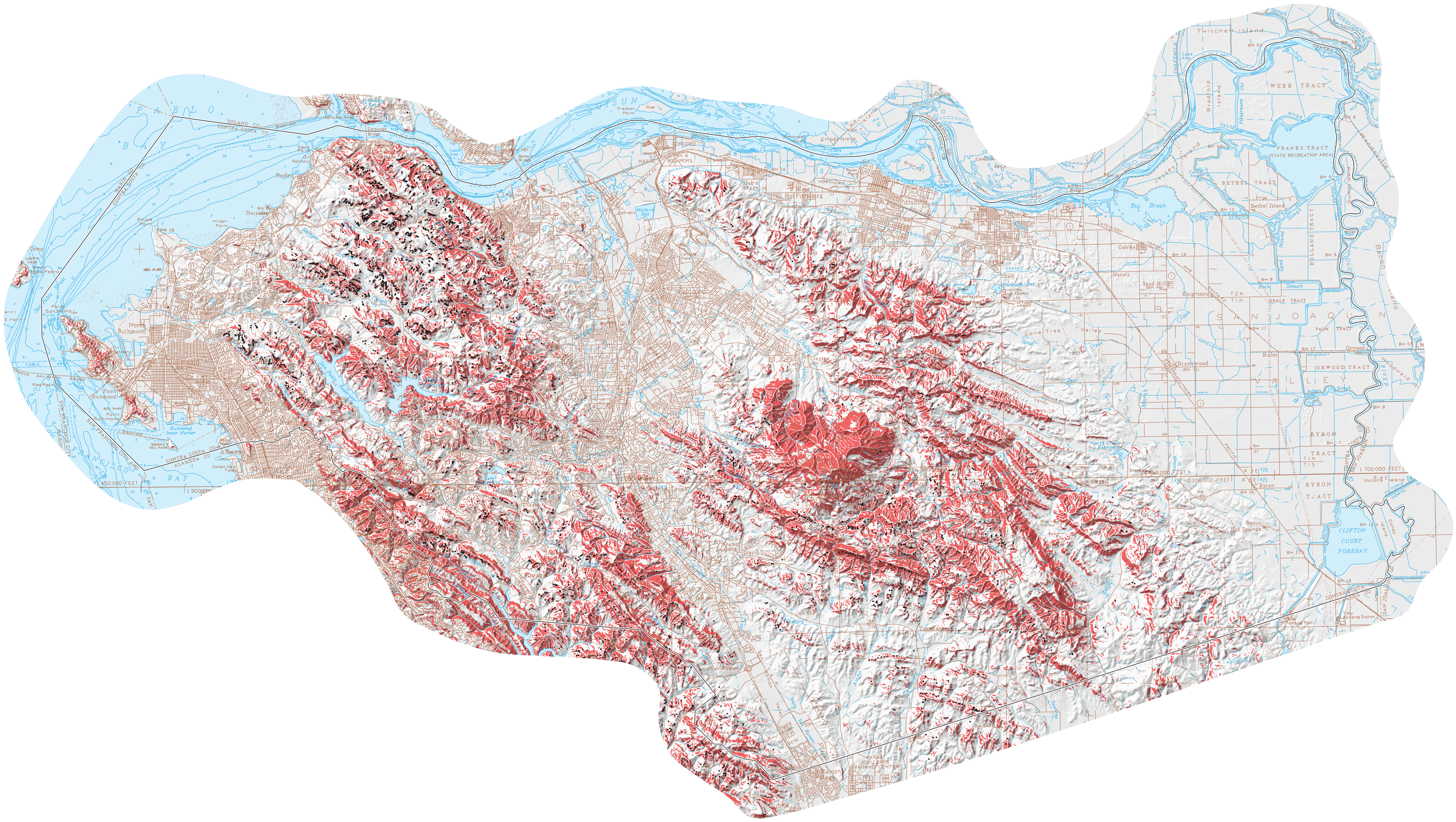


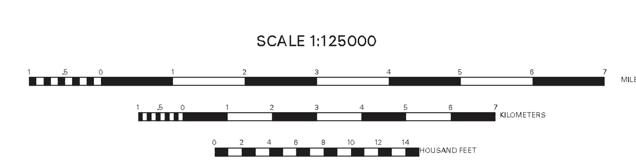
U.S. Department of the Interior
United States Geological Survey

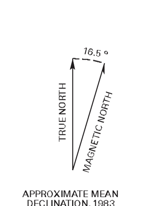
Base scanned from U.S. Geological Survey Bay Region Topograhic Sheets, scale 1:125,000, 1970 (Aitken, D.S., 1997, USGS OFR 97-500)

Shaded relief base derived from Graham, S.E., and Pike, R.J, 1997, USGS OFR 97-745 B

Universal Tranverse Mercator projection, Zone 10

This map is a plot derived from data contained in the digital database Open-File Report 97-745, "San Francisco Bay Region Landslide Folio" A PostScript image of this map is included in the Open-File Report, but the Open-File Report does not contain a paper copy of this map. The Open-File Report consists of the digital data and a pamphlet explaining the database and indicating how to obtain the data from which this map was prepared as well as the PostScript image of the map.





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This database, identified as "San Francisco Bay Region Landslide Folio," has been approved for release and publication by the Director of the USGS. Although this database has been subjected to rigorous review and is substantially complete, the USGS reserves the right to revise the data pursuant to further analysis and review.
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MAP SHOWING PRINCIPAL DEBRIS-FLOW SOURCE AREAS IN CONTRA COSTA COUNTY, CALIFORNIA

By

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INTRODUCTION

This map identifies the principal areas in the San Francisco Bay region that are likely to produce debris flows, which are also called "mudslides." Debris flows that occur in the bay region are fast-moving downslope flows of mud that may include rocks, vegetation, and other debris. These flows begin during intense rainfall as shallow landslides on steep slopes. The rapid movement and sudden arrival of debris flows pose a hazard to life and property during and immediately following the triggering rainfall.

Debris flows in a given storm originate from a number of sources scattered throughout steep parts of the landscape (figure 1). During subsequent storms, new debris flows originate from different sources. These various sources, however, are similar in topographic form because debris-flow initiation requires steep slopes and prefers concave parts of hillsides. These topographic characteristics are used to predict the likely future source areas shown on this map.

MAP UNITS

The red zones of the map portray the principal areas from which debris flows can be expected during future storms. The black dots represent the debris-flow sources mapped after the catastrophic storm of January 1982. The dots provide an example of the abundance of debris flows that might be expected during a major rainstorm, and they illustrate the approximate nature of this predictive map.

HAZARD

Because debris flows travel downslope and downstream from source areas, hazards commonly extend beyond the red zones of the map. In the vicinity of the red zones, common areas of hazard are 1) near the base of steep hillsides, 2) near the mouths of steep sidehill drainages, and 3) in and near the mouths of canyons that drain steep terrain. Examples of these hazardous settings are shown in figure 1.

USE OF THE MAP

The map shows the principal source areas of debris flows from natural hillslopes in the region. Debris flows and other fast-moving landslides may also occur from man-made slopes, such as the cut slopes along highways in hilly terrain, but such sources generally are not shown on the map. Debris flows also are possible from unmodified steep areas outside of the red zones, but we expect that most debris flows will originate in or near the red zones of the map.

Because the map depicts source areas and not flow paths, and because of its broad areal coverage and small scale, the map is intended to be used as a guide to general areas of debris-flow hazard rather than as a predictor of hazard at specific sites. Appropriate uses include storm-preparedness planning for emergency access and response.

PREPARATION OF MAP

The map was produced using a Geographic Information System (GIS) from a 30-meter-square grid of topographic elevations in the region. The grid of elevations, called a digital elevation model (DEM), permits calculation of hillslope steepness and curvature for each 30-m cell. The potential debris-flow sources shown on the map were determined using the values of steepness and curvature defined in table 1. Mapped sources of historical debris flows in calibration areas were used to determine the parameters in table 1; the calibration areas we used are near Montara Mountain in San Mateo County (Wentworth, 1986) and in part of Marin County (plate 6 of Ellen and others, 1988). In these meticulously mapped calibration areas, the red zones include 82 percent of the mapped debris-flow sources. In the bay region as a whole, only 53 percent of the black dots of the map lie within the red zones. This low percentage probably results at least in part from inaccurate location of the black region-wide mapping.

EXPLANATION

Principal predicted debris-flow source areas

Approxiamate sources of debris flows triggered during the storm of January 1982

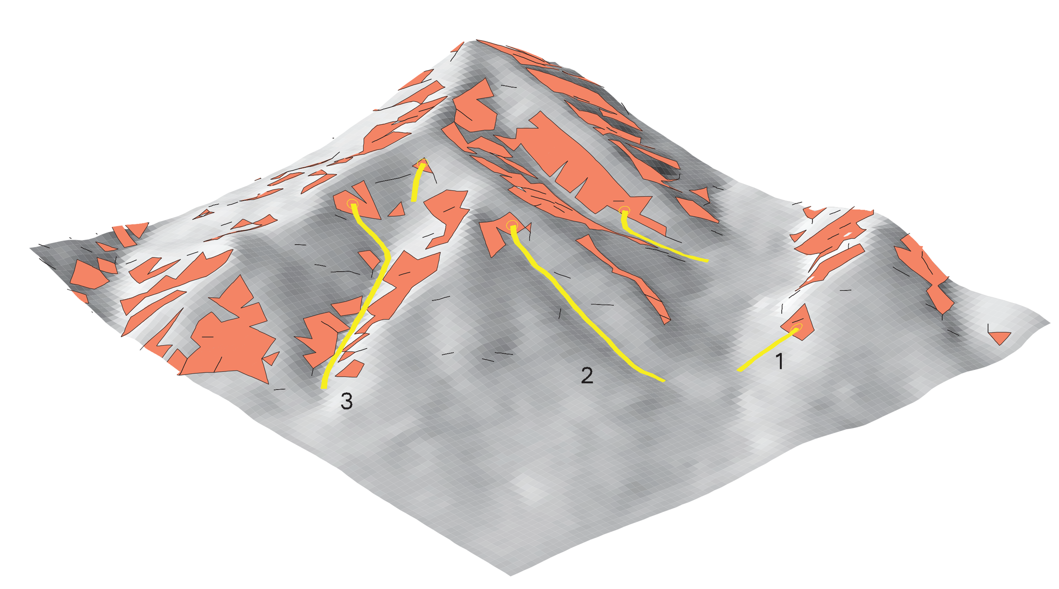

Figure 1: Perspective view showing typical debris flows (yellow) resulting from a major storm, in relation to potential source areas (red zones) like those shown on the map. In any one storm only a small fraction of the potential source areas may be activated. Most debris flows in the San Francisco Bay region travel only several tens of yards or less, but some may travel hundreds of yards downslope from their sources and others have traveled as much as a mile or more down stream channels. Numbers refer to typical hazardous locations discussed above.

Table 1: Hillslope steepness and curvature used to map potential debris-flow source areas [Values as measured on 30-m elevation grids. Plan curvature is curvature of the ground surface in a horizontal plane; it is measured as 1/r, where r is radius of curvature in meters and negative values indicate concave areas such as swales]

Hillslope steepness	Plan curvature
20 degrees and greater	+0.01 and less (including all negative values)

References Cited

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