DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
U.S. ARMY CORPS OF ENGINEERS

MISCELLANEOUS FIELD STUDIES
MAP MF-471

INDEX MAP SHOWING AREA OF THIS INVESTIGATION

EXPLANATION

Y YOUNGER LANDSLIDE--Known to have been active during historic time. Prior to development of the Pacific Palisades area, the greatest historic landslide activity apparently occurred during or shortly after the heavy rains of February and March 1884, December 1889 and January 1890, January and February 1914, and January 1916. In subsequent years, after development of the area began, the greatest landslide activity occurred mostly during or shortly after the heavy rains of January 1934, February and March 1938, February and March 1941, January 1952, March 1952, January 1956, February and March 1958, February 1962, November and December 1965, January 1967, and January and February 1969. Queried where historic activity is inferred solely from topographic features revealed in the field or on photographs or maps. Many younger landslides were preceded by older (prehistoric) landslides in part or all of the same areas. Well-defined separate landslides within the same landslide complex are locally differentiated according to relative age by subscripts: Y_1 is oldest; the later landslides in such a sequence commonly are at least partly within the areas of the earlier landslides. Where landsliding has occurred since November 22, 1957--the date of the aerial photographs used in compiling the topographic base map (except for landslide area no. 26, for which the aerial photographs were taken April 9, 1958)--the contours shown within the landslide boundary are no longer correct.

Yg Landslide, or part of landslide, that has been considerably modified artificially by grading operations. Where such changes occurred before November 22, 1957 (April 9, 1958, in area no. 26), the landslide boundary is plotted without respect to the contours. Where landslide deposit has been completely removed or main scarp has been reshaped by excavation, the lined pattern is shown. Former extent of younger landslide debris on the Pacific Coast Highway is shown only for a few of the larger landslides.

gY Landslide that moved after grading operations that took place since November 22, 1957 (April 9, 1958, in area no. 26); the landslide boundary is plotted without respect to the contours.

Ygs/Ys Landslide for which engineering measures were specifically designed and applied for the purpose of land stabilization.

O OLDER LANDSLIDE--Prehistoric. No historic record of activity; Holocene and (or) late Pleistocene in age. Based on topographic expression, commonly considerably modified by erosion, or on other geologic evidence. Queried where landslide origin is in doubt.

Og Landslide, or part of landslide, that has been considerably modified artificially by grading operations. Where such changes occurred before November 22, 1957 (April 9, 1958, in area no. 26), the landslide boundary is plotted without respect to the contours. Where landslide deposit has been completely removed or main scarp has been reshaped by excavation, the lined pattern is shown.

BOUNDARY OF LANDSLIDE OR BETWEEN ARTIFICIALLY GRADED AND UNGRADED PARTS OF LANDSLIDE--Dashed where approximately located; short dashed where indefinite or inferred; dotted where concealed by artificial fill.

Boundary of landslide indicates displacement of the ground surface or earth materials generally greater than 1 foot. Headward portion of the boundary marks the upper extent of surface of rupture; thus it is drawn at the top of fresh or relatively unmodified scarps, at the base of scarps strongly modified by erosion, and, where topographic evidence is lacking, along the trace on the ground of the surface of rupture. Boundaries of younger landslides as of June 30, 1969; or, where topographic expression considerably modified by artificial grading before June 30, 1969, based on topography at time of latest record prior to modification. Boundaries of older landslides having topographic expression are based on topography shown on earliest reliable maps or photographs.

Boundary between artificially graded and ungraded parts of landslide most commonly marks the upper limit of fill placed on the lower part of a landslide in a canyon (for example, nos. 30, 35, 52, 89, 92, 97, and the west lobe of no. 106) or of excavation of the lower part of a landslide along the coastal palisades to clear the Pacific Coast Highway (nos. 7 and 80; others not shown). Rarely it marks the lower limit of fill placed on the upper part of a landslide (no. 99) or of excavation of the upper part of a landslide (no. 45).

1958 MAJOR CRACK IN GROUND AND DATE WHEN OBSERVED ACTIVE--Shown only outside areas of recognized younger landslides. Dashed where approximately located.

TOP OF LANDSLIDE SCARP--Fresh or relatively unmodified. Scarp that coincides with outer boundary of a landslide area (numbered) is a main scarp. Other scarps shown are located within landslide areas, on the periphery of younger landslides. Presence and location of scarps as of June 30, 1969. Dashed where approximately located; short dashed where inferred.

DIRECTION OF LANDSLIDE MOVEMENT--Arrow indicates general direction of movement of landslide. Dashed where inferred.

(16) LANDSLIDE AREA NUMBER--Numbered consecutively and generally toward the west along the canyon walls and coastal palisades.

NOTES--Annotations on the map refer to status of features as of June 30, 1969, unless an earlier date is indicated.

Landslides smaller than about 20 feet minimum dimension in plan view are not shown on the map.

Thin landslides in soil on the canyon walls were identified chiefly from fresh scars seen on aerial photographs; they are shown only locally on the map. Most of these scars are covered by vegetation within a few years; accordingly the map records only a very small sampling of such shallow slope failures.

INTRODUCTION

A study of landslides and related subjects in the Pacific Palisades area was authorized by Congress by the Flood Control Act of 1966 (Public Law 89-789). The study is under the direction of the Corps of Engineers and is being made in cooperation with the United States Geological Survey. As part of its contribution to the work, the Geological Survey was asked to update and refine the "Preliminary map of landslides in the Pacific Palisades area, City of Los Angeles, California" (McGill, 1959), which was published in 1959 as Miscellaneous Geologic Investigations Map I-284. The present map is a revision that includes new landslides and landslide enlargements that occurred between September 30, 1958, the cutoff date for Map I-284, and June 30, 1969. A 10-year period of additional coverage, from October 1, 1958, to September 30, 1968, had been planned, but the time interval was extended an additional 9 months so as to include landslide activity associated with the recordbreaking rains of January and February 1969.

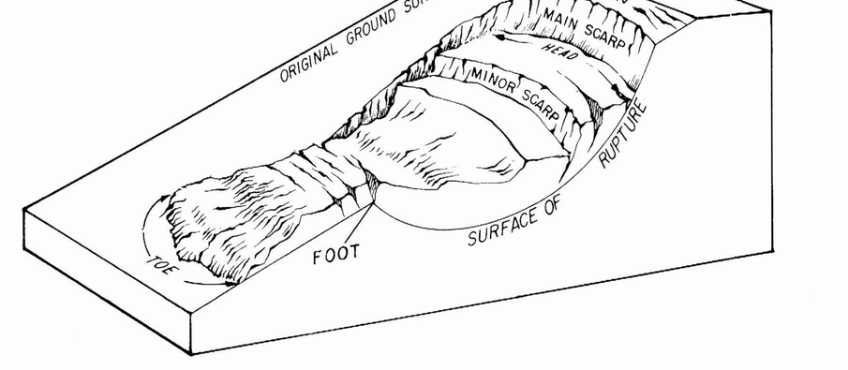
Landslide information has been obtained from published and unpublished records and reports, interpretation of aerial and ground photographs and topographic maps, field investigation of active or recently active landslides, and detailed geologic mapping, chiefly at a scale of 1 inch equals 100 feet, of the entire area since September 30, 1958. The earliest landslide of record apparently occurred in 1874, and the earliest document used in this study is a U.S. Coast Survey topographic map of 1876 that includes the Pacific Palisades area. Pertinent historic records generally date back only to the 1920's, however, when residential subdivision development began in the area.

The topographic base map is the same as that used for Map I-284. This base still provides the most recent detailed topographic coverage of the entire study area, and its use facilitates comparison of the landslides shown here with those shown on Map I-284. It is also the base for maps showing locations of landslides, borings, cross sections, and utilities in the final report of the 1957-59 Pacific Palisades landslide study by the consulting engineering firm of Moran, Proctor, Mueser, and Rutledge (1959) for the State of California. That report incorporated information on landslide distribution from Map I-284. Detailed geologic mapping of the area since 1958 by the U.S. Geological Survey has used the same topographic base map.

TERMINOLOGY

The definition, nomenclature, and classification of landslides used in this study generally follow those of the Highway Research Board Committee on Landslide Investigations (Eckel, 1958). Thus "the term 'landslide' denotes downward and outward movement of slope-forming materials composed of natural rock, soils, artificial fills, or combinations thereof" (Varnes, 1958, pl. 1), but excludes normal surficial creep; movement may be by falling, sliding, or flowing or their combinations. The map shows areas that have been directly affected by such movements as evidenced by landslide deposits and by scars left on ground where the landslide material moved away.

The nomenclature of various parts of a landslide is illustrated by the following drawing (modified from Varnes, 1958, pl. 1), which is of a slump-earthflow type of complex landslide.



MAIN SCARP-A steep surface on the undisturbed ground around the periphery of the landslide, caused by movement, on the surface of rupture, of landslide material away from the undisturbed ground.

MINOR SCARP-A steep surface on the disturbed material, produced by differential movements within the sliding mass.

HEAD-The upper parts of the landslide mass adjacent to the contact between the disturbed material and the main scarp.

FOOT-The line of intersection (sometimes buried) between the lower part of the surface of rupture and the original ground surface.

TOE-The margin of disturbed material most distant from the main scarp.

CROWN-The ground that is still in place, practically undisturbed, adjacent to the highest parts of the main scarp.

ORIGINAL GROUND SURFACE-The slope that existed before the movement which is being considered took place.

The principal types of landslides in the Pacific Palisades area are indicated in the following simplified and generalized chart (modified from Varnes, 1958, fig. 5). However, any classification of landslides is necessarily artificial and somewhat arbitrary, and the distinctions between individual types of slides cannot be rigid. Thus many of the types of landslides are gradational into one another with variations in materials, water content, or type of movement.

TYPE OF MOVEMENT		TYPE OF MATERIAL (before movement)			
		BEDROCK		SOIL (in engineering sense)	
FALL		**ROCKFALL**		**SOILFALL**	
SLIDE	Few units	Rotational **ROCK SLUMP**	Translational **BLOCK GLIDE**	Translational	Rotational **SOIL SLUMP**
	Many units		**ROCKSLIDE**	**DEBRIS SLIDE**	
FLOW		ALL UNCONSOLIDATED			
		SAND	MIXED ROCKS, SOIL, CLAY, ETC.		COMMONLY MUCH PLASTIC CLAY
	Dry	**SAND RUN**			
	Wet		**DEBRIS AVALANCHE** **DEBRIS FLOW**		**EARTHFLOW** **MUDFLOW**
COMPLEX (combinations)		COMMONLY COMBINATIONS OF MATERIALS Example: **DEBRIS SLIDE - EARTHFLOW**			

CHANGES FROM THE 1959 PRELIMINARY MAP OF LANDSLIDES

The present map shows many significant changes from the 1959 preliminary version in the distribution and extent of landslides. Changes in prehistoric (older) and early historic (younger) landslides are based chiefly on my detailed geologic mapping of the area. Additional prehistoric landslides have been discovered, particularly in the western part of the study area (for example, nos. 93, 95, 96, 101, 102, 129, and 130), and the boundaries of some previously mapped prehistoric landslides have been better defined (especially nos. 79, 124, and 125, which are considerably more extensive than shown on the preliminary map). A few local areas containing features previously thought to have been of possible landslide origin have been deleted because new geologic data do not support such an interpretation.

New landslides since 1958 have taken place chiefly along the canyon walls rather than along the palisades facing the sea. The most destructive and therefore best known examples are the Enchanted Way (no. 94), Ocean Woods Terrace (no. 115), and Revello Drive or Ocean Woods Estates (no. 116) landslides, and the landslide at the south end of Grenola Street (no. 78), inside the mouth of Pulga Canyon. A moderate-size landslide on the west wall of middle Potrero Canyon (no. 18) first moved in the winter of 1968, causing part of the backyards of three houses to sink several feet. Numerous small landslides took place on the lower slopes of the walls of Pulga Canyon (for example, nos. 53-56, 59-62, 67, and 68), but they did very little damage. Reactivation, accelerated movement, or enlargement of preexisting younger landslides has been widespread during this period, notably on Castellammare Palisades (especially in parts of nos. 118, 123, 124, and 125), along the west wall of lower Potrero Canyon (nos. 19-22), and in Pulga Canyon (especially nos. 65, 66, 70, 71, and 72). Soilfalls from the eastern part of Huntington Palisades (in areas nos. 6 and 7) repeatedly have blocked the Pacific Coast Highway; at least two soilfalls caused damage to vehicles and one injured a driver. Part of an older landslide in lower Temescal Canyon (no. 38) was reactivated in 1968 after an extensive cut was made for construction of a major highway along the canyon bottom. Also in 1968, cracks formed in the ground adjacent to and south of the eastern part of Asilomar Boulevard, approximately along the upper boundary of a large older landslide area (no. 46).

The extremely heavy rains of the winter of 1969 caused some wholly new landslides, but most of them are relatively small. The main effect of these rains on slope stability was to renew or accelerate movement of many younger landslides, including some of the larger active landslides in the study area. Damage to streets, public utilities, and residences was greatest at Castellammare Palisades, where several younger landslides were reactivated and somewhat enlarged (especially in parts of nos. 118, 123, and 124), and where a new landslide destroyed a residence and part of Portomarina Way near the location of the former Castle Rock (Y_3 in area no. 125). Two moderate-size landslides occurred on the hillside immediately above the Pacific Coast Highway, about 200 feet, and about 650 feet west of the mouth of Pulga Canyon (Y_2 in area no. 79); one is partly within and the other is entirely within the boundaries of previous landslides. The biggest landslide mass to undergo large movement was the long-active Friends Street landslide (no. 22) on the west side of Potrero Canyon. On January 20, 1969, the head of this slide dropped suddenly about 20 to 45 feet. By way of contrast, landslide activity on the opposite or east wall of the same canyon consisted of numerous thin debris slides or debris avalanches, which left long narrow scars on the steep slopes (no. 12 is the only such failure that was mapped; it is larger and wider than most of the scars). Locally, thin vertical slabs of earth fell from the main scarps of some of the larger landslides in the study area. In the weeks and months following the heavy rains, several other landslides showed slow but troublesome movement. The cumulative effects were particularly noticeable at the Enchanted Way landslide (no. 94) and at the large landslide several hundred feet east of the mouth of Santa Ynez Canyon (no. 83), which for years has disrupted the Pacific Coast Highway.

USEFULNESS AND LIMITATIONS OF MAP

Landslides constitute an inherent and very significant part of the physical environment of the Pacific Palisades area. Thus this map record of slope failures provides important and useful background information for general land-use planning and for specific investigations and evaluations of individual sites.

The landslides as shown on the map are not intrinsically proof of present or future slope instability or an adequate basis for evaluating degree of hazard. For example, some slopes that failed became stable as a result of that failure, whereas some slopes for which there is no record of landsliding may be extremely precarious. In general, however, land that has slid still warrants special attention because of the possibility of renewed movement or of enlargement of the landslide mass. The earlier dislocations typically have resulted in fracturing and weakening of the earth materials, impairment of surface and subsurface drainage, and formation of precipitously steep scarps. Past landslides also serve as examples of what might happen in the future under similar circumstances elsewhere in the Pacific Palisades area. The map user is cautioned that very small landslides are not shown, and thin landslides in soil and the former extent of landslide debris on the Pacific Coast Highway are shown only selectively (see Explanation). On the other hand, some features that are shown as questionable older landslides may later be determined to have had other origins.

Each landslide, and indeed each hillside slope, represents a special or unique history and set of conditions and should be judged accordingly. Cursory evaluations tend to be inadequate and may be misleading or even dangerous. Specific and highly detailed engineering geologic and soil engineering investigations, commonly involving subsurface exploration, are necessary for the determination of past or potential causes of slope failure, degree of instability, and appropriate corrective or preventive measures for a given site.

REFERENCES CITED

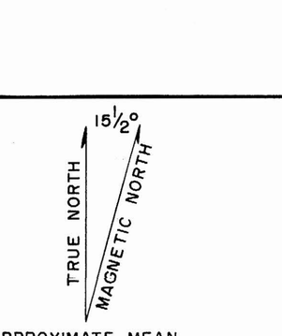
Eckel, E. B., ed., 1958, Landslides and engineering practice: Natl. Research Council, Highway Research Board Spec. Rept. 29, 232 p.

McGill, J. T., 1959, Preliminary map of landslides in the Pacific Palisades area, City of Los Angeles, California: U.S. Geol. Survey Misc. Geol. Inv. Map I-284.

Moran, Proctor, Mueser, and Rutledge, Consulting Engineers, 1959, Final report, Pacific Palisades landslide study: New York, N. Y., Moran, Proctor, Mueser, and Rutledge, Consulting Engineers, Report to Dept. of Public Works, State of California, July 1959, 3 vols.

Varnes, D. J., 1958, Landslide types and processes, Chap. 3 of Eckel, E. B., ed., Landslides and engineering practice: Natl. Research Council, Highway Research Board Spec. Rept. 29, p. 20-47.

Base map by Department of Public Works, State of California, in conjunction with the City of Los Angeles, the City of Santa Monica, and Los Angeles County. Topography mainly from aerial photographs taken November 22, 1957, and April 9, 1958



Based upon a series of rectangular coordinates. Control by triangulation on North American datum of 1927
Point of control for plane coordinates:
N 4,160,926.74 = Latitude 34°08' N
E 4,186,692.58 = Longitude 118°20' W
Lambert Conformal Projection

SCALE 1:4800
0 400 800 1200 1600 2000 2400 FEET
CONTOUR INTERVAL 5 FEET
DATUM IS MEAN SEA LEVEL

MAP SHOWING LANDSLIDES IN THE PACIFIC PALISADES AREA, CITY OF LOS ANGELES, CALIFORNIA

By
John T. McGill

1973

Landslides mapped by J. T. McGill, 1956-69, assisted by C. E. Corbató, 1957-58, and E. C. Jestes, 1959-60.