Appendix A

Mass Wasting Assessment

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APPENDIX A
MASS WASTING ASSESSMENT

1.0 DESCRIPTION OF ASSESSMENT

An assessment of the landslide characteristics of the West Branch WAU was conducted to accomplish the following:

- Map all known landslides.
- Identify topographic, geologic, and management factors controlling the location and frequency of landslides.
- Delineate areas of special consideration for future management.

Forest managers will use information from this assessment to guide future management decisions to reduce the risk of landslides delivering sediment to fish-bearing channels and sediment-sensitive wetlands. This analysis was conducted following Version 3.0 of the *Standard Methodology for Conducting Watershed Analysis* (Washington Forest Practices Board [WFPB] 1995) without modification.

1.1 RESOURCES

The following resources were used in the Mass Wasting Assessment:

- US Geological Survey topographic 7.5-minute quadrangles: Boyer Mountain, Camden, Elk, Deer Lake, Diamond Lake, Fan Lake, Nelson Creek, and Sacheen Lake.
- Geologic maps.

  Stoffel, K. L., N. L. Joseph, S. Z. Waggoner, C. W. Gulick, M. A. Korosec, and B. B. Bunning. 1991. Geologic map of Washington, northeast quadrant. Washington Division of Geology and Earth Resources, Geologic Map GM-39, Olympia.

Waggoner, S. Z. 1990. Geologic map of the Chewelah, 1:100,000 quadrangle, Washington - Idaho. Washington Division of Geology and Earth Resources, Open File Report 90-14, Olympia.

Aerial photographs. Boise Cascade Corporation provided photocopies of 1992 aerial photographs covering the entire WAU at a scale of 1:14,300. The loss of clarity and resolution of photocopies relative to the original aerial photographs is discussed in the Confidence in Assessment section of Appendix B—Surface Erosion Assessment.

1.2 LANDSLIDE INVENTORY

The analyst examined aerial photographs for mass wasting features; only one landslide was identified.

Field observation was then performed by vehicle and by foot to verify the landslide identified on the aerial photographs and to search for mass wasting features that occurred since 1992, when the aerial photographs were taken, or that were not revealed by the photographs. No additional landslides were identified in the field.

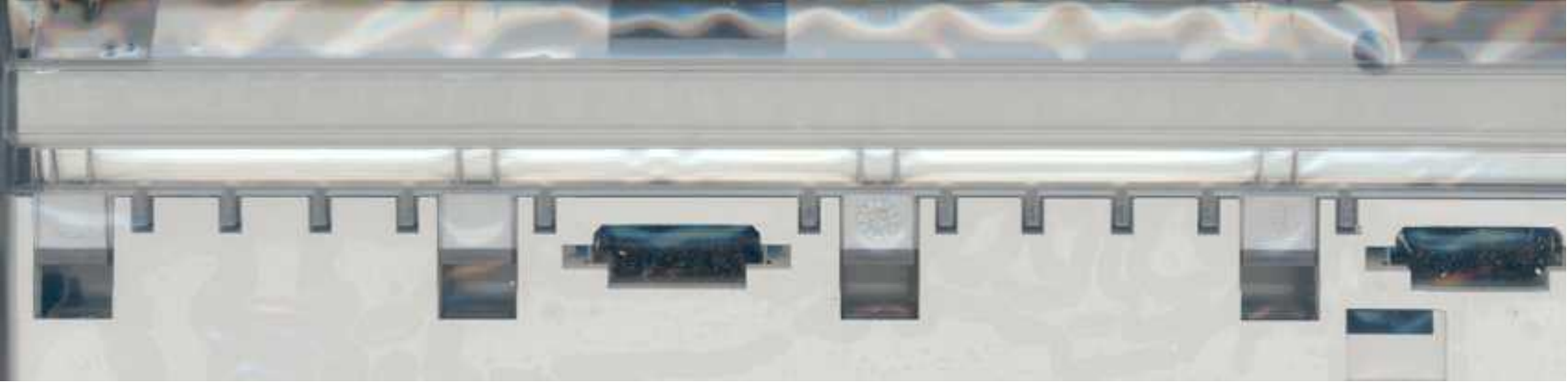
The location and approximate size of the landslide are shown on Map A-1. Because only one landslide was identified, Form A-1 is not included in this report. Instead, the landslide data are listed in the Results section.

1.3 FIELD WORK

The mass wasting field work was done in conjunction with the road inventory for the Surface Erosion Assessment. Twelve person-days were spent in the field searching for mass wasting features, assessing mass wasting potential, and inventorying roads. Nearly every major road system in the WAU was inspected, and mass wasting reconnaissance was performed in every subbasin. The single landslide found on the aerial photographs was confirmed in the field, and as mentioned above, no other landslides were discovered in the field.

1.4 GEOLOGIC SETTING

Because of the low number of landslides identified in the West Branch WAU, the geologic history of the West Branch WAU is discussed in Appendix B—Surface Erosion Assessment.



2.0 WATERSHED CHARACTERISTICS

The elevation of the West Branch WAU ranges from 1,905 feet at the outlet of Eloika Lake to 5,277 feet at Boyer Mountain. Below 2,600 feet the topography is dominated by broad glacial outwash plains dissected by abandoned glacial outwash channels. The glacial outwash channels are now occupied by underfit streams (e.g., Moon Creek) and numerous lakes and wetlands. Erosion from glacial outwash has left a stable landscape with low gradient outwash plains, terraces, and hillslopes.

Although the topography of the upper WAU is gentle, both Buck and Beaver creeks have reaches with steep inner gorges, both of which are located near the confluence with the West Branch Little Spokane River. The inner gorge of Beaver Creek is the only area within the WAU with observed mass wasting.

3.0 RESULTS

3.1 OVERVIEW

The West Branch WAU is nearly devoid of mass wasting features because it lacks extensive areas with steep topography. The gentle topography of the WAU results from long history of surface erosion from deeply weathered bedrock. A history of no or little glacial erosion allowed bedrock to weather and erode over long periods of time (see Geologic Overview section in Appendix B—Surface Erosion Assessment).

The only landslide identified in the West Branch WAU is a debris avalanche, a type of shallow-rapid landslide (Form A-3). This landslide is located in the inner stream channel gorge of Beaver Creek (Map A-1) and originates at a forest road. Because only one landslide was identified, Form A-1 is not included in this report. Instead, the data recorded for this landslide are listed in Table A-1.

Table A-1 Summary of mass wasting data.

Subbasin:	Beaver Creek
Landslide ID number:	1
Full ID number:	T30N, R43E/18
MWMU:	1
Type:	Debris avalanche
Certainty of ID:	Known
Photograph year identified:	1992
Size:	1 acre
Sediment delivered to nearest stream:	No
Surface erosion of scar (percent):	Unknown
Associated land use activity:	Road
Geomorphic character:	Inner gorge
Gradient:	30 percent
Initiation elevation:	Hartill silt loam
Soil type and texture:	2,040 feet
Geologic formation:	Belt Super Group

Form A-3 Mass wasting summary table for MWMU 1.*

Activity	Mass wasting feature				
	Shallow-rapid landslides	Large persistent deep-seated failures	Small sporadic deep-seated failures	Debris torrents	Totals
Clear cut 0-20 years					
Clear cut 20-50 years					
Partial cut					
Road	1				1
Stream crossing					
Landing					
Other forest practices					
Wildfire					
Mature forest					
Non-forest land use					
Totals	1				1

Mass wasting summary tables were not prepared for MWMUs 2 and 3 because no landslides were identified in these MWMUs.

Two additional areas of mass wasting potential were identified in the West Branch WAU. The first is an area with shallow-rapid landslide potential that is similar to the area with the documented landslide. The second is talus.

3.2 AREAS OF MASS WASTING POTENTIAL

3.2.1 Areas with Shallow-rapid Landslide Potential

A debris avalanche, a type of shallow-rapid landslide, occurs when the gravitational force on a nearly planar block of shallow, near-surface soils exceeds the cohesion and root forces holding the soil and/or weathered bedrock to the slope. Debris avalanches are common on steep slopes (greater than 30 degrees or 60 percent), especially in convergent topography (e.g., hillslope hollows and ephemeral channels) or the steep inner gorges of stream channels. Debris avalanches are usually initiated when the soil mantle becomes heavily saturated or when root strength, which helps hold together marginally stable slopes, is lost to decay. Heavy soil saturation initiates failure by increasing the weight of the soil mantle while reducing the cohesion forces at the soil/bedrock interface. Convergent slopes are more prone to debris avalanches because water concentrates in these areas and because soil creep leads to deeper soil mantles.

In the West Branch WAU, the conditions necessary to initiate a debris avalanche appear to be confined to the inner stream channel gorges of Beaver Creek and Buck Creek near their confluences with the West Branch Little Spokane River.

3.2.2 Talus

The steep slopes east and southeast of Horseshoe Lake are mapped as talus (Waggoner 1990). Talus is composed of unconsolidated rock fragments lying at the base of a steep slope or cliff. While talus is relatively stable under natural conditions, it is unconsolidated and rests near the angle of failure, making it prone to failure when disturbed. The probability of talus failing is increased when the natural slope angle of the deposit is increased (e.g., by undermining of the toe of the talus or road construction across the talus).

3.3 MASS WASTING MAP UNIT DESCRIPTIONS

Two mass wasting map units (MWMUs) account for all of the mass wasting features defined. Each MWMU encompasses a unique combination of geology and topography where mass wasting has occurred or has the potential to occur. MWMU 1 is based on the geomorphic characteristics of the single identified landslide in the WAU, and MWMU 2 is composed of steep talus. The MWMUs are depicted on Map A-1, and a description of each is provided in Form A-2. The remainder of the WAU is included in MWMU 3.

3.4 RELATION OF MANAGEMENT TO LANDSLIDE PROCESSES

Road building increases the probability and frequency of debris avalanches. In the case of the single landslide found in the WAU, road fills increased the weight of the soil mantle and the steepness of the slope at the failure site. Concentrated drainage from the road increased the saturation of soils, and this led to the failure. For this reason, relief culverts on roads should discharge to convex or divergent slopes whenever possible; they should not discharge to convergent slopes or hollows.

Form A-2 Mass Wasting Map Unit description form.

MWMU Number:	1
Description:	Inner stream gorges of Beaver and Buck creeks
Materials:	Fractured Precambrian metamorphic rocks, shallow soils
Landform:	Inner gorge
Slope:	60 percent
Elevation:	2,000 to 2,300 feet
Total Area:	60 acres
MW Processes:	One road-related debris avalanche (Beaver Creek)
Forest Practice Sensitivity:	Roading
Delivery:	Probable (Beaver Creek), immediate (Buck Creek)
Delivery Criteria Used:	Observed, steep slopes, proximity to stream
Delivered Hazard Rating:	Moderate
Trigger Mechanism(s):	Slopes in inner gorge along Beaver Creek will fail when oversteepened by forest road construction. Failures are most likely to occur in road fill materials that become saturated by surface drainage. The areas prone to failure are confined to slopes greater than 60 percent.
Confidence:	High. One landslide was observed in this MWMU.

Form A-2 (continued).

MWMU Number:	2
Description:	Vegetated talus field
Materials:	Thick colluvium with a thin mantle of soil, colluvium derived from Precambrian metamorphic rocks
Landform:	Talus
Slope:	30 to > 65 percent
Elevation:	2,000 to 2,500 feet
Total Area:	95 acres
MW Processes:	Rock fall, topple, rock avalanche
Forest Practice Sensitivity:	Roading
Delivery:	Possible, but unlikely
Delivery Criteria Used:	Proximity to county road
Delivered Hazard Rating:	Low to fish habitat, moderate to county road
Trigger Mechanism(s):	This MWMU consists of talus with a thin veneer of soil. This MWMU is inherently stable unless disturbed. Timber harvest using tractor logging or the construction of roads will promote failure by oversteepening the hillslope and destabilizing the unconsolidated material. Loss of tree root strength will also contribute to mass wasting.
Confidence:	Low. This MWMU is based on the probable extent of a talus field from field and aerial photograph investigation. What is not known is how much of a disturbance is required to initiate a mass wasting event.
Comments:	Horseshoe Lake Road starts at the base of the talus, so construction activities on or adjacent to the talus should take place under the supervision of an engineer familiar with the behavior of unconsolidated material.

Form A-2 (continued).

MWMU Number:	3
Description:	West Branch WAU not included in MWMUs 1 or 2
Materials:	Variable
Landform:	Variable
Slope:	Variable
Elevation:	≈ 1,800 to 5,277 feet
Total Area:	≈ 64,000 acres
MW Processes:	None observed
Forest Practice Sensitivity:	None
Delivery:	NA
Delivery Criteria Used:	NA
Delivered Hazard Rating:	NA
Trigger Mechanism(s):	NA
Confidence:	Moderate. There is little evidence of landsliding within the West Branch WAU. This would seem to rule out future mass wasting events; however, under certain rainfall, timber management, and agricultural and rural development conditions, a landslide could be triggered.

4.0 CONFIDENCE IN ASSESSMENT

Because only one landslide was identified, the analyst was able to develop a thorough and accurate mass wasting inventory, and field observations agreed with the aerial photograph interpretation. Confidence in the landslide distribution map (Map A-1) and inventory is therefore high.

The analyst has high confidence that the MWMUs define the important landslide zones. No delivering landslides have been identified in areas outside of the MWMUs, and clear topographic and geologic factors are associated with the MWMUs.

The area given for the one identified landslides is approximate; the scale and resolution of the aerial photographs is inadequate for precisely measuring landslide area. The estimated area is provided as relative index of landslide size.

5.0 REFERENCES

Stoffel, K. L., N. L. Joseph, S. Z. Waggoner, C. W. Gulick, M. A. Korosec, and B. B. Bunning. 1991. Geologic map of Washington, northeast quadrant. Washington Division of Geology and Earth Resources, Geologic Map GM-39, Olympia.

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Washington Forest Practices Board (WFPB). 1995. Standard methodology for conducting watershed analysis under Chapter 222-22 WAC, Version 3.0. Timber/Fish/Wildlife Agreement and WFPB, Olympia.