lines shown are Standard project 250 yr 100 yr 25 yr

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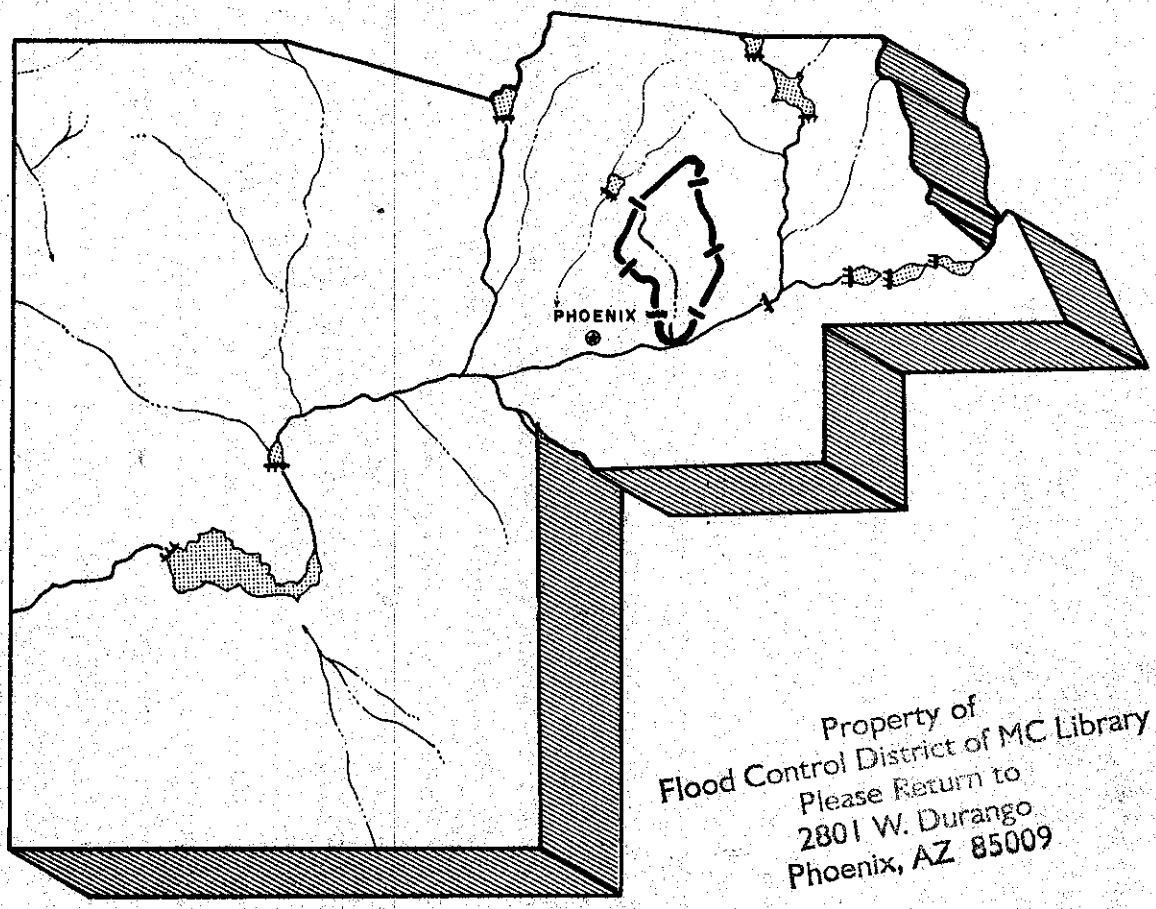
FLOOD-PLAIN INFORMATION STUDY
FOR
MARICOPA COUNTY, ARIZONA

(no 50 yr. lines are shown)



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VOLUME I
INDIAN BEND WASH REPORT

U. S. ARMY ENGINEER DISTRICT, LOS ANGELES
CORPS OF ENGINEERS
JUNE 1964

CARTOGRAPHIC DIVISION

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FLOOD-PLAIN INFORMATION STUDY
FOR
MARICOPA COUNTY, ARIZONA
VOL. 1
INDIAN BEND WASH REPORT

PREFACE

Maricopa County is experiencing a rapid increase in population and in urban development, particularly in the desertlands around Phoenix. These increases have sometimes led to development on the flood plains of washes and rivers without due regard to the presence of the flood hazard. In the case of Indian Bend Wash, the flood hazard is not apparent from casual observation because the wash is shallow and not well defined. Recent urban development of the flood plain has not as yet experienced damaging floods. However, engineering studies reveal that a definite flood hazard exists in this area. Thunderstorms in the drainage area can cause flash floods resulting in inundation of several feet over a wide flood plain.

This report contains an evaluation of the flood hazard that exists along Indian Bend Wash and outlines the minimum area required to preserve an adequate floodway. The study area included is from Indian Bend Road, northwesterly along the wash, to Greenway Road.

It is not the purpose of this report to discourage the use of the flood plain, but rather to encourage prudent development in order to secure an optimum balance between the needs of man for use of the flood plain and of nature for discharge of floodwaters.

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SECTION I - SUMMARY

1. General.--The Flood Control District of Maricopa County has requested the Corps of Engineers to provide flood-hazard information on the flood plains of various streams in the county (see plate 1). This volume presents the results of the study made of the Indian Bend Wash flood plain. The flood plain is that portion of land adjacent to the wash that would be inundated by a flood. The information in this report includes a delineation of overflow areas that would be inundated by floods of various magnitudes, depth and velocity of flow, and an outline of the minimum width required to preserve the capacity of the natural floodway. The reach covered in this report is from Indian Bend Road northeasterly along the wash to Greenway Road.

2. Purpose of flood-plain study.--The Flood Control District of Maricopa County has the responsibility of advising county and city planning organizations and private land developers of the flood hazard that exists and insuring that such land development includes provisions to prevent flocd damages. The purpose of this report is to aid Maricopa County and other interested parties in accomplishing these objectives by presenting an evaluation of the existing flood hazard and suggesting useful guidelines to encourage optimum and prudent use of the flood plain.

3. Scope.--

(a) The portion of Indian Bend Wash included in this study is the 8-1/2-mile reach upstream from Indian Bend Road to Greenway Road, near

32nd Street (see plate 2). Information on the flood hazard from Indian Bend Road downstream to the Salt River has already been furnished to the Flood Control District of Maricopa County in conjunction with Indian Bend Wash survey report (15 April 1962).

Until recently, this area was mostly desert land with some agricultural development near Scottsdale Road. As a result of the rapid increase of population and urban growth that Maricopa County has experienced, particularly around the Phoenix area, several housing developments have been and are being built in the study area, including in the flood plain. This report presents on topographic maps the overflow area that would result from floods of various magnitudes; profiles which indicate the general ground slope and water-surface elevations; and cross sections indicating the depth of inundation within the flood area at various locations along the flood plain. Encroachment lines are also shown to indicate the maximum area that the floodway can be constricted or obstructed by development without causing adverse flood conditions which would increase the flood hazard to adjacent property owners. Further development into the area between the encroachment lines should be made only if a floodway channel is constructed to properly confine the flows.

(b) Important considerations in presenting flood-plain information are selecting the proper flood magnitudes that will be the most useful in defining the flood-hazard area and providing data that can be used in regulating development. The following floods have been selected for use in this report: (1) The Standard Project Flood, which is the largest flood that can reasonably be expected to occur, is used to delineate the maximum limits of the Indian Bend Wash flood plain; (2) The 100-year

flood, which is the flood magnitude selected by the local agency to be used in regulating or zoning; and (3) the 25-year flood, which represents a flood of fairly frequent occurrence. (See Appendix I: Glossary of Selected Terms.)

(c) Sufficient rainfall and flood records exist in this region to develop data for determining flood magnitudes to use for the purpose of regulation. There are 18 rainfall stations in the region. The rainfall station at the Phoenix Post Office has records over the last 85 years. This area experiences general winter storms, general summer storms, and local thunderstorms. The most severe damage usually results from thunderstorms because of their high rainfall intensity. The most severe thunderstorm on record was the 19 August 1954 storm over the Queen Creek drainage area.

4. Flood-plain regulation.--

(a) Flood-plain regulation is the legal process by which communities control the use and development of flood-hazard areas for the purpose of preventing or reducing the loss of life and property damage that might result from floods. Such regulation includes zoning, subdivision regulation, building codes, channel and encroachment statutes, and other similar methods of control. The information and suggestions in this report are presented for consideration and use by the State, Maricopa County, and other local interests for planning the use and regulation of the Indian Bend flood plain.

(b) The State and county will make this information available to any responsible local interest. Further information on use or availability of this report should be requested from the State Land and Water Commission in Phoenix, Ariz., or the Flood Control District of Maricopa County, 4701 East Washington Street, Phoenix 34, Ariz.

(c) Any regulation for flood-plain use resulting from this report would be undertaken by the State, county, or other local agency. This report is not intended to extend any Federal authority over zoning or other regulation of flood-plain use, and the information study and report are not to be construed as committing the Federal Government to investigating, planning, designing, constructing, operating, or maintaining any facilities discussed, or to imply any intent to undertake such activities if not authorized by Congress.

5. Acknowledgement.--The cooperation of the Flood Control District of Maricopa County and individuals who directly and indirectly aided in the preparation and distribution of this report is gratefully acknowledged. Maricopa County furnished the Indian Bend Parkway topographic maps which were the basic maps used in preparing the flood-area maps in this report. Extended topographic coverage was provided by Yost and Gardner Engineers and the U.S. Bureau of Reclamation.

SECTION II - DESCRIPTION OF PROBLEM

6. The Indian Bend basin.--Indian Bend Wash is a tributary of the Salt River and is the principal drainage for Paradise Valley (see plate 3). The drainage area is bounded on the east by the McDowell Mountains, on the north and west by the Cave Creek drainage area, and on the south by the Phoenix Mountains. This study concerns itself with that portion of the drainage area upstream from the Arizona Canal. The Arizona Canal runs through the southern part of the area and is capable of diverting low floodflows of up to 2,000 cubic feet per second in a westerly direction. The drainage area comprises about 152 square miles. A series of variable length, parallel, intermittent streams and washes descend the slopes of the mountains to the alluvial plain where the watercourses are not well defined and floods would spread over a large, shallow area. This type of flow is commonly referred to as sheet flow. The total length of the main watercourse from the northern end of the boundary to the Arizona Canal is 26 miles. Elevations in the area range from about 4,000 feet above mean sea level at McDowell Peak to 1,280 feet at the Arizona Canal. The terrain and climate of Paradise Valley are typically desert in character. The winters are short and mild, and the summers are long and hot. High diurnal temperature variations are characteristic. Temperatures range from a high of 118° in the summer to a low of 17° in the winter.

7. The Indian Bend flood plain.--

(a) Indian Bend Wash is formed in the vicinity of Greenway Road and 32nd Street and flows in a southeasterly direction across the southern portion of the drainage area to the Arizona Canal, a reach of 8-1/2 miles.

The wash crosses the width of the drainage area near the southern boundary of the area (see plate 3). Due to the large tributary areas, large quantities of floodflows can be expected to enter the wash from the north at various points along the wash. The reach of Indian Bend Wash between Shea Blvd. and Indian Bend Road is near the Phoenix Mountains. Due to the steep mountain slopes, large portions of the land between the mountains and the wash could be subjected to flash floods from local thunderstorms. As none of the tributary washes are deep or well defined, a large portion of these floodflows would be overland or sheet flows. The drainage area has been divided into sub-areas in order to determine the general location and magnitude of these tributary inflows. Indian Bend Wash is shallow and not too well defined in many places. The wash is unimproved, except for a leveed channel located north of Northern Avenue and west of Scottsdale Road.

(b) The natural floodway of Indian Bend Wash includes the wash and the adjacent, relatively flat land which has been or could be covered by floodwaters. That adjacent land included in the natural floodway is the flood plain. The flood plain "invites" development because it is flat, easily accessible, and not in the wash. It is not apparent from casual observation that a large flood can cause depths of flow up to 6 feet over the flood plain and result in a floodway width of 4,000 feet as is determined from the study. Until recently, the flood plain was mostly un-developed desertland with some agricultural land near Scottsdale Road. Recently, however, the city limits of Phoenix have been extended into the study area, a new city of Paradise Valley has been formed, and the suburbs of Scottsdale have developed along the flood plain.

8. Prospective development affecting the flood plain.--Maricopa County has experienced a very rapid increase in population and urban area. In 1960, the population of the county was 663,510, which is a 100-percent increase over the 1950 population. During this same period, the urban area increased by 141 percent. The desertland around Indian Bend Wash has recently started to become urbanized (see plate 16). It has been estimated that by 1980 the urban area would extend as far north as Greenway Road and as far east as Pima Road in Paradise Valley.* Developments in this area would probably continue to be residential, with some light industry. Local plans for future development include the building of an express highway, paralleling Indian Bend Wash, for the full length of the reach included in this study.

9. Rainfall and floods.--Three types of storms produce precipitation in the Indian Bend basin - general winter storms, general summer storms, and local thunderstorms.

(a) General winter storms, which usually occur during the months of December to March, originate over the Pacific Ocean as a result of the interaction between polar Pacific and tropical Pacific airmasses and move eastward over the basin. These storms are accompanied by widespread rainfall and often last for several days.

(b) General summer storms, which occur during the months of July to September, are associated with influx of tropical maritime air originating over the Gulf of Mexico or South Pacific Ocean, and are often accompanied by relatively heavy rainfall over large areas for periods up to 24 hours, with light showers continuing for as long as 3 days.

* "Summary Report on A Major Street and Highway Plan - Phoenix Urban Area, Maricopa County - Arizona."

(c) Local thunderstorms can occur at anytime of the year, even during a general storm. However, they are most common from July to September and cover relatively small areas, and result in high-intensity rainfall for durations of 3 hours or less. Severe local storms and floods have occurred in the Phoenix area in the following years: 1921, 1935, 1936, 1939, 1943, 1951, 1954, 1956, and 1957. The most severe storm and flood of record occurred over the Queen Creek drainage area on 19 August 1954. This resulted from a thunderstorm with high rainfall intensities during the first 3 hours of the storm and light rainfall during the next 3 hours. An estimated 100 square miles had over 5 inches of rain, and 1,000 square miles had over 1 inch of rainfall. The peak discharge at the Whitlow Ranch damsite was estimated at 42,000 cubic feet per second (area, 143 square miles). A flood resulting from a thunderstorm, such as that which occurred over the Queen Creek drainage area, would have a high peak discharge and a relatively short duration. Plate 4 is a graphical illustration of the rainfall and runoff characteristics similar to the Queen Creek flood.

SECTION III - FLOOD-HAZARD EVALUATION

10. Flood frequency.--It is important that proper flood magnitudes be selected in order to present flood-hazard data that will be useful in the planning and regulating to secure optimum use of the flood plain. Delineation of the area that has been flooded by a past major flood is desirable, however, no such records exist for the portion of Indian Bend Wash included in this report. The only streamflow gage in the reach is located 1/2 mile upstream from the Arizona Canal. This recording streamflow gage, sponsored by the Corps of Engineers, was installed by the U.S. Geological Survey in January 1961. The one rain gage in the study drainage area is located in the Phoenix Mountains. However, sufficient rainfall and streamflow data are available from areas adjacent to the Indian Bend drainage area to establish the frequency of occurrence of floods of various magnitudes. Frequency of occurrence refers to the number of times during a 100-year period that a flood of a certain magnitude will be equaled or exceeded. For example, to say that the magnitude of a 10-year flood on Indian Bend Wash at the Arizona Canal is 12,500 c.f.s. (cubic feet per second) means that based on past records of rainfall and flood runoff, a flood of 12,500 c.f.s. or greater can be expected to occur 10 times during any future 100-year period. The 25-year flood at this location is 21,000 c.f.s., which means that a flood magnitude of 21,000 c.f.s. or greater can be expected to occur four times during a 100-year period. It does not, however, indicate that it can be expected to occur once every 25 years. Frequency designations, such as "25-year flood," refer to the frequency of occurrence over a long period of time and not to the spacing in time between floods.

11. Flood limits delineated in study.--The floods for which overflow limits have been delineated on the flood area map (plates 5-8) are the Standard Project Flood, the 100-year flood, and the 25-year flood.

(a) The Standard Project Flood (see plate 4) was selected for the purpose of defining the maximum natural floodway limits. For the purpose of this study, it defines the outside limits of the Indian Bend Wash flood plain (see plates 17-19). The Corps of Engineers defines the Standard Project Flood as the flood that would result from the storm with the most severe flood-producing rainfall pattern of any storm on record that is considered reasonably characteristic of the region in which the drainage area is located, giving consideration to the runoff characteristics in the basin. The rainfall pattern of the 19 August 1954 thunderstorm over the Queen Creek drainage area was selected as a basis for estimating the Standard Project Flood on Indian Bend Wash.

(b) The 100-year flood was selected by mutual agreement with local interests as the largest flood used for regulation purposes. The overflow limit that would result from a 50-year flood (not delineated in this report) would be approximately halfway between the limits of the 25-year and 100-year floods.

(c) The 25-year flood was selected for the purpose of delineating that portion of the flood plain which would be subjected to relatively frequent flooding. A 10-year flood would cause a flood hazard to essentially the same area as the 25-year flood because the wash is so flat and shallow. The main difference would be in the flood characteristic. The lesser flow would have a tendency to meander from one side of the wash to the other.

12. Floodway encroachment lines.--The natural floodway of Indian Bend Wash is very wide and relatively shallow. Building in the flood plain, even large commercial buildings or housing tracts, would not necessarily have much adverse effect on the capacity of the natural floodway. Such buildings could be floodproofed either by filling the area to raise the ground elevation, or building the floor level above the expected floodflow elevation. However, if the floodway is constricted beyond a certain limit, a general rise in water surface would occur over and above the flood levels shown on the flood profile which would result in an increase of the flood hazard to the buildings and to adjoining property. The encroachment limits delineated on the flood-area map in this report were determined on the basis of the 100-year flood. These limits represent the maximum obstruction or encroachment which can be allowed on the flood plain without adversely affecting the flood level more than 6 inches. The area between the encroachment lines should be kept clear of further development until such time as an improved flood-control channel is constructed to confine flows.

13. Floodway drawings.--The areas that would be subjected to flooding by 25-year,100-year-frequency floods and by the Standard Project Flood are shown on the flood-area map in this report (plates 5, 6, 7, 8). Also shown on the map are the encroachment lines. Overflow boundaries begin in the vicinity of 32nd Street and Hearn Road. It is not practical to show overflow lines upstream from there because floodflows would converge from a broad upstream area and would be predominantly sheet or overland flow. The flood profile (plates 9 and 10) is presented so that the water-surface elevation at any point along the wash for the various

floods can be determined. Cross sections (plates 11-15) are presented to show the shape of the floodway and the depths of flow that can be expected at various points in the cross section. For convenience in cross-reference, the location of cross sections are indicated by circled letters on the flood area map and flood profile.

14. Flood-hazard analysis.--The magnitude of the floods used in this report and size of area contributing flows are:

C.P.*	Station reach		Drainage Area Sq.Mi.	SPF** c.f.s.	Flood Frequency 100-Year c.f.s.	50-Year c.f.s.	25-Year c.f.s.
1	500+00	535+00	152	72,000	40,000	30,000	21,000
2	535+00	682+00	90	55,000	30,000	21,000	15,000
3	682+00	755+00	69	45,000	25,000	18,000	13,000
4	755+00	850+00	32	25,000	14,000	10,000	7,500
5	850+00	980+00	9	8,000	4,500	3,300	2,300

* C.P. is Concentration Point as shown on drainage area map on plate 3.
** SPF is Standard Project Flood in cubic feet per second.

Flood-hazard analyses by reach are as follows:

(a) Greenway Road to Cactus Road.--The flood plain in this reach is fairly typical in shape to the rest of the area under study. The natural floodway is wide and relatively shallow. Overflow lines start about 1/2 mile south of Greenway Road. The floodway is about 2,400 feet wide. The maximum depths of flow are only 2-1/2 feet deep and average velocity about 3 f.p.s. (feet per second). Maximum velocities toward the center of the floodway would be about 5 f.p.s. (depth and velocity values based on 100-year flood).

(b) Cactus Road to Shea Boulevard.--The natural floodway remains about 2,400 feet wide in this reach. Large quantities of overland or sheet flow can be expected to enter the wash from the sides in this reach, particularly from north of Cactus Road. Downstream from Cactus Road the flood hazard becomes greater due to the large increase in tributary flows. The maximum depth is about 3 to 3-1/2 feet and average velocity about 2.6 f.p.s. Velocity toward the center of the floodway would be about 5 f.p.s.

(c) Shea Boulevard to Mahon Road.--The flood-plain width in this reach varies from 2,200 feet to 4,500 feet. The maximum depths of flow are 3 to 4 feet and average velocity is about 5 f.p.s. The maximum velocity near the center would be about 7-1/2 f.p.s. A swale adjacent to the wash in the vicinity of Double Tree Ranch Road and 56th Street would cause a rapid increase in overflow area for flood magnitudes greater than the 25-year flood.

(d) Mahon Road to Indian Bend Road.--The width of floodway varies from 2,500 feet to 3,200 feet in this reach. A large portion of section 34 (see plate 8) is in agricultural use. A local flood-control system, consisting of a leveed channel 300 feet wide, has been constructed in this area. The alinement takes a zigzag course. The levee heights range from 4 to 7 feet above ground surface. Upstream flows are diverted into this channel by right-angle wing levees. The north-wing levee is high enough to divert flows of 100-year-flood magnitudes or less. However, the freeboard would only be 1 foot for the 25-year flood, which is not considered to be adequate. The south-wing levee would be overtopped and assumed to fail by even a 25-year flood. The levees would not furnish protection on either side downstream from cross section C as shown on plate 8.

Downstream from the leveed channel, as the flows cross Scottsdale Road, the maximum depth would be about 5 feet and average velocity about 4-1/2 f.p.s. Maximum channel velocity would be about 6-1/2 f.p.s. At Indian Bend Road the maximum depth would be 6 feet, average velocity 6 f.p.s., and maximum velocity 9 f.p.s.

SECTION IV - GUIDELINES FOR REDUCING FUTURE FLOOD DAMAGES

15. Introduction.--Future flood damages may be reduced either by flood-control works which will keep floodwaters away from property subject to damage or by flood-plain management which will limit use of the flood plain to developments which are less subject to damage. Either of these means requires planning that takes into account the expected growth of the city and economic analyses to determine which is best and how much flood control or how much flood-plain management is justified.

16. Flood-control works.--

(a) Physical flood-control works include dams and reservoirs to store floodwaters and release them at rates which will not cause damage. Channel improvement works include deepening and widening existing stream channels and digging new channels to carry floodwaters without damage. Levees and floodwalls restrain floodwaters so that they do not overflow onto land outside their boundaries. Upstream watershed treatment also reduces flooding by permitting more of the rainfall to soak into the ground.

(b) The economic feasibility of flood-control works for the reach of Indian Bend Wash under consideration has been examined by the Corps of Engineers. Under present conditions they are not justified. However, the Flood Control District of Maricopa County has plans for future protection of the area.

(c) Future provision of flood-control works might be considered now. For example, if an improved channel is anticipated, the land required should be reserved or acquired as early as possible. The

early establishment of the alinement, right-of-way limits, and required grades permits a better sequence of development. Right-of-way requirements for any future channel improvements are not shown on the flood-area map. If an unlined channel were constructed, it would probably require about a 500- to 600-foot right-of-way width at the downstream end. The width would be less toward the upstream end. The alinement should be such as to have the channel within the area between the floodway encroachment lines, as this would closely approximate the existing flow line of the wash. Once the size and location of the channel are determined, an intermediate channel could be constructed to reduce the hazard from small floods. The earth excavated from the channel could be used as land fill where it is required to raise the ground level in areas otherwise suitable for structural development.

(d) A channel improvement project for Indian Bend Wash downstream from Indian Bend Road is under consideration by the Corps of Engineers.

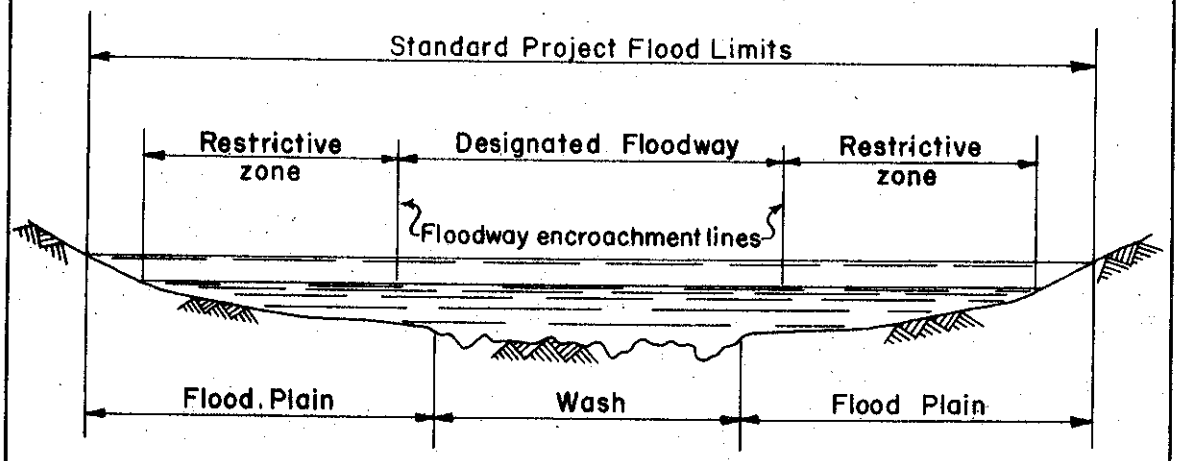
17. Flood-plain management is using the flood plain in such a way that maximum benefits are realized, taking into account the most profitable use to which it can be put and the flood damages which these uses would suffer. Some uses would be subject to very little damage; for example, recreational areas such as parks, playgrounds, and ball diamonds. Until such time as the demand for use of the flood-plain land is great enough to justify flood-control projects, the most practical method of reducing future flood damage is through flood-plain management.

(a) Flood-plain regulations.--When plans have been developed for use of the flood plain, it may be necessary to establish

flood-plain regulations to accomplish the desired results. Flood-plain regulations are established by State statutes, county resolutions, and city ordinances. The term includes zoning ordinances, subdivision regulation, building and housing codes, encroachment laws, open-area regulation, and other similar methods. The type of measure necessary to regulate the use of the flood plain depends on the nature of the hazard. Different measures would be used where the flood hazard might include loss of life, property damage, or excessive floodway obstruction.

(1) Floodway encroachment lines are used to define the limits of the designated floodway (see illustration on page 18). The designated floodway is a zone in the flood plain that could be established through local zoning laws for the purpose of preserving the flood-carrying capacity of the natural floodway. A local zoning or regulatory agency would set forth the criteria for establishing the designated floodway by specifying the flood magnitude and the maximum raise in flood level that would be allowed. The floodway width required for passage of the designated flood can then be determined. The building of any permanent structures that would obstruct the natural flow of floodwaters within the designated floodway would be prohibited. To be effective in preventing the increase of the flood hazard to properties in the flood plain, the flood used in developing the designated floodway should be a flood of infrequent occurrence and should not raise the flood level by a substantial amount. The encroachment lines shown on plates 6 through 8 were determined on the basis of a 100-year-frequency flood and a 6-inch raise in flood level. This basis was established by

SUGGESTED FLOOD ZONES



the Maricopa County Flood Control District, and request was made by that office that encroachment lines be shown. Land in the designated floodway could be used for some agricultural crops, open-air recreation, borrow to fill adjoining land outside of the zone, and other uses that would not form obstructions.

(2) Zoning ordinances may be described as the universally accepted tool used by States and municipalities to regulate the use and development of land within their boundaries. Flood-plain zoning is the set of zoning provisions relating to the use and development of the flood plain. It may include the establishment of the floodway limits, but usually goes beyond to establish zones with different degrees of restriction, depending on the flood hazard (see page 18 for illustration). Within these zones the elevation of floors, land fill, and other improvements could be controlled so as to permit the most effective use of the land without undue risk of damage from flooding. The storage of large quantities of floatable materials should be prohibited, because they could cause structural damage to downstream improvements and cause obstruction to the flow.

(3) Arizona has adopted State statutes enabling counties and cities to zone through the use of properly adopted resolutions and ordinances. Such zoning laws must be in the interest of promoting health, safety, morals, or general welfare, and are generally placed on referendum in a public election. Maricopa County has adopted zoning laws, but not in regard to flood hazards. Flood-plain zoning could be adopted by the county, since it would be in the interest of promoting health, safety, and general welfare.

(4) Subdivision regulations.--The regulation of subdivisions provides one of the most immediately effective means of reducing flood damages in generally undeveloped areas. It, too, is the area in which the municipality should proceed early and rapidly to establish regulations because of the opportunity of producing seemingly ideal developments not hampered by nonconforming existing uses. Floodways and restrictive zones can be established by subdivision regulations in the same manner as with zoning ordinances.

(5) Building codes could be made to provide for the safety of buildings by requiring minimum elevations for floors and installed equipment, such as furnaces, in the restrictive zone of the flood plain.

(6) The Maricopa County Flood Control District has had some flood-hazard studies made on Indian Bend Wash, and has advised potential builders of such hazard. New zoning resolutions are needed, however, to enable Maricopa County better to regulate and zone development on the flood plain for the purpose of reducing flood hazards.

(b) Other management means which could reduce future flood damage include the relocation of existing structures, and the acquisition and setting aside of flood plain land for open spaces and recreation areas, based on the future needs of the city and county for those uses. Tax adjustments could also be used to discourage flood-plain use that would add a burden on the community by increasing the need for flood fighting, relief, and expenditures for repair of flood damages to service facilities. Warning signs placed in flood-plain areas would alert potential builders to the threat of damage.

18. Conclusions.--

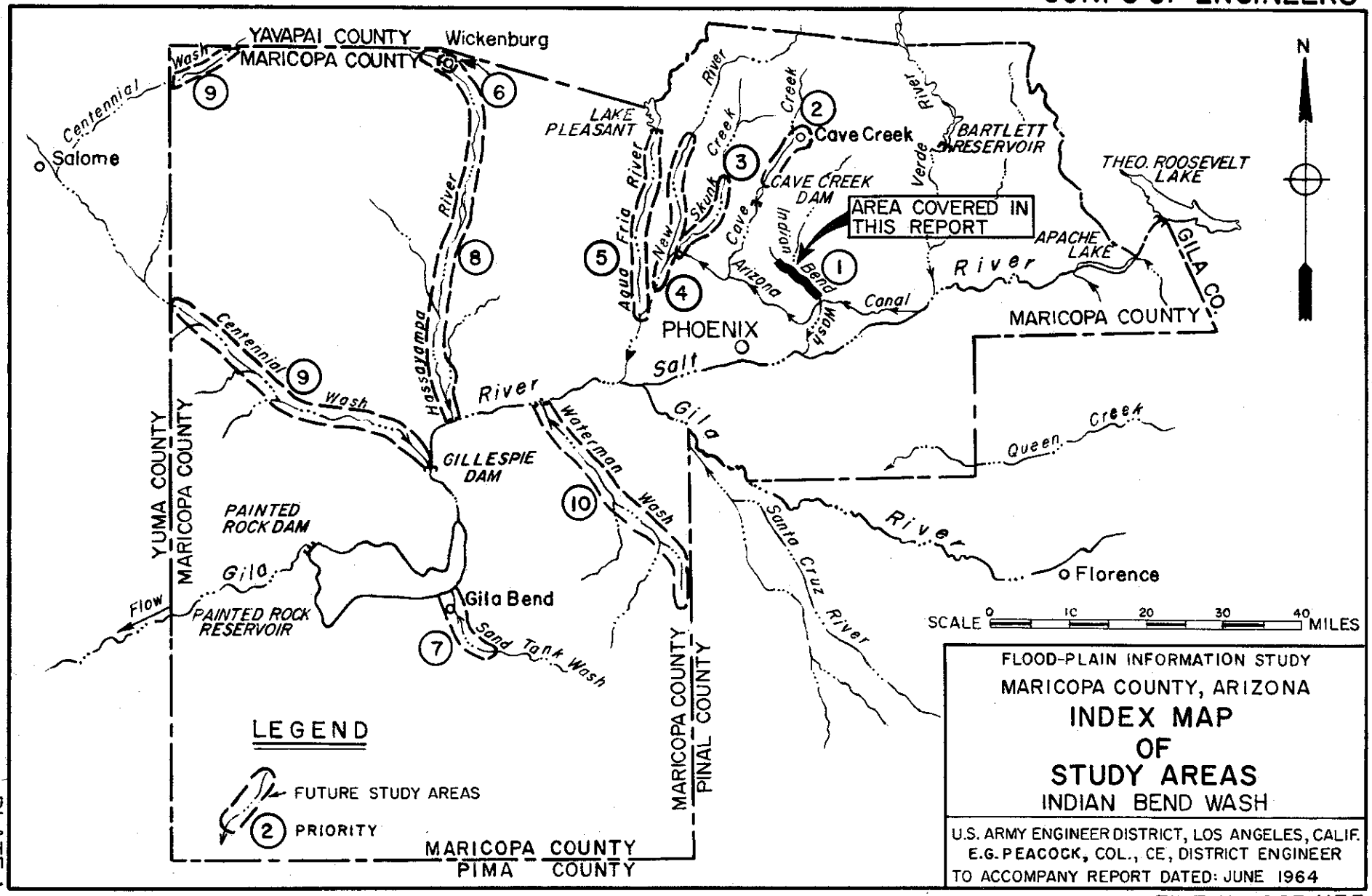
(a) A potential flood hazard exists in the reach of Indian Bend Wash from the vicinity of Greenway Road downstream to Indian Bend Road. Encroachments have already been made in the flood plain in the reach from Greenway Road southward to Emil Zola Street (see hatched area shown as "New Residential Development" on plate 5). Continued encroachment could result in bringing about a serious flood problem in this area. The flood hazard could be minimized by initiation of some form of regulation of the flood plain use.

(b) The information contained in this report is intended to provide a factual basis for the use of the local governmental agencies in formulating appropriate regulatory measures to control the development of the Indian Bend Wash flood plain. It is also intended to furnish information for the guidance of real estate developers or private individuals interested in acquiring or developing land adjacent to upper Indian Bend Wash.

EARL G. PEACOCK
Colonel, Corps of Engineers
District Engineer

U.S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS



FLOOD-PLAIN INFORMATION STUDY

MARICOPA COUNTY, ARIZONA

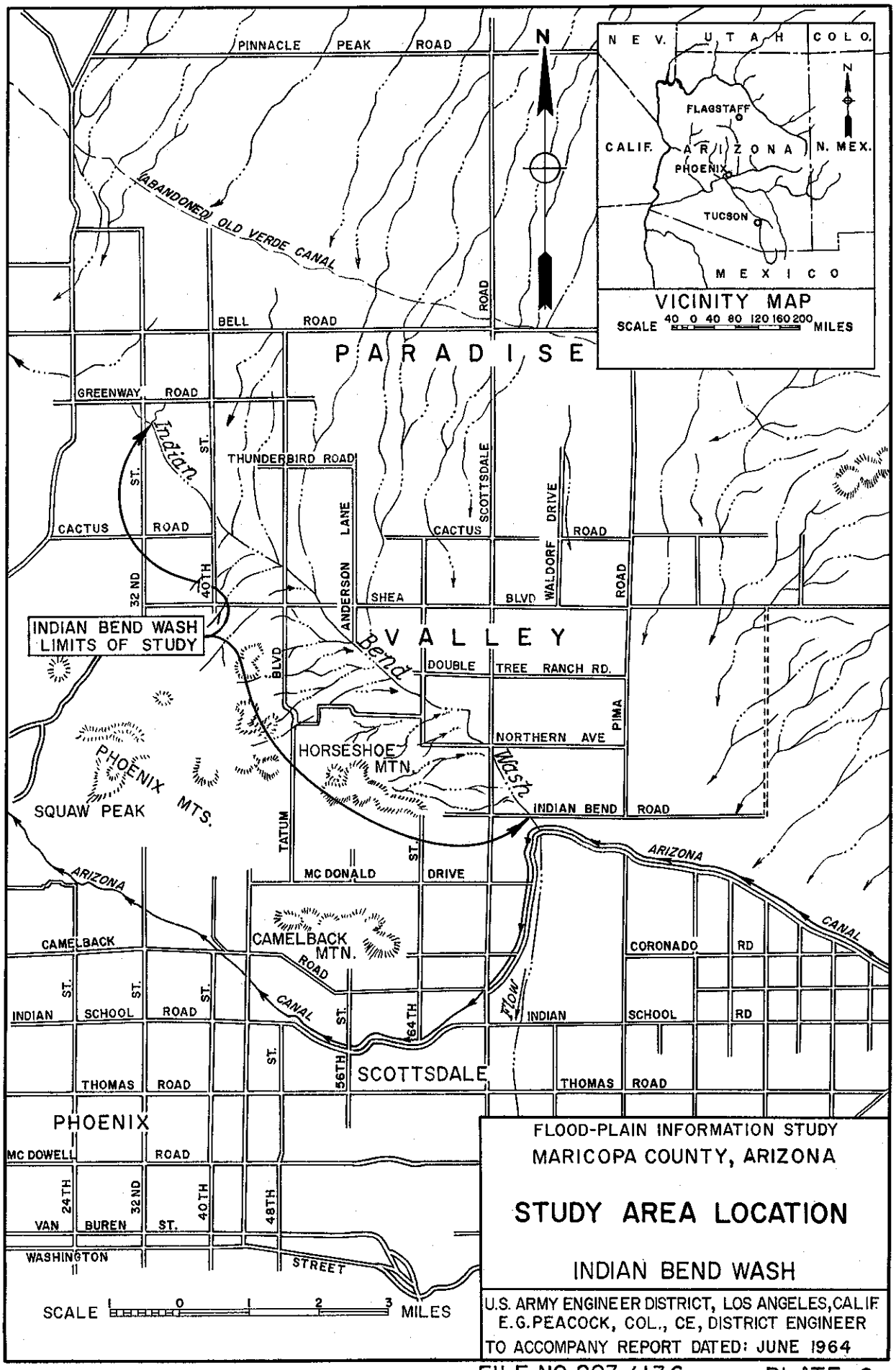
INDEX MAP OF STUDY AREAS

INDIAN BEND WASH

U.S. ARMY ENGINEER DISTRICT, LOS ANGELES, CALIF.
E.G. PEACOCK, COL., CE, DISTRICT ENGINEER
TO ACCOMPANY REPORT DATED: JUNE 1964

PLATE 1

FILE NO. 203/135

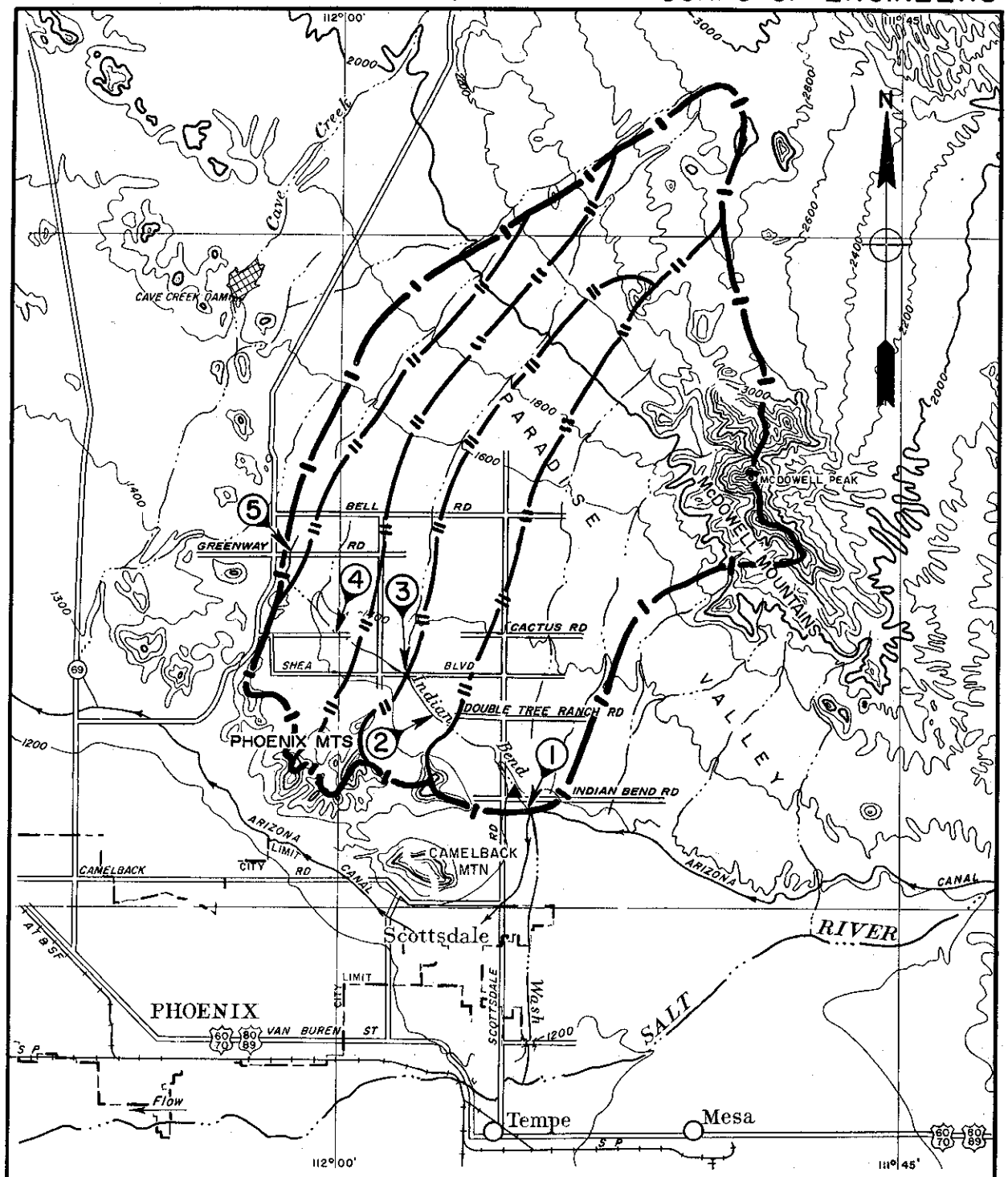


FLOOD-PLAIN INFORMATION STUDY
MARICOPA COUNTY, ARIZONA

STUDY AREA LOCATION

INDIAN BEND WASH

U.S. ARMY ENGINEER DISTRICT, LOS ANGELES, CALIF.
E.G. PEACOCK, COL., CE, DISTRICT ENGINEER
TO ACCOMPANY REPORT DATED: JUNE 1964



SCALE 1 0 1 2 3 4 5 MILES

DATUM IS MEAN SEA LEVEL

LEGEND

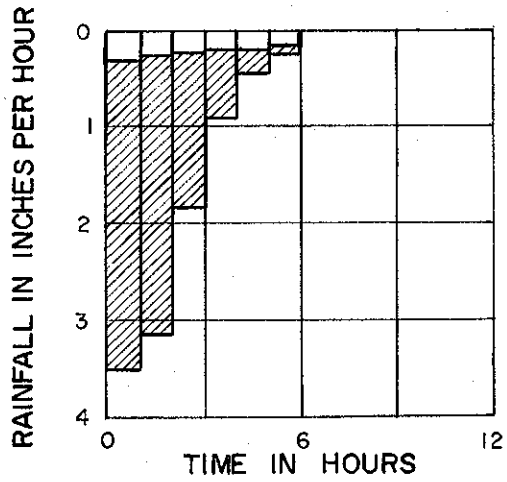
- BOUNDARY OF DRAINAGE AREA
- BOUNDARY OF DRAINAGE SUBAREA
- POINT OF CONCENTRATION
- STREAM-GAGING STATION
- EXISTING FLOOD CONTROL RESERVOIR

FLOOD-PLAIN INFORMATION STUDY
MARICOPA COUNTY, ARIZONA

DRAINAGE AREA MAP

INDIAN BEND WASH

U.S. ARMY ENGINEER DISTRICT, LOS ANGELES, CALIF.
E.G. PEACOCK, COL., CE, DISTRICT ENGINEER
TO ACCOMPANY REPORT DATED: JUNE 1964

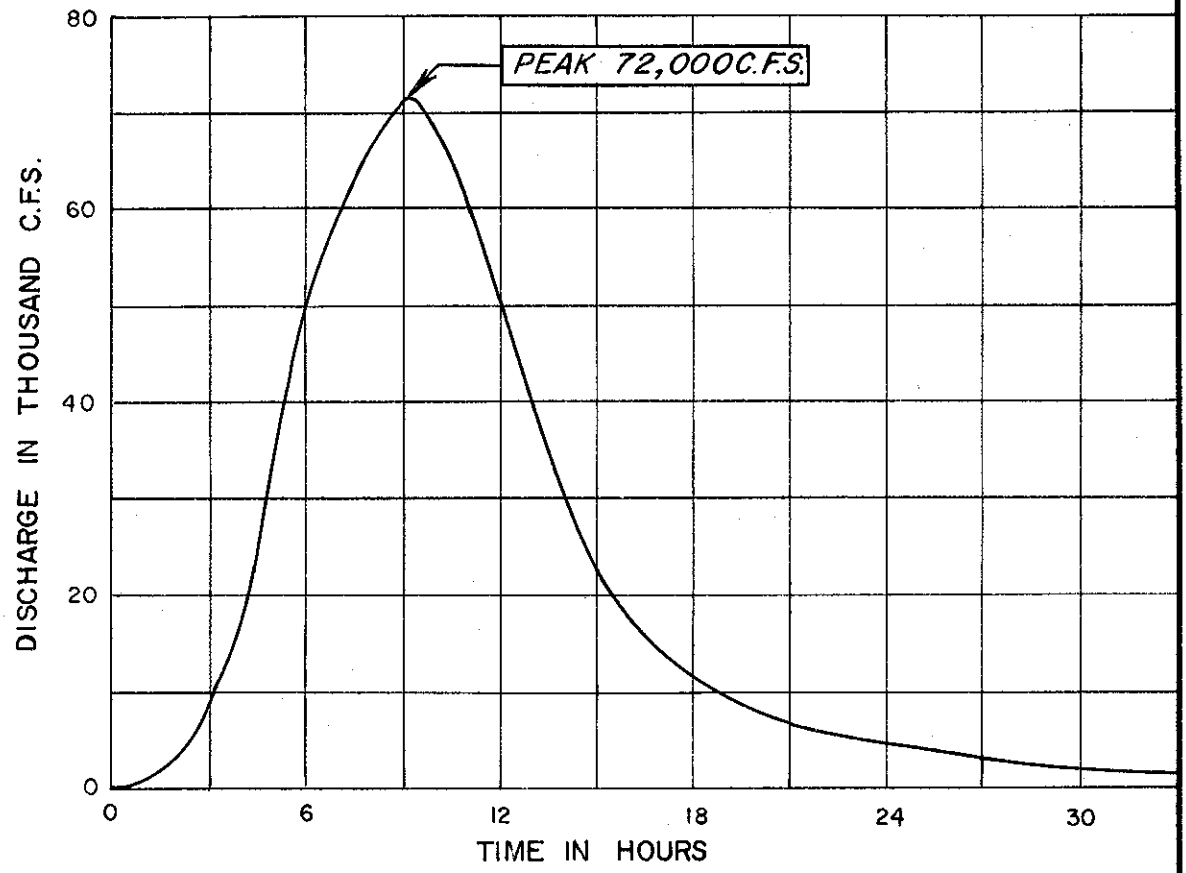


HYETOGRAPH

BASED ON AVERAGE RAINFALL OVER TOTAL AREA UPSTREAM OF C.P. 1 AS SHOWN ON PLATE 3

RAINFALL LOSS

EFFECTIVE RAINFALL (SURFACE RUNOFF)



STANDARD PROJECT FLOOD AT ARIZONA CANAL

TOTAL DRAINAGE AREA ..... 152 SQ. MI.
AVERAGE RAINFALL DEPTH OVER AREA:
TOTAL (3-HOUR) ..... 5.0 INCHES
EFFECTIVE TOTAL ..... 4.2 INCHES

TOTAL SURFACE RUNOFF* ..... 30,400 AC.-FT.

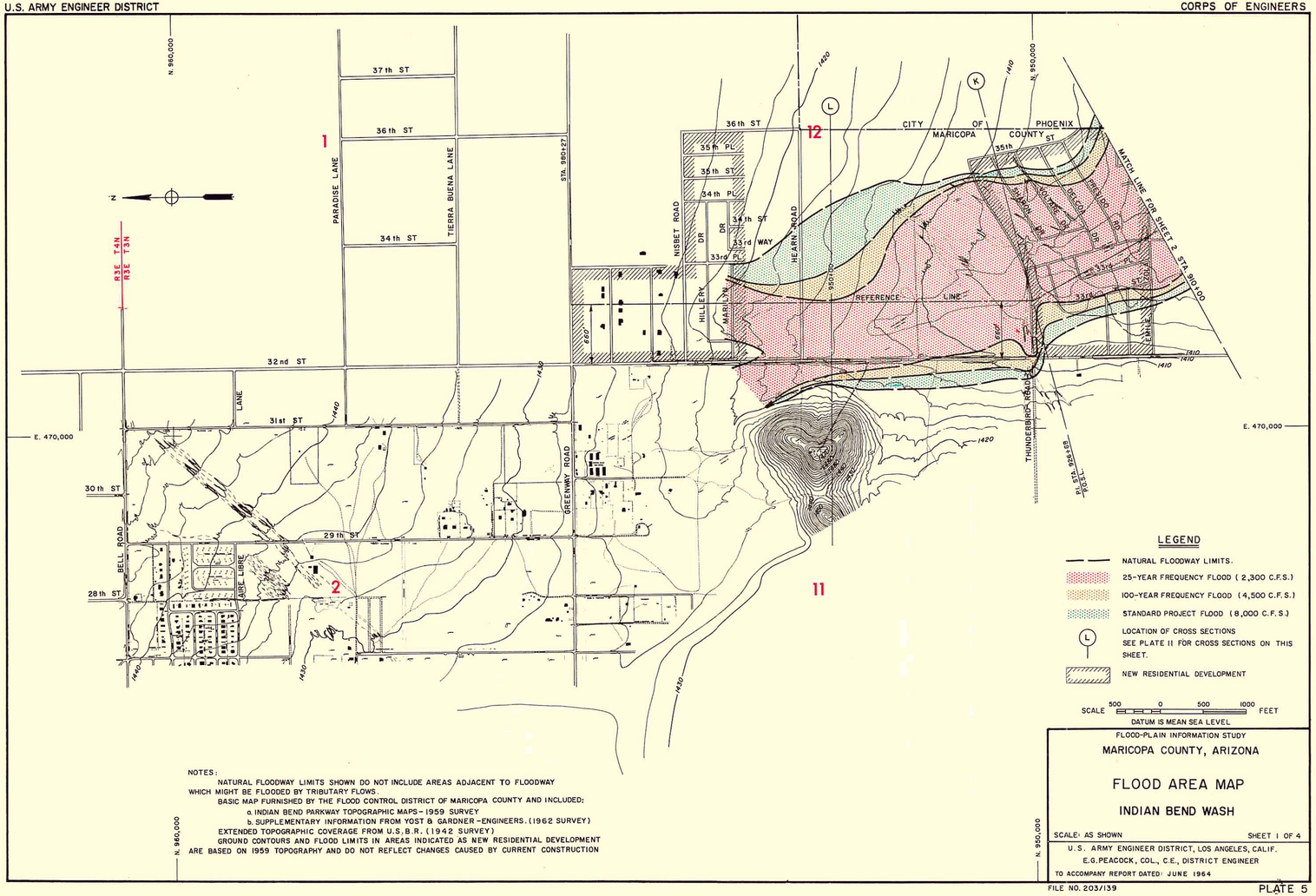
*EFFECTIVE RAINFALL MINUS LOSS BY PERCOLATION.

FLOOD-PLAIN INFORMATION STUDY
MARICOPA COUNTY, ARIZONA

HYDROGRAPH

INDIAN BEND WASH

U.S. ARMY ENGINEER DISTRICT, LOS ANGELES, CALIF.
E.G. PEACOCK, COL., CE, DISTRICT ENGINEER
TO ACCOMPANY REPORT DATED: JUNE 1964



NOTES:

NATURAL FLOODWAY LIMITS SHOWN DO NOT INCLUDE AREAS ADJACENT TO FLOODWAY WHICH MIGHT BE FLOODED BY TRIBUTARY FLOWS.

BASIC MAP FURNISHED BY THE FLOOD CONTROL DISTRICT OF MARICOPA COUNTY AND INCLUDED:

a. INDIAN BEND PARKWAY TOPOGRAPHIC MAPS - 1959 SURVEY

b. SUPPLEMENTARY INFORMATION FROM YOST & GARDNER - ENGINEERS. (1962 SURVEY)

EXTENDED TOPOGRAPHIC COVERAGE FROM U.S.B.R. (1942 SURVEY)

GROUND CONTOURS AND FLOOD LIMITS IN AREAS INDICATED AS NEW RESIDENTIAL DEVELOPMENT ARE BASED ON 1959 TOPOGRAPHY AND DO NOT REFLECT CHANGES CAUSED BY CURRENT CONSTRUCTION

FLOOD-PLAIN INFORMATION STUDY

MARICOPA COUNTY, ARIZONA

FLOOD AREA MAP

INDIAN BEND WASH

SCALE: AS SHOWN

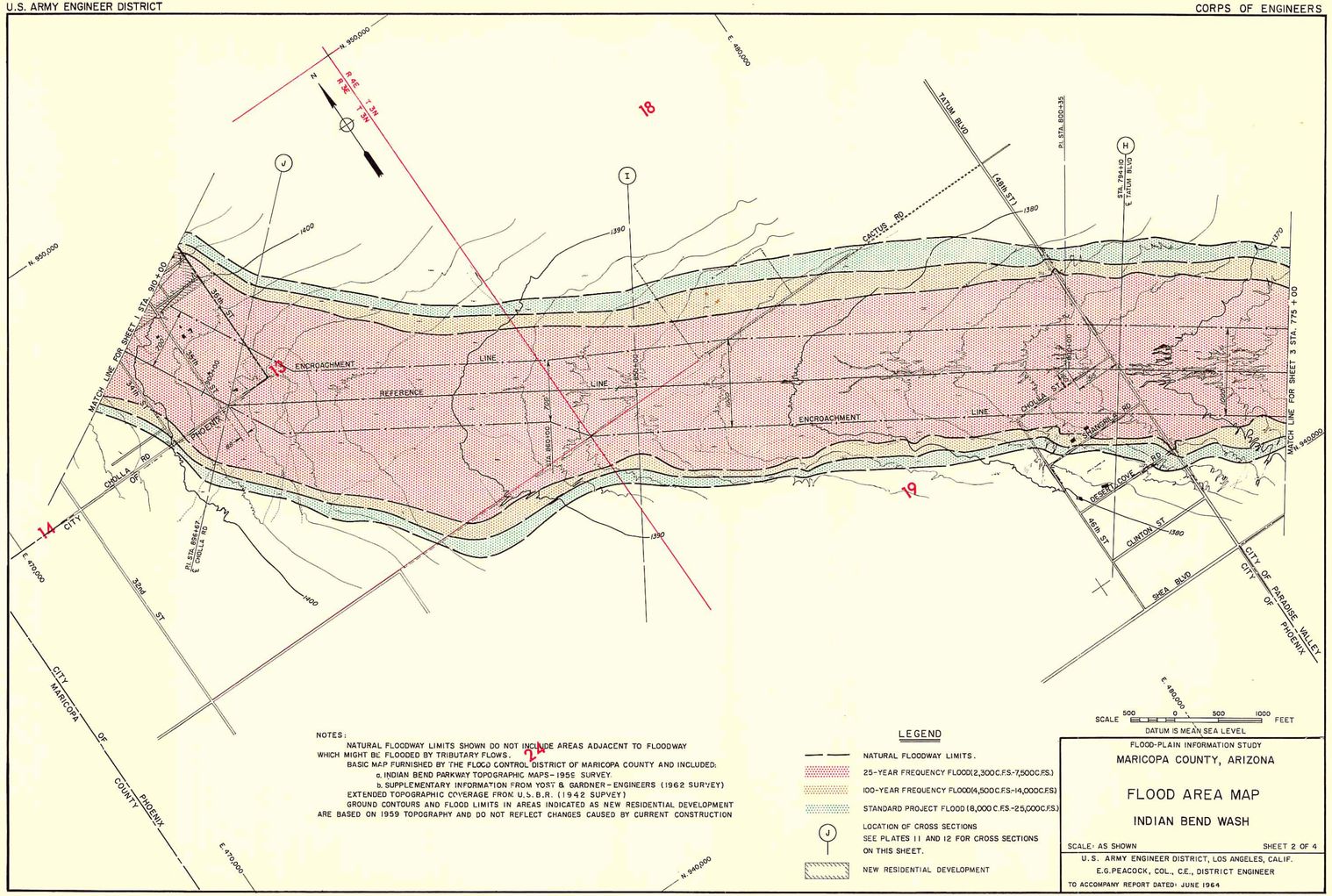
SHEET 1 OF 4

U.S. ARMY ENGINEER DISTRICT, LOS ANGELES, CALIF.

E.G.PEACOCK, COL., C.E., DISTRICT ENGINEER

TO ACCOMPANY REPORT DATED: JUNE 1964

FILE NO. 203/139



NOTES:

NATURAL FLOODWAY LIMITS SHOWN DO NOT INCLUDE AREAS ADJACENT TO FLOODWAY WHICH MIGHT BE FLOODED BY TRIBUTARY FLOWS.

BASIC MAP FURNISHED BY THE FLOOD CONTROL DISTRICT OF MARICOPA COUNTY AND INCLUDED:

a. INDIAN BEND PARKWAY TOPOGRAPHIC MAPS - 1955 SURVEY.

b. SUPPLEMENTARY INFORMATION FROM YOST & GARDNER - ENGINEERS (1962 SURVEY)

EXTENDED TOPOGRAPHIC COVERAGE FROM U.S.B.R. (1942 SURVEY)

GROUND CONTOURS AND FLOOD LIMITS IN AREAS INDICATED AS NEW RESIDENTIAL DEVELOPMENT ARE BASED ON 1959 TOPOGRAPHY AND DO NOT REFLECT CHANGES CAUSED BY CURRENT CONSTRUCTION

LEGEND

NATURAL FLOODWAY LIMITS.

25-YEAR FREQUENCY FLOOD (2,300 C.F.S.-7,500 C.F.S.)

100-YEAR FREQUENCY FLOOD (4,500 C.F.S.-14,000 C.F.S.)

STANDARD PROJECT FLOOD (8,000 C.F.S.-25,000 C.F.S.)

J — LOCATION OF CROSS SECTIONS SEE PLATES 11 AND 12 FOR CROSS SECTIONS ON THIS SHEET.

NEW RESIDENTIAL DEVELOPMENT

FLOOD-PLAIN INFORMATION STUDY

MARICOPA COUNTY, ARIZONA

FLOOD AREA MAP

INDIAN BEND WASH

SCALE: AS SHOWN

SHEET 2 OF 4

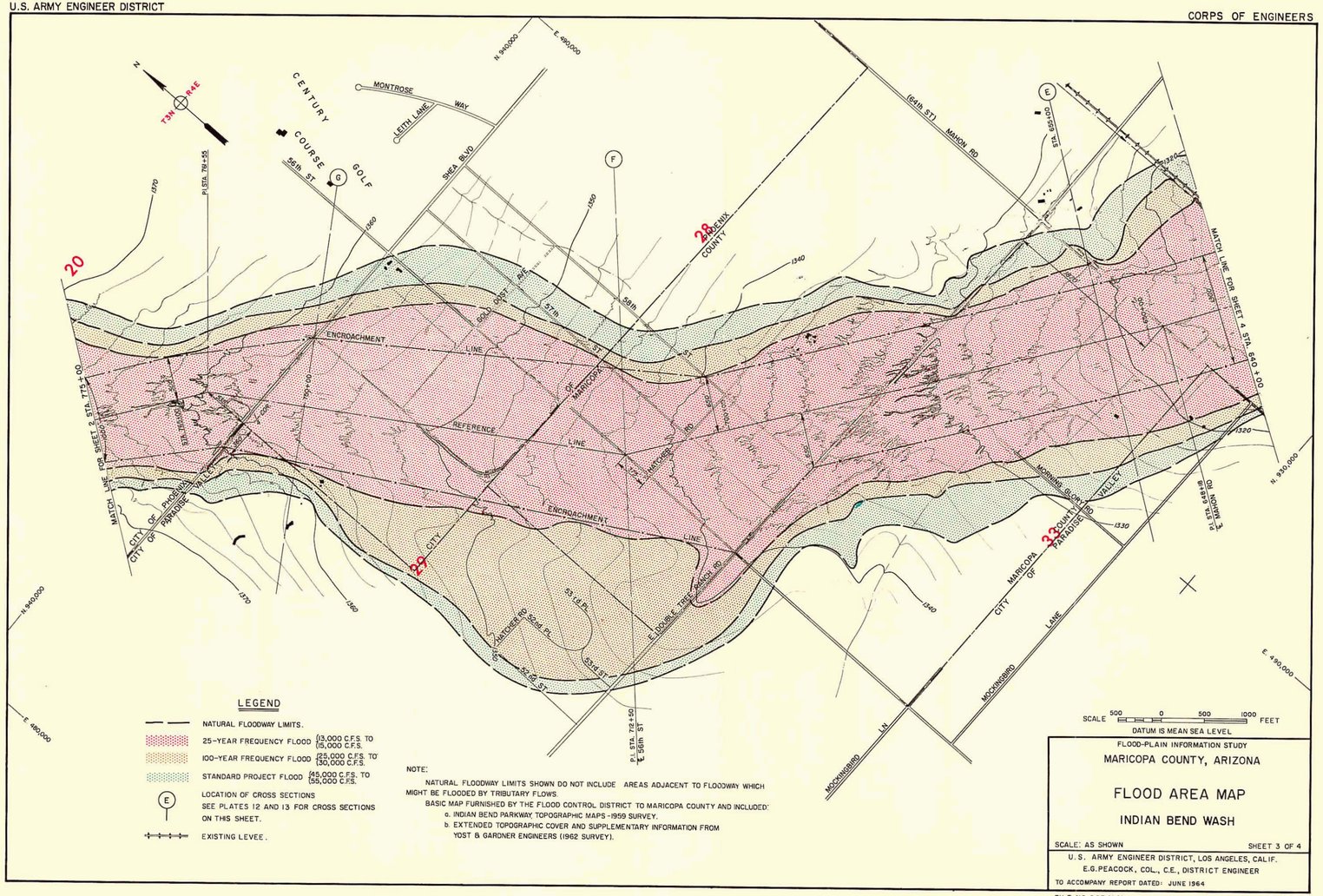
U.S. ARMY ENGINEER DISTRICT, LOS ANGELES, CALIF.

E.G. PEACOCK, COL., C.E., DISTRICT ENGINEER

TO ACCOMPANY REPORT DATED: JUNE 1964

FILE NO. 203/140

PLATE 6



LEGEND

- NATURAL FLOODWAY LIMITS.
- 25-YEAR FREQUENCY FLOOD (13,000 C.F.S. TO 15,000 C.F.S.)
- 100-YEAR FREQUENCY FLOOD (25,000 C.F.S. TO 30,000 C.F.S.)
- STANDARD PROJECT FLOOD (45,000 C.F.S. TO 55,000 C.F.S.)
- (E) LOCATION OF CROSS SECTIONS SEE PLATES 12 AND 13 FOR CROSS SECTIONS ON THIS SHEET.
- EXISTING LEVEE.

NOTE:

NATURAL FLOODWAY LIMITS SHOWN DO NOT INCLUDE AREAS ADJACENT TO FLOODWAY WHICH MIGHT BE FLOODED BY TRIBUTARY FLOWS.

BASIC MAP FURNISHED BY THE FLOOD CONTROL DISTRICT TO MARICOPA COUNTY AND INCLUDED:

a. INDIAN BEND PARKWAY TOPOGRAPHIC MAPS - 1959 SURVEY.

b. EXTENDED TOPOGRAPHIC COVER AND SUPPLEMENTARY INFORMATION FROM YOST & GARDNER ENGINEERS (1962 SURVEY).

FLOOD-PLAIN INFORMATION STUDY

MARICOPA COUNTY, ARIZONA

FLOOD AREA MAP

INDIAN BEND WASH

SCALE: AS SHOWN

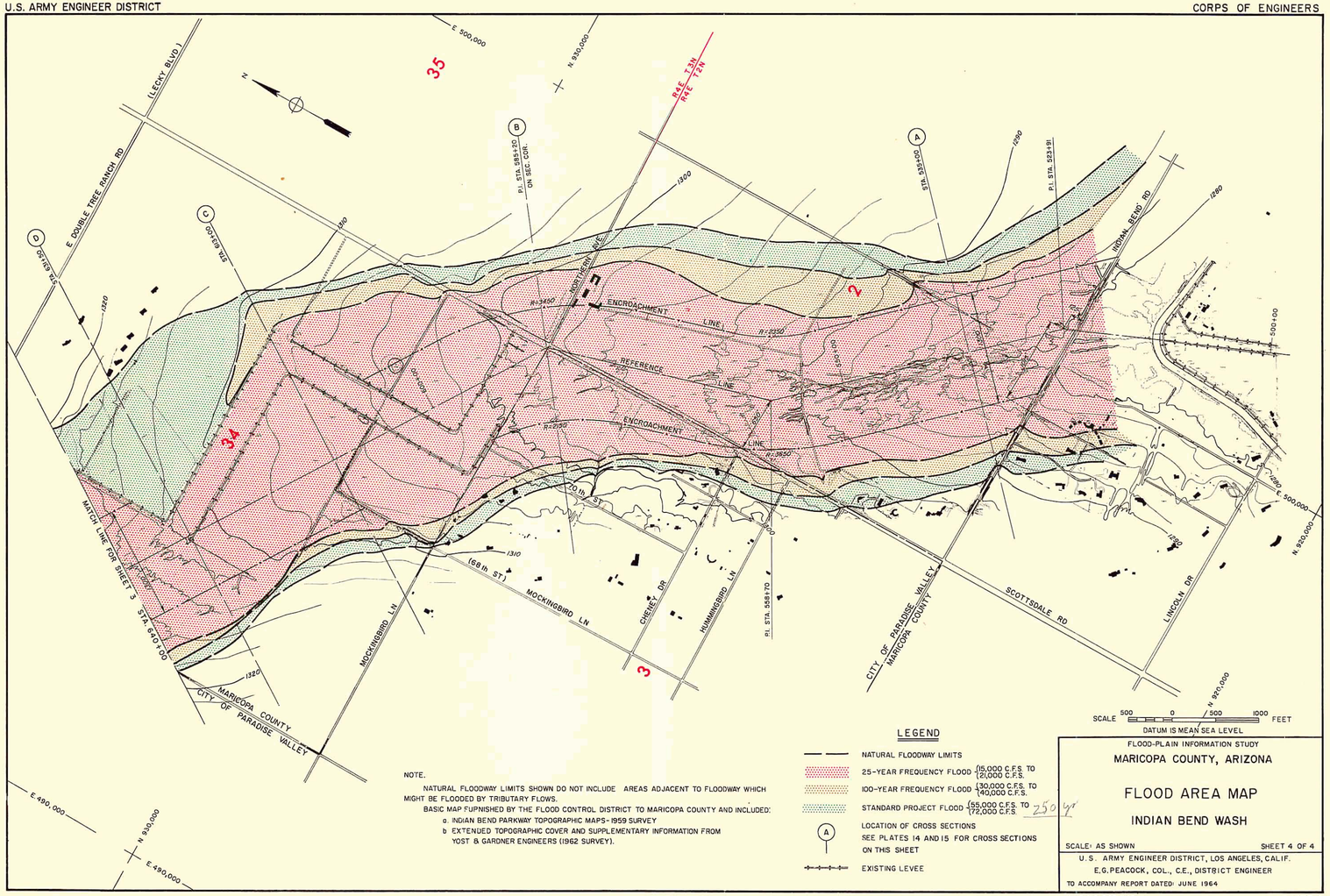
SHEET 3 OF 4

U. S. ARMY ENGINEER DISTRICT, LOS ANGELES, CALIF.

E.G.PEACOCK, COL., C.E., DISTRICT ENGINEER

TO ACCOMPANY REPORT DATED: JUNE 1964

FILE NO. 203/141



NOTE.

NATURAL FLOODWAY LIMITS SHOWN DO NOT INCLUDE AREAS ADJACENT TO FLOODWAY WHICH MIGHT BE FLOODED BY TRIBUTARY FLOWS.

BASIC MAP FURNISHED BY THE FLOOD CONTROL DISTRICT TO MARICOPA COUNTY AND INCLUDED:

a. INDIAN BEND PARKWAY TOPOGRAPHIC MAPS- 1959 SURVEY

b. EXTENDED TOPOGRAPHIC COVER AND SUPPLEMENTARY INFORMATION FROM YOST & GARDNER ENGINEERS (1962 SURVEY).

LEGEND

- NATURAL FLOODWAY LIMITS
- 25-YEAR FREQUENCY FLOOD {15,000 C.F.S. TO 21,000 C.F.S.
- 100-YEAR FREQUENCY FLOOD {30,000 C.F.S. TO 40,000 C.F.S.
- STANDARD PROJECT FLOOD {55,000 C.F.S. TO 72,000 C.F.S. 250 yr
- (A) LOCATION OF CROSS SECTIONS SEE PLATES 14 AND 15 FOR CROSS SECTIONS ON THIS SHEET
- EXISTING LEVEE

FLOOD-PLAIN INFORMATION STUDY

MARICOPA COUNTY, ARIZONA

FLOOD AREA MAP

INDIAN BEND WASH

SCALE: AS SHOWN

SHEET 4 OF 4

U.S. ARMY ENGINEER DISTRICT, LOS ANGELES, CALIF.

E.G. PEACOCK, COL., C.E., DISTRICT ENGINEER

TO ACCOMPANY REPORT DATED: JUNE 1964

FILE NO. 203/142

PLATE 8

U.S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS

FLOOD-PLAIN INFORMATION STUDY

MARICOPA COUNTY, ARIZONA

FLOOD PROFILE

INDIAN BEND WASH

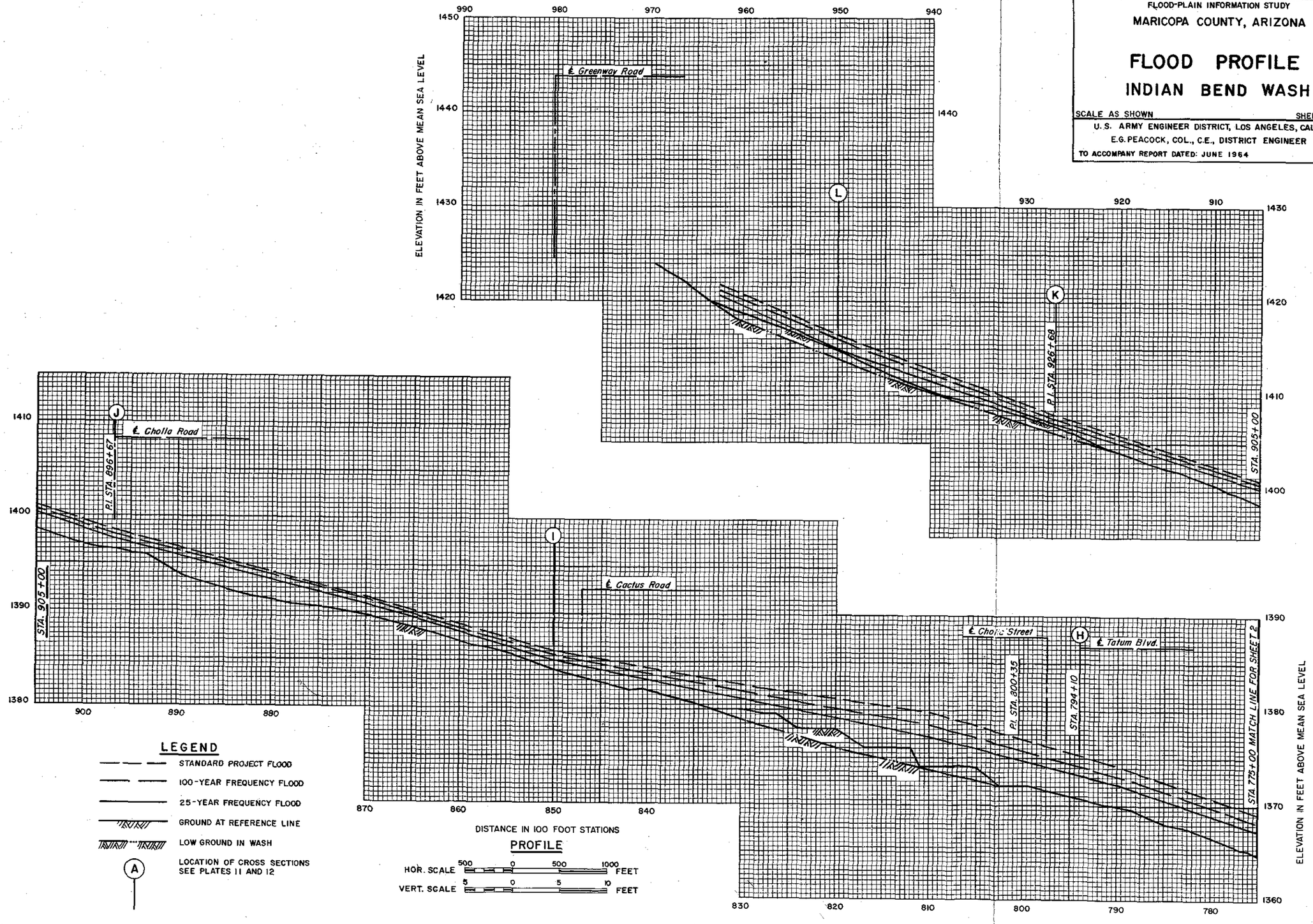
SCALE AS SHOWN

SHEET 1 OF 2

U. S. ARMY ENGINEER DISTRICT, LOS ANGELES, CALIF.

E.G. PEACOCK, COL., C.E., DISTRICT ENGINEER

TO ACCOMPANY REPORT DATED: JUNE 1964



FILE NO. 203/143

PLATE 9

U.S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS

FLOOD-PLAIN INFORMATION STUDY

MARICOPA COUNTY, ARIZONA

FLOOD PROFILE

INDIAN BEND WASH

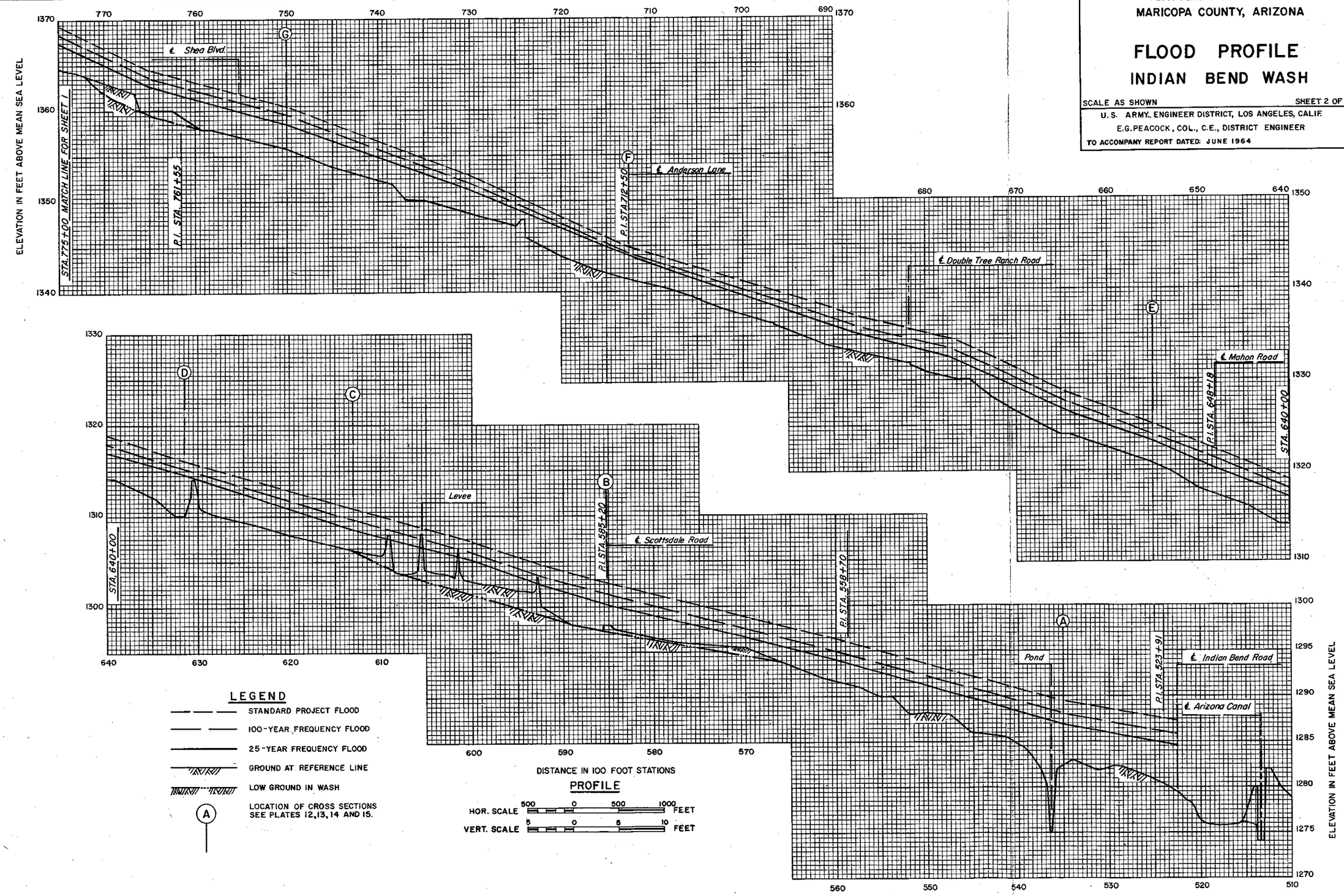
SCALE AS SHOWN

SHEET 2 OF 2

U. S. ARMY. ENGINEER DISTRICT, LOS ANGELES, CALIF.

E.G. PEACOCK, COL., C.E., DISTRICT ENGINEER

TO ACCOMPANY REPORT DATED: JUNE 1964

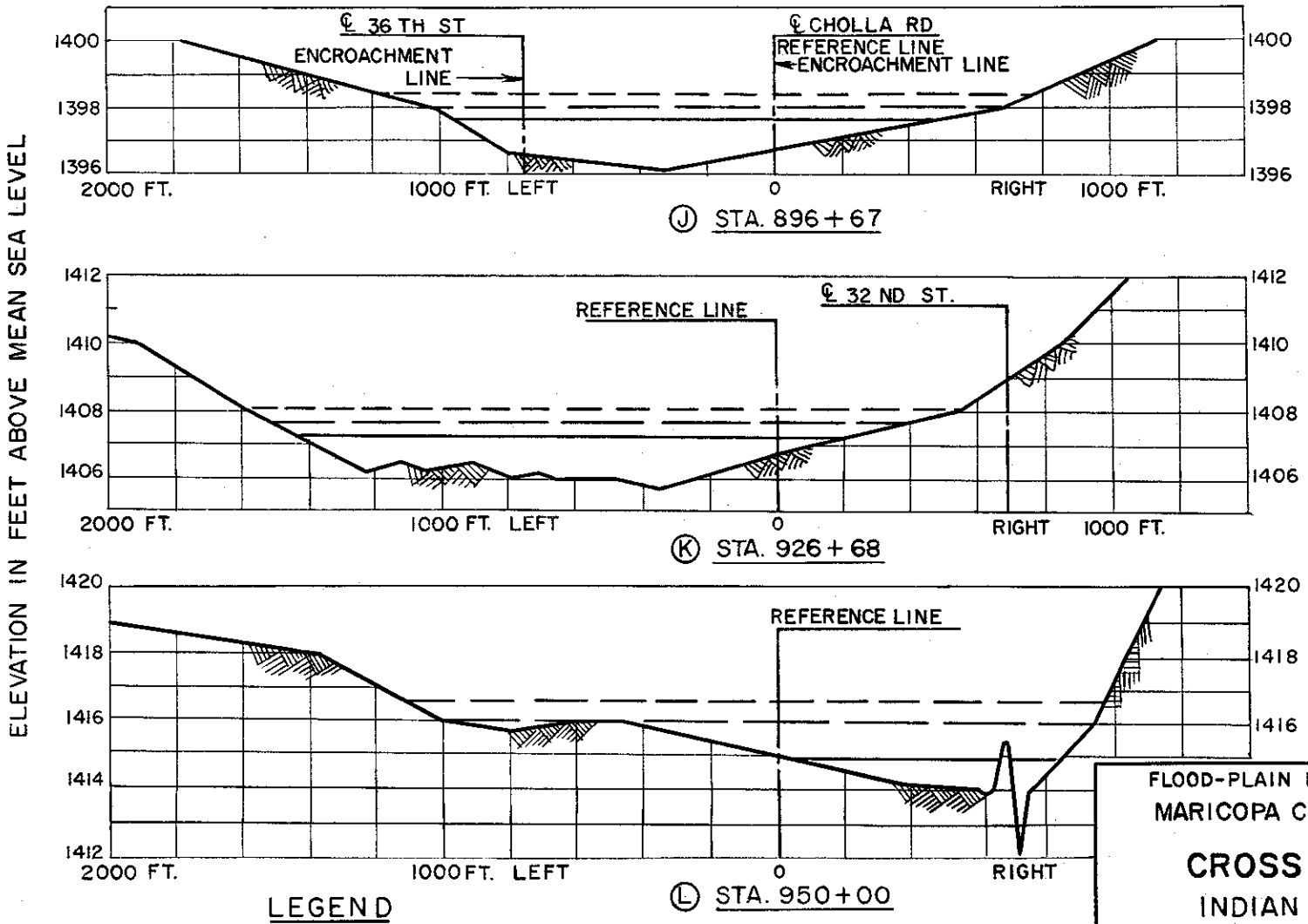


FILE NO. 203/144

PLATE 10

U.S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS



LEGEND

STANDARD PROJECT FLOOD

100-YEAR FLOOD

25-YEAR FLOOD

NOTES: LEFT & RIGHT REFERENCE LOOKING DOWNSTREAM.
TO FIND LOCATION OF THESE CROSS SECTIONS SEE PLATES 5 & 6.

FLOOD-PLAIN INFORMATION STUDY

MARICOPA COUNTY, ARIZONA

CROSS SECTIONS

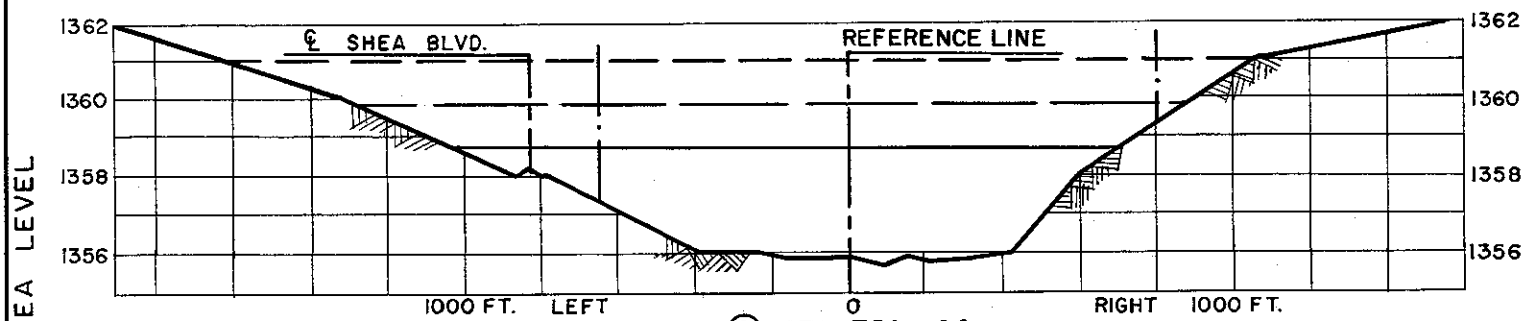
INDIAN BEND WASH

SHEET 1 OF 5 SHEETS

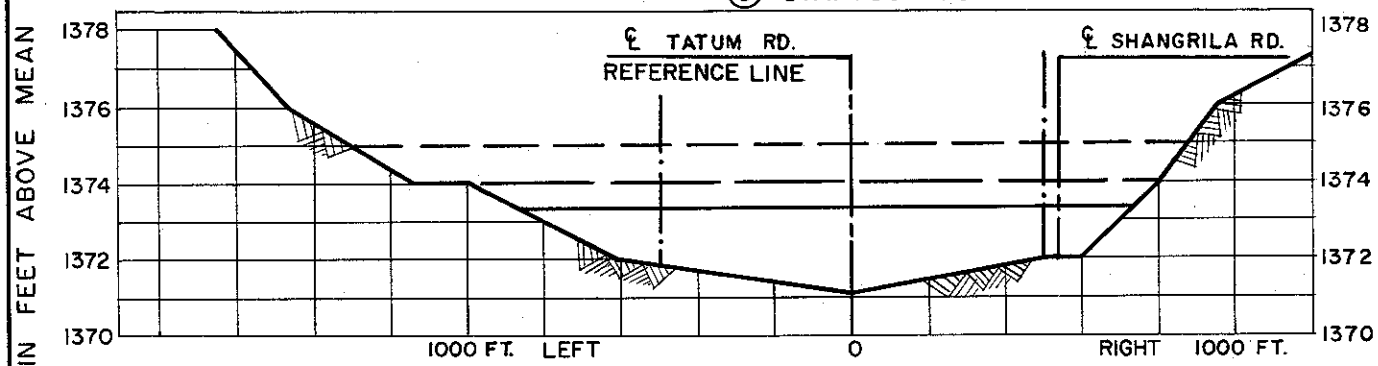
U.S. ARMY ENGINEER DISTRICT, LOS ANGELES, CALIF.
E.G. PEACOCK, COL., CE, DISTRICT ENGINEER
TO ACCOMPANY REPORT DATED: JUNE 1964

PLATE 11

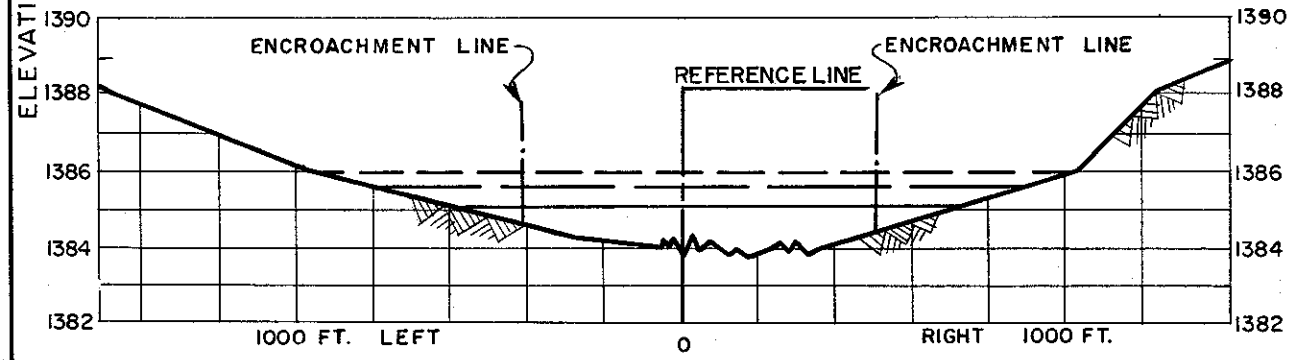
FILE NO. 203/145



Ⓖ STA. 750+00



Ⓗ STA. 794+00



① STA. 850+00

LEGEND

- STANDARD PROJECT FLOOD
- 100-YEAR FLOOD
- 25-YEAR FLOOD

NOTES:
LEFT & RIGHT REFERENCE LOOKING DOWNSTREAM. TO FIND LOCATION OF THESE CROSS SECTIONS SEE PLATES 6 & 7.

FLOOD-PLAIN INFORMATION STUDY
MARICOPA COUNTY, ARIZONA

CROSS SECTIONS
INDIAN BEND WASH

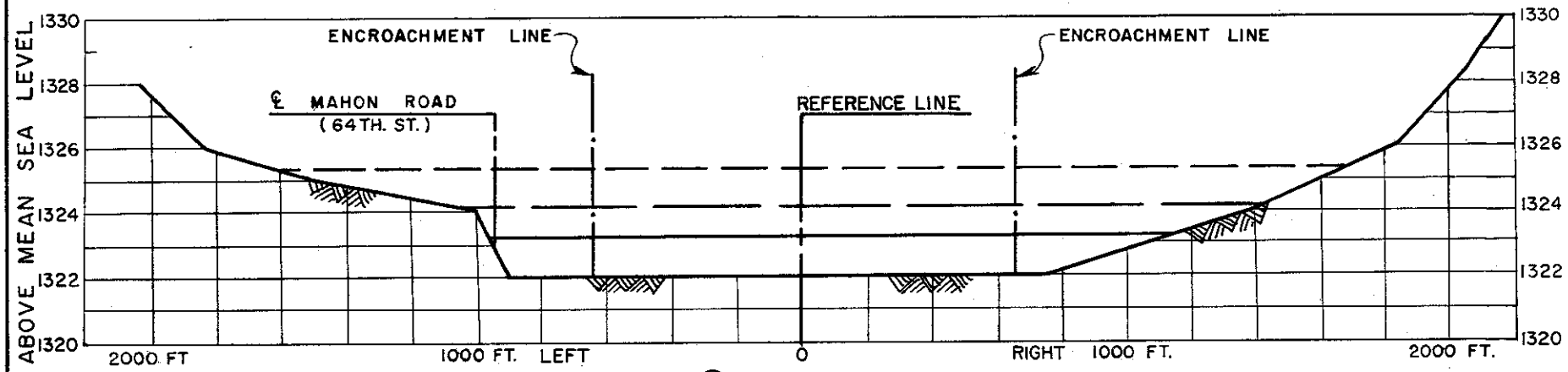
SHEET 2 OF 5 SHEETS

U.S. ARMY ENGINEER DISTRICT, LOS ANGELES, CALIF.
E.G. PEACOCK, COL., CE., DISTRICT ENGINEER
TO ACCOMPANY REPORT DATED: JUNE 1964

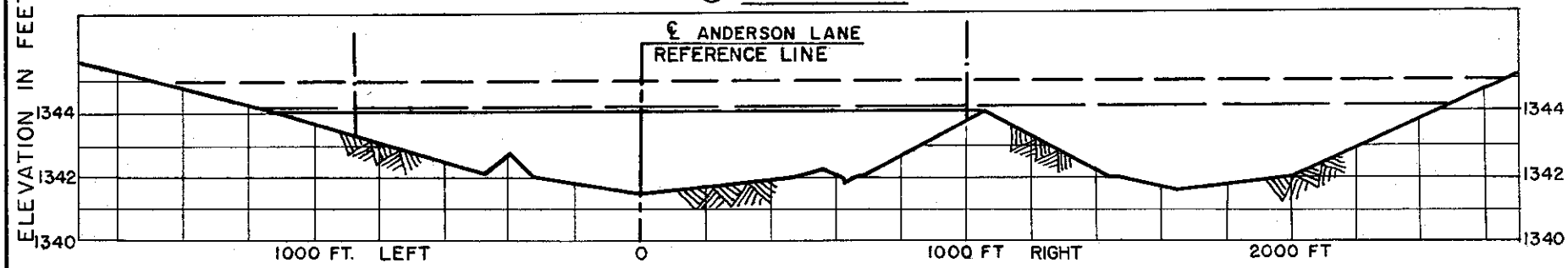
FILE NO. 203/146

U.S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS



Ⓔ STA. 655 + 00



Ⓕ STA. 712 + 50

LEGEND

- STANDARD PROJECT FLOOD
- 100-YEAR FLOOD
- 25-YEAR FLOOD

NOTES: LEFT & RIGHT REFERENCE LOOKING DOWNSTREAM.
TO FIND LOCATION OF THESE CROSS SECTIONS SEE PLATE 7.

FLOOD-PLAIN INFORMATION STUDY

MARICOPA COUNTY, ARIZONA

CROSS SECTIONS

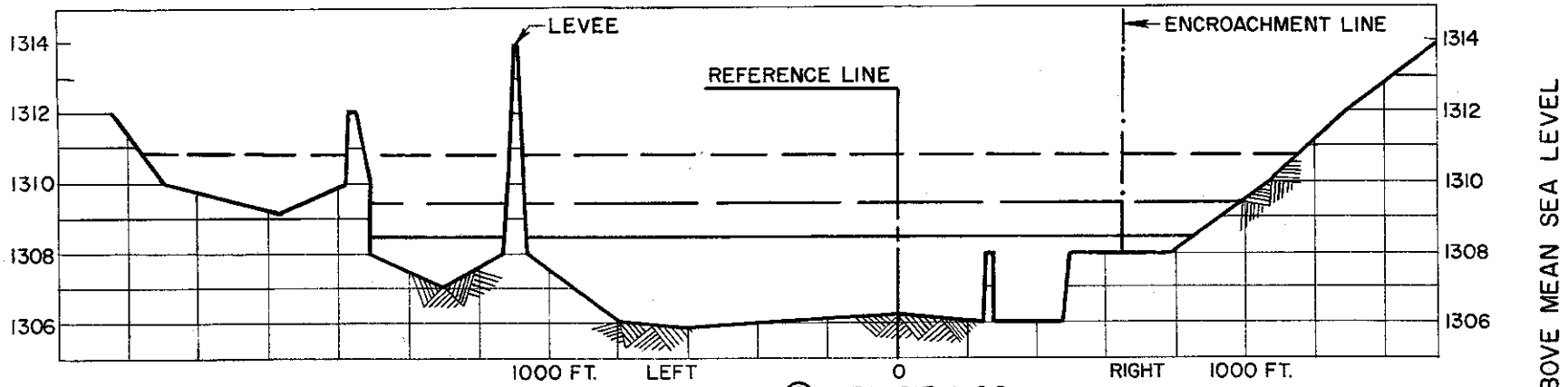
INDIAN BEND WASH

SHEET 3 OF 5 SHEETS

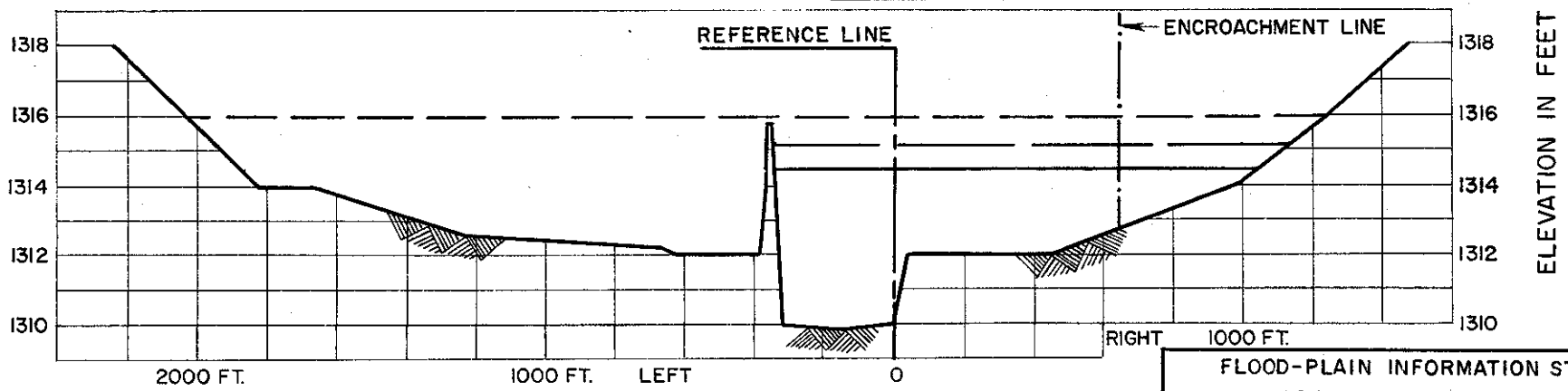
U.S. ARMY ENGINEER DISTRICT, LOS ANGELES, CALIF.
E.G. PEACOCK, COL., CE, DISTRICT ENGINEER
TO ACCOMPANY REPORT DATED: JUNE 1964

FILE NO. 203/147

PLATE 13



Ⓒ STA. 613 + 00



Ⓓ STA. 631 + 50

LEGEND

STANDARD PROJECT FLOOD
100-YEAR FLOOD
25-YEAR FLOOD

NOTES: LEFT & RIGHT REFERENCE LOOKING DOWNSTREAM.
TO FIND LOCATION OF THESE CROSS SECTIONS SEE PLATE 8.

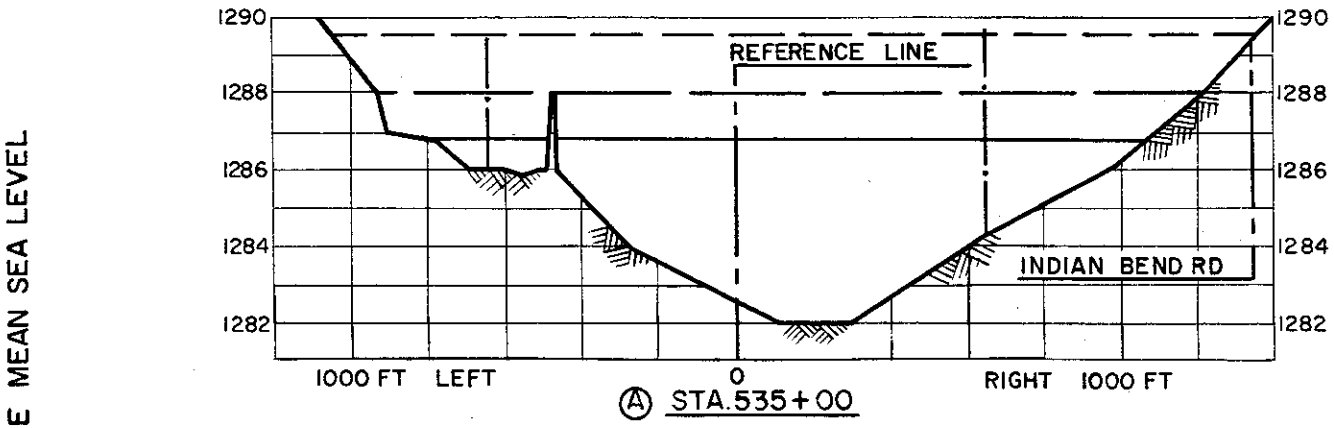
FLOOD-PLAIN INFORMATION STUDY
MARICOPA COUNTY, ARIZONA

CROSS SECTIONS
INDIAN BEND WASH

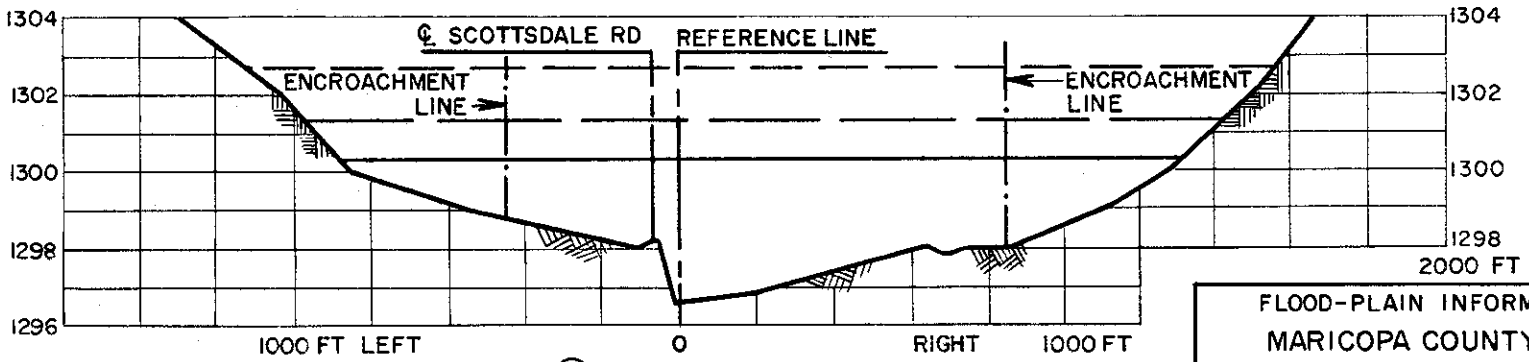
SHEET 4 OF 5 SHEETS

U.S. ARMY ENGINEER DISTRICT, LOS ANGELES, CALIF.
E.G. PEACOCK, COL., CE, DISTRICT ENGINEER
TO ACCOMPANY REPORT DATED: JUNE 1964

FILE NO. 203/148



Ⓐ STA. 535+00



Ⓑ STA. 585+20

LEGEND

STANDARD PROJECT FLOOD
100-YEAR FLOOD
25-YEAR FLOOD

NOTES: LEFT & RIGHT REFERENCE LOOKING DOWNSTREAM.
TO FIND LOCATION OF THESE CROSS SECTIONS SEE PLATE 8.

FLOOD-PLAIN INFORMATION STUDY
MARICOPA COUNTY, ARIZONA

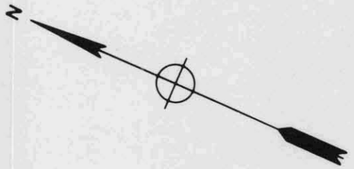
CROSS SECTIONS

INDIAN BEND WASH

SHEET 5 OF 5 SHEETS

U.S. ARMY ENGINEER DISTRICT, LOS ANGELES, CALIF.
E.G. PEACOCK, COL., CE, DISTRICT ENGINEER
TO ACCOMPANY REPORT DATED: JUNE 1964

FILE NO. 203/149



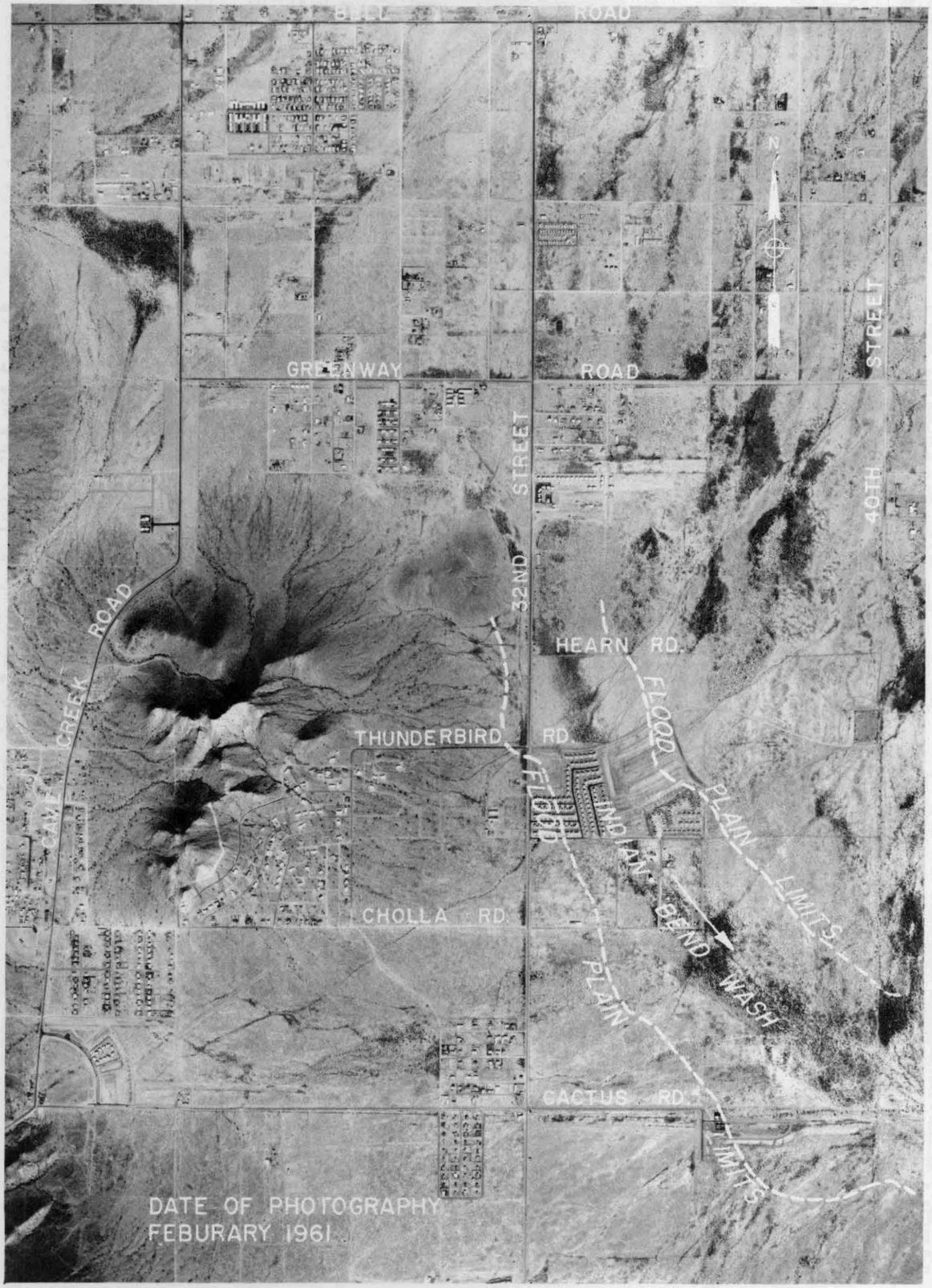
PHOTOGRAPH TAKEN SEPT. 20, 1961

LOOKING NORTHERLY

FLOOD-PLAIN INFORMATION STUDY
MARICOPA COUNTY, ARIZONA
INDIAN BEND WASH

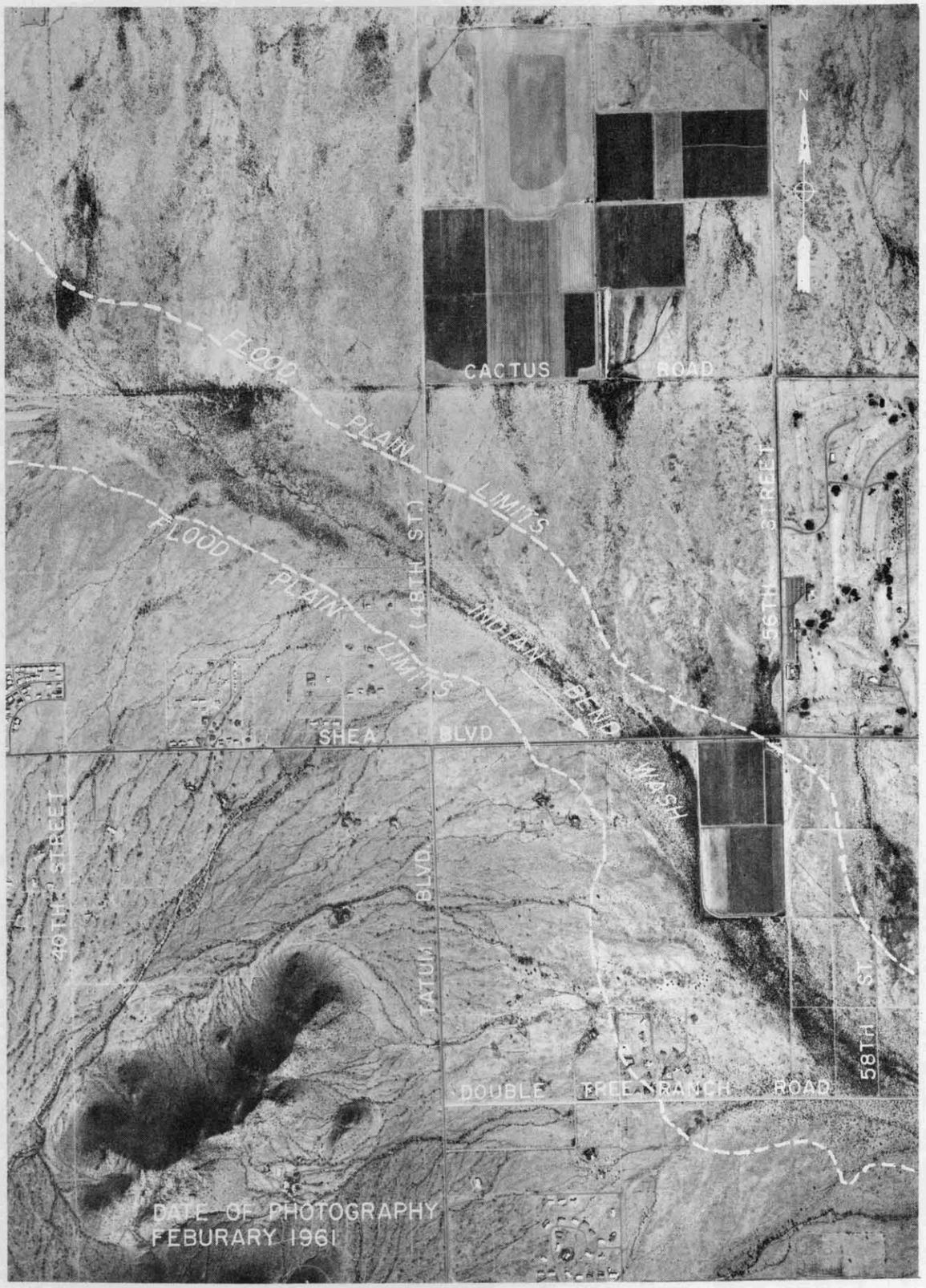
OBLIQUE AERIAL PHOTOGRAPH

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED: JUNE 1964



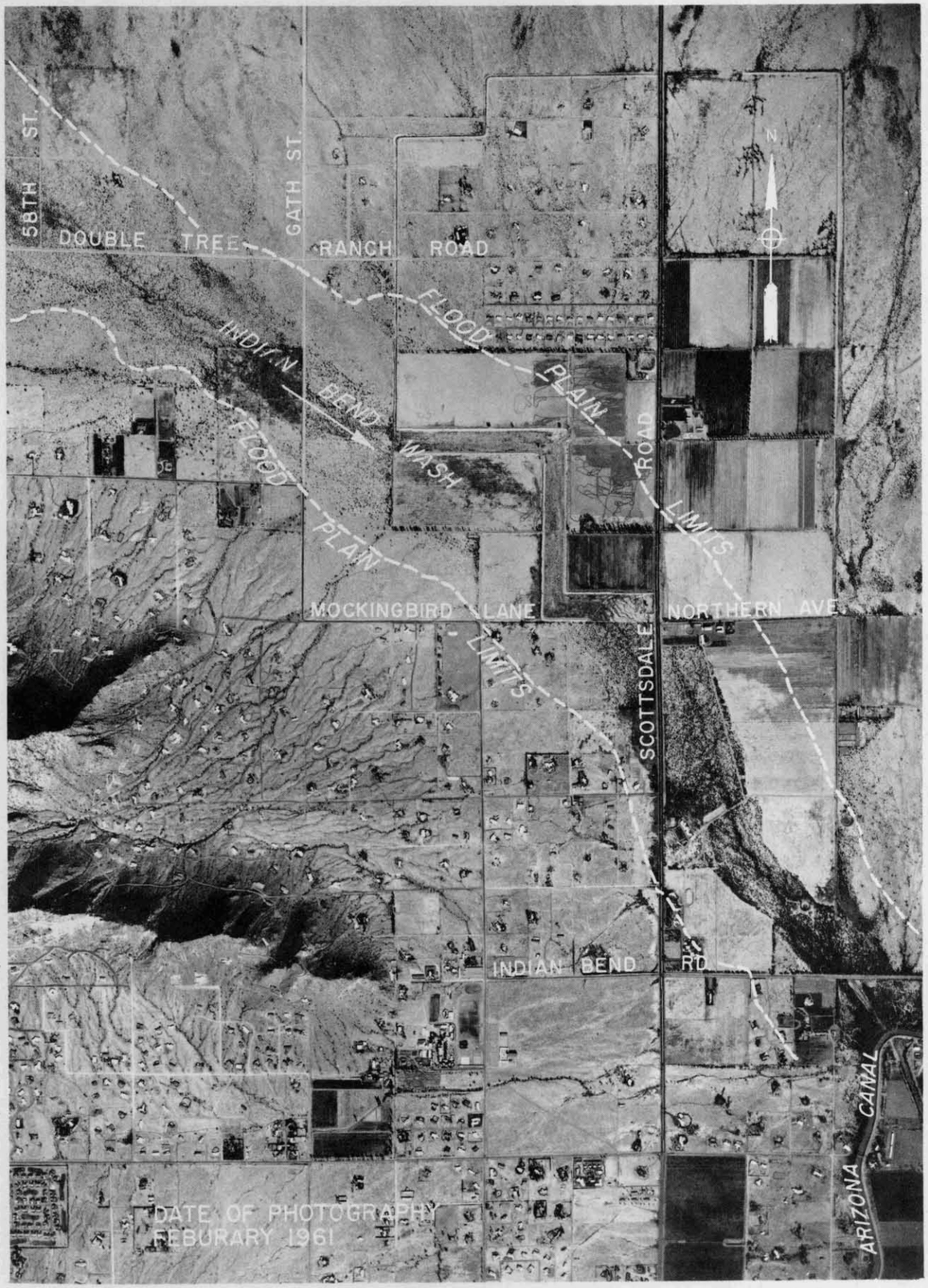
VERTICAL AERIAL PHOTOGRAPH NO. I

PLATE 17



VERTICAL AERIAL PHOTOGRAPH NO. 2

PLATE 18



VERTICAL AERIAL PHOTOGRAPH NO. 3

PLATE 19

FLOOD-PLAIN INFORMATION STUDY
FOR
MARICOPA COUNTY, ARIZONA
VOL. 1 INDIAN BEND WASH

APPENDIX I

GLOSSARY OF SELECTED TERMS

The definitions herein are provided for consistency of use in flood-plain information studies. They supplement and are based on terms in general technical usage.

BASIN - The region drained by one stream. A basin area separated from adjacent areas by ridges or mountain ranges.

CONFINED FLOW - The flow of a river or any stream as confined by levees or other means of channel confinement.

CUBIC FEET PER SECOND c.f.s. - A measure of the magnitude of streamflow - one cubic foot of water passing a point each second.

DESIGNATED FLOODWAY - The wash and that portion of the adjoining flood plain designated by a regulatory agency to reasonably provide for passage of a selected flood.

ENCROACHMENT LINES - Lateral limits or lines along streams beyond which in the direction of the stream no structure or fill may be added without reducing the natural flood carrying capacity of the stream and its flood plain. Their location should be such that the natural floodway between them will handle a designated floodflow. The encroachment lines in this report were determined on the basis of a 100-year flood.

INTERMITTENT STREAM - A stream that flows only in direct response to rainfall. In Maricopa County, such streams are normally dry.

FLOOD - An overflow of lands not normally covered by water and which are used or usable by man. In a hydrologic sense, it is any relatively high temporary rise in water level or discharge of a stream. In this report it is considered in a practical sense as any temporary rise in stream flow or stage that results in significant adverse effects in the vicinity.

FLOOD FREQUENCY - The frequency of occurrence of a flood of some stated magnitude in terms of years. Based on statistical analysis of past flood records, it is possible to determine the probable number of times that a stated flood magnitude will be equalled or exceeded during some future period of time, say 100 years. To say that a 25-year flood has a magnitude of 8,000 cubic feet per second can be taken to mean that during a 100-year period, a flood discharge of 8,000 cubic feet per second can be expected to be equalled or exceeded four times. The use of the term "25-year flood" should not lead to the wrong conclusion that such a flood can occur only once in 25 years and that once it occurs will not happen again for another 25 years. Floods occur randomly and may be grouped or spread out unevenly with respect to time.

FLOOD HYDROGRAPH - A graph or curve representing the flood discharge at a particular location on a stream, plotted against time during a flood.

FLOOD PEAK - The maximum instantaneous discharge of a flood at a given location. It is usually expressed in cubic feet per second.

FLOOD PLAIN - The relatively flat area or low lands adjoining the channel of a river, stream or watercourse, or an ocean, lake, or other body of standing water, which has been or may be covered by flood water.

FLOOD-PLAIN REGULATIONS - A general term applied to the full range of codes, ordinances, and other regulations relating to the use of land and construction within the channel and flood plain areas. The term encompasses zoning ordinances, subdivision regulations, building and housing codes, encroachment line statutes, open area regulations, and other similar methods of control affecting the use and development of the areas.

FLOOD PROFILE - A graph showing the relationship of water surface elevation to location, the latter generally expressed as distance above mouth, for a stream of water flowing in an open channel. It is generally drawn to show surface elevation for the crest of a specific flood, but may be prepared for conditions at any given time or stage.

FLOOD PROOFING - A combination of structural changes and adjustments to properties subject to flooding, primarily for the reduction or elimination of flood damages to such properties.

FLOODWAY - The channel of the stream or body of water and that portion of the flood plain that is inundated by a flood and therefore used to carry the flow of the flood. The term "natural floodway" refers to the floodway as found in nature without improvements such as levees or excavated channels or without artificial obstructions such as houses, bridges, etc. "Maximum natural floodway" is the natural floodway defined by the limits required for the passage of a Standard Project Flood.

GAGING STATION - A particular site on a stream, canal, lake, or reservoir where systematic observation of stage (water surface level) or discharge are obtained.

RESTRICTIVE ZONE - The portion of the natural floodway within the overflow limits of a selected flood and outside of the designated floodway. The restrictive zone is established by a zoning ordinance for the purpose of reducing the flood hazard to life and property by regulating development within the zone.

STANDARD PROJECT FLOOD - The flood that would result from a storm with the most severe flood-producing rainfall pattern of any storm that is considered reasonably characteristic of the region in which the drainage area is located, giving consideration to the runoff characteristics, and excluding extremely rare combinations.

ZONING ORDINANCE - An ordinance adopted by a local governing body, with authority from a state zoning enabling law, which under the police power divides a local governmental area into districts and, within each district, regulates the use of land, the height, bulk, type, and use of buildings or other structures, and the density of population.

FLOOD-PLAIN INFORMATION STUDY
FOR
MARICOPA COUNTY, ARIZONA
VOL. 1 INDIAN BEND WASH

APPENDIX II

Date

AUTHORIZATION

The general authority for flood-plain information studies by the Corps of Engineers is section 206, Public Law 86-645, (approved 14 July 1960), which reads:

> SEC. 206(a) That, in recognition of the increasing use and development of the flood plains of the rivers of the United States and of the need for information on flood hazards to serve as a guide to such development, and as a basis for avoiding future flood hazards by regulation of use by States and municipalities, the Secretary of the Army, through the Chief of Engineers, Department of the Army, is hereby authorized to compile and disseminate information on floods and flood damages, including identification of areas subject to inundation by floods of various magnitudes and frequencies, and general criteria for guidance in the use of flood plain areas; and to provide engineering advice to local interests for their use in planning to ameliorate the flood hazard: Provided, That the necessary surveys and studies will be made and such information and advice will be provided for specific localities only upon the request of a State or a responsible local governmental agency and upon approval by the Chief of Engineers.
>
> (b) The Secretary of the Army is hereby authorized to allot, from any appropriations hereafter made for flood control, sums not to exceed $1,000,000 in any one fiscal year for the compilation and dissemination of such information.

The Arizona State Land Commissioner has been designated by the Governor of Arizona to coordinate and assign priority of need to applications for flood-plain information studies. The Board of Supervisors of Maricopa County and the Board of Directors of the Flood Control District of Maricopa County adopted a resolution on 26 September 1960 requesting this study. The Chief of Engineers, Washington, D. C., approved the request on 14 April 1961 and approved release of the report on 28 May 1964.

FLOOD-PLAIN INFORMATION STUDY
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APPENDIX III

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The following selections are a sampling of literature, mostly recent, on flood-plain regulations and development problems. Those marked by an asterisk (*) contain bibliographies and references which should be consulted for more extensive reading.

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