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WATERBARS - MAKING THEM MORE EFFECTIVE

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ABSTRACT

The requirement to install erosion control structures, such as waterbars, after logging is common to all forest harvesting rules whether state or federal. Although conceptually a relatively simple device, the waterbar is often subject to incorrect location on the skid trail and faulty construction. Most often these two shortcomings are the result of a lack of information rather than shoddy workmanship or deliberate non-compliance with the governing forest practice rules. In addition, some concern has been expressed over the longevity and efficacy of post-harvesting erosion control structures. In several hearings before the California State Board of Forestry, which formulates forest practice rules for non-federal timberlands in California and upon which the senior author of this paper serves as a member, several persons have proposed that timber operators or landowners be required to maintain post-harvest erosion control structures for as long as five years. Whether or not such a requirement would be feasible, legal, or enforceable is open to debate; however, one should expect this proposal to surface more frequently in the future, especially where logging and residential areas abut.

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INTRODUCTION

The purpose of this article is twofold. First, to summarize what is known about constructing good waterbars; and secondly, to relate what we found in a waterbar study.

WATERBARS - Constructing Them Correctly

A waterbar or waterbreak (Figure 1) is a soil berm constructed on roads, skid trails, and landings to help minimize the volume and velocity of water flowing over these exposed areas and to divert water onto places where it will not cause erosion. To simplify this discussion, we have limited ourselves to skid trails in the following paragraphs.

The three objectives of waterbars are: (1) to divert the destructive overland flow of water off the trails; (2) to discharge it onto areas where the erosive energy can be dissipated; and (3) to aid in the establishment of vegetation. The last objective will be achieved if erosion is prevented on the skid trail surface. When a bare surface remains relatively stable, natural processes of freezing and thawing, revegetation and root growth, litter fall, animal activity, water movement, and time will recreate the porous soil structure and aggregation necessary for a productive and erosion resistant soil. However, actively eroding areas will tend to remain bare of vegetation.

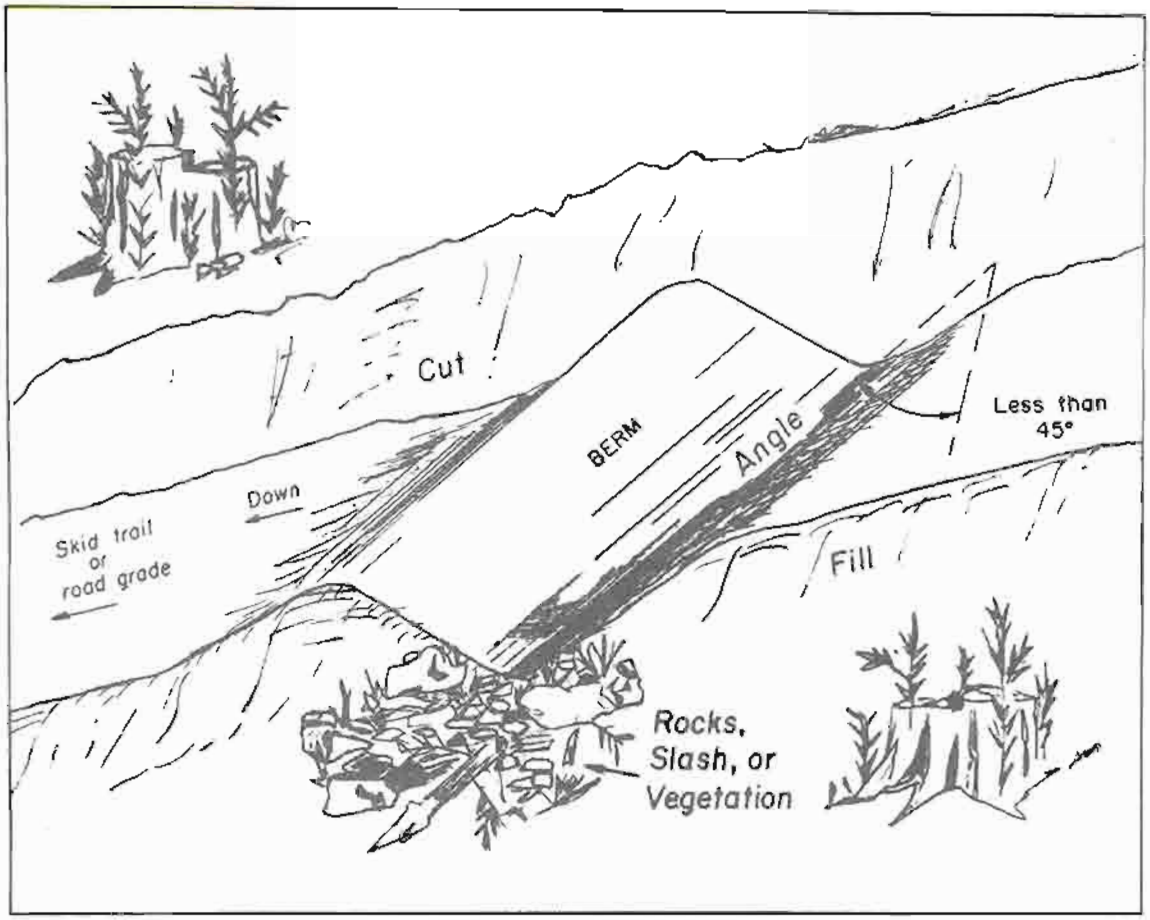

Figure 1. Diagram of a Waterbar (Source: State Forest Note #65)

As is well known, the erosive energy of overland flow of water increases with increased slope and slope length. Therefore waterbars are placed at closer intervals as the slope steepness increases, so that the velocity and volume of overland flow will not cause significant rill and gully erosion. Waterbar effectiveness in preventing erosion depends on the physical parameters of the waterbar, its location on the trail with respect to physical site factors and other waterbars, and the meteorologic conditions occurring following construction of the waterbar. Two criteria can be used to judge the effectiveness of a waterbar. First, the waterbar must prevent erosion from occurring on the skid trail surface and at the discharge area. Second, the waterbar must remain intact and prevent erosion for a sufficient time to allow the skid trail surface to become stable. The time necessary for a skid trail surface to become stable will depend on the persistence of the compacted condition and the amount and rate of revegetation that occurs.

A study of erosion control structures on skid trails in Idaho (Kidd 1963) concluded that:

1. Control structures that divert water off skid trails onto undisturbed forest soils are superior to those that only retard water movement and filter out sediment along the skid trail.

2. Any increase in spacing between control structures is accompanied by an increase in soil movement. (The increase in soil movement with increased spacing occurs regardless of slope.)

3. Optimum spacing between erosion control structures depends upon three factors: the steepness of the slope, whether the skid trail is located on a sidehill or in a ravine, and the soil parent material.

From these few preceding paragraphs, we believe one can get a pretty good picture of what is desired in terms of constructing a good waterbar. However, the question of how well they perform is still to be answered.

WATERBARS - Evaluating Their Effectiveness

In 1982, we completed a study covering logging areas in Mendocino, Humboldt, and Del Norte counties. Georgia-Pacific and Simpson Timber Company were cooperators in this study.

This study examined waterbars constructed on skid trails and rill and gully erosion associated with skid trails. The study area is within the Coast Forest District of California (Figure 2). Thirty-four tractor-logged areas that varied from one to 11 years since timber harvesting were examined. All of the study sites were selected on similar soils (Hugo, Melbourne, and Josephine Soil Series). A wide range of mean annual precipitation was also sampled by the study sites. A total of 960 waterbars were sampled over a matrix covering mean annual precipitation, time since logging occurred, and slope steepness. Geology was generally similar over the study area and was not a consideration in the sampling matrix. Further details on the study design and results can be found in Thomas (1982).

Four types of waterbar failures were observed; 1) the waterbar was broken down from raindrop impact or overland flow of water and no longer prevented water from moving down the trail, 2) significant erosion (a gully greater than 5 cm deep and longer than 6 m) occurred at the waterbar outlet, 3) the waterbar was broken down by vehicular traffic, 4) the waterbar was broken down by animial traffic. The last two types of failures were not significant in terms of frequency or associated rill and gully erosion.

The most important factors affecting the Type 1 failures were operational factors (how the waterbar was built), not the physical site factors of terrain slope, precipitation, etc. The waterbar angle, waterbar outlet (clear or blocked), and height of the waterbar were significant indicators of waterbar effectiveness. Forty-seven percent of the waterbars built with an angle of less than 30 degrees (see Figure 3) had a Type 1 failure while only 6 percent of the waterbars built with an angle of greater than or equal to 30 degrees had failed. Waterbars built with no outlet for runoff water (blocked outlet) had a 66 percent Type 1 failure rate and waterbars with a clear outlet had a 7 percent Type 1 failure rate. Sixty percent of waterbars built in through-cut skid trail sections suffered Type 1 failures.

Distance between waterbars, topographic position, and terrain slope strongly influenced Type 2 failures. Skid trails built within 100 feet (30 m) of a stream channel had higher incidents of Type 2 failure. Mean erosion per waterbar for Type 2 failures was $2.6 yd^3$ ($2.18 m^3$) and for Type 1 failures was $0.9 yd^3$ ($0.74 m^3$). This was onsite rill and gully erosion and it does not necessarily imply total soil lost into streams. Out of 960 waterbars surveyed (ages of 1 to 11 years since logging), there were 209 Type 1 failures and 64 Type 2 failures.

In addition to the above, we were interested in documenting waterbar effectiveness over time. To do this, the waterbars were divided into three groups to examine age relationships. Two groups are used for the Type 1 waterbar failure comparisons. The first group is called the "good" waterbar

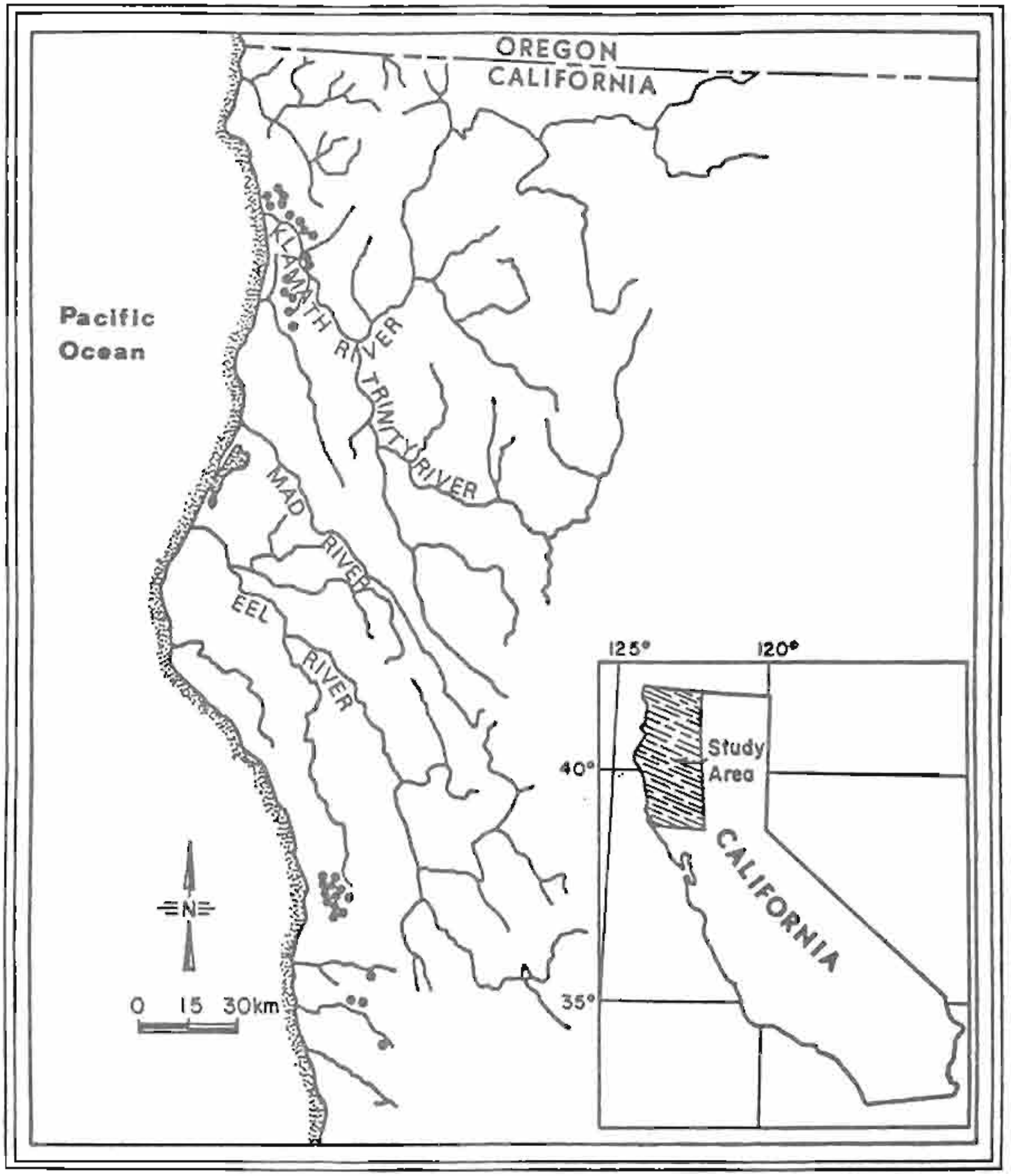

Figure 2: Location of the Study Plots in northern California

group, waterbars with an angle of greater than or equal to 30 degrees and a clear outlet. The second group is the "other" group, waterbars with an angle of less than 30 degrees or a blocked outlet. The third group is all waterbars with a clear outlet, which is for the Type 2 failure comparison.

In the "good" waterbar group, the percentage of Type 1 failures was low, ranging from 0.6 percent to 6.4 percent, and remained similar through all 11 years covered in the study. The percentage of Type 1 failures was much higher, ranging from 40.7 percent to 59.2 percent, in the "other" waterbar group. The percentage of Type 2 failures ranged from 7 to 11 percent. The percentage of Type 1 failures in the "good" waterbar group and the percentage of Type 2 failures did not increase significantly from the one year age class to the nine to eleven year age class. This indicates that the first year following construction of the waterbar is the most crucial and if a waterbar survives this first year, it has a good chance of surviving to 9 or 11 years.

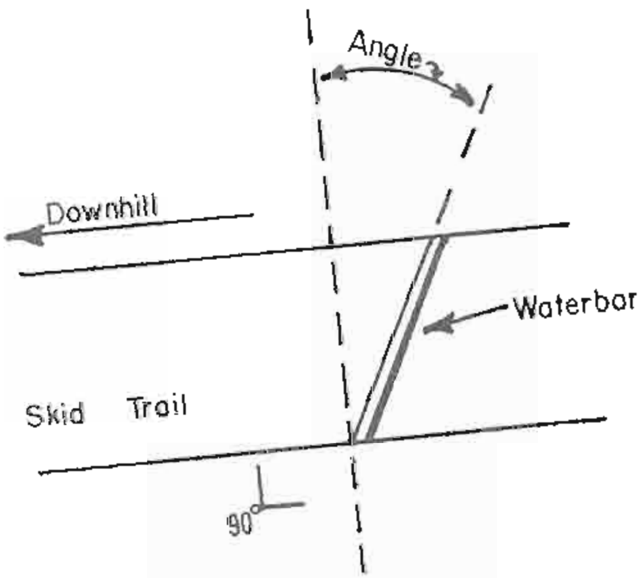

Figure 3: Determination of the Waterbar Angle

RECOMMENDATIONS

From our study and knowledge of previous works (Hauge 1977, Kidd 1963, and others), we recommend that to keep Type 1 failures to a very low number, waterbars be constructed with angles between 30° and 60°, possess clear outlets, and have berm heights of at least 12 inches (30 cm). Type 2 failures can be reduced by better spacing and location of waterbars.

Because Type 1 and 2 failures occurred during the first winter and did not significantly increase over the next ten years, we conclude that land managers can get a good estimate of waterbar effectiveness and maintenance needs (if desired or required) after the first winter.

LITERATURE CITED

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