WASHINGTON STATE DEPARTMENT OF
Natural Resources

Mass Wasting Assessment for the Siouxon Block: Parts of Canyon Creek, Cougar, Siouxon, and Swift Creek Watershed Administrative Units, Clark and Skamania Counties, Washington

State Lands Landslide Hazard Block Mapping Project

Prepared by:

Stephen L. Slaughter and William S. Lingley, Jr.

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State of Washington
Engineering Geologist
324
Licensed Geologist
WILLIAM S. LINGLEY JR.
Dec. 28, 2005

LAND MANAGEMENT DIVISION • 1111 WASHINGTON ST SE • PO BOX 47016 • OLYMPIA, WA 98504-7016

FAX: (360) 902-1789 • TTY: (360) 902-1125 • TEL: (360) 902-1177

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1.0 Introduction and Summary of Methods

1.1 Use of This Report

The purpose of this mass-wasting assessment is to identify State Lands within portions of the Siouxon, Cougar, Swift Creek, and Canyon Creek Watershed Administrative Units (WAU) that have landforms[1] with medium or high risk of landslides due to the effects of forest management (logging, roading, thinning, yarding, etc.). Adjacent non-federal, non-tribal lands are addressed, but only insofar as these are necessary to evaluate State Lands. Maps of these watershed-specific landforms (Map A-2 herein) will be used by the Department of Natural Resources (DNR) Region staff to identify those timber sales and Forest Practice Applications (see Chapter 222-20 WAC) that will require a site investigation prior to assigning the class of forest practice relative to potentially unstable slopes and landforms (Chapter 222-16-050).

Note: this is a reconnaissance study and its level of resolution must be kept in mind when using this document and Maps A-1 and A-2. For example, analysis of individual landslides or slopes is not an appropriate use of this report nor should it be used for zoning purposes. Moreover, the report was prepared according to the schedule necessary to produce a statewide State lands screening tool as quickly as reasonably possible. For this reason, it is likely that some landslides or landforms have been accidentally omitted, some benign features are improperly mapped as landslides, and some data may have been miscoded herein.

Marc Ratcliff, Laura Vaugeois, and Stephanie Zurenko of DNR graciously reviewed this report and edited the text.

1.2 Previous Investigations

Evarts and Ashley (1990) created the sole 7.5-minute geologic map in the study area, a preliminary map of the Cougar Quadrangle that identified seven landslides. DNR Division of Geology and Earth Resources 1:100,000 geologic maps covering the Mt. St. Helens (Philips, 1987) and Vancouver (Philips, 1987a) quadrangles identified four landslides in the study area. Fiksdal (1975) compiled a 1:62,500 scale slope stability map of Clark County and identified five landslides within the Siouxon Block. No other reports were found that addressed slope stability within the study area.

1.3 Summary of Methods

This assessment generally follows the Landslide Hazard Inventory Protocol (Washington Department of Natural Resources, 2005), with minor modifications.

Six sets of aerial photographs (Table 1) acquired between 1969 and 1999 were viewed using a mirrored stereoscope with 3x magnification. Unfortunately, many key photographs were missing from DNR's collection and could not be viewed. In addition, 1998 orthophoto coverage (color, nonstereo) was used as a layer during GIS analysis and mapping. Note that many landslides identified from the orthophotos and indicated as having a 1998 identification date in Appendix A are probably older than the 1998 acquisition date of these data.

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[1] Landforms as defined herein can be more inclusive than the small-scale unstable landforms commonly defined in rule (WAC 222-16-050). These rule-identified landforms include inner gorges, convergent headwalls, the outsides of meander bends, bedrock hollows, and the toes of deep-seated landslides. These will be referred to as "rule-identified landforms" herein.

Table 1. Photographic surveys used in this study.

Year	Scale	Image	Flight symbol	Flight number/lines	Reference/ ownership	Comment
1969	1:63,300	black & white	SW-H-69	72-15A, 125-15A, 125-15B, 125-16, 125-17	USGS	1 missing photograph
1978	1:24,000	color	SW-C-78	44-26, 45B, 45C, 46B, 47B, 48B	DNR	No missing photograph
1980	1:12,000	color	SWP-C-80	57A, 59A, 61B, 63B 64BB, 65B, 67B	DNR	20 missing photographs
1984	1:12,000	color	SWP-C-84	8-52, 18-54, 22-56, 22-57, 22-58, 22-59, 23-55, 40-54	DNR	39 missing photographs
1988	1:14,000	black & white	SW-88	17-90, 28-92, 28-93, 28-94, 28-96, 35-88	DNR	7 missing photographs
1993	1:14,600	black & white	SW-93	13-89,13-90,14-88, 14-89	DNR	8 missing photographs
1999	1:24,000	color	SW-99	47-97,48-99, 48-100, 48-101, 48-103, 49-105, 52-95	DNR	14 missing photographs

Field investigations were carried out on June 10 and 23, July 7, and August 6 and 10, 2005. Twenty percent of mapped landslides were confirmed or rejected during field reconnaissance.

Mapping was generally accomplished by heads-up digitizing the landslides directly in ArcGIS. Control was established by rectifying most landslides with DNR digital orthophotographs as well as with topographic contours and a variety of hillshade layers created with USGS 10-meter digital elevation models (DEM) for Skamania County and lidar digital elevation models (DEM) for Clark County. Varying hillshade layers were used to provide optimal lighting conditions for different slope areas as different combinations of sun azimuth and slope orientations provide drastically different representations of the ground surface. Digitizing landslides was performed at scales equal to or greater than 1:3000 and landforms were digitized at 1:5000 or greater for both the lidar and USGS DEMs.

It should be noted that the resolution of the Clark County lidar data is significantly less than typical 6-foot grids and generalized to 10-meter (32.8 feet) grids. However, the lidar representation of the surface is of greater accuracy than that of a digital elevation model (DEM) derived from USGS topographic contour lines. The lidar DEM proved useful for identifying deep-seated landslides and landforms that could not be identified with aerial photograph analysis or the USGS DEM. Also, landforms such as inner gorges, bedrock hollows, and more subtle convergent topography were easier to identify as were drainages not shown on the USGS DEM.

The resulting landslide mapping is displayed as Map A-1 and is available as PDF files or ArcInfo coverage from the DNR Forest Practices Division. Pertinent attributes of the landslides are recorded on data sheets (Appendices A and B). Slope gradients not measured in the field were determined by exploring DEM-derived slope percent pixels within the upper parts of each landslide polygon on the Map A-1 shapefile. Note that the steepest slope increment only corresponds to the “slope at failure” in medium to large translational landslides. (See *Angle of Slide* in Jackson, 1997).

Once the locations of mass-wasting features were mapped and evaluated, watershed specific landforms[2] with similar mass-wasting potential were delineated. These landforms are shown on Map A-2, which is also available in other formats from the DNR Forest Practices Division.

[2] Referred to simply as "landforms" hereafter.

2.0 Physical Setting Pertinent to Mass-Wasting Interpretations

2.1 Introduction

The study area (Figure 1) covers 50,401 acres (78.8 miles^2) within the DNR Pacific-Cascade Region, 15 miles northeast of the town of Battleground in Clark County and approximately 10 miles south from the summit of Mount St. Helens. Of the total study area, 31,305 acres (48.9 miles^2) are DNR Trust land that is within portions of the Canyon Creek, Cougar, Siouxon, and, Swift Creek WAUs. Elevation ranges from 483 feet at Yale Lake (Reservoir) to 4106 feet at Huffman Peak.

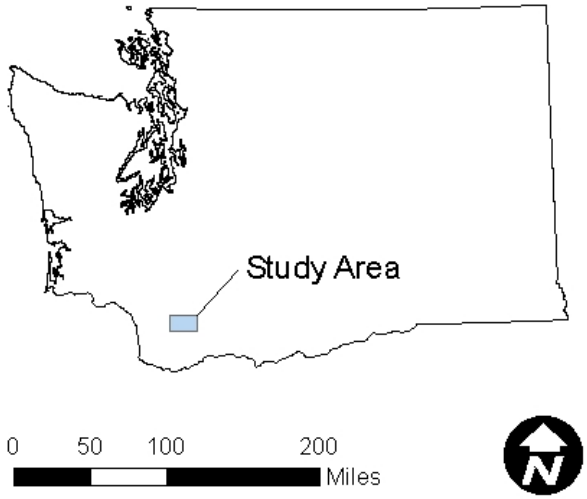

Figure 1. Map of Washington State showing the location of the Siouxon study area.

Precipitation within the watershed is high, averaging 115 inches of rain and 25 inches of snowfall annually (Western Regional Climate Center, 2005). Approximately half of the field area has the potential for rain-on-snow events (DNR Mapping Tools: Climatology: Rain on Snow layer) and snow avalanches have occurred on several slopes above 2500 feet. Rain-on-snow zones within the Siouxon Block are between 1800 feet and 3200 feet and have been recognized to trigger widespread mass wasting along the Cascade foothills.

Near-surface groundwater hydrology consists primarily of transmission through forest duff and soil because the underlying geology is dominantly less permeable volcaniclastic rocks[3], lava flows[4], and intrusive igneous rocks[5].

2.2 Geology

Geology is based on 1:100,000 DNR maps of the Mount Saint Helens (Philips, 1987) and Vancouver (Philips, 1987a) quadrangles as well as the detailed 1:24,000 geologic map of the Cougar quadrangle by Evarts and Ashley (1990), which covers approximately 20 percent of the field area.

[3] Refers to both volcanic and sedimentary rocks composed primarily of volcanic fragments.
[4] Melted rock that cooled above the ground.
[5] Melted rock that cooled below the ground and exposed by subsequent erosion and/or uplift.

In general, the bedrock consists of volcanic and volcaniclastic rocks of Miocene (23.8 to 5.3 million years ago) to Oligocene (33.7 to 23.8 million years ago) age intruded by numerous basalt dikes (Evarts and Ashley, 1990). These rocks are overlain by late Pleistocene (approximately 10,000 years ago) glacial deposits and covered by tephra[6] erupted by Mount St. Helens during the latest Pleistocene to Holocene time (about 8000 years ago; Evarts and Ashley, 1990). Figure 2 is a generalized geologic map of the study area, simplified from the sources cited above. The mapped units include:

MOvc *Miocene-Oligocene volcaniclastic sedimentary rock.* The prevailing rock in the area covers 35,909 acres. The unit consists of well-bedded, well- to moderately sorted siltstone, sandstone, conglomerate, and breccia, all composed of volcanic debris, and less common thin coaly beds (Evarts and Ashley, 1990). The unit is interpreted as dominantly stream and lakebeds deposited low on the flanks of a volcano or in distal environments between local volcanoes (Evarts and Ashley, 1990). The unit strikes to the northeast and the average dip is 15 degrees to the southeast.

Ova *Oligocene andesite lava flows.* The next most widespread rock in the study area covers 6703 acres and is primarily in Clark County. The unit consists of lava flows that cooled on the surface and in some cases "flowed" as a hot, fractured rock that solidified once movement ceased. The unit strikes to the northeast and the average dip is about 20 degrees to the southeast.

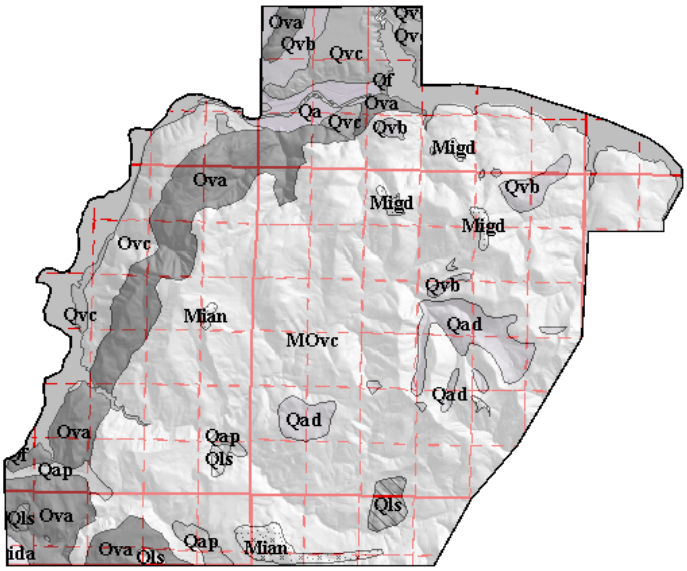

Figure 2. Geologic map of the study area modified from the Mount Saint Helens (Philips, 1987) and Vancouver (Philips, 1987a) 1:100,000 DNR geologic quadrangles. Geologic map is draped over a hillshade layer created from a 10-meter DEM. Note that "ida" in the southwest corner of the map is actually Qida.

[6] Tephra is a general term for volcanic rock fragments of various size blasted into the air by explosions or carried upward by hot gases in eruption columns. Fragments range in size from ash to 3-foot diameter blocks of rock and pumice.

Qad *Quaternary alpine glacial deposits.* The third largest geologic unit are 2261-acres of Frasier and pre-Frasier aged glacial deposits consisting of till and/or outwash sand and gravel sediments deposited from alpine glaciers and alluvium deposited from streams. As the glacial ice advanced, streams flowing from the leading edge of the glacier shed sand and gravel (*advance outwash*) covering older preglacial material. The advance outwash consists of sand to pebble/cobble gravel. The glacier advanced and overrode the advance outwash deposits and deposited a layer of glacial '*till*' beneath the ice. The glacial till consists of an unsorted, very compact, concrete-like mixture of clay, silt, sand, gravel, cobbles, and boulders supported by its matrix[7].

Qvc *Quaternary lahar and pyroclastic flow deposits.* The fourth largest geologic unit in the study area is 20,000-year-old volcanic mudflow (lahar) and rapidly moving, hot, ash cloud (pyroclastic flow) deposits from violent volcanic eruptions that catastrophically melted snow and ice on the flanks of Mount Saint Helens. The ensuing lahars and pyroclastic flows increased in size down slope from the volcano as the mud and water eroded the valley sides. The unit is relatively flat lying and in part, flowed into the Lewis River. The unit covers 1938 acres of the study area and is along the eastern shore of Yale Lake and north of the Lewis River between Yale Lake and Swift Reservoir.

Qvb *Quaternary volcanic basaltic lavas.* Light gray to black lava flows in the northern section of the field area. This unit covers 1192 acres.

Qls *Quaternary landslides.* Five mapped landslides are identified by Phillips (1987, 1987a) were determined to be accurately mapped. The area of these landslides are 610 acres, which consists of unstratified and poorly sorted deposits of clay, silt, sand, gravel, and larger blocks often revealing a hummocky surface.

Migd/Mian *Miocene intrusive plutons.* Two plutons (lava that slowly cooled and solidified underground) have random exposures throughout the field area, which are the granodiorite Spirit Lake Pluton (Migd; 234 acres exposed) and the andesite Silver Star Pluton (Mian; 579 acres exposed).

Qa *Quaternary alluvium.* Consists of silt, sand, and gravel deposited by streambeds and alluvial fans. The only mapped polygon of alluvium circumscribes 735 acres in the Lewis River basin between Yale Lake and Swift Reservoir.

Qf *Quaternary fill.* Two earthen dams back up the Lewis River to create Swift Reservoir and Yale Lake.

Qida *Quaternary volcanic dacite peak.* Tum Tum Mountain is a near perfect conical andesite volcano in the far southwest corner of the study area.

[7] Matrix (as opposed to clast) support indicates that in a deposit of mixed sizes, the finer material carries the weight. Therefore, these deposits can flow. In clast-supported deposits, the weight is carried by grain-to-grain contacts between the larger particles, and these tend to be more resistant.

2.2.3 Geomorphology

The study area can be divided into three main physiographic elements and subdivided into 10 Landforms. The physiographic elements are:

1. Subalpine and other bedrock-dominated hills (Landforms 1, 5, 8, 11, and 12) consisting of lava flows, intrusive plutons, and volcaniclastic sedimentary rocks.
2. The highly convergent topography and incised gorge systems of Canyon and Siouxon Creeks, smaller stream gorge systems, and the dammed sections of the Lewis River, which is today represented by Yale Lake and Swift Reservoir (Landforms 3, 6, and 9).
3. Large, deep-seated landslides and related features (Landforms 2 and 10).

3.0 Summary of Results

Aerial photograph analysis of the area proved sufficient to characterize landslide hazards throughout the field area. Midway through our study, we were able to add new Clark County 10-meter lidar DEM data. These data were used to create and identify additional deep-seated landslides and provided greater accuracy in mapping previously identified deep-seated landslides. Lidar data are insufficient for identification of shallow-rapid landslides and debris flows but is immensely useful for identification of rule-identified features such as bedrock hollows and inner gorges.

During this review, a representative sample of 286 landslides ranging from 'questionable' to 'definite' field-confirmed landslides were inventoried using aerial photographs obtained between 1969 and 1999 (Form A-1, Appendices A, B). Of the landslides identified during this mass-wasting assessment, 51 percent were debris flows, 15 percent were mapped as shallow-rapid undifferentiated failures, 15 percent were snow avalanches, 7 percent were deep-seated undifferentiated, 7 percent were small sporadic deep-seated, 4 percent were rock topples, and 2 percent were earthflows (Fig. 3). We also identified 44 non-forest management related snow avalanches effecting 269 acres.

Snow avalanche delivery values are presented with reference to a separate Landform 12 and are not tallied in the watershed analysis hazard rates (see Section 5). This is because snow avalanche delivery of sediment is far less than a similar sized landslide in unconsolidated sediments. Several snow avalanche chutes are captured by Landform 1 and are therefore assigned a high hazard rating irrespective of the potential for snow avalanches. We speculate the high frequency of snow avalanches in the Siouxon Block may result from the catastrophic Yacolt Burn of 1902 that charred approximately 290,000 acres of timbered land and is considered the largest fire in Washington state history (Moen, 1977). Management has little impact on these snow avalanche chutes because little vegetation exists and thick soils have been removed by past snow avalanches.

On managed lands, 41 percent all of the landslides are road-related (Figure 4). Elsewhere, landslides associated with clear-cuts (0 to 5 years) include 14 percent of all recorded failures, young stands (5 to 15 years) include 26 percent, mature stands include 15 percent, and young stands (5 to 15 years) include 5 percent of observed slope failures.

With the exception of road-related landslides, the majority of landslides are associated with rule-identified landforms[8] (Figure 5). Bedrock hollows contained 34 percent and inner gorges contained 22 percent. Other features include rock outcrops with 14 percent, other with12 percent, avalanche chutes with 6 percent, and terrace face, deep-seated landslides, stream influenced, and convergent headwalls each with 3 percent.

Figure 6 shows initiation/headscarp slope percent for shallow-rapid, debris flows, and deep-seated landslides. These data are suspect because in this watershed, field-checked landslide initiation slopes are typically much higher than values determined from USGS DEM data derived from topographic maps.

[8] See WAC 222-16-050(1).

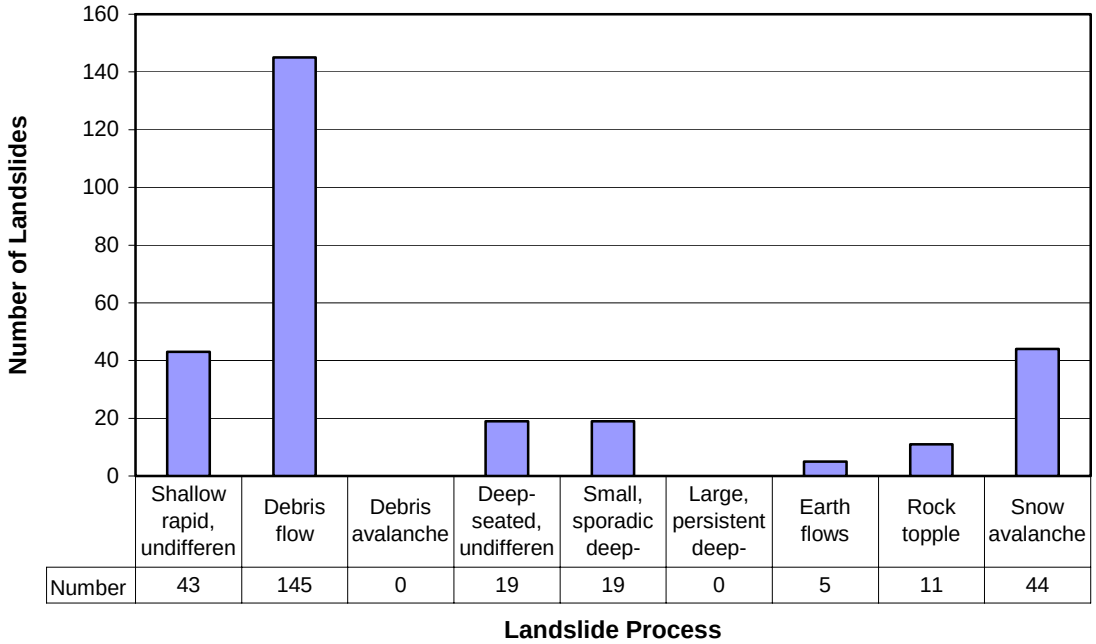

Figure 3. Distribution of landslides observed within the study area by mechanism.

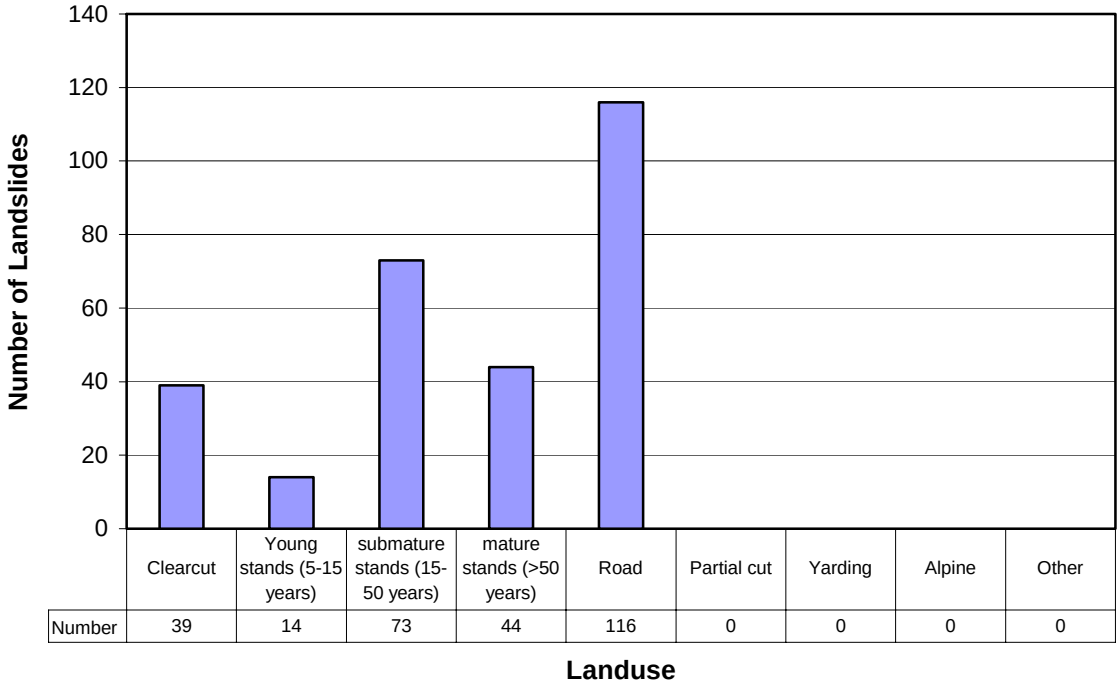

Figure 4. The distribution of landslides by land use association. Note that snow avalanches are included in submature stands, although this ground movement process is essentially alpine in nature.

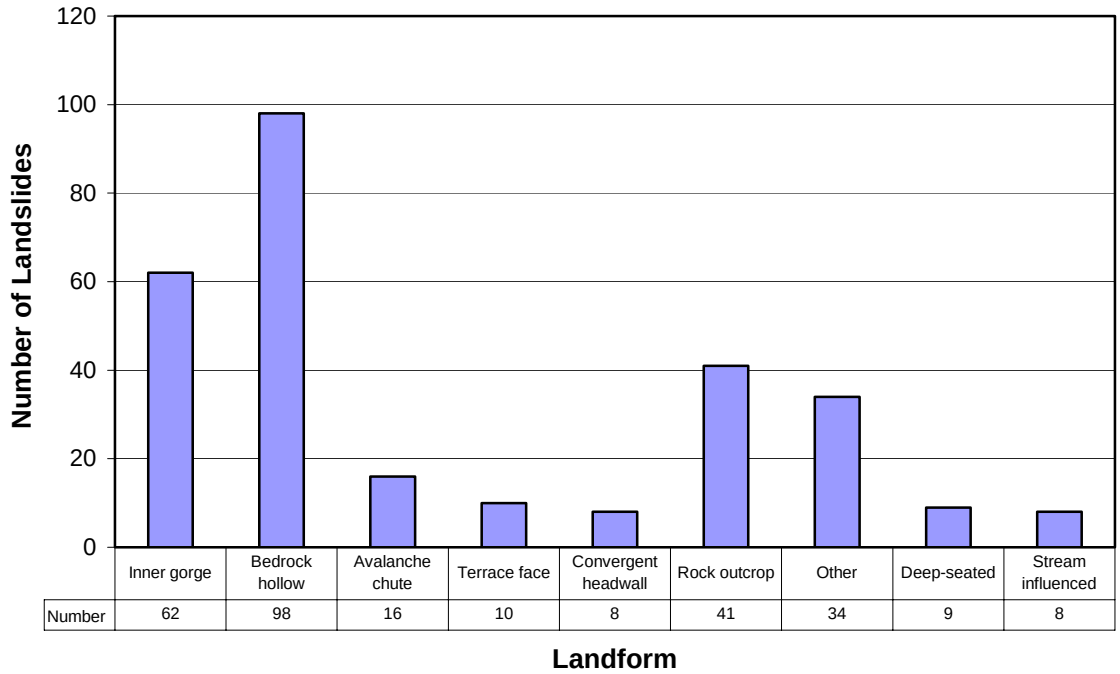

Figure 5. The distribution of landslides by individual small-scale landform association.

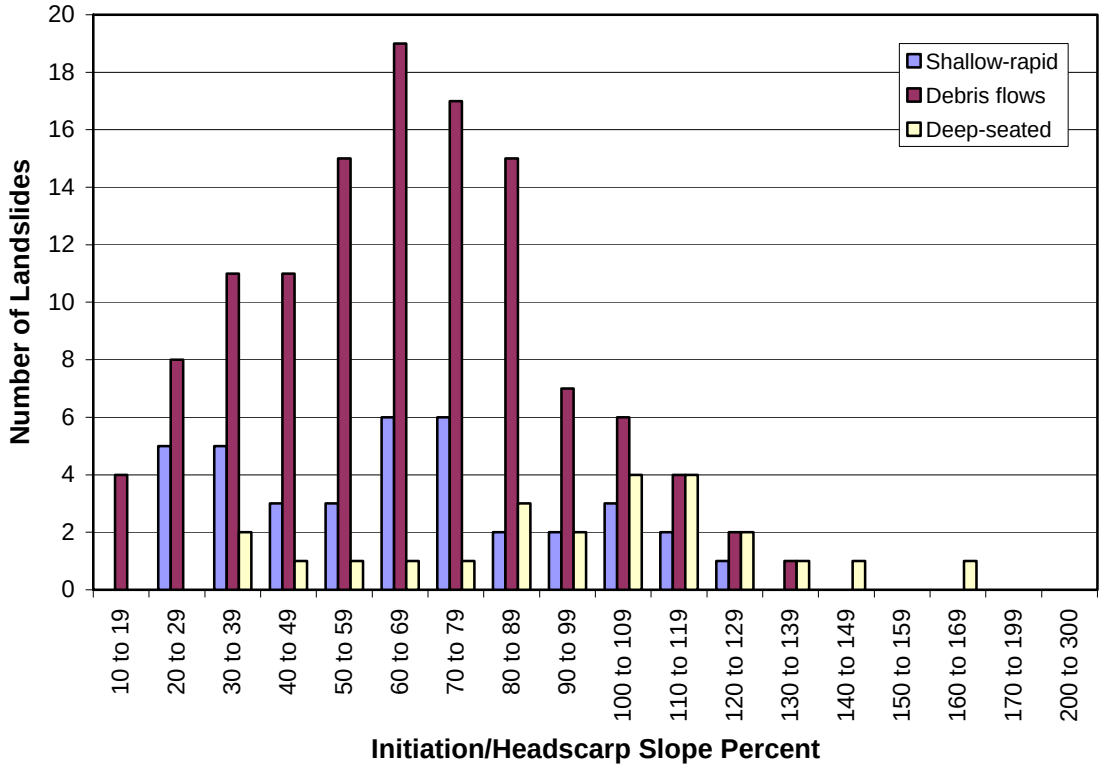

Figure 6. Distribution of all landslides by initiation/headscarp slope.

4.0 Landform Descriptions (Form A-2)

4.1 Introduction

The 10 landforms specific to the Siouxon watershed defined herein have been delineated to show areas having similar mass-wasting potential and potential to deliver to public resources and threaten public safety. The eleven watershed specific landforms are based on landslide process, geology, failure density, lithology, hydrology, geomorphology, and topography. The following sections characterize these Landforms; additional information is given in Appendices A and B.

4.2 Form A-2: Landform Descriptions

In the following descriptions, “Confidence” statements refer to the confidence in the specific landform. Generally confidence in landslide identification and the precision of mapping is generally moderate as the study is designed to provide representative samples rather than exhaustive inventory. In the following sections, low hazard landforms are described with an abbreviated description (Form A-2), whereas moderate and high hazard landforms that will trigger a field investigation by Department of Natural Resources Region personnel are described with a complete Form A-2.

LANDFORM NUMBER	1
LANDFORM NAME	Convergent topography containing rule-identified inner gorges, bedrock/soil hollows, and convergent headwalls
OVERALL HAZARD	Very high
Description of mass-wasting unit	Landform is typically markedly convergent and individual features vary in area from 0.1 to 48.9 acres (average = 2.1 acres). Slopes within Landform 1 are typically greater than 70 percent. Over a third of the landslides identified in the study area initiated within one of the 1,800+ Landform 1 polygons. Vegetation regenerates rapidly in mass-wasting scars, which are often covered with vegetation that masked slope failures on aerial photos. Debris flows account for 48 percent of the mass wasting events, primarily occurring at inner gorges and bedrock/soil hollows.
Number and cumulative area of landslides	87 landslides; 116 acres
Observed slope of Landform	70 percent and greater
Slope shape	Convergent to concave-planar
Materials	All bedrock units
Elevation of landslide initiation	Variable, nearly all elevations possible
Total area of Landform	3842 acres
Mass-wasting processes	Debris flows, shallow-rapid, deep-seated, shallow, sporatic deep-seated, earth flow, rock topple and snow avalanche
Forest Practice sensitivity	Roads and landings can destabilize slopes in these features by undercutting and over steepening slopes. Side cast and road (or landing) fill can oversteepen and add weight to slopes; roads and landings can also capture runoff water or shallow groundwater and channel it to point locations that saturate road or landing fill and/or thin soils draping bedrock, triggering landslides.
Mass-wasting potential	High for road construction and timber harvest.
Number of delivering landslides	75 landslides
Area of delivering landslides	74 acres
Landslide area rate for delivery	646 = high
Delivery potential and delivery criteria used	High, direct observation of delivery to typed waters.
Trigger mechanisms	Saturation of soils during heavy precipitation, rain-on-snow events, diverted streams/channels, over-steepening from roading, and others.
Confidence	High based on the number of landslides captured by this Landform, excellent aerial photograph coverage, and field observations
Comments	There are numerous rule-identified features throughout the study area that cannot be mapped due to poor resolution of DEMs. This unit has a high potential for mass wasting and delivery, so great care should be taken to locate these features in the field.

LANDFORM NUMBER	2
LANDFORM NAME	Earthflows and deep-seated landslides
OVERALL HAZARD	Low
Description of mass-wasting unit	Low relief (typically less than 70 percent) areas throughout the study area may exhibit hummocky topography (small, irregular mounds), parallel side-streams, poorly drained depressions (ponds and small lakes), and botanical evidence of past ground movement (jackstraw or drunken trees). It comprises primarily of the bodies of deep-seated landslides and earthflows. Scarps are captured by higher hazard landforms such as Landform 1 and 8 and toes proximal to streams are bounded by Landform 10. These landslides are recognized as somewhat unstable because the process of slipping, disrupted drainage, and permeability within the Landform that weakens the rocks and sediments.
Number and cumulative area of landslides	7 landslides; 328 acres
Observed slope of Landform	Horizontal to 70 percent
Slope shape	Convergent to planar
Materials	Non-layered and poorly sorted deposits of clay, silt, sand, gravel, and larger blocks.
Elevation of landslide initiation	Minimum = 646 ft; maximum = 1795 ft; average = 1261 ft
Total area of Landform	2860 acres
Mass-wasting processes	Debris flows, shallow-rapid, deep-seated, shallow, sporadic deep-seated, and rock topples
Forest Practice sensitivity	This landform is sensitive to any Forest Practice activity that reduces root strength, undercuts or over steepens or loads these slopes, and/or redirects water onto these slopes.
Mass-wasting potential	Low
Number of delivering landslides	7 landslides
Area of delivering landslides	2 acres
Landslide area rate for delivery	28 = low
Delivery potential and delivery criteria used	Low potential for delivery.
Trigger mechanisms	Natural
Confidence	Moderate. In this watershed, deep-seated landslides can be mapped with moderate confidence.
Comments	A dearth of superimposed shallow rapid landslides and no evidence of rejuvenation suggest these slides are stable.

LANDFORM NUMBER	3
LANDFORM NAME	Slopes of Yale Lake and Swift Reservoir
OVERALL HAZARD	Moderate
Description of mass-wasting unit	Landform 3 comprises of areas with moderate to very steep slopes (greater than 70 percent) forming a gorge system in the ancestral Lewis River, now Yale Lake (reservoir) and Swift Reservoir. Near vertical slopes proximal to the reservoirs are incised by subsidiary, rule-identified bedrock hollows and inner gorges captured in Landform 1. Landform 3 is almost exclusively in volcaniclastic rocks.
Number and cumulative area of landslides	23 landslides; 6 acres
Observed slope of Landform	Greater than 70 percent to vertical
Slope shape	Convergent to planar
Materials	Volcaniclastic rocks (Qvc, Ovc, and MOvc)
Elevation of landslide initiation	Minimum = 923 ft; maximum = 1306 ft; average = 1165 ft
Total area of Landform	1529 acres
Mass-wasting processes	Debris flows and shallow-rapid landslides
Forest Practice sensitivity	Roads appear to be the most significant triggering mechanism for erosion, causing 79 percent of the failures on this landform.
Mass-wasting potential	Moderate
Number of delivering landslides	20 landslides
Area of delivering landslides	6 acres
Landslide area rate for delivery	121 = medium
Delivery potential and delivery criteria used	Delivery potential is high due to proximity to water bodies and roads.
Trigger mechanisms	In convergent areas, saturation of soils from heavy precipitation, diversion of streams/channels, over-steepening from roading, and other causes.
Confidence	Moderate due of resolution of DEM's
Comments	This unit is calculated as a medium hazard; however, within Landform 3 there also exist numerous, superimposed, rule-identified features, which are part of Landform 1. This should be considered during surveys and care should be taken to identify and bound out rule-identified convergent features in the field to prevent unacceptable mass wasting.

LANDFORM NUMBER	5
LANDFORM NAME	Active meander bends
OVERALL HAZARD	High; rule-identified
Description of mass-wasting unit	Comprises of arcuate scarps where a river is actively eroding at meander bends in adjacent banks. Continued erosion at the toe of these slopes will generate landslides with high certainty of delivery. Landform 5 is rated as high-hazard because it is rule-identified.
Number and cumulative area of landslides	2 landslide; 6 acres
Observed slope of Landform	70 percent and greater
Slope shape	Convergent to planar
Materials	Volcanic rocks & various sediments (MOvc, Ova, Qap, Qls)
Elevation of landslide initiation	724 feet
Total area of Landform	126 acres
Mass-wasting processes	Deep-seated
Forest Practice sensitivity	This landform is sensitive to any forest Practice activity that reduces root strength, undercuts or over steepens or loads these slopes, and/or redirects water onto these slopes.
Mass-wasting potential	High
Number of delivering landslides	1 landslide
Area of delivering landslides	3 acres
Landslide area rate for delivery	842 = high
Delivery potential and delivery criteria used	Delivery potential is high when streams cut into the outside meanders in a channel.
Trigger mechanisms	Undercutting by erosion along the outside of meander bends
Confidence	High
Comments	

LANDFORM NUMBER	6
LANDFORM NAME	Inner gorge of streams
OVERALL HAZARD	High (rule-identified)
Description of mass-wasting unit	Landform 6 comprises of areas with moderate slopes (70 percent and greater) forming symmetrical and asymmetrical inner gorge system in drainages throughout the study area. Streams have incised into the underlying strata forming gorges that locally meet the rule-identified definition of inner gorges. Vegetation regenerates rapidly in mass-wasting scars, which are often covered with vegetation that masked slope failures on aerial photos.
Number and cumulative area of landslides	12 landslides; 26 acres
Observed slope of Landform	70 percent and greater
Slope shape	Convergent to concave-planar
Materials	Volcanic rocks and sediments (MOvc and Ova)
Elevation of landslide initiation	Minimum = 1108 ft; maximum = 2254 ft; average = 1550 ft
Total area of Landform	1427 acres
Mass-wasting processes	Debris flow and shallow-rapid
Forest Practice sensitivity	Root strength within inner gorges has been found to be a factor in limiting the rates of mass wasting. Trees adjacent to the inner gorge can have roots extending into the slopes of the gully providing slope stability. Timber harvest, road construction, landing construction and/or other activities that impact root strength on steep slopes in poorly consolidated colluvium draping bedrock can cause slope instability. Roads and landings can destabilize slopes in inner gorges by undercutting and over steepening slopes. Side cast and road (or landing) fill can over steepen and add weight to slopes; roads and landings can also capture runoff water or shallow groundwater and channel it to point locations that saturate road or landing fill and/or thin soils draping bedrock, triggering landslides.
Mass-wasting potential	High for road construction and timber harvest.
Number of delivering landslides	9 landslides
Area of delivering landslides	4 acres
Landslide area rate for delivery	101 = moderate
Delivery potential and delivery criteria used	Delivery potential is high due to proximity to water bodies and roads.
Trigger mechanisms	In convergent areas, soil saturation, diverted streams/ channels, loss of root strength, oversteepening and loading slopes in colluvium
Confidence	High. Excellent aerial photograph coverage and good access in the field
Comments	This unit calculates as a moderate hazard; however, this Landform is rule-identified and contains superimposed Landform 1 polygons that include landslides that occur within Landform 6. This should be considered when surveys are conducted and care should be taken to identify rule-identified, convergent features in the field.

LANDFORM NUMBER	8
LANDFORM NAME	Other Steep Slopes (>70 percent)
OVERALL HAZARD	Low
Description of mass-wasting unit	Landform 8 comprises other steep planar and convergent slopes (>70 percent) and includes steep areas throughout the study area not categorized as rule-identified. In alpine areas, the cliffs appear to be composed of resistant lava flows that have been eroded by the major drainages leaving a distinctive topographic map pattern.
Number and cumulative area of landslides	47 landslides; 2648 acres
Observed slope of Landform	Greater than 70 percent
Slope shape	Convergent to planar and occasionally planar-convex
Materials	Parts of several geologic units
Elevation of landslide initiation	Minimum = 681 ft; maximum = 4119 ft; average = 2261 ft
Total area of Landform	5036 acres
Mass-wasting processes	Debris flow, shallow-rapid, snow avalanche, deep-seated, and rock topple
Forest Practice sensitivity	Moderate hazard for road construction and timber harvest based on
Mass-wasting potential	Moderate
Number of delivering landslides	21 landslides
Area of delivering landslides	10 acres
Landslide area rate for delivery	63 = low
Delivery potential and delivery criteria used	Low
Trigger mechanisms	Soil saturation, diverted streams/ channels, loss of root strength, oversteepening and loading slopes in colluvium
Confidence	High
Comments	This unit calculates as a low hazard; however, this Landform is rule-identified and contains superimposed Landform 1 polygons that include landslides that occur within Landform 8. This should be considered when surveys are conducted and care should be taken to identify rule-identified, convergent features in the field.

LANDFORM NUMBER	9
LANDFORM NAME	Large tear-shaped basin
OVERALL HAZARD	Very high
Description of mass-wasting unit	Bounds a single large basin draining westward into Yale Lake (Sections 10 and 11, T6N, R4E). This basin contains strongly convergent topography. About 30% of this basin has failed during the past 30 years. An alluvial fan has developed at the mouth of the basin in Yale Reservoir.
Number and cumulative area of landslides	5 landslides; 160 acres
Observed slope of Landform	A variety of slopes angles are present
Slope shape	A variety of slope shapes
Materials	Oligocene volcanic rocks (Ovc, Ova, MOvc)
Elevation of landslide initiation	Minimum: 1724 ft; maximum: 2243 ft; average: 1949 ft
Total area of Landform	491 acres
Mass-wasting processes	Deep-seated, debris flow, shallow-rapid landslides, and shallow, sporatic deep-seated landslides
Forest Practice sensitivity	This landform is sensitive to any forest Practice activity that reduces root strength, undercuts, oversteepens or loads these slopes, and/or redirects water onto these slopes.
Mass-wasting potential	Very high
Number of delivering landslides	5 landslides
Area of delivering landslides	160 acres
Landslide area rate for delivery	10,887 = very high
Delivery potential and delivery criteria used	Very high. Gorges superimposed on the deep-seated slides are subject to frequent shallow rapid and debris flow mass wasting that are included in landform. In addition, the area is extremely convergent and over 1/3 of the area above 70 percent.
Trigger mechanisms	This basin may fail as a result of any change in physical conditions.
Confidence	Moderate – Only minimal field checking was possible; however aerial photograph coverage was excellent
Comments	Numerous landslides have been captured by subsidiary Landform 1, as is evident in Map A1.

LANDFORM NUMBER	10
LANDFORM NAME	Toes of deep-seated landslides
OVERALL HAZARD	High; rule-identified
Description of mass-wasting unit	Slope typically greater then 65 percent and terminating in streams.
Number and cumulative area of landslides	6 landslides; 83 acres
Observed slope of Landform	Rule-identified: stream-adjacent slopes at the toes of deep-seated landslides. Areas appear hummocky, timber may appear “jackstaw” or “drunken,” possible large cracks in the ground, and in the case of landslide 1387 and possibly others, boulders several tens of feet across litter the stream channel deposited from the toe.
Slope shape	Convergent to planar
Materials	Older landslide deposits (Unit Qls)
Elevation of landslide initiation	Variable, nearly all elevations possible
Total area of Landform	70 acres
Mass-wasting processes	None observed; however, shallow-rapid, debris flows, and small rotational slides most probable
Forest Practice sensitivity	This landform is sensitive to any forest practice activity that reduces root strength, undercuts or over steepens or loads these slopes, and/or redirects water onto these slopes.
Mass-wasting potential	High
Number of delivering landslides	6 landslides
Area of delivering landslides	83 acres
Landslide area rate for delivery	39,205 = very high
Delivery potential and delivery criteria used	High. Possible reactivation of toe could deliver to a stream.
Trigger mechanisms	Roading or harvest on these rule identified features.
Confidence	High
Comments	Area of mass wasting larger than Landform area due to landslide areas larger than Landform

LANDFORM NUMBER	11
LANDFORM NAME	Low relief areas less than 70 percent
OVERALL HAZARD	Low
Description of mass-wasting unit	Landform 11 consists of colluvial soils, volcaniclastic and igneous rocks that form gentle to moderate slopes, broad ridgelines, rounded hills, and silt, sand, and gravel deposited by streambeds and alluvial fans. The Landform contains all slope shapes and is under 70 percent slope. The Landslide Area Rate for Delivery (see below) is 28, indicating that sediment delivery to public resources is small.

LANDFORM NUMBER	12
LANDFORM NAME	Avalanche zone (>70 percent)
OVERALL HAZARD	Very high
Description of mass-wasting unit	Landform 12 comprises of planar to convergent slopes (>70 percent) above approximately 2500 feet.
Number and cumulative area of landslides	16 snow avalanches; 139 acres
Observed slope of Landform	Greater than 70 percent
Slope shape	Convergent to planar
Materials	Parts of several geologic units
Elevation of landslide initiation	Minimum = 2500 and greater
Total area of Landform	951 acres
Mass-wasting processes	Snow avalanche
Forest Practice sensitivity	Timber immediately below snow avalanche chutes typically slows or halts snow avalanches, so harvest and road construction below snow avalanche chutes should be limited.
Mass-wasting potential	High
Number of delivering landslides	16
Area of delivering landslides	139 acres
Landslide area rate for delivery	4859; very high
Delivery potential and delivery criteria used	High. Many snow avalanche chutes appear active
Trigger mechanisms	Occur on slopes when the load on the upper layers of snow exceeds the bonding forces with the material beneath the snow (vegetation, rocks, soil, etc.).
Confidence	High
Comments	Not all of the snow avalanches are captured by this Landform. Landform 1 bounds out several snow avalanches within Landform 12. Snow avalanches deliver far less sediment than landslides, but they still have the potential to deliver sediment or debris to a public resource and the potential to threaten public safety.

5.0 Hazard Ratings

Overall Hazard Ratings under this protocol may be determined from the following: 1) Specific criteria, such as rule-identified status (WAC 222-16-050), or 2) a combination of the Landslide Frequency Rate and the Landslide Area Rate For Delivery.

The Landslide Frequency Rate for Delivery is simply the area of all landslides normalized for the period of study and the area of each Landform. These values are multiplied by one million to provide whole numbers. Landslide Area Rate for Delivery is calculated in the same manner but includes only delivering landslides and omitting snow avalanches from the overall calculation (Table 3). Snow Avalanches Area Rate for Delivery calculations are in Table 4. The Area Rate for Delivery is especially useful for helping to quantify the potential for delivery of sediment where rule-identified status may mischaracterize slope stability in the landform as outlined in Table A-2 of Washington Forest Practices Board (1997). Note that higher Landslide Area Rates for Delivery can be achieved by reducing the size of the Landform. While this may appear to be data manipulation, it has a favorable effect, which is to help limit the area of high-hazard Mass-Wasting map units to those areas that are actually demonstrated to have high hazard.

Table 3. Form A-4 Landslide Area Hazard Rates without snow avalanches. The annualized rate of landslides that deliver to public resources and threaten public safety in terms of Landslide Frequency Rates and Landslide Area Rates for Delivery during the 30-year study period. For the purposes of this analysis, 'delivering landslides' are taken to include those that move rapidly and have a 'probable' or 'yes' delivery rating. Landslide Frequency Rates include deep-seated failures, but Landslide Area Rates for Delivery generally do not include any deep-seated failures.

	Landform number									Study area
	1	2	3	5	6	8	9	10	11	
Area of Landform (acres)	3842	2860	1529	126	1427	5036	491	70	34130	49509
Number of Landslides	87	7	23	2	12	47	5	6	52	241
Total number of photo years	30	30	30	30	30	30	30	30	30	30
Landslide Frequency Rate = (number of slides * 1,000,000 / Landform area / photo years)	755	82	502	530	280	311	340	2841	51	162
Landslide Frequency Rate Qualtative Rating	High	Low	High	Very high	High	High	High	Very high	Low	Moderate
Number of 'Delivering' Landslides	75	4	20	1	9	21	5	6	40	181
Area of 'Delivering' Landslides (acres)	74.4	2.4	5.6	3.2	4.3	9.6	160.2	82.8	29.2	371.7
Landslide Area Rate for Delivery = (area of delivering landslides * 1 million / Landform area / photo years)	646	28	121	842	101	63	10,887	39,205	28	250
Landslide Area Rate for Delivery Qualitative Rating	High	Low	Moderate	High	Moderate	Low	Very high	Very high	Low	High
Overall Hazard Rating	**High**	**Low**	**Moderate**	**Very high**	**High[1]**	**Low**	**Very high**	**Very high**	**Low**	**High**

[1] Rule-identified

[2] Calculated as low/moderate hazard; changed to high hazard due to numerous subsidary high hazard Landform 1's that captured mass-wasting events within the watershed.

Table 4. Form A-4 Snow Avalanches Area Hazard Rates. The annualized rate of landslides that deliver to public resources and threaten public safety in terms of Landslide Frequency Rates and Landslide Area Rates for Delivery during the 30-year study period. For the purposes of this analysis, ‘delivering landslides’ are taken to include those that move rapidly and have a ‘probable’ or ‘yes’ delivery rating.

	Landform number			Study area
	1	11	12	
Area of Landform (acres)	3842	34,130	951	38,922
Number of Landslides	27	1	16	44
Total number of photo years	30	30	30	30
Landslide Frequency Rate = (number of slides * 1,000,000 / Landform area / photo years)	234	1	561	38
Landslide Frequency Rate Qualtative Rating	High	Low	High	Low
Number of 'Delivering' Landslides	26	1	16	43
Area of 'Delivering' Landslides (acres)	127.4	0.7	138.6	266.8
Landslide Area Rate for Delivery = (area of delivering landslides * 1 million / Landform area / photo years)	1105	1	4859	228
Landslide Area Rate for Delivery Qualitative Rating	Very high	Low	Very high	High
Overall Hazard Rating	**Very high**	**Low**	**Very high**	**Moderate**

6.0 Confidence in Work Product

The confidence in this mass wasting assessment is high. This rating is based on the Landslide Hazard Zonation Project design to provide a watershed overview of slope stability in a timely manner with minimal field verification. As a consequence, fieldwork and the number of aerial photograph sets examined are held to reasonable minimums. Omissions will be present due to the limited field verification of individual features, particularly in forested areas with a dense canopy.

It is critical for the reader to understand that while these decisions are sufficient to characterize aspects of the slope failure as functions of forest management, this assessment would be entirely insufficient and misleading if it is used as a stand alone document for protecting private and public resources or for land use planning. Keep in mind that this is only a reconnaissance study, and undoubtedly, some landslides have been accidentally omitted and some benign features may be improperly mapped as landslides herein.

In addition, there are several sources of systematic error that reduce the confidence in the work products of this analysis, those being omission, misinterpretation, accuracy, and precision. Omission occurs when mass wasting features are not identified on aerial photographs or in the field due to canopy cover, gaps in the aerial photo record, quality of aerial photos, or interpreter errors. Misinterpretation occurs when a mass-wasting feature is identified but incorrectly classified or data are transposed, and where unrecognized software/file instability occurs. Accuracy involves the degree to which the physical parameters of a mass-wasting feature are correctly measured, and precision describes how variability within an assessment can be controlled when making multiple measurements over varying time and spatial scales (Parks, 2000).

This mass wasting assessment was primarily conducted with aerial photographs, and as a result, there is a high likelihood that errors of omission occurred primarily in areas covered by mature forest canopies, steep north facing slopes always in shadow at any given time, and those areas covered with extensive glacial deposits. The scarcity of mass wasting features identified under mature canopy and steep north slope aspect shadow conditions is not necessarily an indication of the relative stability of slopes with mature vegetation regimes or steep north face aspects.

Because many deep-seated landslide features are quite large, remain heavily vegetated during movement, and may not have obvious scars visible through the vegetation canopy, misinterpretation is more likely. A recent detailed study in Cowlitz County, Washington, suggests that up to 25 percent of inferred deep-seated landslides identified from aerial photograph analysis are misinterpreted (Wegmann, 2003). Confidence in work products related to classification of deep-seated landslide processes in this watershed is high due to visibility and completeness of photo coverage.

Another important source of potential error in this assessment is in the accuracy and precision of measurements of mass wasting features. Because very few landslides were actually visited in the field, it is not possible to report the degree to which location and measurement error in the GIS environment compares to on-the-ground field measurements. Similarly, measurements of slope angle from digital elevation models typically misrepresent the true hill slope angle. Given these sources of error, the confidence in the precise location and accuracy of measurements of individual landslides is considered moderate.

6.0 References

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Appendix A. A-1 Form: Landslide Inventory

Mass-Wasting Inventory Data for the Siouxon study area that includes parts of the Siouxon, Cougar, Swift Creek, and Canyon Creek WAU's. Codes for this table are presented on the DNR Forest Practices website. Under Photo_number column "LIDAR" indicates that the landslide was found using GIS lidar layers including layers derived from lidar such as contour lines, slope percent, and various hillshades. "FIELD" indicates that the landslide was discovered in the field and "ORTHO" indicates the landslide was found in the 1998 digital orthophotographs GIS layer.

PRELIM_LSI	LSI_PROCES	CERTAINTY	ld_date	Ls_size	ld2_date	ld2_size	INIT_ELEV	PHOTO_NUM	LANDFORM	SLP_SHP	GRADIENT	DELIVERY	LANDUSE	SIOUXON_LANDFORM	DSLS_ACTIVITY	ACRES	GEOL_UNIT	COMMENT
1005	4	D	2005	5			1164	LIDAR	9	2	83	N	4	2		91.4	Ova(2)	
1006	5	D	1980	5	1984	5	647	SW-PC 57A-2	9	2	80	N	4	6		3.4	Ova(2)	Poss crack/scarp
1009	2	D	1978	5			1894	SW-C 46B-6	2	2	60	P	5	1		0.3	Ova(1)	
1010	2	D	1978	5			1965	SW-C 46B-6	2	2	80	P	5	8		0.2	Ova(1)	
1011	2	D	1978	5			1956	SW-C 46B-6	2	2	72	P	5	8		0.2	Ova(1)	
1013	2	D	1978	5			1737	SW-C 46B-6	2	1	86	Y	5	1		0.7	Ova(1)	
1014	2	D	1978	5	1980	5	1550	SW-C 46B-6	2	2	60	Y	3	1		2.1	Ova(1)	
1015	1	D	1978	5	1980	5	1203	SW-C 46B-6	2	2	64	Y	5	11		0.1	Ova(1)	
1016	2	D	1978	4			1289	SW-C 46B-6	2	3	74	Y	5	6		0.1	Ova(1)	
1017	1	D	1978	3			1102	SW-C 46B-6	2	2	85	Y	5	1		0.3	Ova(1)	
1018	1	D	1978	3			1108	SW-C 46B-6	9	4	72	Y	5	6		0.3	Ova(1)	
1019	2	D	1978	3			1179	SW-C 46B-6	2	3	89	Y	5	1		0.3	Ova(1)	
1020	2	D	1978	3			1157	SW-C 46B-8	2	1	72	Y	5	3		0.6	Qva	
1021	2	P	1978	3			1136	SW-C 46B-8	2	2	34	Y	5	3		0.3	Qvc(1sh)	
1023	1	D	1978	3			868	SW-C 46B-8	7	2	76	N	5	8		0.3	Qvc(sh1)	Possibly destroyed road; 30 ft vertical headwall above road; muddy matrix; landslide runout/body is coved in similar-aged alder; appears much younger than pre-1978 date
1029	2	D	1978	3			693	SW-C 46B-8	2	2	20	Y	5	11		0.1	OEvc(1)	
1030	2	D	1978	3			924	SW-C 46B-8	1	2	15	Y	5	11		0.1	OEvc(1)	
1042	9	D	1978	3			3694	SW-C 47B-8	6	1	100	Y	3	12		6.4	Migd(sl)	
1043	9	D	1978	3			3659	SW-C 47D-8	6	1	158	Y	3	1		4.7	Midg(sl)	
1045	9	P	1978	3			3469	SW-C 47B-4	2	2	57	Y	3	1		4.8	MOvc(2)	
1050	9	D	1978	3			3345	SW-C 47B-4	3	3	71	Y	3	12		11.3	MOvc(2)	
1051	9	D	1978	3			2942	SW-C 47B-4	3	3	89	Y	3	12		6.2	MOvc(2)	
1052	2	D	1978	3			1136	SW-C 47B-8	2	3	79	Y	5	3		0.1	Qvc(1sh)	
1053	9	D	1978	3	1998	3	3371	SW-C 47B-4	3	2	103	Y	3	1		2.3	MOvc(2)	
1054	9	P	1978	3			3177	SW-C 47B-4	3	3	69	P	3	1		3.0	Qad(e)	
1055	9	D	1978	3			3958	SW-C 47B-4	3	3	72	Y	3	12		17.3	MOvc(2)	
1056	9	P	1978	5			3455	SW-C 47B-4	3	2	58	Y	3	1		3.7	MOvc(2)	
1057	9	P	1978	5			3281	SW-C 47B-4	3	2	65	Y	3	1		2.1	MOvc(2)	
1058	9	P	1978	5			3310	SW-C 47B-4	3	2	50	Y	3	1		2.7	MOvc(2)	
1059	9	D	1978	5			4023	SW-C 47B-4	3	2	104	Y	3	1		20.4	MOvc(2)	
1060	9	D	1978	5			3856	SW-C 47B-4	3	2	70	Y	3	1		8.1	Mian(ss)	
1062	9	P	1978	4			3901	SW-C 47B-4	3	2	76	Y	3	12		6.4	Mian(ss)	
1063	9	D	1978	3			3984	SW-C 47B-4	3	2	87	P	3	12		3.8	Mian(ss)	Possible talus
1064	9	P	1978	3			3803	SW-C 47B-4	3	3	103	Y	3	12		5.5	MOvc(2)	
1065	9	P	1978	5			3333	SW-C 47B-4	3	2	70	Y	3	1		1.4	MOvc(2)	
1066	9	P	1978	4	1980	4	3061	SW-C 47B-4	3	2	58	Y	3	1		1.0	MOvc(2)	

PRELIM_LSI	LSI_PROCES	CERTAINTY	ld_date	Ls_size	ld2_date	ld2_size	INIT_ELEV	PHOTO_NUM	LANDFORM	SLP_SHP	GRADIENT	DELIVERY	LANDUSE	SIOUXON_LANDFORM	DSLS_ACTIVITY	ACRES	GEOL_UNIT	COMMENT
1069	2	D	1978	4			3291	SW-C 47B-4	2	1	73	Y	3	1		1.6	MOvc(2)	>90% trees above failure pistol-butt; H2O seep in headwall (<0.5gpm); in failure vine maple bent downslope; horizontal bench at top of headwall; trees not pistol-butt on bench
1072	2	P	1978	2			2415	SW-C 47B-6	2	3	59	Y	3	1		0.3	Qad(e)	
1080	7	D	1978	5			2103	SW-C 47B-6	2	3	78	Y	3	1		0.1	MOvc(2)	Cutbank
1081	9	P	1978	5	1980	5	3191	SW-C 47B-6	3	2	41	Y	3	1		2.4	MOvc(2)	
1083	9	D	1978	5	1980	5	3237	SW-C 47B-6	6	1	73	Y	3	1		2.3	MOvc(2)	
1084	9	D	1978	5	1980	5	3282	SW-C 47B-6	6	2	90	Y	3	1		2.9	MOvc(2)	
1085	9	D	1978	5			2808	SW-C 47B-6	6	3	88	N	3	1		1.1	MOvc(2)	
1092	2	D	1978	5			2243	SW-C 45B-6	2	1	63	Y	3	11		1.0	MOvc(2)	Possible dam created that caused 3000?
1097	2	D	1978	5			2583	SW-C 47B-6	1	1	24	Y	1	11		0.5	MOvc(2)	
1098	9	D	1978	5			3899	SW-C 47B-6	6	2	98	Y	3	12		9.6	Migd(sl)	
1099	9	D	1978	5	1984	5	3901	SW-C 47B-6	6	2	92	Y	3	1		8.8	Migd(sl)	
1100	9	D	1978	5			3866	SW-C 47B-6	6	2	131	Y	3	1		7.3	Migd(sl)	
1101	9	D	1978	5			3665	SW-C 47B-6	6	2	66	Y	3	1		0.8	MOvc(2)	
1102	9	D	1978	5	1980	5	3662	SW-C 47B-6	6	3	73	Y	3	12		4.1	MOvc(2)	
1103	9	D	1978	5	1980	5	3567	SW-C 47B-6	6	3	89	Y	3	1		2.1	MOvc(2)	
1104	9	D	1978	2			3759	SW-C 47B-6	6	3	110	Y	3	12		4.9	MOvc(2)	
1105	9	D	1978	5			3566	SW-C 47B-6	6	3	101	Y	3	12	b	2.8	MOvc(2)	
1106	9	D	1978	3			3461	SW-C 47B-6	6	4	74	Y	3	1		2.9	MOvc(2)	
1107	9	P	1978	3			3553	SW-C 47B-6	6	2	84	Y	3	1		1.7	MOvc(2)	
1108	9	D	1978	3			3742	SW-C 47B-6	6	2	50	Y	3	12		2.5	MOvc(2)	
1109	9	D	1978	3			3811	SW-C 47B-6	6	3	40	Y	3	11		0.7	MOvc(2)	
1110	1	D	1978	4			2323	SW-C 47B-6	1	3	63	Y	5	1		0.2	MOvc(2)	Sidecast failure
1111	1	D	1978	4			2387	SW-C 47B-6	7	3	71	Y	5	8		0.3	MOvc(2)	Sidecast failure
1112	1	D	1978	2			2405	SW-C 47B-6	1	3	40	P	5	1		0.1	MOvc(2)	Sidecast failure?
1113	2	P	1978	2			3509	SW-C 47B-6	1	2	72	Y	1	1		0.7	Migd(sl)	
1114	2	P	1978	4			3512	SW-C 47B-6	1	2	74	Y	1	1		0.7	Migd(sl)	
1115	2	P	1978	3			3329	SW-C 47B-6	1	2	69	Y	5	1		0.6	MOvc(2)	
1116	2	P	1978	4			3052	SW-C 47B-6	7	3	46	Y	5	11		0.3	MOvc(2)	
1117	2	D	1978	5	1988	5	3177	SW-C 47B-8	1	2	82	Y	5	1		4.5	MOvc(2)	Even-aged alder in drainage floor; large log jam upstream of road crossing; underfit (dry) stream; flat drainage floor is over 100 ft wide
1119	9	P	1978	3			3094	SW-C 47B-8	1	1	54	Y	3	1		4.3	MOvc(2)	
1120	9	D	1978	4			3666	SW-C 46B-8	1	1	112	Y	3	1		12.6	Migd(sl)	
1121	9	D	1978	2			3404	SW-C 47B-8	6	4	103	Y	3	12		13.8	MOvc(2)	
1122	9	D	1978	2			3221	SW-C 47B-8	6	2	63	Y	3	1		7.3	MOvc(2)	

PRELIM_LSI	LSI_PROCES	CERTAINTY	ld_date	Ls_size	ld2_date	ld2_size	INIT_ELEV	PHOTO_NUM	LANDFORM	SLP_SHP	GRADIENT	DELIVERY	LANDUSE	SIOUXON_LANDFORM	DSLS_ACTIVITY	ACRES	GEOL_UNIT	COMMENT
1123	9	D	1978	5	1989	5	3584	SW-C 47B-8	6	2	85	Y	3	1		6.8	MOvc(2)	
1125	5	Q	1978	3	1998	3	1631	SW-C 47BN-8	2	1	31	N	4	1		5.3	MOvc(2)	Stream and very wet area; very steep topography; however no signs of mass wasting
1126	2	P	1978	2			1572	SW-C 47B-8	1	1	31	Y	5	11		1.6	MOvc(2)	Possible culvert blow-out; large cobbles in underfit drainage; no current evidence of mass-wasting
1127	2	P	1978	3			1492	SW-C 47B-8	1	2	24	Y	5	11		1.5	Ova(1)	
1128	2	D	1978	3			932	SW-C 47B-8	1	2	48	Y	5	11		0.7	Qvc(1sh)	
1131	2	D	1978	5			1306	SW-C 47B-8	2	3	151	Y	3	3		0.2	Ova(1)	
1132	1	P	1978	5			1067	SW-C 47B-8	4	3	73	Y	2	3		0.1	Qvc(1sh)	
1141	2	D	1978	5			1179	SW-C 47B-8	1	2	69	N	5	3		0.3	Qvc(1sh)	
1142	2	D	1978	4	1988	4	1159	SW-C 47B-8	1	2	67	N	5	3		0.2	Qvc(1sh)	
1143	2	D	1978	3			1260	SW-C 47B-8	4	3	56	Y	5	3		0.2	Qvc(1sh)	
1144	2	D	1978	3			1250	SW-C 47B-8	2	3	69	Y	5	3		0.2	Qvc(1sh)	
1145	2	D	1978	5			1163	SW-C 47B-8	1	3	27	Y	5	3		0.1	Qvc(1sh)	
1146	2	D	1978	4			1163	SW-C 47B-8	1	3	59	Y	5	3		0.2	Qvc(1sh)	
1147	2	P	1978	3			1199	SW-C 47B-8	4	3	70	Y	5	3		0.2	Qvc(1sh)	
1148	2	P	1978	2			1241	SW-C 47B-8	4	3	60	Y	5	3		0.2	Qvc(1sh)	
1151	2	P	1978	2			1272	SW-C 47B-8	4	3	62	Y	5	3		0.2	Qvc(1sh)	
1152	2	P	1978	4			1213	SW-C 47B-8	1	3	74	Y	5	3		0.2	Qvc(1sh)	
1153	2	P	1978	3			1240	SW-C 47B-8	1	3	48	Y	5	1		0.2	Qvc(1sh)	
1154	2	P	1978	3			1202	SW-C 47B-8	2	3	51	Y	5	1		0.1	Qvc(1sh)	
1156	1	D	1978	4			1111	SW-C 47B-8	2	2	109	Y	5	1		0.2	Qvc(1sh)	
1158	2	D	1978	3			1162	SW-C 47B-8	4	3	28	Y	5	3		0.1	Qvc(1sh)	
1159	1	D	1978	4	1988	4	1100	SW-C 47B-8	4	3	53	Y	5	3		0.1	Qvc(1sh)	
1161	9	D	1978	4			4004	SW-C 48B-5	6	3	94	Y	3	12		18.5	MOvc(2)	
1164	9	D	1978	5			4119	SW-C 48B-5	6	3	97	Y	3	12		12.3	MOvc(2)	
1165	9	D	1978	4			3917	SW-C 48B-5	6	2	153	Y	3	1		8.9	MOvc(2)	
1166	9	D	1978	3			3939	SW-C 48B-5	6	3	117	Y	3	12		13.4	MOvc(2)	
1167	9	D	1978	3			3289	SW-C 48B-5	2	1	73	Y	3	1		2.2	MOvc(2)	
1170	2	D	1978	2			2216	SW-C 48B-5	1	2	28	Y	5	11		0.5	MOvc(2)	
1171	2	D	1978	4			2218	SW-C 48B-5	1	3	30	N	5	11		0.2	MOvc(2)	
1172	2	D	1978	4			2243	SW-C 48B-5	2	3	36	N	5	11		0.1	MOvc(2)	
1174	8	P	1978	2			1193	SW-C 44-23	6	3	88	N	4	2		25.1	MOvc(2)	
1174	8	P	1978	2			1193	SW-C 44-23	6	3	88	Y	4	10		6.2	MOvc(2)	
1176	2	P	1978	2			1133	SW-C 44-23	1	2	23	Y	2	8		0.7	Ova(2)	
1177	1	D	1978	2			679	SW-C 44-23	8	2	62	N	5	2		0.8	Qls	
1178	2	P	1978	2			807	SW-C 44-23	7	3	61	N	5	8		0.1	Ova(1)	
1183	4	P	1978	3			724	SW-C 44-23	2	2	113	N	4	5	b	2.9	MOvc(2)	May be recent; disturbed trees in orthophotos
1190	1	P	1978	4			1222	SW-C 45B-8	2	1	80	Y	5	6		3.3	MOvc(2)	80ft wide section road down-dropped 30ft
1191	2	D	1978	5			1243	SW-C 45B-8	2	1	105	Y	5	1		2.7	MOvc(2)	
1192	2	D	1978	2			1243	SW-C 45B-8	2	1	110	Y	5	1		5.4	MOvc(2)	

PRELIM_LSI	LSI_PROCES	CERTAINTY	ld_date	Ls_size	ld2_date	ld2_size	INIT_ELEV	PHOTO_NUM	LANDFORM	SLP_SHP	GRADIENT	DELIVERY	LANDUSE	SIOUXON_LANDFORM	DSLS_ACTIVITY	ACRES	GEOL_UNIT	COMMENT
1193	8	Q	1978	2			2053	SW-C 45B-8	6	3	102	N	4	8		43.5	MOvc(2)	
1194	8	Q	1978	4			2722	SW-C 45B-8	6	2	105	N	4	8		31.2	MOvc(2)	
1196	8	D	1978	3			3013	SW-C 45B-8	6	3	138	N	4	8		6.7	MOian	Rockslide per Evarts and Ashley, 1990
1200	4	D	1978	3			1795	SW-C 45B-8	6	2	119	P	4	10	b	4.0	MOvc(2)	Toe of DSLS
1200	4	D					1795	SW-C 45B-8	6	2	119	N	4	2	b	129.2	MOvc(2)	
1201	2	D	1978	4	1998	4	1363	SW-C 45B-6	2	1	71	Y	5	11		5.3	Ova(2)	
1202	2	D	1978	5			1341	SW-C 45B-6	2	1	48	Y	5	11		2.5	Ova(2)	
1204	5	P	1978	5			2134	SW-C 45B-6	6	3	107	N	4	8		24.7	Mian(ss)	Talus? Is visible in orthophotos
1206	2	D	1978	5			2506	SW-C 45C-4	2	1	82	Y	1	1		4.0	Ova(1)	RO may have made it to lake; AF at stream mouth
1207	2	D	1978	5			2554	SW-C 45C-4	2	1	89	Y	1	1		4.9	Ova(1)	RO may have made it to lake; AF at stream mouth
1208	2	P	1978	5			2218	SW-C 45C-4	1	1	64	Y	3	1		0.5	Ova(1)	Scoured channel
1210	2	P	1978	5			2916	SW-C 45C-4	2	3	63	Y	3	8		2.9	MOvc(2)	
1225	2	D	1980	2			1267	SW-PC 57A-2	8	2	91	P	5	8		0.1	Ova(2)	
1226	2	D	1980	4	1999	4	1205	SW-PC 57A-2	8	3	113	P	5	8		0.1	MOvc(2)	
1227	2	D	1980	3			672	SW-PC 57A-2	9	3	84	Y	5	6		0.1	Ova(2)	
1228	2	D	1980	3			637	SW-PC 57A-2	9	3	124	Y	5	6		0.1	Ova(2)	
1230	2	P	1980	3			948	SW-PC 57A-2	2	2	73	Y	5	1		0.6	Ova(2)	
1231	2	P	1980	5	1998	5	925	SW-PC 57A-2	2	2	65	Y	1	1		1.0	Ova(2)	
1233	1	D	1980	4			931	SW-PC 57A-2	7	3	46	N	5	8		0.0	Ova(1)	
1234	1	D	1980	2			964	SW-PC 57A-2	2	3	43	N	5	11		0.0	Ova(1)	
1236	1	D	1980	5			1274	SW-PC 59A-2	2	3	106	P	5	1		0.6	MOvc(2)	
1238	1	D	1980	2			489	SW-PC 59A-2	2	3	27	Y	3	11		0.1	Movc(2)	
1239	1	D	1980	4			737	SW-PC 59A-2	4	3	40	P	5	11		0.5	Qap(a)	
1240	5	D	1980	4			1129	SW-PC 59A-2	2	3	112	P	1	1		2.1	MOvc(2)	Increased in size after pre-1988 harvest
1246	5	D	1980	5			2126	SW-PC 59A-9	2	2	91	Y	1	1		0.1	Ova(1)	
1247	2	P	1980	5			2517	SW-PC 59A-11	2	1	89	Y	3	1		0.9	MOvc(2)	
1257	2	D	1980	4			1802	SW-PC 63B-14	7	1	31	P	5	11		0.1	MOvc(2)	No evidence during field check
1258	2	D	1980	3			1814	SW-PC 63B-14	7	1	20	P	5	11		0.1	MOvc(2)	No evidence during field check
1259	2	D	1980	5			1812	SW-PC 63B-14	2	1	30	Y	5	11		1.1	MOvc(2)	digiti from photo; DEM does not represent drainage
1260	2	D	1980	4			2516	SW-PC 65B-2	2	1	71	Y	5	1		0.4	Qvb	
1262	1	P	1984	3			1044	SWP-C 8-52-167	2	2	96	N	1	1		0.1	MOvc(2)	
1263	2	D	1984	5			1439	SWP-C 8-52-167	1	1	61	P	1	1		0.2	Ova(2)	
1264	2	D	1984	5			646	SWP-C 8-52-167	8	3	66	Y	5	2		0.1	Qls	

PRELIM_LSI	LSI_PROCES	CERTAINTY	ld_date	Ls_size	ld2_date	ld2_size	INIT_ELEV	PHOTO_NUM	LANDFORM	SLP_SHP	GRADIENT	DELIVERY	LANDUSE	SIOUXON_LANDFORM	DSLS_ACTIVITY	ACRES	GEOL_UNIT	COMMENT
1265	2	P	1984	3			2158	SWP-C 8-52-174	2	1	110	Y	3	1		1.6	Ova(1)	
1266	5	P	1984	5			2090	SWP-C 8-52-174	2	2	93	P	3	1		1.8	Ova(1)	
1267	5	P	1984	5			2433	SWP-C 40-54-114	2	2	86	Y	2	1		2.1	MOvc(2)	
1268	2	D	1984	3			1390	SWP-C 22-56-235	7	3	100	P	5	11		0.7	Ova(1)	Wet soil marked by maple and furns; surrounded by fir trees
1269	2	D	1984	5			1371	SWP-C 22-56-235	2	3	110	P	5	8		0.3	Ova(1)	Wet soil marked by maple and furns; surrounded by fir trees
1270	2	D	1984	5			1297	SWP-C 22-56-235	7	3	95	N	5	11		0.2	Ova(1)	Wet soil marked by maple and furns; surrounded by fir trees
1271	4	Q	1984	5			984	SWP-C 22-56-235	6	2	109	N	4	8	c	32.8	Ova(1)	
1272	2	D	1984	2	2005	2	3038	SWP-C 22-58-176	2	1	61	Y	1	1		0.8	MOvc(2)	
1273	2	D	1984	5			2662	SWP-C 22-58-176	1	2	95	Y	5	1		0.3	MOvc(2)	
1274	2	D	1984	5			2758	SWP-C 22-58-176	1	2	51	P	5	1		0.0	MOvc(2)	
1275	2	D	1984	5			2751	SWP-C 22-58-176	1	2	60	P	5	1		0.0	MOvc(2)	
1277	2	D	1984	3			2986	SWP-C 22-58-178	7	2	36	N	5	11		0.5	MOvc(2)	
1278	2	P	1984	3			2284	SWP-C 22-58-178	4	2	50	Y	1	11		0.2	MOvc(2)	
1279	2	D	1984	2			1828	SWP-C 22-58-178	2	1	89	Y	1	1		0.1	MOvc(2)	
1280	2	P	1984	5			1463	SWP-C 22-58-178	2	1	75	P	5	11		0.4	MOvc(2)	
1281	2	D	1984	3			1272	SWP-C 22-58-178	7	3	163	D	3	3		0.2	Ova(1)	
1282	5	D	1984	3			1751	SWP-C 22-57-199	7	3	32	Y	3	11		0.6	MOvc(2)	
1283	2	D	1988	4			1161	SWP-C 35-88-162	2	2	114	P	5	3		0.8	Ova(1)	Appears as entire road was destroyed
1284	2	D	1988	2			1163	SWP-C 35-88-162	2	2	92	P	5	1		2.1	Ova(1)	Appears as entire road was destroyed
1285	2	D	1988	3			995	SWP-C 35-88-162	2	2	90	P	5	1		0.4	Ova(1)	
1286	1	D	1988	4	1999	4	973	SWP-C 35-88-162	2	3	92	P	5	1		0.2	Ova(1)	
1287	2	D	1988	3			923	SWP-C 35-88-162	1	2	88	P	5	3		0.3	OEvc(1)	

PRELIM_LSI	LSI_PROCES	CERTAINTY	ld_date	Ls_size	ld2_date	ld2_size	INIT_ELEV	PHOTO_NUM	LANDFORM	SLP_SHP	GRADIENT	DELIVERY	LANDUSE	SIOUXON_LANDFORM	DSLS_ACTIVITY	ACRES	GEOL_UNIT	COMMENT
1288	2	D	1988	5			747	SWP-C 35-90-203	8	2	49	N	5	11		0.0	Qap(a)	
1289	2	P	1988	5			3365	SWP-C 28-94-68	1	2	64	Y	1	1		0.6	MOvc(2)	
1290	2	D	1988	2			2542	SWP-C 28-96-12	1	1	38	Y	5	1		0.7	MOvc(2)	
1291	2	D	1988	3			2444	SWP-C 28-96-12	7	1	75	Y	1	8		0.1	MOvc(2)	
1293	2	P	1988	5			1984	SWP-C 28-96-12	7	2	40	N	5	8		0.1	MOvc(2)	
1294	2	D	1988	1			2426	SWP-C 28-96-12	7	2	19	N	5	11		0.1	MOvc(2)	
1295	2	D	1988	2			2620	SWP-C 28-96-12	2	2	39	P	5	1		0.1	MOvc(2)	
1296	2	D	1988	3			3277	SWP-C 28-96-12	7	3	88	N	5	8		0.3	MOva(2)	
1297	2	D	1988	5			2431	SWP-C 28-96-12	2	1	42	Y	1	8		0.5	MOvc(2)	
1298	4	Q	1988	3			2167	SWP-C 27-97-114	7	3	63	N	4	8	c	15.2	MOvc(2)	
1299	2	P	1988	3			1093	SWP-C 27-98-114	7	2	52	Y	1	11		0.1	MOvc(2)	
1300	2	D	1988	4			1532	SWP-C 27-98-114	7	2	57	Y	5	2		0.1	MOvc(2)	
1301	2	D	1993	5			1582	SW 13-90-248	2	1	82	P	1	1		0.5	MOvc(2)	
1302	2	P	1993	2			1239	SW 13-90-248	2	2	97	N	1	1		0.1	MOvc(2)	
1303	2	D	1993	2			1425	SW 13-90-248	7	2	48	N	5	8		0.2	MOvc(2)	
1304	2	D	1993	3			1128	SW 13-90-259	1	2	124	P	5	1		0.9	Ova(1)	
1305	5	P	1990	5			1868		5	2	107	Y	4	9		54.3	OEvc(1)	Evarts and Ashley, 1990
1306	5	P	1990	3			2047		5	2	70	Y	4	9		35.2	Ova(1)	Evarts and Ashley, 1990
1307	5	P	1969	3			1724	SW-H-69 72-15A-13	5	2	161	P	4	9	C	50.4	Ova(1)	
1308	5	P	1990	2			2243		5	2	140	P	4	9		22.6	Ova(1)	Evarts and Ashley, 1990
1309	5	D	1969	5			1469	SW-H-69 72-15A-13	1	1	118	Y	2	9		5.1	OEvc(1)	Maped by Evarts and Ashley (1990)
1345	5	P	1969	4			1695	SW-H-69 72-15A-13	2	2	125	N	4	1	B	3.5	Qls	management related deep-seated
1355	1	P	1969	4			681	SW-H-69 72-15A-12	2	2	73	P	5	8		0.1	MOvc(2)	largest of several small fill failures
1356	2	P	1969	2			1003	SW-H-69 72-15A-12	1	1	76	Y	1	8		0.6	MOvc(2)	
1357	2	D	1969	1			822	SW-H-69 72-15A-12	1	1	68	Y	5	6		0.1	MOvc(2)	
1358	2	D	1969	3			882	SW-H-69 72-15A-12	1	1	20	Y	5	6		0.1	Qap(a)	
1359	2	D	1969	3			886	SW-H-69 72-15A-12	1	1	58	Y	5	6		0.1	Qap(a)	

PRELIM_LSI	LSI_PROCES	CERTAINTY	ld_date	Ls_size	ld2_date	ld2_size	INIT_ELEV	PHOTO_NUM	LANDFORM	SLP_SHP	GRADIENT	DELIVERY	LANDUSE	SIOUXON_LANDFORM	DSLS_ACTIVITY	ACRES	GEOL_UNIT	COMMENT
1360	7	Q	1969	3			1865	SW-H-69 72-15A-12	5	3	134	N	4	8		313.2	Ova(2)	dormant indistinct slump-flow, mapping equivocal
1361	1	D	1969	3			1150	SW-H-69 72-15A-12	2	1	36	Y	5	1		0.5	Qap(a)	
1362	1	P	1969	3			881	SW-H-69 72-15A-12	2	1	89	Y	1	1		0.1	Qap(a)	
1363	1	D	1969	3			1186	SW-H-69 72-15A-12	1	1	23	Y	5	11		3.0	Qap(a)	Big debris flow
1364	1	D	1969	5			739	SW-H-69 72-15A-12	9	4	23	I	5	11		0.0	MOvc(2)	Minor fill failure
1365	1	Q	1969	5			1352	SW-H-69 72-15A-12	2	1	80	Y	4	1		0.9	Movc(2)	Deep inner gorge, almost certainly failed
1366	1	Q	1969	2			1339	SW-H-69 72-15A-12	2	1	127	Y	4	1		0.8	MOvc(2)	Deep inner gorge, almost certainly failed
1367	4	Q	1969	3			1856	SW-H-69 125-15-12	5	2	125	P	4	10	b	29.7	Mian(ss)	Possibly translational; toe
1367	4	Q	1969	3			1856	SW-H-69 125-15-12	5	2	125	N	4	8	b	514.3	Mian(ss)	Possibly translational
1368	4	Q	1969	5			2729	SW-H-69 125-15-12	5	3	83	P	4	10	c	25.9	MOvc(2)	Toe; possible large translational
1368	4	Q	1969	5			2729	SW-H-69 125-15-12	5	3	83	N	4	8	c	1023	MOvc(2)	Possible large translational - why is scarp fresh?
1369	1	Q	1969	3			2349	SW-H-69 125-15-12	2	1	69	Y	3	1		0.6	MOvc(2)	possibly outcrop
1370	2	Q	1969	3			2254	SW-H-69 125-15-12	1	1	51	Y	2	6		0.2	Qad(e)	possible outcrop
1371	8	D	1969	2			3132	SW-H-69 125-15-12	6	2	105	N	4	8		45.6	Moian	Big rock slide - clear on this photo
1372	2	D	1969	5			2205	ORTHO	6	2	109	N	3	8		0.7	Movc(2)	small slide on big rock topple
1373	2		1969	5			1313	ORTHO	1	1	90	Y	3	1		0.4	Qls	possible debris flow on deep seated
1374	8		1969	4			2509	SW-H-69 125-15-12	2	3	193	N	4	1		2.5	Ova(1)	1374-1377 could be one slide
1375	8		1969	2			2625	SW-H-69 125-15-12	2	3	200	N	4	1		1.1	Ova(1)	1374-1377 could be one slide
1376	8		1969	2			2640	SW-H-69 125-15-12	2	3	159	N	4	1		0.4	Ova(1)	1374-1377 could be one slide
1377	8		1969	3			2624	SW-H-69 125-15-12	2	3	103	N	4	1		3.7	Ova(1)	1374-1377 could be one slide
1378	4	Q	1969	2			2677	SW-H-69 125-15-12	5	2	87	N	4	8	b	181.4	MOvc(2)	marginal
1383	1	P	1999	5			731	SW-C-99 52-95-198	2	1	109	Y	5	1		0.1	Ova(2)	starts as cut bank failure
1385	7	Q	1965	5			1739	LIDAR	6	2	100	N	4	8		170.3	MOvc(2)	mapped by analogy with 1384
1386	7	Q	1965	3			1534	LIDAR	6	2	113	N	4	8		77.3	MOvc(2)	mapped by analogy with 1384

PRELIM_LSI	LSI_PROCES	CERTAINTY	ld_date	Ls_size	ld2_date	ld2_size	INIT_ELEV	PHOTO_NUM	LANDFORM	SLP_SHP	GRADIENT	DELIVERY	LANDUSE	SIOUXON_LANDFORM	DSLS_ACTIVITY	ACRES	GEOL_UNIT	COMMENT
1386	7	Q	1965	3			1534	LIDAR	6	2	113	Y	4	5		3.2	MOvc(2)	mapped by analogy with 1384; toe of DSLS
1387	7	P	2005	3			2854	LIDAR	7	2	37	Y	4	10		3.6	MOvc(2)	Toe of earthflow
1387	7	Q	2005	3			2854	LIDAR	7	2	37	N	4	11		406.5	MOvc(2)	
1388	1	P	1998	3			1070	ORTHO	2	1	113	P	4	1		0.1	MOvc(2)	
1389	8	Q	2005	3			1222	LIDAR	6	2	109	N	4	8		8.9	Ova(2)	
1390	5	Q	1999	5			2475	SW-C-99 47-97-229	2	1	84	I	3	1		6.0	Ova(1)	
1391	1	P	1999	5			1064	SW-C-99 47-97-219	4	2	112	I	1	8		5.7	MOvc(2)	stopped at road
1392	2	D	1999	5			924	SW-C-99 47-97-219	8	1	103	Y	1	1		0.2	MOvc(2)	small slides on large shallow rapid
1393	2	D	1999	5			919	SW-C-99 47-97-219	8	1	131	Y	1	1		0.2	MOvc(2)	small slides on large shallow rapid
1394	2	Q	1999	5			1399	SW-C-99 47-97-219	1	1	25	P	1	11		0.1	MOvc(2)	low slope angle, questionable
1395	2	Q	1999	5			1112	SW-C-99 48-99-160	1	1	39	Y	3	3		1.1	Qvc(1sh)	
1396	2	Q	1999	5			1115	SW-C-99 48-99-160	1	1	31	Y	3	3		0.2	Qvc(1sh)	
1397	2	Q	1999	5			1039	SW-C-99 48-99-160	1	1	81	Y	3	3		0.2	Qvc(1sh)	
1398	8	D	1999	4			2327	SW-C-99 48-99-153	6	4	51	N	4	11		0.5	MOvc(2)	
1399	2	Q	1999	2			1175	SW-C-99 48-99-149	2	1	56	Y	1	1		0.1	MOvc(2)	
1400	2	P	1999	3			1588	SW-C-99 48-99-149	1	1	61	Y	1	11		0.1	MOvc(2)	
1401	2	D	1998	4	1999		1980	SW-C-99 48-99-149	2	1	54	Y	1	1		0.5	MOvc(2)	
1402	2	D	1999	3			1988	SW-C-99 48-99-149	1	1	76	Y	5	1		0.3	MOvc(2)	
1403	5	Q	1999	5			2396	SW-C-99 48-101-195	2	2	38	Y	3	11		3.8	MOvc(2)	
1404	1	Q	1999	5			1735	SW-C-99 48-101-195	2	1	39	Y	3	8		2.6	MOvc(2)	
1405	1	Q	1999	2			3012	SW-C-99 48-101-197	2	1	69	Y	3	1		0.0	MOvc(2)	
1406	1	Q	1999	3			1805	SW-C-99 48-101-200	9	2	38	P	1	11		0.1	MOvc(2)	several small streamside slumps
1409	4	Q	1999	5			2446	SW-C-99 48-103-249	6	4	35	N	1	8	b	25.3	MOvc(2)	edge lloks like scarp, age indeterminant
1410	1	P	1999	1			2256	SW-C-99 48-103-249	1	1	51	Y	1	11		0.0	MOvc(2)	
1411	1	Q	1999	2			1282	SW-C-99 48-103-249	2	1	79	P	1	1		0.0	MOvc(2)	
1412	1	Q	1999	3			1878	SW-C-99 48-103-249	1	1	49	P	5	11		0.2	MOvc(2)	

PRELIM_LSI	LSI_PROCES	CERTAINTY	ld_date	Ls_size	ld2_date	ld2_size	INIT_ELEV	PHOTO_NUM	LANDFORM	SLP_SHP	GRADIENT	DELIVERY	LANDUSE	SIOUXON_LANDFORM	DSLS_ACTIVITY	ACRES	GEOL_UNIT	COMMENT
1413	2	P	1999	5			3114	SW-C-99 48-103-247	2	1	114	Y	5	1		1.8	MOvc(2)	
1414	2	P	1999	3			3135	SW-C-99 48-103-247	2	1	112	Y	5	8		0.3	MOvc(2)	
1415	2	P	1999	3			3140	SW-C-99 48-103-247	2	1	110	Y	5	11		0.2	MOvc(2)	
1416	2	P	1999	4			2562	SW-C-99 48-103-247	1	1	64	Y	5	1		0.7	MOvc(2)	
1417	2	P	1999	5			2364	SW-C-99 48-103-247	2	1	41	Y	5	1		1.1	MOvc(2)	
1418	2	P	1999	2			1853	SW-C-99 48-103-247	1	1	56	Y	2	8		0.1	MOvc(2)	
1419	2	P	1999	2			1844	SW-C-99 48-103-247	1	1	75	Y	2	8		0.1	MOvc(2)	
1420	2	Q	1999	3			2781	SW-C-99 48-103-245	1	1	47	Y	1	11		0.3	MOvc(2)	
1421	4	Q	1999	5			3465	SW-C-99 48-103-245	7	2	79	N	4	8	c	11.9	MOvc(2)	
1422	2	Q	1999	3			2829	SW-C-99 48-103-245	1	1	44	Y	1	1		0.3	MOvc(2)	
1423	2	P	1999	3			2553	SW-C-99 48-103-245	1	1	51	Y	1	11		0.3	MOvc(2)	
1425	2	Q	1999	3			2800	SW-C-99 48-103-245	1	1	55	Y	5	11		0.1	MOvc(2)	
1426	4	P	1999	5			2355	SW-C-99 49-105-27	6	3	47	P	4	10	b	13.5	MOvc(2)	distinct translational
1426	4	P	1999	5			2355	SW-C-99 49-105-27	6	3	47	N	4	8	b	77.8	MOvc(2)	distinct translational
1427	2	D	1999	4			1706	SW-C-99 49-105-27	8	1	69	Y	5	2		0.6	Qls	in inner gorge on DSL
1428	1	P	1999	4			1762	SW-C-99 49-105-27	6	3	37	P	5	11		0.9	MOvc(2)	
1430	1	Q	1999	2			1429	SW-C-99 49-105-27	9	1	26	Y	2	11		0.0	MOvc(2)	
1432	2	Q	1999	1			1924	SW-C-99 49-105-27	1	1	65	Y	2	8		0.0	MOvc(2)	
1439	2	D	1999	3			1770	SW-C-99 49-105-27	2	1	51	Y	1	1		0.3	MOvc(2)	
1441	2	D	1999	3			1634	SW-C-99 49-105-27	1	1	16	Y	2	11		0.2	MOvc(2)	
1442	2	D	1999	3			1652	SW-C-99 49-105-27	1	1	15	Y	5	11		0.2	MOvc(2)	
1443	2	D	1999	3			1636	SW-C-99 49-105-27	1	1	28	Y	5	11		0.1	MOvc(2)	
1445	2	Q	1999	3			1555	SW-C-99 49-105-27	1	1	47	Y	1	8		0.1	MOvc(2)	
1446	2	Q	1999	3			1589	SW-C-99 49-105-27	6	2	51	N	4	8		0.2	MOvc(2)	
2000	5	D	2005	5			948	FIELD	8	2	85	Y	1	2		1.6	Qls	Occured 1996 rain-on-snow event; still active

PRELIM_LSI	LSI_PROCES	CERTAINTY	ld_date	Ls_size	ld2_date	ld2_size	INIT_ELEV	PHOTO_NUM	LANDFORM	SLP_SHP	GRADIENT	DELIVERY	LANDUSE	SIOUXON_LANDFORM	DSLS_ACTIVITY	ACRES	GEOL_UNIT	COMMENT
2002	5	D	2005	5			1183	FIELD; verba. comm. w/ Marc Ratcliff	2	2	36	N	5	11		1.2	MOvc(2)	Cracks formed in road; survey stake "slump"
2003	1	D	2005	2			882	FIELD	7	2	69	N	5	8		0.1	Qap(p)	
2004	1	D	2005	3			911	FIELD	7	3	80	N	5	8		0.2	Qap(p)	
2005	2	D	2005	5			1530	Verbal comm from Marc Ratcliff	2	2	83	Y	1	1		1.1	Qva(1)	Mistakenly digitized as a road
2006	2	D	2005	3			1128	FIELD	1	3	105	P	5	1		0.1	Ova(1)	
2007	2	D	2005	3			1143	FIELD	1	3	105	Y	5	1		0.2	Ova(1)	Recent ls; less than 5 yo laders; 20 by 250 ft long; may be visible in 1999 arial photographs
2008	2	D	2005	2			1358	FIELD	7	3	110	P	5	8		0.1	Ova(1)	10 ft by 100+ ft long; no trees on surface; about 6 ft deep incision; directly across from "3 mile" road marker
2009	2	Q	1998	5			1474	ORTHO	2	1	94	Y	3	1		7.4	MOvc(2)	Bedrock hollow above road;
2012	2	D	2005	5			1217	FIELD	2	1	106	Y	3	1		2.5		<10 yo alder
2013	4	D	2005	4			676	FIELD	2	2	102	N	3	6	a	0.7		180ft wide; ~100ft high; ,6ft deep; 9"dbh alder
2014	2	D	2005	2			694	FIELD	7	2	155	P	2	8		0.1	MOvc(2)	
2015	2	D	2005	2			1177	FIELD	7	2	93	N	5	8		0.0	MOvc(2)	
3003	1	P	1998	2			1154	ORTHO	7	3	31	N	5	11		0.2	Ova(1)	
3004	1	D	1980	3			1172	ORTHO	7	3	24	N	5	11		0.1	Ova(1)	
3005	2	Q	1998	5			2045	ORTHO	1	1	86	Y	3	1		1.2	MOvc(2)	Debris dam in Siouxon Ck; probable delivery df?
3006	2	D	1998	5			2601	ORTHO	7	1	38	Y	5	11		1.1	MOvc(2)	
3007	2	P	1998	3			2012	ORTHO	7	2	33	Y	2	11		0.4	MOvc(2)	
3008	2	P	1998	3			1174	ORTHO	2	2	88	Y	2	1		0.1	Ova(1)	
3009	1	D	1998	3			2308	ORTHO	7	3	59	P	5	8		0.2	Migd(sl)	Possible culvert failure; culvert diverted 20 feet down road; verticle headwall
3010	2	P	1998	3			1534	ORTHO	2	2	75	P	2	1		0.2	Ova(1)	
3015	4	Q	2005	5			809	LIDAR	2	1	136	N	4	6	c	17.6	MOvc(2)	
3017	5	Q	2005	5			1862	LIDAR	2	2	98	P	4	9		15.2	Ova(2)	
3018	4	Q	2005	5			928	LIDAR	2	1	114	Y	3	1	b	3.7		
3019	4	P	2005	5			1729	LIDAR	2	1	60	N	4	1	b	11.5	MOvc(2)	
3020	4	Q	2005	5			1259	LIDAR	2	2	107	N	4	1	b	4.4	MOvc(2)	
3021	4	Q	2005	5			1193	LIDAR	2	2	123	N	4	1	b	3.0	MOvc(2)	
3022	4	Q	2005	5			1295	LIDAR	7	2	110	N	4	8	b	26.7	MOvc(2)	
3023	4	Q	2005	5			1687	LIDAR	7	2	115	N	4	2	b	78.8	MOvc(2)	

Appendix B. Mass-Wasting Summary Tables

The following tables are only for moderate, high, and very high hazard Landforms.

Table B-1: Mass-Wasting Summary of Landform 1

Activity	Shallow-rapid landslides	Debris flows	Debris avalanches	Deep-seated	Shallow sporadic deep-seated	Earthflows	Rock topple	Snow avalanche	Totals
Clear cut (timber 0-5 Yrs.)	3	18	-	-	2	-	-	-	23
Young timber (5-15 yrs.)	-	2	-	-	1	-	-	-	3
Submature timber (15-50 yrs.)	2	10	-	1	2	1	-	27	43
Mature timber (>50 yrs.)	3	-	-	3	2	-	4	-	12
Road related	8	25	-	-	-	-	-	-	33
Partial cut	-	-	-	-	-	-	-	-	0
Yarding	-	-	-	-	-	-	-	-	0
Alpine	-	-	-	-	-	-	-	-	0
Other (e.g., housing)	-	-	-	-	-	-	-	-	0
Totals	16	55		4	7	1	4	27	114

Table B-2: Mass-Wasting Summary of Landform 3

Activity	Shallow-rapid landslides	Debris flows	Debris avalanches	Deep-seated	Shallow sporadic deep-seated	Earthflows	Rock topple	Snow avalanche	Totals
Clear cut (timber 0-5 Yrs.)	-	-	-	-	-	-	-	-	0
Young timber (5-15 yrs.)	1	-	-	-	-	-	-	-	1
Submature timber (15-50 yrs.)	-	5	-	-	-	-	-	-	5
Mature timber (>50 yrs.)	-	-	-	-	-	-	-	-	0
Road related	1	16	-	-	-	-	-	-	17
Partial cut	-	-	-	-	-	-	-	-	0
Yarding	-	-	-	-	-	-	-	-	0
Alpine	-	-	-	-	-	-	-	-	0
Other (e.g., housing)	-	-	-	-	-	-	-	-	0
Totals	2	21	0	0	0	0	0	0	23

Table B-3: Mass-Wasting Summary of Landform 5

Activity	Shallow-rapid landslides	Debris flows	Debris avalanches	Deep-seated	Shallow sporadic deep-seated	Earthflows	Rock topple	Snow avalanche	Totals
Clear cut (timber 0-5 Yrs.)	-	-	-	-	-	-	-	-	0
Young timber (5-15 yrs.)	-	-	-	-	-	-	-	-	0
Submature timber (15-50 yrs.)	-	-	-	-	-	-	-	-	0
Mature timber (>50 yrs.)	-	-	-	1	-	1	-	-	2
Road related	-	-	-	-	-	-	-	-	0
Partial cut	-	-	-	-	-	-	-	-	0
Yarding	-	-	-	-	-	-	-	-	0
Alpine	-	-	-	-	-	-	-	-	0
Other (e.g., housing)	-	-	-	-	-	-	-	-	0
Totals	0	0	0	1	0	1	0	0	2

Table B-4: Mass-Wasting Summary of Landform 6

Activity	Shallow-rapid landslides	Debris flows	Debris avalanches	Deep-seated	Shallow sporadic deep-seated	Earthflows	Rock topple	Snow avalanche	Totals
Clear cut (timber 0-5 Yrs.)	-	-	-	-	-	-	-	-	0
Young timber (5-15 yrs.)	-	1	-	-	-	-	-	-	1
Submature timber (15-50 yrs.)	-	-	-	1	-	-	-	-	1
Mature timber (>50 yrs.)	-	-	-	1	1	-	-	-	2
Road related	2	6	-	-	-	-	-	-	8
Partial cut	-	-	-	-	-	-	-	-	0
Yarding	-	-	-	-	-	-	-	-	0
Alpine	-	-	-	-	-	-	-	-	0
Other (e.g., housing)	-	-	-	-	-	-	-	-	0
Totals	2	7	0	2	1	0	0	0	12

Table B-5 Mass -Wasting Summary Table: Landform 9

Activity	Shallow-rapid landslides	Debris flows	Debris avalanches	Deep-seated	Shallow sporadic deep-seated	Earthflows	Rock topple	Snow avalanche	Totals
Clear cut (timber 0-5 Yrs.)	-	-	-	-	-	-	-	-	0
Young timber (5-15 yrs.)	-	-	-	-	1	-	-	-	1
Submature timber (15-50 yrs.)	-	-	-	-	-	-	-	-	0
Mature timber (>50 yrs.)	-	-	-	-	5	-	-	-	5
Road related	-	-	-	-	-	-	-	-	0
Partial cut	-	-	-	-	-	-	-	-	0
Yarding	-	-	-	-	-	-	-	-	0
Alpine	-	-	-	-	-	-	-	-	0
Other (e.g., housing)	-	-	-	-	-	-	-	-	0
Totals	0	0	0	0	6	0	0	0	6

Table B-6 Mass -Wasting Summary Table: Landform 10

Activity	Shallow-rapid landslides	Debris flows	Debris avalanches	Deep-seated	Shallow sporadic deep-seated	Earthflows	Rock topple	Snow avalanche	Totals
Clear cut (timber 0-5 Yrs.)	-	-	-	-	-	-	-	-	0
Young timber (5-15 yrs.)	-	-	-	-	-	-	-	-	0
Submature timber (15-50 yrs.)	-	-	-	-	-	-	-	-	0
Mature timber (>50 yrs.)	-	-	-	4	1	-	1	-	6
Road related	-	-	-	-	-	-	-	-	0
Partial cut	-	-	-	-	-	-	-	-	0
Yarding	-	-	-	-	-	-	-	-	0
Alpine	-	-	-	-	-	-	-	-	0
Other (e.g., housing)	-	-	-	-	-	-	-	-	0
Totals	0	0	0	4	1	0	1	0	6

Table B-6 Mass -Wasting Summary Table: Landform 11

Activity	Shallow-rapid landslides	Debris flows	Debris avalanches	Deep-seated	Shallow sporadic deep-seated	Earthflows	Rock topple	Snow avalanche	Totals
Clear cut (timber 0-5 Yrs.)	2	7	-	-	-	-	-	-	9
Young timber (5-15 yrs.)	1	2	-	-	-	-	-	-	3
Submature timber (15-50 yrs.)	1	1	-	-	2	-	-	1	5
Mature timber (>50 yrs.)	-	-	-	-	-	1	-	-	1
Road related	9	25	-	-	1	-	-	-	35
Partial cut	-	-	-	-	-	-	-	-	0
Yarding	-	-	-	-	-	-	-	-	0
Alpine	-	-	-	-	-	-	-	-	0
Other (e.g., housing)	-	-	-	-	-	-	-	-	0
Totals	13	35	0	0	3	1	0	1	53

Table B-7 Mass -Wasting Summary Table: Landform 12

Activity	Shallow-rapid landslides	Debris flows	Debris avalanches	Deep-seated	Shallow sporadic deep-seated	Earthflows	Rock topple	Snow avalanche	Totals
Clear cut (timber 0-5 Yrs.)	-	-	-	-	-	-	-	-	0
Young timber (5-15 yrs.)	-	-	-	-	-	-	-	-	0
Submature timber (15-50 yrs.)	-	-	-	-	-	-	-	16	16
Mature timber (>50 yrs.)	-	-	-	-	-	-	-	-	0
Road related	-	-	-	-	-	-	-	-	0
Partial cut	-	-	-	-	-	-	-	-	0
Yarding	-	-	-	-	-	-	-	-	0
Alpine	-	-	-	-	-	-	-	-	0
Other (e.g., housing)	-	-	-	-	-	-	-	-	0
Totals	0	0	0	0	0	0	0	16	16