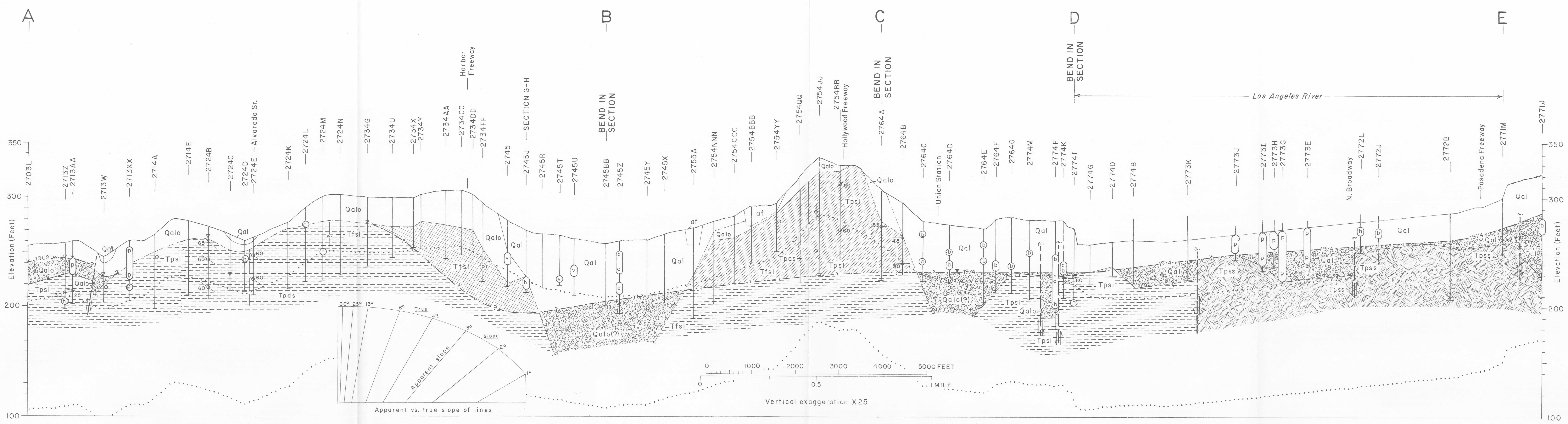
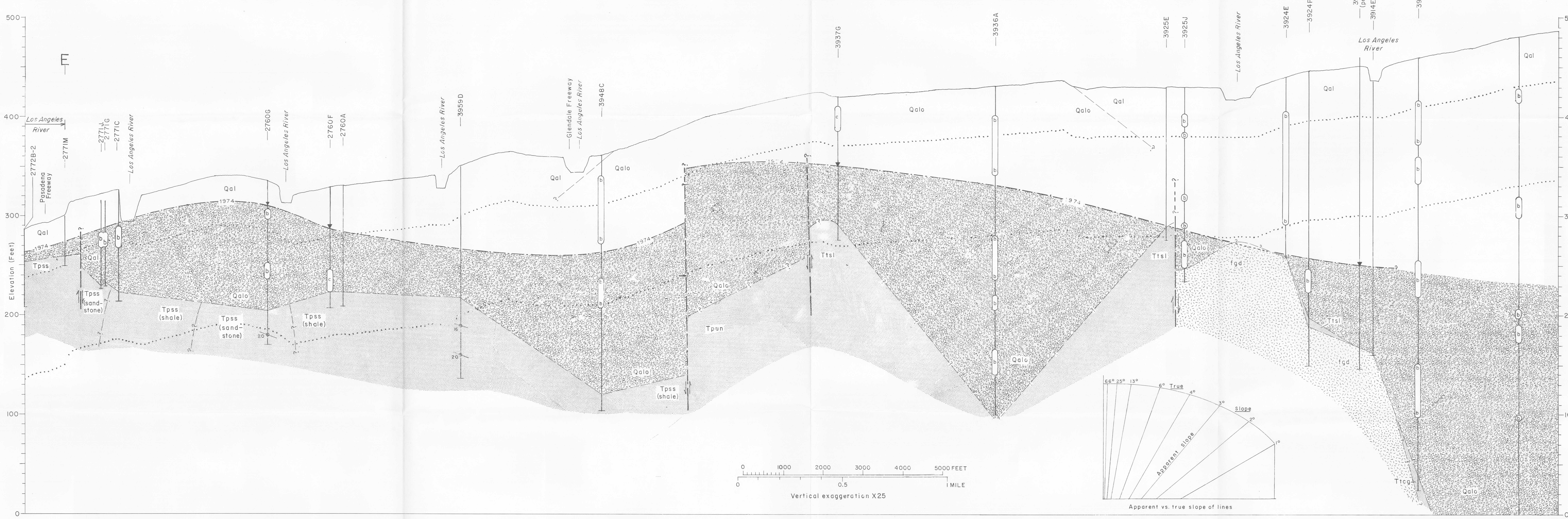




EXPLANATION

Geologic units and tunneling conditions

Approximate tunneling conditions for a given geologic unit may be inferred from its position relative to the water table and reference to the table:

Symbol	Geologic Unit	Lithology	Approximate Penetration Resistance, 50 ft. subsurface (BPF[1/])	Inferred Tunneling Conditions[2/] Dry	Wet
		SURFICIAL DEPOSITS			
af	Artificial fill	Silt, sand, gravel; admixed clay, asphalt, concrete		4-5 10*	6 10*
Qal	Alluvium	Silty to sandy gravel, locally with cobbles and boulders; locally petroliferous; locally slightly consolidated	>40	4-5 10*	6 10*
Qalo, Qt	Old alluvium, Terrace deposits	Slightly consolidated gravel; clayey, with cobbles and boulders; commonly uncemented	>40	3-5 10*	5-6 10*
Qsp	San Pedro Formation of Thomas, Landry, and Turney (1961)	Semiconsolidated sand and fine gravel (<½ in.), interbedded silty sand, sandy silt, and clay		3-5	5-6
		BEDROCK UNITS			
Tfsl	Siltstone, Fernando Formation of Lamar (1970)	Soft, massive siltstone, local layers hard pebble (<¼ in.) conglomerate; rare hard calcareous beds; locally petroliferous	>22	3-4	4-5
Puente Formation of Lamar (1970):					
Tpds	Diatomaceous shale and diatomite	Soft, punky, blocky weathering, thinly laminated; rare beds soft friable sandstone and massive, hard limestone	damp: >38 dry: 24-38	3-4	4-5
Tpsl	Siltstone and very fine-grained sandstone	Poorly cemented, closely jointed, blocky; beds <5 ft. thick; layers shale chips, pebbles, and slabs of hard limestone; few beds <3 in. thick of hard limestone	>~30	3-4	4-5
Tpss	Sandstone	Hard and well cemented (dolomite?) with very hard calcareous concretions; beds <10 ft. thick; local thin beds of shale, fragments shale and siltstone			3-4
Tpun	Undivided sandstone and shale	Hard and well cemented to poorly cemented sandstone; very hard, fissile, siliceous shale and blocky siltstone; some beds <3 ft. hard limestone; also some conglomerate of angular fragments <2 in. of shale and quartz			3-4
Topanga Formation of Lamar (1970):					
Ttsl	Siltstone, sandstone and shale	Commonly very hard, closely jointed, blocky; shale siliceous, hard rhythmically bedded <2 in.; sandstone beds <3 ft.; limestone beds <2 ft.; some very hard tuff and tuffaceous sandstone			3-4
Ttcg	Pebbly sandstone and conglomerate	Commonly hard, well cemented (calcareous?) in beds <4 ft.; pebbles hard rock average 2 in. but contains boulders to 3 ft.			3-4
		BASEMENT ROCKS			
fgd	Feliz Granodiorite of Lamar (1970)	Deeply weathered, soft, crumbly			4-6

1/ 2-in. split spoon, 140-lb. hammer, 30-in. drop; units tested along line of section A-D; see fig. 3 for complete results of tests.

2/ Summary of soft-ground tunneling conditions used (see table 2 for definitions):
- 2 - Hard stratified or schistose
- 3 - Very firm ground
- 4 - Firm ground; may ravel when wet
- 5 - Very blocky or seamy; may ravel when wet
- 6 - Unconsolidated or crushed materials; may run or flow when wet
- 10 - Bouldery (hard rc fragments >10 in. in long diameter)

*If bouldery

Lines and symbols

Contact between geologic units
Solid, well located; long dash, approximately located; short dash, location inferred; queried where doubtful

Fault
Long dash, approximately located; short dash, location inferred; queried where doubtful

Dip of strata
Horizontal — 65 Apparent — Vertical

Symbol shows amount and direction of apparent dip as viewed normal to line of section (not corrected for scale distortion); number gives true dip

pw — 1974
Approximate location of water table
Number shows year of measurement. Solid triangle, location of 1974 measurement; open triangle, location of pre-1974 measurement.
pw, perched water table; queried where inferred

Special symbols

3903N — Identifying number (Sheet 3, table 1)

Surface casing

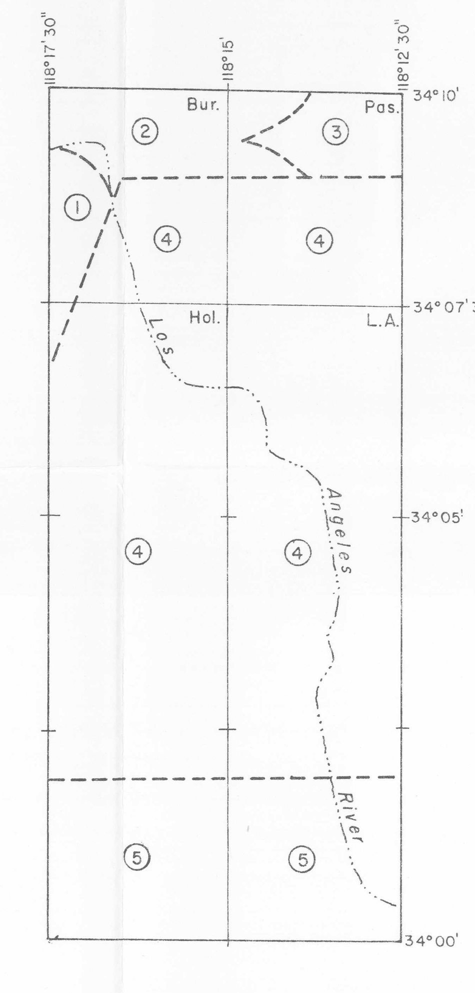
Locus of points 50 ft.

Approximate location of existing tunnel

Well or boring

Significant conditions
- b, boulders (>10 in. in diameter)
- c, cobbles (2½ - 10 in.)
- h, H_2S odor (1962)
- p, petroliferous
- v, very hard drilling (rotary equipment)

INDEX TO SOURCES OF GEOLOGIC MAPPING AND TOPOGRAPHIC QUADRANGLES



Sources of geologic mapping:
1. Hoots (1931).
2. Jennings and Strand (1969).
3. Byer (1968).
4. Lamar (1970).
5. Thomas, Landry and Turney (1961, pl. 3A).

Topographic quadrangles, all 7.5 min., scale 1:24,000, 1966, photorevised 1972:
- Bur: Burbank, contour interval 40'
- Hol: Hollywood, contour interval 20'
- L.A.: Los Angeles, contour interval 20'
- Pas: Pasadena, contour interval 40'

SHEET 1--MAP SHOWING GEOLOGY, DEPTH TO GROUND WATER, AND PETROLEUM DEPOSITS

By R. F. Yerkes, R. E. Lewis, and K. M. Williams

EXPLANATION

GEOLOGIC UNITS

Unconsolidated deposits

QUATERNARY

Holocene

af — Artificial fill and colluvium; silt, sand, and gravel; admixed clay, asphalt, and concrete

Qal — Alluvium; silty to sandy gravel, locally with cobbles and boulders; locally petroliferous

Pleistocene or Holocene / Upper Pleistocene or Holocene

Qls — Landslide deposits
Silt and sand, clayey or pebbly, locally with small amounts siltstone and sandstone

Pleistocene / Upper Pleistocene

Qalo, Qt — Old alluvium and terrace deposits
Qalo, old alluvium; slightly consolidated gravel, clayey and sandy, with cobbles and boulders
Qt, terrace deposits; slightly consolidated gravel, sandy and clayey, with cobbles and boulders; commonly uncemented

Lower Pleistocene

Qsp — San Pedro Formation of Thomas, Landry, and Turney (1961)
Semiconsolidated sand and fine gravel (<½ in.), interbedded silty sand, sandy silt, and clay

Bedrock units

TERTIARY

Pliocene

Tfcg, Tfss, Tfsl — Fernando Formation of Lamar (1970)

Tfcg, conglomerate and coarse conglomeratic sandstone; soft, poorly sorted, up to 60 percent pebbles as large as 6 in. in diameter of hard plutonic rocks and up to 40 percent angular chips and slabs of hard sandstone, limestone, and shale

Tfss, sandstone; very fine grained, massive, very soft and micaceous; scattered small pebbles average ¼ in. in diameter

Tfsl, siltstone; massive, soft, with local layers of hard, pebble (up to ¼ in.) conglomerate; rare hard calcareous beds; locally petroliferous

Miocene / Upper Miocene

Tpds, Tpsl, Tpsh, Tpss, Tpun — Puente Formation of Lamar (1970)

Tpds, diatomaceous shale and diatomite; soft, punky, blocky weathering, thinly laminated; rare beds of soft friable sandstone and massive layers of hard blocky limestone

Tpsl, siltstone and very fine grained sandstone; poorly cemented, blocky, beds as thick as 5 ft; layers of shale chips, pebbles, and slabs and pebbles of hard limestone; local layers to 3 in. of hard limestone

Tpsh, shale and siltstone; well bedded in layers up to 1/8 in. thick, fissile, siliceous, very hard, blocky weathering in layers and slabs up to 2 in. thick; some interbedded sandstone and massive, blocky layers to 3 ft of hard limestone

Tpss, sandstone; hard and well cemented with very hard calcareous concretions; upper part softer and poorly cemented; beds up to 10 ft thick; local thin interbeds of shale and fragments of shale and siltstone

Tpun, undivided sandstone and shale; also contains conglomerate of angular fragments up to 2 in. of slate and quartz in mudstone or sandstone

Miocene / Middle Miocene

Ttss, Ttcg, Ttsl — Topanga Formation of Lamar (1970)

Ttss, sandstone; commonly well cemented, beds up to 10 ft thick, but average 1-3 ft; layers of hard calcareous sandstone up to 3 in. thick and beds of pebble conglomerate up to 10 ft thick containing a few boulders to 3 ft

Ttcg, conglomerate and pebbly sandstone; commonly hard and well cemented in massive beds up to 4 ft thick; pebbles of hard rock average 2 in. but contains a few boulders up to 3 ft

Ttsl, siltstone, sandstone, and hard siliceous shale; commonly very hard, blocky; rhythmically bedded in layers about 2 in thick; beds of sandstone up to 3 ft thick, massive limestone up to 2 ft thick, and very hard tuff and tuffaceous sandstone

JURASSIC OR CRETACEOUS

wqg, vqd, fgd, qd, gn — Basement complex

wqg, Wilson Quartz Diorite of Lamar (1970); medium to coarse grained, massive to well foliated and gneissic; deeply weathered and friable

vqd, Vermont Quartz Diorite of Lamar (1970); commonly deeply weathered, soft and crumbly

fgd, Feliz Granodiorite of Lamar (1970); deeply weathered and fairly soft

qd, quartz diorite; massive, deeply weathered, friable

gn, gneissoid quartz diorite; deeply weathered, soft

GEOLOGIC SYMBOLS

Contact between geologic units
Dashed where approximately located; queried where inferred; dotted where concealed

Fault, showing dip
Dashed where approximately located, queried where poorly located or inferred, dotted where concealed. Dot-dash symbol, fault is inferred to cut buried alluvial deposits

100
Contour showing approximate depth to ground water, in feet below the ground surface (November 1974)
Ticks on downslope side

35 167
Water wells
Showing approximate depth to water, in feet (November 1974). Closed symbol, well penetrated bedrock; open symbol, well did not penetrate bedrock. See sheet 3 for identification

OTHER SYMBOLS

Approximate area of Los Angeles City oilfield
(From Crowder, 1961, plate 2)

Characterized by near-surface petroleum deposits and more than 1150 wells

Area of near-surface petroleum deposits
Indicated by petroleum gas, free oil or tar found in shallow borings

33
Boring or well that penetrated shallow petroleum deposits (gas, free oil, or tar). Number gives subsurface depth in feet to deepest occurrence penetrated

SHEET 2--MAP SHOWING DEPTH TO BEDROCK

By R. F. Yerkes, J. C. Tinsley, K. M. Williams, and J. M. McManus

EXPLANATION

Approximate boundary of exposed bedrock (see sht. 1)

Approximate location of fault inferred to cut buried alluvial deposits and bedrock (see sections, sht. 3)
Queried where location doubtful

50
Contour showing approximate depth to bedrock, in feet below ground surface
Ticks on downslope side; queried where doubtful

25 75
Borehole or well

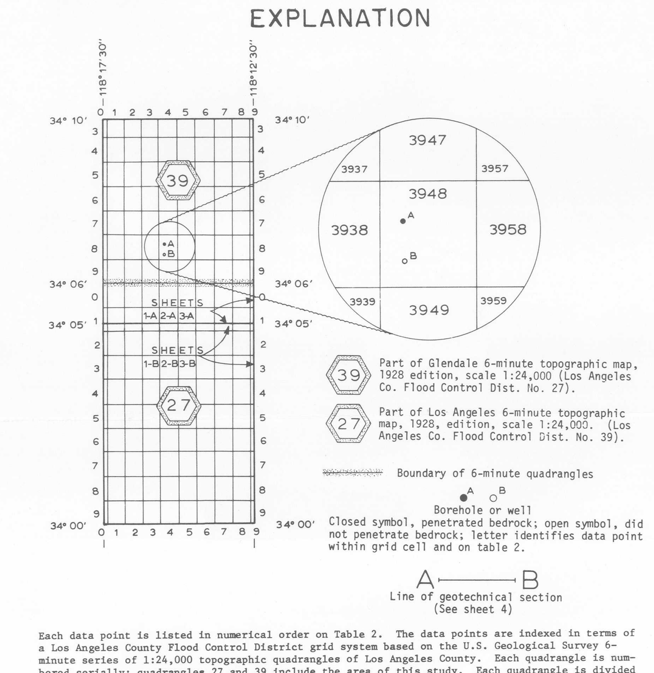
Closed symbol, penetrated bedrock at depth in feet shown by number; open symbol, did not penetrate bedrock at total depth in feet given by number. See sheet 3 and table 2 for identification. Arrow shows distance and direction that well was projected to section

A——B
Line of geotechnical section (see sht. 4)

SHEET 3--MAP SHOWING LOCATIONS OF WELLS AND BORINGS

By J. C. Tinsley, K. M. Williams, J. M. McManus, R. F. Yerkes, and Erik Layman

EXPLANATION



39 — Part of Glendale 6-minute topographic map, 1928 edition, scale 1:24,000 (Los Angeles Co. Flood Control Dist. No. 27).

27 — Part of Los Angeles 6-minute topographic map, 1928, edition, scale 1:24,000. (Los Angeles Co. Flood Control Dist. No. 39).

Boundary of 6-minute quadrangles

Borehole or well
Closed symbol, penetrated bedrock; open symbol, did not penetrate bedrock; letter identifies data point within grid cell and on table 2.

A——B
Line of geotechnical section
(See sheet 4)

Each data point is listed in numerical order on Table 2. The data points are indexed in terms of a Los Angeles County Flood Control District grid system based on the U.S. Geological Survey 6-minute series of 1:24,000 topographic quadrangles of Los Angeles County. Each quadrangle is numbered serially; quadrangles 27 and 39 include the area of this study. Each quadrangle is divided into grid cells that measure 0.6 minutes on a side, thus forming ten columns and ten rows, which are numbered from 0 to 9. Within each cell, each data point is designated by a letter; thus, data point 2748A lies in 6-minute quadrangle 27 (south of lat 34° 06'), within cell 48 (column 4, row 8), and is point A in that cell.

SHEET 4- SECTIONS SHOWING GEOLOGY AND TUNNELING CONDITIONS, AND MAP EXPLANATIONS

BY
R. F. YERKES, J. M. MC MANUS, AND ERIK LAYMAN

GEOLOGIC ASPECTS OF TUNNELING IN THE LOS ANGELES AREA, CALIFORNIA

BY
R. F. YERKES, J. C. TINSLEY, AND K. M. WILLIAMS

1977

Interior--Geological Survey, Reston, Va.--1977