CALIFORNIA DEPARTMENT OF CONSERVATION | CALIFORNIA GEOLOGICAL SURVEY
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NOTE 45
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Guidelines for Engineering Geologic Reports for Timber Harvesting Plans

The following guidelines were prepared by the Department of Conservation's California Geological Survey (CGS) in cooperation with the California Department of Forestry and Fire Protection (CAL FIRE), the State Mining and Geology Board, the State Board for Professional Engineers, Land Surveyors, and Geologists (BPELSG), and the State Board of Forestry. Note 45 was developed with input from representatives from over 30 governmental and professional organizations, universities, industry consultants and the environmental community. Significant comments were made by the Association of Engineering and Environmental Geologists, North Coast Regional Water Quality Control Board, National Marine Fisheries Service, Redwood National Park, and the U.S. Forest Service. The guidelines may be used by California Professional Geologists (PGs), California Certified Engineering Geologists (CEGs), or California Professional Geotechnical Engineers (GEs) when preparing engineering geological reports for Timber Harvesting Plans (THPs) on private, state, and local agency timberlands.

Purpose

Timber harvesting and its associated activities can affect public health and safety, listed species and their habitats, water quality, or public lands by activating landslides or increasing surface soil erosion. The purpose of these guidelines is to aid geologists and engineers in identifying and assessing the geologic framework of proposed timber harvesting operations to evaluate those effects.

An engineering geologic report prepared under these guidelines should assess how activities associated with timber harvesting could affect the physical environment, particularly with respect to sediment input to watercourses and lakes. The level of investigation conducted under these guidelines should be based on the potential risk to public health and safety, listed species and their habitats, water quality, or public lands. In some cases, portions of these guidelines may be modified or omitted due to the absence of given concerns or issues at the site; in other cases, additional geologic information may be required.

Report Contents

The engineering geologic report should be written for review by agencies and the public and be prepared so that Licensed Timber Operators can understand and implement specific mitigation measures. The report should include, at a minimum, the following information:

I. General Information

A. Timber Owner

B. Timberland Owner

C. Name of THP or other identifier

D. Location (also see section IX, b)

1. 7.5' U.S. Geological Survey (USGS) Topographic Quadrangle
2. Legal Description
   a. Township, Range, Section
   b. Assessors Parcel Number (optional)
3. County
4. Watershed
   a. River System from published USGS topographic maps
   b. Named tributary stream (from published topographic maps)
   c. Planning Watershed as defined by CAL FIRE (to be supplied by Registered Professional Forester (RPF) preparing the THP)

E. Methods of Investigation

1. Reference all published and unpublished maps and reports.
2. List all aerial photographs and other imagery used in the study. Include copies of one set of stereo aerial photographs in the report with the THP boundaries outlined.

3. List dates of field investigation/mapping.
4. Describe subsurface exploration methods (if done).
5. Include an analysis of the data (do not just give conclusions).
6. Describe applicable studies and technical models.

F. Individuals Contacted

II. Scope of Investigation

The scope of the engineering geologic investigation and report should be focused to evaluate the potential for proposed timber harvesting activities to adversely affect public health and safety, listed species or their habitat, water quality, or public lands. The scope of the report should be clearly stated and should be based on both the geologic constraints present at or near the site and the potential risk of those hazards on the environment. Where the report is focused on a single geology-related issue, an explanation of why the scope was limited should be included.

A. Public Safety
Has the RPF preparing the THP identified any houses, public buildings, roads or other features in a position where they could potentially be adversely affected by landsliding or surface soil erosion associated with the proposed timber harvesting activities?

B. Water Quality

1. Has the RPF identified that this THP has been in a watershed that has been classified as impaired by sediment by the U.S. Environmental Protection Agency or other regulatory agency?
2. Has the RPF identified any domestic water supplies that could potentially be impaired by sediment derived from timber harvesting activities? If so, these facilities should be shown on a map with respect to the proposed THP.

C. Listed Animal or Plant Species
Has the RPF identified listed rare, threatened or endangered species or their habitats within the watershed that could be adversely affected by potential landsliding or erosion associated with the proposed operations?

D. Public Lands
Has the RPF identified parks, wildlife refuges, or other public lands that could potentially be affected by landslides or soil erosion associated with the proposed timber harvesting activities?

III. Geologic Conditions

A. Bedrock Geology

1. Formation names and ages
2. Lithology (rock types)
3. Fabric (beds, joints, fractures) - The relationship of fabric and structural elements, where they are well defined and continuous, to hillslope aspects within or adjacent to the THP area should be evaluated.
4. General range in physical properties (density, hardness, strength, permeability) based on reconnaissance field work or data from other reports.

B. Seismotectonic Considerations
Provide concise information about the seismic and tectonic setting of the THP site and adjacent area and how it may relate to slope stability, surface soil erosion, or sedimentation.

C. Geomorphology

1. Landslides - Each landslide that could pose a significant risk to public health and safety, listed species or their environments, water quality, or public lands, and that may be adversely affected by proposed timber harvesting activities should be addressed in the engineering geologic report. The following information should be included:
   a. Description of type of landslide and its physical features (use nomenclature of Crudden and Varnes, 1996). Also see definitions for inner gorge, slide areas, unstable areas and unstable soils in the California Forest Practice Rules (see last page of this Note.)
   b. Documentation of landslide dimensions, including width, length, and depth and the method used to measure or estimate the dimensions.
   c. General description of type and density of vegetation and degree of revegetation in landslide area. If large trees are present in the landslide area, are any in a position where the landslide could potentially deliver woody debris to stream channels?
   d. Description of the ground slope(s) of the landslide and adjoining ground. Identify variations in slope greater than 10 percent along the landslide profile. Describe how slope measurements were made.

e. Describe the relative position of the landslide on the slope.

f. Evaluate the volume of sediment delivered to watercourses from landslides that have failed within the past 10 years.

1) Describe how sediment volumes were determined.

2) Estimate volume of sediment in a position to enter watercourses from each landslide, if any, and the relative rate of sediment delivery. Discuss the methods used to make the estimate.

g. Landslide materials (bedrock, weathered bedrock, soil, colluvium).

h. Degree of activity and/or relative stability - when was the landslide last active? Include discussion of reasoning used to determine activity and relative stability. Protocol for assessing relative stability should follow Keaton and DeGraff (1996).

i. Triggering mechanism - For historic landslides with known failure dates, did the landslide fail in response to a storm or earthquake event?

j. Slope modifications - did the landslide fail from a natural or modified slope? Have existing cuts and fills remained stable since the slopes were modified?

k. Identify springs, marshes, or wet areas.

l. Illustrations where needed, such as field-developed or interpretive cross sections, and detailed maps or illustrations of landslide features.

m. Provide other information as needed.

2. Landscape Geomorphology Indicative of Potentially Unstable Slopes

a. Inner Gorge - Refer to CGS Note 50.

b. Debris Slide Slope - CGS Note 50.

c. Other landforms, such as hummocky areas, closed depressions, disorganized drainages, disrupted linear features such as fences or roads, benches of questionable origin, tension cracks, leaning trees, or seepage sites.

d. Potential debris flow source area, such as colluvial filled swales inclined more steeply than 50 percent. Where computer models of steep topographic swales are available for a site from the landowner the RPF, or elsewhere, they should be included in the report.

D. Soil and Regolith from Published Soil Surveys or from the RPF as Modified by On-site Observations

1. Soil series

2. Soil thickness

3. Soil textural properties (grain size, plasticity, Uniform Soil Classification)

4. Soil drainage classification

5. Permeability contrasts between soil and underlying bedrock

6. Potential surface soil erosion hazard - identify how this was determined

E. Regional or local climate information as provided by the RPF. This should include, but not be limited to relative storm intensities, snow accumulations, and potential for rain-on-snow as it may affect terrain stability or surface soil erosion.

IV. Proposed Timber Harvesting Activities (obtained from THP)

A. Silviculture

B. Site Preparation

C. Yarding System(s)

D. Road and Landing Construction / Reconstruction and Maintenance

E. Winter or wet weather operations

F. Equipment operations on steep slopes

G. Other

V. Potential Effects on Slope Stability and Surface Soil Erosion from Proposed Operations

The engineering geologic report should provide a thorough, well-reasoned discussion or rationale and explicit conclusions on how the proposed timber harvesting operations may affect both short- and long- term site-specific slope stability and surface soil erosion. Potential effect-generating activities may include, but are not limited to road design and construction method, excavation and disposal of materials, road and skid trail drainage, road use and maintenance, vegetation removal, and site preparation.

VI. Cumulative Effects Assessment Related to Slope Stability, Surface Soil Erosion, and Sedimentation

A. Identify existing, ongoing problems associated with landsliding, surface soil erosion, and sedimentation within the THP area, including appurtenant and legacy roads. This will probably require interpreta-tion of historical aerial photo-graphy as well as office research, personal contacts, and fieldwork. Discuss how nearby geologically similar areas have responded to harvesting and road building in the context of significant storm events or earthquakes.

B. Discuss potential impacts from current or past activities within the watershed that could interact with potential effects from the proposed THP. These activities would include, but not be limited to, dams and water works, mining, other agriculture and grazing, urbanization, and roads.

C. From the context of geologic and geomorphic conditions and environmental concerns, evaluate how the proposed activities and any reasonably foreseeable future activities could interact with existing conditions within the watershed and how this may impact environmental issues of concern.

VII. Mitigation of Problem Areas

Identify areas of concern. Describe specific mitigative measures needed to minimize potential effects for the identified areas of concern. Where mitigations require an engineered design, the services of a civil engineer will be required. Mitigation monitoring plans developed in cooperation with the RPF should be included. The mitigations may be related to re-cent or dormant landslides, areas of surface soil erosion, new road construction, road reconstruction, stream crossings, yarding activities, silviculture, site preparation, cumulative effects within the watershed, and/or other factors. The mitigation work should be based on the potential hazard process (likelihood of landslide initiation or acceleration or an increase in surface soil erosion), the potential effects of the land-slide or increased erosion with respect to sediment mobilization or water flow, and the potential risk to public health and safety, listed species or their habitats, water quality, forest soil productivity, or public lands. The report should specify inspections and monitoring where needed.

VIII. References

All references used, including aerial photographs and other imagery, should be cited.

IX. Maps and Diagrams: These should i nclude, but not be limited to the following:

A. Regional geologic and geomorphic map(s) at a scale of 1:24,000 or larger. This map should show the location of the THP and identify geologic features and downstream/ downslope resources that could affect or be affected by the proposed timber harvesting operations. This map should also provide regional information for the watershed in which the THP is being submitted to allow for an assessment of potential cumulative effects of sediment or debris identification. All maps should include a north arrow, bar scale, contour interval, and legend consistent with the guidelines defined by the BPELSG (2013).

B. Site location map, typically at a scale of 1:12,000. The scale of the site location map should be large enough to show all needed information. The map should display:

1. THP boundaries
2. Logging units
3. Road locations, characterized by width, drainage design, and surfacing; including existing, planned, and legacy roads (old and unmaintained roads)
4. Landing locations, including existing, planned, and legacy landings
5. Watercourses, springs, and wet areas
6. Silvicultural units
7. Landslides, gullies, or sediment depositional areas, including those not further discussed in the report.
8. Locations of analysis sites and mitigation points

C. Detailed site-specific maps and diagrams. Where specific information or mitigation measures are identified in the engineering geologic report, detailed maps, cross sections, diagrams, and/or schematic illustrations should be included at a scale that adequately presents the needed information.

X. Authority

The California Business and Professions Code requires that the PG, CEG, or GE must be working within his/ her area of expertise and shall sign the final report. Inclusion of license numbers and/or official stamps shall be per the requirements of the licensing board.

REFERENCES

California Geological Survey Note 50, – similar to Note 52 Factors Affecting Landslides in Forested Terrain, January 2013, www.conservation.ca.gov/cgs/information/publications/cgs_notes/note-50

California Board for Professional Engineers, Land Surveyors, and Geologists, 2013, Geologists and Geophysicists Act (Business and Professions Code §§ 7800-7887, Chapter 12.5) with Rules and Regulations (California Code of Regulations, Title 16, Division 29, §§ 3000-3067) and Related Sections of the Business and Professions Code, Government Code, Penal Code and Evidence Code, January 1, 2013.

California Board for Professional Engineers, Land Surveyors, and Geologists, 2013, Professional Engineers Act (Business and Professions Code §§ 6700-6799, Chapter 7) with Rules and Regulations (California Code of Regulations, Title 16, Division 29, §§ 400-476) and Related Sections of the Business and Professions Code, Government Code, Penal Code and Evidence Code, January 1, 2013.

California Board for Professional Engineers, Land Surveyors, and Geologists, 1998, Guidelines for Engineering Geologic Reports, 8 p.

Crudden, D.M. and Varnes, D.J. 1996, Landslide Types and Processes *in* Turner, A.K. and Schuster, R.L., editors, Landslides: Investigation and Mitigation, Transportation Research Board, National Research Council Special Report 247, p. 36-75.

Keaton, J.R. and DeGraff, J.V., 1996, Surface Observation and Geologic Mapping *in* Turner, A.K. and Schuster, R.L., editors, Landslides: Investigation and Mitigation, Transportation Research Board, National Research Council Special Report 247, p. 178-230.

CALIFORNIA FOREST PRACTICE RULES - 2013

(Title 14, California Code of Regulations, Chapters 4, 4.5 and 10)

895.1.Definitions: Inner Gorge, Slide Areas, Unstable Areas, Unstable Soils

Inner Gorge means a geomorphic feature formed by coalescing scars originating from landsliding and erosional processes caused by active stream erosion. The feature is identified as that area beginning immediately adjacent to the stream channel below the first break in slope

Slide Areas are areas indicated by the following characteristics:

1. Shallow-seated Landslide. An area where surface material (unconsolidated rock, colluvium, and soil) has moved downslope along a relatively steep, shallow failure surface. The failure surface is generally greater than 65% in steepness and less than 5 feet in depth. It is usually characterized by: 1) a scarp at the top; 2) a concave scar below the scarp, where surface material has been removed; and sometimes 3) a convex area at the bottom where slide material is deposited. Vegetation is usually disturbed (tilted trees), anomalous (younger, evenaged stand), or absent (bare soil). Minor bank slumps are excluded from this definition.
2. Deep-seated Landslide. An area where landslide material has moved downslope either as a relatively cohesive mass (rotational slides and translational block slides) or as an irregular, hummocky mass (earthflow). The failure surface is generally deeper than five feet and is usually well-exposed at the head scarp. Complex failures with rotational movement at the head and translational movement or earthflows downslope are common. Vegetation on rotational and translational slides is relatively undisturbed, although trees and shrubs may be pistol-butted or tilted. Deep-seated landslides may have intermediate tension cracks, scarps, and shallow slides superimposed throughout the slide mass. Deep-seated landslide risk is usually associated with cohesive soils.

Unstable Areas are characterized by slide areas or unstable soils or by some or all of the following: hummocky topography consisting of rolling bumpy ground, frequent benches, and depressions; short irregular surface drainages begin and end on the slope; tension cracks and head wall scarps indicating slumping are visible; slopes are irregular and may be slightly concave in upper half and convex in lower half as a result of previous slope failure; there may be evidence of impaired ground water movement resulting in local zones of saturation within the soil mass which is indicated at the surface by sag ponds with standing water, springs, or patches of wet ground. Some or all of the following may be present: hydrophytic (wet site) vegetation prevalent; leaning, jackstrawed or split trees are common; pistol-butted trees with excessive sweep may occur in areas of hummocky topography (note: leaning and pistol-butted trees should be used as indicators of slope failure only in the presence of other indicators).

Unstable Soils may be indicated by the following characteristics:

1. Unconsolidated, non-cohesive soils (coarser textured than Loam , as defined in Appendix I.A.1a of Board of Forestry Technical Rule Addendum No. 1, dated December 15, 1981) and colluvial debris including sands and gravels, rock fragments, or weathered granitics. Such soils are usually associated with a risk of shallow-seated landslides on slopes of 65% or more, having non-cohesive soils less than 5 ft. deep in an area where precipitation exceeds 4 in. in 24 hours in a 5-year recurrence interval.
2. Soils that increase and decrease in volume as moisture content changes. During dry weather, these materials become hard and rock-like exhibiting a network of polygonal shrinkage cracks and a blocky structure resulting from desiccation. Some cracks may be greater than 5 feet in depth. These materials when wet are very sticky, dingy, shiny, and easily molded.

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