THE GEOLOGIST'S ROLE IN TIMBER HARVESTING PLAN REVIEW

by

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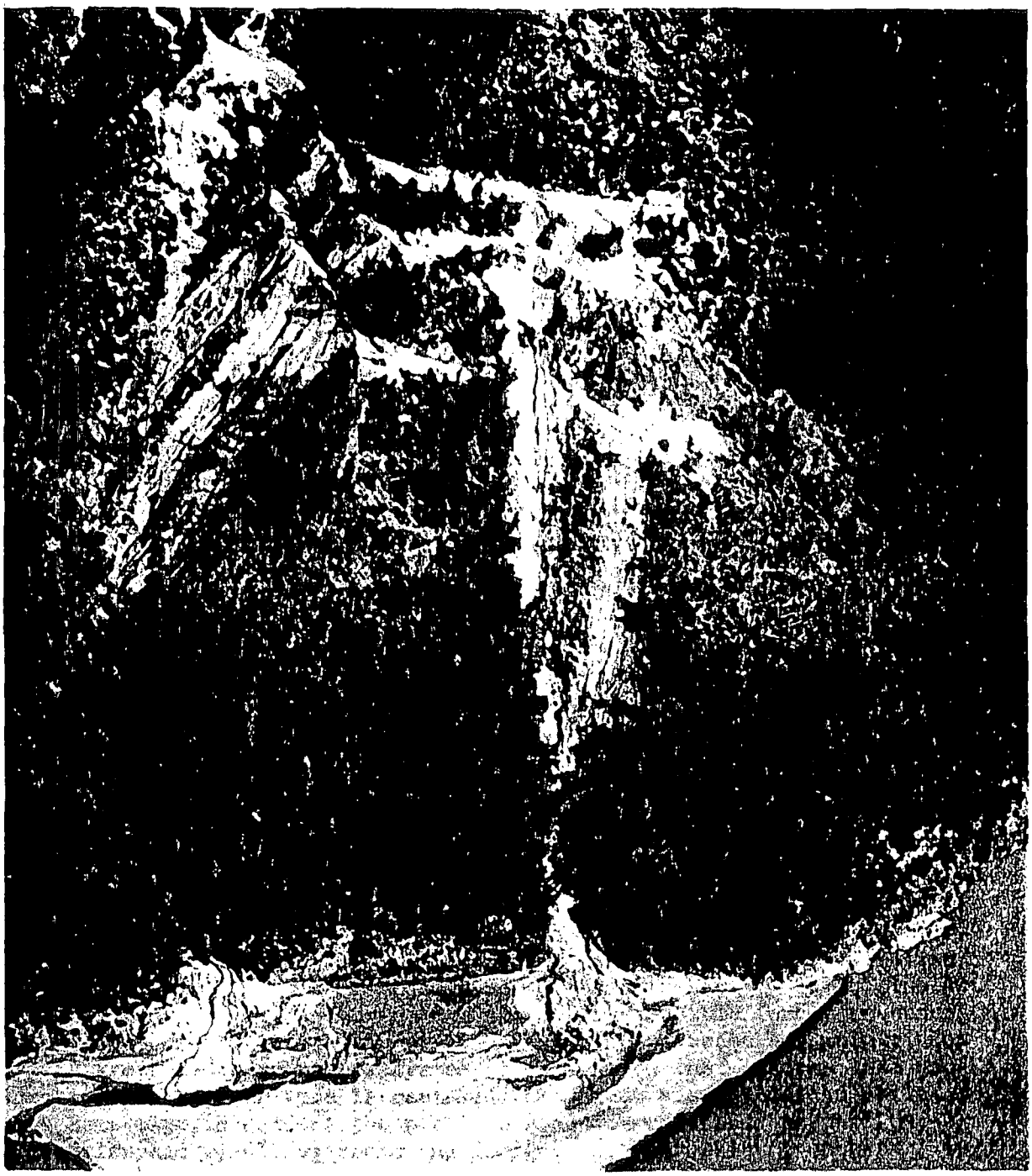
California Division of Mines and Geology



Landslides associated with logging on the slopes of a North Coastal river. (See following page for description.)

Photograph. Landslides associated with logging on the slopes of a North Coastal river (see previous page).

The landslides were the result of logging activities some of which were in violation of the Forest Practice Rules. The logging was done in 1977 and the slides occurred in the ensuing winter rains. Geologic materials are Franciscan sandstone. Thin soil mantles slopes that range from 65 to 90 percent.

The upper road was excavated first. It was then discovered that the road had been constructed on property adjacent to the plan. The middle road therefore was constructed. However, the cable yarding equipment would not reach to the bottom of the plan from the middle road. Therefore, the third and lowest road was constructed.

The concentration of water runoff from roads and sidecast soil from the cuts in a small area on steep slopes appears to have been the chief contributor to the debris avalanches that resulted from the winter rains.

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Introduction

Forest resources and timberlands in California are among the most valuable of the natural resources of the State. Not only do they furnish high-quality timber and other forest products, but they provide recreational opportunities and aesthetic enjoyment. Activities related to the logging of timberlands can, however, have a noticeably large and immediate impact on the geologic environment of forest lands and may result in short-term erosion and sedimentation far in excess of that which would occur under most natural circumstances (Huffman, 1977). The exposure of large areas of surficial geologic materials during road construction and other logging operations commonly results in increased runoff, landsliding, and erosion of unstable soils and rock masses, and altered hydrologic regimens.

Although adverse impacts related to ground disturbance caused by logging activities cannot be completely eliminated, they can be reduced if (1) they are recognized prior to the initiation of logging operations, and, (2) sound engineering geology and engineering practices are used in conjunction with acceptable logging practices. The trained (registered and/or certified) geologist can identify geologic factors conducive to erosion, provide a professional opinion concerning the probable impacts of proposed logging on these factors, and, along with other specialists, recommend suitable mitigative measures.

Since January 1976, the authors have provided geologic reviews of timber harvesting plans for private lands, primarily in the California Department of Forestry (CDF) Coast Forest District, Region I (see figure 1), under a contract between the California Division of Mines and Geology and CDF. In 1976 and 1977, geologic reports were made for 210 plans or approximately 9½ percent, of the 2193 timber harvesting plans filed in Region I. It is believed that, if time and expertise were available, a substantially larger percentage of the plans submitted would benefit from geologic review.

Forest Practice Act And Rules

Recent concern throughout the State related to the utilization, restoration, and protection of forest resources and timberlands has resulted in the adoption of the Z'Berg-Nejedly Forest Practice Act of 1973. The Act is designed to: (1) encourage prudent and responsible forest resource management on nonfederal timber land, and (2) to create and maintain an effective and comprehensive system of regulation that assures that productivity of timberlands is restored, enhanced, and maintained while, at the same time, considers the public's need for watershed protection, fisheries and wildlife, range and forage, and recreational opportunities.

Under the Forest Practice Act, the State is divided into three districts (see Figure 1) based on different physical characteristics such as climate, soil type and principle forest crops. The State Board of Forestry is required to review, adopt, and revise district forest practice rules and

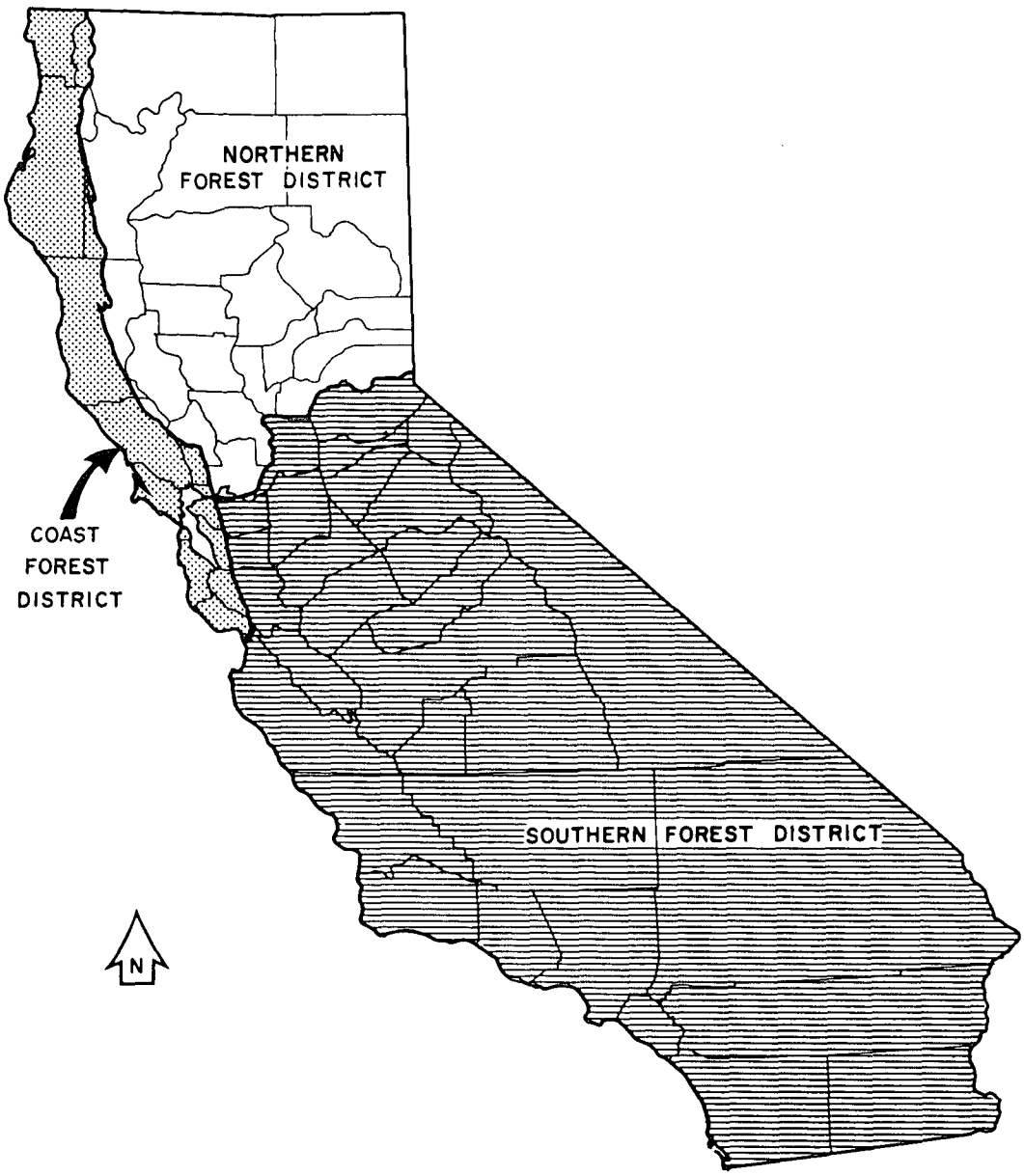

Figure 1. Forest Districts of the California Department of Forestry, 1976. Originally published in CALIFORNIA GEOLOGY, v. 30, no. 9, p. 195.

regulations for each district, based upon a study of the factors that significantly affect the present and future condition of timberlands. During the formulation or revision of such rules and regulations, the Board consults with and carefully evaluates recommendations from CDF and other governmental agencies, educational institutions, civic and public interest organizations, and private organizations and individuals.

Once adopted, the rules and regulations are used as standards by persons preparing and reviewing timber harvesting plans. Although the rules and regulations may vary from district to district, they apply to the conduct of timber operations and include measures for: fire prevention and control; soil erosion control; water quality and watershed control; stocking; protection against timber operations which unnecessarily destroy young timber growth or timber productivity of the soil; prevention and control of damage by forest insects, pests and disease; and protection of natural and scenic qualities in special treatment areas. Additional measures are included in each district for such geologically-related impacts as road construction, erosion hazard ratings, and identification and mitigation of landslide prone areas.

Timber Harvesting Plans

In addition to establishing rules and regulations, the Forest Practice Act of 1973 requires that a timber harvesting plan be submitted to CDF for review and approval prior to logging on private lands.* Except for special cases, the timber harvesting plan must be prepared by a Registered Professional Forester. The plan includes information regarding the timber owner and operator, the proposed logging methods, erosion hazard ratings, size of an area, road construction, stream protection, and fish and wildlife protection. A map showing the area of operation, location of proposed roads, known landslides, streams, and other appropriate information must accompany the timber harvesting plan.

When a timber harvesting plan is officially filed with CDF it becomes available for public inspection. Copies also are transmitted to the California Department of Fish and Game (CDFG) and the appropriate California Regional Water Quality Control Board (WQCB), which, along with CDF, are responsible for reviewing each plan. The timber harvesting plan must be approved or disapproved by CDF within 15 days from the date of a preharvest inspection (or 15 days from the date of filing if there is no preharvest inspection); if CDF takes no action, the plan is automatically approved. The deadline for the decision may be extended by agreement with the submitter in order to discuss and resolve questions about a plan's provisions. The Director of CDF may also delay the decision to approve or disapprove a plan if he finds that the plan contains elements that are not covered by the Forest Practice Act and Rules, but which could result in immediate, significant and long-term harm to natural resources of the State. A determination as to the validity of this finding is made by the Board of Forestry which may then promulgate emergency regulations. If the

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*The California Environmental Quality Act of 1971 requires an environmental impact report (EIR) be prepared for projects which may have a significant effect on the environment. However, Senate Bill 707 (enacted in 1975) provided authority and criteria by which the Secretary for Resources could allow harvesting plans on private timberlands to be submitted in lieu of EIRs.

plan is disapproved, it may be resubmitted at a later date with acceptable modifications, or the submitter may appeal the decision to the State Board of Forestry.

The Review Team

Each timber harvesting plan is reviewed by a team made up of one representative each from CDF, CDFG, and the appropriate regional WQCB. The review team screens the incoming plans for conformance to all standards and rules that are in effect at the time the plan is submitted. The chairman of the review team is the CDF representative. For most plans, the review team requires a preharvest field inspection by a CDF Forest Practice Officer which must be completed within 10 days of filing of the plan. An inspection by a geologist may be requested either by the review team members or the CDF Forest Practice Officer.

The decision as to whether a plan is approved or disapproved is made on the basis of the recommendations that come from the preharvest inspection and a second review team evaluation. After the review team analyzes the preharvest inspection reports and considers any public comments, the review team chairman makes recommendations to the Director of the Department of Forestry for approval or disapproval, and for any changes or mitigative measures to be included in the plan before it is approved. If a member of the review team feels that the recommendations of the chairman do not adequately address or provide sufficient mitigative measures for a particular problem, a statement of non-concurrence may be filed.

In reaching his decision the Director must evaluate and consider public comments as well as the review team deliberations. At the time of his decision he must address in writing all environmental issues raised during the review process, any statements of non-concurrence by review team members, and any recommendations of the review team that are not required in the final plan.

The Preharvest Inspection

Where required, the preharvest inspection is made by the local CDF Forest Practice Officer to inform the review team members of existing conditions on the ground and to recommend mitigative measures if necessary. When requested, the geologist accompanies the CDF Forest Practice Officer and the Registered Professional Forester who prepared the plan. In addition, representatives of CDFG and WQCB may participate. Representatives of the National Park Service accompany the preharvest inspection team on some plans near Redwood National Park. Occasionally, the logger and/or timber owner join the team. Where practicable, agency representatives and the private forester and logger work out in the field mitigating measures for identified problems.

During the preharvest inspection, the geologist identifies and evaluates potential environmental effects of logging practices in unstable geologic environments. Particular attention is given to existing and proposed road alignments, areas of active soil movement, stream crossings, proposed logging on steep slopes, and areas with high or extreme erosion hazard ratings. The geologist also confers with the foresters, biologists, water quality specialists, and loggers concerning potential impacts and alternative methods of logging. Upon completion of the preharvest inspection, he recommends mitigative measures that require an understanding of logging

practices and engineering geology methods, prepares a map for each plan, and writes a report describing his findings and explaining his recommendations. Reports usually must be provided within less than ten days of the preharvest inspection.

In addition to making preharvest field inspections, the geologist should make follow-up inspections of logged areas that have had geologic reviews so that the results of adopted mitigative measures and their effectiveness can be evaluated.

Guidelines for Geologic Review and Mitigation

The geologist works within the framework of State policy which encourages prudent forest management to serve the public's need for timber resources while giving consideration to environmental concerns (Forest Practice Act, Section 4512 C). Therefore, his role is to identify and suggest solutions to potential geologic problems so that timber can be successfully harvested with an adequate level of environmental protection from erosion. To do this he must work co-operatively with other government specialists and private individuals to achieve mutual resolution of common concerns.

Analysis of problem sites involves the identification of geologic hazards and environmental risks. Because geologic phenomena are only approximately predictable in time, place, and magnitude of impact, geologic hazards must be evaluated on the basis of the value of the resources threatened. In this context, the term hazard refers to any of the geologic phenomena that pose a potential threat to some aspect of the environment if triggered by logging activities. The term risk refers to the assessment of the loss which might result from some particular geologic event. The analogous evaluation in the field of public safety would lead to an estimate of the losses in life and property that might ensue from some particular geologic occurrence, such as an earthquake or landslide.

Fish-bearing streams imply a relatively higher risk than do non-fish-bearing streams. Unusually sensitive fishery resources reflect a still higher risk. Domestic water supplies in streams, reservoirs, and sensitive natural environments are also high-risk situations. In such situations, unusual precautions and exceptionally stringent mitigative measures to reduce the potential hazard are usually required. The assessment of environmental risks posed by geologic hazards must be made by the geologists in conjunction with specialists in forestry, water quality, fish and wildlife biology, and other disciplines.

Specific provisions of the Forest Practice Act guide the formulation of mitigative measures. Provisions pertaining to potential hazards generally specify what objective is to be achieved and leave the technical means up to the private forester and logger. For example, one of the most important provisions of the Coast District Rules (Article 5, Erosion Control, Section 915.1 (a) Logging Roads) states, "Road location shall avoid, where possible, soil with highly erodible characteristics, and evidence of slope instability. If these areas are unavoidable, special measures shall be taken to assure stability." The "special measures" referred to are not described in technical detail in the Rules. However they must be described by the Registered Professional Forester in the harvesting plan. Additional measures may be suggested by the CDF Forest Practice Officer and the geologist as a result of the preharvest inspection.

The Board of Forestry has interpreted the Forest Practice Act to indicate

that the timber harvesting plan must reflect the results of a feasibility analysis by the Registered Professional Forester of various possible logging methods, including methods of road construction, yarding techniques, and silvicultural methods. The feasilility analysis must identify and select a method of logging which reduces potential adverse impacts on the environment. The Board has indicated that the feasibility analysis need not be written or described in the plan. However, should the Department of Forestry determine that the feasibility analysis is not reflected in the plan and that a method of logging has not been selected that will reduce adverse environmental impacts, then the Director of the Department of Forestry has grounds to disapprove a plan. One of the most important contributions of the geologist to environmentally sound logging practices is to aid in the determination whether the method of logging proposed is a feasible alternative which substantially lessens potential erosional and geologic impacts and to recommend feasible alternative measures where necessary.

Example of a Feasibility Analysis (See Figure 2)

Original Plan

The plan was for selective logging mainly of young-growth redwood and Douglas fir. In the northeast sector scattered residual old-growth redwood and Douglas fir were present. Logging was to be by tractor. New roads and skid trails were to be constructed in the approximate locations indicated on the accompanying diagram (Figure 2, Map A). A request was made for a geological review by the CDF Forest Practice Officer based upon his observations during the preharvest inspection.

Geologic Conditions

The site is underlain by sheared and fractured sandstone and shale of the "coastal belt" Franciscan assemblage. Regionally, the strata strike northward and dip to the northeast. Soils are of the Hugo type, which commonly form on hard sedimentary rocks of the region. Topography is characterized by a steep (70 - 100 percent) riverside slope which rises several hundred feet to moderate (30 - 50 percent) slopes at the summit elevations. Locally bowed trees indicate shallow soil creep occurs. A recent landslide on the slope of a small drainage disintegrated and moved as a mudflow down the channel. Trees were felled and debris was deposited in a zone 30 to 50 feet wide along the length of the channel. Seepage from the slide scarp indicated that concentration of shallow groundwater probably was the chief factor contributing to movement. No recent activities of man were evident.

Geologic Analysis

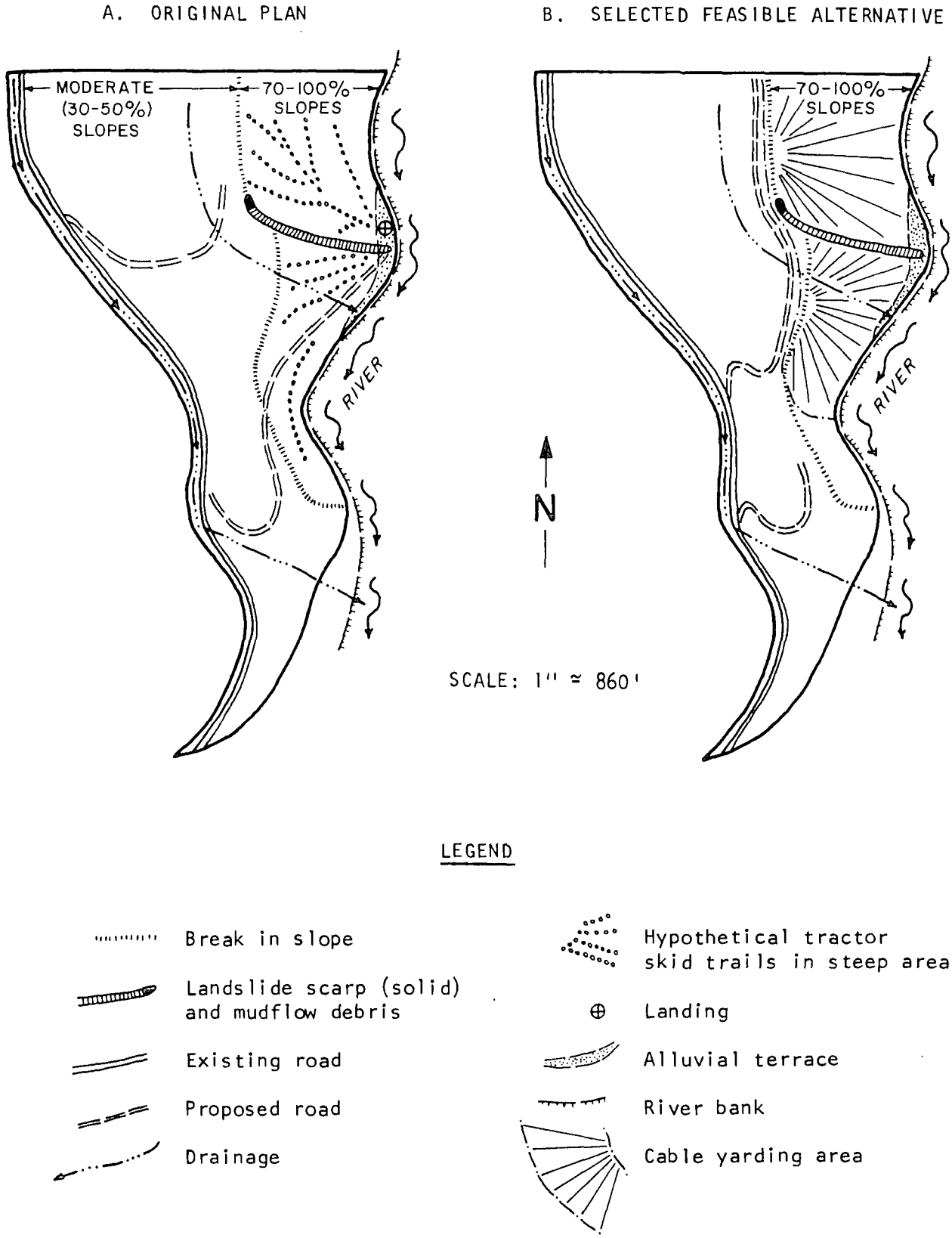
The geologist concluded that the proposed road construction and tractor yarding on the steep river-side slopes posed high hazards of creating erosion and introducing sediment into the river below. The conclusion was based upon several considerations:

1. The large volume of unconsolidated soil that would be sidecast during construction.

2. The undercutting of steep, questionably stable slopes by road and skid-trail excavation.

3. Evidence of potential soil instability as manifest in soil creep, land -

Figure 2. Example of a Feasibility Analysis (see text for explanation).



sliding, and local concentrations of shallow groundwater.

4. Tendency of unconsolidated soil to flow long distances when saturated, as in the mudflow described.

5. Immediate proximity of the stream to potential soil movement (unbuffered by intervening moderate slopes).

Selected Feasible Alternative

Based upon recommendations of the geologist and the CDF Forest Practice Officer, the plan for the area of steep slopes was modified by the private forester to a cable yarding system as illustrated (Figure 2, Map B). Roads were elevated to less steep terrain in order to permit effective cable logging. This alternative eliminated the environmentally hazardous road and tractor trail construction.

Additional Duties of the Geologist

The geologist provides additional services to CDF both formally and informally. He serves on technical committees concerning forest practices, addresses boards and commissions on geologic and erosion hazards on timberlands, and gives training sessions on slope stability and related geologic topics to the Forest Practice Officers.

The geologist also makes field inspections of geologic and erosional problems associated with Forest Practice Act violations. In some situations, he may be called upon as an expert witness in court actions. An aspect of this duty which is significant is that the geologists must know when geologic conditions are not involved in a seeming "geologic" problem. For example, landslides or erosion which result from operator carelessness sometimes may be ascribed to earthquakes, exceptional rainfall, or other unusual natural events. The geologist must be able to comment authoritatively on the role of these phenomena in alleged violations of the Forest Practice Act.

Throughout the years of this assignment, the geologist has contacted a wide sampling of professional foresters engaged in timber harvest planning and timberland use throughout the Coast District. These contacts have raised the general level of awareness of professional foresters of the presence, impact, and mitigation of geologic and erosion hazards.

In addition, because the geologist covers a wide area, involving many companies, different types of problems, ownerships amd methods of logging, he obtains a broad view of the existing state of the art in erosion control. At present, erosion control methods, other than those specified in the Forest Practice Rules, are developed for the most part independently among various companies, private foresters, and other practitioners. The geologist is able to recognize and to disseminate information concerning the best practices throughout the industry. These efforts improve the ability of the industry over-all to cope with erosion problems and potential instability.

Constraints the Geologist Works Under

Detailed geologic investigations that are common to urban engineered development are rarely employed during the preharvest inspection. The geologist must work within constraints imposed by law, convention, technical standards

of other professions, and physical limitations of logging equipment. In general, only a few hours are allotted for the preharvest inspection of plans ranging in size from several acres to several thousand acres. Aerial photographs amd adequate geologic maps usually are not available for examination prior to the inspection. While the CDF Forest Practice Officer is an inspector whose role is to examine and check the Registered Professional Forester's timber harvesting plan for adequacy, the geologist comes on the scene without the benefit of prior site-specific geologic work. He must make what is essentially a site evaluation within the same time-frame and under the same circumstances as the forester makes an inspection of previous work. In addition, most of the observations the forester makes are above ground but the geologist commonly must make inferences about what is beneath the surface based upon land forms that are obscured by a mantle of vegetation. In short, the geologist must prepare a quality report with minimal time for observation, reflection, consultation, or research. He is constrained by limited tools, lack of outcrops, and the necessity of remaining with the group in order to fulfill commitments.

Needs for the Future

The application of geologic knowledge to the problems of logging-induced erosion is increasing because it has proven to be useful in the reduction of erosion and because there is continued demand by the public and government agencies for more effective erosion control. However, because only a limited number of timber harvesting plans submitted can be provided with a geologic review, great improvements can be made in the scope of application.

Geologic criteria need to be established for the review team in analyzing incoming timber harvesting plans so that all appropriate areas will receive the geologic evaluation needed. Presently, plans are selected for geologic review on the basis of several factors including: information in the plan; knowledge of environmentally sensitive features which might be impacted; field observations made by the CDF Forest Practice Officer; and public concerns expressed about the proposed logging. It has been suggested that the geologist screen incoming plans, possibly as a participant on the review team. Maps of geologically unstable and erosion-prone areas should also be developed and interpreted as to potential logging-induced impacts to guide both the review team and others in the identification of potential problem areas. Some progress is being made towards this goal in that CDF recently commenced a program to compile existing geologic maps and other data for Region I. The resulting atlas of maps will put basic geologic information at the fingertips of the review team, field geologists, and foresters.

In addition to receiving geologic input during the review stages, the preparation of large-scale, long-range logging plans by large firms should receive geologic input from consulting geologists so that problems can be recognized and minimized by effective planning. Geologic evaluation and engineering mitigation of severe existing problems, such as landslides that continually disrupt main haul roads, should be common proactice.

There is also a need for greater scientific and technical knowledge, upon which to base practical judgements, that will permit not only better protection for the environment but more precise, and less costly, remedial measures. This knowledge should be gained from future scientific studies and from the experience of specialists who recommend, enforce, and implement

erosion control measures. Such studies should include basic research on the geological impacts of logging, slope stability mapping, and the development of road construction standards suitable for logging purposes.

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Z'Berg-Nejedly Forest Practice Act of 1973, Division 4, Chapter 8, Public Resources Code.