GILA RIVER AND TRIBUTARIES, ARIZONA AND NEW MEXICO

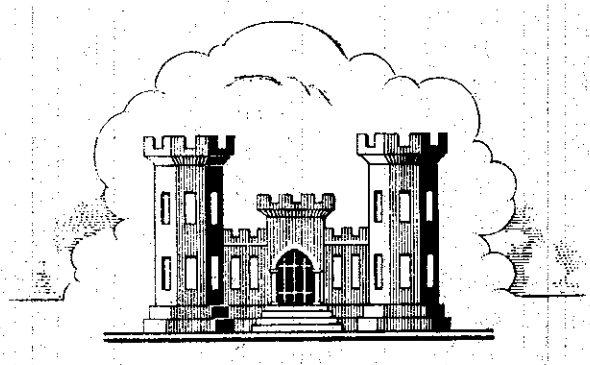
INTERIM REPORT

ON

SURVEY FOR FLOOD CONTROL

INDIAN BEND WASH, ARIZONA

(WITH APPENDIXES)



U. S. ARMY ENGINEER DISTRICT, LOS ANGELES
CORPS OF ENGINEERS
APRIL 15, 1962

INTERIM REPORT OF THE DISTRICT ENGINEER
ON SURVEY FOR FLOOD CONTROL

INDIAN BEND WASH, ARIZONA
GILA RIVER BASIN, ARIZ. AND N. MEX.

SYLLABUS

This interim report, submitted pursuant to act of Congress, Public Law 761, 75th Congress, approved June 28, 1938, considers the flood problems along Indian Bend Wash, located in and adjacent to Scottsdale, Ariz., about 10 miles east of Phoenix, Ariz.

The district engineer finds that a serious flood problem exists along Indian Bend Wash. The existing stream channel is inadequate in capacity, and on the recurrence of floodflows overflow will take place causing recurrent damage of major proportions to urban developments located along the wash. Serious damage would also be incurred by public, transportation, and utility properties located in the path of the floodwaters. Floodflows will cause far greater damage in the future than has occurred in the past because of the great growth that has occurred in the area since 1950 and because such growth is continuing.

After consideration of the plans proposed by local interests, the district engineer finds that economically feasible protection can be provided by the construction of a channel improvement along Indian Bend Wash from the Arizona canal to the Salt River to control all floods up to and including 40,000 cubic feet per second. He finds that the proposed plan of improvement would prevent about 96 percent of the potential damages in the area.

The district engineer estimates the total Federal first cost of the project at $7,250,000 (November 1961) for construction and the total non-Federal first cost at $1,770,000 (November 1961). He estimates the total average annual charges at $292,000, including an average of $22,000 annually for maintenance and operation of the improvement. He estimates the average annual benefits that would accrue from the prevention of flood damages at $530,000. He states that the ratio of average annual benefits to average annual charges would be 1.8 to 1 on the basis of tangible benefits alone. Intangible benefits would add weight to the justification.

The district engineer recommends that the United States adopt a project for the control of floods along Indian Bend Wash in the vicinity of Scottsdale, Ariz., as outlined above, subject to the condition that local interests furnish assurances

satisfactory to the Secretary of the Army that they will acquire and provide, without cost to the United States, all lands, easements, and rights-of-way necessary for the construction and subsequent maintenance and operation of the improvement at a cost estimated at $700,000 (November 1961); perform, without cost to the United States, all necessary construction or relocations of highways, roads, bridges, utilities, irrigation and drainage facilities, and all necessary street and irrigation facility modifications required in connection with the project at a cost estimated at $1,070,000 (November 1961); hold and save the United States free from damages due to the construction works; maintain and operate all the works, after completion, in accordance with regulations to be prescribed by the Secretary of the Army at an average annual cost estimated at $22,000; and prevent any encroachment upon the improved channel that would reduce its flood-carrying capacity.

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APPENDIXES

U. S. ARMY ENGINEER DISTRICT, LOS ANGELES,
CORPS OF ENGINEERS,
OFFICE OF THE DISTRICT ENGINEER,
Los Angeles, Calif., April 15, 1962.

Subject: Interim report on survey for flood control, Indian Bend Wash, Gila River basin, Ariz.

Through: The Division Engineer, U. S. Army Engineer Division, South Pacific, San Francisco, Calif.

To: The Chief of Engineers, Department of the Army, Washington, D. C.

AUTHORITY

1. This report is submitted pursuant to act of Congress, Public Law 761, Seventy-fifth Congress, approved June 28, 1938, which reads in part as follows:

> SEC. 6. The Secretary of War is hereby authorized and directed to cause preliminary examinations and surveys for flood control including floods aggravated by or due to tidal effect at the following-named localities, * * *
>
> * * * * * * * *
>
> Gila River and tributaries, Arizona and New Mexico
>
> * * * * * * * *

2. The survey for the Gila River basin is being covered in 11 interim reports, 3 review reports, and a final comprehensive report. Five of those interim reports have been submitted to Congress, as follows: (a) Tucson, Ariz., and vicinity, dated November 20, 1945; (b) Queen Creek, Ariz., dated February 2, 1946; (c) Gila River and tributaries below Gillespie Dam, Ariz., dated September 1, 1948; (d) Lower Agua Fria River and vicinity, Arizona, dated December 10, 1952; and (e) Gila and Salt Rivers, Gillespie Dam to McDowell damsite, Arizona, dated December 4, 1957. Two of the three review reports have also been submitted to Congress, as follows: (a) Gila River, Camelsback Reservoir site to Salt River, Arizona, dated December 31, 1957; and (b) Tucson, Ariz., and vicinity, dated January 26, 1959.

3. Five interim reports, in addition to the one under consideration, are now in preparation, as follows: (a) Gila River with particular reference to a dam at or near the Camelsback site, Ariz.; (b) Pinal Creek and tributaries, Arizona; (c) Santa Rosa Wash, Ariz.; (d) Phoenix, Ariz., and vicinity, including the New River; and (e) Willcox, Ariz., and vicinity. Work also is under way on the third review report, which considers the flood problem along the Gila River downstream from Painted Rock Reservoir, Ariz.

4. This interim report considers Indian Bend Wash. The final comprehensive report will include summaries of findings and conclusions in all interim and review reports, consideration of problems in areas not covered in any interim report, and analysis of the interrelation of problems and plans of improvement in all parts of the Gila River basin.

SCOPE

5. Geographical scope.--The Flood Control Act of June 28, 1938, authorized the preparation of a survey for flood control in the entire drainage area of the Gila River and tributaries, Arizona and New Mexico. On the basis of the authorization in that act, the Chief of Engineers, on February 13, 1961, authorized an interim survey of Indian Bend Wash, Ariz.

6. An inspection of the Indian Bend Wash basin showed that the major flood problems are along the Indian Bend Wash from the Arizona canal to the Salt River. The limited economic development subject to flood damage upstream from the Arizona canal is not sufficient to justify improvements for flood control at this time. Therefore, detailed consideration in this report is generally limited to the flood problems of urban and agricultural areas between the canal and the Salt River.

7. Functional scope.--The interim survey described in this report was made to consider, in the most part, the need for flood control and the solution of flood problems in the affected areas. Water conservation as a purpose for the project was not considered because of the inadequacy of flow in the area and the lack of adequate sites for storage. However, local interests have been using floodflows, intercepted by the Arizona canal, as a supplement to irrigation flows in the canal. Consideration was given to the incorporation of features in the recommended improvement to permit interception of floodwaters into the canal. The development of hydroelectric power was not considered because the runoff from this relatively dry drainage area, which has a high evaporation rate, would be inadequate for the generation of power. The lack of adequate sites for water storage also precluded consideration of recreational development as a purpose for the project.

PRIOR REPORTS

8. No prior survey report on flood control in the Indian Bend Wash basin has been submitted to Congress by the U. S. Army Corps of Engineers.

DESCRIPTION

9. Location and extent.--The Indian Bend Wash Basin, which is a small part of the 58,200-square-mile drainage area of the Gila River, comprises about 224 square miles in south-central Arizona about 10 miles east and northeast of Phoenix. Indian Bend Wash is tributary to the Salt River upstream from Phoenix. The basin, which is entirely within Maricopa County and partly within the Phoenix metropolitan area, is an elongated area with a maximum north-south length of about 26 miles and a maximum east-west width of about 15 miles. (See index map, pl. 1, at end of the main report.)

10. Streams.--Indian Bend Wash, the main stream in the drainage area, rises on the southwestern slopes of the McDowell Mountains and flows generally southward for about 32 miles to the Salt River. Several unnamed streams are tributary to Indian Bend Wash upstream from the point at which the Arizona canal crosses the wash near Scottsdale. Because that canal continues across the Indian Bend Wash basin, several other unnamed streams that originate to the east of the wash and that formerly entered Indian Bend Wash downstream from the canal crossing are now intercepted by that canal. Flow in these streams reaches Indian Bend Wash, just upstream of Van Buren Street, only in the event of breaks in the canal. Because of the natural low divides between streams and because of topographical changes due to grading for roads and for agricultural purposes, some of this flow would enter the Salt River before it reaches Indian Bend Wash. Surface flow in all streams in the Indian Bend Wash basin is intermittent.

11. In general, stream slopes are steep in the mountains and moderate in the valleys. Stream slopes range from about 100 feet per mile in the mountains to about 20 feet per mile near the confluence of Indian Bend Wash and the Salt River. Downstream from the base of the mountains, the streams generally flow in poorly defined channels that are generally adequate for only small flows.

12. Granite Reef Dam and the Arizona canal, which extends across the Indian Bend Wash basin, are operated so that the canal can intercept all flows in the stream channels ranging up to about 2,000 cubic feet per second in the reach between the Evergreen and Indian Bend Wash wasteways. The Evergreen wasteway is operated to release intercepted flows in excess of 2,000 cubic feet per second into a wash located about 5 miles east of Indian Bend Wash, and the Indian Bend Wash wasteway is operated to release intercepted flows in excess of 2,000 cubic feet per second into Indian Bend Wash upstream from Scottsdale. The canal bank may be breached at almost any point by larger flows. The capacity of the existing Indian Bend Wash channel downstream from the canal is about 1,500 cubic feet per second.

13. Topography and vegetation.--Elevations in the drainage area range from 1,200 feet at the Salt River to about 3,000 feet in the mountains. The elevation of Scottsdale is about 1,250 feet. About 20 percent of the area is mountainous, the remainder being a gently rolling desert plain. The plain has a general slope to the southwest, which ranges from about 40 feet per mile in the lower reaches to about 150 feet per mile in the upper reaches at the base of the mountains.

14. Vegetation in the Indian Bend Wash drainage area above the Arizona canal is sparse. Cactus, creosote bush, sagebrush, and paloverde are the dominant desert plants. The area downstream from the Arizona canal is served with irrigation water by the canal and has been developed into productive farmland and landscaped residential tracts.

ECONOMIC DEVELOPMENT

15. Population.--The principal area affected by improvements considered in this report extends for about 7 miles along both sides of Indian Bend Wash from the Arizona canal to the Salt River. The area includes the eastern part of the town of Scottsdale. According to the U. S. Census, the population of the town of Scottsdale increased from 2,032 in 1950 to 10,026 in 1960, representing a 10-year increase of nearly 400 percent. Estimates by the Maricopa County Planning and Zoning Department indicate that the Scottsdale area with a 1950 population of less than 5,000 and a 1960 population of 32,700 would have a population of 86,000 by 1980, which would represent a 20-year increase of about 160 percent.

16. Occupations and industries.--The economy of the Scottsdale area is closely interwoven with that of the Phoenix urban area. Studies indicate that about 30 percent of the estimated 10,000 employed persons residing in the Scottsdale area commute to jobs outside that area. In the Scottsdale area, the distribution of remaining employed persons is about as follows: manufacturing, 28 percent; resorts, hotels, and tourist apartments, 16 percent; retail trade, 16 percent; construction, 13 percent; personal services, 19 percent; and Government, schools, and utilities, 8 percent.

17. Manufacturing establishments in the Scottsdale area include a major electronics center and research laboratory of Motorola, Inc., and many small plants providing ceramics, handicrafts, textiles, and leather goods for the large tourist trade. Another major occupation is the lodging, feeding, and entertainment of the many tourists who visit the area, especially during the winter season. More than 2,000 rental units are available in apartments, motels, and resorts. During the winter season alone, the average length of stay is 10 weeks in apartment units and 3 weeks in resort units.

18. The overflow area of Indian Bend Wash contains a large number of residences, 2 schools, and a major shopping center with 11 shops and a service station.

19. Land use and development.--Intensive agricultural development within the Indian Bend Wash basin stems from the Reclamation Act of 1902 and the subsequent authorization of the Salt River project. Urban development in the basin began with the establishment of the townsite of Scottsdale in 1913.

20. The availability of irrigation water from the Salt River project facilities resulted in an increasing agricultural development not only for the Scottsdale area but also for the entire Phoenix area. The amount of project land under cultivation reached a high of 227,000 acres in 1940. For years, Scottsdale was primarily an important center for the surrounding intensively developed agricultural land.

21. Shortly after World War II, the Phoenix metropolitan area, including the Scottsdale area, began a trememdous urban, commercial, and industrial expansion. As a result, the economic life of the Scottsdale area became more closely associated with that of the entire Phoenix area. Because of the increasing urban development, agricultural activity decreased and most of the agricultural development continuing in the Indian Bend Wash basin is now confined to the Salt River Indian Reservation, which lies to the east of Indian Bend Wash. The value of agricultural land along Indian Bend Wash reflects its prospective use for residential purposes.

22. Water and power.--Domestic water for the Scottsdale area is supplied by the city of Phoenix water system and private water companies. Irrigation water for the Scottsdale area is obtained directly from Salt River project facilities (Arizona canal and appurtenant laterals) and by pumping from underground supplies. Electric power is available from the Salt River project and from the Arizona Public Service Company.

23. Transportation facilities.--Scottsdale is served by an adequate net of local and State highways. U. S. highways for transcontinental traffic pass through nearby Tempe and Phoenix. A main line of the Southern Pacific railroad serves the area with trackage through Phoenix and Tempe. The Sky Harbor Airport, about 7 miles southwest of Scottsdale, provides complete local and transcontinental air service.

CLIMATOLOGY

24. General.--The climate of the Indian Bend Wash drainage area is subtropical and arid. Winters are mild with practically no snowfall, and the summers are hot. The average length of the growing season between frosts is about 280 days. Average wind velocities are low to moderate except that high gusty winds may accompany thunderstorms, usually occurring during July and August. U. S. Weather Bureau records for nearby stations indicate a long-term average temperature of about 70 degrees Fahrenheit, with the temperature ranging from 17 degrees Fahrenheit in winter to 118 degrees Fahrenheit in summer.

25. Precipitation records.--Precipitation records are available for 18 rainfall stations in and near the Indian Bend Wash drainage area. The only station in the drainage area is in Paradise Valley, with records beginning in 1955. The longest record in the general area is for Phoenix Post Office, with 84 complete years of record during the period 1876-1960, inclusive. Two recording gages are also near the area, the longest record - beginning in 1901 - being also for the Phoenix Post Office.

26. The 90-year mean annual precipitation for stations in the general area with records of more than 5 complete years ranges from 7.26 inches per year at Phoenix Indian School, about 10 miles west of the basin, to 11.71 inches per year at Bartlett Dam, about 15 miles northeast of the headwaters of the basin. The 90-year mean annual precipitation ranges from about 8 inches at the mouth of Indian Bend Wash to about 14 inches in the headwaters, with an average of about $9\frac{1}{2}$ inches for the basin.

27. Storms.--Three types of storms produce rain in the Indian Bend Wash drainage area - general winter storms, general summer storms, and local thunderstorms. The general winter storms, which originate over the Pacific Ocean, are composed of polar Pacific and tropical Pacific air masses moving eastward. Such storms, which occur during the winter, reflect an orographic influence and, though low in intensity, may last several days and cover the entire basin. General summer storms result from an influx of moist tropical air from the Pacific Ocean or from the Gulf of Mexico. These storms approach the Indian Bend Wash drainage area from the south or southeast and produce heavy precipitation on large areas. Such storms reflect some orographic influence. They usually occur during late summer or early fall, and occasionally as early as July or as late as February. Local thunderstorms, which are frequent summer phenomena, cover comparatively small areas and have high rainfall intensities of short duration, usually 3 hours or less.

28. Floods may result from any of the three types of storms. The largest flood on Indian Bend Wash for which an estimate of peak discharge is available (August 1943) occurred as a result of heavy rain from a summer thunderstorm. However, damaging floods of record in adjacent drainage areas have resulted from general winter storms and general summer storms.

29. Runoff data.--No runoff records are available for any streams in the Indian Bend Wash drainage area. A recording stream-gaging station sponsored by the Corps of Engineers was installed by the U. S. Geological Survey in 1961 on Indian Bend Wash, near Scottsdale, $\frac{1}{2}$ mile upstream from the Arizona canal.

FLOODS

30. Floods of record.--Records of discharge measurements for past floods on Indian Bend Wash are limited to the flood of August 1943. The peak discharge of this flood was estimated at 15,000 cubic feet per second at the Arizona canal.

31. However, because floodflows along Indian Bend Wash would be comparable to those along Cave Creek, a contiguous drainage area to the west, the magnitude of past floods on Indian Bend Wash is indicated to some extent by incomplete records of past floods on Cave Creek. Large floods are known to have occurred along Cave Creek in February 1905 and August 1921; small to medium floods in September 1916, November 1919, January 1922, and August 1943; and minor floods in 1935, 1939, 1945, 1951, 1955, 1957, and 1959.

32. Flood characteristics.--Most floods in the Indian Bend Wash basin are of the thunderstorm type that occur unexpectedly, with little time to warn affected communities of impending danger that may result in loss of life and damage to property. However, flooding can also occur from either general summer storms or general winter storms over the area. Duration of flooding from thunderstorms rarely lasts more than a few hours. Little streamflow occurs except immediately following the heavier rains, because climatic and drainage-area characteristics are not conducive to continuous runoff.

33. Because of steep gradients, streamflow in the mountains increases rapidly in response to high-intensity rainfall and causes high-peak debris-laden floods to debouch onto the valley plains below. As the flow reaches the valley plains, it spreads out as overland flow, and a considerable amount of flow is lost to streambed percolation. The stream channels are generally poorly defined and are adequate to accommodate only minor flows. The percentage of impervious area, especially in the lower reaches of the drainage basin, is increasing appreciably because of the urban developments taking place. Vegetation, being sparse, has a negligible effect on flood runoff.

34. Flood frequencies.--Because of the lack of adequate streamflow data for the Indian Bend Wash drainage area, discharge-frequency curves were developed by making adjustments in the discharge-frequency curve for Whitlow Ranch Dam on nearby Queen Creek to reflect differences in drainage-area characteristics. The discharge-frequency curve and more detailed information on its development are included in appendix 4. The estimated frequencies of uncontrolled floods of various magnitudes for Indian Bend Wash at Thomas Road are listed in the following table:

Estimated flood frequencies, Indian Bend Wash at Thomas Road

Number of times that flood would be equaled or exceeded in 100 years	Uncontrolled peak discharges
	Cubic feet per second
0.23	72,000*
1.0	40,000
5.0	19,000
10.0	12,500
20.0	7,600
50.0	2,900
72.0	1,500**

* Standard project flood.
** Nondamaging.

35. Standard project flood.--A standard project flood is an estimated or hypothetical flood that might be expected from the most severe combination of meteorological and hydrological conditions that are considered reasonably characteristic of the geographical region involved, excluding extraordinarily rare combinations. Such a flood could occur in the area considered in this report if a storm equivalent in magnitude to that of the largest storm of record in the general region were to center critically over the drainage area when ground conditions were conducive to a high rate of runoff. The magnitude of such a flood constitutes a reasonable appraisal of the flood-producing potentialities of the wash and is considered a reasonable upper limit in determining the size of the flood for which flood-control improvements might be designed.

36. Estimates of the magnitude of the standard project flood in the area considered in this report are based on calculations of runoff that would result if a storm having characteristics of the August 19, 1954, thunderstorm, which centered over the Queen Creek drainage area, were to center over the Indian Bend Wash drainage area. Detailed information on the determination of the standard project flood is given in appendix 1. The peak discharges of the standard project flood at pertinent points along Indian Bend Wash are given in the following table:

Estimated peak discharges of standard project flood on Indian Bend Wash, Arizona

Location	Peak discharge
	Cubic feet per second
Along Indian Bend Wash:	
At Arizona canal (stream mile 7)	72,000
At Thomas Road (stream mile 3)	72,000
At mouth (excluding tributary flow entering the wash at Van Buren St.)	73,000

EXTENT AND CHARACTER OF OVERFLOW AREA

37. Location and extent.--The overflow area affected by the improvements considered in this report consists of 3,100 acres along Indian Bend Wash from the Arizona canal to Salt River, a distance of about 7 miles. (See pl. 3.)

38. Type and value of property in overflow areas.--The developed areas subject to overflow by floods along Indian Bend Wash include both urban and agricultural improvements. Information on the type and value of improvements in the overflow area considered is given in the following subparagraphs:

(a) The 3,100-acre overflow area along Indian Bend Wash ranges in width from about 2,000 feet at McDowell Road to almost 5,000 feet just downstream from the Arizona canal. In that overflow area, the present value of residential property - although occupying only about 9 percent of the area - is estimated at about 48 percent of the total value in the area. The residential property includes more than 900 homes, ranging in value from $10,000 to $18,000. A similar comparison shows that the present value of agricultural property - although occupying about 48 percent of the area - is estimated at only about 26 percent of the total value. Agricultural property includes land, crops, farm buildings (exclusive of dwellings) and equipment, fences, farm roads, and livestock. Commercial and public developments and utility, street, and highway improvements account for about 18 percent of the value and about 3 percent of the overflow area. About 40 percent of the overflow area is presently undeveloped.

(b) Past growth in the area under consideration, the growth that is now taking place, and forecasts of future growth indicate that future values over the next 100 years will be considerably greater than present values. Analysis was made of (1) population growth studies of the Phoenix urban area, (2) economic analyses and projections for the city of Phoenix and Maricopa County, (3) a comprehensive plan prepared for the town of Scottsdale by the Maricopa County Planning and Zoning Department, and (4) estimates of available space for expansion and of the availability of water supply. Population projections were made for a 50-year period for Maricopa County, the Scottsdale area, and the Indian Bend Wash overflow area. Because of the large growth expected to occur in the area during the next 50 years and the lack of suitable data to predict growth in this area beyond 50 years, it was conservatively assumed, for the purpose of this report, that the development and population would remain constant during the 50- to 100-year period. These analyses indicated that average future values in Maricopa County over the next 100 years (assuming 1961 price levels) for

residential, commercial, public, utility, street, and highway property would be about 115 percent greater than present values. These analyses also indicated that growth in the Scottsdale area would probably exceed the average growth in Maricopa County. It was further conservatively assumed for the purpose of this report that, over the next 100 years, the value of the property indicated above, in the overflow area of Indian Bend Wash, would follow the county pattern. The value of agricultural and undeveloped property will decrease during the period to account for the lands used in the increased development.

39. In order to reflect the 100-year period of development, future values were discounted by the application of present-worth factors. Additional information on the present and considered average future development in the overflow area is given in appendix 4. A summary of the value of property in the overflow area is given in the following table:

Summary of estimated value of property subject to damage by an uncontrolled standard project flood in the overflow area along Indian Bend Wash

Property	Present (1961) value of property	Average future value of property*
Residential	$15,200,000	$32,800,000
Commercial	2,000,000	4,300,000
Public	1,200,000	2,600,000
Farmland and improvements	**8,000,000	**6,200,000
Crops	300,000	200,000
Irrigation works	400,000	400,000
Highways, roads, and streets	1,000,000	2,100,000
Utilities	1,300,000	2,800,000
Undeveloped land	***2,400,000	1,800,000
Total (3,100 acres)	31,800,000	53,200,000

* The value of average future development for period 1961-2060 without additional flood control was discounted by using present-worth factors.

** Reflects the value of agricultural land susceptible to subdivision for urban development.

*** 1,200 acres of undeveloped land under present conditions.

40. Damages from past floods.--No monetary estimates of damages from past floods on Indian Bend Wash are available, primarily because of the lack of major improvements in the overflow area prior to 1950. Since 1950, although developments have increased in the overflow area, only minor damages have been reported. However, the occurrence of damaging floods in nearby drainage areas and the increasing development along Indian Bend Wash have alerted local interests to the need for protection against damage by similar floods in the Indian Bend Wash drainage area. The flood of August 1943 caused considerable damage to the Arizona canal, but no monetary estimate of damage to developments in the overflow areas was made. However, a theoretical study was made of the probable overflow area resulting from a discharge of 15,000 cubic feet per second reported at the Arizona canal for the August 1943 flood. An analysis of damages that would occur from such a flood to both present and estimated future development was then made. It is estimated that the August 1943 flood would cause total damages amounting to $1,050,000 if it were to occur under present conditions, and $1,600,000 if it were to occur under average future conditions.

41. Most of the development along Indian Bend Wash has taken place during the last 10 years. The occupants of that area have not witnessed a storm producing a large damaging discharge along Indian Bend Wash during that time. The largest damaging flood that occurred in recent years in the general area occurred in August 1951 along Trilby Wash, about 20 miles west of Phoenix, Ariz. At that time, a general summer flood with a magnitude of 34,000 cubic feet per second caused damages estimated at $2,850,000 (1951 prices) to a predominantly agricultural area. Since both areas are in the same region of meteorological homogeniety, it is possible and probable that a storm such as the 1951 storm could occur over the Indian Bend Wash area. If that storm had centered over the Indian Bend Wash drainage area, the resultant estimated discharge in Indian Bend Wash at the Arizona canal would have been about 22,000 cubic feet per second, causing damages under present conditions of about $1,800,000.

42. Damages from future floods.--Hydraulic and economic studies were made to determine the effect of floods of various magnitudes on present and future development. In estimating the damage from a single flood, consideration was given to the probable extent of its overflow area; the type and value of property subject to damage; and the extent of damage that would occur to each type of property from floodwaters of computed depth and velocity. The selected flood magnitudes range from a discharge that would cause a small amount of damage to the discharge of the standard project flood. The estimates of damages include physical damages, emergency costs, and business and financial losses that would be caused in the overflow area by floods of various magnitudes.

43. In the following tables are given (a) pertinent information on damages that, under present conditions, would occur to various types of property as a result of the standard project flood on Indian Bend Wash, and (b) a summary of estimates of damages from future floods of various magnitudes in the overflow area.

Estimated damage resulting from a standard project flood along Indian Bend Wash, Arizona

Property	Present (1961) value	Damages based on present (1961) conditions		
		Physical damages	Emergency costs and business losses	Total
Residential	$15,200,000	$2,980,000	$300,000	$3,280,000
Commercial	2,000,000	300,000	80,000	380,000
Public	1,200,000	110,000	11,000	121,000
Farmland and improvements	8,000,000	140,000	14,000	154,000
Crops	300,000	100,000	34,000	134,000
Irrigation works	400,000	70,000	4,000	74,000
Highways and roads	1,000,000	70,000	24,000	94,000
Utilities	1,300,000	30,000	3,000	33,000
Undeveloped land	2,400,000	0	0	0
Total	31,800,000	3,800,000	470,000	4,270,000

Summary of the estimated damages from future floods of various magnitudes along Indian Bend Wash

Flood magnitude	Damages based on present (1961) developments and price levels			Total damages based on present worth of average future developments*
	Physical damages	Emergency costs and business losses	Total	
Cubic feet per second				
**72,000	$3,800,000	$470,000	$4,270,000	$7,060,000
20,000	1,060,000	160,000	1,220,000	1,839,000
8,000	550,000	110,000	660,000	990,000
1,500	0	0	0	0

* For period 1961-2060 without additional flood control (based on 1961 price levels).
** Standard project flood.

Note: Flood magnitudes are measured at Thomas Road.

44. Average annual flood damages.--A curve was drawn showing the relationship between peak discharge and resultant damages under conditions of average future development for the overflow area along Indian Bend Wash. The curve was combined with the discharge-frequency curve described under a preceding heading, "Flood frequencies," to obtain a damage-frequency curve. The discharge-damage curve and the damage-frequency curve are shown on plate 2 of appendix 4.

45. The area under the damage-frequency curve represents the estimated average annual flood damage. The average annual flood damages, based on present and average future value of development, are shown in the following table:

Estimated average annual future damages in the overflow area along Indian Bend Wash, Arizona

	Average annual damages
Under present (1961) development	$330,000
Under average future development	*550,000

* Based on (a) the value of average future development (1961-2060) after discounting by using present-worth factors and (b) 1961 price levels.

46. Intangible flood damages.--In addition to the tangible damages evaluated in this report, serious damages not susceptible of monetary evaluation would result from future floods in the overflow areas considered in this report. Such intangible damages from future floods would result from loss of life; interruption of delivery of water through the Arizona canal, with resultant interruption of deliveries of irrigation water and of deliveries to the Phoenix municipal water system; isolation of the Indian Bend Wash area from the remainder of the metropolitan area of Phoenix; interruption of homelife and school and other normal community activities; and general lowering of community morale.

EXISTING CORPS OF ENGINEERS FLOOD-CONTROL IMPROVEMENTS

47. No existing flood-control project in the Indian Bend Wash drainage area is under the jurisdiction of the U. S. Army Corps of Engineers. The improvements being considered for construction would not be affected by any other improvements in the Gila River basin.

48. However, discharges from the considered improvements would empty into the Salt River channel to be cleared under the existing Corps of Engineers' project for the Gila and Salt Rivers levee and channel improvement. That project, which was authorized by the Flood Control Act of July 14, 1960, would include (a) levees along the Salt River in the vicinity of Phoenix and Tempe, Ariz., (b) a cleared floodway along the Salt and Gila Rivers between Granite Reef and Gillespie Dams, and (c) low-flow or pilot channels along parts of the cleared floodway. (See H. Doc. 279, 86th Cong., 2d sess.)

IMPROVEMENTS BY OTHER FEDERAL AND NON-FEDERAL AGENCIES

49. No improvements for the control of floods in the Indian Bend Wash basin have been constructed by either non-Federal agencies or other Federal agencies. However, the Arizona canal, a unit of the Salt River project that conveys irrigation water from Granite Reef Dam on Salt River to lands north of the river, extends in an east-west direction across the drainage area and intercepts flows not exceeding its capacity. The canal has a capacity of about 2,000 cubic feet per second in the reach between the Evergreen and Indian Bend wasteways. Its capacity to handle floodflows is dependent upon the amount of water in the canal and the ability of operators of the canal to discharge irrigation water into the wasteways at time of floodflows.

IMPROVEMENTS DESIRED

50. Public hearing.--The district engineer held a public hearing at Phoenix, Ariz., on December 9, 1959. The hearing was attended by 178 persons, including interested private citizens and representatives of various agencies of the Federal Government, the State of Arizona, and Maricopa County. The hearing was held to gather information regarding flood control for Phoenix, Ariz., and vicinity, including New River. Indian Bend Wash is in the Phoenix metropolitan area.

51. Improvements desired by local interests.--At the public hearing, local interests, including Maricopa County, the cities of Phoenix and Scottsdale, and the Salt River project (all represented by the Flood Control District of Maricopa County), presented a plan of improvement providing for channelization of Indian Bend Wash.

52. Reasons advanced in justification of improvements desired.--Representatives of local interests stressed the need for control of floods along Indian Bend Wash. Such flood control would (a) prevent inundation of a highly developed residential area in the town of Scottsdale and adjoining areas, (b) prevent interruption of the delivery of irrigation water in the Arizona canal, and (c) prevent interruption of highway and street traffic.

FLOOD PROBLEMS AND RELATED PROBLEMS

53. A serious flood problem exists along Indian Bend Wash, especially downstream from the Arizona canal, because of the inadequate capacity of the stream channel. Because the area is developing rapidly, future floodwaters could cause recurrent damage of much greater proportions to land and improvements along the wash than formerly occurred. Damage would be caused principally by inundation and by debris deposition. Most of the damage would occur to residential and business property. However, considerable damage also would occur to agricultural, irrigation, public, highway, and utility properties. Water-conservation problems or other problems related to flood problems are not of sufficient magnitude to warrant detailed investigation in connection with this flood-control survey.

PLANS OF IMPROVEMENT CONSIDERED

54. General.--Because of a lack of suitable reservoir sites and because of high evaporation rates and relatively low average annual rainfall, no consideration was given to a Federal multiple-purpose project providing for water conservation, hydroelectric power, fish and wildlife development, or recreational development in addition to flood control. However, interruption of delivery (via the Arizona canal) of water diverted at Granite Reef Dam because of damages to the canal in and adjacent to the Indian Bend wasteway would be prevented by operation of the recommended improvements.

55. Consideration was given to the construction of detention basins. However, a reservoir located just upstream from the Arizona canal would involve excessive rights-of-way costs and a high cost of dam construction. A reservoir located above the presently developed area would not provide an adequate degree of control of floods along Indian Bend Wash downstream from the Arizona canal.

56. Plan proposed by local interests.--The plan proposed by local interests for the protection of lands along Indian Bend Wash provides for a channel extending for about 16 miles generally along Indian Bend Wash from a point in the vicinity of Bell Road (an east-west road about 4 miles north of Shea Blvd.) and 48th Street to the confluence with the Salt River.

57. Plans considered.--Two plans of improvement were considered for the protection of the area. The recommended plan of improvement provides for the construction of a channel improvement along Indian Bend Wash from the Arizona canal to the Salt River. Channelization of Indian Bend Wash north of the Arizona canal to Bell Road was considered but could not be economically justified. The alternative plan considered would have provided for the interception of Indian Bend Wash flows and the diversion of these flows in a southeasterly direction to the Salt River.

58. Indian Bend Wash channel improvement (recommended plan).--The Indian Bend Wash channel improvement meets the needs for flood control in the Scottsdale area, as expressed by local interests. The major feature of the recommended plan (see pl. 3 of main report and pls. 1, 2, and 3 of appendix 2) would be a concrete-lined channel about 7 miles long, starting at the Arizona canal and extending in a southerly direction to the Salt River. The design flood of 40,000 cubic feet per second would be controlled by the improvement.

59. Two earth levees would be required just upstream from the Arizona canal to collect and direct the floodwaters toward the channel. The levees would be designed so as not to be overtopped by a standard project flood. The Arizona canal would be

siphoned under the channel improvement by means of a box culvert, about 700 feet long, comprising 4 - 11 by 11 feet barrels. The capacity of the siphon would be 2,000 cubic feet per second. A gated structure would be provided at the head of the siphon to control canal flows. The headworks could be regulated to completely stop all flow in the canal past that point and shunt it through a gated wasteway into the Indian Bend Wash channel. The concrete-lined channel would be about 7 miles long and would have a trapezoidal section with a bottom width of 14 feet and side slopes of one vertical on 2¼ horizontal. The depth of the channel would vary from 23.5 feet to 26.5 feet. The channel would be excavated entirely below the natural ground. At the downstream end, an outlet transition consisting of a leveed channel section would be provided to direct the flows into the proposed cleared channel of the Salt River and to dissipate energy. The levees in the transitions would be revetted on the channel side. The bottom of the outlet transition would be paved with stone.

60. Bridges would be provided at Camelback Road, Indian School Road, Thomas Road, McDowell Road, and Van Buren Street. All sewer, water, gas, electric, and other utility lines interfering with the construction would be relocated. A restrictive easement would be required for all lands between elevation 1,290 feet and the collection levees in the area north of the Arizona canal to provide for ponding of water during design flood conditions. Permanent rights-of-way would be required for the collecting levees. Rights-of-way required for the channel section would vary from 170 feet to 180 feet in width.

61. Indian Bend Wash diversion levee (alternative plan considered).--Consideration was also given to a plan involving the diversion of floodflows above the Arizona canal from Indian Bend Wash southeasterly to the Salt River. The improvement would consist of an earthfill levee about 11 miles long and about 16 feet high above the natural ground surface. The levee would cross the Arizona canal about 1,600 feet upstream or easterly of the Evergreen wasteway and would deliver flow to the Salt River just upstream from that point. Standard project flows, ranging from 55,000 cubic feet per second at the upstream end to 72,000 cubic feet per second at the lower end of the levee, would be intercepted and diverted to the Salt River. In order to accommodate these flows behind the levee, a floodway width varying from 2,200 feet to 2,400 feet would be required. A bridge for the Phoenix-Payson-Beeline Highway and six road ramp crossings of the levee would be provided.

62. Preliminary considerations indicated that this plan might be superior to the recommended plan. Preliminary estimates indicated that the cost of this alternative plan would be $4,600,000 (November 1961 prices), of which $2,400,000 would be for construction, $1,500,000 for rights-of-way, and $700,000 for relocations of utilities, highways, and irrigation facilities. Average annual benefits were estimated at $630,000, of which $495,000 would accrue along Indian Bend Wash and $135,000 in the Evergreen area to the east of Indian Bend Wash. Average

annual charges were estimated at $184,000 and the benefit-cost ratio was computed at 3.4 to 1. However, a large portion of the length of the diversion levee would have been located on lands within the Salt River Pima-Maricopa Indian Reservation, just uphill from the Arizona canal. When the alternative plan was presented to local interests, strong objections were raised by the Salt River Pima-Maricopa Indian Tribe and by the Bureau of Indian Affairs, as follows:

(a) The levee proposed under the alternative plan would dissect an area proposed by the Pima-Maricopa Tribe for future development. (A master plan has since been developed for the area, embracing residential and commercial developments.) The Pima-Maricopa Community Council believes that the diversion levee and the required easements for its floodway (about 1/2 mile wide) would impair the reservation lands so that the development plan would not be workable.

(b) The Pima-Maricopa Community Council stated that the adverse effect on their land would be considerably greater than the beneficial effect they would enjoy from flood control if the diversion levee were built. They pointed out that Indian Bend Wash flows originate on lands outside the Indian Reservation and they object to sacrificing their lands to provide protection primarily to non-Indian lands. They indicated that a plan of improvement providing protection to their land should be located upstream from their lands.

(c) The Community Council did not agree with the estimated costs for rights-of-way. They pointed out that the estimated average value per acre for the rights-of-way amounted to about $300, whereas they believed that average values substantially higher than that amount should be applied. They contended that as their development plan materializes (and they felt rather strongly that the plan would be realized) the Indian lands would achieve a value equal to that of desirable land in the Scottsdale area, worth about $3,500 per acre.

(d) Land tenure arrangements in the reservation would complicate the situation. The lands through which the levee and floodway would pass are allotted lands. If the diversion levee were to be built, reallocation of remaining reservation land would have to be made so that individual affected members of the tribe would receive other land allotments of equal value. The ramifications of this problem are very great since most of the desirable land in the reservation has been allotted and most of the remaining land is mountainous.

63. Because of the strong objections raised by the Salt River Pima-Maricopa Indian Tribe and by the Bureau of Indian Affairs, no further consideration was given to the diversion

levee plan. It was recognized that the diversion plan would not be consonant with the proposed developments being planned by the Community Council. An adequate estimate of the justification of the diversion plan would be dependent to a large degree upon the actual costs of rights-of-way. Recognizing the objections of the Indian tribe, it was realized that actual costs for rights-of-way would have to be determined by a Federal court and it is impossible to forecast an equity determination involving Indian land. If the court were to decide the rights-of-way costs were in line with the values estimated by the Indian tribe, the diversion plan would not be as favorable, economically, as the recommended plan. The problem of acquiring necessary easements or rights-of-way without the cooperation of the Indian tribe would become impracticable. Since the recommended plan provides economically feasible protection to the area along the Indian Bend Wash, further detailed studies were restricted to that plan.

MULTIPLE-PURPOSE FEATURES

64. No storage for water conservation was included in project plans. However, the recommended plan is designed in such a way as to allow some floodflows or irrigation return flows to be delivered to existing canals downstream from the Arizona canal.

65. All lands for the project would be supplied by local interests. These lands would be administered by local interests in connection with their operation and maintenance of the project.

ESTIMATES OF FIRST COST AND ANNUAL CHARGES

66. Estimates of first cost.--The estimated first costs of the recommended improvements include expenditures for preauthorization studies; for construction of channel works; for construction, relocation, or modification of roads, utilities, and bridges; and for acquisition of rights-of-way. Estimates of the costs were based on prices prevailing in November 1961. Allowances were made for the cost of engineering, overhead, inspection, and contingencies.

67. Details of the estimated first cost of the improvements under the recommended plan are given in appendix 3 and a summary of these costs is given in the following table:

Estimated first costs of Indian Bend Wash channel improvement (recommended plan) based on November 1961 prices

Plan	Cost
Federal	*$7,250,000
Non-Federal	1,770,000
Total	9,020,000

* Does not include $60,000 expended for preauthorization studies.

68. Estimates of annual charges.--The estimates of annual charges for the improvements considered in this report include (a) interest on the total investment, (b) amortization of the total investment in 100 years, and (c) average annual costs of maintenance and operation. The annual charges were computed using a 2-5/8 percent interest rate. Because the interest rate used is less than the fair rate of return (5 percent) of land in the area, an adjustment was made for the net loss of productivity of land to be used for the improvement.

69. Construction of the recommended improvement is estimated at 2 years. However, benefits would accrue as construction proceeds and no interest on the first cost during construction was charged. Estimates of investment and of average annual charges for the recommended plan are given in the following table:

Estimated investment and average annual charges, Indian Bend Wash channel improvement, recommended plan (based on November 1961 prices)

(a)	Federal first cost and total investment.....	$7,250,000
(b)	Federal annual charges:	
	(1) Interest, 2-5/8 percent on item (a).....	190,300
	(2) Amortization of Federal investment in 100 years at 2-5/8 percent (.00213) times item (a).....	15,400
	(3) Total Federal annual charges.....	205,700
(c)	Non-Federal first cost and total investment.....	1,770,000
(d)	Non-Federal annual charges:	
	(1) Interest, 2-5/8 percent on item (c).....	46,500
	(2) Amortization of non-Federal investment in 100 years at 2-5/8 percent (.00213) times item (c).....	3,800
	(3) Net loss of productivity of land, 2-3/8 percent times $600,000.....	14,250
	(4) Maintenance and operation.....	22,000
	(5) Total non-Federal annual charges.....	86,550
(e)	Total annual charges:	
	(1) Federal.....	205,700
	(2) Non-Federal.....	86,550
	(3) Total annual charges.....	292,250
	(4) (Say).....	292,000

ESTIMATE OF BENEFITS

70. Tangible benefits.--Tangible benefits would accrue from the prevention of primary flood damages under the recommended plan of improvement. The improvement would protect all lands along Indian Bend Wash between the Arizona canal and the Salt River from damages from all floods up to 40,000 cubic feet per second. Only those flows exceeding 40,000 cubic feet per second would cause any damage and these flows would occur only on very rare occasions. On the occurrence of a flow exceeding 40,000 cubic feet per second, the channel would still provide a large degree of protection since only that portion of flow above 40,000 cubic feet per second would cause damage. Within the protected area, average annual damages prevented would amount to about $530,000, which is about 96 percent of the total average annual potential damage. The flood-control channel would also provide an outlet for all storm drainage works which may be constructed by local interests in the area.

71. Benefits resulting from interception of floodwaters for conservation (irrigation) purposes were not considered susceptible of tangible analysis because of the lack of a firm yield and because much of this water is presently being intercepted by the existing canal system. Secondary benefits were not estimated and were not considered in project evaluation.

72. Intangible benefits.--Many benefits not susceptible of monetary evaluation would accrue from the operation of the improvements considered in this report. Such benefits would include reduction of the danger of loss of life from floods. No loss of life has been reported from past floods along Indian Bend Wash, but loss of life has occurred in the Phoenix area. With the high-velocity flows and the increasing development in the overflow area, the danger of loss of life is increasing. Other intangible benefits would result from (a) the prevention of interruption of service from the Arizona canal, which serves the Phoenix domestic water-supply system, as well as agricultural areas; (b) the reduction in the menace of epidemics caused by flood damage to sewer and water systems; (c) the prevention of interruptions to business transactions, to public-utility services, to homelife, and to school and other normal community activities; and (d) the preservation of community morale by reducing the fear of floods in the overflow areas.

73. Summary of benefits.--The average annual benefits that would accrue under the recommended plan of improvement are summarized in the following table. Additional information on the development of such benefits is given in appendix 4.

Estimates of average annual benefits from the Indian Bend Wash channel improvement (recommended plan)

Item	Average annual damages
Without flood-control improvements	$550,000
With flood-control improvements	20,000
Prevented	530,000

74. Summary of economics.--A summary of the economics of the recommended plan of improvement is given in the following table. Secondary and intangible benefits would add weight to the justification. Consideration of such benefits would not change the conclusions or recommendations of this report.

Summary of economics for Indian Bend Wash channel improvement (recommended plan)

Item	Value
Total first cost (November 1961)	$9,020,000
Total annual charges	292,000
Average annual primary benefits	530,000
Benefit-cost ratio	1.8 to 1
Intangible benefits	Large

75. Project formulation.--Construction of the improvements recommended in this report would provide economically feasible protection to an intensely developed residential area along Indian Bend Wash, in and adjacent to Scottsdale, Ariz. The recommended channel improvement would control all floods up to the design flood (40,000 cubic feet per second), which is expected to recur on the average of about once in 100 years. A flood of this magnitude, although only about 56 percent of the standard project flood, is more than 2-1/2 times as large as any known flood of record. The capacity of the channel would be more than 25 times the nondamaging capacity of the existing wash.

76. The design flood was selected on the basis of economic factors and on the desired degree of protection to be provided. The area subject to overflow along Indian Bend Wash is developing very rapidly to residential and commercial occupancy. Control of a flood smaller than a 100-year flood would be undesirable, so long as 100-year control can be justified. The hazards of loss of life and the effects of disruption of community activities on the occurrence of floods are great and support the need for a high degree of protection in the Indian Bend Wash overflow area. Consideration of a design discharge greater than a 100-year flood indicates, however, that increasing the design discharge could not be justified. The capacity of the recommended channel would be exceeded only at very infrequent intervals and residual average annual damages would be very small ($20,000 annually as compared to a total of $550,000 annually - less than 4 percent). Increasing the design discharge beyond 40,000 cubic feet per second could not be justified by these small residual average annual damages. In addition, it was considered that when the diversion works, contemplated by the

Bureau of Reclamation in connection with the Central Arizona project, are built, those facilities would offer additional flood protection to the area subject to damage along Indian Bend Wash. The degree of protection to be provided is considered reasonable in light of present and future development expected in the area.

77. Local interests expressed agreement with the recommended plan in that it meets the needs for flood control in the Scottsdale area; and they considered that the recommended plan would give adequate flood protection to the area. In addition, they felt that because of the infrequency of overflow of the recommended channel and the small amount of residual damages, they would not want to spend the larger sums of money needed to build longer bridges for a standard project flood capacity channel; nor would they want to lose the additional acreage of desirable land required for a larger flood-control channel.

78. Control of such floods would prevent about 96 percent of the total average annual damages in the overflow area along Indian Bend Wash between the Arizona canal and the Salt River. However, flows exceeding the design flood would result in average annual damages amounting to $20,000. The recommended improvement would also provide a major outlet for the local storm drainage system.

79. Preliminary consideration indicated that construction of a channel improvement along Indian Bend Wash between Bell Road and the Arizona canal could not be economically justified at this time because of the relatively small development in that area. Also, under present conditions, such an improvement would do little to prevent flood damage because runoff exists as widespread sheetflow along many relatively small washes, concentrating at the Arizona canal. A channel in this reach, without adequate tributary and collecting drains, would therefore have a small effect on reducing flood damages.

80. Such additional information on the recommended plan and considered plan as called for by Senate Resolution 148, 85th Congress, 2d session, adopted on January 28, 1958, is contained in a supplement to this report.

RELATIONSHIP OF RECOMMENDED PLAN TO COMPREHENSIVE BASIN PLAN

81. The recommended improvement, which provides protection to a serious local flood-problem area, would be an integral part of the comprehensive basin plan for the Gila River basin, a unit of the Colorado River basin. It would provide economically justified flood protection along Indian Bend Wash in and adjacent to Scottsdale and permit the stabilization of values within the flood plain. Removal of the flood hazard would permit optimum development in this fast-growing area. The flood problem along Indian Bend Wash is not interconnected with flood problems in other parts of the Gila River basin. Flood magnitudes along Indian Bend Wash are small compared with flood magnitudes along the Salt River and floodflows along both streams are generally not coincident. Floods along Indian Bend Wash rarely cause damages along the Salt River downstream from the mouth of Indian Bend Wash. In addition, the authorized Gila and Salt Rivers levee and channel improvement will improve flow conditions downstream from Indian Bend Wash.

82. The Bureau of Reclamation is now developing preliminary plans for the Central Arizona Project. These plans include an aqueduct from the Colorado River to the Salt River in the vicinity of the Granite Reef Dam. This aqueduct, as presently planned, would traverse the Indian Bend Wash drainage area several miles upstream from the Arizona canal. To provide flood protection to the aqueduct, the Bureau is giving consideration to a levee upstream from the aqueduct to divert flows away from the area. This diversion levee, in addition to providing protection to the aqueduct, would, if and when constructed, provide considerable flood protection to lands located north of the Arizona canal and would also reduce flood peaks downstream (south) of Arizona canal. This protection would be supplemental to the protection provided by the proposed improvement. Without the recommended Indian Bend Wash channel improvement, the diversion channel under consideration by the Bureau of Reclamation would reduce the standard project flood at the Arizona canal from 72,000 cubic feet per second to 64,000 cubic feet per second, which would not, in itself, provide adequate protection to the Scottsdale area.

83. The recommended plan would provide needed flood protection to the Arizona canal, one of the main irrigation canals in the Salt River Valley. Interruption of delivery of irrigation water and domestic water for the Phoenix municipal water system would be lessened considerably with resultant beneficial effects on the economy and morale in the valley.

PROPOSED LOCAL COOPERATION

84. The local cooperation that would be required for the project is based on the requirements of applicable laws. As a requisite to construction of improvements by the United States under the recommended plan, responsible local interests would be required to:

(a) Provide, without cost to the United States, all lands, easements, and rights-of-way necessary for the construction and subsequent maintenance and operation of the project, at a cost estimated at $700,000 (November 1961).

(b) Perform, without cost to the United States, all necessary construction or relocations of highways, roads, bridges, utilities, irrigation and drainage facilities, and all necessary street and irrigation-facility modifications required in connection with the project, at a cost presently estimated at $1,070,000 (November 1961).

(c) Hold and save the United States free from damages due to the construction works.

(d) Maintain and operate all the works, after completion, in accordance with regulations to be prescribed by the Secretary of the Army.

(e) Prevent any encroachment upon the improved channel that would reduce its flood-carrying capacity.

85. The Board of Supervisors of Maricopa County, Ariz., and the Board of Directors of the Flood Control District of Maricopa County, Ariz., by resolution dated 5 February 1962, indicated a willingness to provide the items of local cooperation listed above. A copy of the resolution is included in appendix 6: Resolution by Local Interests. Available information indicates that the Board of Supervisors of Maricopa County and the Directors of the Flood Control District of Maricopa County, under existing State law and through their taxing authority, are able to meet the specified local-cooperation requirements.

86. The Department of Commerce has informed the Chief of Engineers that Federal-aid highway funds are not available to defray any part of the costs of altering Federal-aid highways for flood-control projects, where local interests are required to assume the cost of such adjustment as part of the local-cooperation requirements.

COORDINATION WITH OTHER AGENCIES

87. The flood problem and possible remedial measures for Indian Bend Wash were discussed with representatives of agencies of Maricopa County, the State of Arizona, and interested Federal agencies.

88. Meetings were held in Phoenix, Ariz., on August 7, 1961, December 19, 1961, and February 2, 1962, to present the proposed plan to local interests and to Federal and State agencies; to ascertain their views; and to insure that the recommended plan would be coordinate with any other plans under consideration.

89. Preliminary plans for Indian Bend Wash diversion levee (the alternative plan considered) were submitted to the Arizona Game and Fish Department and to the U. S. Fish and Wildlife Service. Both agencies agreed that no important fish and wildlife resources were involved, inasmuch as the area is urbanized. After reviewing a draft of this report, each agency came to the same conclusion as above, but also stated that additional benefits could be realized if water could be impounded permanently as part of the project. However, the lack of adequate sites precluded consideration of water impoundment for any of the purposes of the project.

90. Draft copies of this report were submitted to all Federal and State agencies known to have an interest in the investigation. Comments received from those agencies and replies by the U. S. Army Engineer District, Los Angeles, where pertinent, are inclosed in appendix 5. Plans for the recommended improvement do not conflict with the plans of other Federal or non-Federal agencies. A summary of significant comments is given in the following subparagraphs:

(a) The Bureau of Reclamation agreed that the basic plan would provide a much needed improvement for the area. Minor changes in the plan suggested by the Bureau were incorporated into the recommended facilities.

(b) The Bureau of Indian Affairs indicated approval of the general plan of improvement. That agency suggested that a modification of the crossing of the Arizona canal by Indian Bend Wash be considered so that floodwater would not back up the canal to a dangerous elevation on the upstream Indian lands. The design shown in the report should permit floodwaters in the canal to pass into Indian Bend Wash without detrimental effect on the upstream Indian lands. Additional analysis of the problem would be made at the time of later detailed design studies.

(c) The Bureau of Land Management noted that certain lands near the outlet of the proposed Indian Bend Wash channel were withdrawn by Secretarial Order, dated January 25, 1923, for the

Bureau of Reclamation. In response to inquiry by this office regarding those lands, the Bureau of Reclamation stated that they had informed local interests that an easement would be granted when flood-control works are actually instituted.

(d) The National Park Service indicated a desire to make an archeological survey of the area if the project is authorized.

(e) The U. S. Public Health Service noted that the reduction in flooding of lowland areas expected from the proposed flood-prevention measures should result in a reduction in natural aquatic habitats which are favorable for the production of mosquitoes of public health importance. It pointed out that appropriate preventative and control measures should be planned and built into the project and continued as a part of the regular operation to prevent the development of man-made aquatic habitats highly favorable for the production of mosquitoes. The Service recommended certain principles and practices in the design, construction, operation, and maintenance of the proposed project to minimize conditions which would increase populations of mosquitoes of public health importance. These recommendations would be considered in later detailed design studies and during construction of the project.

(f) The Bureau of Public Roads affirmed the statement in the report that Federal-aid highway funds are not available for use on highways or bridges built or reconstructed as part of the local-cooperation requirements.

(g) The representative of the Governor of Arizona for flood-control matters stated that the Arizona Game and Fish Department, as indicated above, is not concerned with the project as proposed since fish and wildlife benefits will not be realized. He concurred with the recommendations of the district engineer, since the project meets the needs for flood control in the Scottsdale area as expressed by local interests, and since the project has been found to be economically feasible.

CONCLUSIONS

91. The district engineer concludes that:

(a) A serious flood problem exists along Indian Bend Wash where intensively developed urban areas are subject to damage by floods.

(b) The danger of loss of life and of menace to health is great.

(c) Economically feasible protection can be provided by the construction of a channel improvement along Indian Bend Wash from the Arizona canal to the Salt River designed to accommodate a discharge of 40,000 cubic feet per second. This proposed plan of improvement would prevent about 96 percent of the potential damages in the area.

(d) The total first cost of the recommended improvement is estimated at $9,020,000 (November 1961 prices). Based on estimates of average annual charges of $292,000 and average annual tangible primary benefits of $530,000, the benefit-cost ratio is indicated to be 1.8 to 1.

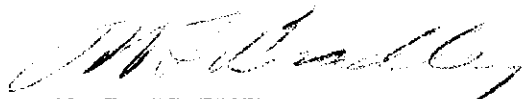
(e) The recommended improvement is feasible from an engineering standpoint, is well justified by the tangible primary benefits alone, and is further justified by significant intangible benefits.

RECOMMENDATIONS

92. The district engineer recommends:

(a) That the United States adopt a project for the control of floods along Indian Bend Wash in the vicinity of Scottsdale, Ariz., at an estimated total first cost of $9,020,000 (November 1961), and an average annual cost of $22,000 for operation and maintenance.

(b) That construction of the recommended improvement at a total estimated cost to the United States of $7,250,000 (November 1961), be subject to the condition that local interests furnish assurances satisfactory to the Secretary of the Army that they will: (1) provide free of cost to the United States all lands, easements, and rights-of-way necessary for the construction and subsequent maintenance and operation of the project at a cost estimated at $700,000 (November 1961); (2) perform, without cost to the United States, all necessary construction or relocations of highways, roads, bridges, utilities, irrigation and drainage facilities, and all necessary street and irrigation-facility modifications required in connection with the project at a cost estimated at $1,070,000 (November 1961); (3) hold and save the United States free from damages due to the construction works; (4) maintain and operate all works, after completion, in accordance with regulations to be prescribed by the Secretary of the Army at an average annual cost estimated at $22,000; and (5) prevent any encroachment upon the improved channel that would reduce its flood-carrying capacity.



6 Appendixes
(See table of contents)

W. T. BRADLEY
Colonel, Corps of Engineers
District Engineer

SPDGP (15 Apr 62) 1st Ind
SUBJECT: Interim Report on Survey for Flood Control, Indian Bend Wash, Gila River Basin, Ariz.

U S Army Engr Div, South Pacific, San Francisco, Calif 16 Nov 1962

TO: Chief of Engineers

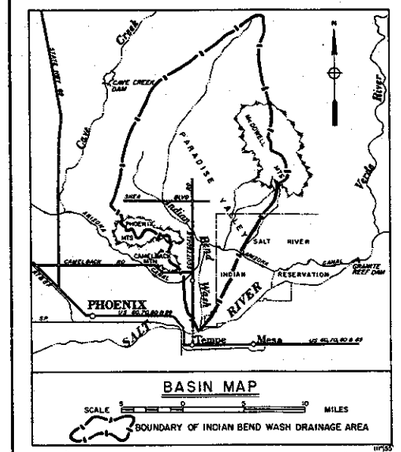
I concur in the conclusions and recommendations of the District Engineer.

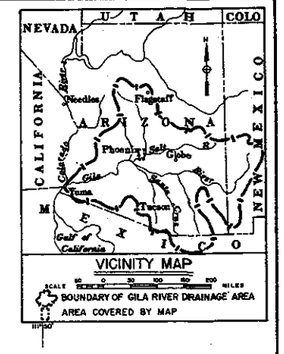
6 Incl
n/c

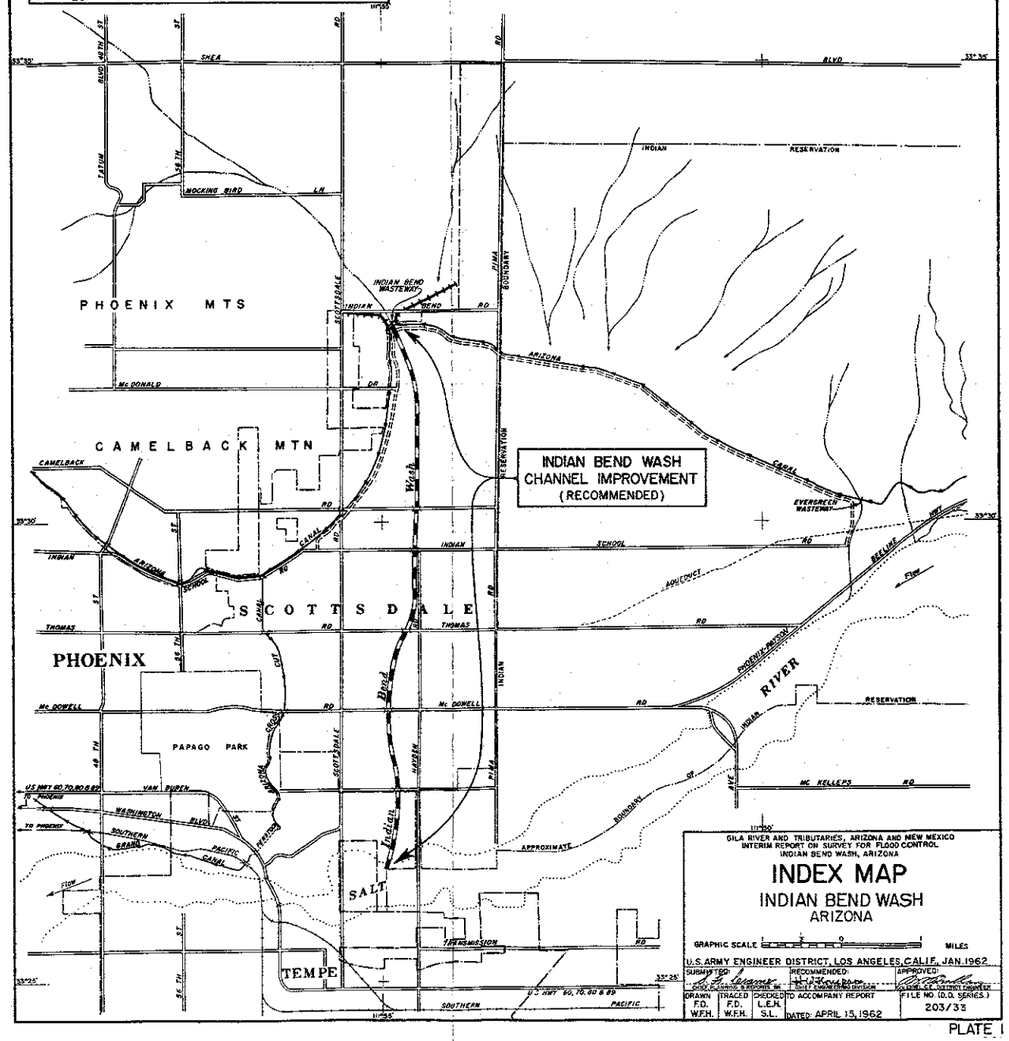
ARTHUR H. FRYE, JR.
Brigadier General, U. S. Army
Division Engineer

U.S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS







GILA RIVER AND TRIBUTARIES, ARIZONA AND NEW MEXICO
INTERIM REPORT ON SURVEY FOR FLOOD CONTROL
INDIAN BEND WASH, ARIZONA

INDEX MAP

INDIAN BEND WASH
ARIZONA

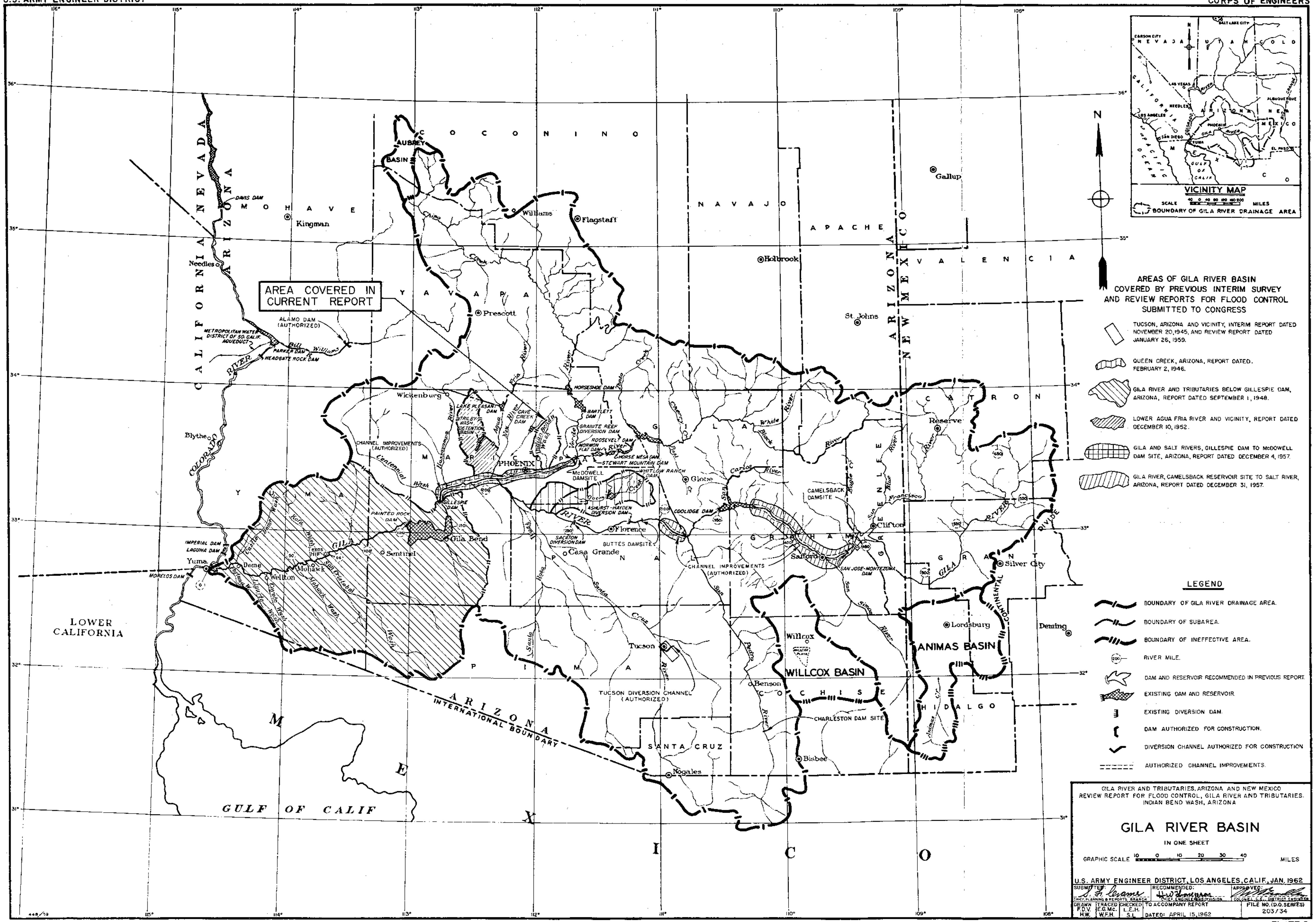
GRAPHIC SCALE 1 0 1 MILES

U.S. ARMY ENGINEER DISTRICT, LOS ANGELES, CALIF. JAN. 1962

SUBMITTED:	RECOMMENDED:	APPROVED:
Chief, Planning Branch	Chief, Engineering Division	Colonel, C.E., District Engineer

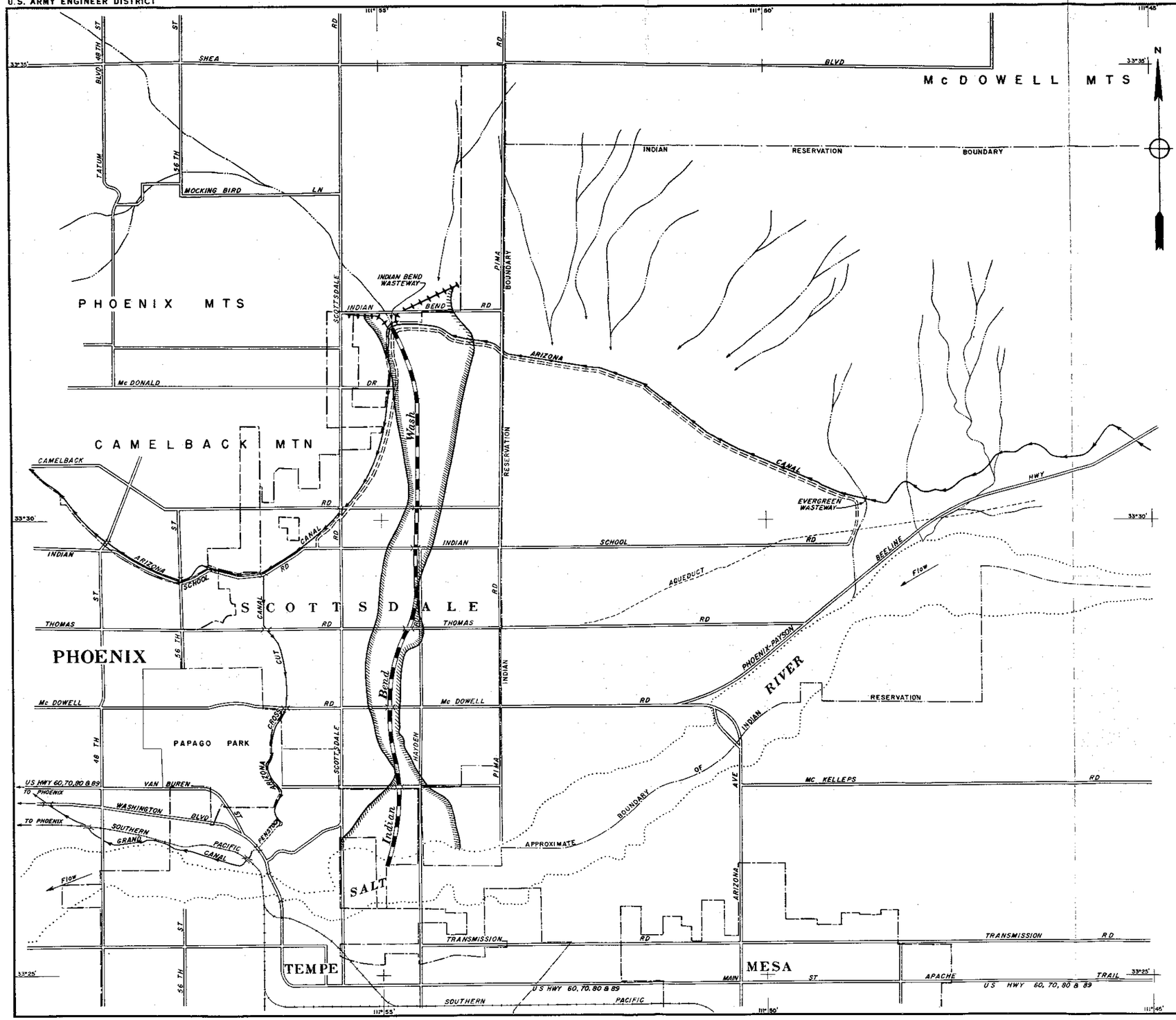
DRAWN	TRACED	CHECKED	TO ACCOMPANY REPORT	FILE NO. (D.O. SERIES)
F.D. W.F.H.	F.D. W.F.H.	L.E.H. S.L.	DATED APRIL 15, 1962	203/33

PLATE I


VICINITY MAP
BOUNDARY OF GILA RIVER DRAINAGE AREA
AREAS OF GILA RIVER BASIN COVERED BY PREVIOUS INTERIM SURVEY AND REVIEW REPORTS FOR FLOOD CONTROL SUBMITTED TO CONGRESS
TUCSON, ARIZONA AND VICINITY, INTERIM REPORT DATED NOVEMBER 20, 1945, AND REVIEW REPORT DATED JANUARY 26, 1959.
QUEEN CREEK, ARIZONA, REPORT DATED FEBRUARY 2, 1946.
GILA RIVER AND TRIBUTARIES BELOW GILLESPIE DAM, ARIZONA, REPORT DATED SEPTEMBER 1, 1948.
LOWER AGUA FRIA RIVER AND VICINITY, REPORT DATED DECEMBER 10, 1952.
GILA AND SALT RIVERS, GILLESPIE DAM TO McDOWELL DAM SITE, ARIZONA, REPORT DATED DECEMBER 4, 1957.
GILA RIVER, CAMELSBACK RESERVOIR SITE TO SALT RIVER, ARIZONA, REPORT DATED DECEMBER 31, 1957.
LEGEND
BOUNDARY OF GILA RIVER DRAINAGE AREA.
BOUNDARY OF SUBAREA.
BOUNDARY OF INEFFECTIVE AREA.
RIVER MILE.
DAM AND RESERVOIR RECOMMENDED IN PREVIOUS REPORT.
EXISTING DAM AND RESERVOIR.
EXISTING DIVERSION DAM.
DAM AUTHORIZED FOR CONSTRUCTION.
DIVERSION CHANNEL AUTHORIZED FOR CONSTRUCTION.
AUTHORIZED CHANNEL IMPROVEMENTS.
AREA COVERED IN CURRENT REPORT
COCONINO
MOHAVE
YAVAPAI
NAVAJO
APACHE
VALENCIA
CATRON
GILA
MARICOPA
YUMA
PINAL
PIMA
GRAHAM
GREENLEE
GRANT
COCHISE
HIDALGO
SANTA CRUZ
CALIFORNIA
NEVADA
ARIZONA
NEW MEXICO
LOWER CALIFORNIA
MEXICO
GULF OF CALIF
AUBREY BASIN
WILLCOX BASIN
ANIMAS BASIN
Kingman
Williams
Flagstaff
Gallup
Holbrook
St. Johns
Needles
Prescott
Wickenburg
Blythe
PHOENIX
Globe
Reserve
Clifton
Safford
Silver City
Florence
Casa Grande
Gila Bend
Sentinel
Yuma
Dome
Wellton
Mohawk
Tucson
Willcox
Benson
Bisbee
Nogales
Lordsburg
Deming
DAVIS DAM
PARKER DAM
HEADGATE ROCK DAM
ALAMO DAM (AUTHORIZED)
METROPOLITAN WATER DISTRICT OF SO. CALIF. AQUEDUCT
IMPERIAL DAM
LAGUNA DAM
MORELOS DAM
PAINTED ROCK DAM
GILLESPIE DAM
LAKE PLEASANT DAM
CAVE CREEK DAM
HORSESHOE DAM
BARTLETT DAM
GRANITE REEF DIVERSION DAM
ROOSEVELT DAM
MORMON FLAT DAM
HORSE MESA DAM
STEWART MOUNTAIN DAM
McDOWELL DAMSITE
WHITLOW RANCH DAM
ASHURST-HAYDEN DIVERSION DAM
SACATON DIVERSION DAM
BUTTES DAMSITE
COOLIDGE DAM
CAMELSBACK DAMSITE
SAN JOSE-MONTEZUMA DAM
CHANNEL IMPROVEMENTS (AUTHORIZED)
TUCSON DIVERSION CHANNEL (AUTHORIZED)
CHARLESTON DAM SITE
COLORADO RIVER
GILA RIVER
SALT RIVER
SAN PEDRO RIVER
SANTA CRUZ RIVER
SAN CARLOS RIVER
SAN FRANCISCO RIVER
CONTINENTAL DIVIDE
INTERNATIONAL BOUNDARY
GILA RIVER AND TRIBUTARIES, ARIZONA AND NEW MEXICO
REVIEW REPORT FOR FLOOD CONTROL, GILA RIVER AND TRIBUTARIES.
INDIAN BEND WASH, ARIZONA
GILA RIVER BASIN
IN ONE SHEET
GRAPHIC SCALE 10 0 10 20 30 40 MILES
U.S. ARMY ENGINEER DISTRICT, LOS ANGELES, CALIF., JAN. 1962
SUBMITTED: RECOMMENDED: APPROVED:
DRAWN F.D.V. H.W. TRACED E.G.Mc. W.F.H. CHECKED L.E.H. S.L.
TO ACCOMPANY REPORT DATED: APRIL 15, 1962
FILE NO. (D.O. SERIES) 203/34

U.S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS



LEGEND

- BOUNDARY OF AREA SUBJECT TO OVERFLOW.
- RECOMMENDED CHANNEL.
- RECOMMENDED LEVEE.

GILA RIVER AND TRIBUTARIES, ARIZONA AND NEW MEXICO
INTERIM REPORT ON SURVEY FOR FLOOD CONTROL
INDIAN BEND WASH, ARIZONA

OVERFLOW AREA AND RECOMMENDED PLAN OF IMPROVEMENT

GRAPHIC SCALE — IN ONE SHEET — MILES

U.S. ARMY ENGINEER DISTRICT, LOS ANGELES, CALIF. JAN. 1962

SUBMITTED:	RECOMMENDED:	APPROVED:
CHIEF, PLANNING BRANCH	CHIEF, ENGINEERING DIVISION	COLONEL, C.E., DISTRICT ENGINEER

DRAWN	TRACED	CHECKED	TO ACCOMPANY REPORT	FILE NO. I.D.O. SERIES
F.D.	F.D.	L.E.R. S.L.	DATED: APRIL 15, 1962	203/35

PLATE 3

U. S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS

AERIAL PHOTOGRAPH TAKEN MAY 10, 1962

GILA RIVER & TRIBUTARIES, ARIZ. & NEW MEX.
INTERIM REPORT ON SURVEY FOR FLOOD CONTROL
INDIAN BEND WASH, ARIZONA

AERIAL PHOTOGRAPH

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED: APRIL 15, 1962

FILE NO. 203/52

PLATE 4

APPENDIX 1 - HYDROLOGY

INDIAN BEND WASH, ARIZONA
GILA RIVER BASIN, ARIZ. AND N. MEX.

CONTENTS

TABLES

PLATES

H Y D R O L O G Y

INDIAN BEND WASH, ARIZONA
GILA RIVER BASIN, ARIZ. AND N. MEX.

SCOPE

1. This appendix contains descriptions of studies made to determine the standard project flood as required for selected concentration points in the Indian Bend Wash drainage area near Phoenix, Ariz. These floods are pertinent to flood-control planning discussed in the main report. The locations of the concentration points, the boundary of the drainage area, and drainage subareas are shown on plate 1. Locations on Indian Bend Wash for which standard project floods have been determined are listed in the following table:

Concentration point number	Location*	Drainage area
		Square miles
	Indian Bend Wash:	
1	At Salt River near Tempe	203
2	At Van Buren St.	168
3	At Arizona canal	152

*See pl. 1

GENERAL DESCRIPTION OF DRAINAGE AREA

2. Physiographic characteristics.--Indian Bend Wash, a tributary of Salt River, is located in Maricopa County in the central part of Arizona, northeast of Phoenix (see pl. 1). Indian Bend Wash drains into the Salt River about 1-1/2 miles east of the Tempe bridge and is the principal drainage for Paradise Valley. The drainage area is bounded on the east by the McDowell Mountains, on the north and west by the Cave Creek drainage area, the southwest by the Phoenix Mountains and Camelback Mountain, and on the south by the Salt River. The drainage boundary between Cave Creek and Indian Bend Wash is in some places indistinct. The Arizona Canal, flowing from east to west, runs through the lower part of the area and for low flows acts as a barrier. The mountain area is characterized by rugged terrain and steep gradients, while the lower part of the area is characterized by fairly flat valley land and regular alluvial slopes. Approximately 24 percent of the area is mountainous and the remaining 76 percent is on the alluvial plains where the number of suburban developments is increasing.

3. The drainage area above the considered channel at the Salt River comprises about 203 square miles. A series of variable length, parallel, ephemeral streams descend the slopes of the mountains to the alluvial plains where the watercourses are not well defined and spread out over a large area. The length of the main watercourse is approximately 31 miles. Elevations in the area range from about 4,000 feet above mean sea level at McDowell Peak to approximately 1,160 feet at the Salt River near Tempe. The gradient of the main stream ranges from about 100 feet per mile in the headwaters to about 20 feet per mile at the lower end of the considered channel. The gradient of the headwaters of streams in the McDowell Mountains is about 1,000 feet per mile.

4. The rock materials in the mountains vary widely in character. Fine-grained, coarse-grained, and metamorphosed granites, including gneiss and schist; sandstones, breccias, and metamorphosed sedimentary rocks; and various lava rocks including basalt, andesite, rhyolite, volcanic glass, and white tuff are present. The soils are typical of desert and semidesert regions, being mostly shallow, rocky, and poorly developed. The soils in the mountains are residual. The valley area occupies a broad plain that has been built up from water-deposited soil-forming materials and rock debris. These soils consist of various forms of clays and loams. The soils range from coarse material in the upper part to fine material in the lower part of the area. The soils in the lower foothill and valley areas are alluvial and in some places are fairly well developed.

5. In general, the vegetation is sparse. Cacti grow throughout the area along with other desert shrubs on the fairly level areas at the lower elevations. A few stunted trees, including juniper, paloverde, mesquite, ironwood, and scrub oak, are among the shrubs. The vegetation tends to be thicker along and adjacent to the stream courses. Perennial grasses form a negligible part of the present vegetation, but good covers of annual grasses occur after the winter rains. The natural vegetation is being replaced by suburban development on the alluvial plains.

6. Hydrometeorological characteristics.--The climate is typically desert in character, with short, mild winters and long, hot summers. High diurnal temperature variations are characteristic. A summary of climatological data at Phoenix is given in table 1. The prevailing winds are from the east and are usually light, although severe wind storms occur at rare intervals. The 90-year mean annual precipitation ranges from about 7.8 inches at the Salt River near Tempe to about 14.0 inches in the headwater area with an average of 9.5 inches for the drainage area (see pl. 1). Rainfall is divided about equally between the summer and winter seasons (see table 1).

7. Three types of storms produce precipitation in the Indian Bend Wash area: general winter storms, general summer storms, and local thunderstorms. A brief description of each storm type is given in the following subparagraphs:

(a) General winter storms usually occur during the period from December to March, inclusive. They 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, which often last for several days, reflect orographic influences and are accompanied by widespread precipitation in the form of snow or rain.

(b) General summer storms usually occur during the period from July to September, inclusive. They are associated with an influx of tropical maritime air originating over the Gulf of Mexico or the South Pacific Ocean and entering the area from a southeast to a southwest direction. Usually the influx of tropical air is caused by the circulation about a high pressure area centered in southeastern United States, but occasionally it is caused by remnants of a tropical hurricane. General summer storms are often accompanied by relatively heavy rainfall over large areas for periods up to 24 hours, but showers may continue for as long as 3 days.

(c) Local thunderstorms can occur at any time of the year, either during general storms or as isolated phenomena. However, they are most common during the period from July to September, inclusive, when the basin is frequently covered by moist unstable air originating over the Gulf of Mexico. The storms cover comparatively small areas and result in high-intensity rainfall for durations of 3 hours or less.

8. Runoff characteristics.--Little streamflow occurs except immediately following the heavier rains, because climatic and drainage-area characteristics are not conducive to continuous runoff. Because of steep gradients, streamflow in the mountains increases rapidly in response to high-intensity rainfall and causes high-peak, debris-laden floods to debouch onto the valley plains below. When the flood reaches the valley plains, the debris is deposited as it spreads out as overland flow and a considerable amount of floodwater is lost to percolation. The percentage of impervious area is increasing appreciably with the suburban development taking place in the area. Vegetation, being sparse, has negligible effect on flood runoff.

9. Existing structures.--No major flood control structures are in the Indian Bend Wash drainage area.

10. Precipitation records.--Precipitation records are available for 18 rainfall stations in and near the drainage area of Indian Bend Wash. The longest record is for Phoenix Post Office, which has 84 complete years of record during the period 1876-1960, inclusive. There are two recording gages near the area, of which the longest period is for Phoenix Post Office, beginning in 1901. The areal coverage of precipitation stations is inadequate, as there is only one active station in the area at present. The mean annual precipitation for all stations with at least 5 years of record was determined by the least-squares method. The Tucson station, with a 90-year continuous record, was selected as the base station for extrapolation of stations with short duration to a common 90-year period (see pl. 1). Pertinent data on rainfall stations are given in table 2, and station locations are shown on plate 1.

11. Runoff records.--No runoff records are available for any streams in the Indian Bend Wash drainage area. A recording stream-gaging station sponsored by the Corps of Engineers was installed by U. S. Geological Survey in January 1961 on Indian Bend Wash, near Scottsdale, Ariz., 1/2 mile upstream from the Arizona Canal.

12. Storms and floods of record.--Historical accounts indicate that many damaging floods have occurred in the Gila River basin. Sizeable floods were produced by the general storms of February 1884, February 1891, January 1916, and February-March 1938, but available records and estimates of severity are insufficient for detailed analysis for the considered drainage area. Little or no hydrologic information is available concerning any floods in the drainage area of Indian Bend Wash. General winter storms may cause flooding. Floods generally occur during the summer months when local thunderstorms produce flows in excess of the capacity of the stream channels. Severe local storms and floods occurred in the Phoenix area in 1921, 1935, 1936, 1939, 1943, 1951, 1955, 1956, and 1957. Records for these floods are scarce as are records of other storms that may have occurred in that period. Brief descriptions of the storms and floods of January 1916, July 24-26, 1936, August 3, 1943, August 26-29, 1951, together with the August 19, 1954, storm (southeast of Phoenix) which was used to develop the design hydrology, are described in the following subparagraphs:

(a) Storms and floods of January 1916.--Two general winter storms occurred over the Gila River basin in January 1916. The first storm period extended from January 14-21 and the second from January 25-30. Both storms originated over the Pacific Ocean. Both were centered in the area north of Roosevelt Reservoir, with secondary centers in the Pinal and Santa Catalina Mountains. The later storm had another secondary center in the area tributary to Agua Fria and Hassayampa Rivers. The first storm, which was of

broader areal extent than the second, produced the larger flood. The isohyetal map on plate 2 shows the area distribution of the precipitation which occurred between January 14 and 21. Observed total rainfall at Phoenix for the two storms was only 2.07 inches. Ground conditions were rather severe owing to the occurrence of light rain on January 10-12 and to the presence of snow cover over much of the mountain area.

(b) There are no records of runoff in the Indian Bend Wash drainage area. On the Salt River near Roosevelt (drainage area 4,310 sq. miles) the peak discharge of the first flood was estimated at 100,000 cubic feet per second.

(c) Storm and flood of July 24-26, 1936.--This storm was characterized by showers and thunderstorms caused by an inflow of unstable, moist, tropical air. A strong convergence zone developed over the area with the deepening of a low in western Arizona. Locally heavy showers, causing flash floods, occurred in the vicinity of Camelback Mountain on the 24th. No measurements of this rain are available. The rainfall for July 25-26 in Phoenix was 2.35 inches. On July 26 there was recorded in Phoenix a rainfall intensity for a 5-minute period of 5.16 inches per hour and for a 1-hour period of .97 inches.

(d) No estimates of peak discharge are available for Indian Bend Wash.

(e) Storm and flood of August 3, 1943.--The August 3, 1943, flood was caused by heavy rains resulting from thunderstorms over the desert areas north and east of Phoenix. The Phoenix 24-hour rainfall for August 3 was 2.12 inches.

(f) Runoff was heavy upstream of the Arizona Canal. A series of 22 breaks occurred in the south bank levee of the canal in the vicinity of Indian Bend Wash.

(g) Storm and flood of August 26-29, 1951.--A tropical hurricane entered the mainland of Mexico from the east in the vicinity of Tampico on August 22. Moist air associated with this storm (general summer type) crossed Mexico to the eastern coast of the Gulf of California. This moist air began flowing into southwestern Arizona during the 26th, mostly in the vicinity of Organ Pipe Cactus National Monument. By the morning of the 27th, rainfall had become quite general over southern and central Arizona. Heavy rains spread northward and northeastward to the northern border of Arizona by the 29th. Rainfall continued moderate to heavy from the 27th through the 29th. The storm was most severe east and north of Phoenix, which had a total storm precipitation of 3.85 inches. Heaviest rainfall for the period was 13.55 inches at Crown King and 12.11 inches at Sunflower. About 65 percent of the total storm occurred during a 24-hour period. The storm isohyets are shown on plate 3.

(h) There was considerable flooding in the vicinity of Luke Air Force Base to the northwest of Phoenix and at various places in the principal storm area. No flood estimates are available for Indian Bend Wash.

(i) Storm and flood of August 19, 1954.--Very moist, warm, tropical air that originated over the Gulf of Mexico entered Arizona and New Mexico from the south during the storm period, accompanied by widespread thunderstorm activity. The storm and flood of August 19, 1954, were the most severe of record within the Queen Creek drainage area, approximately 50 miles east-southeast of Phoenix. Rain in the area occurred between 0100 and about 0900 hours on the morning of the 19th of August in the Superstition Mountains and Pinal Mountains areas. The rainfall intensities were high during the first 3 hours of the storm. Light precipitation prevailed generally for another 3 hours. Boyce Thompson South Western Arboretum, located about 4 miles west of Superior, reported the highest rainfall amount of 5.3 inches (most of it falling within 3 hours). Florence Junction, located about 15 miles west of Superior, reported 1- and 6-hour amounts of 1.8 and 4.2 inches, respectively. An estimated 100 square miles of area had over 5 inches of rain and approximately 1,000 square miles had over 1 inch of rainfall. The isohyets of total precipitation are shown on plate 4.

(j) Peak discharge at the gaging station, Queen Creek at Whitlow Ranch damsite near Superior, Ariz. (area, 143 sq. miles), was estimated at 42,900 cubic feet per second. No estimate is available for Indian Bend Wash.

13. Relative magnitude of local storms.--The relative magnitude of recorded local storms is best shown by area-depth and intensity-duration curves (see pl. 5). Curves shown represent the most severe major local storms of record in the general region for which adequate information is available. The curves indicate that the August 19, 1954, storm, which occurred in the Queen Creek basin, is one of the most severe storms of the group as far as area-depth relationships are concerned.

SYNTHESIS OF STANDARD PROJECT FLOOD

14. General.--The standard project flood is described in EM 1110-2-1411. The standard-project-flood discharges presented herein were developed according to instructions given in that manual.

15. Determination of standard project storm.--The standard project storm for the areas above selected concentration points was determined by evaluation of the assumed occurrence of the most severe local storm (thunderstorm) considered reasonably characteristic of the region, critically centered over the pertinent area. Snowmelt was considered a negligible factor, because the most severe local storms occur during the summer.

16. Standard project storm.--The August 19, 1954, thunderstorm that centered generally in the Queen Creek drainage area was determined to be the storm with the most critical precipitation factors that may reasonably be expected to occur over the drainage area. While the storm lasted about 8 hours, local observations during the storm indicated that most of the precipitation fell during a 3-hour period. The assumption was therefore made that the total precipitation amount would fall during a 3-hour period, and the standard project storm was developed accordingly. The further assumption was made that during the prior 3-hour period sufficient rain (say 0.5 to 1.0 inch) to condition the ground for runoff would occur. The method used to determine the areal and time distribution of precipitation is explained in the following subparagraphs:

(a) Precipitation.--Precipitation was obtained from isohyets (see pl. 4) of the August 19, 1954, thunderstorm, transposed and centered over pertinent areas. Depth-duration relationships for the areas above the concentration points are 3.3 inches and 5.0 inches for the maximum 1-hour and 3-hour durations, respectively.

(b) Rainfall-intensity pattern.--The time distribution of rainfall used for this study was based on characteristic patterns for 13 thunderstorms that occurred in Arizona, which varied in length from 3/4 to 3-1/2 hours. A time interval of 30 minutes was selected as the shortest time interval for which rainfall intensities would be required to determine peak discharges. A typical rainfall-intensity pattern is shown on plate 6.

17. Rainfall-runoff relationships.--Available rainfall and runoff records are inadequate for an analysis of rainfall-runoff relationships for the Indian Bend Wash basin. The rainfall-runoff relationships that were adopted for this study were based on information from hydrologic investigations made for other flood-control reports for comparable streams in southwestern United States. Unit hydrographs, rainfall-loss rates, base flow, and overland-flow percolation used to develop the standard project floods are explained in the following subparagraphs:

(a) Unit hydrographs.--The method used to develop unit hydrographs is explained in paragraphs 70-75, inclusive, of the district engineer's report titled "Hydrology, San Gabriel River and the Rio Hondo Above Whittier Narrows Flood-Control Basin with Addendum on the Hydrologic Effect of Diverting Outflow from Whittier Narrows Flood-Control Basin to Los Angeles River Via the Rio Hondo," dated December 20, 1944, and revised July 10, 1946.* The synthetic unit hydrographs used for all subareas were determined by the use of a lag relationship curve (see pl. 7) derived from data developed in studies of several areas in the Gila River basin and in southern California, and an S-graph (see pl. 8) which was developed to apply to regional drainage areas of less than 1,500 square miles in the Gila River basin. The lag for all subareas (except subarea B) was increased by 25 percent, which is conservative, on the basis that there are no definite entrenched channels; therefore, the flow would spread out essentially as sheet flow and the velocity would be reduced (estimates indicate a 50-60 percent reduction). Subarea B is in the developed suburban area and therefore the flow would not spread out as sheet flow. The value of lag and pertinent elements for subareas tributary to the selected concentration points are given in table 3.

(b) Rainfall-loss rates.--The selection of rainfall-loss rates for the Indian Bend Wash drainage area was based on rainfall-loss-rate studies for areas in southwestern United States. As previously stated, a prior 3-hour rain was assumed to have satisfied the expected initial loss. For the mountain areas, a variable-loss rate was assumed for the critical 3-hour period, ranging from 0.65 to 0.20 inch per hour, with an average loss rate of 0.35 inch per hour. The loss rate in the valley area (0.20 inch per hour) was assumed constant during the standard project storm. On the basis of previous studies of probable population increase and resulting urban development during the next 100 years, it was assumed that about 54 percent of the valley area (lower part) would become improved and that 25 percent of the improved valley area would become all-impervious. Therefore, in development of the standard project flood for each concentration point, 25 percent of the assumed improved area of each valley subarea was considered all-impervious and the amounts of effective rainfall (total rainfall minus rainfall loss) were computed accordingly.

(c) Base flow.--Base flow was assumed negligible during the standard project flood.

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*Report was approved by the Chief of Engineers in 2nd Indorsement dated May 12, 1945, and 6th Indorsement dated October 1, 1946, to basic letter dated January 30, 1945, subject: "Hydrology, Whittier Narrows Flood-Control Basin, Los Angeles County Drainage Area, California."

(d) Overland-flow percolation loss.--In addition to precipitation losses, there are losses due to percolation into the alluvial fan areas. In the absence of definitive data for these areas, rates were assumed on the basis of derived estimates for other Arizona areas and comparative soils characteristics. The assumed rates (for valley areas only) are 0.50 cubic foot per second per wetted acre for the upper one-fourth of the area and 0.25 cubic foot per second per wetted acre for the lower three-fourths of the area where the soils are finer textured.

18. Determination of standard project flood.--The standard project flood was determined at each of the selected concentration points by the following procedures: (a) determination of unit-time increments of rainfall for each subarea; (b) determination of effective rainfall by subtraction of loss rate and application of the imperviousness factor; (c) determination of subarea surface-runoff hydrograph by application of subarea synthetic unit-hydrograph values to the effective unit-period rainfall; and (d) determination of total flood hydrograph for the concentration points by channel routing, subtraction of percolation losses and combining subarea hydrographs.

19. The routing of the flood to and through the considered channel was accomplished by the successive average-lag method that is described in EM 1110-2-1408. The travel times are given in table 4.

20. Standard-project-flood peak discharges.--The standard-project-flood peak discharges for the Indian Bend Wash diversion levee (alternative plan considered) were approved by the Chief of Engineers in 2d indorsement dated June 8, 1961, to basic letter dated May 23, 1961, subject: "Gila River and Tributaries, Arizona and New Mexico, Interim Report on Survey for Flood Control, Indian Bend Wash, Arizona." The standard-project-flood peak discharges for the channel improvement (recommended plan) were developed by extending those basic studies. A typical standard-project-flood hydrograph with pertinent data is shown on plate 6.

ADEQUACY OF STANDARD PROJECT FLOOD

21. Because of lack of streamflow records, the adequacy of the standard project flood is best appraised from the magnitude of the factors used in its synthesis. The use of the August 19, 1954, storm transposed to produce the most critical rainfall over the drainage area, as well as the use of a more intense rainfall pattern and comparatively low loss rates, represent a reasonably severe combination of factors. Therefore, the standard project flood as developed is of a magnitude that would be exceeded only on rare occasions.

22. The adequacy of the standard-project-flood peak discharges is further indicated by comparison of those discharges with enveloping curves of peak discharge shown on plate 10. It may be noted that the points that define the enveloping curve of recorded and estimated peaks are for discharges from areas of higher rainfall than Phoenix. (See plate 1 for location.)

Table 1

Summary of climatological data at Phoenix, Ariz., Indian Bend Wash, Ariz.

Month	Temperatures			Precipitation		
	Mean monthly	Record highest	Record lowest	Mean monthly	Maximum monthly	Minimum monthly
	Degrees Fahrenheit	Degrees Fahrenheit	Degrees Fahrenheit	Inches	Inches	Inches
January	51.6	85	17	0.78	3.31	0
February	55.5	88	22	.83	4.64	.02
March	60.4	92	29	.72	4.16	0
April	67.7	104	32	.42	3.36	0
May	75.7	113	42	.15	1.31	0
June	84.9	117	50	.07	.95	0
July	90.4	118	61	.94	6.47	T
August	88.7	115	60	1.06	5.56	.07
September	83.4	118	49	.70	4.23	0
October	71.5	104	36	.49	2.66	0
November	59.7	91	25	.61	3.61	0
December	52.4	88	22	.92	3.94	0
Period of record*	70.2	118	17	**7.73	6.47	0

* 56 years, 1905-60, inclusive.
** Mean annual precipitation.

Note.--Above data from U. S. Weather Bureau climatological data for Phoenix, Ariz.

Table 2

Precipitation stations in and near Indian Bend Wash, Ariz.

Number*	Station**	Elevation	Latitude	Longitude	Period of record		Complete years of record	Computed 90-year mean annual precipitation
					Recording gage	Non-recording gage		
		Feet	Degrees and minutes	Degrees and minutes				Inches
13-P-7....	Phoenix Indian School.	1,115	33-30	112-04	.....	1920-60	21	7.26
13-P-8....	Phoenix Nursery (Phoenix 2).	1,189	33-31	112-03	.....	1905-15	3	.....
13-P-9....	Phoenix Post Office...	1,083	33-27	112-04	1901-60	1876-1960	84	7.53
13-P-10...	Phoenix WB Airport....	1,109	33-26	112-01	1953-60	1933-60	20	7.31
13-P-31...	Alhambra 2 NE.....	1,135	33-31	112-07	.....	1946-60	17	7.89
13-P-36...	Cave Creek Dam.....	1,630	33-43	112-03	.....	1950-60	10	9.65
13-P-37...	Deer Valley.....	1,245	33-35	112-09	.....	1950-60	9	8.37
13-P-48...	Sunnyslope.....	1,316	33-34	112-04	.....	1948-60	.....	.....
14-P-8....	Paradise Valley.....	1,421	33-33	111-58	.....	1955-60	5	.....
14-P-14...	Granite Reef Dam.....	1,325	33-31	111-42	.....	1889-1960	72	9.60
14-P-16...	Wilbur Ranch.....	1,375	33-27	111-43	.....	1924-28	4	.....
14-P-18...	Mesa Experiment Farm..	1,225	33-25	111-52	.....	1896-1960	64	8.03
14-P-26...	Goodyear.....	1,203	33-25	111-52	.....	1918-33	12	8.37
14-P-35...	Tempe.....	1,150	33-26	111-56	.....	1889-1960	34	7.58
14-P-45...	Bartlett Dam.....	1,650	33-49	111-38	.....	1939-60	21	11.71
14-P-47...	Falcon Field.....	1,320	33-26	111-45	.....	1942-60	13	8.23

See footnotes at end of table.

Table 2

Precipitation stations in and near Indian Bend Wash, Ariz.--Continued

Number*	Station**	Elevation	Latitude	Longitude	Period of record		Complete years of record	Computed 90-year mean annual precipitation
					Recording gage	Non-recording gage		
		Feet	Degrees and minutes	Degrees and minutes				Inches
14-P-49...	Tempe U. of A. Citrus Experiment Station.	1,180	33-25	111-58	.....	1943-60	14	7.74
14-P-60...	Camelback.....	1,250	33-29	111-58	.....	1920-60	29	8.00

* Stations numbered in accordance with quadrangle-index system of the U. S. Army Engineer District, Los Angeles, Corps of Engineers.

** See pl. 1 for location.

Note.--Above data, except station number and 90-year mean annual precipitation, obtained from publications of the U. S. Weather Bureau.

Table 3

Lag and pertinent elements, Indian Bend Wash, Ariz.

Subarea*	Drainage area	L	L_{ca}	S	$\frac{L \cdot L_{ca}}{S^{\frac{1}{2}}}$	Lag**
	Square miles	Miles	Miles	Feet per mile		Hours
A	34.6	15.6	8.5	118	12.2	3.6
B	16.3	7.8	3.2	168	1.9	***1.4
C	24.3	11.4	7.1	200	5.7	2.6
D	32.5	14.6	7.9	102	11.4	3.5
E	53.3	19.3	9.5	77	20.8	4.4
F	41.8	17.8	6.7	58	15.6	4.0

* See pl. 1 for location.

** See pl. 7 for lag curve. Lag values have been increased 25 percent which is conservative on the basis that there are no definite entrenched channels; therefore, the flow would spread out essentially as sheet flow and the velocity would be reduced (estimates indicate a 50-60 percent reduction).

*** Not increased 25 percent (in developed suburban area).

Table 4

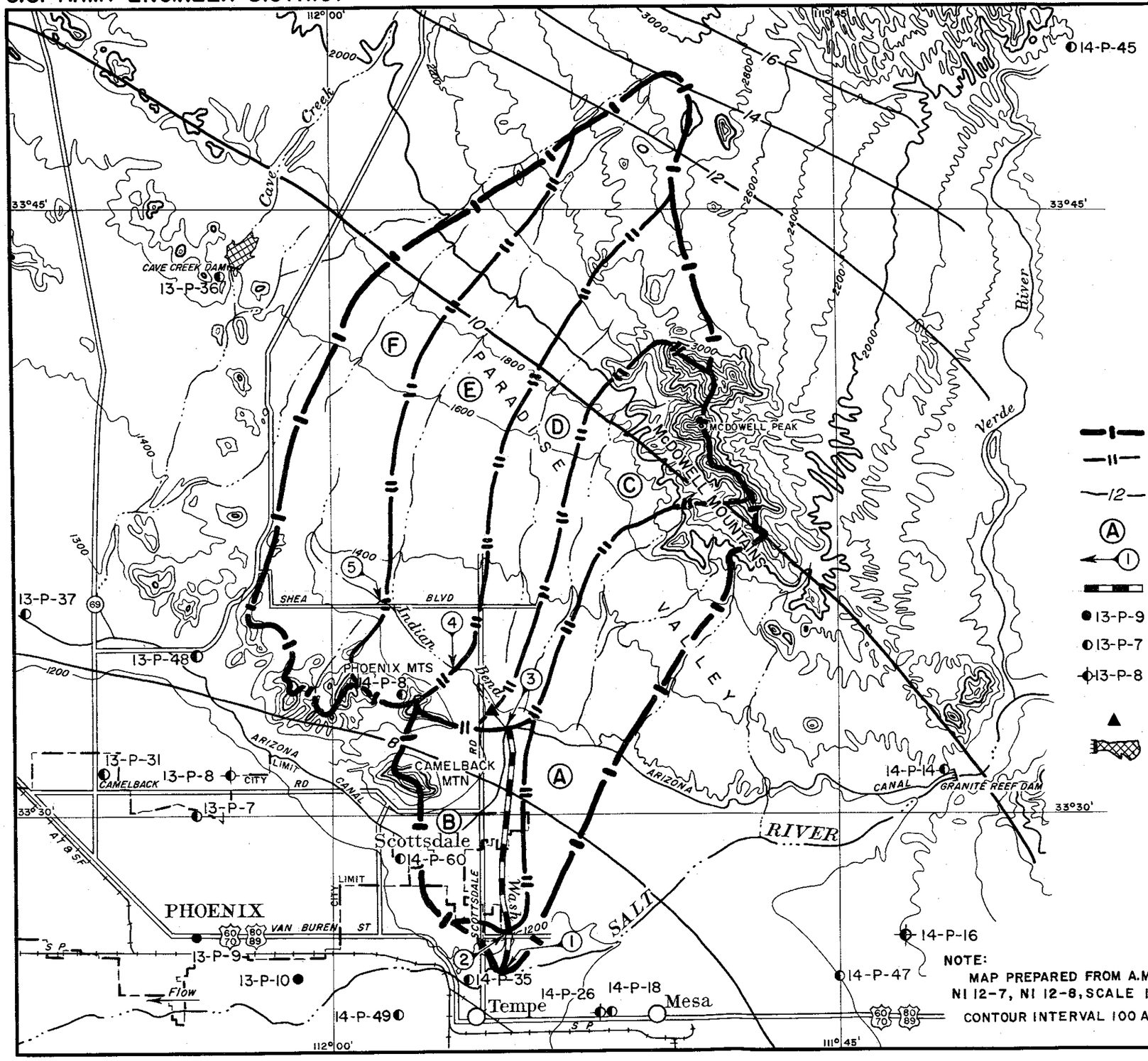
Travel times used for channel routing, Indian Bend Wash, Ariz.

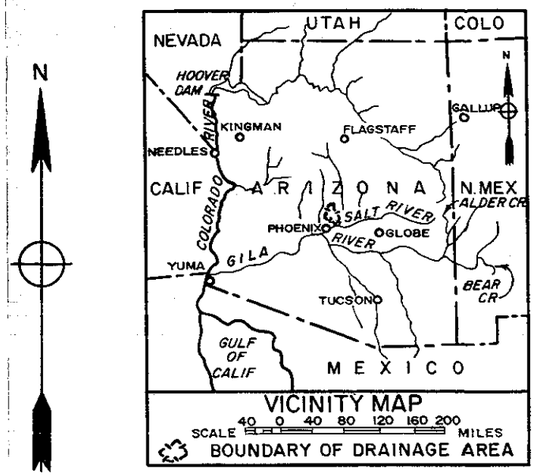
Concentration point number*		Travel time in hours
From	To	
5	4	0.4
4	3	0.5
3	2	1.2
2	1	0.2

* See pl. 1 for location.

U.S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS





N

LEGEND

- BOUNDARY OF DRAINAGE AREA.
- BOUNDARY OF DRAINAGE SUBAREA.
- 12 — LINE OF EQUAL 90-YEAR MEAN ANNUAL PRECIPITATION IN INCHES.
- (A) SUBAREA DESIGNATION.
- (1) POINT OF CONCENTRATION.
- CONSIDERED CHANNEL.
- ● 13-P-9 PRECIPITATION STATION AND NUMBER (RECORDING).
- ◐ 13-P-7 PRECIPITATION STATION AND NUMBER (NON-RECORDING).
- ◐ 13-P-8 PRECIPITATION STATION AND NUMBER. (NON-RECORDING, DISCONTINUED).
- ▲ STREAM-GAGING STATION.
- EXISTING FLOOD CONTROL RESERVOIR.

SCALE 1 0 1 2 3 4 5 MILES

DATUM IS MEAN SEA LEVEL

NOTE:
MAP PREPARED FROM A.M.S. SHEETS NI 12-7, NI 12-8, SCALE 1:250,000.
CONTOUR INTERVAL 100 AND 200 FEET

GILA RIVER & TRIBUTARIES, ARIZ. & NEW MEX.
INTERIM REPORT ON SURVEY FOR FLOOD CONTROL
INDIAN BEND WASH, ARIZONA

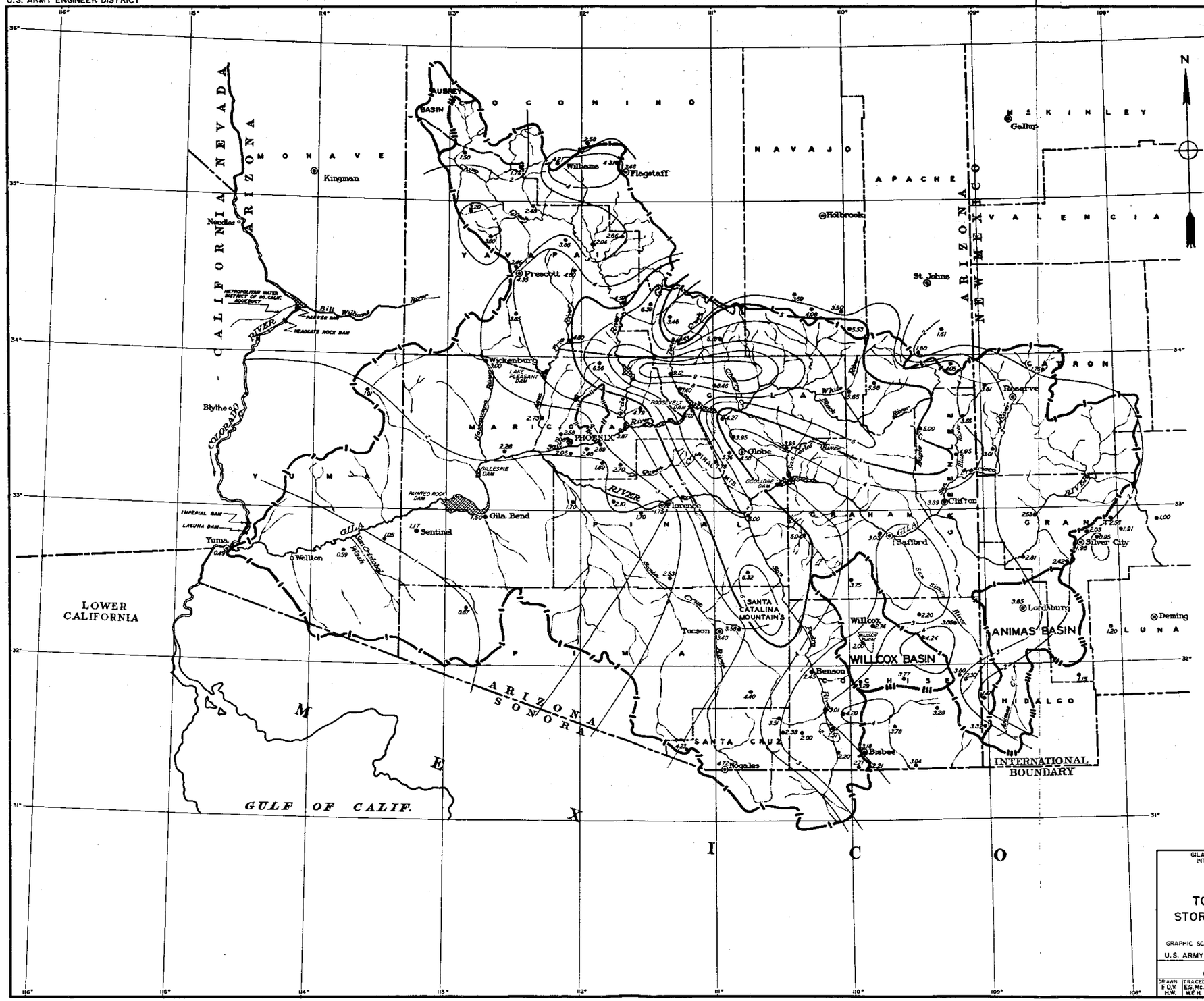
HYDROLOGIC MAP

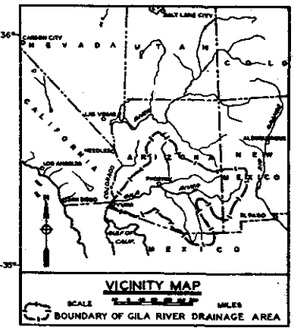
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED: APRIL 15, 1962

FILE NO. 203/39 APPENDIX I PLATE I

U.S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS





LEGEND

- BOUNDARY OF GILA RIVER DRAINAGE AREA.
- BOUNDARY OF INDIAN BEND WASH DRAINAGE AREA.
- BOUNDARY OF INEFFECTIVE AREA.
- 6 — LINE OF EQUAL PRECIPITATION IN INCHES.
- 1.80 PRECIPITATION IN INCHES AND POINT OF OBSERVATION.
- EXISTING DAM AND RESERVOIR.

GILA RIVER AND TRIBUTARIES, ARIZONA AND NEW MEXICO
INTERIM REPORT ON SURVEY FOR FLOOD CONTROL
INDIAN BEND WASH, ARIZONA

ISOHYETS
TOTAL-STORM PRECIPITATION
STORM OF JANUARY 14-21, 1916

IN ONE SHEET

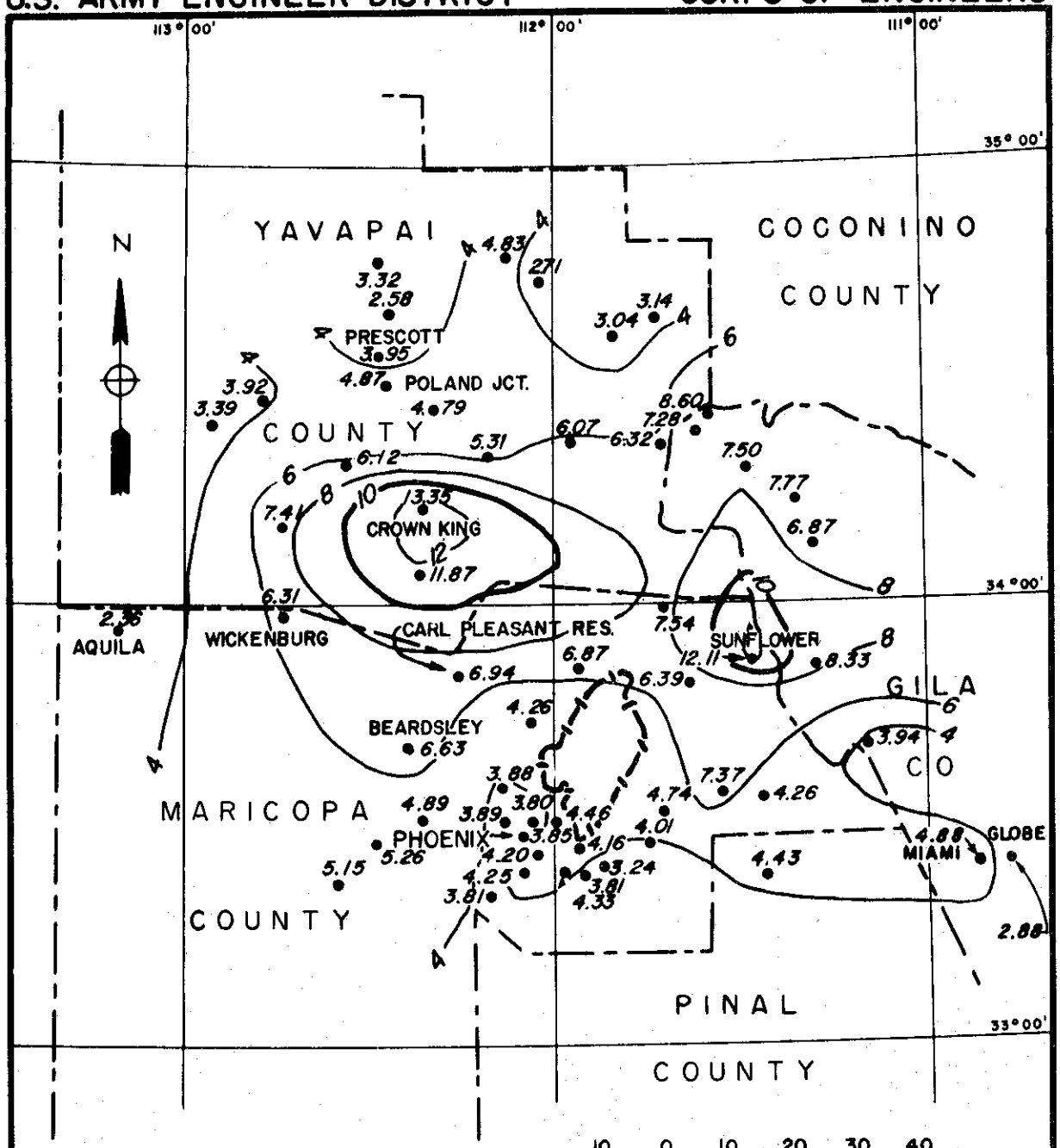
GRAPHIC SCALE 0 10 20 30 40 MILES

U.S. ARMY ENGINEER DISTRICT, LOS ANGELES, CALIF., DEC. 1961

PREPARED UNDER THE DIRECTION OF
W.T. BRADLEY, COL., C.E., DISTRICT ENGINEER

DRAWN	TRACED	CHECKED	TO ACCOMPANY REPORT	FILE NO. (D.O. SERIES)
F.D.V. M.W.	E.G.Mc. W.F.H.	P.C.B. F.E.T.	DATED: APRIL 15, 1962	203/40

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



LEGEND

—1— BOUNDARY OF DRAINAGE AREA.
—8— LINE OF EQUAL PRECIPITATION IN INCHES.
• 6.31 RECORDED PRECIPITATION DEPTH IN INCHES.

GILA RIVER AND TRIBUTARIES, ARIZ, AND NEW MEX.
INTERIM REPORT ON SURVEY FOR FLOOD CONTROL
INDIAN BEND WASH, ARIZ.

ISOHYETS

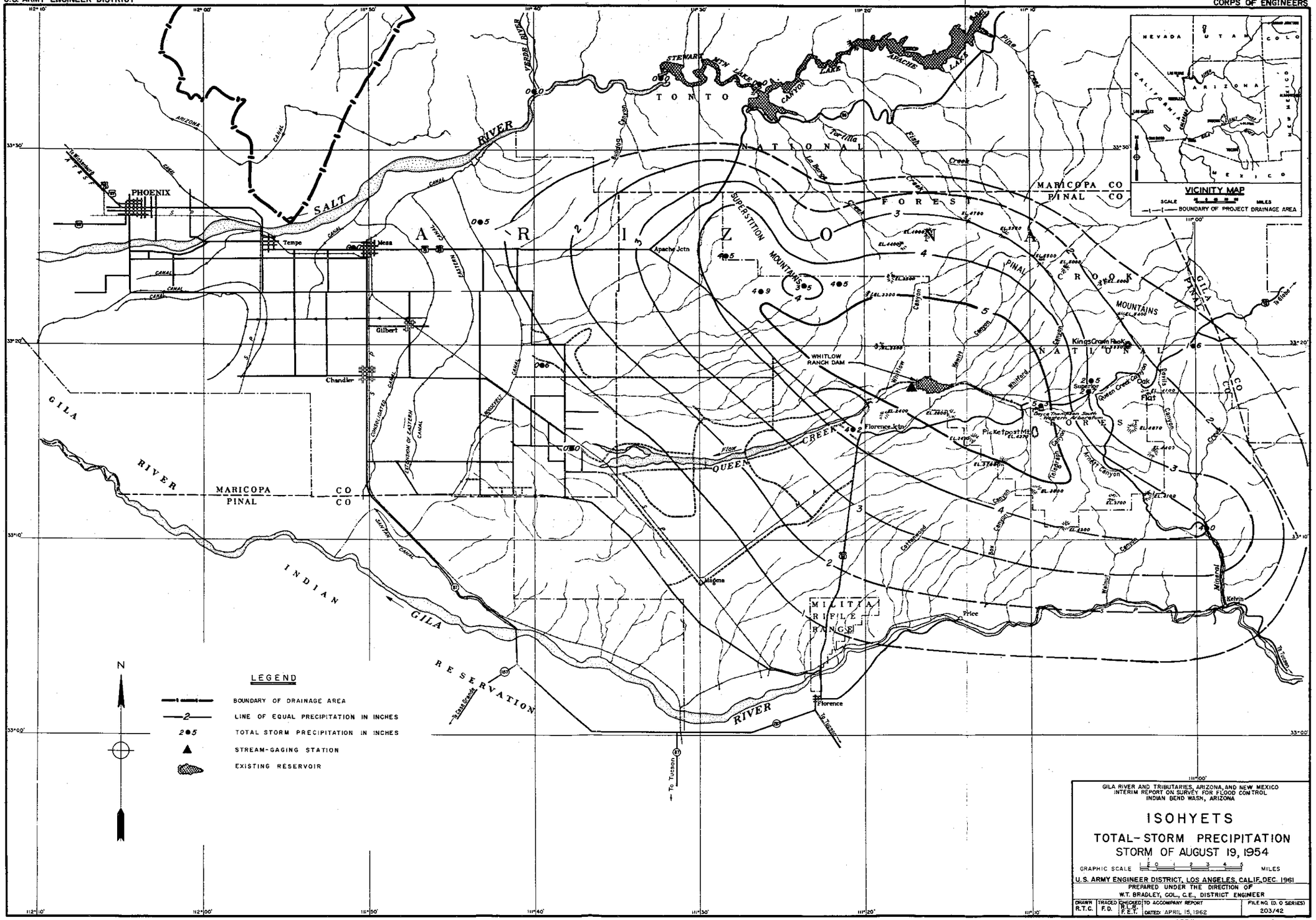
TOTAL-STORM PRECIPITATION
STORM OF AUGUST 26-29, 1951

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED: APRIL 15, 1962

FILE NO. 203/41 APPENDIX I PLATE 3

U.S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS



N

LEGEND

- BOUNDARY OF DRAINAGE AREA
- 2 — LINE OF EQUAL PRECIPITATION IN INCHES
- 2●5 — TOTAL STORM PRECIPITATION IN INCHES
- ▲ — STREAM-GAGING STATION
- EXISTING RESERVOIR

GILA RIVER AND TRIBUTARIES, ARIZONA, AND NEW MEXICO
INTERIM REPORT ON SURVEY FOR FLOOD CONTROL
INDIAN BEND WASH, ARIZONA

ISOHYETS

TOTAL-STORM PRECIPITATION
STORM OF AUGUST 19, 1954

GRAPHIC SCALE 0 1 2 3 4 5 MILES

U.S. ARMY ENGINEER DISTRICT, LOS ANGELES, CALIF. DEC. 1961
PREPARED UNDER THE DIRECTION OF
W.T. BRADLEY, COL., C.E., DISTRICT ENGINEER

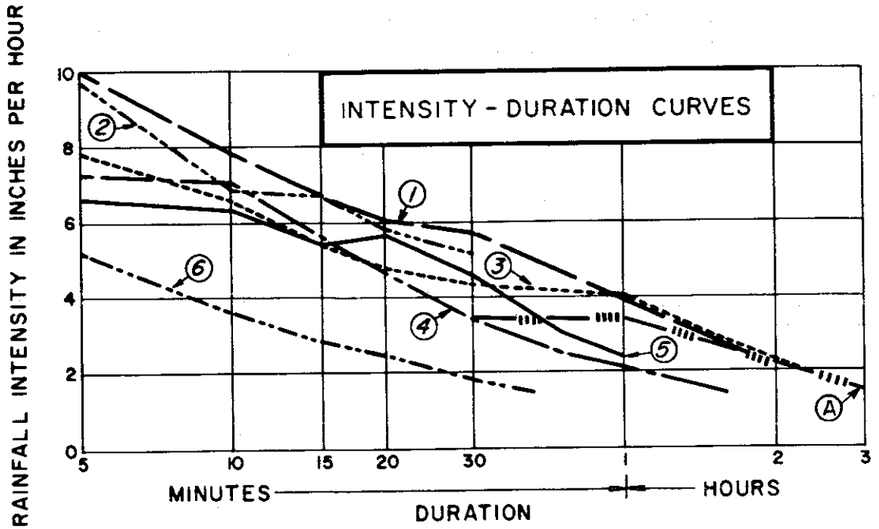
DRAWN	TRACED	CHECKED	TO ACCOMPANY REPORT	FILE NO. (D. O SERIES)
R.T.C.	F.D.	R.L.P. F.E.T.	DATED: APRIL 15, 1962	203/42

APPENDIX I

PLATE 4

U.S. ARMY ENGINEER DISTRICT

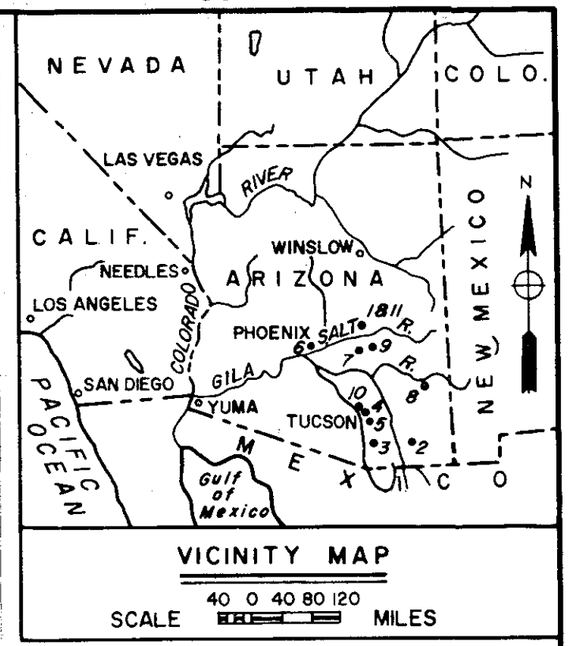
CORPS OF ENGINEERS



NOTE:

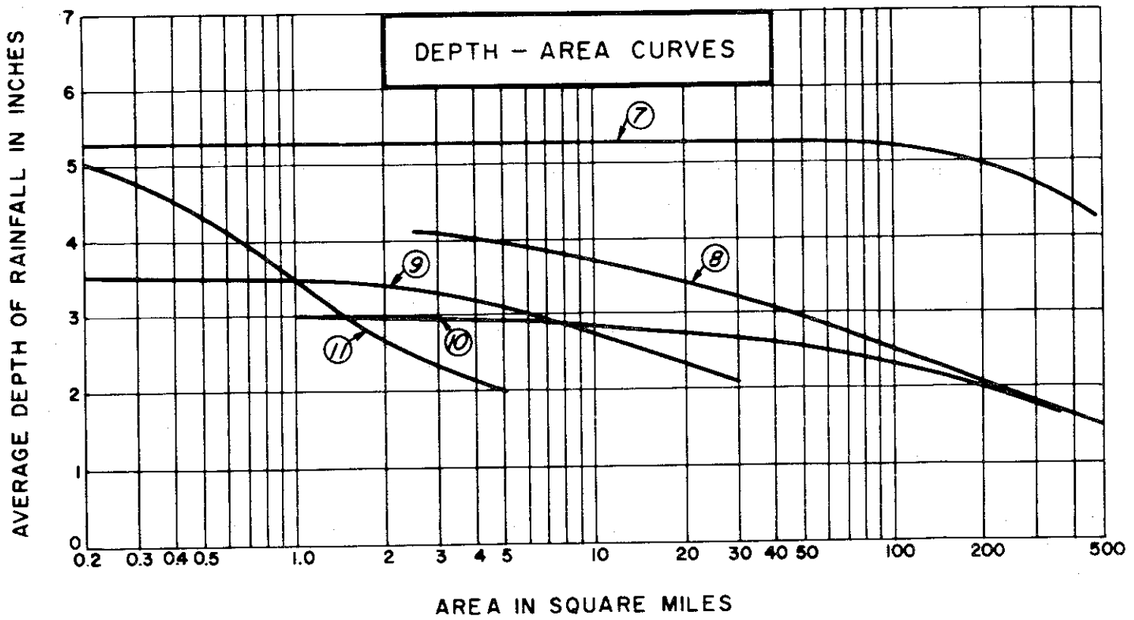
DATA FOR INTENSITY-DURATION CURVES ARE FOR STATIONS WITHIN THE STORM AREA BUT NOT NECESSARILY AT THE STORM CENTER.

(A) STANDARD PROJECT STORM (AVERAGE OVER AREA) ABOVE CONCENTRATION PT. I, INDIAN BEND WASH. (203 SQ. MILES).



VICINITY MAP

SCALE 40 0 40 80 120 MILES



CURVE NO.	STORM LOCATION *	DATE	APPROXIMATE DURATION HRS.	MIN.
1	PARKER CREEK	SEPT. 10, 1933	1	45
2	WALNUT GULCH	OCT. 4-5, 1954	0	30
3	SANTA RITA	JUNE 29, 1959	2	20
4	UNIV. OF ARIZONA	AUG. 13, 1940	1	35
5	TUCSON AIRPORT	SEPT. 24, 1943	1	0
6	PHOENIX	JULY 26, 1936	0	40
7	QUEEN CREEK	AUG. 19, 1954	6	0
8	THATCHER	SEPT. 16, 1939	1	30
9	GLOBE	JULY 29, 1954	1	0
10	TUCSON	SEPT. 24, 1943	3	0
11	PARKER CREEK	AUG. 5, 1939	2	20

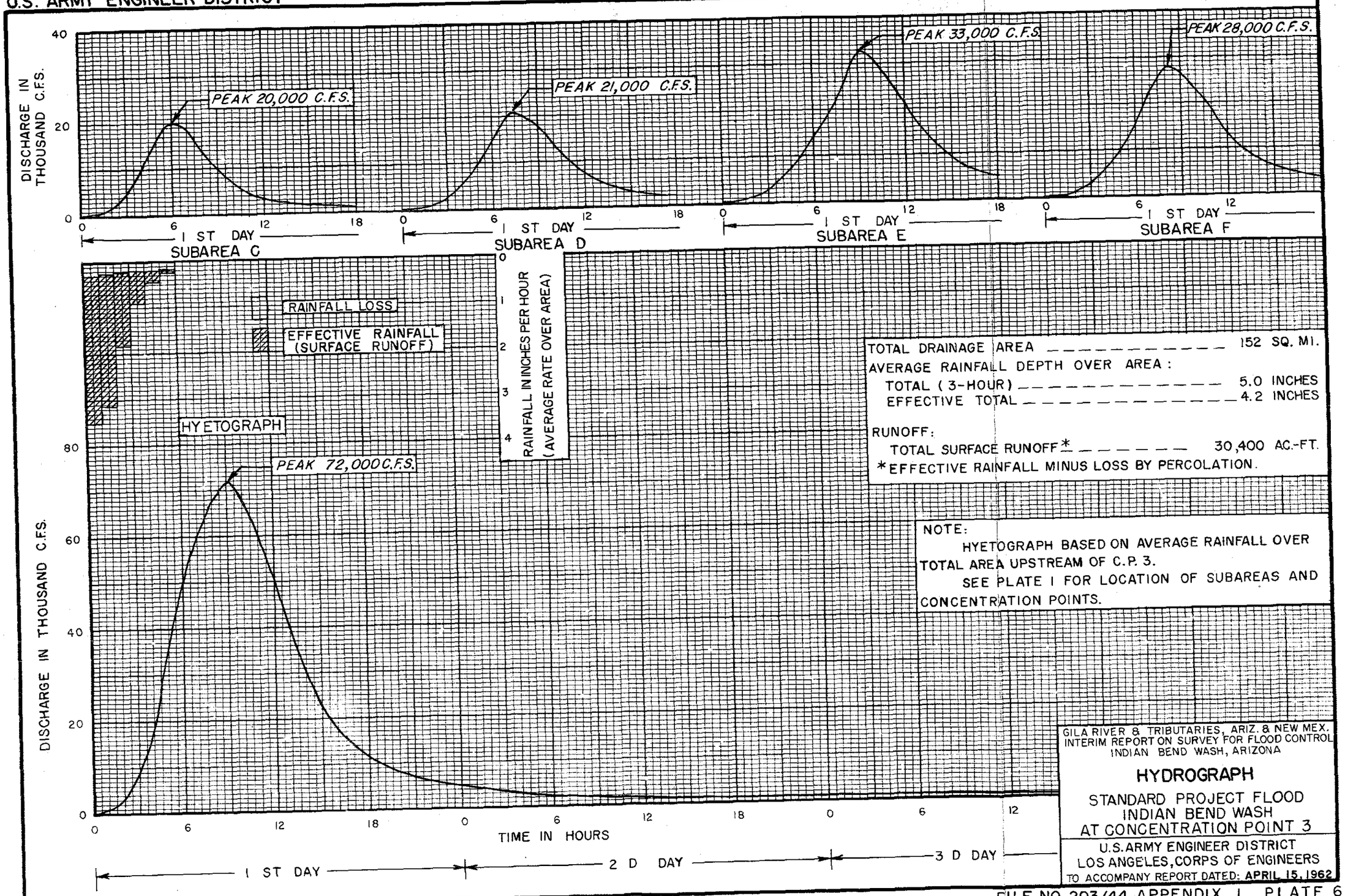
* SEE VICINITY MAP

GILA RIVER & TRIBUTARIES, ARIZ. & NEW MEX.
INTERIM REPORT ON SURVEY FOR FLOOD CONTROL
INDIAN BEND WASH, ARIZ.

INTENSITY - DURATION AND DEPTH - AREA CURVES

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED: APRIL 15, 1962

FILE NO. 203/43 APPENDIX I PLATE 5



TOTAL DRAINAGE AREA	152 SQ. MI.
AVERAGE RAINFALL DEPTH OVER AREA:	
TOTAL (3-HOUR)	5.0 INCHES
EFFECTIVE TOTAL	4.2 INCHES
RUNOFF:	
TOTAL SURFACE RUNOFF*	30,400 AC.-FT.

*EFFECTIVE RAINFALL MINUS LOSS BY PERCOLATION.

NOTE:
HYETOGRAPH BASED ON AVERAGE RAINFALL OVER TOTAL AREA UPSTREAM OF C.P. 3.
SEE PLATE I FOR LOCATION OF SUBAREAS AND CONCENTRATION POINTS.

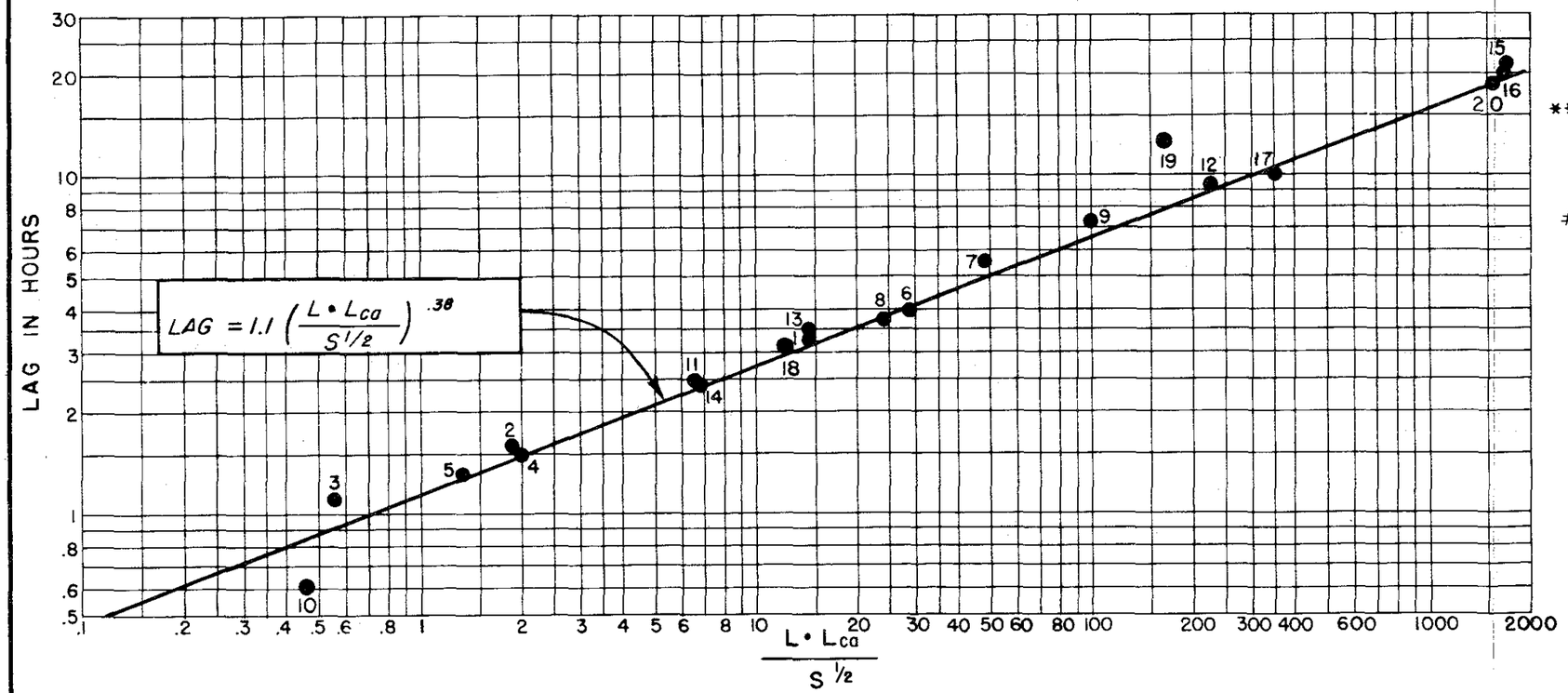
GILA RIVER & TRIBUTARIES, ARIZ. & NEW MEX.
INTERIM REPORT ON SURVEY FOR FLOOD CONTROL
INDIAN BEND WASH, ARIZONA

HYDROGRAPH

STANDARD PROJECT FLOOD
INDIAN BEND WASH
AT CONCENTRATION POINT 3

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED: APRIL 15, 1962

	DRAINAGE AREA SQ. MI.	L MILES	L_{ca} MILES	S FT/MI.	LAG HOURS
1. SAN GABRIEL RIVER AT SAN GABRIEL DAM, CALIF. *	162	23.2	11.6	350	3.3
2. WEST FORK SAN GABRIEL RIVER AT COGSWELL DAM, CALIF.	40.4	9.3	4.2	450	1.6
3. SANTA ANITA CREEK AT SANTA ANITA DAM, CALIF.	10.8	5.8	2.5	690	1.1
4. SAN DIMAS CREEK AT SAN DIMAS DAM, CALIF.	16.2	8.6	4.8	440	1.5
5. EATON WASH AT EATON WASH DAM, CALIF.	9.5	7.3	4.4	600	1.3
6. MURRIETA CREEK AT TEMECULA, CALIF.	220	27.2	10.3	95	4.0
7. SANTA CLARA RIVER NEAR SAUGUS, CALIF.	355	36.0	15.8	140	5.6
8. TEMECULA CREEK AT PAUBA CANYON, CALIF. **	168	26.0	11.3	150	3.7
9. SANTA MARGARITA RIVER NEAR FALLBROOK, CALIF.	645	46.0	22.0	105	7.3
10. EAST FULLERTON CREEK AT FULLERTON DAM, CALIF.	3.1	3.2	1.7	140	0.6
11. TUJUNGA CREEK AT BIG TUJUNGA DAM NO.1, CALIF.	81.4	15.1	7.3	290	2.5
12. SANTA MARGARITA RIVER AT YSIDORA, CALIF.	740	61.2	34.3	85	9.5
13. LOS ANGELES RIVER AT SEPULVEDA DAM, CALIF.	152	19.0	9.0	145	3.5
14. PACOIMA WASH AT PACOIMA DAM, CALIF.	27.8	15.0	8.0	315	2.4
15. GILA RIVER AT CONNER NO. 4 DAM SITE, ARIZ.	2840	131	71	29	21.5
16. SAN FRANCISCO RIVER AT JUNCTION WITH BLUE RIVER, ARIZ. ***	2000	130	74	32	20.6
17. BLUE RIVER NEAR CLIFTON, ARIZ.***	790	77	37	65	10.3
18. SAN VICENTE CREEK AT FOSTER, CALIF.	75	182	7.4	111	3.2
19. SANTA ANA RIVER AT PRADO DAM, CALIF.#	1466	68	26	115	13.0
20. SALT RIVER NEAR ROOSEVELT, ARIZ.	4310	160	66	45	18.6



TERMINOLOGY

L = LENGTH OF LONGEST WATERCOURSE.

L_{ca} = LENGTH ALONG WATERCOURSE, MEASURED UPSTREAM, TO POINT OPPOSITE CENTER OF AREA.

S = OVER-ALL SLOPE OF DRAINAGE AREA BETWEEN HEADWATERS AND COLLECTION POINT.

LAG = ELAPSED TIME FROM BEGINNING OF UNIT RAINFALL TO INSTANT THAT SUMMATION HYDROGRAPH REACHES 50% OF ULTIMATE DISCHARGE.

* EXCLUDES AREA ABOVE COGSWELL DAM.

** PALOMAR MOUNTAIN PORTION. ENTIRE AREA IS 319 SQUARE MILES, OF WHICH 151 SQUARE MILES DID NOT CONTRIBUTE APPRECIABLE FLOOD FLOWS DURING THE FLOODS ANALYZED.

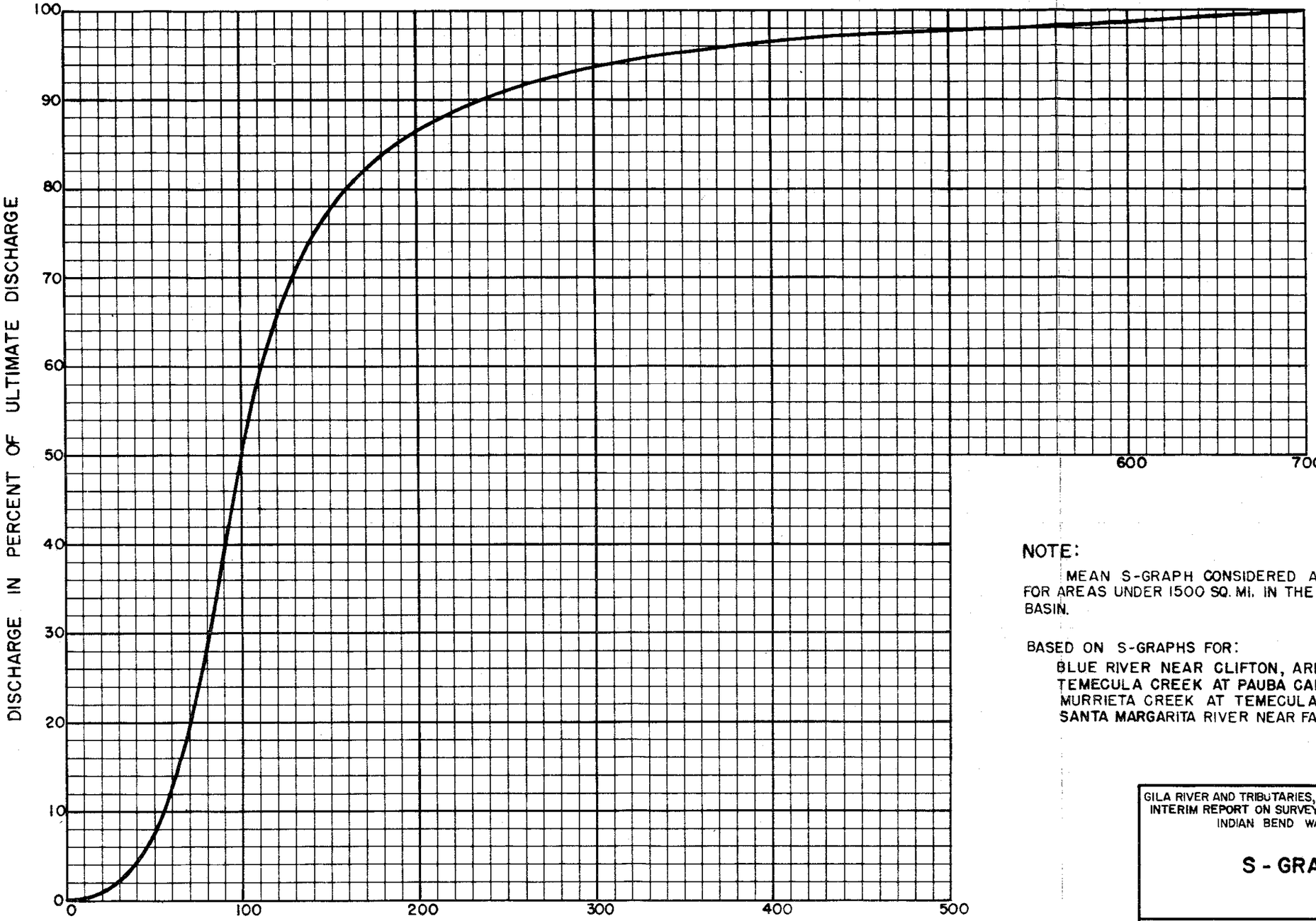
*** UNIT-GRAPH STUDY BASED ON RUNOFF RECORDS FOR SAN FRANCISCO RIVER AT CLIFTON (DRAINAGE AREA = 2790 SQ. MI.)

\# EXCLUDED 25 SQUARE MILES TRIBUTARY TO BALDWIN LAKE AND 767 SQUARE MILES TRIBUTARY TO LAKE ELSINORE.

GILA RIVER AND TRIBUTARIES, ARIZ., AND NEW MEX.
INTERIM REPORT ON SURVEY FOR FLOOD CONTROL
INDIAN BEND WASH, ARIZ.

LAG RELATIONSHIPS
STREAMS IN ARIZONA AND SOUTHERN CALIFORNIA

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED: APRIL 15, 1962



NOTE:

MEAN S-GRAPH CONSIDERED APPLICABLE FOR AREAS UNDER 1500 SQ. MI. IN THE GILA RIVER BASIN.

BASED ON S-GRAPHS FOR:

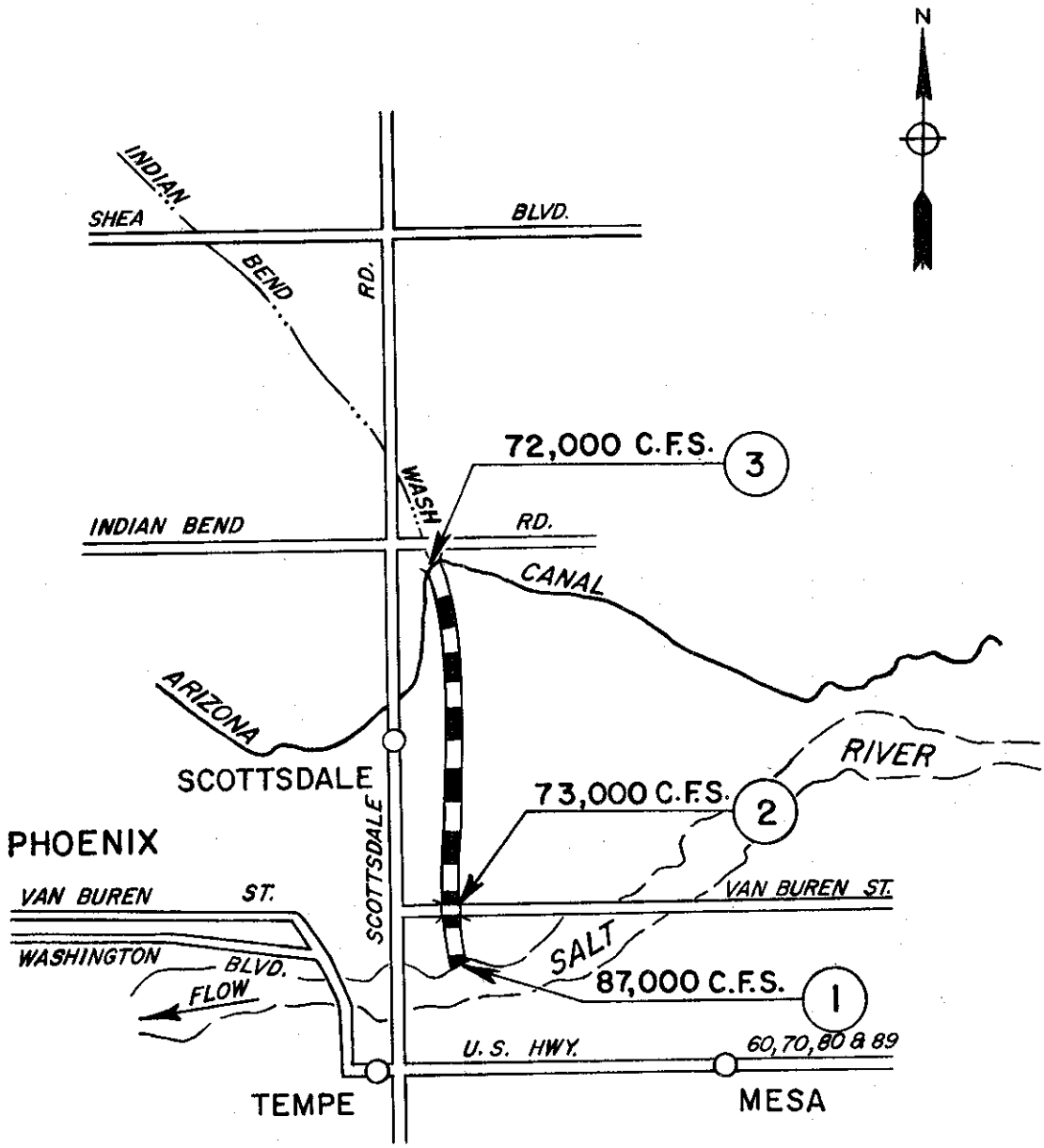
BLUE RIVER NEAR CLIFTON, ARIZ.
TEMECULA CREEK AT PAUBA CANYON, CALIF.
MURRIETA CREEK AT TEMECULA, CALIF.
SANTA MARGARITA RIVER NEAR FALLBROOK, CALIF.

GILA RIVER AND TRIBUTARIES, ARIZ. AND NEW MEX.
INTERIM REPORT ON SURVEY FOR FLOOD CONTROL
INDIAN BEND WASH, ARIZ.

S - GRAPH

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED: APRIL 15, 1962

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



NOT TO SCALE

LEGEND

72,000 C.F.S. 3 — STANDARD PROJECT FLOOD PEAK DISCHARGE AND CONCENTRATION POINT

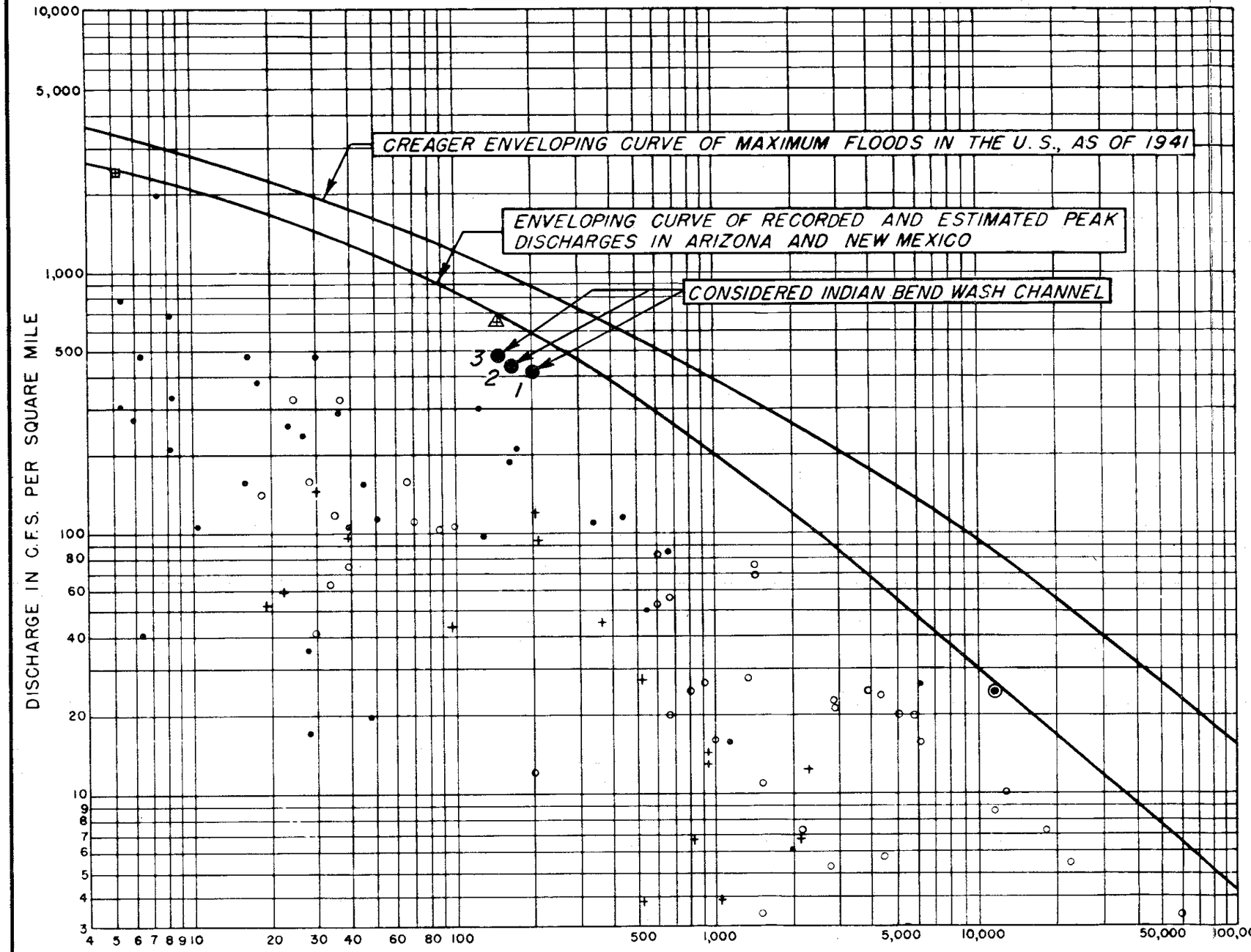
CONSIDERED CHANNEL

GILA RIVER AND TRIBUTARIES, ARIZ, AND NEW MEX.
INTERIM REPORT ON SURVEY FOR FLOOD CONTROL
INDIAN BEND WASH, ARIZ.

STANDARD PROJECT FLOOD PEAK DISCHARGES

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED: APRIL 15, 1962

FILE NO. 203/47 APPENDIX I PLATE 9



LEGEND

- ○ FLOODS FROM GENERAL RAIN OR SNOW MELT RUNOFF.
- \+ FLOODS FROM LOCAL SUMMER STORMS.
- • FLOOD TYPE UNDETERMINED.
- ⊞ ALDER CREEK AT MOUTH-LOCAL STORM.
- ◬ BEAR CREEK AT MOUTH-LOCAL STORM.
- ◉ SALT RIVER AT GRANITE REEF DAM – GENERAL STORM.
- ● 1 STANDARD PROJECT FLOOD AND CONCENTRATION POINT.

GILA RIVER AND TRIBUTARIES, ARIZ., AND NEW MEX.
INTERIM REPORT ON SURVEY FOR FLOOD CONTROL
INDIAN BEND WASH, ARIZ.

ENVELOPING CURVES OF PEAK DISCHARGES

STREAMS IN ARIZONA AND NEW MEXICO

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED: APRIL 15, 1962

APPENDIX 2 - BASES FOR DESIGN

INDIAN BEND WASH, ARIZONA
GILA RIVER BASIN, ARIZ. AND N. MEX.

CONTENTS

PLATES

BASES FOR DESIGN

INDIAN BEND WASH, ARIZONA
GILA RIVER BASIN, ARIZ. AND N. MEX.

1. General.--This appendix covers the engineering aspects of the channel improvements recommended for the control of floods along Indian Bend Wash at Scottsdale in Maricopa County, Arizona. The recommended plan would control a flood discharge of 40,000 cubic feet per second. The improvement is shown on plate 3 at the end of the text of the main report and details of the improvement are shown on plates 1 through 3 of this appendix.

2. Recommended plan.--The recommended plan would provide for channel improvements of Indian Bend Wash, including (a) channel-inlet wing levees, (b) Arizona canal crossing, (c) about 7 miles of improved channel from Arizona canal to Salt River, and (d) relocation of utilities, streets, and highways.

3. Topography and geology.--The Indian Bend Wash improvement is located on an alluvial plain bounded by the Phoenix Mountains on the southwest and the McDowell Mountains on the northeast. The maximum thickness of the alluvial material in the plain is not known. The alluvial plain at the project alinement has a slope of .004 to .008 towards the southwest.

4. Foundation conditions.--The entire project is underlain by alluvial materials. In general, the surface soils are silts and silty sands. Near the upstream end of the project, the soils are sands and gravelly sands. Coarse gravelly sand is exposed in the banks of the arroyos and of the Salt River at the downstream end of the project. Where the gravelly sand is exposed in the banks, it is overlain by about 10 feet of silts and silty sand. While groundwater table levels will vary from year to year, it is necessary to provide a subdrainage system which will relieve and prevent uplift under the trapezoidal channel.

5. Channel inlet levees.--Revetted earthfill levees would be provided at the upstream end of the project to direct flood flows into the concrete channel. The right wing levee, about 2,500 feet long, would extend upstream to and along Indian Bend Road; the left wing levee, about 5,000 feet long, would cross Indian Bend Road. Access to levee berms would be by ramps from existing adjacent streets. Barriers would be placed across the ramps to prevent access by unauthorized vehicles.

6. Arizona canal crossing.--A gated, box siphon, with 4 - 11 x 11 feet barrels, would be constructed to pass the Arizona canal under the Indian Bend Wash floodway. Upstream of the siphon in the canal, a gated wasteway would be provided from the canal to the proposed Indian Bend Wash channel.

7. Channel.--The trapezoidal channel would be about 35,400 feet long. Approximately 33,500 feet would be lined with concrete and have a bottom width of 14 feet and an average depth of about 25 feet. The side slopes would be 1 vertical on 2.25 horizontal. For the most part, the concrete channel would be below the surrounding ground surface. The concrete-lined portion of the channel would extend from the intake wing levees at the Arizona canal to the outlet transition at Salt River. The outlet transition would be about 1,860 feet long and consist of grouted stone in the upper portion and dumped stone in the lower portion.

8. Street and highway relocations.--The proposed plan provides for five clear-span street and highway bridges.

9. Utilities relocation.--Utility lines, including power, water, gas, and two Phoenix water supply lines (60- and 45-inch), would be relocated to clear the channel construction.

10. Hydraulic design, general.--The improvement under consideration would collect the design storm of 40,000 cubic feet per second and confine it in a 14-foot-base-width trapezoidal channel, terminating at the Salt River.

(a) Existing channel.--Upstream from the Arizona canal, the Indian Bend Wash channel is the thalweg of a broad valley which intersects numerous small gullies and washes from the mountains. The channel is not well defined, and flow would occupy a very wide cross section. Downstream from the Arizona canal the channel cuts through a broad plain to the Salt River. Some reaches of the channel downstream from the canal have been obliterated by extension of farm units and other land development.

(b) Channel alinement and cross section.--The alinement of the proposed improvement would follow the historic water course. The type and size of channel cross sections were selected after giving consideration to maintaining existing street grades, clear-span bridges, minimum excavation, utilization ot the most efficient hydraulic section, as well as rights-of-way considerations. Selected channel cross sections from the upstream to the downstream end of the project are: two collector wing levees, a concrete-lined trapezoidal transition, a 14-foot-base-width concrete-lined trapezoidal channel about 33,500 feet long, and a stone-lined transition to the Salt River.

(c) Bridges.--All bridges in the project would be clear span and would present no interference to flow.

(d) Channel inlet.--The channel inlet would consist of two wing levees separated by about 7,300 feet at the upper end and converging to 425 feet at the Arizona canal. The top of these levees would be above the standard-project-flood (72,000 cfs) water-surface

profile. However, downstream of the Arizona canal standard-project-flood flows would not be contained in the transition or the channel downstream.

(e) Arizona canal.--Structures on and pertinent to the Arizona canal would consist of (1) 4-barrel box siphon, whose hydraulic capacity would be 2,000 cubic feet per second, (2) gated head works, and (3) a gated wasteway into the Indian Bend Wash channel. The head works at the siphon could be regulated to completely stop all flow in the canal past that point, and shunt it through a gated wasteway into Indian Bend Wash channel. The top of the wasteway gates would be set so that in the closed position the top of the gates would act as a skimming weir to waste any flow in the canal in excess of 2,000 cubic feet per second.

(f) Downstream terminus.--A stone-lined transition section having a divergence ratio of 1:20 would join the 14-foot-base-width channel to the Salt River. The upper reach, 860 feet long, would be grouted stone. The lower reach, 1,000 feet long, would be lined with dumped stone, and the base width at the junction with the Salt River would be 200 feet. Downstream of the formal levee section a 200-foot-base-width excavated channel would be continued to a point in the Salt River that would be compatible with the low flow channel authorized by the Flood Control Act of 1960 (see H. Doc. 279, 86th Congress, 2d sess., which contains the interim survey report, Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Ariz.).

(g) Channel gradient.--With the exception of the inlet and exit, the channel slopes would vary between 0.2 and 0.7 percent. These grades are steep enough to produce supercritical flow in the channel.

(h) Water surface computations.--Friction losses were evaluated by use of the Manning formula, using "n" values of 0.03, 0.014, and 0.04 at the channel inlet, channel and the downstream terminus, respectively. The water surface profile was determined by the reach method. Flow through the inlet would be subcritical with the critical section at the downstream end of the transition. The maximum velocity in the inlet section would be 11 feet per second. Flow in the channel downstream of the inlet would be supercritical with velocity and depth of about 28 feet per second and 22 feet, respectively. The transition at the downstream end would be stone-lined with sufficient projection of the stones to produce a roughness coefficient of 0.04 to act as an energy dissipator. Flow in this reach would be undulating above and below critical depth. At the downstream end, when there is no flow in the Salt River, critical depth would occur with a maximum velocity of about 16 feet per second.

(i) Superelevation and freeboard.--Superelevation of the water surface through the curved portion of the channel would be accommodated by raising the walls. Freeboard would be a minimum of 2.5 feet for the design discharge.

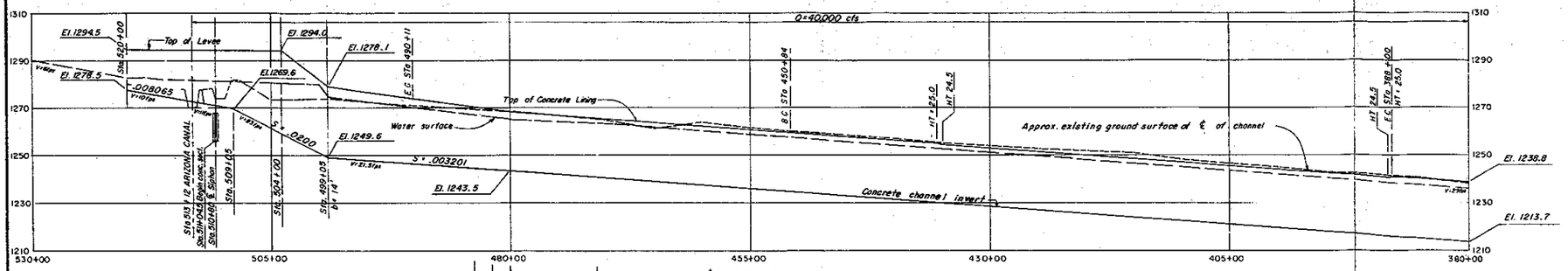
11. Diversion and control of water.--Control of runoff during construction would be a minor problem. The duration of runoff rarely exceeds 6 hours. Partial protection is afforded by the Arizona canal which may intercept minor flood discharge runoff.

12. Construction schedule.--Construction would require approximately two years.

13. Sources of construction material.--Ample quantities of construction materials would be available from excavated materials at the project site and from commercial plants. Cobblestone for revetment could be obtained from rock processing plants on the Salt River about 4 miles from the project site. There are no known operating quarry sites in the immediate vicinity of the recommended project. However, granite quarrystone could be obtained from McDowell Pass 8 miles northeast of the project. Basalt from McDowell Mountains, about 5 miles from the project, may prove to be suitable for revetment. Portland cement would be available from plants at Rillito or Clarksdale, located about 125 miles from the project site. Aggregates for concrete construction would be available from sources previously approved for other construction. These sources include rock processing plants located in the Salt River Valley about 4 miles from the project site.

14. Rights-of-way.--Permanent rights-of-way would be required for land on which the channel would be constructed. A flowage easement would be required at the upper end of the project where the wing levees are concentrating the waterflow into the concrete channel. Easements would be required for contractor work area and for spoil disposal area.

U.S. ARMY ENGINEER DISTRICT — CORPS OF ENGINEERS



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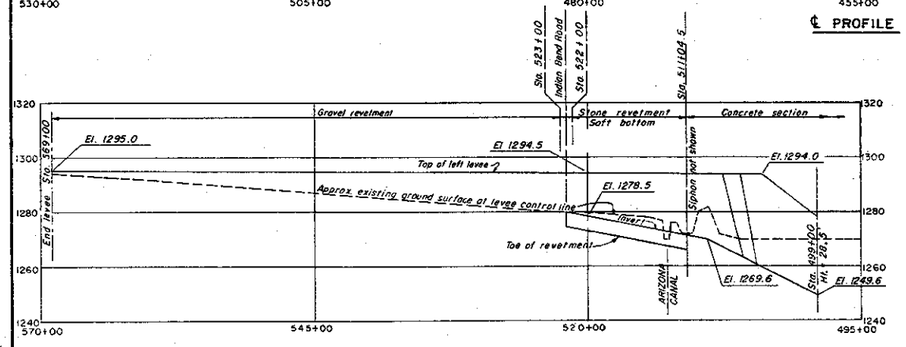
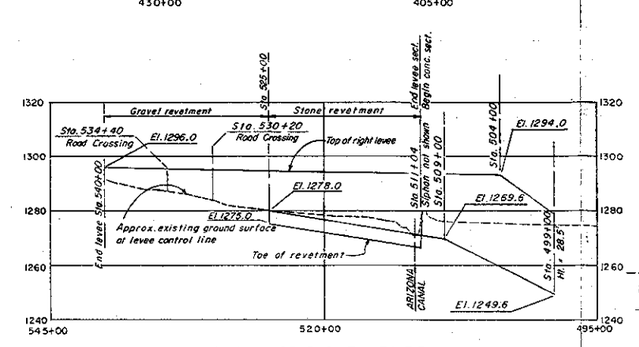


PROFILE OF LEFT LEVEE



PROFILE OF RIGHT LEVEE

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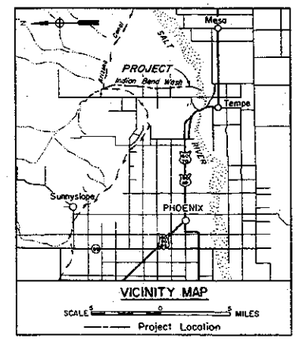

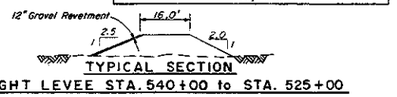

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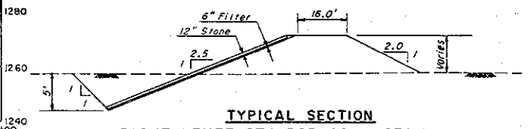
LEFT LEVEE STA. 569+00 to STA. 523+00
NO SCALE



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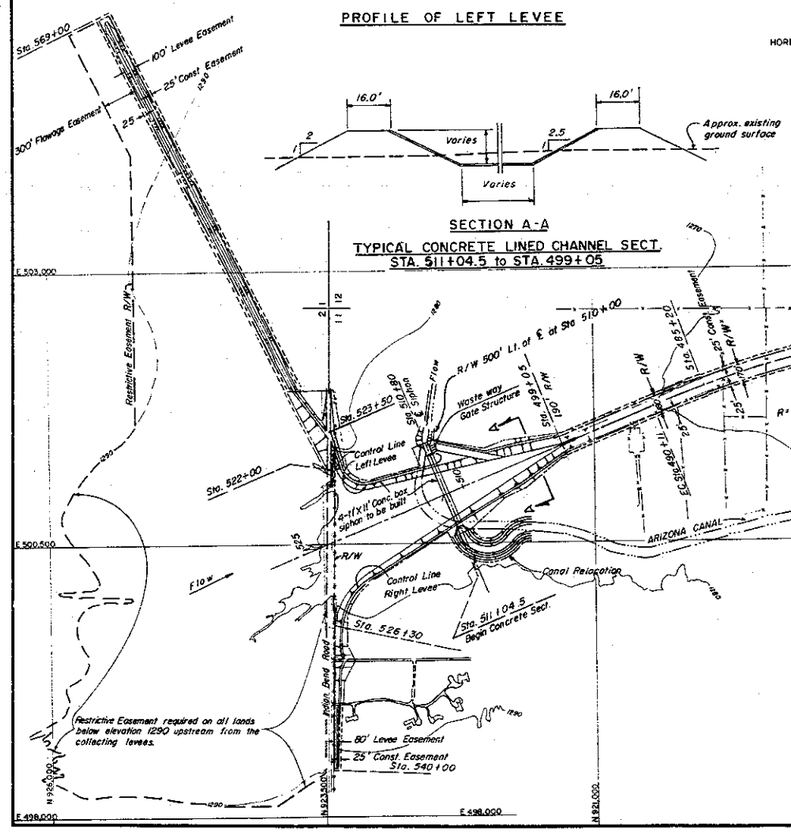
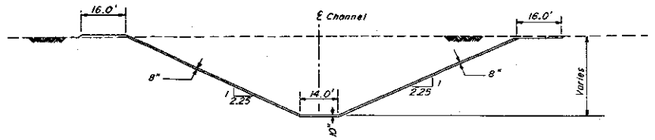


SECTION A-A
TYPICAL CONCRETE LINED CHANNEL SECT.
STA. 511+04.5 to STA. 499+05

PLAN
SCALE 500 0 500 1000 1500 FEET

REFERENCE:
TOPOGRAPHIC MAPS "INDIAN BEND PARKWAY" MARICOPA FLOOD CONTROL AGENCY PHOENIX, ARIZONA. DATED 1959

NOTE:
SECTION CORNER LOCATIONS ARE APPROXIMATE, TAKEN FROM U.S.G.S. QUADRANGLE SHEETS.



TYPICAL CONCRETE LINED CHANNEL SECTION
STA. 499+05 to STA. 380+00
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THIS DRAWING SUPERSEDES DRAWING FILE NO 203/36

GILA RIVER AND TRIBUTARIES, ARIZONA AND NEW MEXICO
INTERIM REPORT ON SURVEY FOR FLOOD CONTROL
INDIAN BEND WASH, ARIZONA

INDIAN BEND WASH
CHANNEL
PLAN, PROFILES AND SECTIONS
STA. 569+00 to STA. 380+00

SCALE: AS SHOWN — SHEET 1 OF 3
DATUM IS MEAN SEA LEVEL

U.S. ARMY ENGINEER DISTRICT, LOS ANGELES, CALIF., NOV. 1961

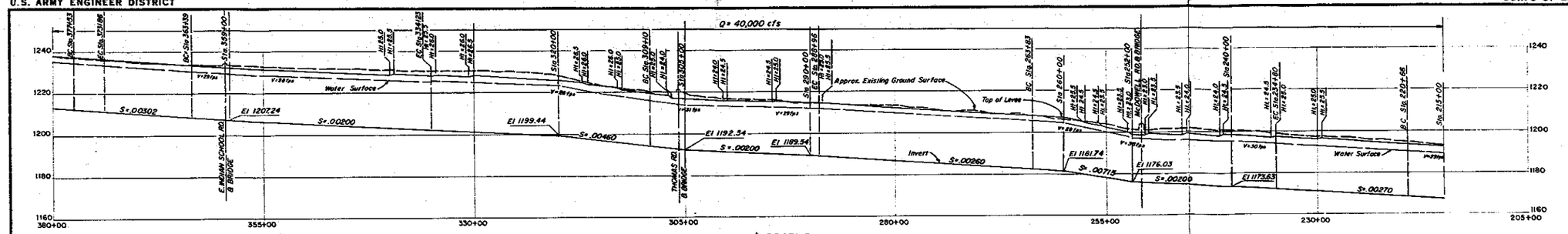
SUBMITTED:	RECOMMENDED:	APPROVED:
CHIEF, DESIGN BRANCH	CHIEF, ENGINEERING DIVISION	COL., CE, DISTRICT ENGINEER

ENGR.	DRAWN	CHECKED	TO ACCOMPANY REPORT	FILE NO. (D. O. SERIES)
G.C.A.	P.M.S. J.D.D.	R.F.R. A.A.K.	DATED: APRIL 15, 1962	203/36.1

APPENDIX 2 PLATE 1

U.S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS



℄ PROFILE

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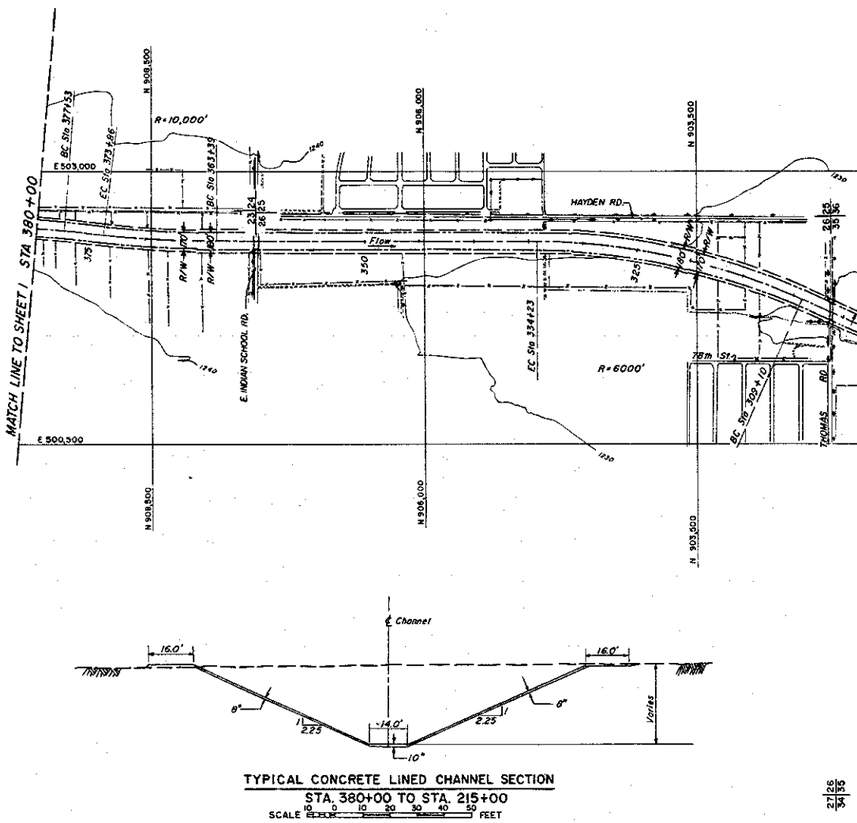
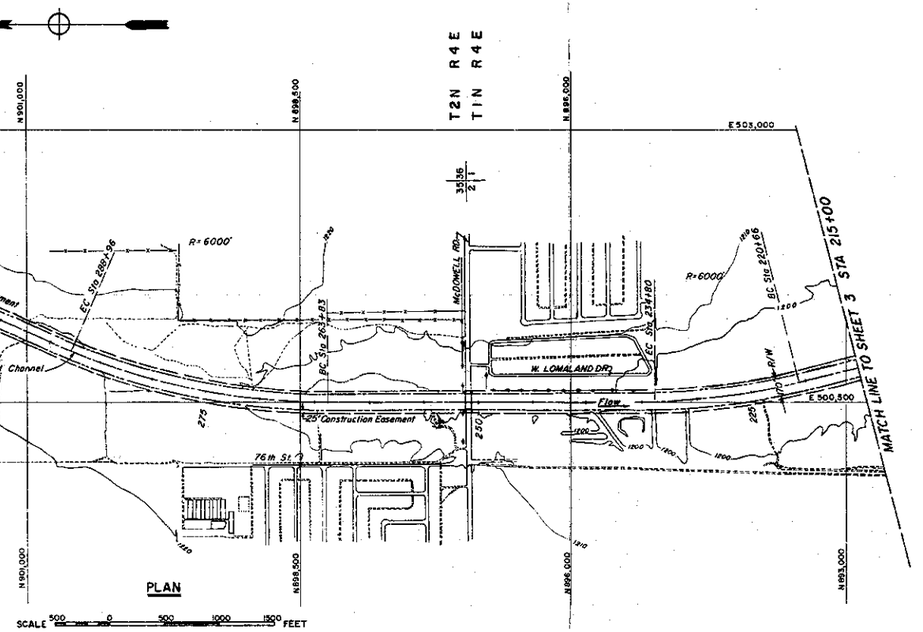
VERT. SCALE 10 0 10 20 30 40 50 FEET





PLAN

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TYPICAL CONCRETE LINED CHANNEL SECTION

STA. 380+00 TO STA. 215+00

SCALE 10 0 10 20 30 40 50 FEET

THIS DRAWING SUPERSEDES DRAWING FILE NO. 203/37

GILA RIVER AND TRIBUTARIES, ARIZONA AND NEW MEXICO
INTERIM REPORT ON SURVEY FOR FLOOD CONTROL
INDIAN BEND WASH, ARIZONA

INDIAN BEND WASH
CHANNEL
PLAN, PROFILE AND SECTION
STA 380+00 TO STA 215+00

SCALE: AS SHOWN

SHEET 2 OF 3

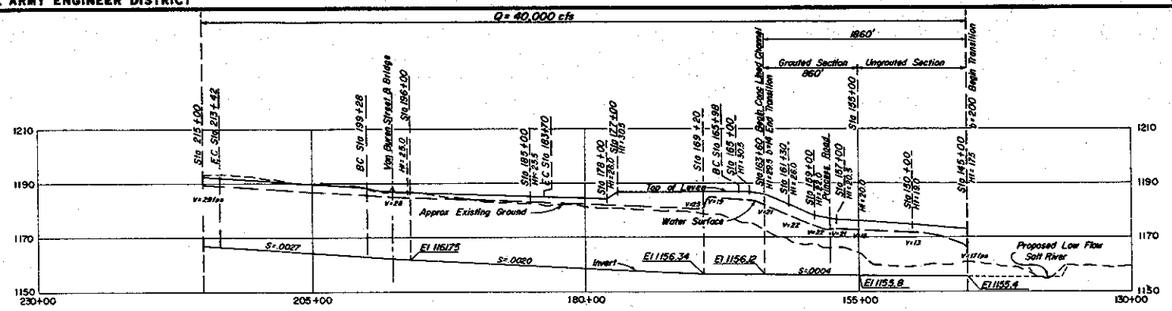
DATUM IS MEAN SEA LEVEL

U.S. ARMY ENGINEER DISTRICT, LOS ANGELES, CALIF., NOV. 1961

SUBMITTED:	RECOMMENDED:	APPROVED:
CHIEF, DESIGN BRANCH	CHIEF, ENGINEERING DIVISION	COLONEL, C.E. DISTRICT ENGINEER

ENGR	DRAWN	CHECKED	TO ACCOMPANY REPORT	FILE NO. (D. O. SERIES)
G.C.A.	F.S.S.	A.A.K. R.F.R.	DATED: APRIL 15, 1962	203/37.1

APPENDIX 2 PLATE 2



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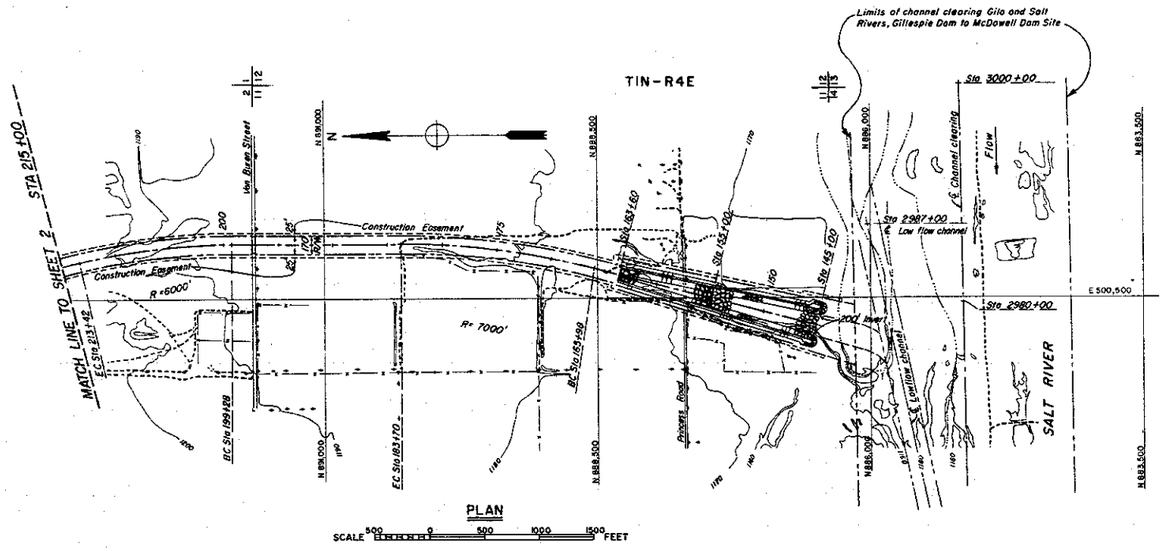

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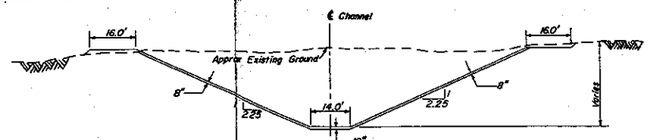

TYPICAL CONCRETE LINED CHANNEL SECTION

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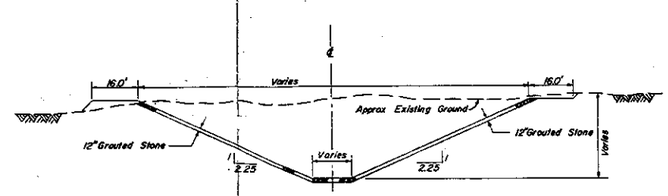

TYPICAL SECTION

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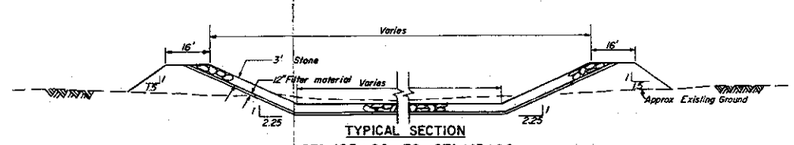

TYPICAL SECTION

STA 155+00 TO STA 145+00

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GILA RIVER AND TRIBUTARIES, ARIZONA AND NEW MEXICO
INTERIM REPORT ON SURVEY FOR FLOOD CONTROL
INDIAN BEND WASH, ARIZONA

INDIAN BEND WASH

CHANNEL

PLAN, PROFILE AND SECTIONS

STA 215+00 TO STA 145+00

SCALE: AS SHOWN — SHEET 3 OF 3

DATUM IS MEAN SEA LEVEL

U.S. ARMY ENGINEER DISTRICT, LOS ANGELES, CALIF. NOV. 1961

SUBMITTED:	RECOMMENDED:	APPROVED:
CHIEF, DESIGN BRANCH	CHIEF, ENGINEERING DIVISION	COLONEL, C.E. DISTRICT ENGINEER

ENGR.	DRAWN	CHECKED	TO ACCOMPANY REPORT	FILE NO. (D. O. SERIES)
G.C.A.	P.M.S.	A.A.K. R.F.R.	DATED: APRIL 15, 1962	203/38.1

THIS DRAWING SUPERSEDES DRAWING FILE NO. 203/38

APPENDIX 2 PLATE 3

APPENDIX 3 - COST ESTIMATES

INDIAN BEND WASH, ARIZONA
GILA RIVER BASIN, ARIZ. AND N. MEX.

CONTENTS

TABLE

C O S T E S T I M A T E S

INDIAN BEND WASH, ARIZONA
GILA RIVER BASIN, ARIZ. AND N. MEX.

1. General.--This appendix presents the detailed estimate of construction and maintenance costs of the recommended Indian Bend Wash channel improvements for flood control at Scottsdale, Ariz.

2. The estimated first costs include estimates for construction, relocations, rights-of-way, engineering and design, and supervision and administration. Construction costs include allowances for contingencies. Costs of preauthorization studies are not included in the estimate.

3. Unit prices.--Concrete prices were developed from available information and by using typical unit prices for work involved. Unit prices for structures were based on current material and labor cost typical of work of this nature in the vicinity of the project. All unit prices are based on prices prevailing in November 1961.

4. Construction period.--Construction would require about two years.

5. Maintenance and operation.--Average annual maintenance charges for the recommended project are estimated at $22,000. Maintenance would require periodic inspection of the work, removal of debris found within the channel area, and repair of damage to the concrete channel and levees.

6. Rights-of-way.--The site of the proposed improvement was inspected in February and May of 1961. The real estate market concerned was analyzed to make an appraisal of cost. The estimate for rights-of-way includes an item for acquisition.

Cost estimate for recommended Indian Bend Wash channel, Indian Bend Wash, Ariz.

Cost acct. No.	Description	Unit	Estimated quantity	Unit price	Amount Subtotal	Amount Total
	FEDERAL COSTS					
09.	Channel:					
	Clearing and grubbing	Job	Job	Lump sum	$15,000	
	Excavation	Cu. yd.	2,820,000	.50	1,410,000	
	Fill, compacted	Cu. yd.	415,500	.20	83,100	
	Concrete, invert	Cy. yd.	20,200	12.00	242,400	
	Concrete, side slopes	Cu. yd.	97,200	13.50	1,312,200	
	Revetment stone	Cu. yd.	39,500	6.00	237,000	
	Gravel, filter	Cu. yd.	20,500	4.60	94,300	
	Grouting, stone revetment	Cu. yd.	2,450	12.00	29,400	
	Cement	Bbl.	181,000	4.30	778,300	
	Reinforcement steel	Lb.	10,254,000	.10	1,025,400	
	Subdrain system	Job	Job	Lump sum	70,000	
	Fencing	Lin. Ft.	72,000	1.00	72,000	
	Contingencies				1,070,900	
	Total, channel					$6,440,000
30.	Engineering and design					440,000
31.	Supervision and Administration					370,000
	Total project cost to the United States					*7,250,000

Cost estimate for recommended Indian Bend Wash channel, Indian Bend Wash, Ariz.--Continued

Cost acct. No.	Description	Unit	Estimated quantity	Unit price	Amount Subtotal	Amount Total
	NON-FEDERAL COSTS					
	Rights-of-way				$700,000	
	Relocations:					
	Roads and bridges				350,000	
	Utilities				50,000	
	Irrigation facilities				670,000	
	Total project cost to local interests					$1,770,000
	Total project cost					9,020,000

* Does not include costs of $60,000 for preauthorization studies.

APPENDIX 4 - BENEFITS FROM FLOOD CONTROL

INDIAN BEND WASH, ARIZONA
GILA RIVER BASIN, ARIZ. AND N. MEX.

CONTENTS

PLATES

No.	Title
1.	Discharge-frequency curve, Indian Bend Wash.
2.	Damage-discharge and damage-frequency curve, Indian Bend Wash channel improvement overflow area.
3.	Population curves.

BENEFITS FROM FLOOD CONTROL

INDIAN BEND WASH, ARIZONA
GILA RIVER BASIN, ARIZ. AND N. MEX.

SCOPE

1. This appendix presents supplemental material on the determination of flood frequencies and on the evaluation of flood-control benefits from construction of the recommended Indian Bend Wash channel.

FLOOD FREQUENCIES

2. Runoff records for Indian Bend Wash are insufficient for the development of discharge-frequency relationships. Only one estimate of flow along Indian Bend Wash is available - for the flood of August 1943. Although general information is available regarding floods on Cave Creek to the west of Indian Bend Wash, sufficient quantitative estimates of discharge are not available to develop a discharge-frequency relationship for that stream. In addition, flows on Cave Creek have been affected by the existing Cave Creek Dam and the peak discharge of natural inflows into the dam could not be determined. Discharge-frequency relations for Indian Bend Wash were therefore developed on the basis of (a) synthetic rainfall-runoff relationships for the area, and (b) correlation with the discharge-frequency curve for Queen Creek at Whitlow Ranch Reservoir.

3. Flood peaks for 50-and 10-year frequency were computed using rainfall-runoff relationships explained in the hydrology appendix and rainfall-frequency data given in U. S. Weather Bureau Technical Paper No. 28 titled "Rainfall Intensities for Local Drainage Design in Western United States for Durations of 20 Minutes to 24 Hours and 1 to 100 Year Return Periods," and dated November 1956. Points representing the resulting peaks are shown on plate 1 of the appendix.

4. The discharge-frequency curve for Queen Creek at Whitlow Ranch Reservoir was selected for comparison inasmuch as Queen Creek is within the same region of meteorological homogeneity as Indian Bend Wash and has one of the longest combined historical and actual records in the region. Peak discharge data used to develop the discharge-frequency curve for Queen Creek at Whitlow Ranch Reservoir are given in the following table:

Peak discharge data for Queen Creek at Whitlow Ranch Reservoir, Ariz.

Date	Peak discharge	Date	Peak discharge
	Cubic feet per second		Cubic feet per second
1884 Feb. 2-11...	15,000 - 30,000*	1940 Aug. 3.....	600
1890 Jan.....	4,000 - 15,000*	Dec. 31.....	8,600
1891 Feb. 19-26..	30,000 - 70,000*	1941 Mar. 14.....	7,200
1896 Jul.....	9,000	1948 Jul. 21.....	680
Aug.....	1,430	Dec. 27.....	570
Sep.....	3,430	1949 Jul. 22.....	2,630
Oct.....	1,190	Aug. 8.....	1,710
1897 Jan.....	3,540	1950 Jul. 18.....	5,100
1899 Jun. 25.....	1,170	Aug. 5.....	1,790
Jul. 30.....	5,520	1951 Jan. 30.....	840
Sep. 7.....	4,800	Aug. 3.....	1,510
1905 Nov. 26-27..	4,000 - 15,000*	Aug. 26.....	1,320
1914 Dec. 18-19..	4,000 - 15,000*	Dec. 31.....	1,130
1916 Jan. 28.....	10,000	1952 Jan. 18.....	1,170
1917 May 20.....	2,800	Mar. 17.....	620
1918 Aug. 5-6....	5,000	1953 Mar. 2.....	1,020
Nov. 24.....	550	Jul. 29.....	1,780
1919 Aug. 1.....	10,000	1954 Mar. 22.....	4,260
1920 Feb. 20.....	750	Aug. 5.....	6,260
1925 Jul. 2-3....	15,000 - 30,000*	Aug. 19.....	42,900
Sep. 16-19..	4,000 - 15,000*	1955 Jun. 12.....	3,070
1926 Jul. 27.....	4,000 - 15,000*	Jul. 25.....	3,450
1927 Aug. 16.....	4,000 - 15,000*	Aug. 3.....	5,430
1930 Aug. 8.....	4,000 - 15,000*	1956 Jul. 25.....	1,400
1931 Aug. 8.....	13,000	Aug. 17.....	4,100
Nov. 22.....	7,000	1957 Jul. 25.....	2,580
Dec. 10.....	3,900	Aug. 19.....	8,260
1932 Feb. 10.....	4,100	Oct. 31.....	2,280
Dec. 15.....	2,200	1958 Feb. 4.....	1,240
1933 Sep. 8-11...	10,200	Mar. 7.....	650
1935 Mar. 3-4....	4,800	Mar. 22.....	3,970
1936 Feb. 24-25..	2,300	Apr. 16.....	1,000
Jul. 24-25..	4,800	Sep. 13.....	650
Aug. 20-21..	2,200	Oct. 6.....	480
1939 Aug. 7.....	11,500	1959 Aug. 17.....	25,000
Sep. 11.....	1,300	Oct. 29-30..	8,000
Oct. 26-27..	1,000	Dec. 24-26..	6,800
		1960	(**)

* Range of discharge estimated on basis of historical records.
** Negligible flow during year.

A partial duration discharge-frequency curve was prepared on logarithmic probability paper from the preceding tabulated data by using the equation $f = \frac{100\ (n-0.5)}{t}$, in which f is the number of times in 100 years that the discharge is equalled or exceeded, n is the series number of flood in order of decreasing magnitude, and t is the number of years of record - 38 years in this case. The discharge-frequency curve shown on plate 1 of this appendix is based on records of (a) Queen Creek at Whitlow Ranch for the years 1949 to date, (b) Queen Creek near Florence Junction for years 1896, 1897, 1899, 1916-20, inclusive, and 1925, and (c) estimates of peak discharges (adjusted for size of area) of Queen Creek near Roosevelt Canal for years 1931-33, inclusive, 1935-37, inclusive, and 1939. The assumption was made that the above years of record were consecutive and are representative of floods for the entire period because of the following reasons: (a) the lowest flow listed in the previous table is 480 cubic feet per second, and it is reasonable to assume that the flows in the missing years would be similar to those listed; (b) the records of floods on other streams in the general vicinity of Queen Creek show floods in some of the years that are missing for Queen Creek; and (c) in obtaining records of floods from people and newspapers, it is reasonable to assume that they only remember or record the floods that affected them; therefore, it is impossible to say what the magnitude is of the missing floods.

5. In the drawing of the frequency curve (pl.1) for Indian Bend Wash at the Arizona canal, consideration was given to (a) the computed frequency flood peaks; and (b) the assumption that the frequency of the standard-project-flood peak (72,000 c.f.s.) for Indian Bend Wash at Arizona canal is similar to the frequency of the standard-project-flood peak (110,000 c.f.s.) for Queen Creek at Whitlow Ranch Reservoir; and (c) the assumption that the upper end of the frequency curve would be parallel to the upper end of the frequency curve for Queen Creek. The lower end of the Whitlow Ranch curve is not considered applicable because the flow in Indian Bend Wash is not confined to entrenched channels. On the recurrence of small flows, considerable sheetflow would result with consequent losses due to percolation. The curve in the lower end was therefore drawn by extending the straight line rather than curving upward.

PRESENT AND FUTURE DEVELOPMENT OF PROPERTY IN OVERFLOW AREA

5. Two estimates were made for property values in the overflow areas along Indian Bend Wash. The first estimate is based on present (1961) development, and the second on the average future development over the next 100-year period. Estimates of the 1961 values of land and improvements subject to flood damage were made by use of (a) assessed valuations, adjusted to market value of the property, (b) valuation data supplied by local interests, and (c) field inspections and appraisals of the present development in the overflow areas. Estimated average future values were made principally by using population, residential, and business trends in the overflow areas considered. The space available for future expansion was also considered. The future development studies for this report were based on data and estimates supplied by the Maricopa County Planning and Zoning Commission and by private interests.

6. Plate 3 of this appendix shows a curve of 90-year population growth (1920-2010) for Maricopa County, Scottsdale, and the overflow area. The town of Scottsdale was not incorporated until 1951. Records of population in the overflow area prior to 1960 are very limited. Those that do exist are combined with records of other areas in such a way that accurate separations cannot be made. The curve for the Indian Bend Wash overflow area was assumed to be parallel to the curve for Maricopa County. This is considered to be conservative. If the overflow area developed in the same proportion as predicted by the estimates of the Maricopa County Planning and Zoning Commission in their report covering the Scottsdale area, the 1980 population would be 130 percent of that assumed in this report. A study of the future land use plan and population density for the Scottsdale area indicates sufficient space in the overflow area to accommodate a maximum population of 34,000, which is over ten times the present population. The population at the end of 50 years, as indicated by the curve, is 13,600, or four times present population. Because of the lack of suitable data to predict growth in this area beyond 50 years, it was assumed, for the purpose of this report, that no substantial increase in population would occur after the 50th year.

7. Property valuations over the next 100-year period for residential, business, public, utility and highway properties in the overflow area will generally follow the population growth. No appreciable change in the value of irrigation works would take place. A decrease in farmland and farm values would occur due to the use of these lands for residential and associated developments. In order to provide the space needed for increased residential, business, public, utility and highway developments along Indian Bend Wash, it was estimated that about 1,000 acres of land will be taken out of agricultural production over the next 50 years. This change in land use is due to developments that will occur in the overflow area whether or not flood-control improvements are constructed.

8. The values of average future developments were discounted to present-worth amounts. In order to determine present worth of estimated future values in the overflow area, an analysis was made for 10-year intervals on the basis of future developments increasing in the same ratio as the estimated population increase. The methods established in EM 1120-2-118, appendix II, were used in the development of present-worth factors.

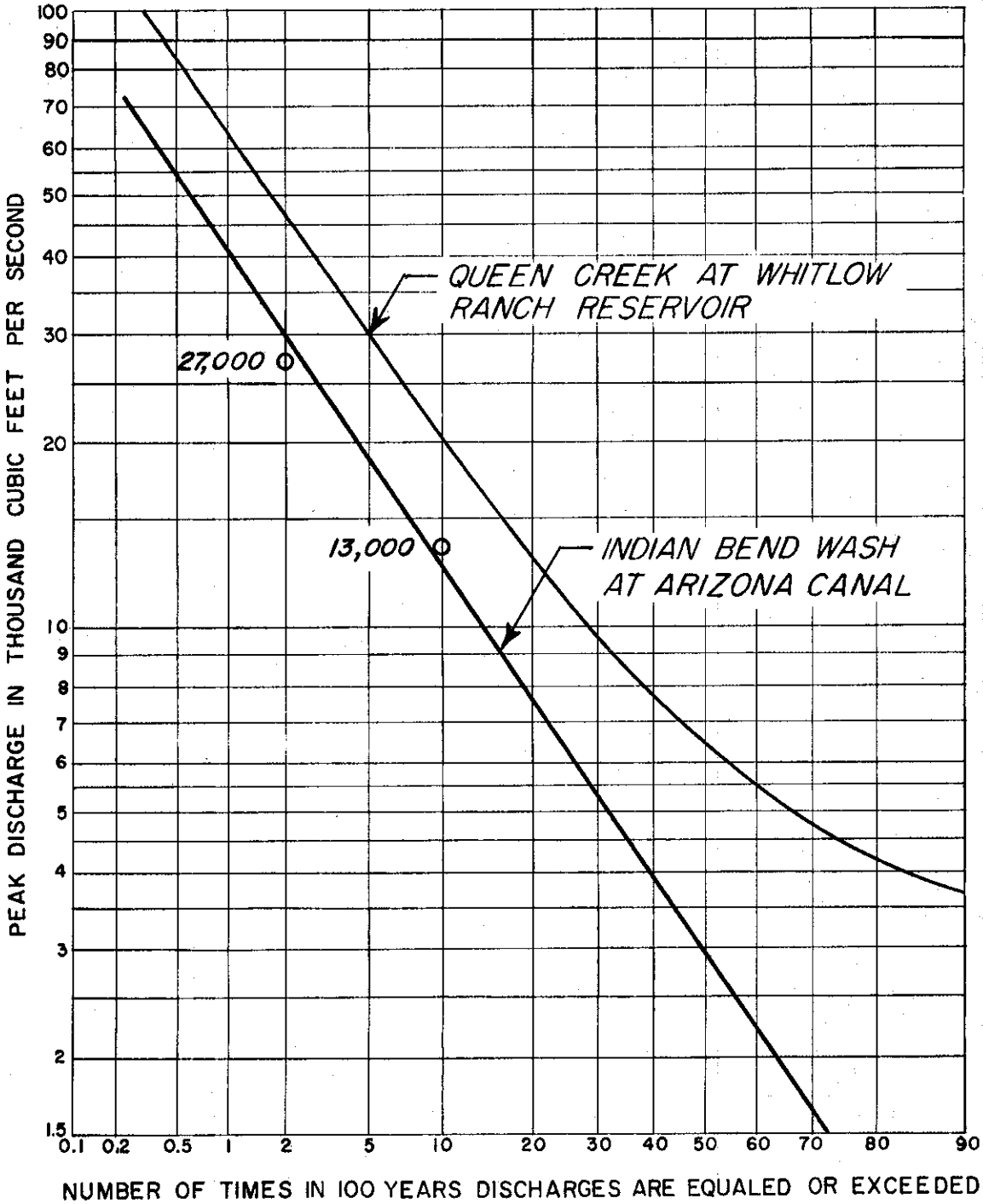
9. The results of this analysis indicate that over the next 100-year period the value of average future development of (a) residential, business, public, utility and highway properties would be 215 percent of the value of present developments, (b) irrigation facilities would be the same as present values, and (c) farmland and farm values would be 80 percent of present values. Undeveloped land supplied some of the land required for the increase in residential and associated developments.

10. A summary of average future values is given in the main report, included under the paragraph heading "Type and value of property in overflow area."

DAMAGES FROM FUTURE FLOODS

11. A summary of estimates of damage that would result from future floods of various magnitudes along Indian Bend Wash is given in the main report. A curve showing the relationship between peak discharges in cubic feet per second and total damage in dollars under average future conditions is shown on plate 2. The discharge-damage curve was combined with the discharge-frequency curve shown on plate 1 to obtain the damage-frequency curve (plate 2). The area under the damage-frequency curve represents the estimated total flood damages during a 100-year period for the overflow area; that total divided by 100 is the estimated average annual damage for the area.

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



⊙ DISCHARGES DETERMINED ON BASIS OF FREQUENCY RAINFALL

THIS DRAWING SUPERSEDES DWG. FILE NO. 203/49.

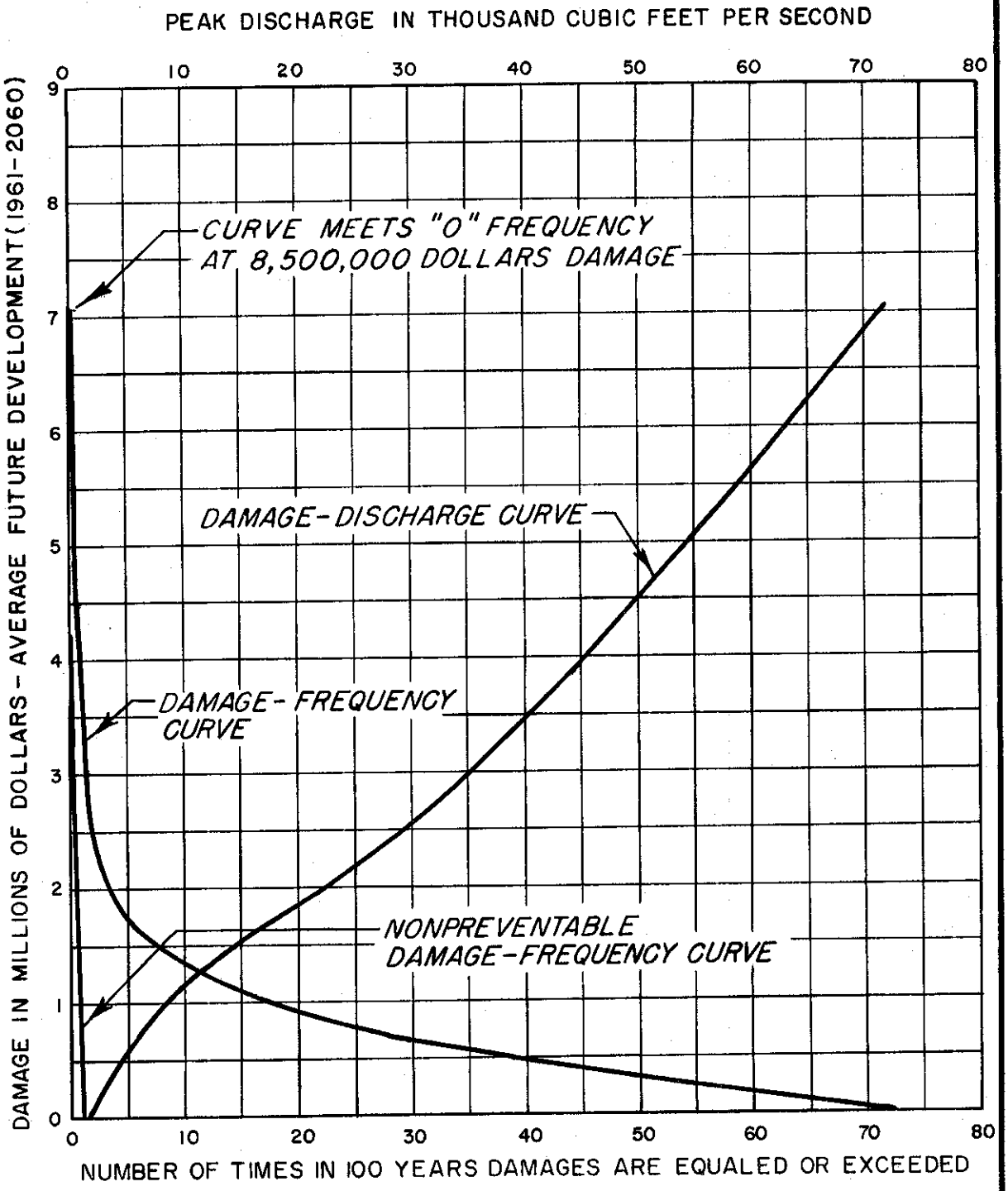
GILA RIVER AND TRIBUTARIES, ARIZ, AND NEW MEX.
INTERIM REPORT ON SURVEY FOR FLOOD CONTROL
INDIAN BEND WASH, ARIZ.

DISCHARGE — FREQUENCY CURVES

INDIAN BEND WASH

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED: APRIL 15, 1962

FILE NO. 203/49.1 APPENDIX 4 PLATE 1



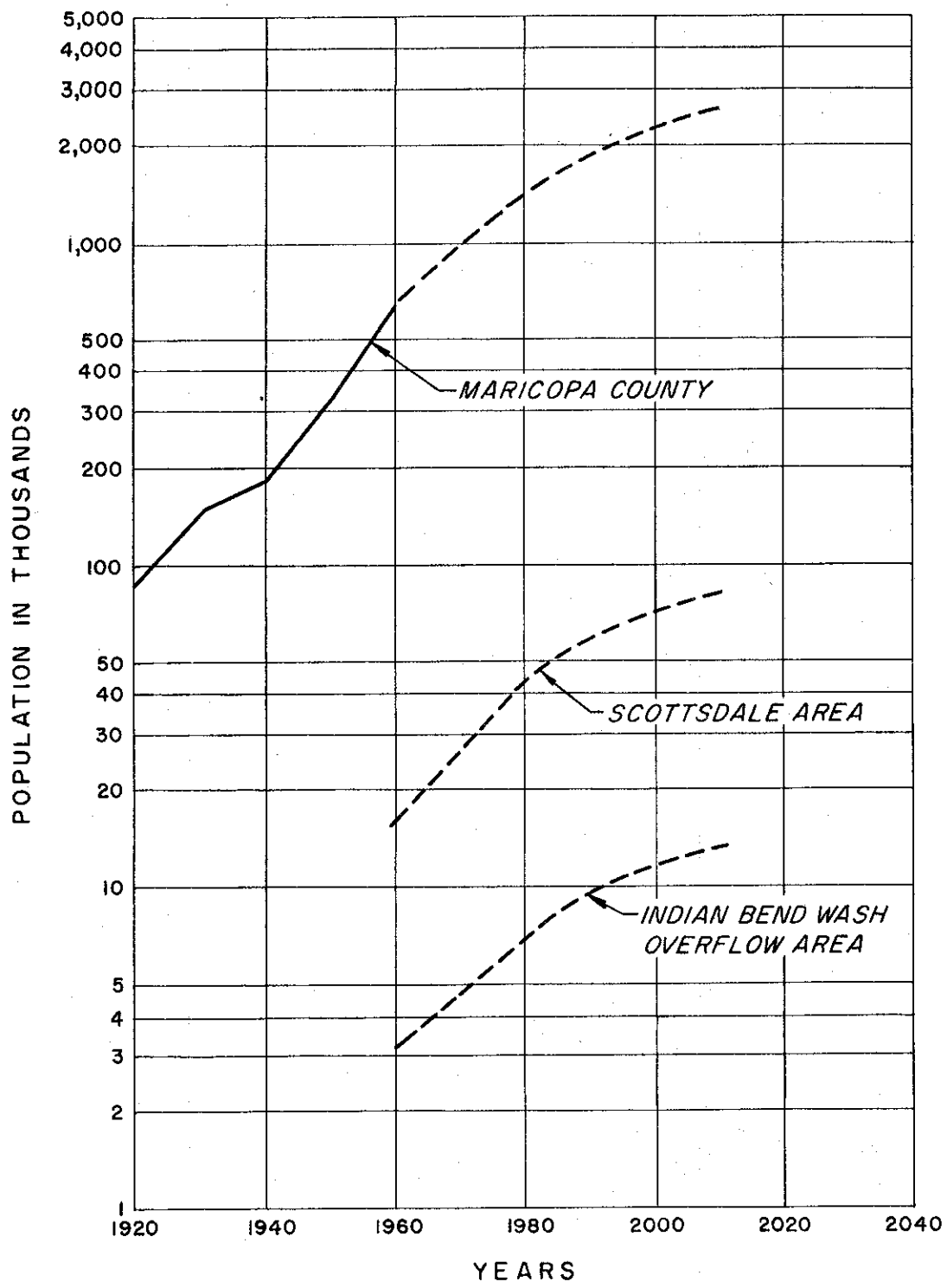
GILA RIVER AND TRIBUTARIES, ARIZ., AND NEW MEX.
INTERIM REPORT ON SURVEY FOR FLOOD CONTROL
INDIAN BEND WASH, ARIZ.

DAMAGE - DISCHARGE AND DAMAGE FREQUENCY CURVES

INDIAN BEND WASH

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED: APRIL 15, 1962

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



LEGEND

— ACTUAL

– – ESTIMATED

GILA RIVER AND TRIBUTARIES, ARIZ., AND NEW MEX.
INTERIM REPORT ON SURVEY FOR FLOOD CONTROL
INDIAN BEND WASH, ARIZ.

POPULATION CURVES
1920–2010

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED: APRIL 15, 1962

FILE NO. 203/51 APPENDIX 4 PLATE 3

APPENDIX 5 - COMMENTS OF OTHER AGENCIES

INDIAN BEND WASH, ARIZONA
GILA RIVER AND TRIBUTARIES, ARIZONA AND NEW MEXICO

CONTENTS

SCOPE

This appendix includes the comments of Federal and State agencies on this report. Where pertinent, replies of the U. S. Army Engineer District, Los Angeles, are included.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
REGION 3
BOULDER CITY, NEVADA

April 23, 1962

In reply
refer to: 3-700

District Engineer
U. S. Army Engineer
District, Los Angeles
P. O. Box 17277, Foy Station
Los Angeles 17, California

Dear Sir:

We have reviewed your proposed interim report on survey for flood control, Indian Bend Wash, Arizona and have the following comments.

We agree that the basic plan would provide a much needed improvement for the area. It would also furnish a drainage channel into which surface or piped runoff from the adjacent areas and streets could be routed. With the protection provided by the channel, local improvements could, and no doubt would, be completed by the community and private initiative. At present, a variable width band of low-lying land adjacent to the ill-defined wash is undeveloped or partially occupied by low cost structures. Many of these buildings present a very unsightly appearance and depreciate the value of adjacent areas.

It is believed that the proposed plan of routing flood waters across the Arizona Canal and spilling over the south bank would create serious operating difficulties. The most critical situation would occur after a heavy flow had passed over the open section of the canal. It is conceivable that debris and sediment could be deposited in the canal to such an extent that scheduled deliveries could not be resumed until a cleanup operation had been completed, possibly requiring several days. This could be critical during the summer flash flood period in regard to both agricultural and municipal water needs. The City of Phoenix diverts water from the Arizona Canal to its Squaw Peak purification plant (located between 22nd and 24th Streets). It is our understanding that other similar plants

possibly may be built by other municipalities. We seriously question the advisability of dumping sediment and debris laden flood flows directly into the Arizona Canal.

It is suggested that further consideration be given to plans which would provide desired protection with a minimum of interference with operation of the canal. This might be accomplished by an overchute to carry the flood waters across the canal or by siphoning the canal under the wash. This would require the construction of new wasteway facilities in the Arizona Canal to replace the existing Indian Bend wasteway.

The original design capacity of the Arizona Canal at Granite Reef Diversion Dam was 2,000 second-feet. It is believed that this capacity should be maintained to the bifurcation works at Cross Cut Canal. Permanent limitation to a lesser capacity by a new structure at Indian Bend would not be advisable, particularly with the possibility of increased flows in the canal which could occur with the construction of the potential Central Arizona Project. The Interim Report indicates, on page 19 and elsewhere by inference, that the capacity of the Arizona Canal at Indian Bend is 1,500 cfs.

The Interim Report does not detail the items for which the $300,000 for irrigation structures will be expended (Appendix 3-3). Therefore, we are unable to comment on these features. We wish to call your attention to the fact that the Indian Bend Wash has for years been used by the Salt River Project as a wasteway for return irrigation flows and, from Thomas Road south, it is used to convey the flow from several irrigation pumps. The total waste and pumped flow are diverted into what is known as Indian Bend Pump Lateral, which eventually connects with the Grand Canal in the SE¼ of Section 9, T. 1 N., R. 4 E. For orientation purposes, this ditch crosses Scottsdale Road at Princess Road. Possibly arrangements could be made for this water to be conveyed in the proposed flood channel if suitable means could be provided to divert the flow into the Indian Bend Pump Lateral. If such an arrangement could be provided, it would also be possible to intercept, for irrigation use, some of the minor storm runoff resulting mostly from street and area drainage mentioned previously. If diversion could not be provided from the proposed flood channel to the lateral, a parallel conveyance channel (pipe or open ditch) would be needed. Due to the rapid development

of the area and conversion of irrigated land to homesites, it is expected that, in the near future, little waste water will be involved; however, operation of the irrigation pumps will be continued. The possibility exists that one of the wells, located approximately one-half mile south of Van Buren Street, may be within the desired right-of-way and may have to be relocated.

We appreciate the opportunity to review and comment on your report.

Sincerely yours,

/s/ R. S. WELSH

For A. B. WEST
Regional Director

In duplicate

U. S. ARMY ENGINEER DISTRICT, LOS ANGELES
CORPS OF ENGINEERS
751 South Figueroa Street
Los Angeles 17, California

SPLGP-F

13 June 1962

Mr. A. B. West
Regional Director, Region 3
Bureau of Reclamation
U. S. Department of the Interior
Boulder City, Nevada

Dear Mr. West:

Reference is made to your letter dated 23 April 1962 containing comments to our proposed interim report on survey for flood control, Indian Bend Wash, Arizona.

We have given further consideration to the design of the proposed flood channel crossing of the Arizona Canal and are changing the design shown in the proposed report so that the canal will be siphoned under the channel.

You indicate in your letter that the original design capacity of the Arizona Canal of 2,000 cubic feet per second should be maintained at Indian Bend Wash. In our analysis, we did not intend to change the present capacity of the canal and are using 2,000 cubic feet per second in the design of the siphon. We are also revising the report to indicate that the capacity of the Arizona Canal is about 2,000 cubic feet per second.

You mention a possible arrangement to divert both return irrigation flows and minor storm runoff from the proposed channel into the Indian Bend Pump Lateral, just south of Van Buren Street. Design studies show that such a facility could be provided. This feature will be indicated on the plates in the completed issue of the report.

Sincerely yours,

/s/ EDWARD KOEHM
Chief, Engineering Division

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
P. O. Box 1306
Albuquerque, New Mexico

April 3, 1962

District Engineer
Corps of Engineers, U. S. Army
P. O. Box 17277, Foy Station
Los Angeles, California

Dear Sir:

Reference is made to your letter of March 16, 1962, transmitting for our review a copy of your Interim Report on Indian Bend Wash, Arizona. The changes made in your report do not materially change the analysis presented in our letter report of August 14, 1961. The area is urbanized and no important fish and wildlife resources are involved. Extensive benefits could be realized, however, if a permanent water area suitable for fishing could be developed as part of the project.

This opportunity to review your report is appreciated.

Sincerely yours,

/s/ CAREY H. BENNETT, Chief
Division of Technical Services

cc:
Director, Arizona Game and Fish Department, Phoenix, Arizona
Field Supervisor, Branch of River Basin Studies, Bureau of Sport Fisheries and Wildlife, Salt Lake City, Utah

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
P. O. BOX 1306
Albuquerque, New Mexico

August 14, 1961

District Engineer
Corps of Engineers, U. S. Army
P. O. Box 17277, Foy Station
Los Angeles 17, California

Dear Sir:

This letter constitutes our report on your investigations of flood control problems along Indian Bend Wash, Vicinity of Scottsdale, Arizona. It has been prepared in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), and has received the concurrence of the Arizona Game and Fish Department by letter dated August 7, 1961, signed by Director Robert J. Smith.

It is our understanding that the plan under consideration would comprise an earth diversion levee about 59,000 feet long running north of the Arizona canal from Indian Bend Wash eastward to a point near the Evergreen Wasteway and then on into the Salt River.

The project area is largely urbanized and no significant fish and wildlife values are involved. The project itself will cause no significant losses and no fish and wildlife benefits will be realized. If, however, study by your office should reveal the feasibility of impounding one or more areas of permanent water suitable for fish production, important benefits could be achieved.

Sincerely yours,

/s/ JOHN C. GATLIN
Regional Director

Distribution:

(2) Director, Arizona Game and Fish Department, Phoenix, Arizona
(2) Field Supervisor, Branch of River Basin Studies, Bureau of Sport Fisheries and Wildlife, Salt Lake City, Utah

ARIZONA GAME & FISH DEPARTMENT
105 State Office Building
Phoenix 7, Arizona

Robert J. Smith
Director

Wendell Swank
Assistant Director

August 7, 1961

District Engineer
U. S. Army Engineer District, Los Angeles
P. O. Box 17277, Foy Station
Los Angeles 17, California

AIR MAIL

File No. SPLGP-F

Dear Sir:

We appreciate having Mr. Thompson's letter and attached maps requesting our comments on the proposed Indian Bend Wash flood control project.

It appears that an earth diversion levee some 59,000 feet long is proposed for construction from Indian Bend Wash west of Scottsdale Road through the Salt River Indian Reservation to the Salt River.

Much of the project area is urbanized or within the Indian Reservation and no significant wildlife values will be affected. It does not appear that any benefits to either fish or wildlife can be realized in connection with the proposal. Should it be determined as project plans develop that one or more areas for permanent water impoundment might be provided, important fish and recreational benefits could result and our office would appreciate being advised accordingly.

Sincerely,

R. J. SMITH, Director

/s/ By: O. N. ARRINGTON
Lands Division

In reply refer to:
Land Operations

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF INDIAN AFFAIRS
Phoenix Area Office
P. O. Box 7007
Phoenix 11, Arizona

April 16, 1962

Your reference: SPLGP-F

District Engineer
U. S. Army Engineer District, Los Angeles
Corps of Engineers
751 So. Figueroa St.
Los Angeles 17, Calif.

Dear Sir:

Reference is made to your letter dated 16 March 1962, concerning the proposed interim report for flood control, Indian Bend Wash, Arizona.

The plan proposed in the report for a concrete-lined channel lying west of the Salt River Indian Reservation meets with the approval of the Phoenix Area Office of the Bureau of Indian Affairs.

The only suggestion which we have to offer is that some modification of the crossing of Indian Bend Wash and the Arizona Canal be considered which would permit flow of water from the north side of the canal into the proposed flood channel without backing up the canal to a dangerous elevation as to Indian lands upstream.

Thank you for the opportunity to review this interim report.

Sincerely yours,

/s/ GEORGE W. HEDDEN
Assistant Area Director

U. S. ARMY ENGINEER DISTRICT, LOS ANGELES
CORPS OF ENGINEERS
751 South Figueroa Street
Los Angeles 17, California

SPLGP-F

30 April 1962

Mr. George W. Hedden
Assistant Area Director
Phoenix Area Office
Bureau of Indian Affairs
U. S. Department of the Interior
P. O. Box 7007
Phoenix 11, Arizona

ATTENTION: Land Operations

Dear Mr. Hedden:

Reference is made to your letter of 16 April 1962 regarding our interim report on flood control, Indian Bend Wash, Arizona.

You suggested that a modification of the crossing of Indian Bend Wash and Arizona Canal be considered. If the project is authorized for construction, we will make detailed design studies to provide a canal crossing which will meet the requirements of all concerned agencies.

Sincerely yours,

/s/ EDWARD KOEHM
Chief, Engineering Division

In reply refer to
E

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
STATE OFFICE
3022 Federal Building
Phoenix 25, Arizona

March 28, 1962

Mr. H. W. Thompson
Chief, Engineering Division
U. S. Army Engineer District
751 South Figueroa St.
Los Angeles 17, California

Dear Mr. Thompson:

We refer to your Interim Report on Survey for Flood Control Indian Bend Wash, Arizona, which was sent to us by your letter of March 16, 1962.

Your proposed construction on the Indian Bend Wash affects the $N\frac{1}{2}NE\frac{1}{4}$ and the $NE\frac{1}{4}NW\frac{1}{4}$, and $SW\frac{1}{4}NW\frac{1}{4}$, sec. 14, T. 1 N., R. 4E. The above 160 acres are Federal lands which were withdrawn by Secretarial Order dated January 25, 1923 for the Bureau of Reclamation.

The above lands are under the control of the United States Bureau of Reclamation Salt River Project. We suggest you obtain approval of that agency for right-of-way and use of these lands.

It would be helpful if the township and range lines were on your maps.

Sincerely yours,

/s/ FRED J. WEILER
State Director

U. S. ARMY ENGINEER DISTRICT, LOS ANGELES
CORPS OF ENGINEERS
751 South Figueroa Street
Los Angeles 17, California

Refer to File No.
SPLGP-F

30 April 1962

Mr. A. B. West
Regional Director, Region 3
Bureau of Reclamation
U. S. Department of the Interior
Boulder City, Nevada

Dear Mr. West:

We have been informed by the Arizona State Director of the Bureau of Land Management that the $N\frac{1}{2}NE\frac{1}{4}$, the $NE\frac{1}{4}NW\frac{1}{4}$, and the $SW\frac{1}{4}NW\frac{1}{4}$, sec. 14, T. 1 N., R. 4 E., generally in the Salt River at the mouth of Indian Bend Wash and just northeast of Tempe, Arizona, are Federal lands withdrawn by Secretarial Order dated 25 January 1923 for the Bureau of Reclamation.

These lands are at the outlet of the proposed Indian Bend Wash channel project described in the Interim Report on Survey for Flood Control, Indian Bend Wash, Arizona, copy of which was sent to you for review and comment on 16 March 1962.

We would appreciate a statement of the present status of these lands and whether the Bureau of Reclamation intends using them. Such a statement would be useful in our planning of the proposed Indian Bend Wash project.

Sincerely yours,

/s/ EDWARD KOEHM
Chief, Engineering Division

U. S. ARMY ENGINEER DISTRICT, LOS ANGELES
CORPS OF ENGINEERS
751 South Figueroa Street
Los Angeles 17, California

SPLGP-F

18 May 1962

Mr. Fred J. Weiler
Arizona State Director
Bureau of Land Management
U. S. Department of the Interior
State Office, 3022 Federal Building
Phoenix 25, Arizona

Dear Mr. Weiler:

Your reference "E"

Reference is made to your letter of 28 March 1962, regarding our Interim Report on Survey for Flood Control, Indian Bend Wash, Arizona.

We have written the Bureau of Reclamation regarding the status of the lands you mentioned in your letter. Further contact with that agency will be made when the need for the use of the lands arises.

The township and range lines, as you suggested in your letter, will be shown on the design drawings in the report.

Sincerely yours,

/s/ EDWARD KOEHM
Chief, Engineering Division

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
Region 3
Boulder City, Nevada

3-420

Your reference:
SPLGP-F

May 7, 1962

District Engineer
United States Army Engineer District,
Los Angeles
P. O. Box 17277, Foy Station
Los Angeles 17, California

Attention: Mr. Edward Koehm
Chief, Engineering Division

Dear Sir:

The following information is furnished in reply to the letter from your office of April 30, 1962, concerning the land described as the $N\frac{1}{2}NE\frac{1}{4}$, $NE\frac{1}{4}NW\frac{1}{4}$, and the $SW\frac{1}{4}NW\frac{1}{4}$, Section 14, T. 1 N., R. 4 E., G&SRM. These tracts of land are under Reclamation withdrawal and are being held as potential material sites for use in the construction of the Central Arizona Project. During the interim, permits have been granted to the Arizona Highway Department, Maricopa County, and the city of Phoenix, to remove sand and gravel from these lands. These lands are also crossed by various utilities, rights-of-way for which have been granted by this office. If any further information is necessary, please contact us.

Sincerely yours,

/s/ A. B. WEST
Regional Director

5-14

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
Region 3
Boulder City, Nevada

3-420

May 16, 1962

Your reference:
SPLGP-F

District Engineer
United States Army Engineer District,
Los Angeles
P. O. Box 17277, Foy Station
Los Angeles 17, California

Attention: Mr. Edward Koehm
Chief, Engineering Division

Dear Sir:

Since our reply of May 7, 1962, to your letter of April 30, 1962, it has been suggested that possibly the reason for your inquiry concerning these lands was that they were needed for right-of-way for flood control works in Indian Bend Wash. In this connection, Maricopa County has previously contacted us requesting an easement for flood control works across the Reclamation-withdrawn lands in Section 14, T. 1 N., R. 4 E., G&SRM. We have prepared a document for an easement which was satisfactory to the County, and have informed it that such document would be executed if and when flood control works were actually instituted.

Sincerely yours,

/s/ A. B. WEST
Regional Director

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
Region III

Office of
Regional Director

224 New Custom House
Denver 2, Colorado

April 19, 1962

District Engineer
U. S. Army Engineer District,
Los Angeles
P. O. Box 17277, Foy Station
Los Angeles 17, California

Dear Sir:

Referring to your letter of March 16, 1962, File No. SPLGP-F, concerning the proposed interim report for flood control, Indian Bend Wash, Arizona, we transmit the following comments:

Indian Bend Wash is the main drainage channel in Paradise Valley, which lies between the Phoenix Mountains and Camelback Mountains on the west and the McDowell Mountains on the east. Arizona Canal, one of the main canals of the Salt River system, draws water from Granite Reef Reservoir, flows westward and crosses Indian Bend Wash just north of Scottsdale. When Arizona Canal was built, the area along Indian Bend Wash, and between it and Salt River was being farmed, but now it includes the eastern part of Scottsdale, a town of about 10,000 people. The stream channels between Arizona Canal and Salt River are generally poorly defined and recurring heavy rainstorms flood the area. The District Engineer, U. S. Army Corps of Engineers, proposes to reduce flood hazards by constructing a channel along Indian Bend Wash from Arizona Canal to Salt River.

The major source of sand and gravel used during the last ten years in construction in the Phoenix area has been the bed of the Salt River between Gilespie Dam and McDowell Reservoir.

In a previous investigation (interim report on survey for flood control, Gila and Salt Rivers, Gilespie Dam to McDowell Dam site, Arizona) proposed channel improvements along the Salt River from Gilespie Dam to McDowell Reservoir were investigated, and it was determined that there would be no ill effect on sand and gravel

operations in the area. Although channel improvements along the lower part of Indian Bend Wash will expedite the runoff from this area into the Salt River, it is believed that the increase will not be sufficient to materially change findings already reported. No other mineral commodities or installations are known in the affected area.

Sincerely yours,

/s/ ROBERT W. GEEHAN
Regional Director, Region III

UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
Region Three
Santa Fe, New Mexico

L7423

April 4, 1962

District Engineer
U. S. Army Engineer District, Los Angeles
P. O. Box 17277, Foy Station
Los Angeles 17, California

Dear Sir:

Thank you for the opportunity to review your proposed interim report for flood control, Indian Bend Wash, Arizona.

Any construction along Indian Bend Wash will almost certainly damage or destroy prehistoric structures. If this project is authorized, an archeological survey of the area will be made by the National Park Service.

Sincerely yours,

/s/ THOMAS J. ALLEN
Regional Director

U. S. ARMY ENGINEER DISTRICT, LOS ANGELES
CORPS OF ENGINEERS
751 South Figueroa Street
Los Angeles 17, California

SPLGP-F

30 April 1962

Mr. Thomas J. Allen
Regional Director, Region Three
National Park Service
U. S. Department of the Interior
Santa Fe, New Mexico

Dear Mr. Allen:

Reference is made to your letter of 4 April 1962 regarding our interim report for flood control, Indian Bend Wash, Arizona.

If the project is authorized for construction, we will coordinate our plans to permit an archeological survey of the area by your agency.

Sincerely yours,

/s/ EDWARD KOEHM
Chief, Engineering Division

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
TOPOGRAPHIC DIVISION
345 Middlefield Road
Menlo Park, California
Davenport 5-6761

April 3, 1962

Memorandum

To: H. W. Thompson, Chief, Engineering Division
Corps of Engineers, Los Angeles

From: R. O. Davis, Geological Survey Member, PSFC

Subject: Corps of Engineers report on "Indian Bend Wash, Arizona"

Copies of the subject report have been given quick review in our field offices and no significant suggestions are made at this time.

We appreciate the opportunity to review the report and are holding the three copies in our files for reference purposes.

/s/ ROBERT O. DAVIS

DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
REGIONAL OFFICE

April 12, 1962

Public Health Service
447 Federal Office Building
San Francisco 2, California

Colonel W. T. Bradley
District Engineer
U. S. Army Engineer District, Los Angeles
Corps of Engineers
P. O. Box 17277, Foy Station
Los Angeles 17, California

Dear Colonel Bradley:

In accordance with the policies and procedures of the Federal Inter-Agency Committee on Water Resources, we have prepared the enclosed public health comments on your "Interim Report on Survey for Flood Control, Indian Bend Wash, Arizona (with appendixes)".

We appreciate the opportunity of reviewing the project, and wish to be kept informed of its development.

Sincerely yours,

/s/ WILLIAM B. SCHREEDER
Chief, Water Resources Development
Section, DWS&PC, PHS, Region IX

Enclosure

cc: Mr. G. W. Marx
Mr. M. B. Rainey
Mr. Charles E. Sponagle

REPORT

on

THE PUBLIC HEALTH ASPECTS

of the

INTERIM REPORT ON SURVEY FOR FLOOD CONTROL

on

INDIAN BEND WASH, ARIZONA

(with appendixes)

for

THE U. S. CORPS OF ENGINEERS

Prepared by

THE U. S. PUBLIC HEALTH SERVICE

DEPT. OF HEALTH, EDUCATION, & WELFARE

REGION IX - SAN FRANCISCO, CALIFORNIA

April 1962

PUBLIC HEALTH ASPECTS

on

INDIAN BEND WASH, ARIZONA

INTRODUCTION

In accordance with the policies and procedures of the Federal Inter-Agency Committee on Water Resources, this office has reviewed the "Interim Report on Survey for Flood Control, Indian Bend Wash, Arizona, (with appendixes)", as requested by the Corps of Engineers. The Public Health Service has requested and received the comments of the Arizona State Department of Health.

The Indian Bend Wash basin, which is a small part of the 58,200-square-mile drainage area of the Gila River, comprises about 224 square miles in south-central Arizona about 10 miles east and northeast of Phoenix. Indian Bend Wash is tributary to the Salt River upstream from Phoenix. The basin, which is entirely within Maricopa County and partly within the Phoenix metropolitan area, is an elongated area with a maximum north-south length of about 26 miles and a maximum east-west width of about 15 miles.

The Arizona canal, which crosses the upper end of the project area, tends to intercept and divert minor flows (up to 1,500 cubic feet per second) away from the developed areas. However, flows in excess of that amount breach the south bank of the canal and cause damage of major proportions to residential, commercial, public, utility, irrigation, street and highway, and agricultural properties.

The recommended plan of improvement provides for a concrete lined trapezoidal channel, extending along Indian Bend Wash from the Arizona canal to the Salt River, to control a flood of 40,000 cubic feet per second. This size flood is estimated to occur, on the average, about once in 100 years.

Two revetted earth levees would be required just upstream from the Arizona canal to collect and direct the floodwaters toward the channel. The concrete channel would be about 7 miles long and would be excavated entirely below the natural ground. The channel section would have a bottom width of 14 feet and side slopes of 1 vertical on 2.25 horizontal. The depth of channel would vary from 23.5 feet to 26.5 feet.

At the downstream end, an outlet transition consisting of a leveed channel section would be provided to direct the flows into the cleared channel and the low flow channel of the Salt River. The levees would be revetted on the channel side. Construction of the channel would require construction of bridges at Camelback Road, Indian School Road, Thomas Road, McDowell Road, and Van Buren Street; and the relocation of two City of Phoenix water supply mains and also other utilities.

SANITARY ENGINEERING

Water Supply

The proposed flood control improvements will not divert or impound water applicable to municipal and industrial use. Two Phoenix water lines (60- and 45-inch), however, would be relocated to clear the channel construction. Such relocation should be directed in accordance with State health regulations, and with a minimal discontinuance of service.

Sewage Disposal

Relocation of sewage facilities should similarly be directed in accordance with State health regulations, and with a minimal discontinuance of service.

Water Pollution Control

By reducing the sediment load of flood waters through channel improvement, the proposed works should improve the physical quality of downstream waters. Measures should be incorporated in the work plan to protect against the deposition of solid wastes in the channel.

Low-Flow Augmentation

Section 2b(2) of Public Law 660, amended by Public Law 87-88, is not applicable, at this time, to this project.

General Sanitation

All construction facilities, both permanent and temporary, shall be constructed and operated in accordance to local regulations governing water supply, waste disposal, and public health and safety. Inspection of the works is desirable, primarily after each major flood, to determine the general sanitary improvements required.

VECTOR PROBLEMS

Public Health and Socio-Economic Importance

Mosquitoes are the principal vectors which might be affected by the project. Several species of mosquitoes of public health importance may be produced in large numbers in the area when suitable aquatic habitats are present. Encephalitis, commonly known as sleeping sickness or brain fever, is now the most important mosquito-borne disease in the United States and the area in which the proposed project will be located. Mosquitoes transmit the encephalitis viruses among birds and from them to humans and horses. There are no effective chemotherapeutic measures for preventing or treating human cases, and some individuals, particularly children, who recover from encephalitis often suffer permanent mental disability.

Records of the U. S. Department of Agriculture show that equine encephalitis cases occurred in Maricopa County and/or neighboring counties during all years of the 17-year period, 1939 through 1955, for which records are available. During 4 of these years, Maricopa County had an incidence in excess of 5 encephalitis cases per 1,000 horses.

According to personnel of the State health department, there were four human encephalitis cases reported from Maricopa County during 1960; in the same year there were 25 equine encephalitis cases reported from the county. Both Culex tarsalis and Culex quinquefasciatus occur in the area and are considered primary vectors of encephalitis. These mosquitoes are produced in a wide range of aquatic habitats containing either fresh or foul water, such as roadside ditches, seepage pools, flooded depressions, and other semipermanent and permanent bodies of water.

Several species of vicious-biting Aedes and Psorophora mosquitoes, including Aedes vexans and Psorophora confinnis, also occur in the area. Large numbers of these mosquitoes may create public health problems by interfering with the healthful outdoor activities of both children and adults during the summer months. Individuals, particularly children, frequently require medical attention and sometimes hospitalization for treatment of secondary infections and allergic reactions resulting from mosquito bites. The Aedes and Psorophora mosquitoes may be produced in temporary surface pools and in ponds and reservoirs which have shallow vegetated areas subject to fluctuating water levels. Overflow pools along streams also provide favorable larval habitats for several species of the highly pestiferous Aedes and Psorophora mosquitoes.

In addition to their public health importance, large numbers of biting mosquitoes also cause severe economic losses by lowering meat and milk production, by reducing the efficiency of agricultural and industrial workers, by interfering with recreational enterprises, and by lowering the value of real estate.

Anticipated Effects of the
Project on Vector Problems

The reduction in flooding of lowland areas expected from the proposed flood prevention measures should result in a reduction in natural aquatic habitats which are favorable for the production of mosquitoes of public health importance. On the other hand, certain project elements may result in the development of man-made aquatic habitats highly favorable for the production of mosquitoes unless appropriate preventive and control measures are planned and built into the project and continued as a part of the regular operation. The various types of aquatic habitats that may result in the production of mosquitoes have been discussed in previous sections of this report. By making provisions for the prevention and control of man-made mosquito sources, the over-all benefits from the project can be greatly increased.

Recommendations

In order to minimize public health hazards, every possible effort should be made to avoid creating conditions which will increase populations of mosquitoes of public health importance. It is recommended that the following principles and practices be adhered to in the design, construction, operation, and maintenance of the proposed project.

Responsibility for Mosquito Control

Responsibility for mosquito prevention and control is normally associated with land ownership or operating rights. Therefore, the agency, group, or individuals responsible for various aspects of the proposed project should be prepared to accept full responsibility for the prevention and control of mosquito problems resulting from the design, construction, operation, or maintenance of the project.

Prevention and Source Reduction Measures

1. Borrow areas resulting from construction of the levees should be made self-draining.

2. Excavated channel material unsuitable for levee construction or backfill operations should be disposed of in such a way that it will not result in ponding.

3. Adequate drains should be installed to prevent ponding on berms or behind spoil banks, levees, or concrete channels.

4. Drainage ditches should be designed, constructed, and maintained so that they will concentracte low flows and reduce silt deposition and subsequent ponding, thereby insuring free flows at all times.

5. Underdrains, culverts, inlets, etc., should be placed on grade to prevent ponding.

6. All areas of natural drainageways that are cut off or bypassed by the new channels should be filled or provided with adequate drains.

7. Interior drainage facilities should be well maintained to avoid excessive ponding.

Supplemental Chemical Control Measures

In situations where adequate vector control is not obtained through the prevention and source reduction measures outlined above, provisions should be made for supplemental use of insecticides and rodenticides to achieve the desired level of control.

ACCIDENT PREVENTION

Generally, the reduced flood danger should lead to a safer environment; however, the following additions to the planned facilities are recommended:

1. All channels should be fenced through residential areas and should be so designed as to prevent public access insofar as feasible; and

2. All facilities shall be suitably posted to inform the public of any hazard or danger, including the feasibility of flash floods.

GENERAL

It is further recommended that the U. S. Public Health Service and State of Arizona Department of Health be forwarded two copies each of any revisions in workplans or construction for a public health review and comment.

U. S. ARMY ENGINEER DISTRICT, LOS ANGELES
CORPS OF ENGINEERS
751 South Figueroa Street
Los Angeles 17, California

SPLGP-F

30 April 1962

Mr. William B. Schreeder
Chief, Water Resources Development Section
Water Supply and Pollution Control
Public Health Service, Region IX
447 Federal Office Building
San Francisco 2, California

Dear Mr. Schreeder:

Your comments inclosed with your letter of 12 April 1962 regarding our proposed interim report for flood control, Indian Bend Wash, Arizona, are appreciated.

We note that the reduction in flooding of lowland areas expected from the proposed flood prevention measures should result in a reduction in natural aquatic habitats which are favorable for the production of mosquitoes of public health importance.

Your comments also contain a number of recommendations regarding the prevention of man-made ponding. If the project, described in the report, is authorized, your recommendations will be taken into careful consideration at the time of later detailed design studies.

Sincerely yours,

/s/ EDWARD KOEHM
Chief, Engineering Division

U. S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS
230 N. 1st Avenue
Phoenix 25, Arizona

Region Seven

May 2, 1962

In reply refer to:
07-02.6

U. S. Army Engineer District,
Los Angeles
Corps of Engineers
751 South Figueroa Street
Los Angeles 17, California

Attn: Mr. Edward Koehm
Chief, Engineering Division

Dear Sir:

Reference is made to your letter of April 30, 1962, concerning our comments on your interim report for flood control, Indian Bend Wash, Arizona.

We have no comment to add to that already carried in Paragraph 85 of the report wherein Federal-aid highway funds are stated to be ineligible for use on highways or bridges built or reconstructed as part of the local contribution to financing the project.

Sincerely yours,

W. H. BAUGH
Division Engineer

/s/ by V. G. WATSON
District Engineer

U. S. ARMY ENGINEER DISTRICT, LOS ANGELES
CORPS OF ENGINEERS
751 South Figueroa Street
Los Angeles 17, California

SPLGP-F

18 May 1962

Mr. J. van de Erve
Western Area Engineer
U. S. Weather Bureau
650 Capitol Ave., Rm. 1618
Sacramento 14, California

Dear Mr. van de Erve:

This will acknowledge receipt of a copy of the letter dated 20 March 1962 from Mr. Louis R. Jurwitz, Meteorologist in Charge, Weather Bureau, Phoenix, Arizona, regarding our interim report on flood control, Indian Bend Wash, Arizona.

The correction in climatological data in the Hydrology appendix, indicated in Mr. Jurwitz' letter, will be made in the final report.

Thank you for the comments.

Sincerely yours,

/s/ EDWARD KOEHM
Chief, Engineering Division

cc: Mr. Louis R. Jurwitz

UNITED STATES
DEPARTMENT OF COMMERCE
WEATHER BUREAU
2800 Sky Harbor Blvd.
Room 135
Phoenix 34, Arizona

March 20, 1962

Mr. J. van de Erve
Western Area Engineer
U. S. Weather Bureau
650 Capitol Avenue, Room 1618
Sacramento 14, California

Dear Mr. van de Erve:

I have reviewed the copy of the Indian Bend Wash, Arizona, interim report which Mr. Thompson so graciously provided with a copy of his letter to you dated 16 March 1962.

In checking climatological data in Table 1, pages 1-12 of Appendix 1-Hydrology, I find that City Office records at Phoenix indicate 4.82 inches of precipitation as the maximum monthly amount for March. This occurred during March 1941. (Airport total for the month was 4.16 inches).

I believe the interim report is quite comprehensive in view of the lack of specific field hydrologic data. It is hoped that the recommended works can be constructed as they will afford a great measure of protection to properties in the eastern sections of Phoenix and in Scottsdale.

Sincerely yours,

/s/ LOUIS R. JURWITZ
Meteorologist in Charge

cc: Chief Engineer,
Los Angeles Corps of Engineers

U. S. DEPARTMENT OF COMMERCE
COAST AND GEODETIC SURVEY
Washington 25, D. C.

611/2/ABC/jw

April 17, 1962

Mr. H. W. Thompson
Chief, Engineering Division
U. S. Army Engineer District
Los Angeles Corps of Engineers
751 South Figueroa Street
Los Angeles 17, California

Dear Sir:

Your letter of March 16, 1962, and the enclosed proposed report for flood control, Indian Bend Wash, Arizona, has been referred here from our Los Angeles District Office.

Primary horizontal and vertical control now exists in the area under consideration, and is considered adequate to meet project needs.

Sincerely yours,

/s/ JAMES C. TISON, JR.
Rear Admiral, USC&GS
Deputy Director

U. S. DEPARTMENT OF COMMERCE
COAST AND GEODETIC SURVEY
417 South Hill, Room 535
Los Angeles 13, California

May 1, 1962

U. S. Army Engineer District,
Corps of Engineers
751 South Figueroa Street
Los Angeles 17, California

Attention: Edward Koehm,
Chief, Engineering Division

Gentlemen:

We refer to your File No. SPLGP-F, letter dated April 30, 1962.

We offer no comment on the proposed interim report for flood control, Indian Bend Wash, Arizona, submitted with your letter dated March 16, 1962.

Sincerely yours,

/s/ E. B. BROWN
Captain, C&GS
Los Angeles District Officer

FEDERAL POWER COMMISSION
REGIONAL OFFICE
555 Battery Street, Room 415
San Francisco 11, Calif.

85-Gila R.
WA 34

April 4, 1962

Colonel W. T. Bradley
District Engineer
U. S. Army Engineer District, Los Angeles
Corps of Engineers
P. O. Box 17277, Foy Station
Los Angeles 17, California

Dear Colonel Bradley:

We have reviewed your proposed interim report for flood control, Indian Bend Wash, Arizona, sent us by Mr. Thompson's letter of March 16, 1962 (file SPLGP-F). Your report shows there is a serious flood problem along Indian Bend Wash, and that the existing stream channel is inadequate in capacity. You found that the construction of a channel improvement along Indian Bend Wash from the Arizona Canal to the Salt River would control all floods up to and including 40,000 cubic feet per second, and would prevent about 96 percent of the potential damages in the area. The total first cost of the improvement is estimated at $8,500,000, and the benefit-cost ratio, based on tangible benefits alone, is about 1.8 to 1.

In your studies you also gave consideration to the use of reservoirs and detention basins, but found them either inadequate or high in cost. No consideration was given to a Federal multiple-purpose project providing for flood control, hydroelectric power, and other functions because of the lack of suitable sites and other factors.

Our review indicates you have thoroughly studied the needs and solutions for the flood control problem, and that the development of hydroelectric power is not involved in the proposed improvement.

We thank you for making the proposed report available for our review.

Sincerely yours,

/s/ LESHER S. WING
Regional Engineer

HOUSING AND HOME FINANCE AGENCY
OFFICE OF THE REGIONAL ADMINISTRATOR
989 Market Street
San Francisco 3, California

Region VI

March 23, 1962

District Engineer
U. S. Army Engineer District
751 South Figueroa Street
Los Angeles 17, California

Dear Sir:

In reference to letter file SPLGP-F, dated March 16, 1962, be advised that there are no current projects located in the area of Indian Bend Wash, Arizona.

Sincerely yours,

/s/ PAUL EMMERT
Regional Director
Community Facilities

UNITED STATES
DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
2180 Milvia Street
Berkeley 4, California

May 3, 1962

Mr. Edward Koehm, Chief
Engineering Division
Corps of Engineers
U. S. Army Engineer District, L. A.
P. O. Box 17277, Foy Station
Los Angeles 17, California

Dear Mr. Koehm:

Reference is made to your letter of 30 April concerning the proposed interim report for flood control, Indian Bend Wash, Arizona sent to us under date of 16 March for review and comment.

In accordance with prescribed procedures, distribution of the report was made to Robert V. Boyle, State Conservationist, Soil Conservation Service, Phoenix, Arizona; and to Fred H. Kennedy, Regional Forester, U. S. Forest Service, Albuquerque, New Mexico. Comments from these offices were received and coordinated in this office, and the individual agency comments were furnished to your office under dates of 23 March and 16 April respectively.

This office has reviewed the report and feels that the comments from Messrs. Boyle and Kennedy are adequate considering the minimal effect the proposed works of improvement appear to have on the agriculture of the area. My comments are limited strictly to the agricultural concepts presented in the report.

Thanks for the opportunity to review the report.

Sincerely yours,

/s/ KIRK M. SANDALS
River Basin Representative

UNITED STATES
DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Arizona State Office
Room 6015, Federal Building
Phoenix 25, Arizona

April 16, 1962

AIR MAIL

District Engineer
U. S. Army Engineer District, L. A.
P. O. Box 17277, Foy Station
Los Angeles 17, California

Dear Sir:

Reference is made to your letter of March 16, 1962, transmitting your Interim Report on the Survey for Flood Control of the Indian Bend Wash in Arizona.

Any affects of this program on agriculture in the area would be insignificant. As you mentioned in the report - "Most of the agricultural development in the Indian Bend Wash Basin is now confined to the Salt River Indian reservation ---". There are no soil conservation districts in this area.

We appreciate the opportunity to review the subject reports.

Sincerely yours,

/s/ ROBERT V. BOYLE
State Conservationist

WER:gr

UNITED STATES
DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Southwestern Region
517 Gold Ave., SW
Albuquerque, New Mexico

3520 March 23, 1962

Mr. H. W. Thompson, Chief
Engineering Division
Corps of Engineers
U. S. Army Engineer District
Los Angeles, California

Dear Mr. Thompson:

Reference is made to your letter of March 16, in which you request comments on the Interim Report on Survey for Flood Control, Indian Bend Wash, Arizona.

We have reviewed the report and find that the U. S. Forest Service administers no lands within the project area and thus we have no comments to make on the report.

Sincerely yours,

FRED H. KENNEDY
Regional Forester

/s/ By: O. M. Jackson

ARIZONA HIGHWAY DEPARTMENT
Phoenix 7, Arizona

9 April 1962

District Engineer
U. S. Army Engineer District,
Los Angeles
P. O. Box 17277 - Foy Station
Los Angeles 17, California

Attention: H. W. Thompson
Chief, Engineering Division

RE: SPLGP-F

Gentlemen:

In accordance with your letter of 16 March, I have reviewed the proposed interim report for flood control, Indian Bend Wash, Arizona.

The Arizona Game & Fish Department is not concerned with the project as proposed since fish and wildlife benefits will not be realized. Their specific comments will be forwarded directly to your office.

No comments or expressions of interest have been received from any other State agency.

Since the recommended improvement meets the needs for flood control in the Scottsdale area as expressed by local interests, and since the report has shown the project to be feasible and economical, I concur with the recommendations as expressed therein.

Very truly yours,

/s/ MARTIN TONEY
Engineer of Bridges and Dams

MT:hh

ARIZONA GAME & FISH DEPARTMENT
105 State Office Building
Phoenix 7, Arizona

April 9, 1962

District Engineer
U. S. Army Engineer District, Los Angeles
P. O. Box 17277, Foy Station
Los Angeles 17, California

Dear Sir:

We appreciate receiving a copy of your Interim Report on Survey for Flood Control, Indian Bend Wash, Arizona and your request of March 16, 1962, for any further comments we may have regarding this proposed project.

The proposed project developments are within an area that is urbanized or rapidly becoming so and no significant fish and wildlife values are involved. As a result, our Department will have no concern unless your office determines prior to construction that it is feasible to impound water permanently at some point which would be suitable for fish production. In that event important benefits could be achieved in one of the most desirable residential areas in the southwest.

Sincerely,

R. J. SMITH, Director

/s/ By: O. N. ARRINGTON, Chief
Special Services Division

ONA:o

cc: U. S. Fish and Wildlife Service, Albuquerque
Martin Toney, Phoenix

APPENDIX 6 - RESOLUTION BY LOCAL INTERESTS

INDIAN BEND WASH, ARIZONA
GILA RIVER BASIN, ARIZ. AND N. MEX.

MARICOPA COUNTY RESOLUTION

WHEREAS, Act of Congress, Public Law 761, Seventy-fifth Congress, approved June 28, 1938, authorized a preliminary examination and survey for flood control on the Gila River and tributaries, Arizona and New Mexico;

WHEREAS, a flood-control project for Indian Bend Wash in the vicinity of Scottsdale, Arizona, is being considered in an interim report for flood control on Indian Bend Wash, Arizona, and is being prepared by the District Engineer, U. S. Army Corps of Engineers at Los Angeles, California;

WHEREAS, protection against flood damage would be provided to property along Indian Bend Wash in and adjacent to Scottsdale, Arizona, by a channel improvement under consideration for construction by the United States;

WHEREAS, Section 3 of Public Law 738, Seventy-fourth Congress, provides that no money appropriated shall be expended on the construction of any project until States, political subdivision thereof, or any other responsible local agencies have given assurances satisfactory to the Secretary of the Army that they will assume certain enumerated obligations;

WHEREAS, Title 45, Chapter 10, Section 45-2323 of the Arizona State Water Code authorizes the Board of Supervisors of any county, separately or severally, to cooperate with the United States for the construction of a flood-control project within any such county or counties for local flood-control protection;

WHEREAS, the Board of Supervisors of Maricopa County has considered the need for flood control along Indian Bend Wash in and adjacent to Scottsdale, Arizona, and has agreed that it go on record supporting the flood-control program under consideration by the United States Army Engineers.

NOW, THEREFORE, BE IT RESOLVED by the Board of Supervisors of Maricopa County, Arizona and the Board of Directors of the Flood Control District of Maricopa County, Arizona, that, if a flood-control project consisting of a channel improvement along Indian Bend Wash between the Arizona Canal and the Salt River be found economically feasible and be authorized by Act of Congress, the County of Maricopa and the Flood Control District of Maricopa County will participate to the best of their ability by assuming the following obligations:

a. Acquire and provide, without cost to the United States, all lands, easements, and rights-of-way necessary for the construction of the project, at a cost presently estimated at $700,000.

b. Perform, without cost to the United States, all necessary relocations of highways and roads (including bridges), utilities, drainage and irrigation facilities, and all necessary street modifications required in connection with the project, at a cost presently estimated at $700,000.

c. Hold and save the United States or any instrumentality, department, or agency thereof, free from any damages arising from construction, maintenance, and operation of the work.

d. Maintain and operate, upon completion all works in accordance with regulations to be prescribed by the Secretary of the Army.

e. Establish and enforce flood-channel limits and regulations, satisfactory to the Secretary of the Army, for the preservation of the flood-carrying capacity of the proposed improvement.

BE IT FURTHER RESOLVED that this resolution be entered in the minutes of the Board of Supervisors of the County of Maricopa and the minutes of the Board of Directors of the Flood Control District of Maricopa County and that the Clerk of said County be, and is hereby directed to forward a certified copy of this resolution to the District Engineer, U. S. Army Engineer District, Los Angeles, Corps of Engineers, Post Office Box 17277, Foy Station, Los Angeles 17, California.

PASSED AND APPROVED THIS 5th day of February, 1962.

/s/ Ruth A. O'Neil
Chairman of the Board of Directors
of the Flood Control District of
Maricopa County

/s/ Ruth A. O'Neil
Chairman of the Board of Supervisors
of Maricopa County

ATTEST:

/s/Rhea Averill
Clerk of the Board

INDIAN BEND WASH, ARIZONA
GILA RIVER BASIN, ARIZ. AND N. MEX.

Information called for by
Senate Resolution 148, 85th Congress
Adopted January 28, 1958

1. Problems considered.--This report considers the flood problem along Indian Bend Wash, in and near Scottsdale, Ariz. Indian Bend Wash is a tributary of the Salt River just upstream of Phoenix. The drainage area comprises about 224 square miles. The Arizona canal, which crosses the upper end of the developed area, tends to intercept and divert minor flows (up to 2,000 cubic feet per second) away from the developed areas. However, flows in excess of that amount breach the south bank of the canal and cause damage of major proportions to residential, commercial, public, utility, irrigation, street and highway, and agricultural properties.

2. Recommended improvement.--(a) The recommended plan of improvement provides for a concrete lined trapezoidal channel, extending along Indian Bend Wash from the Arizona canal to the Salt River, to control a flood of 40,000 cubic feet per second. This size flood is estimated to occur, on the average, about once in 100 years. Such a flood, although about 56 percent of the standard project flood, is about 2-1/2 times as large as any known flood of record and would be more than 25 times the average non-damaging capacity of the existing wash. About 96 percent of the average annual damages would be prevented by the recommended plan of improvement.

(b) Two revetted earth levees would be required just upstream from the Arizona canal to collect and direct the floodwaters toward the channel. A concrete box culvert would siphon canal flows under the channel. The concrete lined channel would be about 7 miles long and would be excavated entirely below the natural ground. The channel section would have a bottom width of 14 feet and side slopes of 1 vertical on 2.25 horizontal. The depth of channel would vary from 23.5 feet to 26.5 feet.

(c) At the downstream end, an outlet transition consisting of a leveed channel section would be provided to direct the flows into the cleared channel and the low flow channel of the Salt River authorized by the Flood Control Act of 1960 (see H. Doc. 279, 86th Cong., 2d sess., which contains the interim survey report, flood control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Ariz.). The levees would be revetted on the channel side. The bottom of the outlet transition would be paved with stone.

(d) Construction of the channel would require construction of bridges at Camelback Road, Indian School Road, Thomas Road, McDowell Road, and Van Buren Street; and the relocation of 2 city of Phoenix water supply mains and also other utilities.

3. Project costs.--Estimated costs for the recommended project, based on November 1961 prices, are as follows:

Item	Estimated costs
Federal (construction of channel)	$7,250,000
Non-Federal (rights-of-way and relocations)	1,770,000
Total	9,020,000

The average annual cost (all non-Federal) for operation and maintenance is estimated at $22,000. Preauthorization costs of $60,000 already expended are not included in the above estimates.

4. Benefit-cost ratio.--Average annual costs and benefits and benefit-cost ratios for the recommended project, developed on the basis of an economic life of 100 years as well as an economic life of 50 years, are given in the following table. An interest rate of 2-5/8 percent was applied. November 1961 prices were used.

Item	Life of project	
	100 years	50 years
Average annual costs:		
Interest and amortization (Federal)	$205,700	$262,000
Interest and amortization (non-Federal)	64,750	78,250
Maintenance and operation (non-Federal)	22,000	22,000
Total	292,250	362,250
(Say)	292,000	362,000
Average annual benefits:		
Prevention of flood damages	530,000	490,000
Ratio of benefits to costs	1.8 to 1	1.4 to 1

5. Intangible project effects.--Many benefits not susceptible of monetary evaluation would accrue to the flood-control channel provided by the recommended plan. Such benefits would include reduction of hazards to life; prevention of interruptions to business, homelife, and other normal community activities; preservation of community morale by reducing fear of floods; and reduction of the menace from epidemics caused by flood damage to sewer and water systems. These benefits were not evaluated in monetary terms.

6. Current and future needs.--The recommended project is feasible from an engineering standpoint and would provide substantial protection to residential, commercial, public, utility, street and highway, and irrigation properties in and adjacent to Scottsdale, Ariz. The plan of improvement should meet all the foreseeable justifiable needs of Indian Bend Wash for flood control.

7. Allocation of costs.--The recommended plan would provide for a single-purpose flood-control improvement, and no allocation of costs between purposes would be involved.

8. Local cooperation.--The terms of local cooperation for the recommended project would provide that, prior to construction, local interests furnish assurances satisfactory to the Secretary of the Army that they will (a) acquire and provide, without cost to the United States, all lands, easements, and rights-of-way necessary for the construction and subsequent maintenance and operation of the project; (b) perform, without cost to the United States, all necessary relocations of highways, roads, bridges, irrigation facilities, and utilities required in connection with construction of the flood-control works; (c) hold and save the United States free from any damages due to the construction works; (d) maintain and operate all the works, after completion, in accordance with regulations to be prescribed by the Secretary of the Army; and (e) establish and enforce flood-channel limits and regulations, satisfactory to the Secretary of the Army, for the preservation of the flood-carrying capacity of the channel improvement. These terms are in accordance with provisions of flood-control law for local-protection projects.

9. Extent of interest in project.--Local interests desire protection along Indian Bend Wash to prevent flood losses and eliminate interruptions to highway, irrigation, and utility services. They offer to cooperate.

10. Other plans considered.--(a) Preliminary consideration was given to channelization of Indian Bend Wash north of the Arizona canal to Bell Road. Such an improvement could not be economically justified.

(b) Consideration was given to the construction of detention basins, but such plans were found to be infeasible.

(c) Consideration was also given to a plan involving the diversion of floodflows above the Arizona canal from Indian Bend Wash southeasterly to the Salt River. The improvement would consist of an earthfill levee about 11 miles long and about 16 feet high above the natural ground surface. The levee would cross the Arizona canal about 1,600 feet upstream or easterly of the Evergreen Wasteway. Standard project flows, ranging from 55,000 cubic feet per second at the upstream end to 72,000 cubic feet per second at the lower end of the levee, would be intercepted and diverted to the Salt River. In order to accommodate these flows behind the

levee, a floodway width varying from 2,200 feet to 2,400 feet would be required. Preliminary considerations indicated that this plan might be superior to the recommended plan. Preliminary estimates indicated that the cost of this alternative plan would be $4,600,000 (November 1961 prices), of which $2,400,000 would be for construction, $1,500,000 for rights-of-way, and $700,000 for relocations of utilities, highways, and irrigation facilities. Average annual benefits were estimated at $630,000, of which $495,000 would accrue along Indian Bend Wash and $135,000 on the Evergreen area to the east of Indian Bend Wash. Average annual charges were estimated at $184,000 and the benefit-cost ratio was computed at 3.4 to 1. However, a large portion of the length of the diversion levee would have been located on lands within the Salt River Pima-Maricopa Indian Reservation, just uphill from the Arizona canal. When the alternative plan was presented to local interests, strong objections were raised by the Salt River Pima-Maricopa Indian Tribe and by the Bureau of Indian Affairs, as follows:

(1) The levee proposed under the alternative plan would dissect an area proposed by the Pima-Maricopa Tribe for future development. (A master plan has since been developed for the area, embracing residential and commercial developments.) The Pima-Maricopa Community Council believes that the diversion levee and the required easements for its floodway (about 1/2 mile wide) would impair the reservation lands so that the development plan would not be workable.

(2) The Pima-Maricopa Community Council stated that the adverse effect on their land would be considerably greater than the beneficial effect they would enjoy from flood control if the diversion levee were built. They pointed out that Indian Bend Wash flows originate on lands outside the Indian Reservation and they object to sacrificing their lands to provide protection primarily to non-Indian lands. They indicated that a plan of improvement providing protection to their land should be located upstream from their lands.

(3) The Community Council did not agree to the estimated costs for rights-of-way. They pointed out that the estimated average value per acre for the rights-of-way amounted to $300, whereas they believed that average values substantially higher than that amount should be applied. They contended that as their development plan materializes (and they felt rather strongly that the plan would be realized) the Indian lands would achieve a value equal to that of desirable land in the Scottsdale area, worth about $3,500 per acre.

(4) Land tenure arrangements in the reservation would complicate the situation. The lands through which the levee and floodway would pass are allotted lands. If the diversion levee were to be built, reallocation of remaining reservation land would have to be made so that individual affected members of the tribe would receive other land allotments of equal value. The ramifications of this problem are very great since most of the desirable land in the reservation has been allotted

and most of the remaining land is mountainous. Because of the strong objections raised by the Salt River Pima-Maricopa Indian Tribe and by the Bureau of Indian Affairs, no further consideration was given to the diversion levee plan. It was recognized that the diversion plan would not be consonant with the proposed developments being planned by the Community Council. An adequate estimate of the justification of the diversion plan would be dependent to a large degree upon the actual costs of rights-of-way. Recognizing the objections of the Indian tribe, it was realized that actual costs for rights-of-way would have to be determined by a Federal court and it is impossible to forecast an equity determination involving Indian land. If the court were to decide the rights-of-way costs were in line with the values estimated by the Indian tribe, the diversion plan would not be as favorable, economically, as the recommended plan. The problem of acquiring necessary easements or rights-of-way without the cooperation of the Indian tribe would become impracticable. Since the recommended plan provides economically feasible protection to the area along the Indian Bend Wash, further detailed studies were restricted to that plan.