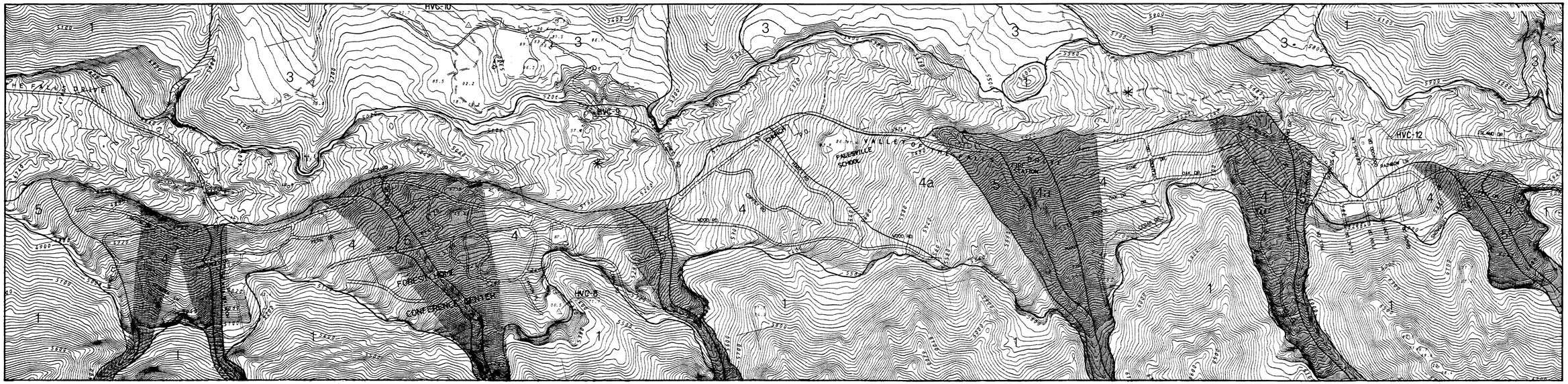
DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA, GRAY DAVIS, GOVERNOR
THE RESOURCES AGENCY, MARY NICHOLS, SECRETARY FOR RESOURCES
DEPARTMENT OF CONSERVATION, DARRYL YOUNG, DIRECTOR

DMG OPEN-FILE REPORT 95-17
LANDSLIDE HAZARD MAP NO. 43
DEBRIS FLOW RUNOUT POTENTIAL
PLATE B-2 (Revised 2000)



SCALE 1:4800

0 400 800 1200 1600 2000 Feet

DATUM IS MEAN SEA LEVEL

CONTOUR INTERVAL 4 AND 20 FEET

PLATE B-2

RELATIVE DEBRIS-FLOW RUNOUT POTENTIAL IN THE FOREST FALLS AREA, SAN BERNARDINO COUNTY, CALIFORNIA

By

Siang S. Tan

1995
(REVISED 2000
by
C.J. Wills and S.S. Tan)

Note: This is not an Official Seismic Hazard Zone Map under the provisions of Chapter 7.8 of the California Public Resources Code.

EXPLANATION

INTRODUCTION:

Plate B-2 documents the relative debris-flow runout potential in the Forest Falls area. Debris-flow runout is the process where a debris flow that has formed in very steep terrain flows out from its source areas, slowing and beginning to deposit material. Commonly this begins where the debris flow leaves the steep narrow channel in the mountains and spreads across an alluvial fan. This process has formed the relatively gently sloping land where most structures in the Forest Falls area are built. Deposits of past debris flows underlie this land surface and landforms related to recent debris flows can be found throughout the area. Hazards related to debris-flow runout occur when fast-moving debris impacts man-made structures or roadways. These flows are referred to as "stream-related" debris flow on Plate B-1.

The updating and revision of Plate B-2 was initiated by the July 11, 1999 disaster (one death and more than 30 damaged dwellings) when a high velocity debris flow (a debris avalanche) jumped a channel. See Plate B-1 explanation for further historic notes on the thunderstorm damage to the Forest Falls area.

METHODS:

The study included limited field observation and analysis of aerial photographs, topographic maps and other significant data listed below, in an effort to identify areas susceptible to debris-flow runout in the Forest Falls residential area.

Other data analyzed in producing Plate B-2 are: (a) local drainage courses (Types A, B and C on Plate B-1), their watershed pattern and topographical features, and (b) past debris flow/flood event and damage history.

Although Plate B-2 is at a large scale (1:4,800), it is a generalized product of a interpretive, brief and limited study. More field mapping and quantitative analysis are needed for site-specific hazards evaluations. Additional investigations for more comprehensive studies could include: (a) obtaining a more accurate topographic map of the area; (b) field mapping of debarked (damaged) trees that indicate previous forceful debris flows; (c) estimation of peak flow, sediment yield and other values of the watersheds (see Plate B-1) that are the sources of the debris flows; (d) locating sites of historic damage due to debris flows in the area; and (e) field mapping of the relative ages of ground surfaces (sedimentation, erosion, vegetational ground cover, etc.) indicating activity levels of debris flow/flood in the Forest Falls developed area. These types of investigation were not performed for this more general, regional study.

Plate B-2 is based on natural conditions of the Forest Falls area and, in some cases, the effects of existing development. However, no attempt was made to evaluate the effectiveness of existing debris-flow hazard mitigation (such as the modification and redirection of drainage channels, construction of berms, dikes, culverts, and street drainage). Site-specific geotechnical evaluation is essential to assess whether existing engineering measures are adequate.

RELATIVE DEBRIS-FLOW RUNOUT POTENTIAL

1	2	3	4	5
VERY LOW	LOW (not mapped)	MODERATE	HIGH	VERY HIGH

AREA 1: **Very low debris-flow runout potential.** Debris-flow runout hazards are unlikely within this area due to the regional steepness of slopes. However, the susceptibility of slope-related hazard (such as slope failures, landslides, rockfall, avalanche and erosion) is very high in Area 1 as depicted on landslide susceptibility maps of the region (Tan, 1990).

Recommended Application: Debris-flow runout mitigation is generally not necessary for any proposed development in Area 1, although slope-failure related hazard and its mitigation should be investigated.

AREA 3: **Moderate debris-flow runout potential.** This area contains alluvial fans with moderate slopes on the north side of Mill Creek. These alluvial fans are most commonly composed of stream transported sediment rather than debris-flow deposits. Debris flows are apparently less frequent in these areas, possibly due to the size and geometry of the watersheds or slightly lower likelihood of intense rainfall on the north side of the Mill Creek canyon.

Recommended Application: Due to the variability in terrain, debris-flow mitigation investigation is advisable for Area 3 prior to development.

AREA 4: **High debris-flow runout potential.** The area contains areas on either side of Type B drainages and most type C drainage courses on the south side of Mill Creek. These alluvial fans are composed almost entirely of debris-flow deposits. Landforms and vegetation patterns on these fans show evidence for debris flows in the recent past. The area includes gentle to moderate slopes, where slope angles are generally less than 10 degrees. Intense rainfall can cause extensive erosion and small landslides in the steep watersheds of Type B streams, leading to debris flows in their channels. As these debris flows reach the less steep area at Forest Falls they may flow across the upper parts of the fans before slowing and beginning to deposit their sediment. Deposition of debris in the channel may cause later flows to leave the clogged channel and flow through adjacent areas. Area 4 is highly susceptible to debris-flow runout, Most recent debris flows have occurred in areas mapped as Very High potential, area 5, but as channels are filled with debris, areas of debris flow runout and deposition shift. Most of area 4 is not in the current path of debris flow runout, but has been in the past and will be in the future as the pattern of flow changes. The large alluvial fan between the Fallsvale School and the fire station appears to be particularly unstable. Many recent debris flows have occurred and several have left the well-developed channels. This area where debris flows appear to be less confined to the existing channels is shown on the map as area 4a.

Recommended Application: Due to the variability in terrain debris-flow mitigation investigation is advisable for Area 4 prior to development.

AREA 5: **Very High debris flow runout potential**. The area contains the channels of Type B (intermediate) and some type C (minor) drainage courses as shown on Plate 1. These channels have been areas of debris flow deposition and areas affected by debris flows in the recent past. The area includes gentle to moderate slopes, where slope angles are generally less than 10 degrees. Most recent debris flows have been confined to the intermediate channels but locally have spread out on the lower parts of the fans, particularly in the area southwest of the fire station. The debris flow hazards are greatest along these relatively narrow areas from the mouths of the canyons to the channel of Mill Creek. Overflowing of Type B drainages onto paved roads (such as the Valley of Falls Drive highway) is particularly hazardous and possibly life-threatening. Runoff is not thoroughly channeled and major spills onto streets create potentially hazardous conditions due to the high speed of high-density flow on less resistant surfaces of paved roads.

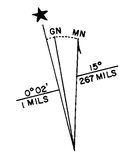
Recommended Application: Due to the variability in terrain, debris-flow mitigation investigation is advisable for Subarea 5 prior to development. The area is subject to property damage and life-threatening situations during intense rainfall.

* AREA NOT RATED — As debris flows enter Mill Creek, they are diluted and the material is transported downstream with the stream flow. Consequently, debris flows are not known to occur in the Mill Creek channel. Debris flows are, in effect, incorporated within flood flows within the creek. No attempt has been made to rate the hazards of flooding and erosion for this map so these areas are not rated.

Potential debris avalanche area: Exceptionally fast-moving debris flows (called debris avalanches) may leave the channels by jumping the channel at a bend; the 1999 fatality occurred in this type of condition. Because only one flow of this type has been recorded, the frequency of this type of event is unknown. Debris avalanches can occur in areas that are directly below the mouths of canyons of type B drainages as shown by the pattern on the map.

ACKNOWLEDGMENT:

We would like to acknowledge the encouragement, contributions, guidance and review of Allan G. Barrows and Michael S. Reichle, of the California Division of Mines and Geology, Wessly A. Reeder (San Bernardino County geologist) for suggesting this study and providing advice, and Douglas M. Morton (U.S. Geological Survey) for sharing his knowledge of the debris flows at Forest Falls.



INDEX MAP