WASHINGTON STATE DEPARTMENT OF
Natural Resources

DOUG SUTHERLAND
Commissioner of Public Lands

MEMORANDUM

To: Laura Vaugeois – Forest Practices
Karl Wegmann - Geology

From: Bill Lingley – Geology

Date: August 9, 2003

Subject: Deer Creek Watershed Analysis -- Review

Summary

The Ten Thousand Year Institute (Kennard, 1999) has produced an excellent mass wasting module for the Deer Creek Watershed. This module meets or exceeds most U.S. Forest Service in effect at the time the work was completed and it appears to meet current Washington State standards. The author identifies a majority of the definite and probable landslides that were mappable at the time of their study. This module should be sent out for final external review.

New mapping (Dragovich and others, 2003) helps emphasize Kennard's finding that earth flows and earth slumps in glacial lacustrine blue clays and recessional sandy outwash are important sources of instability in the Deer Creek valley. In order to adapt the watershed analysis to the new mapping, it is recommended that additional areas mapped as glacial lacustrine and recessional sand deposits are included in revised Mass Wasting Map Unit (2). It is also recommended that 29 questionable to definite landslides identified herein be added to the Landslide Hazard Inventory.

Introduction

This memorandum has been prepared as part of the Landslide Hazard Zonation project (Vaugeois and others, 2002) and follows the protocol for Priority #1 Watersheds developed by Wegmann and Vaugeois (2003). My review is designed as a spot-check only. It addresses the draft Deer Creek Watershed Analysis - Mass Wasting Module (Kennard, 1999), which was completed at a high standard but not distributed for final review. This memorandum and related work addresses only those parts of the watershed covered by State and fee ownership in the southwestern parts of the basin.

Methods

The watershed analysis (Kennard, 1999) and landslide mapping by Eide (1989) were reviewed during early August. Following this work, 2001 color aerial photography (DNR photo set NW-C-01) was evaluated to check Kennard's work and to locate new sources of sedimentation. These data were combined with an analysis of geomorphology using topographic mapping (U.S. Geological Survey, 1989). Additional rule-identified unstable landforms were identified using a SLPSTAB interpretation produced by Laura Vaugeois. Extensive field notes I collected during the summers of 2001 and 2002 were compared with these data as a final check. No new fieldwork was performed.

Key Questions

1. *Are the majority of landslides in the basin adequately identified?*

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Yes.

Both Eide and Kennard concentrated on mapping debris flows, shallow-rapid failures, and secondary landslides superimposed on deep-seated failures, as these types of instability are generally the most sensitive to management. They mapped a total of 240 landslides. Of these, about 60% are shallow rapid failures and approximately 20% each are deep-seated landslides and debris flows (Kennard, 1999).

I mapped an additional 29 possible landslides. Of these, only 15 have "definite" or "probable" certainty status. Seventeen are shallow rapid failures or debris flows that appear to postdate the watershed analysis. In addition, I mapped 12 earth flows and earth slumps, many of which were previously delineated by patterns of secondary shallow rapid and debris identified by Kennard or Eide.

2. *Do the Mass Wasting Map Units reflect reasonable assumptions based upon your review of the geology and landslides in the basin?*

Yes.

Ten mass wasting map units are delineated on the basis of three criteria: 1) landslide type, 2) density of landslides as measured in failures per unit area, and 3) sediment delivery. These are essentially the same criteria that are currently in use.

However, little attention is given to mapping geologic units, which have a dominating impact on slope stability in the basin. Kennard divides the basin into only two geologic units: bedrock and glacial materials. However, most of the unstable slopes are developed on recessional glacial sediments, especially the thick sequences of poorly graded orange-weathering sand (Units Qgo_e and Qgo_{se} of Dragovich and others, 2003). The triggering mechanism is almost certainly groundwater perching on massive glacio-lacustrine clays that occupy several stratigraphic intervals (Heller, 1981). While steep hollows and inner gorges in older bedrock units are an important source of management-related debris flows, these appear to show a stronger correlation with outcrops of Chuckanut Formation sedimentary rocks (Unit Ec_h of Dragovich and others, 2003a) than with the SLPSTAB "most susceptible-to-mass-wasting" polygons. (The explanation for instability within the Chuckanut outcrop pattern may be that these softer rocks weather more readily than adjacent Jurassic metamorphic rocks and create thicker soil horizons.)

3. *Are the hazard ratings assigned to the Mass Wasting Map Units reinforced by the distribution of landslides as shown in the Landslide Inventory for the WAU?*

Yes.

Most of the area is mapped as "Low Hazard" and consists of slopes of less than 40% in indurated bedrock capped by cohesive lodgment till. Convergent topography on the steeper hills is protected with moderate to high hazard ratings where possible debris flows and shallow rapid slides are mapped.

The main area of concern is the valley of Deer Creek, especially its inner gorge and adjacent Pleistocene terraces. Interlayering of loose sand and impermeable clay has created a remarkably unstable terrain as evidenced by the giant Deforest Creek slide. Several different types of mass

wasting are ongoing in the gorge (i.e., shallow rapid failures, earth slumps and flows, debris flows, failure within the Darrington Devils Mountain Fault Zone, and erosion at meanders). In general, Kennard has protected these unstable areas with appropriate hazard ratings. However, new mapping allows more careful delineation of Kennard's *Mass Wasting Map Units 2 and 3: large and small deep-seated earth flows and associated upslope groundwater recharge*. These mass wasting map units as re-delineated herein, are shown on the accompanying map.

4. *Are there landforms that seem to have a large number of landslides, but no associated Mass Wasting Map Unit?*

   No

5. *Does the text describing the Mass Wasting Map Units do an adequate job in presenting the landform / geology information that a forester using this map would need to identify the features on the ground?*

   Yes.

   The watershed analysis is couched in the same language used in the current version of the Forest Practices SEPA Rule [WAC 222-16-050(1(d(i(A-E))))] and therefore it is particularly easy to use relative to older watershed analyses.

6. *Are there additions to the mass wasting assessment products?*

   Yes.

   Maps showing the most of the 29 few new "questionable" to "definite" features and proposed modifications to the mass wasting map units described below is attached. Six other deep-seated failures will be transferred digitally to you from the Dragovich and others (2003a) GIS coverages.

   Proposed modifications to the mass wasting map units extend unit 9a further west and expand the area covered by mass wasting map unit 2. These modifications are intended to gather areas of interlayered unconsolidated sand and impermeable lacustrine clay units. Together these can create a setting conducive to failure by the deep-seated glacial recharge mechanism. The expanded polygons are based on the new geologic mapping and cover units Qgo_e, Qgo_{se}, Qva, Qglv, Qgle, and moderately constrained Qls polygons of Dragovich and others (2003). The expanded polygons do not include areas where a perching layer is not present or where much of the polygon is greater than 2,000 feet from Deer Creek or its major tributaries.

   The expanded areas should be given a hazard rating of "moderate" to reflect the low frequency of failure associated with large deep seated landslides.

7. *Should Forest Practices Division send this Mass Wasting Assessment out for final external review?*

   Yes

   After addition of revisions to mass wasting map unit 2, the Deer Creek Watershed Analysis Module will be ready to send out for external review.

References

Dragovich, Joe D.; Stanton, Benjamin, W.; Lingley, William S., Jr.; Griesel, Gerry A.; Polenz, Michael, 2003, Geologic map of the Oso 7.5-minute quadrangle, Skagit and Snohomish Counties, Washington: Washington Division of Geology and Earth Resources Open File Report 2003-11 1 sheet, scale 1:24,000.

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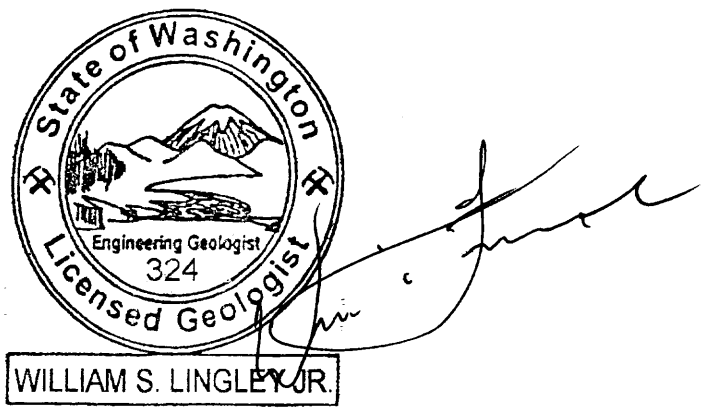
Respectfully, Submitted,



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