 1991	Landslide	Bonner	The damaging event that occurred near Sandpoint in April 1991 illustrates the somewhat confusing continuum between flash floods and debris flows. Although classified in the State declaration as a flash flood, the high debris load makes it somewhat indistinguishable from a debris flow. The torrents blew out large sections of the road leading to Schweitzer Basin ski area, stranding dozens of people; contaminated the city's primary water supply; and heavily damaged the water treatment facility. The cost to clean out and repair the water treatment facility was several hundred thousand dollars.
July 24, 1993	Landslide	Gooding	On July 24, 1993, approximately 100 acres of ground failed and slid into the Snake River just south of Bliss. The river was temporarily dammed, and a new set of rapids was created. The access road on the south side of the river was destroyed. The initial slide and subsequent erosion of the toe introduced a large amount of sediment into the river. The landslide site shows extensive evidence of earlier activity.

Date(s) of Event	Event Type	Counties Affected	Description
November 1996	Severe Storms, Flooding, Mud and Landslides (DR-1154)	Adams, Benewah, Boise, Bonner, Boundary	During late December 1996, above-normal snowfall in Northern and Central Idaho was quickly followed by significant amounts of warm rain. The melting snow and heavy rains overwhelmed rivers and their tributaries, leading to widespread landslides and severe flooding, mainly in the West-Central region of the State. Large sections of the highway system were damaged or destroyed, isolating several communities for days. Six deaths and three serious injuries were attributed to this disaster. Massive landslides and floods occurred in the Payette, Weiser, and Little Salmon river basins, causing extensive damage to structures, roads, and bridges. Boise County in particular experienced substantial landslide damage. Numerous soil failures on saturated faces of hillsides resulted in major landslides and mud flows. Numerous small landslides obstructed culverts, flowed over roads, and caused undercutting on the downhill side. Numerous debris flows throughout Western Idaho caused extensive damage. Deposits left by these flows were several feet deep and up to 300 feet wide, and they overwhelmed the 1- to 3-foot culverts designed to pass rainfall runoff. Several gulches had significant slides that overwhelmed structures built on the alluvial fans of debris flow. A massive debris flow that hit the community of Lower Banks flowed down from an area burned over in 1992. The slide deposited mud, rocks, and debris at the base of the slope and expanded to cover the whole community. Most buildings (residential and business) appeared to be damaged or destroyed. Buildings were moved from their foundations and submerged in mud up to two-thirds of the buildings' height. Many public facilities were damaged or destroyed. From Horseshoe Bend to Banks, access to U.S. Highway 55 was restricted for one week. Several slides occurred in a half-mile section near Banks, with the largest estimated at 100,000 cubic yards. Highways 17 and 21 were closed by landslides, isolating the communities of Lowman and Garden Valley. On Old Idaho 17 there were miles of highway with landslides every 200-500 feet. U.S. 95 experienced 11 washouts that isolated residents for days, and McCall was isolated and suffered economic hardship due to the disruption of its winter recreation activities. Local roads and forest access were likewise affected. Mudslides destroyed much of the 6,000-mile road system in the Boise National Forest, threatening fisheries and access to popular recreation areas in the spring. On January 4, 1997, the President declared a major disaster (designated as DR-1154) in the State of Idaho, 18 counties were declared eligible for Federal assistance. As of February 1, 2001, this funding included $19,404,105 in public assistance, $39,988 in individual assistance, $125,937 from the NRCS, $576,314 from the U.S. Army Corps of Engineers, and $5,593,892 in hazard mitigation grants. Much of the impact of these landslides occurred on virtually unpopulated public and private lands managed by the Forest Service, Bureau of Land Management, Idaho Department of Lands, and Boise Cascade Corporation. In addition to infrastructure damage (e.g., forest roads), the impact included a large input of sediment and woody debris into stream channels. The increased sediment in the stream channels affected fish habitat. Based on past studies, it is suspected that road

Date(s) of Event	Event Type	Counties Affected	Description
			construction played a large role in the origin of these slides. Recent wildfires may also have played a role in the extent and severity of the landslide by reducing root strength, reducing transpiration by plants, and increasing runoff due to reduced infiltration.
January 1997	Landslide	Clearwater, Elmore, Gem, Idaho, Kootenai, Latah, Nez Perce, Owyhee, Payette, Shoshone, Washington	In early March 1997, northern Idaho received 12 to 18 inches of snow on top of an existing snow pack that exceeded 150 to 170 percent of the average. A subsequent rainstorm caused a rapid snowmelt. The resulting mudslides and flooding lasted for an extended period and damaged many public facilities, including county road systems. The President issued a Federal Disaster declaration (DR-1177) on June 13, 1997, for Boundary, Bonner, Benewah, Kootenai, and Shoshone Counties. Additional counties were affected by the rains.
March 1997	Severe Storms, Snowmelt, Land/Mud Slides, Flooding (DR-1177)	Benewah, Bonner, Boundary, Kootenai	In early March 1997, northern Idaho received 12 to 18 inches of snow on top of an existing snow pack that exceeded 150 to 170 percent of the average. A subsequent rainstorm caused a rapid snowmelt. The resulting mudslides and flooding lasted for an extended period and damaged many public facilities, including county road systems. The President issued a Federal Disaster declaration (DR-1177) for flooding on June 13, 1997, for Boundary, Bonner, Benewah, Kootenai, and Shoshone Counties.
May 4, 1998	Landslide	Lemhi, Nez Perce, Washington	A landslide that began on May 4, 1998, blocked Snake River Avenue in Lewiston, restricting access to some businesses. A second slide on May 13 destroyed a mobile home and caused an additional road closure. The Lewiston Elks Temple was also threatened by ongoing slide activity in the vicinity. Total public costs for this event are estimated at just under $4.5 million; approximately $4 million for Idaho Transportation Department and $485,000 for Nez Perce County.
October 19, 1998	Landslide	Boundary	On October 19, 1998, a mudslide covered Highway 95, 1 mile north of Bonner's Ferry. Additional sliding the next day caused extensive damage to the State highway, a county road, and 1,000 feet of Union Pacific Railroad tracks. The blockage kept emergency medical and fire services from half the county. Truck traffic was rerouted 112 miles around the slide, and up to five trains were stranded each day. The Governor declared a disaster (due to economic impact).
Summer 1999	Landslide	Twin Falls	The Bluegill Landslide (near Buhl on Salmon Falls Creek, 5 to 10 miles from its confluence with the Snake River) was identified during the summer of 1999, when local rock climbers noted changes in the bedrock cliffs, an unusual amount of rock fall, and fractures opening up on the trail. Subsequently, a 12-acre block of canyon rim composed of basalt and sediments began sliding into Salmon Falls Creek. This ongoing slide activity threaten irrigation pumping stations and generate flood risks to upstream and downstream development.
January 30, 2000	Landslide	Kootenai	A major landslide on January 30, 2000, blocked the only access road to Ravens Point (near Bayview). A second rockslide two days later exacerbated the problem. Access to 75 homes was cut off. Kootenai and Bonner counties, Timber Lakes Fire District, and Lakes Highway District provided essential services. Residents shared personal resources and maintained communication through a specially designed Web page. A 65-passenger ferry was leased for travel to

Date(s) of Event	Event Type	Counties Affected	Description
			and from Bayview. Governor Kempthorne and the Legislature authorized up to $725,400 for BHS to reimburse local agencies. The NRCS provided much-needed Federal assistance in stabilizing the banks above the lake and removing road blockage. The State paid the non-Federal match required by NRCS. The request for a Presidential disaster declaration was not approved.
January 15, 2006	Landslide	Kootenai	On January 15, 2006, a landslide was caused by construction on U.S. Highway 95, north of Worley. It resulted in approximately $7,500 in damages to the project.
March 2011	Landslide, Flooding, Mudslides (DR-1987)	Bonner, Clearwater, Idaho, Nez Perce, Nez Perce Tribe, Shoshone	On May 6, 2011, Governor C.L. "Butch" Otter requested a major disaster declaration due to flooding, landslides, and mudslides during the period of March 31 to April 11, 2011. The Governor requested a declaration for Public Assistance for six counties and one Tribe and Hazard Mitigation statewide. On May 20, 2011, President Obama declared that a major disaster exists in the State of Idaho. This declaration made Public Assistance requested by the Governor available to State, Tribal, and eligible local governments and certain private nonprofit organizations on a cost-sharing basis for emergency work and the repair or replacement of facilities damaged by the flooding, landslides, and mudslides. This declaration made Public Assistance requested by the Governor available to State, Tribal, and eligible local governments and certain private nonprofit organizations on a cost-sharing basis for emergency work and the repair or replacement of facilities damaged by the flooding, landslides, and mudslides in Bonner, Clearwater, Idaho, Nez Perce, and Shoshone Counties and the Nez Perce Tribe. This declaration made Hazard Mitigation Grant Program assistance requested by the Governor available for hazard mitigation measures statewide.
May – June 2013	Landslide	Gem	The State of Idaho Transportation Department (ITD) maintenance crews have been cleaning up debris from a sandstone ledge under a large canal on State Highway 52. The ledge has been falling apart for some time and the quantity of material required non-stop attention. The roadway was closed in June. The uncontrolled debris threatened public safety, canal stability, communication lines, transportation, economy, and infrastructure. Gem County was declared a disaster area on June 6, 2013 and ITD set up barriers and restricted traffic to one lane on the highway. Testing revealed water seepage from canal but has not been conclusively determined to cause the landslide. The canal was drained and will be relined.
August 4, 2014	Landslide, Severe Weather	Elmore	State Disaster Proclamation ID-01-2014
February 12, 2016	Landslide	Idaho	State Disaster Proclamation ID-01-2016 for HWY 14 Landslide
March 2016	Landslide	Ada	Cracks started appearing in homes in the Terra Nativa subdivision north of Table Rock recreation area and just south of Table Rock road in Boise. An investigation revealed that the ground under the homes was shifting slowly downhill.

Date(s) of Event	Event Type	Counties Affected	Description
			A half-dozen homes on Alto Via Court have been abandoned, and the owners are suing the city of Boise, Terra Nativa's developers and engineers who worked on the project.
March 6, 2017	Landslides, Severe Storms, Flooding, Mudslides (DR-4313)	Benewah, Bonner, Boundary, Clearwater, Idaho, Kootenai, Latah, Shoshone, Valley	State Disaster Proclamation ID-03-2017 and federal DR-4313 for flooding, landslides and avalanches that caused over $9 million in losses. The northern panhandle counties received persistent rainfall and snowmelt that caused widespread flooding, landslides, water over roads, damaged levees and flooding of homes and basements.
May 6, 2017	Landslides, Mudslides, Flooding (DR-4333)	Blaine, Camas, Custer, Elmore, and Gooding	State Disaster Proclamation ID-05-2017 Spring flooding and federal DR-4333 that caused over $3 million in losses. Landslides caused highways to be blocked. In particular, State Highway 3 between Kendrick and Juliaetta was blocked.

Sources: FEMA 2017; Idaho State HMP 2013

FEMA Disaster Declarations

Between 1954 and 2017, FEMA declared that Idaho experienced five landslide-related disasters (DR) as a combination of the following disaster types: severe storms, snowmelt, flooding, and mudslides. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. However, not all counties experienced landslides that were included in the disaster declarations as determined by FEMA (FEMA 2017).

Based on all sources researched, known landslide events that have affected Idaho and were declared a state and/or FEMA disaster, are identified in Table 3.7.H. This table provides information on the disaster declarations for landslides, including date of event, state disaster declaration, federal disaster declaration and disaster number, and counties affected. Figure 3.7.I illustrates the number of FEMA-declared disasters by county.

Table 3.7.H. Landslide State and Federal Declarations (2011 to 2017)

Year	Date	State	Federal	Counties Affected
1996	November 1996	X	DR-1177	Adams, Benewah, Boise, Bonner, Boundary, Camas, Clearwater, Elmore, Gem, Idaho, Kootenai, Latah, Nez Perce, Owyhee, Payette, Shoshone, Valley, Washington
1997	March 1997	X	DR-1154	Benewah, Bingham, Bonner, Bonneville, Boundary, Butte, Custer, Fremont, Jefferson, Kootenai, Madison, Shoshone
2011	March 31, 2011	X	DR-1987	Bonner, Clearwater, Idaho, Nez Perce, Nez Perce Tribe, Shoshone
2014	August 4, 2014	ID-01-2014	none	Elmore
2016	February 12, 2016	ID-01-2016	None	Idaho
2017	March 6, 2017	ID-03-2017	DR-4313	Benewah, Bonner, Boundary, Clearwater, Idaho, Kootenai, Latah, Shoshone, Valley
	May 6, 2017	ID-05-2017	DR-4333	Blaine, Camas, Custer, Elmore, and Gooding

State Disasters

Bonner County, 1991: The damaging event that occurred near Sandpoint in April 1991 illustrates the somewhat confusing continuum between flash floods and debris flows. Although classified in the State declaration as a flash flood, the high debris load makes it indistinguishable from a debris flow. The torrents blew out large sections of the road leading to Schweitzer Basin ski area, stranding dozens of people; contaminated the city's primary water supply; and heavily damaged the water treatment facility. The cost to clean out and repair the water treatment facility was several hundred thousand dollars.

Norht and Central Idaho (Lower Banks), 1996: During late December 1996, above-normal snowfall in Northern and Central Idaho was quickly followed by significant amounts of warm rain. The melting snow and heavy rains overwhelmed rivers and their tributaries, leading to widespread landslides and severe flooding, mainly in the West-Central region of the State. Large sections of the highway system were damaged or destroyed, isolating several communities for days. Six deaths and three serious injuries were attributed to this disaster.

Massive landslides and floods occurred in the Payette, Weiser, and Little Salmon river basins, causing extensive damage to structures, roads, and bridges. Boise County in particular experienced substantial landslide damage. Numerous soil failures on saturated faces of hillsides resulted in major landslides and mud flows. Numerous small landslides obstructed culverts, flowed over roads, and caused undercutting on the downhill side. Numerous debris flows throughout Western Idaho caused extensive damage. Deposits left by these flows were several feet deep and up to 300 feet wide, and they overwhelmed the 1- to 3-foot culverts designed to pass rainfall runoff. Several gulches had significant slides that overwhelmed structures built on the alluvial fans of debris flow. A massive debris flow that hit the community of Lower Banks flowed down from an area burned over in 1992. The slide deposited mud, rocks, and debris at the base of the slope and expanded to cover the whole community. Most buildings (residential and business) appeared to be damaged or destroyed. Buildings were moved from their foundations and submerged in mud up to two-thirds of the buildings' height. Many public facilities were damaged or destroyed. From Horseshoe Bend to Banks, access to U.S. Highway 55 was restricted for one week. Several slides occurred in a half-mile section near Banks, with the largest estimated at 100,000 cubic yards. Highways 17 and 21 were closed by landslides, isolating the communities of Lowman and Garden Valley. On Old Idaho 17 there were miles of highway with landslides every 200-500 feet. U.S. 95 experienced 11 washouts that isolated residents for days, and McCall was isolated and suffered economic hardship due to the disruption of its winter recreation activities. Local roads and forest access were likewise affected. Mudslides destroyed much of the 6,000-mile road system in the Boise National Forest, threatening fisheries and access to popular recreation areas in the spring.

On January 4, 1997, the President declared a major disaster (designated as DR-1154) in the State of Idaho, 18 counties were declared eligible for Federal assistance. As of February 1, 2001, this funding included $19,404,105 in public assistance, $39,988 in individual assistance, $125,937 from the NRCS, $576,314 from the U.S. Army Corps of Engineers, and $5,593,892 in hazard mitigation grants. Much of the impact of these landslides occurred on virtually unpopulated public and private lands managed by the Forest Service, Bureau of Land Management, Idaho Department of Lands, and Boise Cascade Corporation.

In addition to infrastructure damage (e.g., forest roads), the impact included a large input of sediment and woody debris into stream channels. The increased sediment in the stream channels affected fish habitat. Based on past studies, it is suspected that road construction played a large role in the origin of these slides. Recent wildfires may also have played a role in the extent and severity of the landslide by reducing root strength, reducing transpiration by plants, and increasing runoff due to reduced infiltration.

Boundary County, 1998: On October 19, 1998, a mudslide covered Highway 95, 1 mile north of Bonner's Ferry. Additional sliding the next day caused extensive damage to the State highway, a county road, and 1,000 feet of Union Pacific Railroad tracks. The blockage kept emergency medical and fire services from half the county. Truck traffic was rerouted 112 miles around the slide, and up to five trains were stranded each day. The Governor declared a disaster (due to economic impact).

Nez Perce County, 1998: A landslide that began on May 4, 1998, blocked Snake River Avenue in Lewiston, restricting access to some businesses. A second slide on May 13 destroyed a mobile home and caused an additional road closure. The Lewiston Elks Temple was also threatened by ongoing slide activity in the vicinity. Total public costs for this event are estimated at just under $4.5 million, approximately $4 million for Idaho Transportation Department and $485,000 for Nez Perce County.

Kootenai County, 2000: A major landslide on January 30, 2000, blocked the only access road to Ravens Point (near Bayview). A second rockslide two days later exacerbated the problem. Access to 75 homes was cut off. Kootenai and Bonner counties, Timber Lakes Fire District, and Lakes Highway District provided essential services. Residents shared personal resources and maintained communication through a specially designed Web page. A 65-passenger ferry was leased for travel to and from Bayview.

Governor Kempthorne and the Legislature authorized up to $725,400 for IOEM to reimburse local agencies. The NRCS provided much-needed Federal assistance in stabilizing the banks above the lake and removing road blockage. The State paid the non-Federal match required by NRCS. The request for a Presidential disaster declaration was not approved.

Other Landslide Events

Warm Springs Mesa Landslide, Boise, 1973 -/+ "Of all the inactive landslides mapped, the Warm Springs Mesa Landslide is by far the largest. It has a surface area greater than 300 acres and the volume is roughly calculated to be 30 million cubic yards. The slide mass moved toward the southwest, a minimum distance of about 1200 feet. The toe of the slide rises 180 feet above the Boise River and projects out onto the flood plain creating an obvious anomaly in the alignment of bluffs along the north side of the valley" (Holenbaugh 1973 - http://digital.boisestate.edu/cdm/ref/collection/p15948coll4/id/352). The Warm Springs Mesa area continues to have issues with failing slopes, primarily in boulders closing residential roads.

Hat Creek Landslide, 1974: Hat Creek Landslide, located on U.S. Highway 95 near the town of Pollock, Idaho, started moving on January 27, 1974. The slide closed U.S. Highway 95 and the toe impinged into the Little Salmon River. The slide was about 2,300 by 500 feet and involved about one million cubic yards of material. Investigation and analysis centered around four alternatives: complete removal, lower slide removal, upper slide removal, and stabilization of the upper slide with groundwater control. The stabilization of the upper slide by groundwater control was selected as the most cost-effective alternative. A construction dewatering system, consisting of 45 eductor well points, was installed to provide a stable trench excavation. A drain trench, 700+ feet long, was constructed across the head of the slide. The drain trench contained 6-inch perforated pipe and 10-inch collector drainpipe covered by 4-1/2 feet of filter material. The stabilization work was completed in November 1977 and realignment of U.S. Highway 95 in the fall of 1978 for a total cost of $770,000.

Hagerman Fossil Beds National Monument, 1979+: A series of major landslides has struck the plateau along the Snake River located in Hagerman Fossil Beds National Monument since 1979. These large slope failures have occurred approximately every two years, and typically affect areas ranging from 300 to 800 feet wide and up to 1,000 feet long. The 1987 event destroyed a $1 million irrigation pumping facility and nearly killed two workers.

Gooding County, 1993: On July 24, 1993, approximately 100 acres of ground failed and slid into the Snake River just south of Bliss. The river was temporarily dammed, and a new set of rapids was created. The access road on the south side of the river was destroyed. The initial slide and subsequent erosion of the toe introduced a large amount of sediment into the river. The landslide site shows extensive evidence of earlier activity.

Twin Falls County, 1999+: The Bluegill Landslide (near Buhl on Salmon Falls Creek, 5 to 10 miles from its confluence with the Snake River) was identified during the summer of 1999, when local rock climbers noted changes in the bedrock cliffs, an unusual amount of rock fall, and fractures opening up on the trail. Subsequently, a 12-acre block of canyon rim composed of basalt and sediments began sliding into Salmon Falls Creek. This ongoing slide activity may threaten irrigation pumping stations and generate flood risks to upstream and downstream development. The slide is still active and moving.

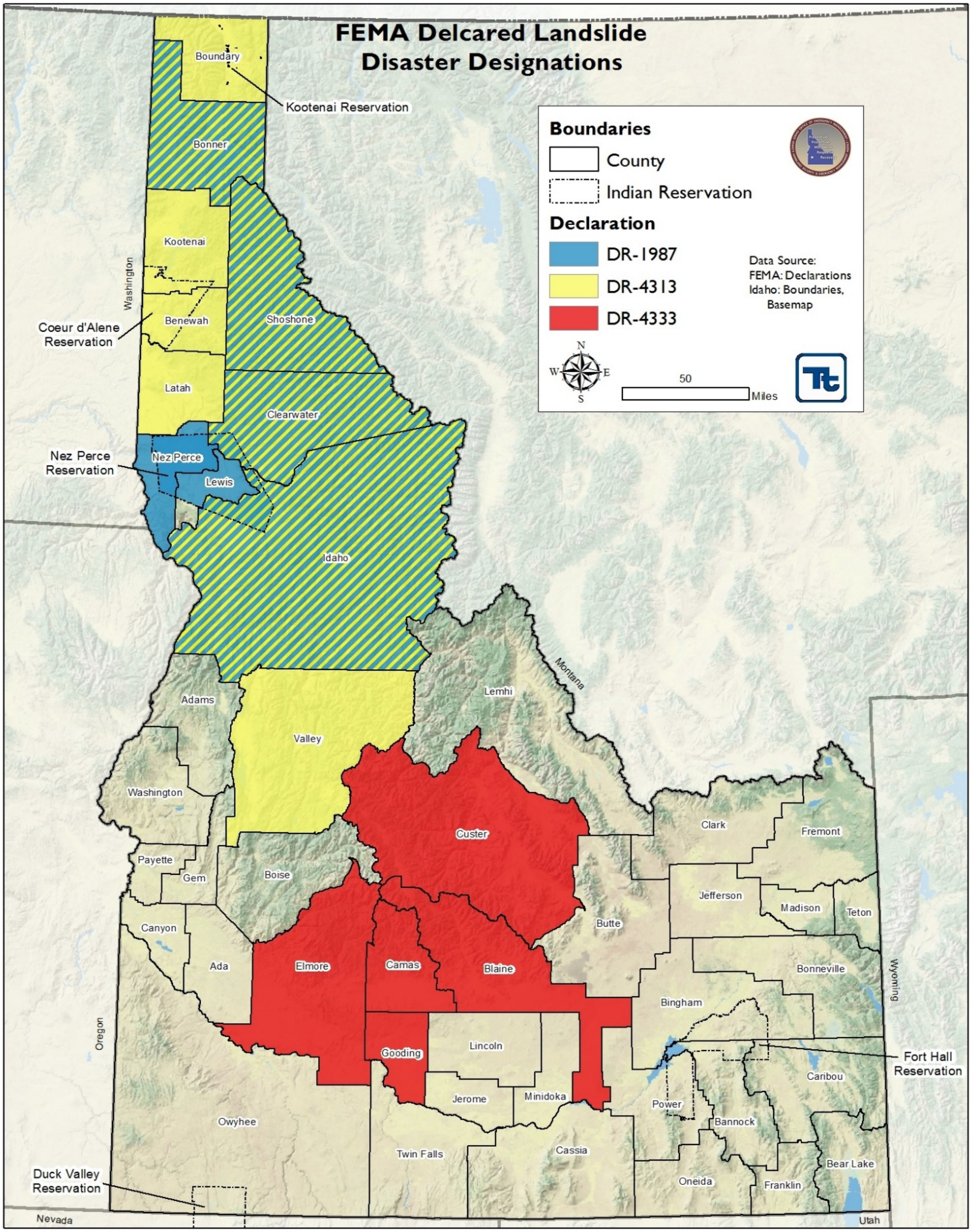
Kootenai County, 2006: On January 15, 2006, a landslide was caused by construction on U.S. Highway 95, north of Worley. It resulted in approximately $7,500 in damages to the project.

Terra Nativa, Boise Foothills, Boise, 2016: Cracks started appearing in homes in the Terra Nativa subdivision north of Table Rock recreation area and just south of Table Rock road in Boise. An investigation revealed that the ground under the homes was shifting slowly downhill. A half-dozen homes on Alto Via Court have been abandoned, and the owners are suing the city of Boise, Terra Nativa's developers and engineers who worked on the project. This is still ongoing and no official damage assessment has been completed.

At least one home in Terra Nativa's third phase has been condemned and most people who once lived there have moved out. Damage caused by shifting ground has forced families to abandon homes in the Foothills development. **Sven Berg** - sberg@IdahoStatesman.com

Source: http://www.idahostatesman.com/news/local/community/boise/article85521032.html

Figure 3.7.I. FEMA Disaster Declarations in Idaho



Future Occurrence

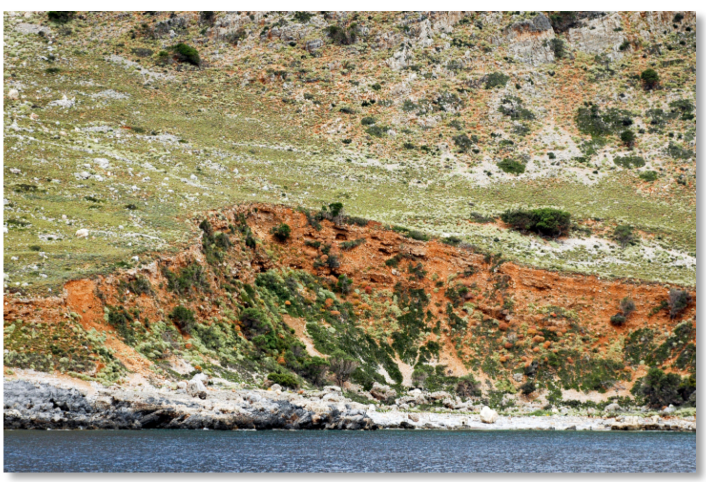
Landslides are often triggered by other natural hazards such as earthquakes, heavy rain, floods or wildfires, so landslide probability is often related to the frequency of these other hazards. They typically occur during and after major storms, so the landslide potential largely coincides with the potential for sequential severe storms that saturate steep, vulnerable soils. Until better data is generated specifically for landslide hazards, this severe storm frequency is appropriate for the purpose of ranking risk associated with the landslide hazard.

Landslides are most likely during periods of higher than average rainfall. The ground must be saturated prior to the onset of a major storm for significant landslides to occur.

The geophysical processes that contribute to landslides during a particular year are statistically independent of past events. Unfortunately, the short period of recorded and observed landslides and associated conditions that contribute to the risk make it difficult to develop return periods for landslide-prone areas in Idaho. Landslide occurrence is not directly attributed to a specific major meteorological event, such as the 1-percent-annual-chance or 100-year snowfall; though rainfall events are one known cause of events.

Environmental Impacts

Landslides have minor environmental impacts compared to several other hazards discussed in this document, but more than avalanches, which have the buffering effects of snow cover. Impacts to the natural environment due to landslides are generally localized in nature. The impacts do not tend to travel beyond the confines of the event, as compared to the potential effects from hazardous material leaks or volcanic ash fall. An exception to this would be seiche effects in a lake due to landslide, where bank vegetation and other resources could be impacted relatively far from the initial event.



Landslides can cover vegetative communities, destroying habitat; however, it is unlikely that the continued existence of rare species or vegetative communities would be jeopardized by landslide, because of the localized nature of the hazard. There is potential for unique historic and archeological resources to be damaged or lost. With respect to geology and soils, landslides can change topography and remove topsoil, but farmland soils are not usually located in the steeper areas where landslides are more common. Landslides have the potential to alter floodplains and drainage patterns. In addition, debris can form dams, causing flooding upstream and disrupting the aquatic habitat.

Climate Change Impacts

Climate change may influence storm patterns, increasing the probability of more frequent, intense storms with varying duration. Increase in global temperature is likely to affect the snowpack and its ability to hold and store water. Warming temperatures also could increase the occurrence and duration of droughts, which would increase the probability of wildfire, reducing the vegetation that helps to support steep slopes. All of these factors would increase the probability for landslide occurrences.

Development Trend Impacts

An understanding of population and development trends can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The State considered the following factors to examine previous and potential conditions that may affect hazard vulnerability: potential or projected development; projected changes in population; and other identified conditions as relevant and appropriate.

The U.S. EPA's Integrated Climate and Land-Use Scenarios (ICLUS) project generated projected population and land use projections for the United States through 2100. The project examined multiple scenarios taking into account various population growth and economic development parameters that have been used as the baseline for the Intergovernmental Panel on Climate Change's (IPCC) Special Report on emissions Scenarios (SRES). Population change took into account assumptions regarding fertility, mortality, and immigration, which was then used to drive the land use projections. The SRES provides two development scenarios: economic development (A) and environmentally-driven development (B), where the A scenario will result in more sprawled development, and the B scenario will result in more compact developments close to the existing urban centers. Additionally, the model scenarios included parameters for global development (1) and regional development (2) (EPA, 2013). The model estimated projections for each decade from 2010 to 2100.

The ICLUS scenario 'A2' was selected to examine if changes in land use and housing density estimates from 2010 to 2020 are projected in the wildfire hazard area. The 2010 data was used as a baseline to determine if any changes in development by 2020 may result in increases or decreases in the hazard area. The resulting housing density and land use categories are defined as follows: Urban, which equates to 0.25 acres/unit; Suburban, which equates to 0.25 to 2 acres/unit; Exurban, which equates to 2 to 40 acres/unit; Rural, which equates to 40 acres/unit; Commercial and Industrial.

Table 3.7.J lists the estimated land-use area (square miles) located in the identified landslide hazard area for 2010 and projected area for 2020 by jurisdiction. Map 2.F. in Chapter 2 (State Profile) displays the projected population growth by 2026. Changes in land-use are seen in the exurban and rural categories. Overall, 0.4 square miles of exurban area is projected to be developed into the landslide hazard area by 2020, with the greatest additions in Custer County. As for rural land, statewide there is a projected decline of approximately 1.3 square miles of land. This decline is the greatest in Caribou County, where a reduction of 0.5 square miles of rural land is projected; these changes coincide with the increase in higher housing densities, which will place a greater number of people in the hazard area.

Table 3.7.J. Projected Development Change from 2010 to 2020 in the Landslide Hazard Area (square miles)

Jurisdiction	Urban			Suburban			Exurban			Rural			Commercial/ Industrial		
	2010	2020	Change	2010	2020	Change	2010	2020	Change	2010	2020	Change	2010	2020	Change
Ada County	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.0	0.0	0.0	0.0
Blaine County	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.6	0.0	3.5	3.5	0.0	0.0	0.0	0.0
Boise County	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.7	38.7	0.0	0.0	0.0	0.0
Butte County	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0
Caribou County	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	-0.1	11.7	11.2	-0.5	0.0	0.0	0.0
Clark County	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	48.1	48.1	0.0	0.1	0.1	0.0
Custer County	0.0	0.0	0.0	0.5	0.5	0.0	8.0	8.2	0.2	50.1	49.9	-0.2	0.4	0.4	0.0
Duck Valley Tribe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.7	5.4	-0.3	0.0	0.0	0.0
Elmore County	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.6	0.0	8.9	8.9	0.0	0.0	0.0	0.0
Idaho County	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	16.3	16.3	0.0	0.0	0.0	0.0
Lemhi County	0.0	0.0	0.0	0.1	0.1	0.0	1.3	1.3	0.0	18.1	18.1	0.0	0.0	0.0	0.0
Owyhee County	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	1.4	-0.2	0.0	0.0	0.0
Teton County	0.0	0.0	0.0	0.0	0.0	0.0	3.5	3.6	0.1	7.0	6.8	-0.2	0.0	0.0	0.0
Twin Falls County	0.0	0.0	0.0	0.0	0.0	0.0	2.3	2.3	0.0	20.1	20.1	0.0	0.0	0.0	0.0
Idaho Total	**0.0**	**0.0**	**0.0**	**0.7**	**0.7**	**0.0**	**16.5**	**16.9**	**0.4**	**230.3**	**229.0**	**-1.3**	**0.5**	**0.5**	**0.0**

Source: EPA 2013, USGS 2001

Notes: Projected development includes changes in housing density and land use. Only the counties located in the landslide hazard area are listed.

Areas directly affected by wildfire and those located below or downstream of burn areas are most at risk for mud flows. Human development within forested areas has increased the risk to life and property as a result to wildfire, which can in turn increase risk to landslides. According to the USGS, post-fire landslide hazards include fast-moving, highly destructive debris flows in years following a wildfire event due to heavy rainfall events; they can occur with little warning, can exert great impulsive loads on objects in their paths, damage structures, and endanger human life (USGS).

A known area of landslide concern for development is the Boise Foothills area. The Terra Nativa subdivision north of Table Rock recreation area and just south of Table Rock road in Boise is evidence of this, as cracks started appearing in homes, roads, and sidewalks in this neighborhood, causing development to halt and many families to evacuate as the ground under the homes was shifting slowly downhill.

Analysis of historical data indicates relatively little damage to structures and does not indicate that development causes more structures to be destroyed by landslides. Past events have impacted transportation corridors, often limiting access to communities for a short time. This needs to be taken into account as development occurs, and possible mitigation measures should be considered. Overall, any development within known or suspected landslide areas will increase the potential for future impacts.

Vulnerability Assessment

Critical Infrastructure and State Facility Impacts

A statewide landslide analysis was conducted using best available data for the State of Idaho. This section discusses statewide vulnerability of areas susceptible to landslides and potential losses to state assets (State owned and leased buildings) and critical facilities. The identified landslide hazard area are areas of 'High Incidence' or High Incidence/Moderate Susceptibility as defined by the USGS (refer to Figure 3.7.O and Figure 3.7.P). The data was derived using areas in the conterminous US where large numbers of landslide have occurred and areas which are susceptible to landslide (USGS 2001). To assess the State's exposure to the landslide hazard, a spatial analysis was conducted to determine if State-owned and leased facilities are located in the landslide hazard area. Using ArcGIS software, the landslide hazard layer was overlaid with the State asset inventory to determine the number of State facilities exposed and potentially vulnerable.

Major highways, railways, and power/communication transmission lines would be the State assets most impacted by a landslide event. Generally, State facilities are not located in known landslide paths; although a wildfire event could expose new areas to this hazard. Such potential damage, while significant, cannot be forecasted.

Landslides are essentially localized events. Establishing the likelihood and potential magnitude of events at specific sites requires detailed site analysis and can be a time-consuming and expensive process. It is therefore extremely difficult to generate a statewide projection of future landslide activity and disasters. Some generalizations may be made, however, and geologists and planners can identify zones of potential landslide hazard based on geology, topography, and climate through broad-brush analyses. The geology of the central, western, and Panhandle regions of the State lends itself to landslide-prone terrain. Large and damaging landslides may be expected to continue to occur. Most landslide-prone areas have steep slopes of significant length. Although these characteristics are often associated with the mountainous areas of the State, occurrences may be found throughout the State. Even in the relatively flat Snake River Plain and Owyhee County regions, numerous landslides occur along the near-vertical walls of deeply incised river canyons.

Many landslides are associated with precipitation events and/or saturated soils. Throughout the State, these conditions may be expected to occur in the winter (heavy rain storms), spring (during snow melt), or summer (significant thunderstorms). In the evaluation of local sites, the conditions that lead to landslides are generally understood and predictable. The factors contributing to landslides described above (natural factors, human activities, and landslide triggers) should all be considered when evaluating hazards.

Additionally, significant damage often occurs in areas that show evidence of past landslides. An evaluation of past activity can be a powerful projection tool. Landslides may be expected to occur throughout the State, where local conditions are favorable. However, these events generally only have disastrous consequences when they occur in populated areas or intersect infrastructure such as highways. Consequently, the mountainous areas of the State are most at risk from future landslide activity. In these areas, a considerable number of communities, transportation systems, and supporting infrastructure are located in steep canyons and alluvial fans close to rivers. Development of forest and mineral resources has also resulted in the construction of roads in steep and potentially unstable terrain. Recent population growth has caused development to occur more frequently in hazardous areas. This trend is expected to continue in the near future.

For the purposes of this risk assessment, an asset is considered potentially vulnerable if it is located in an identified hazard area. To assess the vulnerability of the State-owned and -leased facilities, geographic information system (GIS) software was used to overlay the landslide hazard area with the State-owned and –leased buildings and critical facilities. Tables 3.7.K and 3.7.L summarize the State-owned and -leased facilities located in the landslide hazard area by county and Tribal Nation, and state agency, respectively. Table 3.7.M summarizes the total number of critical facilities located in the landslide hazard area by county and Tribal National. Refer to Figure 3.7.O which illustrates the assets located within the landslide hazard area in the State.

The spatial analysis indicates that two State-owned buildings are located within in the defined hazard area. Both facilities are owned by the Department of Fish Game; one is located in Lemhi County and the other is located in Teton County. At the county level, Custer County has the greatest number of critical facilities located in the landslide hazard area (29 facilities).

Table 3.7.K. Number of State-Owned and Leased Buildings Located in the Landslide Hazard Area by Jurisdiction

	State-Owned Buildings		State-Leased Buildings		Total Number of State-Owned and Leased Buildings	
Jurisdiction	Number in the Landslide Hazard Area	Value in the Landslide Hazard Area	Number in the Landslide Hazard Area	Value in the Landslide Hazard Area	Total Number	Total Value
Ada County	0	$0	0	$0	589	$2,989,418,989
Adams County	0	$0	0	$0	3	$1,783,594
Bannock County	0	$0	0	$0	156	$1,103,616,221

Jurisdiction	State-Owned Buildings		State-Leased Buildings		Total Number of State-Owned and Leased Buildings	
	Number in the Landslide Hazard Area	Value in the Landslide Hazard Area	Number in the Landslide Hazard Area	Value in the Landslide Hazard Area	Total Number	Total Value
Bear Lake County	0	$0	0	$0	5	$735,496
Benewah County	0	$0	0	$0	1	$2,749,464
Bingham County	0	$0	0	$0	90	$77,767,107
Blaine County	0	$0	0	$0	22	$5,902,697
Boise County	0	$0	0	$0	17	$2,887,850
Bonner County	0	$0	0	$0	64	$15,374,769
Bonneville County	0	$0	0	$0	55	$128,187,998
Boundary County	0	$0	0	$0	10	$2,921,183
Butte County	0	$0	0	$0	0	$0
Camas County	0	$0	0	$0	0	$0
Canyon County	0	$0	0	$0	217	$150,244,776
Caribou County	0	$0	0	$0	15	$2,277,825
Cassia County	0	$0	0	$0	28	$3,167,401
Clark County	0	$0	0	$0	2	$71,311
Clearwater County	0	$0	0	$0	6	$258,189
Coeur D'Alene Tribe	0	$0	0	$0	21	$8,410,014
Custer County	0	$0	0	$0	19	$2,331,691
Duck Valley Tribe	0	$0	0	$0	0	$0
Elmore County	0	$0	0	$0	33	$8,637,861
Fort Hall Tribe	0	$0	0	$0	1	$4,546,934
Franklin County	0	$0	0	$0	7	$2,244,517
Fremont County	0	$0	0	$0	191	$59,931,586
Gem County	0	$0	0	$0	8	$1,846,444
Gooding County	0	$0	0	$0	88	$49,454,311
Idaho County	0	$0	0	$0	27	$21,047,034
Jefferson County	0	$0	0	$0	50	$19,079,527
Jerome County	0	$0	0	$0	18	$13,471,464
Kootenai County	0	$0	0	$0	71	$83,386,890
Kootenai Tribe	0	$0	0	$0	0	$0
Latah County	0	$0	0	$0	390	$1,497,479,249
Lemhi County	1	$37,238	0	$0	48	$11,258,674
Lewis County	0	$0	0	$0	0	$0
Lincoln County	0	$0	0	$0	20	$11,258,939
Madison County	0	$0	0	$0	4	$3,514,980
Minidoka County	0	$0	0	$0	9	$6,314,545
Nez Perce County	0	$0	0	$0	135	$305,323,161
Nez Perce Tribe	0	$0	0	$0	62	$26,895,878
Oneida County	0	$0	0	$0	2	$832,428
Owyhee County	0	$0	0	$0	12	$2,639,778

Jurisdiction	State-Owned Buildings		State-Leased Buildings		Total Number of State-Owned and Leased Buildings	
	Number in the Landslide Hazard Area	Value in the Landslide Hazard Area	Number in the Landslide Hazard Area	Value in the Landslide Hazard Area	Total Number	Total Value
Payette County	0	$0	0	$0	7	$3,405,151
Power County	0	$0	0	$0	33	$4,323,726
Shoshone County	0	$0	0	$0	8	$2,604,226
Teton County	1	$15,759	0	$0	27	$8,821,471
Twin Falls County	0	$0	0	$0	63	$86,924,836
Valley County	0	$0	0	$0	58	$9,575,027
Washington County	0	$0	0	$0	21	$2,024,672
Idaho Total	**2**	**$52,998**	**0**	**$0**	**2,713**	**$6,744,949,885**

Source: USGS 2001, Risk Management Technical Records
Value = Replacement cost value of the structure and contents

Table 3.7.L. Number of State-Owned and Leased Buildings Located in Landslide Hazard Area by Agency

Agency	State-Owned Buildings		State-Leased Buildings		Total Number of State-Owned and Leased Buildings	
	Number in the Landslide Hazard Area	Value in the Landslide Hazard Area	Number in the Landslide Hazard Area	Value in the Landslide Hazard Area	Total Number	Total Value
Administration - Department Of	0	$0	0	$0	16	$545,649,861
Blind Commission	0	$0	0	$0	1	$12,931,760
Board Of Pharmacy	0	$0	0	$0	1	$550,280
Boise State University	0	$0	0	$0	216	$1,478,845,528
Boise Veteran's Home	0	$0	0	$0	3	$35,009,037
Commission On The Arts	0	$0	0	$0	1	$178,978
Correctional Industries	0	$0	0	$0	4	$12,070,521
Dairy Products Commission	0	$0	0	$0	1	$2,302,604
Deaf And Blind School	0	$0	0	$0	17	$35,062,732
Department Of Agriculture	0	$0	0	$0	8	$19,838,429
Department Of Corrections	0	$0	0	$0	111	$566,639,088
Department Of Fish And Game	2	$52,998	0	$0	503	$106,038,567
Department Of Juvenile Corrections	0	$0	0	$0	196	$58,581,570
Department Of Labor	0	$0	0	$0	9	$46,110,479
Department Of Lands	0	$0	0	$0	115	$56,967,411
Department Of Parks And Recreation	0	$0	0	$0	242	$50,186,766

Agency	State-Owned Buildings		State-Leased Buildings		Total Number of State-Owned and Leased Buildings	
	Number in the Landslide Hazard Area	Value in the Landslide Hazard Area	Number in the Landslide Hazard Area	Value in the Landslide Hazard Area	Total Number	Total Value
Department Of Transportation	0	$0	0	$0	228	$160,342,438
Department Of Transportation-Aeronautics	0	$0	0	$0	3	$2,559,109
Department Of Water Resources	0	$0	0	$0	1	$160,000
Dept Of Health & Welfare, Region I	0	$0	0	$0	1	$612,067
Dept Of Health & Welfare, Region II	0	$0	0	$0	1	$1,842,609
Dept. Of Health & Welfare, Region V	0	$0	0	$0	2	$3,859,869
Dept. Of Health & Welfare, Region VI	0	$0	0	$0	3	$7,875,177
Eastern Idaho Technical College	0	$0	0	$0	8	$76,544,215
Historical Society	0	$0	0	$0	52	$61,850,665
Idaho Barley Commission	0	$0	0	$0	1	$10,506
Idaho Crop Improvement Association	0	$0	0	$0	5	$1,875,876
Idaho State University	0	$0	0	$0	118	$1,071,183,355
Idaho Wheat Commission	0	$0	0	$0	1	$888,285
IDHW - Bureau Of Laboratories	0	$0	0	$0	1	$19,366,868
IDHW - State Hospital North	0	$0	0	$0	14	$19,793,423
IDHW - State Hospital South	0	$0	0	$0	14	$50,573,434
IDHW - Welfare Medicaid Operations	0	$0	0	$0	1	$113,141
IDHW Southwest Idaho Treatment Center	0	$0	0	$0	31	$65,257,596
ISP - Idaho State Police	0	$0	0	$0	15	$74,050,639
Lava Hot Springs Foundation	0	$0	0	$0	10	$14,994,779
Lewis-Clark State College	0	$0	0	$0	41	$228,497,894
Lewiston Veteran's Home	0	$0	0	$0	2	$12,096,807
Lottery Commission	0	$0	0	$0	2	$14,665

Agency	State-Owned Buildings		State-Leased Buildings		Total Number of State-Owned and Leased Buildings	
	Number in the Landslide Hazard Area	Value in the Landslide Hazard Area	Number in the Landslide Hazard Area	Value in the Landslide Hazard Area	Total Number	Total Value
Military Division	0	$0	0	$0	70	$70,015,196
Pocatello Veteran's Home	0	$0	0	$0	4	$13,558,252
Public Employees Retirement System	0	$0	0	$0	2	$12,602,747
Public Health District 1 (Panhandle)	0	$0	0	$0	7	$17,949,011
Public Health District 2 (North Central)	0	$0	0	$0	5	$10,948,557
Public Health District 3 (Southwest)	0	$0	0	$0	5	$9,551,538
Public Health District 4 (Central)	0	$0	0	$0	3	$10,807,899
Public Health District 5 (South Central)	0	$0	0	$0	5	$8,898,081
Public Health District 6 (South Eastern)	0	$0	0	$0	3	$8,479,572
Public Health District 7 (Eastern)	0	$0	0	$0	9	$10,187,921
State Insurance Fund	0	$0	0	$0	2	$21,023,875
State Liquor Division	0	$0	0	$0	1	$14,451,435
University Of Idaho	0	$0	0	$0	590	$1,631,136,168
Veterans State Cemetery	0	$0	0	$0	8	$4,012,608
Total	**2**	**$52,998**	**0**	**$0**	**2,713**	**$6,744,949,885**

Source: USGS 2001, Risk Management Technical Records

Table 3.7.M. Number of County Critical Facilities Located in the Landslide Hazard Area by Jurisdiction

Jurisdiction	Total Count	Number of Facilities Located in the Landslide Hazard Area	Percent (%) of Total
Ada County	1,078	0	0.0%
Adams County	96	0	0.0%
Bannock County	513	0	0.0%
Bear Lake County	152	0	0.0%
Benewah County	67	0	0.0%
Bingham County	334	0	0.0%
Blaine County	320	0	0.0%
Boise County	157	0	0.0%
Bonner County	466	0	0.0%
Bonneville County	493	0	0.0%
Boundary County	206	0	0.0%
Butte County	80	0	0.0%

Jurisdiction	Total Count	Number of Facilities Located in the Landslide Hazard Area	Percent (%) of Total
Camas County	41	0	0.0%
Canyon County	961	0	0.0%
Caribou County	220	0	0.0%
Cassia County	272	0	0.0%
Clark County	66	1	1.5%
Clearwater County	114	0	0.0%
Coeur D'Alene Tribe	126	0	0.0%
Custer County	122	29	23.8%
Duck Valley Tribe	1	0	0.0%
Elmore County	374	3	<1%
Fort Hall Tribe	34	0	0.0%
Franklin County	207	0	0.0%
Fremont County	228	0	0.0%
Gem County	204	0	0.0%
Gooding County	216	0	0.0%
Idaho County	197	2	1.0%
Jefferson County	187	0	0.0%
Jerome County	236	0	0.0%
Kootenai County	758	0	0.0%
Kootenai Tribe	0	0	0.0%
Latah County	366	0	0.0%
Lemhi County	182	12	6.6%
Lewis County	0	0	0.0%
Lincoln County	129	0	0.0%
Madison County	173	0	0.0%
Minidoka County	196	0	0.0%
Nez Perce County	116	0	0.0%
Nez Perce Tribe	335	0	0.0%
Oneida County	111	0	0.0%
Owyhee County	252	0	0.0%
Payette County	267	0	0.0%
Power County	161	0	0.0%
Shoshone County	210	0	0.0%
Teton County	111	2	1.8%
Twin Falls County	761	1	0.1%
Valley County	314	0	0.0%
Washington County	241	0	0.0%
Idaho Total	**12,451**	**50**	**<1%**

Source: USGS 2001, ICRMP, HSIP, IOEM, IDWR

Table 3.7.N lists the miles of canals that located in the wildfire hazard area by County and Tribal Nation. Custer County has the greatest proportion of canals exposed (13.4%), while Twin Falls County has the greatest total mileage of canals located in the hazard area (24 mi.).

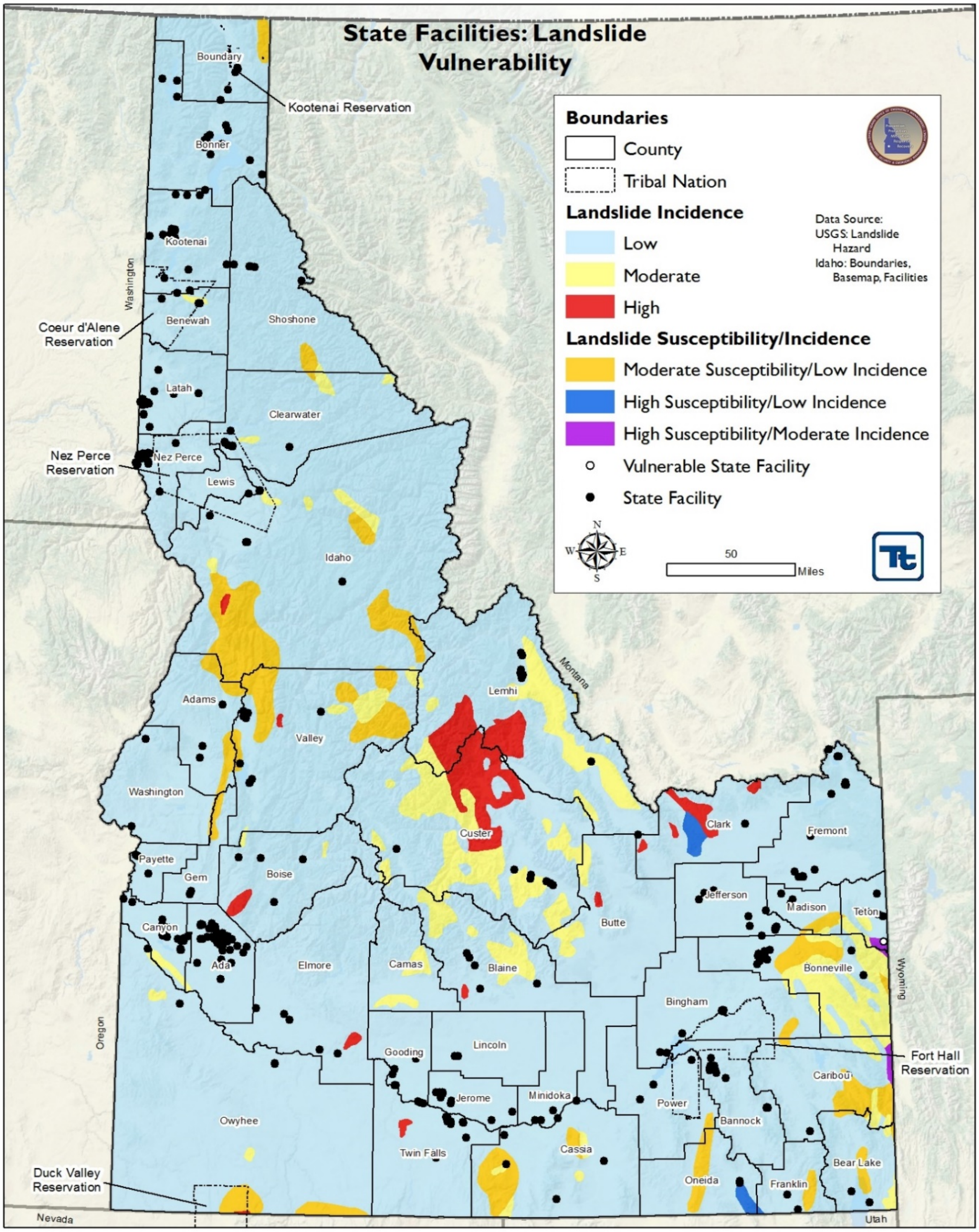
Table 3.7.N. Miles of Canals Located in the Landslide Hazard Area by Jurisdiction

Jurisdiction	Total Canal Length (miles)	Length of Canal in the Landslide Hazard Area (miles)	% of Total
Ada County	422.0	0	0.0%
Adams County	28.7	0	0.0%
Bannock County	92.6	0	0.0%
Bear Lake County	198.7	0	0.0%
Benewah County	0.0	0	0.0%
Bingham County	455.6	0	0.0%
Blaine County	114.5	0	0.0%
Boise County	10.6	0	0.0%
Bonner County	1.0	0	0.0%
Bonneville County	385.4	0	0.0%
Boundary County	72.0	0	0.0%
Butte County	166.9	0	0.0%
Camas County	4.9	0	0.0%
Canyon County	855.0	0	0.0%
Caribou County	168.2	1	<1%
Cassia County	625.1	0	0.0%
Clark County	66.9	1	1.3%
Clearwater County	0.0	0	0.0%
Coeur D'Alene Tribe	5.3	0	0.0%
Custer County	115.9	16	13.4%
Duck Valley Tribe	21.0	0	0.0%
Elmore County	197.2	15	7.6%
Fort Hall Tribe	201.7	0	0.0%
Franklin County	214.2	0	0.0%
Fremont County	366.2	0	0.0%
Gem County	117.2	0	0.0%
Gooding County	383.1	0	0.0%
Idaho County	22.0	0	0.0%
Jefferson County	401.0	0	0.0%
Jerome County	431.5	0	0.0%
Kootenai County	26.0	0	0.0%
Kootenai Tribe	6.8	0	0.0%

Jurisdiction	Total Canal Length (miles)	Length of Canal in the Landslide Hazard Area (miles)	% of Total
Latah County	0.0	0	0.0%
Lemhi County	111.2	4	3.7%
Lewis County	0.0	0	0.0%
Lincoln County	220.8	0	0.0%
Madison County	165.8	0	0.0%
Minidoka County	252.6	0	0.0%
Nez Perce County	1.6	0	0.0%
Nez Perce Tribe	10.0	0	0.0%
Oneida County	39.8	0	0.0%
Owyhee County	349.6	0	0.0%
Payette County	230.2	0	0.0%
Power County	57.7	0	0.0%
Shoshone County	0.0	0	0.0%
Teton County	82.3	8	9.4%
Twin Falls County	500.4	23	4.7%
Valley County	59.4	0	0.0%
Washington County	55.5	0	0.0%
Idaho Total	**8,315.6**	**68**	**<1%**

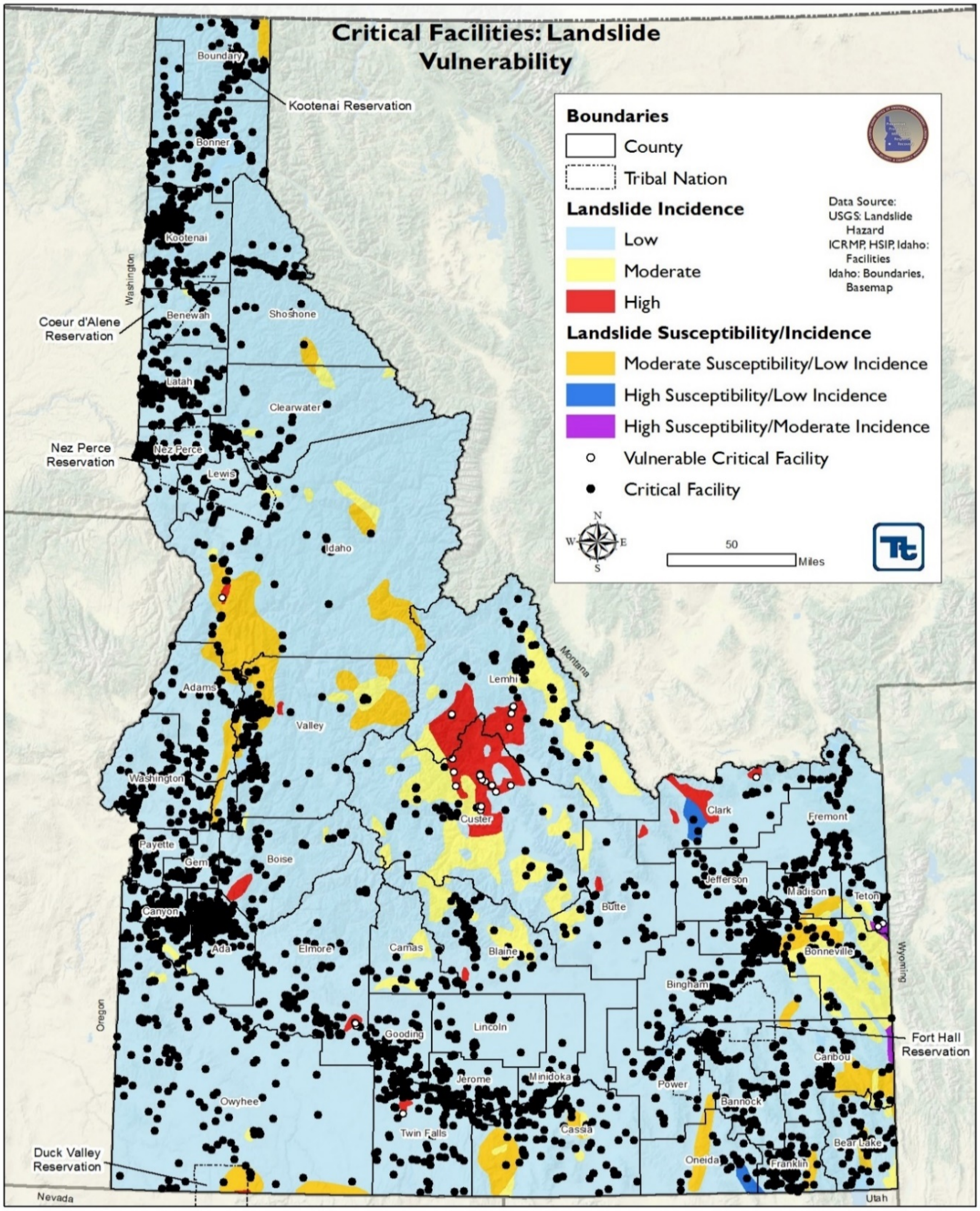
Source: IOEM, USGS 2001

Figure 3.7.O. State Facilities: Landslide Vulnerability



Note: A vulnerable facility means that the facility is located in the identified hazard area.

Figure 3.7.P. Critical Facilities: Landslide Vulnerability



Note: A vulnerable facility means that the facility is located in the identified hazard area.

Hazard Mitigation Vulnerability Assessments

Presidential Disaster DR-1987, which occurred in 2011, seems to have helped increase the visibility to this hazard, especially for those jurisdictions in the northern panhandle of the State.

Loss Estimation

No specific, statewide loss estimation exists for the hazard of landslide. Historical losses tend to be related to infrastructure damages more than to loss of life and injuries.

From a general perspective, landslides damage and destroy public, commercial, and private property. The resulting costs are for debris removal, stabilizations, restoration, maintenance, response, and post de facto litigation. Road and railroad closures are not uncommon. The economic costs of these disruptions can be significant, especially in areas with limited access options.

This section discusses the vulnerability of jurisdictions to areas susceptible to landslides. It provides a summary of vulnerability and potential losses to population and buildings by county and Tribal Nation and discusses the jurisdictions most threatened by the landslide hazard. Similar to the analysis for state assets, a spatial exposure analysis was conducted using the USGS Landslide data to determine the population (2010 U.S. Census) general building stock (default HAZUS-MH 4.0 dasymetric census block data) located in the hazard area Blocks with their centroid in the hazard area were deemed exposed and potentially vulnerable; these results are summarized below.

Population

Table 3.7.Q displays the total population located in the landslide hazard area. Custer County has the greatest count located in the landslide hazard area. Overall, less than 1% of the State’s total population is located in the landslide hazard area.

While all people located in the landslide hazard area are considered exposed and potentially vulnerable, populations considered most vulnerable include the elderly (persons over the age of 65) and individuals living below the United States Census poverty threshold. These socially vulnerable populations are most susceptible based on a number of factors including their physical and financial ability to react or respond during a hazard, the location and construction quality of their housing, and the ability to be self-sustaining for prolonged periods after an incident because of limited ability to stockpile supplies. The population over 65 makes up 9.2% of the total population of Custer County located in the hazard area, and approximately 5.8% of its total population is classified, as low income population is located within the hazard area as well. Chapter 2 (State Profile) summarizes the State’s demographics by Jurisdiction.

Table 3.7.Q. 2010 U.S. Census Population Located in the Landslide Hazard Area by Jurisdiction

Jurisdiction	Total Population	Population Located in the Landslide Hazard Area	Percent (%) of Total Population	Population Over 65 Located in the Landslide Hazard Area	Percent (%) of Total Population	Low Income Population Located in the Landslide Hazard Area	Percent (%) of Total Population
Ada County	392,365	0	0.0%	0	0.0%	0	0.0%
Adams County	3,976	0	0.0%	0	0.0%	0	0.0%
Bannock County	80,722	0	0.0%	0	0.0%	0	0.0%
Bear Lake County	5,986	0	0.0%	0	0.0%	0	0.0%
Benewah County	4,743	0	0.0%	0	0.0%	0	0.0%
Bingham County	42,775	0	0.0%	0	0.0%	0	0.0%
Blaine County	21,376	32	<1%	1	<1%	0	0.0%
Boise County	7,028	4	<1%	0	0.0%	0	0.0%
Bonner County	40,877	0	0.0%	0	0.0%	0	0.0%
Bonneville County	104,234	0	0.0%	0	0.0%	0	0.0%
Boundary County	10,858	0	0.0%	0	0.0%	0	0.0%
Butte County	2,891	0	0.0%	0	0.0%	0	0.0%
Camas County	1,117	0	0.0%	0	0.0%	0	0.0%
Canyon County	188,923	0	0.0%	0	0.0%	0	0.0%
Caribou County	6,963	13	<1%	2	<1%	0	0.0%
Cassia County	22,952	0	0.0%	0	0.0%	0	0.0%
Clark County	982	53	5.4%	14	1.4%	5	<1%
Clearwater County	3,038	0	0.0%	0	0.0%	0	0.0%
Coeur D'Alene Tribe	6,765	0	0.0%	0	0.0%	0	0.0%
Custer County	4,368	2,360	54.0%	400	9.2%	254	5.8%
Duck Valley Tribe	356	0	0.0%	0	0.0%	0	0.0%
Elmore County	27,038	150	<1%	27	<1%	3	<1%
Fort Hall Tribe	5,769	0	0.0%	0	0.0%	0	0.0%
Franklin County	12,786	0	0.0%	0	0.0%	0	0.0%
Fremont County	13,242	0	0.0%	0	0.0%	0	0.0%
Gem County	16,719	0	0.0%	0	0.0%	0	0.0%
Gooding County	15,464	0	0.0%	0	0.0%	0	0.0%
Idaho County	11,936	75	<1%	23	<1%	11	<1%
Jefferson County	26,140	0	0.0%	0	0.0%	0	0.0%
Jerome County	22,374	0	0.0%	0	0.0%	0	0.0%
Kootenai County	136,271	0	0.0%	0	0.0%	0	0.0%
Kootenai Tribe	114	0	0.0%	0	0.0%	0	0.0%
Latah County	37,244	0	0.0%	0	0.0%	0	0.0%

Lemhi County	7,936	330	4.2%	118	1.5%	82	1.0%
Lewis County	36	0	0.0%	0	0.0%	0	0.0%
Lincoln County	5,208	0	0.0%	0	0.0%	0	0.0%
Madison County	37,536	0	0.0%	0	0.0%	0	0.0%
Minidoka County	20,069	0	0.0%	0	0.0%	0	0.0%
Nez Perce County	34,664	0	0.0%	0	0.0%	0	0.0%
Nez Perce Tribe	18,440	0	0.0%	0	0.0%	0	0.0%
Oneida County	4,286	0	0.0%	0	0.0%	0	0.0%
Owyhee County	11,170	0	0.0%	0	0.0%	0	0.0%
Payette County	22,623	0	0.0%	0	0.0%	0	0.0%
Power County	6,997	0	0.0%	0	0.0%	0	0.0%
Shoshone County	12,765	0	0.0%	0	0.0%	0	0.0%
Teton County	10,170	789	7.8%	52	<1%	10	<1%
Twin Falls County	77,230	679	0.9%	88	<1%	32	<1%
Valley County	9,862	0	0.0%	0	0.0%	0	0.0%
Washington County	10,198	0	0.0%	0	0.0%	0	0.0%
Idaho Total	**1,567,582**	**4,485**	**<1%**	**725**	**<1%**	**397**	**<1%**

Source: US Census 2010, USGS 2001

General Building Stock

The general building stock inventory was overlaid with the landslide hazard area to assess the vulnerability. Table 3.7.R lists the number of buildings and total replacement cost by county and Tribal Nation located in the landslide hazard area. Overall, Custer County has the greatest building stock exposure to the landslide hazard area with 1,346 total buildings at an estimated $436 million in replacement cost value. Similar to population exposure, Custer County's general building stock located in the hazard area accounts for more than half of the potentially vulnerable statewide building stock.

Table 3.7.R. Estimated General Building Stock Located in the Landslide Hazard Area by Jurisdiction

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value	Number of Buildings Located in the Landslide Hazard Area	Percent (%) of Total Buildings	Value Located in the Landslide Hazard Area	Percent (%) of Total Value
Ada County	94,345	$67,917,280,000	0	0.0%	$0	0.0%
Adams County	2,824	$768,231,000	0	0.0%	$0	0.0%
Bannock County	16,672	$12,223,383,000	0	0.0%	$0	0.0%
Bear Lake County	3,911	$1,196,118,000	0	0.0%	$0	0.0%
Benewah County	2,456	$698,652,000	0	0.0%	$0	0.0%
Bingham County	6,206	$5,405,079,000	0	0.0%	$0	0.0%
Blaine County	12,602	$5,476,705,000	51	<1%	$14,202,000	<1%
Boise County	5,475	$1,497,585,000	5	<1%	$8,664,000	<1%

Bonner County	24,133	$7,701,597,000	0	0.0%	$0	0.0%
Bonneville County	21,966	$18,775,427,000	0	0.0%	$0	0.0%
Boundary County	5,112	$1,556,926,000	0	0.0%	$0	0.0%
Butte County	1,127	$452,406,000	0	0.0%	$0	0.0%
Camas County	762	$247,126,000	0	0.0%	$0	0.0%
Canyon County	25,059	$24,048,014,000	0	0.0%	$0	0.0%
Caribou County	2,880	$1,176,048,000	5	<1%	$1,193,000	<1%
Cassia County	1,389	$3,061,608,000	0	0.0%	$0	0.0%
Clark County	419	$124,419,000	17	4.1%	$7,647,000	6.1%
Clearwater County	2,028	$625,216,000	0	0.0%	$0	0.0%
Coeur D'Alene Tribe	3,651	$1,379,028,000	0	0.0%	$0	0.0%
Custer County	2,603	$987,374,000	1,346	51.7%	$435,828,000	44.1%
Duck Valley Tribe	52	$15,524,000	0	0.0%	$0	0.0%
Elmore County	954	$3,778,122,000	80	8.4%	$16,978,000	<1%
Fort Hall Tribe	250	$596,710,000	0	0.0%	$0	0.0%
Franklin County	4,943	$1,742,513,000	0	0.0%	$0	0.0%
Fremont County	8,810	$2,807,781,000	0	0.0%	$0	0.0%
Gem County	7,294	$2,308,168,000	0	0.0%	$0	0.0%
Gooding County	907	$1,934,143,000	0	0.0%	$0	0.0%
Idaho County	4,252	$2,057,570,000	76	1.8%	$18,079,000	<1%
Jefferson County	2,127	$3,163,139,000	0	0.0%	$0	0.0%
Jerome County	1,461	$2,620,168,000	0	0.0%	$0	0.0%
Kootenai County	50,322	$22,058,607,000	0	0.0%	$0	0.0%
Kootenai Tribe	50	$13,200,000	0	0.0%	$0	0.0%
Latah County	12,216	$5,264,747,000	0	0.0%	$0	0.0%
Lemhi County	4,833	$1,429,223,000	300	6.2%	$49,965,000	3.5%
Lewis County	34	$11,318,000	0	0.0%	$0	0.0%
Lincoln County	156	$629,652,000	0	0.0%	$0	0.0%
Madison County	4,371	$3,682,487,000	0	0.0%	$0	0.0%
Minidoka County	2,141	$2,594,005,000	0	0.0%	$0	0.0%
Nez Perce County	14,271	$6,382,936,000	0	0.0%	$0	0.0%
Nez Perce Tribe	8,389	$2,580,646,000	0	0.0%	$0	0.0%
Oneida County	1,995	$684,026,000	0	0.0%	$0	0.0%
Owyhee County	1,140	$1,258,911,000	0	0.0%	$0	0.0%
Payette County	8,108	$2,900,679,000	0	0.0%	$0	0.0%
Power County	80	$1,011,694,000	0	0.0%	$0	0.0%
Shoshone County	7,056	$2,248,057,000	0	0.0%	$0	0.0%
Teton County	5,156	$1,793,082,000	540	10.5%	$186,536,000	10.4%

Twin Falls County	17,970	$11,430,233,000	46	<1%	$66,260,000	<1%
Valley County	11,335	$3,764,632,000	0	0.0%	$0	0.0%
Washington County	4,642	$1,615,788,000	0	0.0%	$0	0.0%
Idaho Total	**420,935**	**247,695,983,000**	**2,386**	**0.6%**	**$805,352,000**	**<1%**

Source: HAZUS-MH v4.0, USGS 2001

Value = Estimated replacement cost of structure and contents

Local Hazard Mitigation Plan Loss Estimations

Out of the six localities that ranked landslides as a major hazard, only Bonner County provided loss estimates, which equated to $3,375,622,000.

Direct costs can be defined as the cost of debris removal, stabilization, and response for a specific landslide event. All other costs are indirect and include (1) loss of industrial and commercial productivity as a result of damage to infrastructure, facilities, or interruption of services, (2) loss of access to communities and facilities, , and (3) the cost of litigation as a consequence of the release. Some of these indirect costs are difficult to measure and tend to be ignored. As a result, most estimates of loss are far too conservative.

Consequence Analysis Evaluation

On June 8, 2017, a Consequence Analysis Evaluation was conducted aligning with hazards profiled in the State Hazard Mitigation Plan. The assessment was conducted by a diverse planning team comprised of subject matter experts from across the State. This effort mirrored a similar exercise that occurred during both the 2010 and 2013 State Hazard Mitigation Plan updates.

The exercise is intended to provide another way to assess the State's vulnerability to its hazards and was conducted as a group exercise. Participants were asked to individually rank the following systems on a scale from 0 (no consequences) to 5 (most severe consequences), separately evaluating both the short-term (0-6 month) and long-term (6+ months) consequences of the scenario.

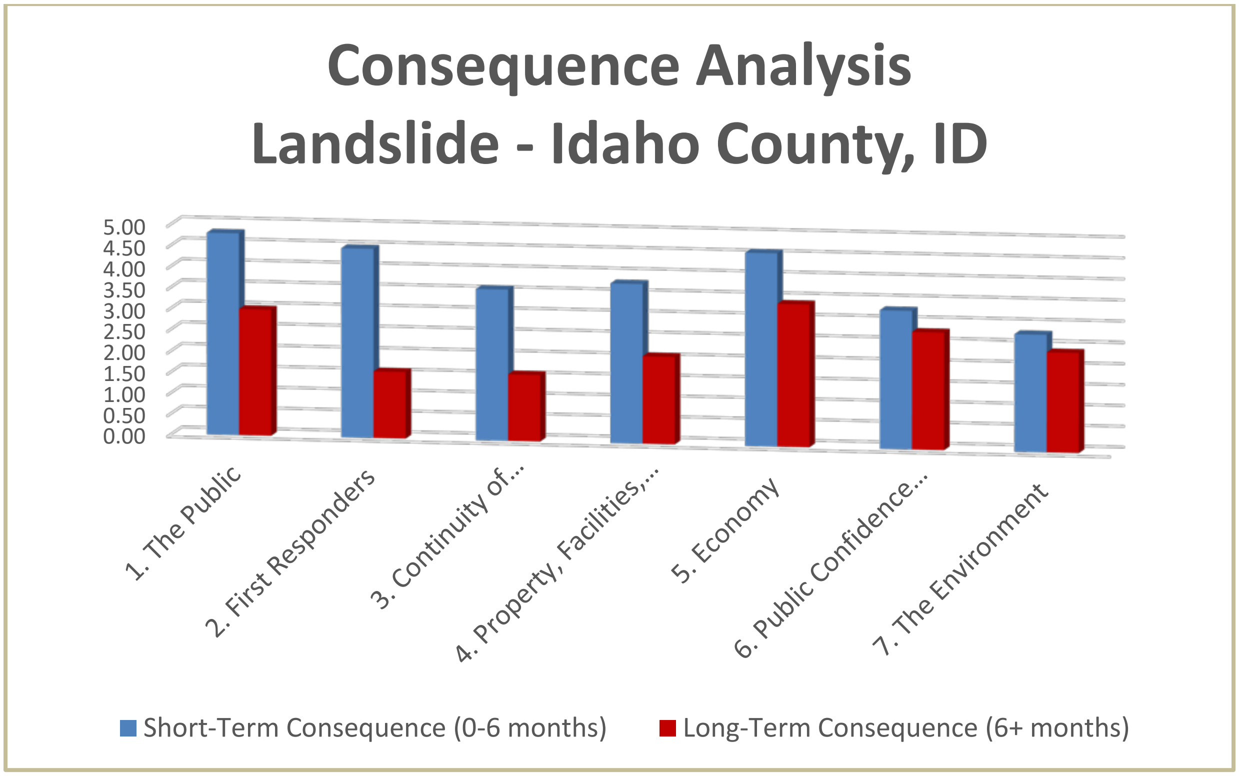
Systems Evaluated:

- The public
- First responders
- Continuity of operations
- Property, facilities, and infrastructure
- Economic conditions
- Public confidence in government

Scenario

February: This morning a landslide occurred on Highway 14, about 10 miles west of Elk City in Idaho County. About 14 tons of rock, trees and debris slid onto the highway causing a 40-foot deep complete blockage of the roadway. The town of Elk City is completely cut off as there are no alternative routes that are open during the winter months.

Results



Looking at the short-term consequences of this landslide event, exercise participants felt that the most severe consequences would be felt by the public, the economy, and first responders. From a long-term standpoint, the three systems suffering the most severe consequences (in decreasing order) include the economy, the public, and the public's confidence in government. Overall, what stands out is that the short-term impacts of this type of landslide event are expected to be greater than the long-term consequences for all systems assessed.

Some observations of the group to note included:

- If this were to occur in the summer, the population impacted would be four to five times greater.
- This scenario's winter occurrence affects many systems more negatively, due to difficulty in accessing alternate routes.
- There is concern there could be regional impacts, specifically dealing with the tribal fishery in the area.

- Over the past few years, there have been positive advancements in evaluating the risk present across the State.

Mitigation Rationale

"Landslide" is the general term for the movement of a soil and/or rock mass down a slope. It covers a variety of processes and landforms derived from those processes. In general, the term "landslide" is employed in this document for situations involving any of these processes. Although all landslides may pose serious hazards, one type is of particular interest. This type is a "flow," including debris flows, which is often difficult to distinguish from a flash flood and possesses similar destructive potential and rapid onset. Debris flows generally occur during periods of intense rainfall or rapid snowmelt. They usually start on steep hillsides as shallow slides that liquefy and accelerate. The consistency of debris flows ranges from watery mud to thick, rocky mud that can carry large items such as boulders, trees, and cars. Material can be accumulated as a slide grows, and flows from converging drainage may join. When the flows reach canyon mouths or flatter ground, debris can spread over a broad area, sometimes accumulating in thick deposits.

General Mitigation Approaches

Landslides are site-specific hazards that may be influenced by offsite conditions (e.g., inappropriately channeled runoff) and may have large-scale consequences (e.g., the disruption of transportation routes or contamination of water sources). Mitigation must balance the need for localized action with the potential of regional benefits.

As with all hazards, the preferred method of mitigation is to separate human development and population from hazard-prone areas. When this is not possible or practical, a variety of measures may be employed to reduce the potential impact of events on property and lives. Some landslide hazards cannot be mitigated or are too costly to mitigate and, therefore, are best avoided. Other landslide-prone areas are easily mitigated and need not influence land use significantly as long as the hazard is identified. Because of this, general landslide hazard information should be utilized in developing local master plans and zoning ordinances, so that land use can take landslide hazards into account.

Hazard Management

There are two basic approaches of hazard management: diversion of debris and landslide/slope stabilization. The choice of mitigation approach should be based on a thorough investigation of the site in order to evaluate all pertinent characteristics of a potential landslide site.

Diversion of Debris: This mitigation activity involves redirecting the debris from its run-out path to avoid damage to existing development.

Landslide/Slope Stabilization: This mitigation to stabilize a landslide or an unstable slope area may involve any one or more of three strategies:

- Drainage control: conveyance of surface and shallow groundwater away from the site.
- Re-grading of the hazard area: removing soil from the slope in order to reduce the weight of the slide mass and lower slope gradient, both of which will increase slope stability.
- Mechanically restraining slope movement: vegetation or armoring of slope surfaces or construction of retaining walls.

Information/Outreach and Public Education

Many property owners and residents are unfamiliar with the landslide hazard associated with their property and homes. Relatively small steps in home construction and landscaping can play a large role in hazard reduction. As with all natural hazards, public information and education is the first line of defense, not only increasing people's knowledge of the problem but also gaining higher compliance with regulatory and voluntary mitigation measures.

At the time of the 2018 plan update, IGS is seeking Idaho Transportation Department internal research funds to create and maintain a new, centralized landslide inventory database. A proposal was submitted to ITD outlining a two-year project to develop a database structure, define a hazard criteria ranking system, compile landslide records from ITD and other sources, populate the database, and publish it as an interactive online map. The resulting database would serve as an important data source for researchers, emergency managers, and transportation planners, and would help ITD prioritize their hazard mitigation efforts. The proposed project directly addresses at least four recommendations listed in the 1997 Governor's Landslide Task Force report:

- Recommendation #2: Assess landslide hazards and produce landslide hazard maps of critical areas.
- Recommendation #5: Initiate field-based, interdisciplinary technical studies of landslide processes to improve hazard assessment techniques.
- Recommendation #8: Update and maintain existing statewide landslide database and provide for periodic surveillance in problem areas.
- Recommendation #10: Develop a method for prioritizing landslide mitigation projects.

Infrastructure

Infrastructure should be constructed to avoid landslide hazard areas. Where infrastructure elements (e.g., roads) and public facilities are at direct risk from landslides, steps should be taken to mitigate the hazard (through debris diversion of slope stabilization) or provide for functional backups.

Regulatory

The generally preferred method of landslide mitigation is avoidance of hazard areas. Mitigation by avoidance involves a designation of landslide hazard area buffers and building setbacks or, in more extreme cases, may involve the total restriction of use or occupation within the hazard area. In addition to restricting new development from hazardous areas, regulations can require that landscaping and construction activities do not contribute to slope instability. This step can help minimize the impact on existing development and avoid increasing the extent of hazard areas. When landslide regulations are developed, the first step is to identify potentially hazardous areas. Geotechnical investigations performed by qualified engineering geologists and engineers are required to address hazards and recommend appropriate action prior to development in "potentially hazardous areas."

A good example of regulatory mitigation of hazards is the City of Boise. Boise has adopted specific guidelines in zoning and ordinances for development within the foothills, an area widely known in the geological community to be prone to and a site of historic landslides. An excerpt from the Boise City Foothills Policy Plan states, "Development within areas of landslides, fault zones, and unstable soils shall be prohibited, unless the Project Engineer can demonstrate to the City Engineer that these site limitations can be overcome. The intent is to prevent hazards to life and property, and lessen the adverse effects of development on the safety, use or stability of public ways and drainage channels. The risk evaluation will be based on engineering reports which will be subject to peer review." (https://parks.cityofboise.org/media/4172/01_Foothills_Policy_Plan.pdf)

It would be a useful mitigation strategy in the future to have a consolidated listing at the state agency level of all local jurisdiction ordinances pertaining to landslide planning for a statewide analysis and understanding of the effectiveness of such policies.

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