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Northwest Region

**FROM:** John McKenzie  
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**SUBJECT:** **MEMORANDUM**  
In or Around Landslides  
Uncle Walt Timber Sale

**DATE:** August 3, 2016

The purpose of this Memorandum is to briefly discuss landslides recorded in the Forest Practices Landslide Inventory (FPLI) database that are either in or around the Uncle Walt Timber Sale (Sale). Several other landslides not recognized during preparation of the FPLI database, but identified during office review or field reconnaissance of the Sale area are also discussed. In addition, an opinion regarding the potential impact of the proposed harvest on the stability of the landslides within or about the Sale following timber harvest is also provided. It should be noted that there are no Rule Identified Landforms (RILs) within the Sale, all have been bounded out of the Sale.

This Memorandum is based on review of LiDAR derived topographic maps and slope maps, review of published bedrock and surficial deposits geologic mapping that encompasses the area of the timber sale, review of landslides cataloged in the FPLI database, review of pertinent orthophotographs and stereoscopic aerial photographs on file at the Northwest Region office, and field reconnaissance on May 10, 2016.

The Uncle Walt Timber Sale is composed of one unit located in portions of Sections 28, 29, 32, and 33, T40N, R6E, about two miles east of Maple Falls (Figure 1), in Whatcom County. The Sale is located in the Warnick Watershed Administrative Unit (WAU). Watershed analysis was prepared for this WAU in 1994. (*Warnick Watershed Analysis; prepared by Dapaul, Inc. for Washington State Department of Natural Resources*). To date Landslide Hazard Zonation has not been prepared for this watershed. In 2013 the mass wasting prescriptions for the Warnick Watershed were rescinded; replaced by the *Guidelines for Evaluating Potential Unstable Slopes and Landforms*, Section 16 in the Forest Practices Board Manual.

Field reconnaissance included traverse of the road system through the southern area of the Sale and observations, from the edge of the river (where access was possible), of the north-facing slopes along the steep, high, southern bank of the North Fork Nooksack River.

## PHYSICAL SETTING

The Uncle Walt Timber Sale is located on a terrace-like landform on the south side of the North Fork Nooksack River, essentially at the foot of the north side of Slide Mountain (Figure 1). The topography of the Sale is characterized by gentle slopes (0 to 25%) and low relief, with occasional steep slopes of short pitches (35 to 69%). Over all the western two-thirds of this terrace-like surface exhibits a general slope to the west, the eastern one-third has a gentle slope to the east. The Sale is drained by several Type-4 streams that flow generally to the west (with one exception flowing north) through some relatively small wet-lands to Aldrich Creek, a northwest-flowing stream on the western side of the Sale. Ultimately this stream and the north-flowing stream empty into the North Fork Nooksack River. Just to the north of the Sale is a long high, steep slope that borders the northern margin of the Sale (Figures 1 and 2). This slope varies from 70- to 220-feet high and is characterized by inclinations of 70 percent and greater for its entire length. It is in effect an inner-gorge slope (a RIL and it is bounded out of the Sale). The North Fork Nooksack River flows along much of the toe of this slope. This reach of the river is characterized by a well-developed braided river system up to 500-feet or more wide. The NF-ML and NF-78 Road and several other short spur roads traverses the southern area of the Sale.

The geology of the Uncle Walt Timber Sale is characterized deposits of a blanket of surficial earth materials overlying the bedrock. Compilation of geologic mapping underlying the area of the Uncle Walt Timber Sale was published in 2000 by Lapen (*Geologic map of the Bellingham 1:100,000 Quadrangle, Washington; Washington Division of Geology and Earth Resources Open File Report 2000-5; scale 1:100,000*). This map shows the Sale is underlain by bedrock of the Slide Member of the Eocene age Chuckanut Formation. This member is composed of fine- to medium-grained sandstone, siltstone, and mudstone that has been folded into a series of anticlines and syncline throughout the area surrounding the Sale. In the immediate area of the Sale these bedrock earth materials are overlain by terrace gravels and landslide debris. Field reconnaissance showed in-place bedrock exposed on the lower and mid-slopes of the inner-gorge slopes along south side of the North Fork Nooksack River.

## HARVEST HISTORY AND PROPOSED MANAGEMENT ACTIVITIES

Based on review of aerial photographs and discussions with you it appears the first entry in the area of the Sale was perhaps in the very early 1900s. A second entry occurred in the early to mid-1970s, again based on interpretation of aerial photographs. The trees on the steep slope along the North Fork Nooksack River were not cut, leaving a band of timber between the edge of the terrace-like surface and the river. The current road system within the Sale was apparently

constructed presumably at the same time as the second entry. It is proposed to harvest the timber in the Sale using VRH prescriptions with ground-based yarding systems.

## LANDSLIDES

Within the Uncle Walt Timber Sale landslides are confined to the toe of a deep-seated landslide that extends up slope for a distance of almost 2¼ miles. Landslide processes around the Sale are confined to shallow landslides on the north-facing inner-gorge slopes along the North Fork Nooksack River near the northern margin of the Sale. These two groups of landslides are discussed below.

**Deep-Seated Landslides** – The FPLI database shows that in the area of the Uncle Walt Timber Sale two very large deep-seated landslides have been recognized. In the database they are labeled 30371 and 31758. Landslide 30371 is located to the west of the Sale and separated from the Sale by the stream that borders the western margin of the Sale. Thus, it is hydrologically separated from the Sale and it is not expected that timber harvest in the Sale would have an impact on Landslide 30371, and thus it is not further discussed. As noted, Landslide 31758 is a very large deep-seated landslide. The eastern two-thirds of the Uncle Walt Timber Sale is located on the toe of this landslide (Figure 2). The boundaries of this landslide as shown on the FPLI database are incorrect and exaggerate the size of this landslide. A more accurate representation of the boundaries is shown on Figure 2. Based on the work done for this Memorandum, the landslide is estimated to be about 14,000-feet long (over 2¼ miles) and varies from about 4,000-feet wide (perhaps a bit wider) at the head of the landslide to as little as 600-feet wide at in the central area of the landslide to about 5,000-feet wide at the toe (Figure 2). It is estimated to be up to at least a couple of hundred feet thick in some areas of the landslide. The in-place bedrock exposed along the south side of the North Fork Nooksack River shows the toe of the large, deep-seated landslide in question does not toe-out along the river. The landslide is likely best characterized as a dormant-indistinct (Forest Practices unstable-slopes board manual, 11/2015), or a dormant-mature (Cruden and Varnes, 1996, in Turner, K.A. and Schuster, R. L. eds., *Landslides Investigation and Mitigation: Transportation Research Board, National Research Council, Special Report 247; National Academy Press, Washington, D.C.*) rotational-translational earth flow. The topography of the landslide is subdued and it does not appear to be active. The location of the Sale on the toe of this landslide is in an area of the landslide that is essentially flat

It appears that since the initial failure of large, deep-seated Landslide 31758 there has been reactivation of portions of the lower areas of the landslide. This is suggested by the horseshoe-shaped, graben-like topography displayed by the LiDAR DEM. The apex of this horseshoe-shaped, graben-like topography is located from 2,700- to 3,000-feet upslope (south) of the southern margin of the Sale. The graben-like structure is up to about 200-feet wide and up to about 70-feet deep. Assuming the landform just discussed represents the head area of a deep-seated landslide, the landslide would be about 4,100-feet long and up to 2,600-feet wide with an overall surface slope of about 12 percent. The portions of the landslides traversed during field

reconnaissance were characterized by subdued topography, and over all gentle slopes. At the toes of the large, deep-seated landslides there are a few very small, isolated patches of slopes greater than 65 percent within the Sale. These patches vary in size from about 50- to 150-feet long and in height from about 10 to 30 feet. They are not judged to be Rule Identified Landforms because there are no streams at the toes of these slopes, and thus no potential for delivery of sediment to a public resource.

**Shallow Landslides** – During compilation and preparation of the FPLI database the small-scale landslide processes occurring on the high, steep, north-facing slopes along the northern margin of the Sale were not recognized. These landslides do not show on the FPLI database. During review of aerial photographs and field reconnaissance these landslides were noted and their locations are shown on Figure 3. These landslides vary in size from about 50-feet to about 200-foot wide. They extend up slope to about mid-slope areas or less, to about three-quarters the height of the slope. They are characterized by raveling, shallow sloughing and slumping, and shallow translational debris-slide processes. Figure 4 presents an inventory of the landslides cataloged from review of stereoscopic aerial photographs and orthophotographs, and the year of the photography on which the landslide was first observed. Inventorying the landslides cataloged on Figure 4 was hampered by shadows created by the tall trees, sun angle at the time the photograph was taken, and the steep north-facing slopes that characterize the terrain between the Sale and the North Fork Nooksack River. This was particularly true of certain years of orthophotographs (e.g., 2013). The images captured by the stereoscopic aerial photographs (1970 to 2001) are much less hampered by shadows on the slopes between the Sale and the river.

This shadow effect explains, in part in some situations, the lack of observed presence of many of the small landslides over the decades recorded by the aerial photography. Another explanation for the lack of observation may be that the slide scar finally revegetated to the point that the scar was no longer obvious upon viewing the aerial photography.

## **POTENTIAL INFLUENCE OF THE SALE ON THE NORTH-FACING SLOPE**

An important question regarding harvest of the Uncle Walt Timber Sale and landslide processes on the north-facing slope between the river and the Sale is: Will timber harvest increase the frequency or size of the landslides occurring on that slope?

On Figure 4 two events related to the second entry in the early/mid 1970 are demarcated. They are the time of the entry itself and the time of hydrologic maturity, a time about 25 years after harvest. Of the 14 landslides identified from the aerial photography, seven were present/active prior to the 1970 entry: Landslides 1, 4, 5, 6, 10, 11, and 14. Following harvest three new landslides appear in 1978; Landslides 2, 8, and 9; and there appears to be enlargement of one – Landslide 6 to create Landslide 7. From post-1978 to about 2000 three other landslides appear. Early during that time period Landslide 3 and 9 developed, and about the time of the close of the 25-year hydrologic-maturity envelope one landslide – 13 developed. One appeared after hydrologic maturity was achieved – Landslide 12. In total five landslides developed during the

period of hydrologic maturity. Three of those landslides – 3, 8, and 9 were essentially small and short lived (10 years or so). One, Landslide 2, was of modest size and persisted for several decades following harvest but apparently revegetated by the early 2000s. Landslides 6 and 7, which appears to be interrelated, are still active to current time.

How much harvest from the second entry influenced development of the shallow landslides noted during evaluation of the Uncle Walt Timber Sale is unclear. Erosion by the river along the toe of the slope is in-and-of-itself an important factor in initiating landslide processes on the slope. In 1970 a channel of the river was adjacent to the toe of the slope in the area of Landslides 5 and 6, but the main stem was more toward the central area of the braided stream-system network. By 1978 the main channel was adjacent to the toe of the slope in the area of Landslides 5, 6, 7, and 8. Likewise at the location of Landslide 2. By 1983 the locations of Landslides 3 and 9 were being eroded by the river. Thus, at the time the landslides that developed during the hydrologic maturity envelope appeared, the toe of the slope where they appeared was being eroded by the river. Currently the only landslides that are active are Landslides 5, 6, 7, 10, and 11. And except for 10, they are all located on slopes where the river is eroding the toe of those slopes. It appears that erosion by the river of the toe of the slope is an important factor in the development of landslides on the steep slopes between the Sale and the North Fork Nooksack River.

Another factor to consider is the slope of most of the terrace-like surface is to the west and the smaller eastern portion to the east. Save for one northward-flow stream in the western area of the Sale, drainage is either to the west to Aldrich Creek, or to the east; not north toward the steep slopes between the Sale and the river. This suggests that it is likely that much of the groundwater flow is likewise directed away from the north-facing steep slopes which border the river, reducing the amount of water delivered to those north-facing slopes.

Following the second-entry harvest in the early/mid 1970s a few landslides developed on the steep slope between the currently proposed sale and the North Fork Nooksack River. For the most part these landslides were small and short lived. They developed at the toe of the slope at times when the river was eroding the toe of the slope where they developed. This suggests a strong influence by the river on development of these landslides. In addition, the direction of inclination of the slopes of the terrace underlying the area of the Sale suggests an unfavorable setting for directing much groundwater toward the north-facing slopes. These two factors taken together suggest that the development of the landslides that appeared during the 25-year hydrologic maturity envelope were more likely related to river erosion than increased groundwater flow toward the north-facing slope. This is not to say that there may not have been some influence from the harvest; it cannot be certain that there was none. However, the likelihood that the early/mid 1970 harvest had an influence appears to be low and what influence there was, was small. Thus, in my opinion the probably of the proposed forest practices activity to increase the frequency or size of the landslides occurring on the north-facing slope is judged to be low.

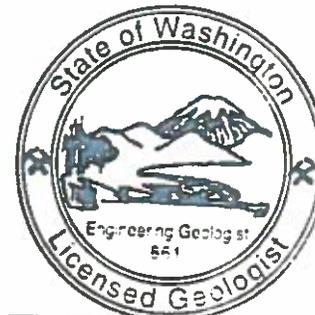
In addition, it is my judgment that the probably that harvest of the Uncle Walt Timber Sale, on the toe of the very large, deep-seated landslide, to adversely impact the stability of that landslide, or any part of it, is also low. This is due impart to the scale of the deep-seated landslide as compared to the size of the Uncle Walt Timber Sale (the deep-seated landslide is about 12 times larger), the location of the Sale in an area of low slope-gradients on the landslide and gentle terrain, and the reasoning that the area was entered in the early/mid-1970s without any apparent impact to the stability of the very-large deep-seated landslide in question.

Channel migration does not appear to be an issue on the south side of the Nooksack River at the location of the Uncle Walt Timber Sale. Review of aerial photography representing the last 45 years shows the location of the south bank of the North Fork Nooksack River in the area in question has remained essentially unchanged, a long straight reach in the area in question. This is likely due to the presence of Chuckanut Formation bedrock along the south side of the channel in this area. In addition, the current stand of timber on the bank slopes along the river and at the top of the bank slopes dates from before 1970 (the date of the earliest set of aerial photographs reviewed; these trees are clearly present) and thus are likely no younger than the earliest entry in the early 1900s. This argues that the bank and slopes in question have not been subjected to channel migration processes for over 100 years. It does appear that there has been some localized erosion along the toe of the bank slopes, triggering the relatively minor landslide processes observed during review of aerial photographs and orthophotographs. However, these processes do not appear to be leading to whole-sale erosion of the bank slopes and southward migration of the channel of the North Fork Nooksack River.

If you have any questions, please call.



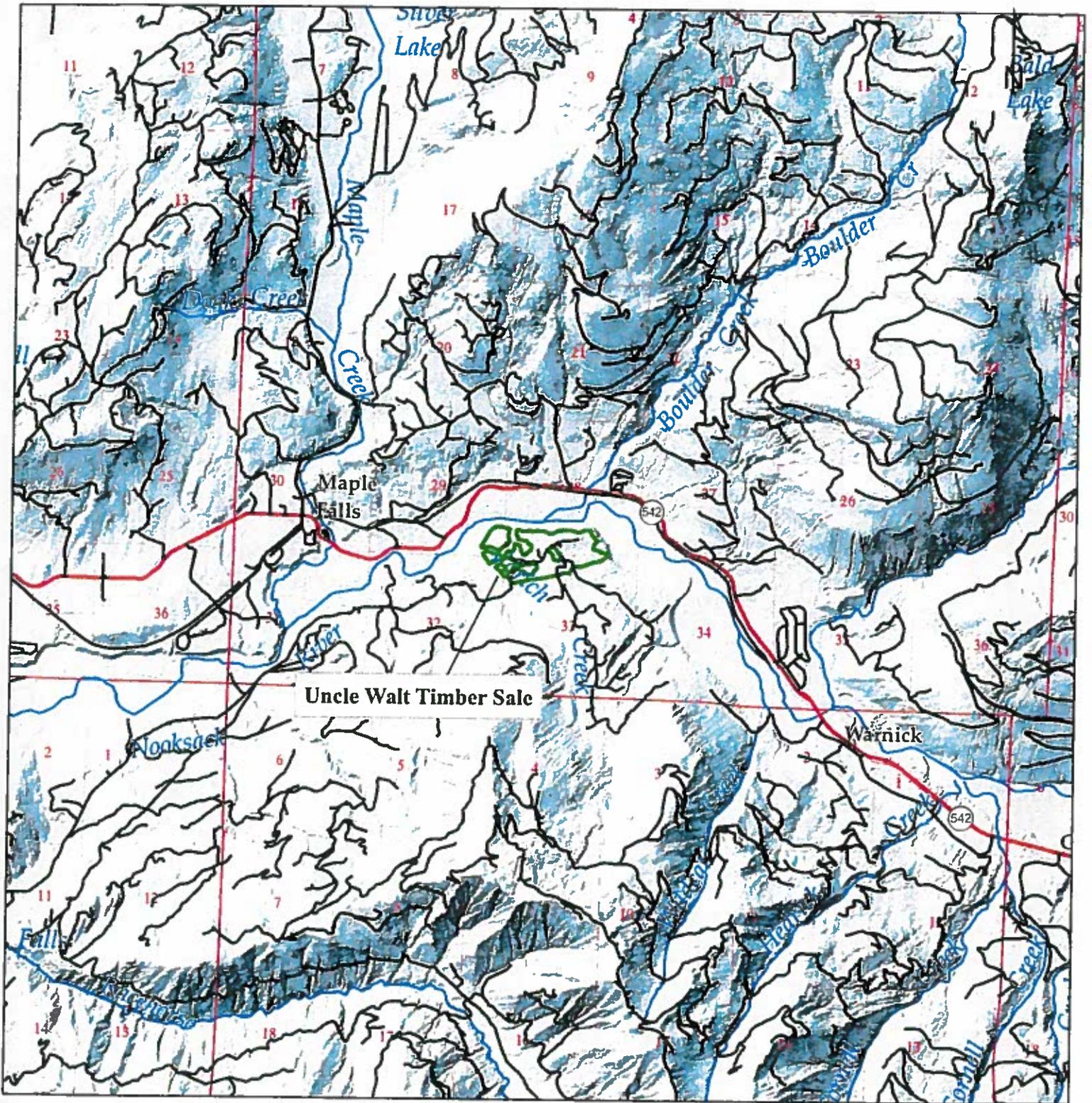
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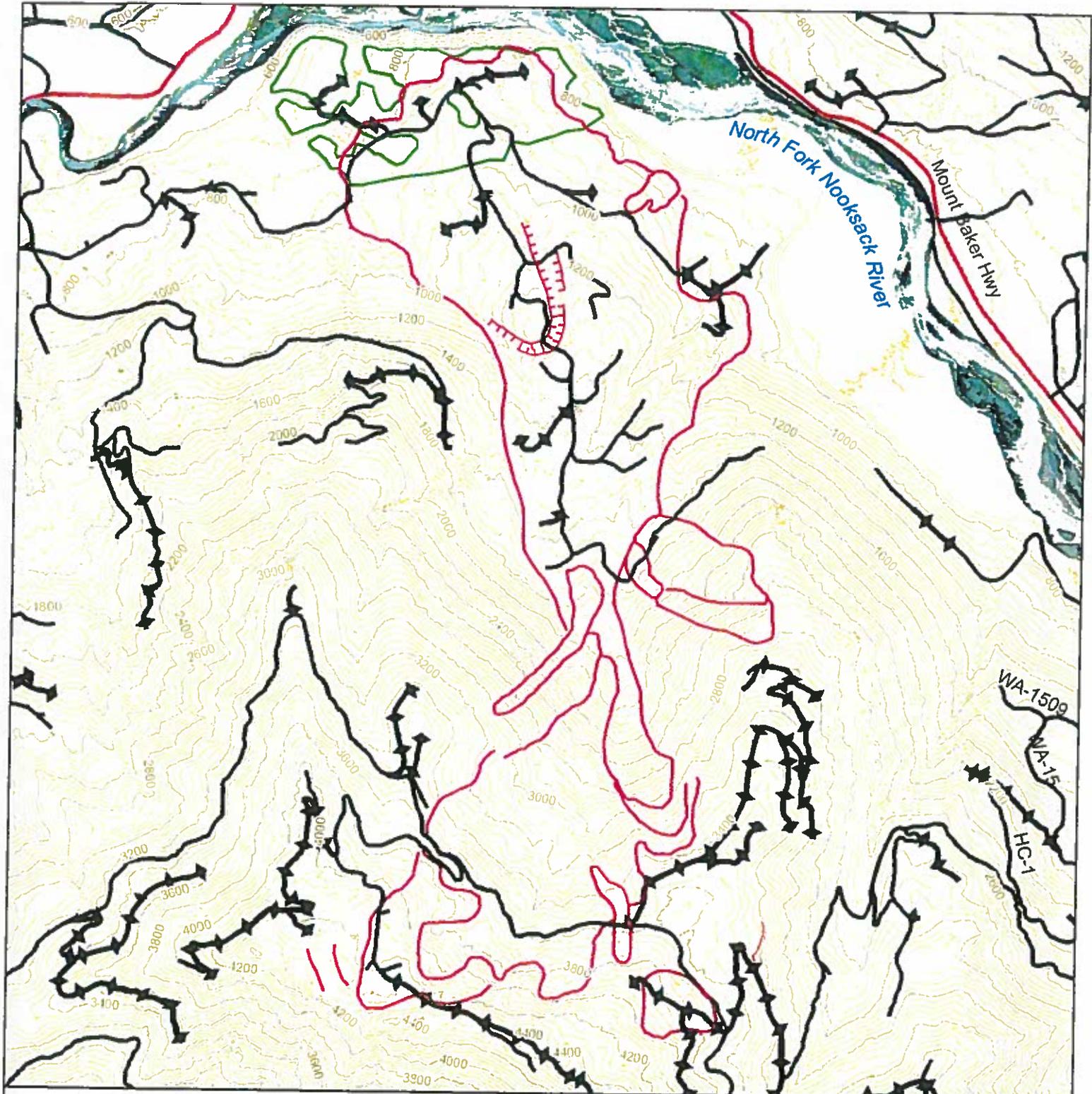
Attachments:

- Figure 1 Location Map
- Figure 2 Map Showing Deep-Seated Landslides
- Figure 3 Map of Shallow Landslides on Slopes Around Sale
- Figure 4 Small-Landslide Matrix



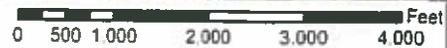
**FIGURE 1 LOCATION MAP**  
Uncle Walt Timber Sale  
1 inch = 1 mile





**EXPLANATION**

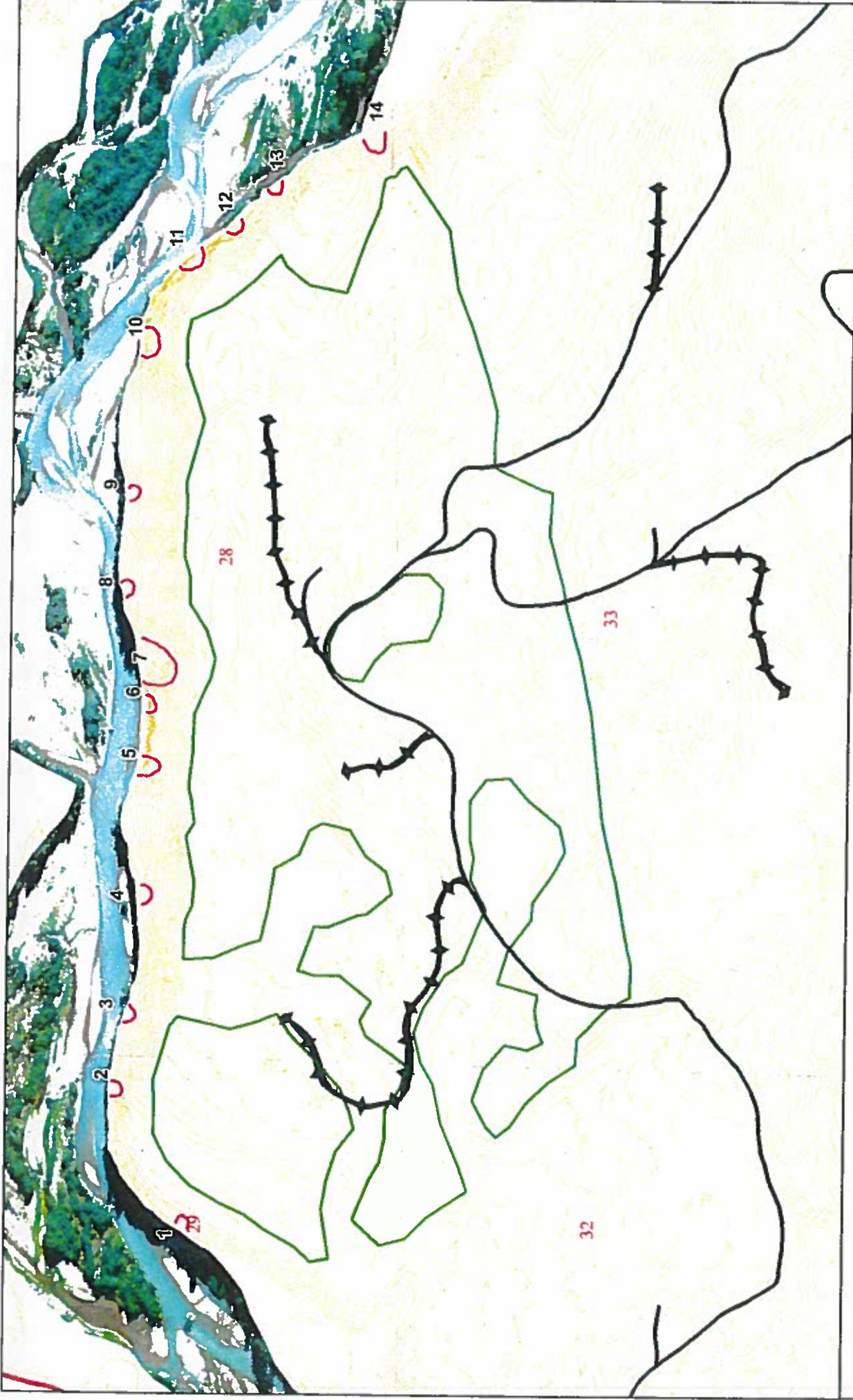
- Timber Sale Boundary
- ◆ Road, diamonds where abandoned
- Graben



1 inch = 2,000 feet      1:24,000



**FIGURE 2 MAP SHOWING DEEP-SEATED LANDSLIDES**  
 Uncle Walt Timber Sale

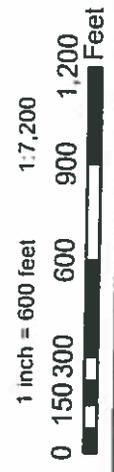
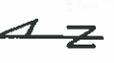


Timber Sale Boundary  

◆
 Road, diamonds where abandoned

Landslide, number label landslide

**EXPLANATION**



**FIGURE 3 TIMBER SALE MAP WITH LANDSLIDES**

Uncle Walt Timber Sale

YEAR OF PHOTOGRAPH SLIDE OBSERVED

SLIDE #	70	78	83	91	96	90-00/01	03	06	09	11	13	15	TOE EROSION
1	X	X		X	X								Yes
2		X	X	X	X	X							Yes
3			X										Yes
4	X	X		X	X	X							Yes
5	X	X		X		X	X	X	X	X	S	X	Yes
6	X	X	X	X	X	X	X			X	H	X	Yes
7		X	X	X		X	X	X	X	X	A	X	Yes
8		X	X								D		Yes
9		X	X								O		Yes
10	X	X	X	X	X	X	X			X	W	X	Yes
11	X		X		X	X	X	X		X	S	X	Yes
12						X		X		X			Yes
13					X	X		X					Yes
14	X												No
	Harvest			Hydrologic Maturity									

Notes: Slides 3, 8, and 9 are small-scale failures; Slide 2 is estimated to be of modest size. Slide 7 is part of Slide 6. On the 2013 orthophotographs shadows obscure slopes in question.

**FIGURE 4 SMALL-LANDSLIDE MATRIX**  
 Inner-Gorge Slopes North Fork Nooksack River  
 Uncle Walt Timber Sale