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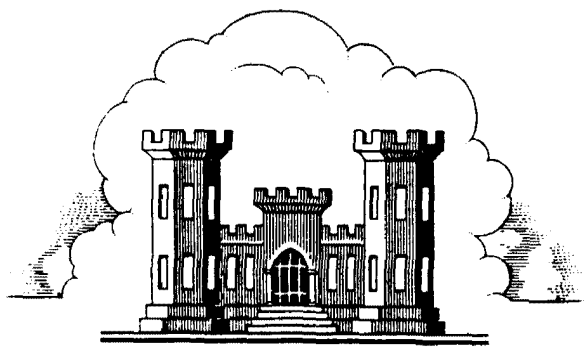
GILA RIVER BASIN , ARIZONA AND NEW MEXICO

RESERVOIR REGULATION MANUAL

FOR

PAINTED ROCK RESERVOIR



U. S. ARMY ENGINEER DISTRICT , LOS ANGELES

CORPS OF ENGINEERS

JUNE 1962

ADDRESS REPLY TO:
DISTRICT ENGINEER
U. S. ARMY ENGINEER DISTRICT, LOS ANGELES
P. O. BOX 17277, FOY STATION
LOS ANGELES, CALIFORNIA 90017

REFER TO FILE NO.

U. S. ARMY ENGINEER DISTRICT, LOS ANGELES
CORPS OF ENGINEERS
751 SOUTH FIGUEROA STREET
LOS ANGELES, CALIFORNIA 90017

SPLGP-H

20 September 1963

SUBJECT: Reservoir Regulation Manual for Painted Rock Reservoir, Gila River Basin, Arizona and New Mexico

TO: Division Engineer
U. S. Army Engineer Division, South Pacific
ATTN: SPDGT-H
San Francisco, California 94111

1. Inclosed are four revised copies of the "Reservoir Regulation Manual for Painted Rock Reservoir," dated June 1962. Please destroy the copies in your possession as they are obsolete.

2. The manual was originally transmitted to SPD for approval by letter, SPLGP-H, dated 24 July 1962, subject as above. Approval was received from SPD by 1st indorsement and from OCE by 2nd indorsement, subject to certain revisions. Additional revisions were requested by SPD in a 5th indorsement.

3. The inclosed manuals have been revised as requested in the referenced indorsements. Because of the relatively large number of pages with minor revisions, new manuals were prepared rather than revised pages.

1 Incl (quad)
as

EARL G. PEACOCK
Colonel, Corps of Engineers
District Engineer

SPDGT-H (20 Sep 63) 1st Ind
U S Army Engr Div, South Pacific, San Francisco, Calif 26 Feb 64

TO: Chief of Engineers, ATTN: ENGCW-EY

1 Incl
2 cy wd

F. C. K.

COLLINS/ao/59472

ENGCW-EY (24 July 62) 2nd Ind
SUBJECT: Reservoir Regulation Manual for Painted Rock Reservoir, Gila River Basin, Arizona and New Mexico

Hq, DA, Office of the Chief of Engineers, Washington, D.C., 29 November 1962

TO: Division Engineer, U.S. Army Engineer Division, South Pacific, San Francisco, California

The Reservoir Regulation Manual for Painted Rock Reservoir is approved subject to the following comments:

a. Paragraphs 10 and 26 state that Painted Rock Reservoir is necessary in connection with the 1944 Water Treaty with Mexico. Pertinent provisions of that Treaty and a discussion of the relation between operation of the reservoir and the Treaty should be included in the manual.

b. Paragraph 19 should contain some discussion of the relative importance of the different types of property subject to flood damage. If some types of property are not affected until relatively high flows occur, that should be indicated.

c. Paragraph 36 should cover the existing capacity of the channel in this reach even though improvement has been recommended.

d. Paragraph 38 should indicate the nature of damages caused by releases of 3000 c.f.s. and also for the planned release rate of 22,500 c.f.s.

e. Paragraph 60 states that Colorado River levees were designed on the basis of an agreement that releases from Painted Rock Reservoir would be stopped during peak flow on the Colorado River. This agreement and its effect on the regulation of the reservoir should be discussed.

f. Paragraph 65 provides for reduction of releases during Colorado River or downstream flood peaks. Specific criteria and regulation for these conditions should be included in the paragraphs on "Flood-Control Operation."

g. Rating curves for key stations have not been included. Possibly that is because they shift frequently; if so, that should be explained. Some information on stages during floods should be given, and adding stages to Table 11 would be helpful. If the reservoir is to be operated for Colorado River floods, similar data for the Colorado River should be given.

FOR THE CHIEF OF ENGINEERS:

Incl wd

WENDELL C. JOHNSON
Chief, Engineering Division
Civil Works

U. S. ARMY ENGINEER DISTRICT, LOS ANGELES
CORPS OF ENGINEERS
751 SOUTH FIGUEROA STREET
LOS ANGELES 17, CALIFORNIA

ADDRESS REPLY TO:
DISTRICT ENGINEER
U. S. ARMY ENGINEER DISTRICT, LOS ANGELES
P. O. BOX 17277, FOY STATION
LOS ANGELES 17, CALIFORNIA

REFER TO FILE NO.

SPLGP-H

24 July 1962

SUBJECT: Reservoir Regulation Manual for Painted Rock Reservoir, Gila River Basin, Arizona and New Mexico

TO: Division Engineer
U. S. Army Engineer Division, South Pacific
ATTN: SPDGT-H
San Francisco, California

1. Transmitted for approval is the report titled "Reservoir Regulation Manual for Painted Rock Reservoir," dated June 1962.

2. A draft of the manual was transmitted to the Division Engineer by letter, SPLGP-H, dated 22 September 1961, subject: "Draft of Reservoir Regulation Manual for Painted Rock Reservoir, Gila River Basin, Arizona and New Mexico." In his indorsement to the subject letter, the Division Engineer approved the manual for reproduction in final form subject to certain revisions. The requested revisions have been made.

FOR THE DISTRICT ENGINEER:

Lee R. Klemm

EDWARD KOEHM
Chief, Engineering Division

1 Incl (in trip)
as

RESERVOIR REGULATION MANUAL

FOR

PAINTED ROCK RESERVOIR
GILA RIVER BASIN, ARIZ. AND N. MEX.

CONTENTS

CONTENTS--Continued

TABLES

CONTENTS--Continued

TABLES--Continued

CONTENTS--Continued

PLATES

PLATES--Continued

RESERVOIR REGULATION MANUAL

FOR

PAINTED ROCK RESERVOIR
GILA RIVER BASIN, ARIZ. AND N. MEX.

PERTINENT DATA

Drainage area (excluding Willcox and Animas closed drainages)....sq. miles..	50,800
Reservoir:	
Elevation Real estate fee ft., m.s.l.	585
Streambed....ft., m.s.l..	524
Spillway design surcharge level....ft., m.s.l..	696.3
Area (survey of March 1953)	
Spillway crest....acres..	53,200
Spillway design surcharge level....do...	81,500
Top of dam....do...	90,100
Capacity, gross (survey of March 1953)	
Spillway crest....acre-feet..	2,491,700
Spillway design surcharge level....do.....	4,834,600
Top of dam....do.....	5,575,000
Allowance for silting....do.....	200,000
Dam-type....	Earthfill
Top elevation....ft., m.s.l..	705
Height above original streambed....ft..	181
Top length (excluding saddle dikes and spillway)....ft..	4,780
Spillway - type....Detached,	broadcrest
Crest elevation....ft., m.s.l..	661
Crest length....ft..	610
Design surcharge on spillway crest....ft..	35.3
Discharge at design surcharge....c.f.s..	401,700
Outlets:	
Gates - type....	Tainter
Number....	3
Size....	10'Wx18'H
Gate sill elevation....ft., m.s.l..	530
Conduits -	
Number and type....circular..	1
Size - inside diameter....ft..	25
Length....ft..	925
Maximum capacity at spillway crest....c.f.s..	30,480
Regulated capacity at spillway crest....c.f.s..	22,500

Reservoir design flood:		
Length of design flood	days	18
Inflow volume of design flood	acre-feet	2,800,000
Inflow peak	c.f.s.	300,000
Outflow, maximum average	c.f.s.	22,500
Reduction in peak	c.f.s.	227,500
Time to drain reservoir from maximum water-surface elevation (net storage)	days	70
Spillway design flood:		
Length of flood	days	18
Inflow volume of design flood	acre-feet	7,680,000
Inflow peak	c.f.s.	620,000
Outflow peak	c.f.s.	436,500
Reduction in peak	c.f.s.	183,500

RESERVOIR REGULATION MANUAL

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PAINTED ROCK RESERVOIR
GILA RIVER BASIN, ARIZ. AND N. MEX.

GENERAL INFORMATION

1. Authority.--The authority for the preparation of this manual is contained in paragraph 6, Engineering Regulation 1110-2-240, titled "Engineering and Design, Reservoir Regulation," and dated 8 December 1958. Detailed instructions pertaining to the contents of the manual are contained in chapter 6, Engineering Manual 1110-2-3600, titled "Engineering and Design, Reservoir Regulation," and dated 25 May 1959.

2. Scope.--This manual contains: (a) general descriptive information pertaining to the drainage area and project; and (b) a description of the plan of operation, the district's organization and methods for applying the plan, and examples of its application to various floods.

3. Project history and authorization.--The project consists of Painted Rock dam and reservoir on the Gila River, Ariz. (See pl. 1 for project location). A public hearing was held at Yuma, Ariz., on 11 February 1938, in connection with the preparation of the preliminary examination report dated 9 May 1938, on the Gila River from Gillespie Dam to a point near Wellton, Ariz. Another public hearing was held at Phoenix, Ariz., on 20 October 1938, in connection with the preliminary examination report dated 10 January 1939, on the Gila River and tributaries, Arizona and New Mexico. Local interests indicated at these two meetings that they desired (a) a flood-control and water-conservation dam on the Gila River at the Sentinel damsite (river mile 112), and (b) channel improvements on the Gila River downstream from the damsite. In the publication titled "Interim Report on Survey, Flood Control, Gila River and Tributaries Below Gillespie Dam, Arizona," dated 1 September 1948, various plans of improvement were considered. The plan recommended in that report provided for an earthfill dam to create a flood-control basin at Painted Rock site (river mile 126). Studies indicated that there was a lack of justification for water conservation in the reservoir behind the dam. Furthermore, consideration of the Sentinel site was dropped on the basis of geological investigations. No recommendations pertaining to the downstream channel were made. Although no public hearings

were held subsequent to authorization of the project, public officials and representatives of many local groups appeared before the appropriation committees in support of the project.

4. The construction of Painted Rock Reservoir project (as set forth in H. Doc. 331, 81st Cong., 1st sess.) was authorized by act of Congress of 17 May 1950, Public Law 516, 81st Congress, 2d session.

5. Physiographic characteristics.--Painted Rock Dam is located in the southwest part of Maricopa County in the State of Arizona about 20 miles northwest of the town of Gila Bend (See pl. 1). The dam is on the Gila River, 38 miles downstream from Gillespie Dam. The drainage area above the dam is 50,800 square miles, excluding the Willcox and Animas closed drainages. The Gila River basin, which is an irregular area of 57,950 square miles (excluding the Animas and Willcox closed drainages) extends from the Continental Divide in southwestern New Mexico to the Colorado River at Yuma, Ariz. It includes practically all the southern half of the State of Arizona and constitutes a region of widely varying topographic and climatological characteristics. A topographical map of the basin is shown on plate 2. The river, which is 654 miles long, rises in an area of high mountains and plateaus and flows westward, in a generally central course through the basin, to a point on the Colorado River about 3 miles upstream from Yuma, Ariz.

6. Much of the northern part of the basin is extremely irregular and rugged, the boundary elevations ranging from about 7,000 feet to more than 12,000 feet. This part of the basin is mostly drained by the Salt River, the largest tributary, which joins the Gila River at river mile 198 near Phoenix. The eastern half of the southern part of the basin consists largely of long desert valleys lying between north-south ranges of rugged mountains; here the elevations are generally lower but in places are above 10,000 feet. The southwest third of the basin consists essentially of broad, flat, flow-lying desert valleys and isolated mountains of relatively low relief. Comparatively few localities are more than 4,000 feet in elevation and a large part is below 1,000 feet; the elevation of the river mouth near Yuma is about 130 feet.

7. In general, the mountains in the Gila River basin are of igneous rock, mostly granitic, schistose, or volcanic. The valleys along the Gila River and its tributaries are alluvial fills of varying depth. The soil in the valleys is fertile, and where water without a high saline content is available for irrigation, the crop yields are high. The type, density, and distribution of vegetation in the Gila River basin reflect the differences in

elevation, temperature, and precipitation. The desert vegetation is sparse and composed principally of cacti, creosote bush, and sagebrush. Mesquite, salt cedar, and arrowweed grow in dense thickets in stream bottoms and other areas where the water table is near the surface of the ground. Grasses interspersed with desert and semidesert shrubs grow at elevations ranging from 3,000 to 8,000 feet. Chaparral, oak, pinion, and juniper grow at elevations ranging from 4,000 to 7,000 feet. Aspen and conifers, such as fir, spruce, and pine are common above elevations of 6,000 feet.

8. Existing improvements.--There are numerous dams in the Gila River basin above Painted Rock Reservoir; however, only eight of them influence the regulation of major floods at Painted Rock Reservoir. A tabulation of pertinent data for these eight reservoirs is given in table 1 and their locations are shown on plate 1.

9. Downstream economic development.--With the exception of a few widely dispersed residences, no developments exist along the Gila River from Painted Rock Reservoir to Texas Hill (see pl. 1). From Texas Hill to the Colorado River (see pl. 3), the principal occupations in the Gila River basin are agriculture and related industries. The U. S. Bureau of Reclamation is constructing the Gila project which provides for diverting Colorado River water to 115,000 acres of irrigable land in the lower Gila River basin. According to 1959 figures, the total value of property at that time in the overflow area and outside of the overflow area along the Gila River from Texas Hill to the Gila siphon subject to damage by the occurrence of a standard project flood below Painted Rock Reservoir was $69,000,000. Damage to areas outside of the overflow area would be caused by disruption of irrigation facilities. This property included residential, crops, farmland, irrigation works, highways and roads, drainage works, utilities, and riverbed and wasteland.

10. Below the confluence of the Gila and Colorado Rivers, Painted Rock Reservoir provides flood protection to the city of Yuma and the towns of Gadsden and Somerton in Arizona. Protection is also provided for extensive irrigation facilities, Federal, State, and county highways, and bridges for the Southern Pacific Railroad and San Diego and Arizona Eastern Railroad. Also, residences, irrigation works, highways and railroads in Imperial Valley, Calif., are protected.

11. In addition to providing flood protection for developed areas in the United States, provisions pertinent to the operation of Painted Rock Reservoir are of interest to the International Boundary and Water Commission because of the Commission's

responsibilities under the 1944 Water Treaty with Mexico. In accordance with Article 13 of that treaty, the International Boundary and Water Commission is charged with investigating and preparing plans for flood control on the lower Colorado River between Imperial Dam and the Gulf of California. The operation of Painted Rock Dam affects the lower Colorado River because a reduction in flood flows on the Gila River reduces flood flows in the lower Colorado River. Also, much Gila River sediment that might otherwise be deposited in the Colorado River is retained in Painted Rock Reservoir. These effects serve to promote river-channel stability. The design of any flood-control structures constructed in the lower Colorado River as a result of the 1944 Water Treaty must take into account the effects of Painted Rock Reservoir. In fact, the design capacity for levees completed in the Yuma area in 1952 is based partly on those effects as indicated in a subsequent paragraph.

12. Hydrometeorological characteristics.--The climate of the Gila River basin as a whole is semiarid but, depending principally upon elevation, ranges from hot to arid in some subareas to cool and humid in others. A summary of climatological data at representative stations in and near the basin is given in tables 2 through 9 and the locations of these stations are shown on plate 4. The average annual precipitation ranges from less than 4 inches in the lower desert to 30 inches or more in the highest mountains. Isohyets of mean seasonal precipitation are shown on plate 5. Most of the precipitation occurs in two distinct seasons, summer (July through September) and winter (December through March), and is about equally divided between them. Little rain falls during spring and autumn. During any season there may be many successive rainless days. In winter, snow may accumulate to considerable depth at elevations above 4,000 feet, but snow practically never falls at elevations below 2,000 feet. Isohyets of mean winter precipitation are shown on plate 6. Three types of storms produce precipitation in the Gila River basin: 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 the southeast or southwest. 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 the remnants of a tropical hurricane. General summer storms are often accompanied by 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. These storms cover comparatively small areas and result in high-intensity rainfall of short duration.

13. Runoff.--Runoff from various portions of the drainage area varies considerably. The streams in the desert portion of the southern part of the basin have little flow other than during and immediately after the heavier rains, while the northern and headwater portions of the basin have some flow throughout the year. Prior to the construction of Painted Rock Dam, no stream-gaging station existed at the damsite. However, records of flow below Gillespie Dam located 38 river miles above Painted Rock Dam are available since 1921. Hydrographs of mean daily flows at this location for the period of record are shown on plates 7 and 8. A tabulation of runoff data below Gillespie Dam is given in table 10. The volume of flow at Painted Rock Dam is approximately 75 percent of the flow at Gillespie Dam because of percolation, evaporation, and other losses. Runoff data for the stream-gaging station near Dome, Ariz., located 12 river miles above the confluence with the Colorado River are available since 1903; however, no peak discharges were recorded prior to 1929. A tabulation of peak discharges and maximum mean daily discharges for the Dome gaging station is given in table 11. The locations of this station and the station at Gillespie Dam are shown on plate 4.

14. Floods.--Historical references to floods on the Gila River extend back to 1833 but continuous records of discharge measurements are not available prior to 1903. Historical accounts indicate that general floods occurred in 1833, 1862, 1869, 1880, 1884, 1886, 1889, 1890, 1891, 1893, 1895, and 1903. Records since 1903 show that floods and/or storms occurred in March 1905, November 1905, December 1906, December 1914, January 1915, January 1916, October 1916, November 1919, February 1920, December 1923, September 1926, February 1927, February 1937, March 1938, March 1941, and September 1946. The flood of 1884 was the earliest for which a reasonable estimate of severity can be made. This flood and the flood of 1891, possibly, were comparable to the flood of 14-21 January 1916, the greatest of record.

15. Storms and floods of January 1916.--Two storms occurred over the Gila River basin in January 1916, one from the 14th to the 21st, and another from the 25th to the 30th. The first storm which was of broader coverage than the second, produced the larger flood. Both storms were of the general winter type. The average precipitation over the drainage area above Painted Rock Reservoir site was about 3.5 inches for the first storm and 1.3 inches for the second; in each storm, approximately half of the precipitation occurred in a 24-hour period. Ground conditions were rather severe, owing to the occurrence of light rain on 10-12 January and to the presence of snow cover over much of the area. The estimated peak discharges of the Gila River at the mouth were 230,000 and 155,000 cubic feet per second, respectively, for the two floods. Discharges on many of the tributaries were likewise severe, especially in the northern part of the drainage area. For example, 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. Pertinent hydrologic data for the two storms and floods are given on plate 9.

16. Storm and flood of September 1946.--The storm and flood of September 1946 illustrates the magnitude of rainfall that sometimes occurs in general summer storms. Beginning as a series of thunderstorms about noon of the 17th, the storm produced practically continuous rain from the afternoon of the 17th until the morning of the 19th. The average depth of rain over the drainage area above Painted Rock Reservoir site was 2.0 inches, more than three-fourths of which fell in a 24-hour period. Because the ground was relatively dry when the storm began, only minor runoff resulted. The peak discharge on the Salt River near Roosevelt was 15,100 cubic feet per second. On the Gila River, the peak discharge below Gillespie Dam was only 4,290 cubic feet per second, and flow at the river mouth was zero.

17. Flood damages.--Floods on the Gila River prior to the construction of Painted Rock Dam caused severe damage to property in the lower Gila Valley, and along the Colorado River below Laguna Dam. Monetary estimates of damage are not available for floods prior to 1890 and are incomplete for floods since that date. In addition to property damage, loss of life has been reported.

18. In connection with this office's "Review Report for Flood Control, Gila River and Tributaries Downstream from Painted Rock Reservoir, Ariz.," dated 1 April 1961, information was compiled on flood damages along the Gila River from Texas Hill to the Gila siphon (see pl. 3 for area subject to overflow). Detailed consideration was not given to the rest of the Gila River below Painted Rock Dam because (a) there are relatively few improvements

in the overflow area between the dam and Texas Hill, and (b) the U. S. Bureau of Reclamation is responsible for flood protection below the Gila siphon.

19. Although large floods have occurred along the Gila River in the area under consideration, damages have been relatively small because of the small development in the area prior to 1949, when construction was initiated in the Wellton-Mohawk division of the Gila project. No flood has occurred along the main stream of the Gila River downstream from Painted Rock Reservoir since 1949. A flood occurring in August 1955 caused damages estimated at $500,000 along several tributaries of the Gila River, below Painted Rock Reservoir, including Ligurta and Fortuna Washes. Large damages were caused to irrigation facilities including a pumping plant on the Wellton-Mohawk Canal, to agricultural lands, and to highway and power facilities. Flood-control improvements constructed by the U. S. Bureau of Reclamation along Ligurta Wash and widening of the highway bridge across Fortuna Wash by the Arizona State Highway Department have provided control of floodwaters along these two tributaries of the Gila River.

20. Table 12 shows monetary estimates of damages that would result from (a) the occurrences of various size floods between Texas Hill and the Gila siphon, and (b) the various prolonged releases from Painted Rock Reservoir. Developed areas subject to overflow between Texas Hill and the Gila siphon are predominately agricultural. Expensive agricultural lands are serviced by an extensive irrigation distribution system valued at $43,500,000 (including electrical facilities). A major drainage system estimated to cost about $12,500,000 is under construction. Much of these two systems is subject to overflow. About 21,500 cultivated acres would be subject to overflow from the largest scheduled releases from Painted Rock Reservoir. In addition, such releases could seriously damage the Gila main canal and the Wellton-Mohawk canal so that 72,000 acres lying outside of the overflow area would be subject to interruption of irrigation. About 27 miles of major canals, 2 pumping plants, the Gila siphon, 145 miles of concrete-lined laterals, 72 miles of main canal in the drainage system, 33 miles of collector drains, and other drainage facilities such as sumps, wells, and other siphons are in the overflow area. A few residences, some small commercial and industrial properties, several miles of roads and highways, and some utility lines are also in the overflow area. The improvements are in general distributed throughout the overflow area.

21. Upstream regulation.--Although numerous reservoirs exist upstream of Painted Rock Dam, only eight of them (see table 1 for a tabulation of pertinent data for these reservoirs and plate 1 for their locations) exert any appreciable control on floodflows.

These reservoirs were constructed for irrigation or irrigation and power and have a combined usable storage space below effective spillway crests of 3,446,100 acre-feet. They intercept runoff from an area of 26,742 square miles, which is about 53 percent of the total drainage area above Painted Rock Dam.

22. Hydrologic basis of design.--Determination of the spillway crest elevation was made by routing the reservoir design flood through the reservoir assuming net storage available. At the beginning of the routing, it was assumed that the reservoir was empty (elevation 530). Flood-control operation plan B was used. A maximum water-surface elevation of 660.5 feet was reached and, on this basis, the spillway crest elevation was set at 661.0 feet.

23. The reservoir design flood for Painted Rock Reservoir was based on the 14-21 January 1916 storm, the greatest of record in the area. This storm was transposed to effect the most critical amounts of rainfall over the drainage area above Painted Rock Reservoir. A 6-hour period was selected as the smallest time interval for which information on rainfall intensities would be required in developing the standard project flood. Based on rainfall-runoff studies for the area, average effective rainfall percentages ranging from 25 to 35 percent of the total rainfall were used for the various subareas. These percentages were assumed to include adequate allowances for snowmelt and base flow. The reservoir design flood has an inflow peak of 300,000 cubic feet per second and a maximum 8-day volume of 2,490,000 acre-feet.

24. The top of the dam was determined by routing the spillway design flood through the reservoir. At the beginning of the routing, it was assumed that the reservoir water-surface elevation was at spillway crest and the outlets were discharging at full capacity. A maximum water-surface elevation of 696.3 was reached and using the computed freeboard of 8.7 feet (based on possible wind set-up, wave height and ride-up) the top of the dam was set at elevation 705.0.

25. The spillway design flood was based on the U. S. Weather Bureau's estimate of maximum possible precipitation and antecedent snowpack over the drainage area above the dam. In general, rainfall for the storm of 14-21 January 1916, transposed over the drainage area, was increased 34 percent and maximum snow depths of record were used. Snowmelt was computed in conformance with principles and procedures developed under Civil Works Investigation Project CW-171 by the Snow Investigations Unit, North Pacific Division, Portland, Oreg. Loss rates of 0.10 inch per hour or 0.15 inch per hour were used except when the rain and snowmelt for a 6-hour period was less than 0.667 inch and 1.0 inch, respectively;

loss rates equal to 90 percent of the rain plus snowmelt for the period were then used. Base flow for the drainage subareas varied from 0.39 to 4.56 cubic feet per second per square mile and was derived from a study of peak base flows in the Gila River basin and southern California. The spillway design flood has an inflow peak of 620,000 cubic feet per second and a total 18-day volume of 7,680,000 acre-feet.

26. The storage volume alloted for sediment was determined after a study of the drainage area, the mean annual runoff at the site, and silt accumulation rates in existing reservoirs in southwestern United States. From this study, it was estimated that 200,000 acre-feet of sediment would be deposited in the reservoir during a 50-year period. The distribution of the sedimentation deposit was in accordance with a study based on frequency of flooding.

27. Description of the project.--Painted Rock Dam is an earth (rolled-fill) embankment with a crest length of 4,780 feet (excluding saddle dikes and spillway) and a crest width of 20 feet. The top of the dam (elevation 705) is 181 feet above the original streambed at the centerline of the dam. The upstream slope of the embankment is 1 on $2\frac{1}{4}$ to elevation 651 and 1 on 2-3/4 from elevation 651 to 705 (top of dam). The downstream slope is 1 on 2. The general plan of the embankment; and the profile, sections, and details for the embankment are shown on plates 10 and 11, respectively.

28. The reservoir formed by Painted Rock Dam has an area and gross capacity at spillway crest (elevation 661) of 53,200 acres and 2,491,700 acre-feet, respectively; at the top of the dam (elevation 705) the area is 90,100 acres and the capacity is 5,575,000 acre-feet. Area and capacity curves are shown on plate 12 and a tabulation of areas and gross capacities is given in table 13. With the water surface at spillway crest, the reservoir would be approximately 24 miles long with an average width of 3.5 miles.

29. The outlet works located in the right abutment consist of an approach channel, a gated intake structure, a transition section joining the intake to an outlet conduit, an outlet conduit, and an exit channel. The approach channel is an unlined trapezoidal section approximately 150 feet in length with a base width of 67 feet. The intake structure consists of three gated passages each 10 feet wide by 18 feet high controlled by hydraulically operated Tainter gates. The Arizona Public Service Company supplies 480-volt power to a $7\frac{1}{2}$ horsepower motor connected to a pump that generates hydraulic pressure for operating the gates. An identical motor and pump serves as a standby unit. In case commercial power fails, a diesel-electric generator is

available. The gates are operated one at a time with a speed of approximately 1 foot per minute. The three gates passages are connected to an outlet conduit by a 123-foot transition. The 25-foot-diameter, reinforced, concrete-lined outlet conduit is 925 feet long. It discharges into an unlined trapezoidal rock channel 330 feet long. The plan and profile of the outlet works are shown on plate 13 and the intake structure is shown on plate 14. Outlet discharge curves are shown on plate 15.

30. A detached broad-crested spillway is located 600 feet beyond the right abutment. It is 610 feet long and its crest elevation is 661.0. It has a trapezoidal cross section with side slopes of 1 vertical on 1/2 horizontal. The invert and side slopes of the spillway are lined with concrete from 25 feet upstream to 60 feet downstream of the crest with a cutoff wall at each end. The side slopes are paved to a height of 47 feet. The spillway channel empties into a small canyon which enters the Gila River about 800 feet below the downstream toe of the embankment. The spillway plan and the profile, sections, and details are shown on plates 16 and 17, respectively. A spillway discharge curve is shown on plate 18.

31. Hydrologic facilities.--Hydrologic facilities at and in the vicinity of the dam consist of (a) a recording rain gage at the dam tender's residence; (b) a glass-tube rain gage at the control house; (c) an outflow-gaging station located about a mile below the dam (see pl. 19 for the rating curve), which is equipped with a battery powered "Telemark" connected to the control house by landline; (d) staff gages to measure water-surface elevations located at the outflow-gaging station, the borrow pit below the dam, and the upstream face of the dam; (e) a reservoir water-surface elevation recorder in the control house; and (f) an automatic recorder and dial indicator, located in the control house, which records and indicates the operation of each gate.

32. Collection of hydrologic data.--In addition to hydrologic data from facilities at and in the vicinity of the dam, locations of other places in the drainage area from which hydrologic information is received are shown on plate 4. A brief description of this information is given in the following subparagraphs.

(a) Gage heights will be received at Painted Rock Dam from the existing stream-gaging stations on the Gila River near Dome and on the Gila River below Gillespie Dam. These stations are equipped with radio "Telemarks" for the transmission of reports. Information on flows in the lower Colorado River will be obtained from the gaging station on the Colorado River below Cibola through the U. S. Bureau of Reclamation, and the station at Yuma, through the U. S. Geological Survey. Pertinent rating curves are shown on

plates 20 through 23. The curves for the Dome, Cibola and Yuma stations are subject to change because of unstable streambed. The curve for the Gillespie Dam station is reasonably firm.

(b) Weather forecasts, severe weather reports, and precipitation reports are collected at the Corps' Arizona office by telephone from the U. S. Weather Bureau office in Phoenix and relayed to Painted Rock Dam by radio. The precipitation reports are for Tucson, Flagstaff, Yuma, Ajo, Phoenix, Show Low, Clifton, Payson, Wickenburg, Prescott, and Jerome, Ariz., and Cliff, N. Mex.

(c) Hydraulic data and precipitation reports for Lake Pleasant Dam are received from Maricopa County Municipal Water Conservation District No. 1 in Beardsley, Ariz., by telephone at the Arizona office and relayed to Painted Rock Dam by radio.

(d) Hydraulic data and precipitation reports for the Salt River system (Roosevelt, Horse Mesa, Mormon Flat, and Stewart Mountain Dams) and the Verde River system (Horseshoe and Bartlett Dams), plus streamflow data for the Salt River near Roosevelt and the Verde River below Tangle Creek are collected from the Salt River Valley Water Users Association in Phoenix by telephone at the Arizona office and relayed to Painted Rock Dam by radio.

(e) Hydraulic data and precipitation reports for Coolidge Dam and Ashurst-Hyden diversion dam are received by radio at the Arizona office from the U. S. Bureau of Indian Affairs, San Carlos project, Coolidge, Ariz. This information is then relayed to Painted Rock Dam by radio.

(f) Hydraulic data and precipitation reports for Parker and Imperial Dams, and discharges for the Bill Williams River near Alamo and the Colorado River below Cibola will be received by radio at Painted Rock Dam from the U. S. Bureau of Reclamation station at Imperial Dam.

(g) Information on snow cover and water equivalent of snow is obtained from publications of the U. S. Soil Conservation Service office in Phoenix, Ariz. If necessary, the Corps' Arizona office can telephone the Soil Conservation Service office and relay pertinent information to Painted Rock Dam by radio. Data for snow courses in and near the Gila River basin are shown in table 14.

(h) Assistance in obtaining special streamflow reports or records of streamflow or reservoir data in the Gila River basin or lower Colorado River basin is obtained by telephone from the U. S. Geological Survey office in Tucson.

33. Communication facilities.--The communication facilities at Painted Rock Reservoir are described in the following subparagraphs.

(a) Commercial telephones are installed in the control house, at the dam tenders' residence, and in the project office.

(b) A 100-watt single sideband AM radio transceiver is installed in the control house. This radio is used for communication with the Los Angeles District Office, the Los Angeles District Maintenance Yard, and the Arizona office.

(c) A 50-watt AM radio transceiver is installed in the project office. This radio is used as a standby for the 100-watt single sideband transceiver. In addition, it will be used to exchange hydrologic data with the U. S. Bureau of Reclamation station at Imperial Dam, Calif.-Ariz.

34. Sedimentation measurements.--An aerial survey of the reservoir area was completed in March 1953. This survey was the basis used in computing the reservoir capacity and area curves. A series of index ranges have been established, consisting of Category A sediment ranges in the reservoir and Category C ranges below the dam as a means of observing channel changes. These ranges are shown on plate 24. They will be resurveyed after every major flood or approximately every 10 years if no major flood has occurred. A resurvey of the reservoir will be made as required based on information obtained from resurveys of the range lines within the reservoir.

35. Diversion structures.--No diversion structures were constructed by the Corps of Engineers in connection with the Painted Rock Reservoir project.

36. Downstream channel.--The Gila River channel from Painted Rock Dam to Texas Hill is, in general, in poor condition because no floodflows have occurred for many years. The streambed is filled with sediment and overgrown with brush, small trees, and other vegetation in many places. In fact, along some sections of the river, no definite channel is evident. Immediately downstream from the dam, a lake formed in the borrow-pit area is used for recreational purposes. Below this lake to Texas Hill, very little development of any kind exists and scheduled reservoir releases would cause little if any damages.

37. A map of the Gila River channel from Texas Hill to the Colorado River confluence and the Colorado River from Laguna Dam downstream is shown on plate 3. Existing and proposed levees as well as irrigation and drainage facilities are also depicted. The

district engineer in his "Review Report for Flood Control, Gila River and Tributaries Downstream from Painted Rock Reservoir, Ariz.," dated 1 April 1961, has concluded that a serious flood problem exists along the Gila River from Texas Hill to the Gila siphon and has recommended levee and channel improvements to control a 50,000-cubic-foot-per-second flood at Dome, Ariz. The existing nondamaging channel capacity is about 2,500 cubic feet per second. Areas subject to overflow along the reach below Texas Hill are shown on plate 3. The existing capacity of the Colorado River channel from Laguna Dam to Yuma, Ariz., is about 35,000 cubic feet per second. From Yuma, Ariz., to the international boundary, the channel capacity as improved by the U. S. Bureau of Reclamation, is 140,000 cubic feet per second.

38. This 140,000 cubic feet per second design capacity was agreed upon at a meeting held on 24 September 1948, attended by representatives of the Los Angeles District, Corps of Engineers, the U. S. section of the International Boundary and Water Commission, and the U. S. Bureau of Reclamation. Such capacity would be required to carry the peak discharge from a summer storm similar to that of September 1939, critically centered over the tributary area. Under this condition, releases from both Painted Rock Reservoir and the proposed Alamo Reservoir would be curtailed. If necessary, releases from Painted Rock Reservoir could be discontinued completely during a critical Colorado River flood of this kind.

39. The U. S. Bureau of Reclamation has been authorized to construct levees in Yuma Valley as part of the Colorado River front-works system. The Bureau's plan of improvement provides for levees along the left (east) bank of the Colorado River from Yuma, Ariz., to a point near Laguna Dam with tie-back levees along the Gila River from the mouth to the Gila siphon. The capacities of all these different parts of the overall levee system will be mutually consistent.

40. Under existing conditions prolonged releases from Painted Rock Reservoir of about 5,000 cubic feet per second would breach a critical section of the Wellton-Mohawk canal. Large physical damages would occur to the canal and pumping plants and extensive irrigation service interruptions would occur to the entire Wellton-Mohawk diversion and to the Mesa unit of the Gila project, which are dependent upon an uninterrupted source of irrigation water. These damages would total about $960,000.

41. As previously indicated, releases of 22,500 cubic feet per second would inundate 21,500 cultivated acres and would interrupt irrigation deliveries to 72,000 additional acres. About two-thirds of the monetary damage would relate to the irrigation works

(physical damages and interruption of irrigation). Nearly all of the additional monetary damage would relate to agricultural properties and to drainage facilities. The total damage from release of 22,500 cubic feet per second would amount to $11,110,000 (1959 price levels).

42. Changes to authorized plan.--The primary ways in which the final project plan presented in this report differs from the plan approved by Congress are given in the following subparagraphs.

(a) The top of the dam was raised from elevation 698 to 705 and the length increased from 4,710 feet to 4,780 feet. This change increased the storage capacity at the top of the dam from 5,200,000 acre-feet to 5,575,000 acre-feet.

(b) The spillway design was changed from two detached broadcrested spillways, each 525 feet long with crests at elevation 660, to a single detached broadcrested spillway, 610 feet long with crest elevation 661. The storage capacity at spillway crest changed from 2,480,000 acre-feet to 2,491,700 acre-feet.

(c) The outlet design was changed from twelve 6-foot by 9-foot gated outlets with sill at elevation 540 to three 10-foot by 18-foot gated outlets with sill at elevation 530. The original outlet capacity at spillway crest of 33,400 cubic feet per second was reduced to 30,480 cubic feet per second.

43. Construction history.--Construction of Painted Rock Dam began on 25 July 1957, and closure was made 1 April 1959. The structure was officially completed on 18 January 1960, at a cost of $13,670,000 (excluding cost of lands and severence damages).

44. Development of reservoir area.--As of 30 June 1960, the government had acquired or scheduled for acquisition in fee, 5,205 acres of land within the reservoir taking line. Much of this land is leased out for raising crops or for pasture. On the same date, flowage easements had been acquired or scheduled for acquisition on 51,436 acres of land within the reservoir taking line.

45. The Los Angeles District's Design Memorandum No. 8, titled "Master Plan for Administration and Development of Project Land and Water Areas, Painted Rock Reservoir, Gila River, Ariz.," proposes a plan to develop a game-management area above the dam. This area would include sanitary facilities, game-feeding areas, service roads, and parking areas. Downstream from the dam, a lake of about 412 acres exists in the borrow-pit area. The Arizona Game and Fish Department leases the area covered by the lake from the U. S. Bureau of Land Management. The lease is subject to

flood-operation restrictions imposed by the Corps of Engineers. A boat-launching ramp, sanitary facilities, and swimming area buoys have been installed at the lake. Picnicking areas, grading of beaches, tent and trailer camping areas, parking areas, additional boat-launching ramps, and additional service roads are contemplated. A map of the recreational development plan which also indicates the taking line is shown on plate 25.

PLAN OF OPERATION

46. Operational requirements.--Painted Rock Reservoir is operated for flood control to achieve the following objectives insofar as possible: (a) to provide protection from floods for agricultural lands along the Gila River downstream from the dam, along the lower Colorado River in Arizona and California, and in the Imperial Valley of California; and (b) to provide flood protection to residential, commercial and industrial properties in the city of Yuma and towns of Gadsden and Somerton, Ariz.; to extensive irrigation facilities; to transportation facilities; and to important defense installations.

47. Prior operation plans.--The project document (H. Doc. No. 331) for Painted Rock Reservoir presented a general method of operation based on increasing the outflow in steps to a maximum controlled value of 22,500 cubic feet per second.

48. The operation presented in the report titled "Design Memorandum No. 3, General Design for Painted Rock Reservoir," dated March 1955, required the selection of one of two fixed operation plans, A or B. Under plan A, a debris pool would be developed to elevation 550. Then as the reservoir level rose, the outflow would be increased in steps until a value of 22,500 cubic feet per second was reached at elevation 640. This outflow would be maintained as long as possible, using surcharge storage above spillway crest. Under plan B, a debris pool would be developed to elevation 550 as in plan A. Above this elevation, to protect the outlet conduits from debris, the outlet gates would be regulated so that the openings equalled one-fourth of the reservoir water depth. Under this operation plan, a controlled outflow of 22,500 cubic feet per second would be reached at elevation 600 and maintained as long as possible using surcharge storage above spillway crest. The choice of plan depended on available storage space in upstream reservoirs and predicted flow into Painted Rock Reservoir. Plan A would be used to control small floods to relatively nondamaging discharges. If upstream storage space were limited and a major flood was predicted at Painted Rock Reservoir, operation plan B would be used. This plan of operation would control the reservoir design flood below spillway crest.

49. In the report titled "Design Memorandum No. 6, Dam and Appurtenances for Painted Rock Reservoir," dated November 1956, Painted Rock Reservoir would be operated in accordance with plan B, described in the preceding paragraph. Minor floods would be regulated on a prediction basis so that damage to developments below the dam would be kept to a minimum.

50. Flood-control operation.--The flood-control operation presented in this manual is similar to the operation described in Design Memorandum No. 3. One of two fixed operation plans, A or B, is selected for use depending on available upstream storage and water-surface elevation in Painted Rock Reservoir. Plans A and B are essentially as described under "Prior Operation Plans." The stepped outlet gate operation schedules for these plans are tabulated in tables 15 and 16, respectively.

51. With due regard for any release already in effect, the selection of operation plan A or B is made at the beginning of a flood. Whenever it is not in conflict with conditions resulting from operations for an immediately prior flood, an appropriate operation plan is determined by entering plate 26 with the water-surface elevation in Painted Rock Reservoir and the available storage space in upstream reservoirs. Refer to the note on plate 26 for instructions on the selection of the operation plan. The curves for plans A and B on plate 26 are based on a series of routings through Painted Rock Reservoir. Gross storage was used in these routings and the initial water-surface elevation necessary to control a given flood to spillway crest was calculated. The flood in each case was equal to the reservoir design flood depleted by the storage in upstream reservoirs available to control that flood. A safety factor was integrated into the curves for plans A and B, by assuming 10 percent more storage space would be required in upstream reservoirs than the results of the routings indicated. A form for tabulating the available storage space in upstream reservoirs that can be used to control a reservoir design flood is shown on plate 27. Actual storage and storage capacity of the upstream reservoir system for the period August 1910 through December 1960 are shown on plates 28 and 29.

52. If a flood of reservoir design magnitude should occur, it could be controlled to spillway crest by plan A if the available storage in upstream reservoirs and the water-surface elevation in Painted Rock Reservoir at the beginning of the flood define a point on plate 26 lying to the right of plan A curve. If the point lies between plan A and B curves, plan B can control the flood. If the point lies to the left of plan B curve, the flood cannot be controlled below spillway crest by plan B.

53. If the water surface in Painted Rock Reservoir is at elevation 640.0 feet or lower at the beginning of the spillway design flood, operation plan A or B will control the flood to maximum water-surface elevation 696.3 or lower. However, at a higher initial elevation, the outlets must be fully opened at the time the water surface reaches the elevation shown on plate 30, to control a spillway flood to elevation 696.3. All floods

occurring with initial water-surface elevation at 640.0 or higher will be treated as possible spillway design floods. (This deviation from the fixed operation plan above the spillway crest is required because at the beginning of the spillway design flood routing, it had been assumed that the water surface was at spillway crest, elevation 661.0 and the outlets fully open. The outlet discharge was not transferred above spillway crest as in operation plans A and B.)

54. Operation to reduce flows during downstream floods.--The travel time for releases from Painted Rock Reservoir to the Colorado River is roughly 2 days, which is about equal to the travel time from Parker Dam to the Gila River confluence. Therefore, if floodflows are reported, or are imminent on the Colorado River below Parker Dam, releases from Painted Rock Reservoir can be modified in time to be effective in reducing floods on the Colorado River below the confluence. The criteria for determing whether releases can be reduced, regardless of the time of year, will be determined from plate 26, i.e., it will be permissible to reduce releases if the point on plate 26 defined by available storage in upstream reservoirs and the water-surface elevation in Painted Rock Reservoir lies below the plan B curve. If a flood of reservoir design magnitude should occur above Painted Rock Dam, it would then be controlled to or below spillway crest. In summer, storm conditions may permit reducing the outflow to zero, as indicated in paragraph 68.

55. Conservation operation.--There is no written authority for conservation operation of Painted Rock Reservoir. However, considerable incidental water-conservation benefits result from the flood-control operation of the reservoir. Flood flows are reduced by the stepped operation to releases not exceeding an average discharge of 22,500 cubic feet per second. This operation promotes recharge of the underground basin downstream of the dam.

56. Limitations on storage.--Water cannot legally be stored above the taking line (approx. elevation 661) shown on plate 25. The government has acquired fee title to lands below approximately 585 feet and flowage easements to lands between approximately 585 and 661 feet.

57. Limitation on releases.--Except in floods larger than the reservoir design flood, releases are limited to a maximum average discharge of 22,500 cubic feet per second as shown in the gate operation schedules A and B (tables 15 and 16), which is the rate above which excessive damage occurs.

58. Division of responsibility for operation.--The hydraulic operation of Painted Rock Dam has been delegated through channels

to the Chief, Hydrology and Reservation Regulation Section, Engineering Division. During normal operations, he is assisted by the Reservoir Regulation and Radio Units. The Chief, Reservoir Regulation Unit supervises the Reservoir Regulation and Hydrography Sub Units. The Chief, Reservoir Regulation Sub Unit is responsible for (a) collecting hydraulic data, (b) transmitting operating instructions, (c) investigating and improving operating techniques, (d) keeping the district's "Emergency Flood Control Activities" manual current, (e) preparing reservoir regulation manuals and keeping them current, (f) maintaining prescribed records, and (g) training flood emergency personnel. The Chief, Hydrography Sub Unit is responsible for (a) collecting rainfall and runoff data, (b) maintaining a record of reservoir operation, (c) installing and servicing hydrographic and meteorological instruments, (d) scheduling sedimentation surveys, and (e) preparing reports to higher authority. The Chief, Radio Unit is responsible for (a) maintaining communications and (b) supervising the installation of new radio facilities.

59. During flood emergencies, the normal hydraulic operations organization is greatly expanded and implemented by other district employees who have been trained in their respective flood emergency duties. A Hydraulic Operations Center is established under the supervision of the Chief, Hydrology and Reservoir Regulation Section to supervise the operation of a Control Group, a Hydrography Group, and a Radio Communications Group. The Control Group contains a Flood Prediction Unit for forecasting floodflows and plotting hydraulic and hydrologic data, a Dam Operations Unit to supervise operation of the dams, a Communications Unit to receive data and transmit operating instructions and a River Patrol Unit to observe flow conditions in downstream areas. The Hydrography Group is primarily responsible for obtaining, computing, and recording hydrographic data. The Tucson, Ariz. District Office of the U. S. Geological Survey has agreed to maintain and make necessary stream-gaging measurements for the stations on the Gila River at Gillespie Dam, below Painted Rock Reservoir, and at Dome, Ariz. (records for these stations are published in the U. S. Geological Survey's, "Water Supply Papers"). These measurements are used by the Computing Unit of the Hydrography Group to revise rating curves and tables as required. The Telemark Unit maintains a record of current streamflow reports from the Gila River basin. The Radio Communications Group is responsible for the maintenance and improvement of the district's radio communications system. Reference is made to the district's current "Emergency Flood Control Activities" manual for more detailed information on organization and personnel assignments in the Los Angeles District during flood emergencies.

60. Responsibility for the physical operation of Painted Rock Reservoir has been delegated to the Construction Division.

The duties of the Construction Division include: (a) safeguarding the project at all times, (b) maintaining the project in good working condition, (c) performing routine tests of equipment, (d) operating hydrologic and hydraulic equipment, (e) maintaining records as prescribed by the Hydrology and Reservoir Regulation Section, and (f) keeping informed of the information contained in the reservoir regulation manual.

61. Normal organization.--The organization for effecting operation of Painted Rock Reservoir during normal periods is shown on plate 31. The names and telephone numbers of key personnel are shown on plate 32.

62. Flood-emergency organization.--The organization for effecting operation of Painted Rock Reservoir during flood emergencies is shown on plate 33. The names and telephone numbers of key personnel are shown on plate 34.

63. Instruction to dam tenders.--The dam tender at Painted Rock Reservoir is required to (a) be present at the dam when rainfall or runoff is occurring or furnish the Control Group at the District office a telephone number through which he can be reached; (b) see that all equipment at the reservoir such as recorders, indicating gages, gate mechanisms, power units, radios, etc., is in operating condition; (c) operate gates in accordance with instructions from the Control Group; (d) keep the Control Group notified of any unusual developments such as trash accumulation, power failure, mechanical difficulties, etc.; (e) follow the current fixed-gate operation schedule posted in the control house in the absence of communications with the Control Group and in the absence of a representative from that group; (f) assist engineers dispatched by the Control Group during flood emergencies in every way possible; (g) maintain routine records such as water-surface elevations, outflow gage heights, precipitation amounts, gate openings, and a daily log on prescribed forms; (h) notify local authorities and interested agencies of anticipated releases from the reservoir when instructed to do so by the Control Group or if communications are interrupted; and (i) obtain hydrologic and hydraulic data from other agencies upon request of the Control Group.

64. Modification of regulations.--As previously indicated, the reservoir regulation plans given in the fixed operation schedules, tables 15 and 16, serve as guides for personnel operating Painted Rock Dam during flood conditions. These schedules represent the best methods of operation to control a reservoir design flood under given initial conditions of water-surface elevation in Painted Rock Reservoir and storage in upstream reservoirs. Deviation from the fixed operation schedule may be desirable, if

there is high confidence in the prediction of inflow into the reservoir, to prevent or reduce flooding in the following areas: (a) along the Gila River downstream from Painted Rock Dam; (b) along the Colorado River between Laguna Dam and Mexico; and (c) in Imperial Valley, Calif. (flooding possible if the levees in Mexico are breached). Further, if a spillway design flood occurs with the initial reservoir water-surface elevation above 640, it will be necessary to deviate from the fixed operation schedule to control the flood to maximum water-surface elevation 696.3.

65. Deviation from the fixed schedule of operation will normally be made only by responsible persons in the District office. In the event of communications failure, the engineer dispatched from the District office will assume responsibility for deviation from the fixed schedule. Only under extreme emergency, involving imminent levee failure, severe property damage, or possible loss of lives, should the reservoir outflow be throttled or stopped. As soon as the emergency is over, the gates should be slowly opened to agree with the fixed schedule.

66. Other agencies' connection with the operation.--A list of agencies together with a brief explanation of their connection with the operation of Painted Rock Reservoir is given in the following subparagraphs.

(a) U. S. Weather Bureau Airport Station, Phoenix, Ariz.--The Phoenix Weather Bureau office is the River District office for the Colorado River and tributaries from the Colorado River above the mouth of the San Juan River to the Arizona-Mexico border. Flood conditions, weather forecasts, and precipitation reports for the Gila River basin are telephoned to the Corps of Engineers' office in Phoenix. These reports are then relayed by radio to Painted Rock Dam.

(b) U. S. Geological Survey, District Office, Tucson, Ariz.--Current records of streamflow and reservoir storage for the lower Colorado River and Gila River basins are filed in the District office at Tucson, Ariz., and are available to the Los Angeles District.

(c) U. S. Bureau of Reclamation, Region 3, Boulder City, Nev.--Hydraulic and hydrologic data for the lower Colorado River basin are available in the U. S. Bureau of Reclamation's Boulder City office. This information will be relayed by radio to Painted Rock Dam through the Bureau's station at Imperial Dam. The Bureau of Reclamation is responsible for operation of the lower Colorado River system and for flood protective works on the main stem of the river.

(d) U. S. Soil Conservation Service Office, Phoenix, Ariz.--Current data on snow cover in the Gila River basin are available from the Soil Conservation Service office in Phoenix.

(e) U. S. Bureau of Indian Affairs, San Carlos project, Coolidge, Ariz.--Coolidge Dam and Ashurst-Hayden diversion dam are operated by the U. S. Bureau of Indian Affairs. The Corps of Engineers has installed a radio in the Coolidge office so that hydraulic and hydrologic data can be quickly relayed to Painted Rock Dam through the Corps' Arizona office.

(f) U. S. International Boundary and Water Commission, El Paso, Tex.--The International Boundary and Water Commission is interested in the operation of Painted Rock Reservoir because of the Commission's responsibilities relating to the 1944 Water Treaty with Mexico.

(g) Arizona Game and Fish Department, Phoenix, Ariz.--The Arizona Game and Fish Department is interested in maintaining the lake in the borrow pit below Painted Rock Dam as a recreation area. Any operation affecting the level of the lake is of interest to the Department.

(h) Salt River Valley Water Users Association, Phoenix, Ariz.--The Salt River Valley Water Users Association operates the Salt River system consisting of Roosevelt, Horse Mesa, Mormon Flat and Stewart Mountain Dams; and the Verde River system consisting of Horseshoe and Bartlett Dams. Hydraulic and hydrologic data for these reservoirs are available to the Los Angeles District upon request.

(i) Maricopa County Municipal Water Conservation District No. 1, Beardsley, Ariz.--Hydraulic and climatologic data for Carl Pleasant Dam are available from Maricopa County Municipal Water Conservation District No. 1, the agency that operates the dam.

67. Coordination with other projects.--The operation of Painted Rock Reservoir is closely coordinated with the operation of dams on the Colorado River. Furthermore, the choice of operation plans for the reservoir is determined by the available storage space in reservoirs upstream from Painted Rock Reservoir.

68. It is particularly important to operate Painted Rock Reservoir for the reduction of flood peaks on the lower Colorado River so that the present capacity of the channel from the Yuma levees to the confluence with the Gila River (35,000 c.f.s.) will not be exceeded. All flood releases are therefore carefully coordinated with releases from reservoirs operated by the U. S. Bureau of Reclamation, the agency responsible for flood protective works on

the main stem of the Colorado River. The U. S. Bureau of Reclamation's Wellton-Mohawk Irrigation project located on the lower Gila River flood plain is subject to floods originating below Painted Rock Reservoir. If such a flood occurs, every effort will be made to reduce or cut off releases from the reservoir to minimize damages. During the occurrence of a summer flood it is possible to withhold releases until the downstream peak has passed because the reservoir design flood was based on a winter storm which is more critical than a summer storm.

69. Additional information relating to coordination of the operation of Painted Rock Reservoir with other projects can be found in this manual under the following subjects: "Upstream Regulation," "Hydrologic Facilities," "Communication Facilities," "Flood-Control Operation," and "Other Agencies' Connection with the Operation."

70. Examples of regulation.--The flood of 14-21 January 1916 (modified to reflect present upstream conditions), the reservoir design (standard project) flood, and the spillway design (maximum probable) flood were routed through Painted Rock Reservoir to test the adequacy of the flood operation plan. These routings are shown on plates 35 through 38, respectively. A tabulation of pertinent data pertaining to the routings is given in table 17. Net storage was assumed available in Painted Rock Reservoir at the beginning of each routing.

71. The flood of 14-21 January 1916, was the largest of record above Painted Rock Reservoir. A routing of this flood, modified to reflect present upstream conditions, is shown on plate 35. Assuming the reservoir empty at the beginning of the routing and using operation plan A, the peak inflow of 195,000 cubic feet per second is reduced to a maximum average outflow of 22,500 cubic feet per second and a maximum water-surface elevation of 657.4 feet is reached.

72. The reservoir design flood routing under operation plan B is shown on plate 36. Assuming the reservoir empty at the beginning of the routing, the peak inflow of 300,000 cubic feet per second is reduced to a maximum average outflow of 22,500 cubic feet per second and a maximum water-surface elevation of 660.5 feet is reached.

73. The spillway design flood routing, assuming the reservoir full to spillway crest and outlet gates fully open at the beginning of the routing, is shown on plate 37. The peak inflow of 620,000 cubic feet per second is reduced to a peak outflow of 436,500 cubic feet per second and a maximum water-surface elevation of 696.3 feet is reached.

74. The spillway design flood routing, assuming the reservoir full to elevation 640 at the beginning of the routing and using fixed operation plan A or B (identical above elevation 640) is shown on plate 38. The peak inflow of 620,000 cubic feet per second is reduced to a peak outflow of 404,000 cubic feet per second and a maximum water-surface elevation of 696.3 is reached.

75. Filling frequency.--A filling frequency curve for Painted Rock Reservoir is shown on plate 39. In deriving this curve, floods of record were routed through the reservoir using stepped operation plan A (table 15) and assuming net capacity available.

76. Operation reports.--The dam tender at Painted Rock Reservoir reports by radio to the Hydrology and Reservoir Regulation Section at 0900 hours Pacific Standard time each workday or as requested. During storms, reports are received more often. The hydraulic data reported for Painted Rock Reservoir is entered by the dam tender on the form shown on plate 40, and the rainfall data on the form on plate 41. The original records are forwarded to the Hydrology and Reservoir Regulation Section immediately following the end of the month. The data reported by radio are tabulated by the Hydrology and Reservoir Regulation Section's Reservoir Regulation Unit on the form shown on plate 42 and hydraulic information is transferred to the form on plate 43 for computation. Information from other locations in the Gila River basin, used in the operation of Painted Rock Reservoir, is recorded on the form shown on plate 44. The locations of dams, stream-gaging stations, precipitation stations, and snowfall courses from which data are obtained are shown on plate 4.

77. Operation record.--The operation record and rainfall records for Painted Rock Reservoir are maintained in the Hydrology and Reservoir Regulation Section files. A record of operation is submitted to the Division Engineer and to the Chief of Engineers each month, using the form on plate 45. This record is submitted by the 15th of each month and contains data for the preceding month.

78. Daily flows at the following selected gaging stations pertinent to the operation of Painted Rock Reservoir are published annually in the "United States Geological Survey Water Supply Papers:" (a) Gila River below Gillespie Dam, (b) Gila River below Painted Rock Dam, and (c) Gila River near Dome. Daily rainfall records for Painted Rock Dam and for other precipitation stations in the Gila River basin are published in the U. S. Weather Bureau's monthly publication titled "Climatological Data."

79. Weather forecasts.--A daily weather forecast for the Gila River basin is received from the U. S. Weather Bureau Forecast

Center at the International Airport in Los Angeles. The forecast, which is especially prepared for flood control use and contains predictions of precipitation amounts, is transmitted over a teletype circuit to the Control Center in the District office. Revised forecasts and special storm warnings are issued when necessary.

80. An automatic weather chart recorder is installed in the Control Center to supplement the service received from the local Weather Bureau office. The following weather information is normally received from Suitland, Md., over the National Weather Facsimile network: (a) current surface chart, (b) prognostic surface chart, (c) winds aloft plot, (d) temperature data, (e) rainfall amounts, and (f) snow cover depth.

81. Additional weather information is obtained from the U. S. Weather Bureau station at Sky Harbor Airport, Phoenix, Ariz. This information is collected over the telephone by the Corps of Engineers' Arizona office and relayed by radio directly to the Los Angeles District office or through Painted Rock Dam.

82. Flood predicition.--At the present time, no very detailed prediction method has been developed for the drainage area above Painted Rock Reservoir. The problem is complicated by the large area involved (50,800 sq. miles), the many flood-control structures in the area, the difficulties in predicting rainfall amounts, and the varying influence of snow cover. However, a good idea of the magnitude and extent of storms in the area can be obtained from weather forecasts and hydrologic data obtained during storm periods (see par. 32). Thus a fair estimate of flood magnitude can be made. Approximate travel times between important points in the Gila River basin for a storm of standard project flood magnitude are given in table 18.

83. Studies in progress or planned.--In order to improve reservoir regulation techniques, this office plans to (a) investigate the affects of snow cover and antecedent rainfall on runoff so that general limitations on the size of a possible flood can be established, and (b) develop methods for using the district's electronic computer in flood routing and flood prediction studies, thereby providing a rapid method of integrating the operation of Painted Rock Reservoir with upstream reservoir systems, and downstream developments.

Table 1

Pertinent data for existing dams that influence the regulation of major floods at Painted Rock Reservoir, Gila River basin, Ariz. and N. Mex.

Dam	Reservoir	River	Drainage area*	Usable storage space below spillway crest	Purpose
			Square miles	Acre-feet	
Coolidge	San Carlos	Gila	12,886	1,205,000	Irrigation & power
Lake Pleasant	Lake Pleasant	Agua Fria	1,460	163,800	Irrigation
Roosevelt	Roosevelt Lake	Salt	5,830	1,382,000	Irrigation & power
Horse Mesa	Apache Lake	do	5,940	245,000	Do.
Mormon Flat	Canyon Lake	do	6,100	58,000	Do.
Stewart Mountain.	Saguaro Lake	do	6,211	70,000	Do.
Horseshoe	Horseshoe	Verde	5,991	142,800	Irrigation
Bartlett	Bartlett	do	6,185	179,500	Do.

* Excluding all closed drainages.

Table 2

Summary of climatological data at Gila Bend, Ariz., Painted Rock Reservoir, Gila River basin, Ariz. and N. Mex.*

Month	Temperature			Precipitation		
	Mean monthly	Record highest	Record lowest	Mean monthly	Maximum monthly	Minimum monthly
	Degrees Fahrenheit	Degrees Fahrenheit	Degrees Fahrenheit	Inches	Inches	Inches
Jan.	53.0	90	11	0.62	3.32	0
Feb.	56.7	95	23	.44	2.87	0
Mar.	62.6	101	27	.61	3.74	0
Apr.	69.5	108	30	.21	2.29	0
May	77.5	116	39	.10	1.50	0
Jun.	86.9	121	42	.06	1.01	0
Jul.	93.0	123	47	.80	3.36	0
Aug.	91.4	118	55	.99	5.60	0
Sep.	85.8	120	37	.42	3.29	0
Oct.	74.1	109	35	.36	2.36	0
Nov.	61.6	99	22	.42	3.84	0
Dec.	53.8	95	15	.64	2.92	0
Period of record	72.2	123	11	**5.67	5.60	0

* Latitude 32° 57' N.; longitude 112° 43' W.; elevation 737 ft. above mean sea level (see pl. 4).

** Mean seasonal.

Note.--Period of record for temperature values is as follows: Mean 62 years (1897-1958); maximum 46 years (1913-58); minimum 45 years (1914-58). Period of record for precipitation values 71 years (1888-1958). No snowfall reported during 18-year period (1941-58). Previous to that period no observations for snowfall were made.

Table 3

Summary of climatological data at Payson, Ariz., Painted Rock Reservoir, Gila River basin, Ariz. and N. Mex.*

Month	Temperature			Precipitation			Snowfall		
	Mean monthly	Record highest	Record lowest	Mean monthly	Maximum monthly	Minimum monthly	Mean monthly	Maximum monthly	Minimum monthly
	Degrees Fahrenheit	Degrees Fahrenheit	Degrees Fahrenheit	Inches	Inches	Inches	Inches	Inches	Inches
Jan.	34.9	78	-18	2.41	7.85	T	7.0	37.3	0
Feb.	38.7	81	-18	2.30	7.85	T	5.9	40.0	0
Mar.	43.3	84	1	2.02	6.65	0	3.3	13.0	0
Apr.	48.7	88	16	1.09	5.90	0	1.0	11.0	0
May	57.1	97	19	.40	1.91	0	.2	4.0	0
Jun.	65.8	103	25	.50	2.67	0	0	T	0
Jul.	72.9	107	33	2.56	6.33	.45	0	0	0
Aug.	71.5	102	37	3.09	9.38	.39	0	T	0
Sep.	63.9	101	27	1.94	5.78	0	0	T	0
Oct.	54.2	93	12	1.46	4.80	0	T	1.0	0
Nov.	39.7	85	-6	1.50	6.95	0	1.7	20.0	0
Dec.	37.3	84	-12	2.09	8.43	0	4.4	26.0	0
Period of record	52.3	107	-18	**21.36	9.38	0	**23.5	40.0	0

* Latitude 34° 14' N.; longitude 111° 20' W.; elevation 4,848 ft. above mean sea level (see pl.4).
** Mean seasonal.

Note.--Period of record for temperature values 41 years (1918-58). Period of record for precipitation values 56 years (1903-58). Period of record for mean snow values 47 years (1912-58). Period of record for maximum and minimum snowfall values 50 years (1909-58). "T" represents trace.

Table 4

Summary of climatological data at Flagstaff, Ariz. (Municipal Airport), Painted Rock Reservoir, Gila River basin, Ariz. and N. Mex.*

Month	Temperature			Precipitation			Snowfall		
	Mean monthly	Record highest	Record lowest	Mean monthly	Maximum monthly	Minimum monthly	Mean monthly	Maximum monthly	Minimum monthly
	Degrees Fahrenheit	Degrees Fahrenheit	Degrees Fahrenheit	Inches	Inches	Inches	Inches	Inches	Inches
Jan.	25.3	61	-15	1.69	6.46	0.22	18.9	44.3	2.2
Feb.	28.8	65	-16	1.74	3.63	.38	13.0	33.5	T
Mar.	34.4	70	-9	1.57	3.90	.08	13.8	44.4	1.0
Apr.	42.1	75	7	1.26	1.74	.28	5.0	14.8	T
May	50.0	87	16	.53	2.02	T	1.6	7.1	0
Jun.	58.3	94	22	.53	2.92	T	T	T	0
Jul.	65.2	92	32	2.49	4.47	.75	0	0	0
Aug.	63.4	89	35	2.60	5.50	1.42	0	0	0
Sep.	57.0	90	23	1.85	6.60	T	0	0	0
Oct.	46.1	83	13	1.46	3.66	T	.8	3.9	0
Nov.	35.8	71	-13	.89	4.24	.05	7.5	25.0	T
Dec.	28.4	68	-11	1.86	5.45	T	7.3	16.4	T
Period of record	44.6	94	-16	**18.47	6.60	T	**67.9	44.4	0

* Latitude 35° 08' N.; longitude 111° 40' W.; elevation 6,993 ft. above mean sea level (see pl. 4).
** Mean seasonal.

Note.--Period of record for maximum and minimum temperature and precipitation values 10 years (1950-59). Period of record for mean temperature and precipitation values 30 years (1921-50). Period of record for all snowfall values 10 years (1950-59). "T" represents trace.

Table 5

Summary of climatological data at Phoenix, Ariz. (Sky Harbor Airport), Painted Rock Reservoir, Gila River basin, Ariz. and N. Mex.*

Month	Temperature			Precipitation		
	Mean monthly	Record highest	Record lowest	Mean monthly	Maximum monthly	Minimum monthly
	Degrees Fahrenheit	Degrees Fahrenheit	Degrees Fahrenheit	Inches	Inches	Inches
Jan.	49.7	85	17	0.60	2.14	0
Feb.	54.3	88	22	.79	2.23	.06
Mar.	59.9	92	29	.66	4.16	0
Apr.	67.1	104	32	.35	2.10	T
May	75.5	113	42	.17	.94	0
Jun.	83.9	117	50	.06	.95	0
Jul.	90.1	118	61	.70	4.19	T
Aug.	88.3	115	60	.99	5.56	.07
Sep.	82.7	118	49	1.00	4.23	0
Oct.	70.8	104	36	.40	2.66	0
Nov.	58.4	91	25	.47	3.04	0
Dec.	52.1	88	22	.97	3.94	0
Period of record	69.4	118	17	**7.16	5.56	0

* Latitude 33° 26' N.; longitude 112° 01' W.; elevation 1,109 ft. above mean sea level (see pl. 4).

** Mean seasonal.

Note.--Period of record for maximum and minimum temperature and precipitation values 21 years (1938-58). Period of record for mean temperature and precipitation values 30 years (1921-50). "T" represents trace. Maximum monthly snowfall reported during 21-year record (1938-58) was 0.6 inch.

Table 6

Summary of climatological data at Tucson, Ariz. (Municipal Airport), Painted Rock Reservoir, Gila River basin, Ariz. and N. Mex.*

Month	Temperature			Precipitation			Snowfall		
	Mean monthly	Record highest	Record lowest	Mean monthly	Maximum monthly	Minimum monthly	Mean monthly	Maximum monthly	Minimum monthly
	Degrees Fahrenheit	Degrees Fahrenheit	Degrees Fahrenheit	Inches	Inches	Inches	Inches	Inches	Inches
Jan.	49.7	87	16	0.63	2.37	T	0.4	4.7	0
Feb.	53.2	92	20	.92	2.27	0.02	.1	1.1	0
Mar.	57.9	92	26	.68	2.26	0	.2	3.4	0
Apr.	65.0	102	27	.32	1.66	0	.1	1.0	0
May	73.1	107	38	.21	.89	0	0	0	0
Jun.	82.1	111	47	.30	1.46	0	0	0	0
Jul.	86.2	111	63	1.80	5.20	.27	0	0	0
Aug.	83.8	109	61	2.15	7.93	.46	0	0	0
Sep.	80.1	107	48	1.48	3.59	0	0	0	0
Oct.	69.6	101	35	.47	2.62	0	T	T	0
Nov.	58.2	90	24	.76	1.90	0	.3	6.4	0
Dec.	52.0	84	18	.94	2.01	0	.1	1.4	0
Period of record	67.6	111	16	**10.66	7.93	0	**1.2	6.4	0

* Latitude 32° 07' N.; longitude 110° 56' W.; elevation 2,584 ft. above mean sea level (see pl. 4).
** Mean seasonal.

Note.--Period of record for maximum and minimum temperature and precipitation values 19 years (1941-59). Period of record for mean temperatures and precipitation values 30 years (1921-50). Period of record for all snowfall values 19 years (1941-59). "T" represents trace.

Table 7

Summary of climatological data at Prescott, Ariz. (Municipal Airport), Painted Rock Reservoir, Gila River basin, Ariz. and N. Mex.*

Month	Temperature			Precipitation			Snowfall		
	Mean monthly	Record highest	Record lowest	Mean monthly	Maximum monthly	Minimum monthly	Mean monthly	Maximum monthly	Minimum monthly
	Degrees Fahrenheit	Degrees Fahrenheit	Degrees Fahrenheit	Inches	Inches	Inches	Inches	Inches	Inches
Jan.	35.3	71	-5	1.10	3.06	0.04	6.7	35.5	0
Feb.	39.4	76	-3	1.33	2.15	.03	3.3	14.5	0
Mar.	44.8	78	8	.98	2.57	0	3.8	18.8	0
Apr.	52.9	87	18	.80	2.07	.04	.5	3.1	0
May	60.9	97	28	.30	1.24	T	T	T	0
Jun.	70.1	102	34	.23	1.87	0	0	0	0
Jul.	76.0	103	48	2.71	9.61	.71	0	0	0
Aug.	73.9	101	45	3.70	5.53	.12	0	0	0
Sep.	68.2	101	37	2.16	3.06	T	0	0	0
Oct.	57.0	91	21	.68	1.99	0	.1	1.5	0
Nov.	45.6	79	9	.62	1.87	0	1.3	7.8	0
Dec.	37.8	73	0	1.37	2.41	T	1.6	5.1	0
Period of record	55.2	103	-5	**15.98	9.61	0	**17.3	35.5	0

* Latitude 34° 39' N.; longitude 112° 26' W.; elevation 5,014 ft. above mean sea level (see pl. 4).
** Mean seasonal.

Note.--Period of record for maximum and minimum temperature and precipitation values 17 years (1943-59). Period of record for mean temperature and precipitation values 30 years (1921-50). Period of record for all snowfall values 17 years (1943-59). "T" represents trace.

Table 8

Summary of climatological data at Yuma, Ariz. (Yuma County Airport), Painted Rock Reservoir, Gila River basin, Ariz. and N. Mex.*

Month	Temperature			Precipitation		
	Mean monthly	Record highest	Record lowest	Mean monthly	Maximum monthly	Minimum monthly
	Degrees Fahrenheit	Degrees Fahrenheit	Degrees Fahrenheit	Inches	Inches	Inches
Jan.	55.3	86	30	0.33	1.29	T
Feb.	60.1	94	28	.29	1.82	T
Mar.	65.7	95	32	.26	.62	0
Apr.	72.8	107	42	.10	.40	0
May	80.4	115	49	.02	.05	0
Jun.	87.8	120	54	.01	T	0
Jul.	94.6	119	63	.23	1.07	T
Aug.	93.7	117	64	.50	1.31	0
Sep.	88.3	115	58	.64	.02	0
Oct.	76.4	109	44	.32	2.68	0
Nov.	64.2	94	30	.14	.37	0
Dec.	57.1	86	28	.55	1.07	0
Period of record	74.7	120	28	**3.39	2.68	0

* Latitude 32° 40' N.; longitude 114° 36' W.; elevation 199 ft. above mean sea level (see pl. 4).

** Mean seasonal.

Note.--Period of record for maximum and minimum temperature and precipitation values 9 years (1951-59). Period of record for mean temperature and precipitation values 30 years (1921-50). "T" represents trace. No snowfall reported during 9-year period (1951-59).

Table 9

Summary of climatological data at Clifton, Ariz., Painted Rock Reservoir, Gila River basin, Ariz. and N. Mex.*

Month	Temperature			Precipitation			Snowfall		
	Mean monthly	Record highest	Record lowest	Mean monthly	Maximum monthly	Minimum monthly	Mean monthly	Maximum monthly	Minimum monthly
	Degrees Fahrenheit	Degrees Fahrenheit	Degrees Fahrenheit	Inches	Inches	Inches	Inches	Inches	Inches
Jan.	45.0	79	10	0.94	3.77	0	1.0	20.0	0
Feb.	50.8	84	16	1.00	6.22	0	.2	4.0	0
Mar.	56.6	92	26	.82	6.07	0	T	T	0
Apr.	64.1	99	26	.40	2.35	0	T	T	0
May.	72.6	107	39	.33	1.80	0	0	0	0
Jun.	81.9	113	49	.44	2.60	0	0	0	0
Jul.	84.3	114	42	2.16	5.78	.34	0	0	0
Aug.	82.8	113	54	2.40	6.20	.29	0	0	0
Sep.	78.3	110	45	1.60	5.36	T	0	0	0
Oct.	67.9	102	34	.95	4.30	0	0	0	0
Nov.	54.2	94	22	.59	2.87	0	T	T	0
Dec.	45.8	78	18	.99	5.95	0	T	.5	0
Period of record	65.4	114	10	**12.62	6.22	0	**1.2	20	0

* Latitude 33° 03' N.; longitude 109° 17' W.; elevation 3,465 ft. above mean sea level (see pl. 4).
** Mean seasonal.

Note.--Period of record for temperature values 50 years (1909-58). Period of record for precipitation values 68 years (1891-1958). Period of record for snowfall values 20 years (1940-59). "T" represents trace.

Table 10

Runoff data, Gila River below Gillespie Dam, Painted Rock Reservoir, Gila River basin, Ariz. and N. Mex.*

Season**	Maximum peak discharge	Maximum gage height	Date	Maximum mean daily discharge	Date
	Cubic feet per second	Feet		Cubic feet per second	
1920-21	26,800	.....	22 Aug	(#)	.....
1921-22	32,700	.....	4 Jan	(#)	.....
1922-23	13,100	.....	20 Sep	(#)	.....
1923-24	85,000	16.00	28 Dec	(#)	.....
1924-25	15,200	2.30	20 Sep	12,500	20 Sep
1925-26	38,300	3.95	30 Sep	25,200	8 Apr
1926-27	67,300	5.45	18 Feb	60,000	18 Feb
1927-28	9,220	1.70	6 Feb	7,270	6 Feb
1928-29	20,700	2.74	6 Apr	15,900	6 Apr
1929-30	13,900	2.19	10 Aug	11,100	10 Aug
1930-31	17,500	2.50	16 Feb	16,500	16 Feb
1931-32	44,500	4.47	11 Feb	32,400	12 Feb
1932-33	2,180	.70	9 Oct	820	22 Jan
1933-34	3,100	.88	30 Aug	1,810	30 Aug
1934-35	7,470	.....	10 Feb	6,280	10 Feb
1935-36	3,240	.90	29 Jul	2,390	29 Jul
1936-37	45,800	3.48	9 Feb	24,500	9 Feb
1937-38	60,000	4.95	5 Mar	35,800	5 Mar
1938-39	3,240	.97	13 Sep	2,720	13 Sep
1939-40	2,620	.87	19 Aug	1,540	19 Aug
1940-41	45,800	4.45	16 Mar	29,900	17 Mar
1941-42	580	.30	13 Dec	530	14 Dec
1942-43	2,200	.75	5 Aug	1,640	5 Aug
1943-44	580	.29	25 Feb	380	12 Aug
1944-45	1,350	.53	14 Aug	1,050	14 Aug
1945-46	4,290	1.26	19 Sep	2,530	23 Sep
1946-47	4,390	1.23	9 Aug	1,880	9 Aug
1947-48	330	.23	9 Aug	158	7 Aug
1948-49	976	.42	7 Aug	665	19 Sep
1949-50	1,460	.56	19 Oct	655	19 Oct
1950-51	16,600	2.55	28 Aug	10,900	28 Aug
1951-52	430	5.23	22 Jan	372	22 Jan
1952-53	1,000	.....	2 Aug	78	20 Nov
1953-54	1,760	5.64	12 Aug	1,490	12 Aug
1954-55	3,660	.....	28 Aug	3,140	27 Aug
1955-56	0	.....	.....	0	.....
1956-57	959	.....	13 Jan	65	13 Jan
1957-58	976	10.48	13 Sep	474	13 Sep
1958-59	480	10.22	17 Aug	430	17 Aug
1959-60	640	10.31	19 Jan	580	19 Jan
1960-61	380	10.21	23 Jul	82	23 Jul

* Data from U. S. Geological Survey Water Supply Paper. Gaging station located at left end of Gillespie Dam, 8 miles downstream from Hassayampa River (See pl. 4 for location). Drainage area 49,620 sq. miles.

** 1 October-30 September, inclusive.

\# Records unreliable

Table 11

Runoff data, Gila River near Dome, Ariz., Painted Rock Reservoir, Gila River basin, Ariz. and N. Mex.*

Season**	Maximum peak discharge	Maximum gage height	Date	Maximum mean daily discharge	Date
	Cubic feet per second	Feet		Cubic feet per second	
1928-29	1,500	.....	9 Aug	530	10 Sep
1929-30	3,600	10.50	14 Aug	2,340	14 Aug
1930-31	11,400	13.78	19 Feb	10,200	19 Feb
1931-32	20,700	16.75	15 Feb	16,800	15 Feb
1932-33	770	3.90	10 Oct	338	10 Oct
1933-34	220	3.44	5 Aug	82	5 Aug
1934-35	757	5.35	16 Feb	651	16 Feb
1935-36	0	.....	.....	0	.....
1936-37	8,530	12.68	24 Mar	8,110	24 Mar
1937-38	8,670	12.92	10 Mar	7,920	10 Mar
1938-39	905	7.47	13 Sep	632	13 Sep
1939-40	0	.....	.....	0	.....
1940-41	14,000	13.93	22 Apr	13,500	22 Apr
1941-42	0	.....	.....	0	.....
1942-43	0	.....	.....	0	.....
1943-44	0	.....	.....	0	.....
1944-45	0	.....	.....	0	.....
1945-46	0	.....	.....	0	.....
1946-47	380	5.25	9 Aug	119	9 Aug
1947-48	0	.....	.....	0	.....
1948-49	0	.....	.....	0	.....
1949-50	0	.....	.....	0	.....
1950-51	1,100	7.94	7 Sep	1,080	7 Sep
1951-52	293	5.24	30 Oct	91	30 Oct
1952-53	47	4.36	17 Sep	32	23 Aug
1953-54	56	4.33	3 Sep	33	22 Mar
1954-55	1,070	9.62	17 Aug	581	5 Sep
1955-56	86	4.99	12 Oct	32	3 Oct
1956-57	66	4.70	29 Aug	32	29 Aug
1957-58	719	8.63	31 Jul	217	31 Jul
1958-59	802	9.45	8 Aug	590	8 Aug
1959-60	2,130	12.12	1 Sep	675	1 Sep
1960-61	168	5.93	3 Aug	113	13 Jan

* Data from U. S. Geological Survey Water Supply Paper. Gaging station located on right bank, 400 ft. upstream from Arizona State Highway 95 bridge, 3 miles west of Dome and 12 miles upstream from mouth (See pl. 4 for location). Drainage area 58,080 sq. miles.

** 1 October-30 September, inclusive.

Table 12

Damages on the Gila River between Texas Hill and Gila siphon resulting from floods or reservoir releases, Gila River basin, Ariz. and N. Mex.

Flood magnitude	Reservoir releases*	Total damages
Cubic feet per second	Cubic feet per second	
92,000**		$21,440,000
50,000		16,450,000
20,000		7,650,000
10,000		1,420,000
5,000		540,000
	22,500	11,110,000
	10,000	7,560,000
	5,000	960,000

summer?

winter?

* For a period of time ranging from a few days to a couple of months.
** Standard project flood at Dome.

NOTE.--Prices based on 1959 price level.

Table 13

Area and Gross Capacity
Painted Rock Reservoir, Gila River Basin, Ariz. and N. Mex.*

Elevation (Feet above mean sea level)	Capacity (Acre-feet)	Area (Acres)	Elevation (Feet above mean sea level)	Capacity (Acre-feet)	Area (Acres)	Elevation (Feet above mean sea level)	Capacity (Acre-feet)	Area (Acres)	Elevation (Feet above mean sea level)	Capacity (Acre-feet)	Area (Acres)
530	83	27	553	17,400	1,960	576	119,800	7,590	599	399,000	16,700
531	160	68	554	19,500	2,130	577	127,800	7,980	600	416,800	17,100
532	250	108	555	21,700	2,300	578	136,200	8,370	601	435,000	17,700
533	390	149	556	24,000	2,470	579	144,500	8,760	602	453,000	18,300
534	560	189	557	26,500	2,640	580	154,300	9,160	603	471,000	18,800
535	760	230	558	29,100	2,810	581	164,000	9,520	604	490,000	19,400
536	990	270	559	31,800	2,980	582	174,000	9,890	605	510,000	19,900
537	1,280	311	560	34,700	3,150	583	184,000	10,300	606	530,000	20,400
538	1,580	351	561	37,900	3,400	584	194,000	10,600	607	550,000	20,800
539	1,920	392	562	41,400	3,650	585	205,000	11,000	608	571,000	21,200
540	2,320	432	563	45,200	3,900	586	216,000	11,400	609	592,000	21,700
541	2,800	504	564	49,200	4,150	587	227,000	11,800	610	613,300	22,100
542	3,360	575	565	53,500	4,450	588	239,000	12,300	611	635,000	22,700
543	4,000	647	566	58,100	4,680	589	252,000	12,700	612	657,000	23,200
544	4,700	718	567	63,000	4,970	590	265,600	13,100	613	680,000	23,800
545	5,500	790	568	68,200	5,250	591	279,000	13,500	614	703,000	24,300
546	6,400	922	569	73,700	5,530	592	292,000	13,900	615	727,000	24,800
547	7,400	1,050	570	79,500	5,800	593	305,000	14,300	616	751,000	25,300
548	8,600	1,190	571	85,500	6,090	594	318,000	14,700	617	776,000	25,800
549	10,000	1,320	572	91,700	6,370	595	332,000	15,100	618	802,000	26,400
550	11,700	1,450	573	98,200	6,650	596	348,000	15,500	619	831,000	26,900
551	13,500	1,620	574	105,000	6,920	597	364,000	15,900	620	861,200	27,400
552	15,400	1,790	575	112,200	7,200	598	381,000	16,300	621	891,000	28,000

*See footnote at end of table.

Table 13--Continued

Area and Gross Capacity
Painted Rock Reservoir, Gila River Basin, Ariz. and N. Mex.*

Elevation (Feet above mean sea level)	Capacity (Acre-feet)	Area (Acres)	Elevation (Feet above mean sea level)	Capacity (Acre-feet)	Area (Acres)	Elevation (Feet above mean sea level)	Capacity (Acre-feet)	Area (Acres)	Elevation (Feet above mean sea level)	Capacity (Acre-feet)	Area (Acres)
622	920,000	28,500	643	1,643,000	41,000	664	2,650,000	55,300	685	3,970,000	70,800
623	949,000	29,000	644	1,683,000	41,600	665	2,706,000	55,800	686	4,042,000	71,700
624	978,000	29,600	645	1,723,000	42,100	666	2,763,000	56,700	687	4,115,000	72,600
625	1,007,000	30,200	646	1,764,000	42,800	667	2,821,000	57,400	688	4,189,000	73,500
626	1,036,000	30,700	647	1,808,000	43,600	668	2,880,000	58,100	689	4,264,000	74,400
627	1,066,000	31,200	648	1,854,000	44,300	669	2,940,000	58,800	690	4,339,000	75,300
628	1,098,000	31,800	649	1,901,000	45,000	670	3,006,000	59,600	691	4,415,000	76,300
629	1,130,000	32,300	650	1,948,800	45,700	671	3,061,000	60,200	692	4,492,000	77,300
630	1,162,500	32,800	651	1,997,000	46,400	672	3,122,000	60,900	693	4,570,000	78,200
631	1,195,000	33,400	652	2,045,000	47,000	673	3,184,000	61,600	694	4,649,000	79,200
632	1,228,000	34,100	653	2,093,000	47,600	674	3,246,000	62,200	695	4,729,000	80,200
633	1,261,000	34,700	654	2,142,000	48,300	675	3,309,000	62,900	696	4,810,000	81,200
634	1,295,000	35,300	655	2,191,000	48,900	676	3,372,000	63,600	697	4,892,000	82,200
635	1,330,000	35,900	656	2,240,000	49,600	677	3,436,000	64,300	698	4,974,000	83,100
636	1,366,000	36,600	657	2,290,000	50,400	678	3,500,000	65,000	699	5,057,000	84,100
637	1,405,000	37,300	658	2,340,000	51,100	679	3,565,000	65,700	700	5,141,000	85,100
638	1,444,000	38,000	659	2,390,000	51,800	680	3,630,500	66,400	701	5,226,000	86,100
639	1,483,000	38,700	660	2,440,200	52,500	681	3,696,000	67,300	702	5,312,000	87,100
640	1,523,400	39,400	661	2,491,700	53,200	682	3,763,000	68,200	703	5,399,000	88,100
641	1,563,000	39,900	662	2,543,000	53,900	683	3,831,000	69,000	704	5,487,000	89,100
642	1,603,000	40,500	663	2,596,000	54,600	684	3,900,000	69,900	705	5,575,000	90,100

* Table based on survey of March 1953.

Table 14

Pertinent data for snow courses in and near the Gila River basin, Painted Rock Reservoir, Gila River basin, Ariz. and N. Mex.*

Station No.**	Name	Station elevation	Average water content of snow on indicated dates***			
			15 Jan	1 Feb	1 Mar	1 Apr
		Feet	Inches	Inches	Inches	Inches
7-S-1	Taylor Creek	7,850	0.5	0.6	0.4	0
7-S-2	Inman	7,800	.4	.5	.5	0
8-S-1	Frisco Divide	8,000	1.3	2.1	1.7	.5
8-S-2	Mogollon	7,000	.5	.7	1.3	.3
9-S-1	Baldy	9,125	3.6	5.5	5.9	3.4
9-S-2	Maverick Fork	9,050	4.9	6.4	7.5	5.5
9-S-4	Nutrioso	8,500	1.4	2.0	1.7	.5
9-S-5	Pacheta	7,800	2.4	2.7	2.4	.6
9-S-6	Beaver Head	8,000	2.1	2.9	2.3	.7
9-S-7	Coronado Trail	8,000	1.9	2.6	2.3	1.1
9-S-8	State Line	8,000	1.5	2.5	2.1	.5
9-R-1	Milk Ranch	7,000	.8	2.0	.9	0
9-R-2	McNary	7,200	1.5	2.7	2.4	.2
9-R-5	Fort Apache	9,160	4.4	6.1	6.8	6.4
10-T-1	Bear Wallow	8,100	2.2	3.0	2.6	.9
10-T-2	Rose Canyon	7,300	.7	1.6	.7	.3
10-S-1	Workman Creek	6,900	2.8	3.4	1.5	1.2
10-R-4	Heber	7,600	1.4	3.2	2.4	.4
10-R-5	Gentry	7,600	1.4	3.0	2.4	.3
10-R-6	Forest Dale	6,430	.6	1.5	1.0	0
10-R-7	Canyon Creek No.2.	7,500	.....	.....	.....	.....
11-R-1	Munds Park	6,500	1.5	2.6	1.6	.6
11-R-2	Casner Park	6,930	2.5	4.1	2.2	1.0
11-R-3	Mormon Mountain	7,500	3.0	5.1	4.6	2.4
11-R-4	Mormon Lake	7,350	2.6	5.2	4.9	3.5
11-R-5	Happy Jack	7,630	1.7	3.0	2.6	1.3
11-P-2	Fort Valley	7,350	2.0	2.9	2.3	1.2
12-R-1	Camp Wood	5,700	.9	1.5	.8	0
12-R-2	Iron Springs	6,200	1.3	1.7	1.2	0
12-R-3	Mingus Mountain	7,100	.8	1.7	1.1	0
12-R-4	Gaddes Canyon	7,600	1.3	3.4	2.7	1.6
12-P-1	Chalender	7,100	2.5	3.4	2.8	1.6

* See pl. 4 for location of snow courses.
** Soil Conservation Service number.
*** For period 1943-57.

Table 15

Plan A — See Plate 26 — Use with low initial storage

Outlet gate operation schedule, Painted Rock Reservoir, Gila River basin, Ariz. and N. Mex.*

Step No.	When reservoir water surface is between elevation S (1000 AF)	Gate setting for gates indicated: No. 1	No. 2	No. 3	Computed discharge	Downstream gage height
	Feet above mean sea level	Feet of opening	Feet of opening	Feet of opening	Cubic feet per second	Feet
1	**530 - 550 0.1	0	0	0	0	0
2	550 - 554	3.2	3.2	3.2	2,400 - 2,600	7.50 - 7.60
3	554 - 558	2.8	2.8	2.8	2,400 - 2,600	7.50 - 7.60
4	558 - 563	2.6	2.6	2.6	2,400 - 2,600	7.50 - 7.60
5	563 - 568	2.4	2.4	2.4	2,400 - 2,600	7.50 - 7.60
6	568 - 577	2.2	2.2	2.2	2,400 - 2,600	7.50 - 7.60
7	577 - 583	2.0	2.0	2.0	2,400 - 2,600	7.50 - 7.60
8	583 - 589	1.8	1.8	1.8	2,400 - 2,600	7.50 - 7.60
9	589 - 591 2.9	1.7	1.7	1.7	2,400 - 2,450	7.50 - 7.55
10	591 - 602	3.5	3.5	3.5	4,800 - 5,200	8.50 - 8.63
11	602 - 603	3.3	3.3	3.3	4,950 - 5,050	8.55 - 8.58
12	603 - 614	6.8	6.8	6.8	9,600 - 10,400	9.92 - 10.13
13	614 - 618 6.2	6.4	6.4	6.4	9,850 - 10,150	10.00 - 10.08
14	618 - 626	13.8	13.8	13.8	19,500 - 20,500	12.30 - 12.50
15	626 - 635	13.0	13.0	13.0	19,500 - 20,500	12.30 - 12.50
16	635 - 640	12.5	12.5	12.5	19,750 - 20,250	12.35 - 12.47
17	640 - 648 12.3	13.8	13.8	13.8	22,000 - 23,000	12.80 - 13.00
18	648 - 657	13.2	13.2	13.2	22,000 - 23,000	12.80 - 13.00
19	***657 - 661.6 12.92	12.5	12.5	12.5	22,000 - 23,000	12.80 - 13.00
20	661.6 - 662.4	11.3	11.3	11.3	21,000 - 23,000	12.60 - 13.00
21	662.4 - 663.0	10.1	10.1	10.1	21,000 - 23,000	12.60 - 13.00
22	663.0 - 663.5	8.9	8.9	8.9	21,000 - 23,000	12.60 - 13.00
23	663.5 - 664.1	7.7	7.7	7.7	21,000 - 23,000	12.60 - 13.00
24	664.1 - 664.5	6.6	6.6	6.6	21,000 - 23,000	12.60 - 13.00
25	664.5 - 664.9	5.5	5.5	5.5	21,000 - 23,000	12.60 - 13.00
26	664.9 - 665.2	4.5	4.5	4.5	21,000 - 23,000	12.60 - 13.00
27	665.2 - 665.6	3.4	3.4	3.4	21,000 - 23,000	12.60 - 13.00
28	665.6 - 665.9	2.5	2.5	2.5	21,000 - 23,000	12.60 - 13.00
29	665.9 - 666.2	1.5	1.5	1.5	21,000 - 23,000	12.60 - 13.00
30	666.2 - 666.5	.6	.6	.6	21,000 - 23,000	12.60 - 13.00
31	666.5 - 666.8	0	0	0	21,600 - 23,000	12.72 - 13.00
32	666.8 & above				Spillway flow only See Instructions	

* Schedule applicable for rising or falling stages.
** Gates may be 1/2 ft. open between elevations 530 - 535 ft. to pass low flows.
*** Spillway crest elevation 661 ft.

INSTRUCTIONS

1. Communications with the District Office, existing.

a. Notify the Hydraulic Operations Center when a gate change will be required according to the schedule.

b. To report gate settings, while operating on schedule, give the applicable step number only.

c. Notify the Hydraulic Operations Center if unable to set gates as instructed.

2. Communications with the District Office, interrupted.

a. Follow the gate operation schedule.

b. If one or more of the gates cannot be operated, adjust the remaining gates gradually and uniformly until the downstream gage height agrees with the scheduled values. Keep a close check on gage height and change the gate opening as often as required. If the downstream gage height is not obtainable, adjust the gates that are functioning so that the sum of the gate openings will equal the sum of the openings in the schedule.

3. Flood occurring with initial reservoir water-surface elevation at 640 or higher.

a. Outlet gates will be fully opened at the elevation indicated on the "Curve for Determining Operation Above Spillway Crest" (plate 30).

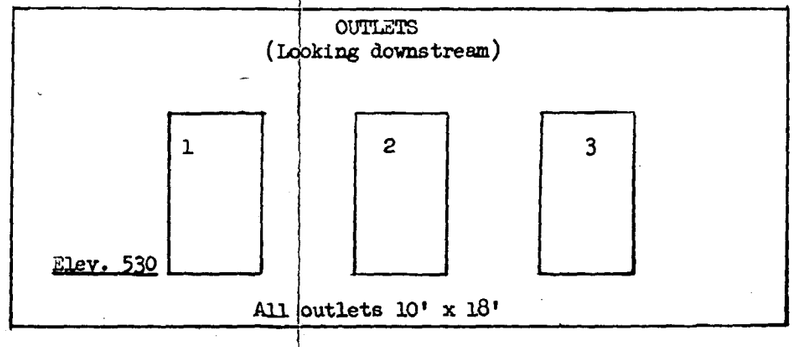

Table 16

Plan B Use if elev is 595 or higher initially See plate 26

Outlet gate operation schedule, Painted Rock Reservoir, Gila River basin, Ariz. and N. Mex.*

Step No.	When reservoir water surface is between elevation	Gate setting for gates indicated			Computed discharge	Downstream gage height
		No. 1	No. 2	No. 3		
	Feet above mean sea level	Feet of opening	Feet of opening	Feet of opening	Cubic feet per second	Feet
1	**530 - 550	0	0	0	0	0
2	550 - 554	5.0	5.0	5.0	3,600 - 3,950	8.05 - 8.20
3	554 - 558	6.0	6.0	6.0	4,600 - 5,050	8.45 - 8.60
4	558 - 562	7.0	7.0	7.0	5,750 - 6,200	8.80 - 8.95
5	562 - 566	8.0	8.0	8.0	6,900 - 7,400	9.05 - 9.30
6	566 - 570	9.0	9.0	9.0	8,150 - 8,700	9.50 - 9.70
7	570 - 574	10.0	10.0	10.0	9,400 - 10,000	9.85 - 10.00
8	574 - 578	11.0	11.0	11.0	10,900 - 11,400	10.25 - 10.40
9	578 - 582	12.0	12.0	12.0	12,300 - 12,800	10.60 - 10.75
10	582 - 586	13.0	13.0	13.0	13,700 - 14,300	11.00 - 11.10
11	586 - 590	14.0	14.0	14.0	15,200 - 15,800	11.30 - 11.50
12	590 - 594	15.0	15.0	15.0	16,600 - 17,300	11.65 - 11.80
13	594 - 598	16.0	16.0	16.0	18,200 - 18,900	12.00 - 12.15
14	598 - 602	17.0	17.0	17.0	19,800 - 20,500	12.35 - 12.50
15	602 - 611	18.0	18.0	18.0	21,500 - 23,000	12.70 - 13.00
16	611 - 617	17.0	17.0	17.0	22,000 - 23,000	12.80 - 13.00
17	617 - 624	16.1	16.1	16.1	22,000 - 23,000	12.80 - 13.00
18	624 - 631.5	15.3	15.3	15.3	22,000 - 23,000	12.80 - 13.00
19	631.5 - 640	14.5	14.5	14.5	22,000 - 23,000	12.80 - 13.00
20	640 - 649.5	13.7	13.7	13.7	22,000 - 23,000	12.80 - 13.00
21	649.5 - 657	13.0	13.0	13.0	22,000 - 22,700	12.80 - 12.97
22	***657 - 661.6	12.5	12.5	12.5	22,000 - 23,000	12.80 - 12.97
23	661.6 - 662.4	11.3	11.3	11.3	21,000 - 23,000	12.60 - 13.00
24	662.4 - 663.0	10.1	10.1	10.1	21,000 - 23,000	12.60 - 13.00
25	663.0 - 663.5	8.9	8.9	8.9	21,000 - 23,000	12.60 - 13.00
26	663.5 - 664.1	7.7	7.7	7.7	21,000 - 23,000	12.60 - 13.00
27	664.1 - 664.5	6.6	6.6	6.6	21,000 - 23,000	12.60 - 13.00
28	664.5 - 664.9	5.5	5.5	5.5	21,000 - 23,000	12.60 - 13.00
29	664.9 - 665.2	4.5	4.5	4.5	21,000 - 23,000	12.60 - 13.00
30	665.2 - 665.6	3.4	3.4	3.4	21,000 - 23,000	12.60 - 13.00
31	665.6 - 665.9	2.5	2.5	2.5	21,000 - 23,000	12.60 - 13.00
32	665.9 - 666.2	1.5	1.5	1.5	21,000 - 23,000	12.60 - 13.00
33	666.2 - 666.5	.6	.6	.6	21,000 - 23,000	12.60 - 13.00
34	666.5 - 666.8	0	0	0	21,600 - 23,000	12.72 - 13.00
35	666.8 & above				Spillway flow only See Instructions	

* Schedule applicable for rising or falling stages.
** Gates may be 1/2 ft. open between elevations 530 - 535 ft. to pass low flows.
*** Spillway crest elevation 661 ft.

INSTRUCTIONS

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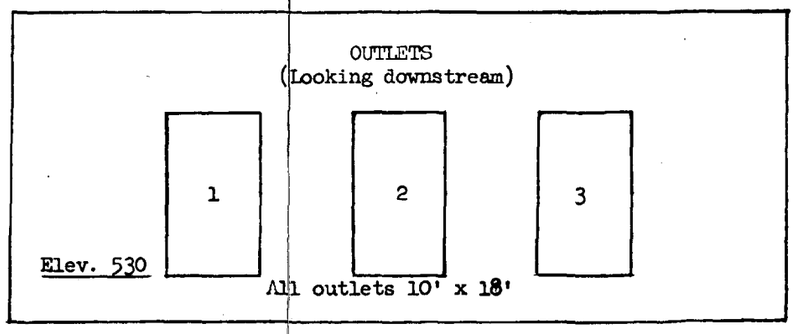

Table 17

Summary of flood routings - Painted Rock Reservoir, Gila River basin, Ariz. and N. Mex.

Flood	Operation plan	Maximum inflow	Maximum outflow	Maximum water-surface elevation	Assumptions at start of routing	
					Reservoir	Storage
		Cubic feet per second	Cubic feet per second	Feet above mean sea level		
Modified 14-21 January 1916.*	A.....	195,000	22,500	657.4	Reservoir empty.	Net.
Reservoir design.	B.....	300,000	22,500	660.5	...do.....	Do.
Spillway design.	.....	620,000	436,500	696.3	Reservoir full to spillway crest. Outlet gates fully open.	Do.
Do.....	A or B (identical above elevation 640).	620,000	404,000	696.3	Reservoir full to elevation 640.	Do.

* Reflects present upstream conditions above Painted Rock Reservoir.

Table 18

Approximate travel time for standard project flood peak, Gila River basin, Ariz. and N. Mex.

Reach	River	Travel time
		Hours
Coolidge Dam to Painted Rock Reservoir.	Gila	62
Roosevelt Dam to Painted Rock Reservoir.	Salt-Gila	54
Horseshoe Dam to Painted Rock Reservoir.	Verde-Salt-Gila	55
Lake Pleasant Dam to Painted Rock Reservoir.	Agua Fria-Gila	45
Gillespie Dam to Painted Rock Reservoir.	Gila	16
Painted Rock Reservoir to Texas Hill.	...do	16
Painted Rock Reservoir to Colorado River.	...do	48
Davis Dam to Parker Dam	Colorado	13
Parker Dam to Yuma, Ariz.	...do	50

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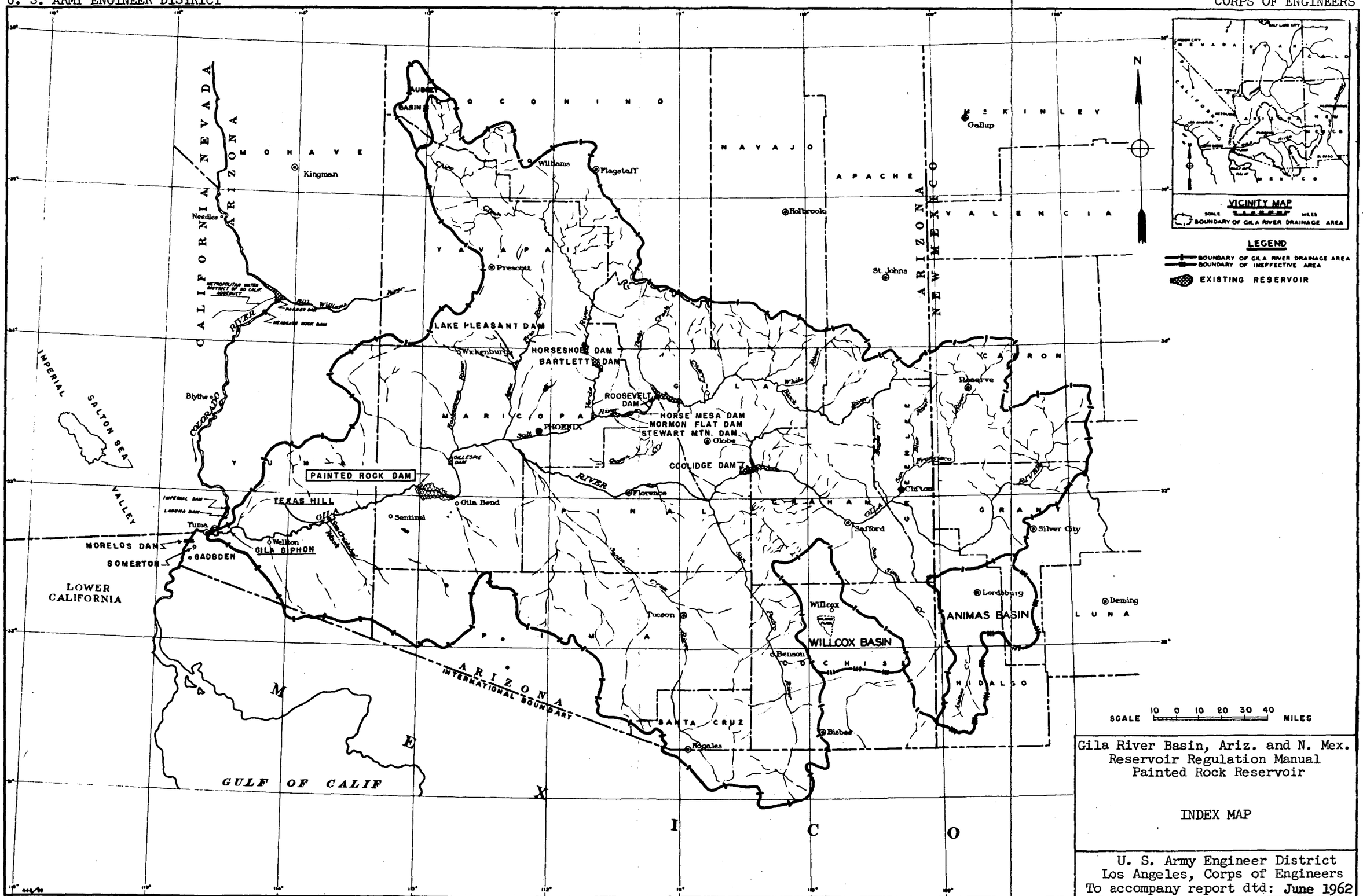
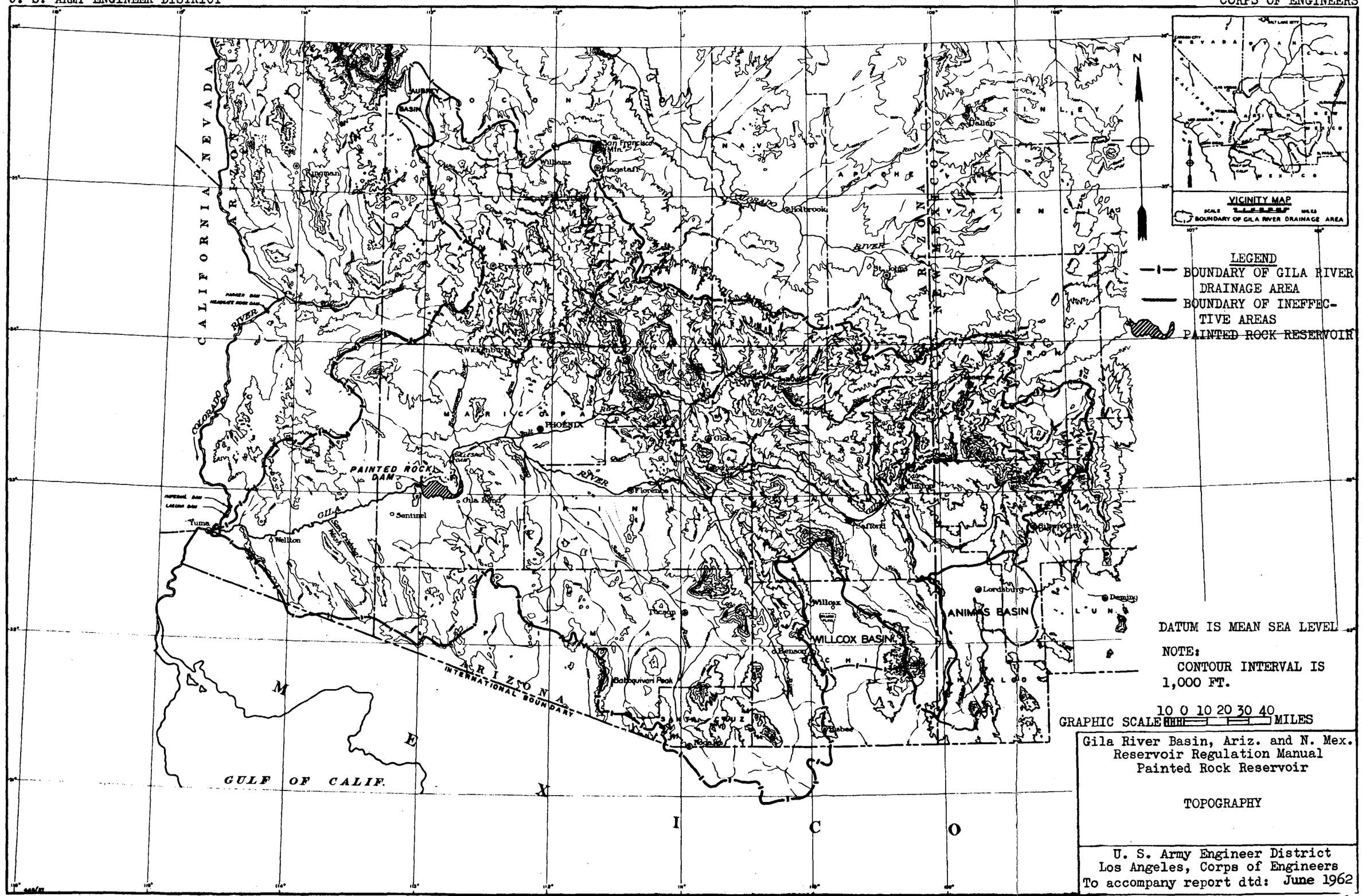


Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

INDEX MAP

U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

PLATE 1



Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

TOPOGRAPHY

U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

PLATE 2

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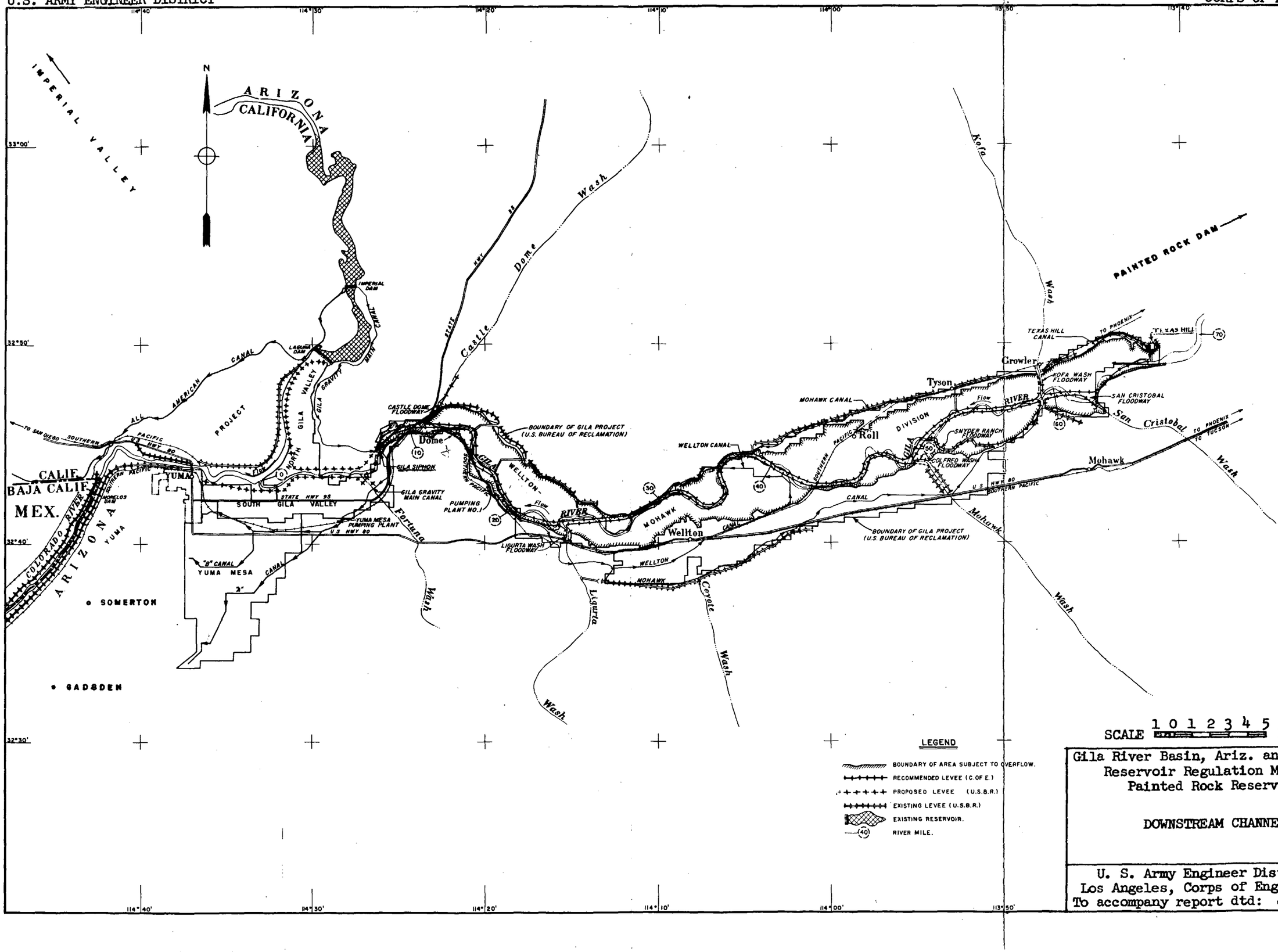

LEGEND

- BOUNDARY OF AREA SUBJECT TO OVERFLOW.
- RECOMMENDED LEVEE (C.OF E.)
- PROPOSED LEVEE (U.S.B.R.)
- EXISTING LEVEE (U.S.B.R.)
- EXISTING RESERVOIR.
- (40) RIVER MILE.

SCALE 1 0 1 2 3 4 5 MILES

Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

DOWNSTREAM CHANNEL

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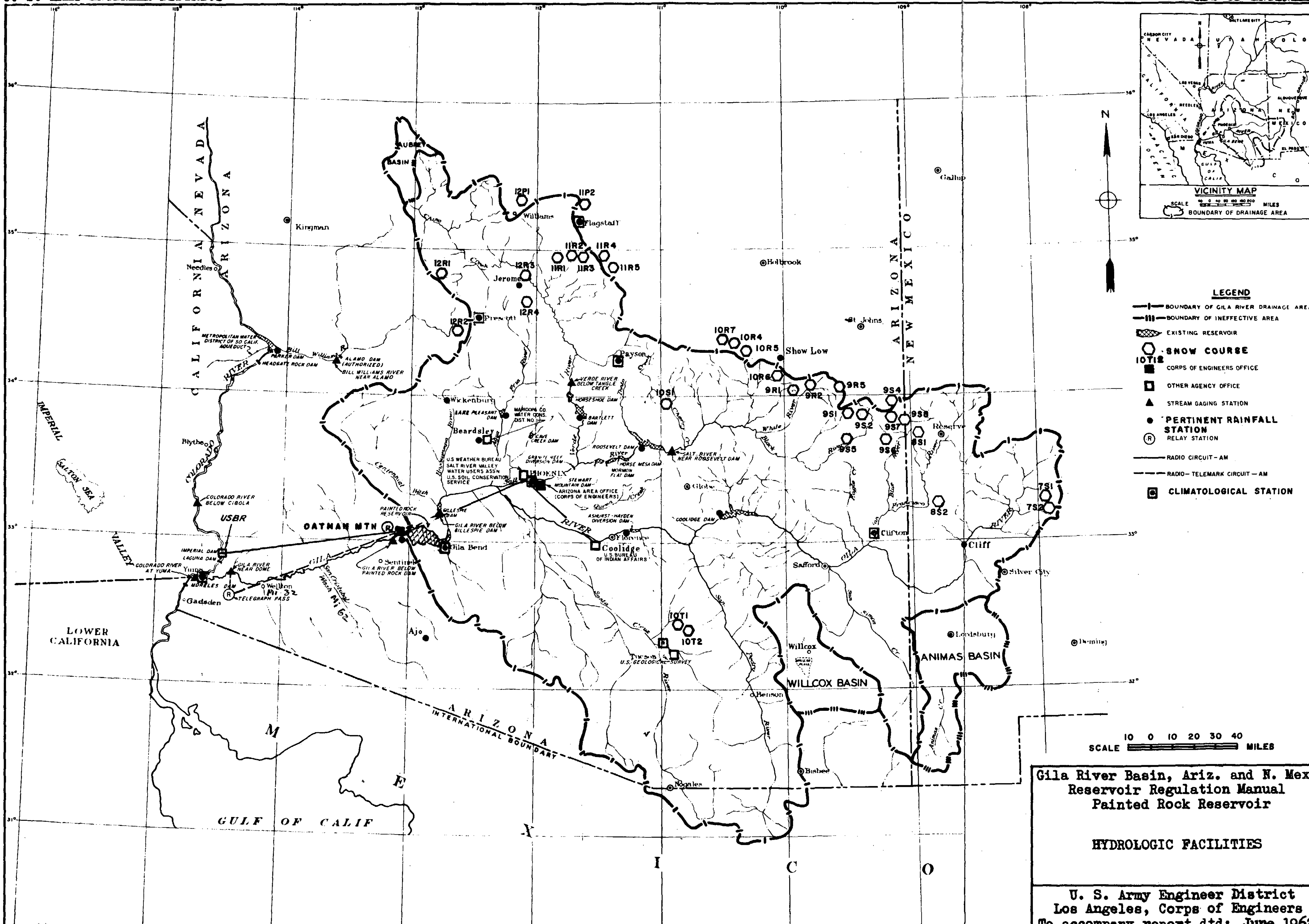
To accompany report dtd: June 1962

PLATE 3



Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

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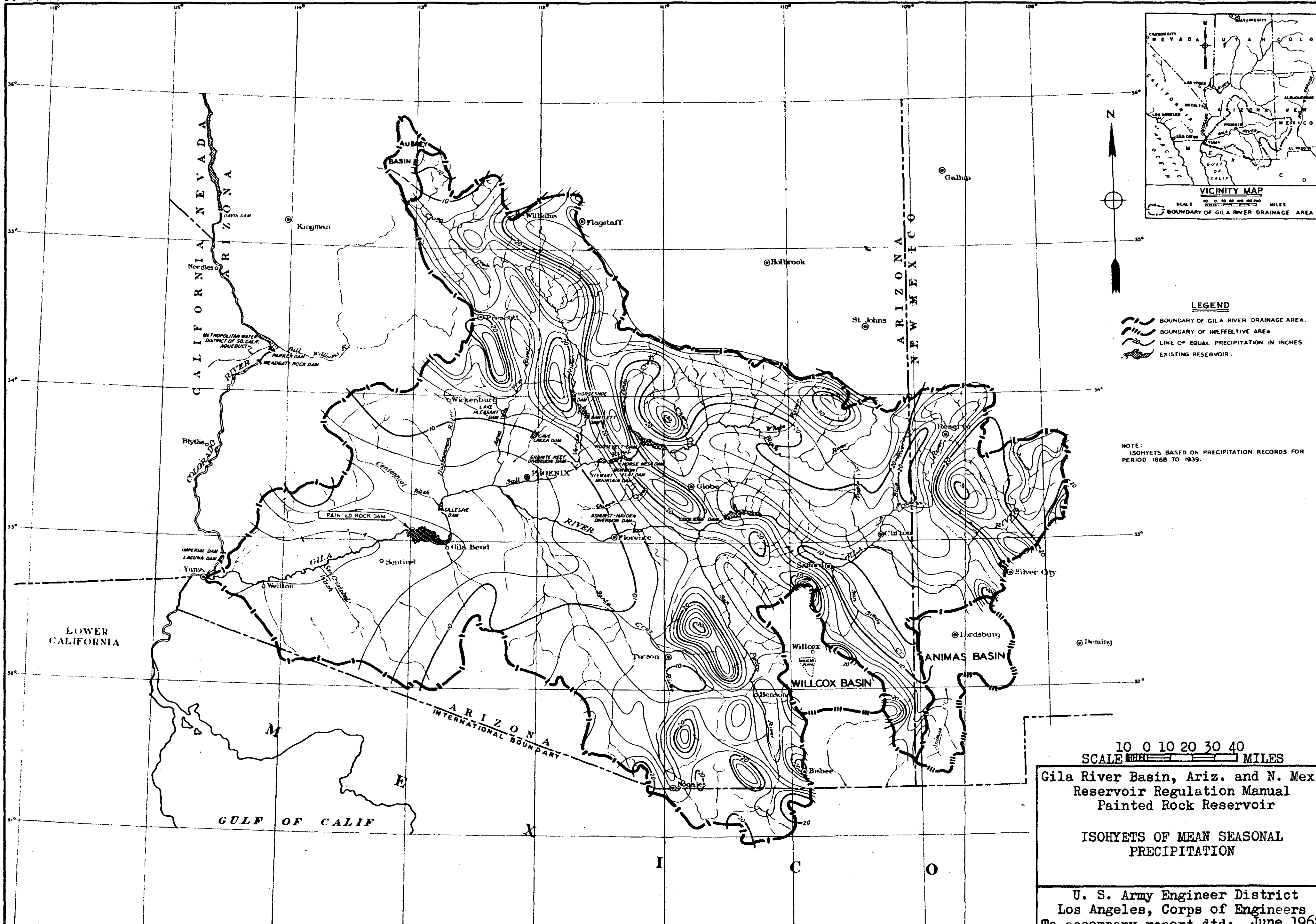
U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

PLATE 4



Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

ISOHYETS OF MEAN SEASONAL PRECIPITATION

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To accompany report dtd: June 1962

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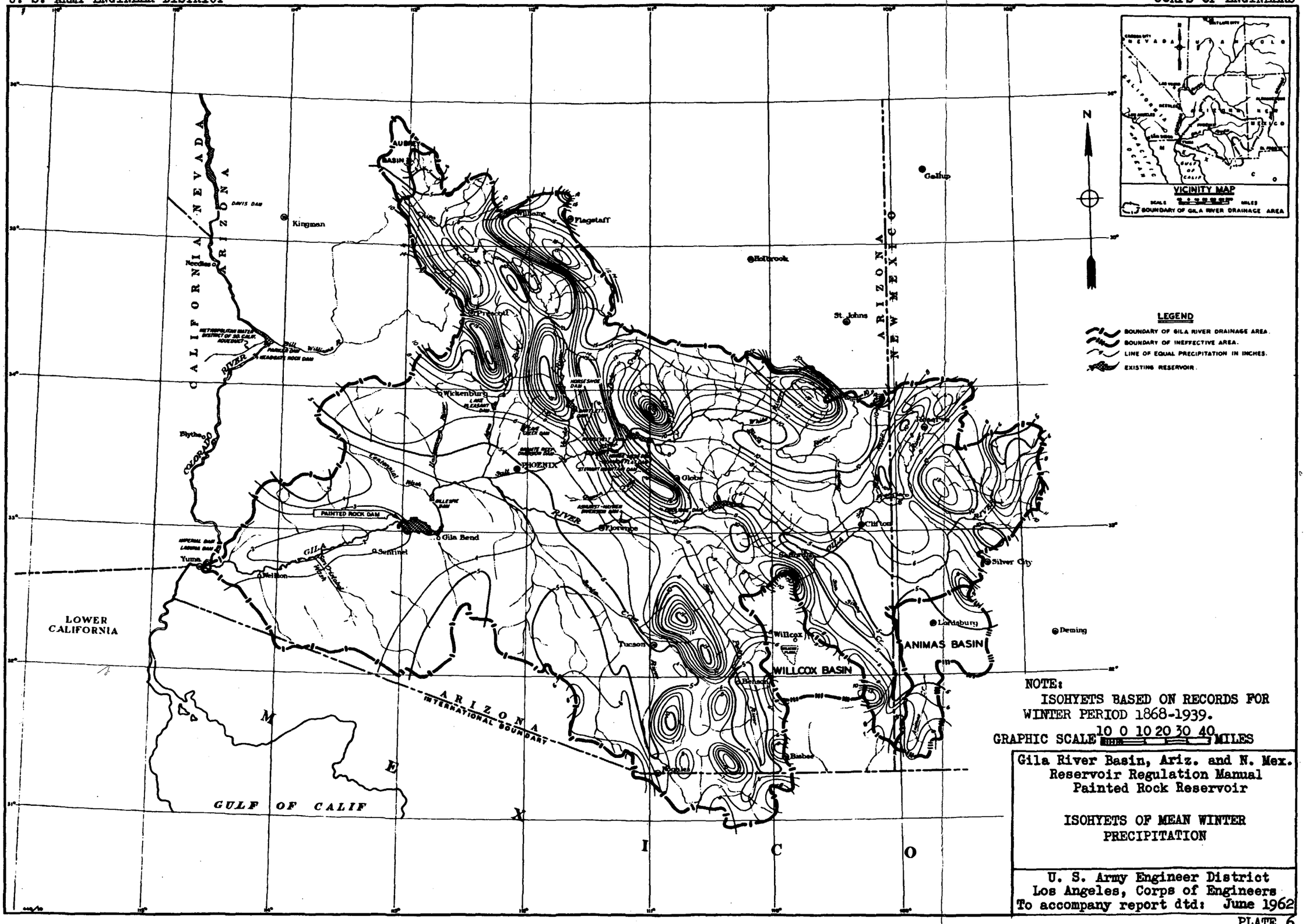

NOTE:
ISOHYETS BASED ON RECORDS FOR WINTER PERIOD 1868-1939.

GRAPHIC SCALE 10 0 10 20 30 40 MILES

Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

ISOHYETS OF MEAN WINTER PRECIPITATION

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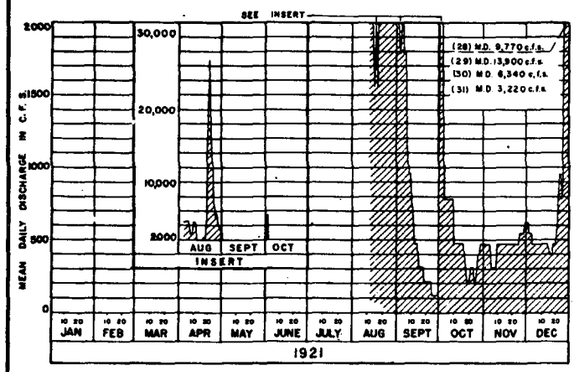
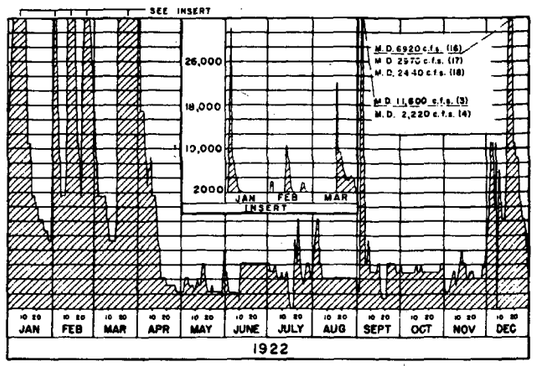
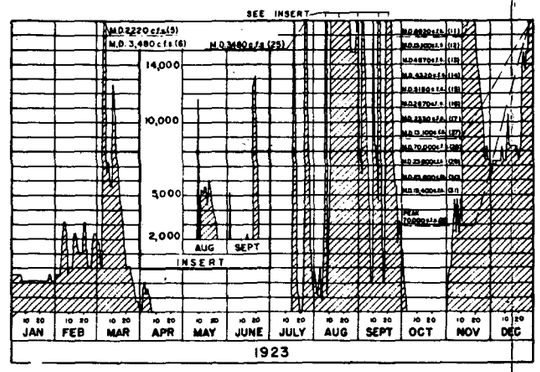
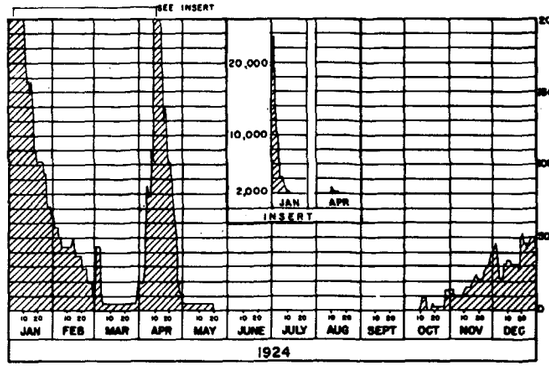
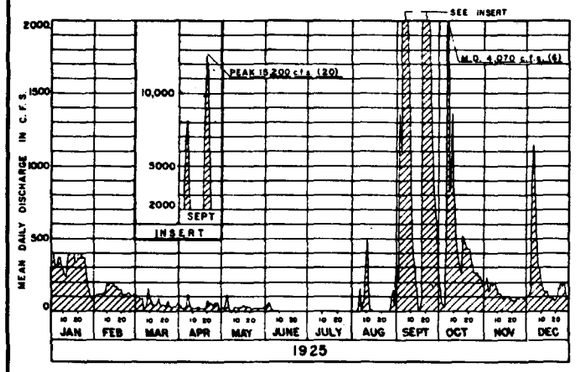
PLATE 6

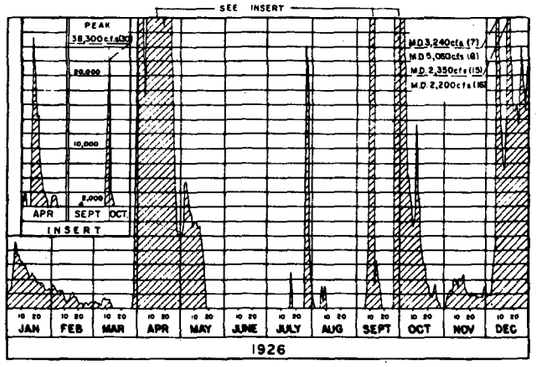


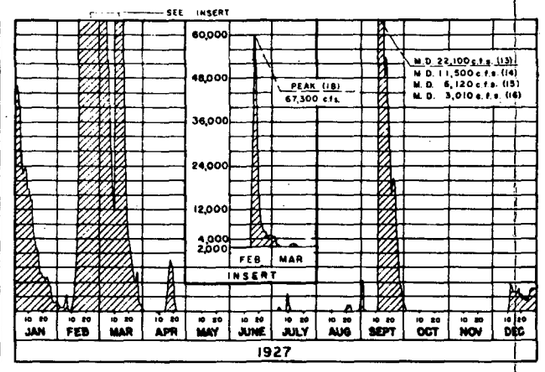


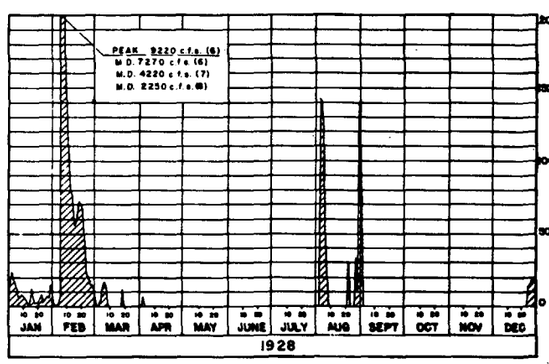


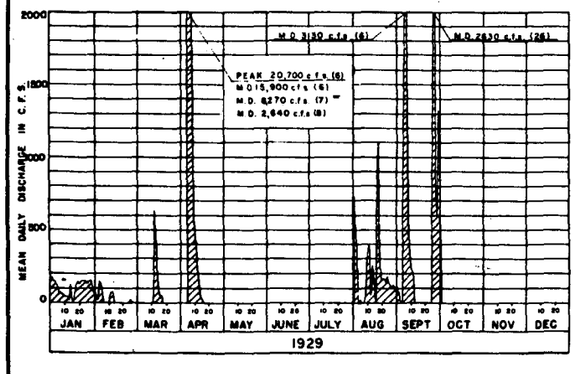


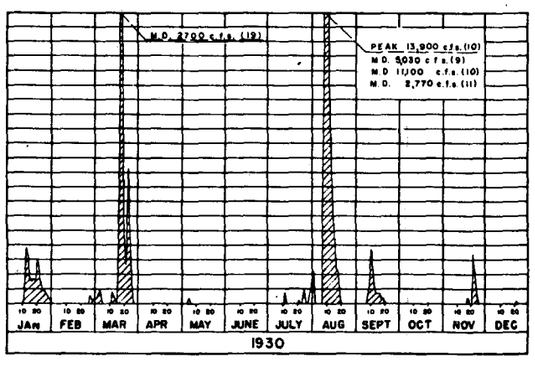


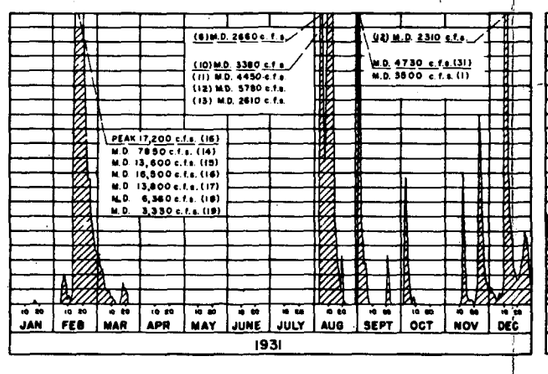


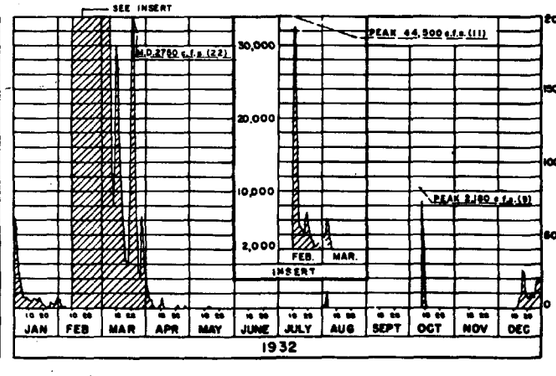


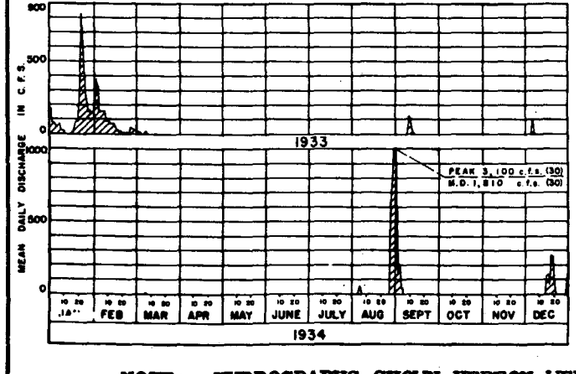


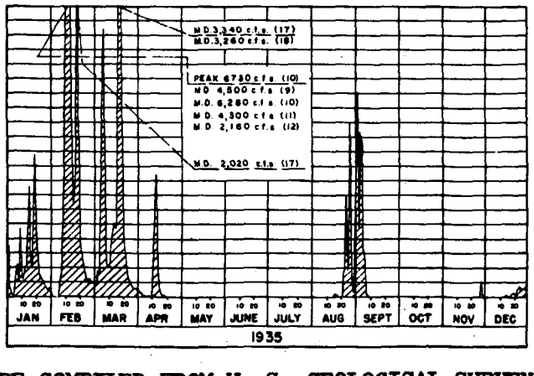


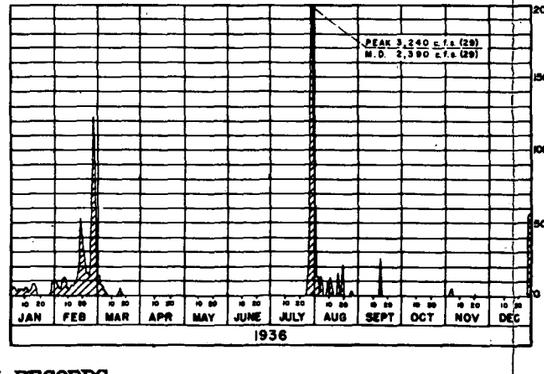












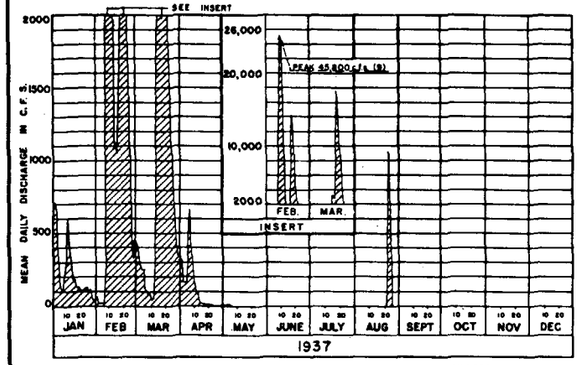
NOTE: HYDROGRAPHS SHOWN HEREON WERE COMPILED FROM U. S. GEOLOGICAL SURVEY RECORDS.

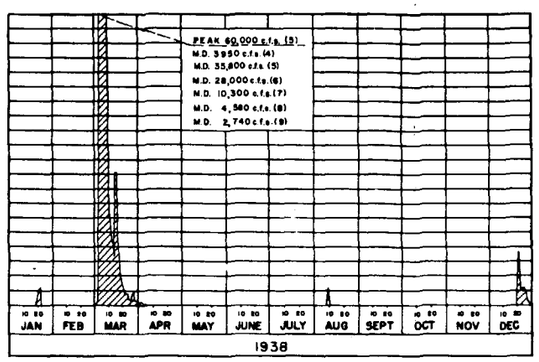
Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

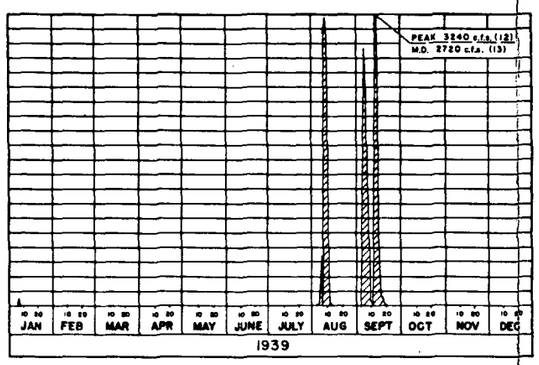
HYDROGRAPHS
1921-36

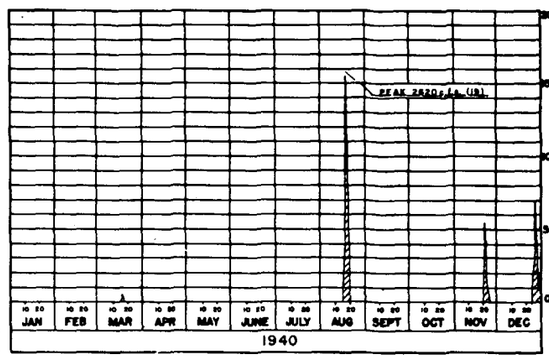
Gila River Below Gillespie Dam

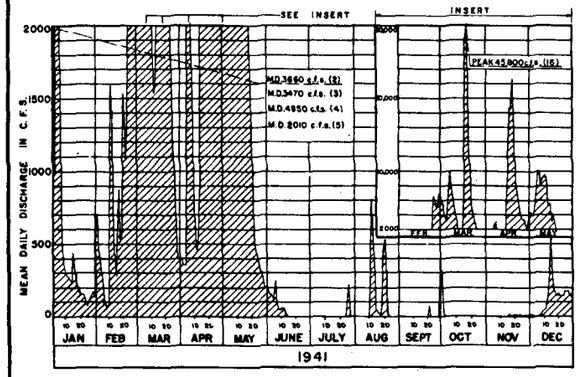
U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

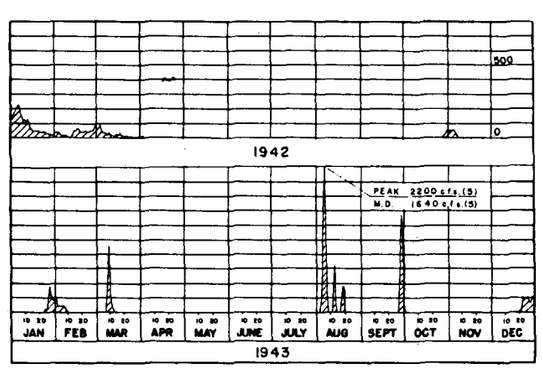


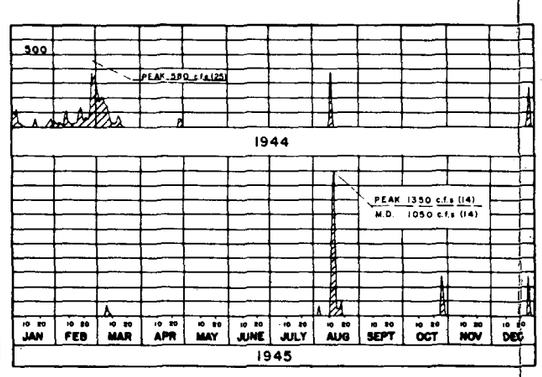


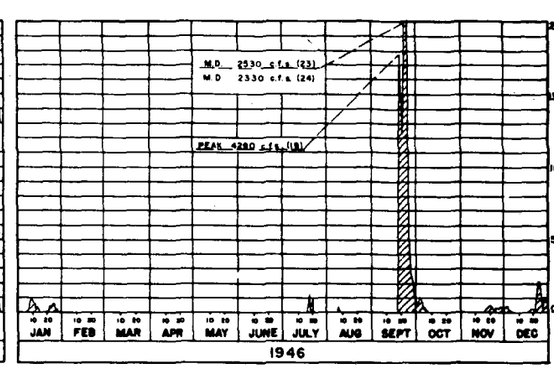


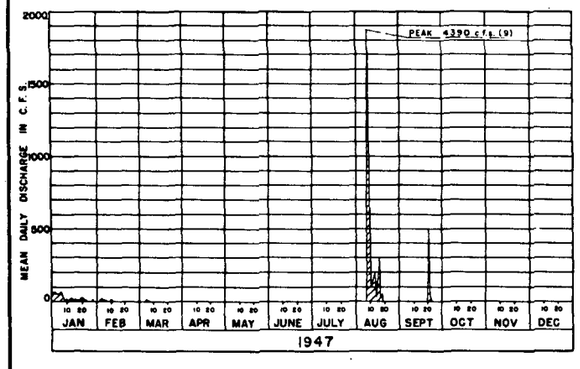


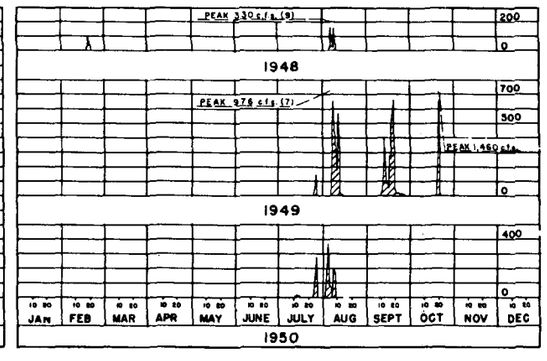


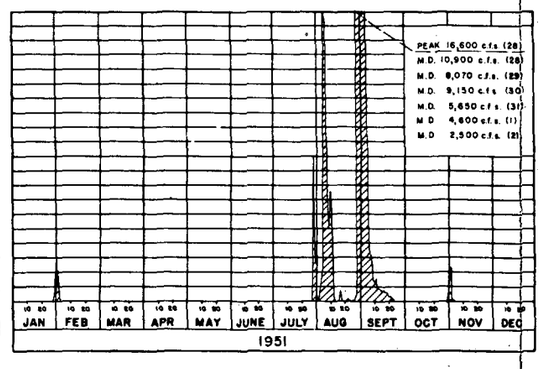


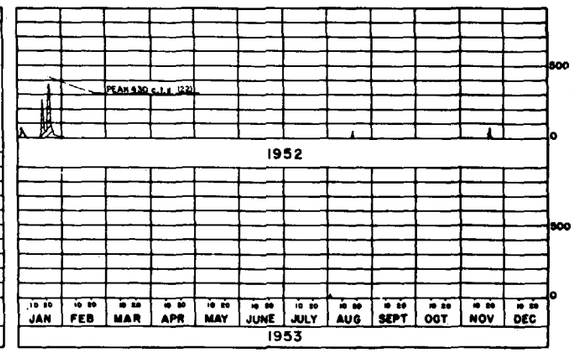


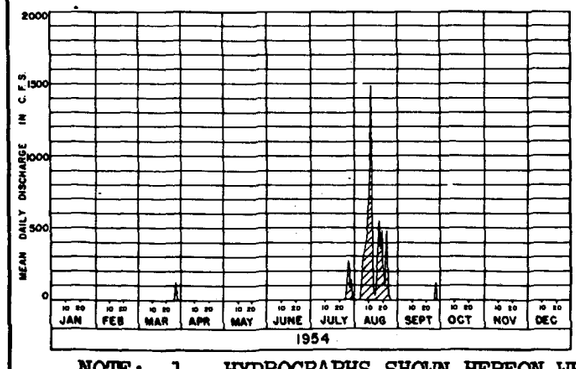


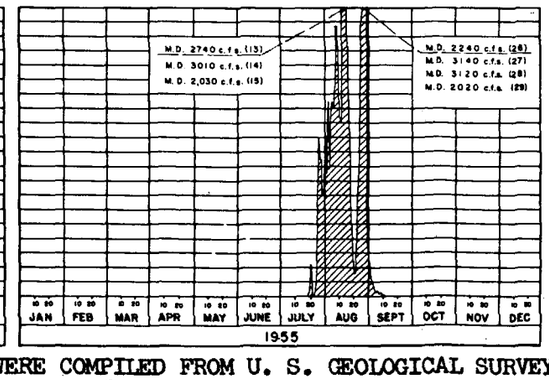


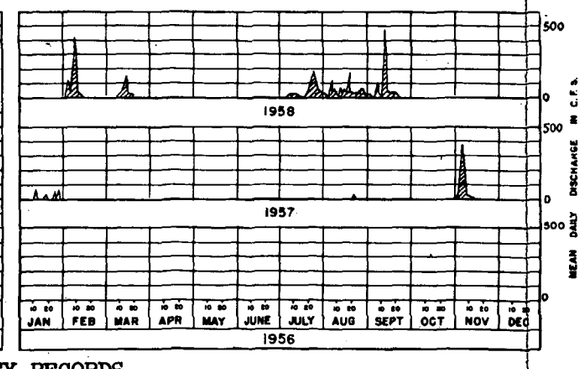












NOTE: 1. HYDROGRAPHS SHOWN HEREON WERE COMPILED FROM U. S. GEOLOGICAL SURVEY RECORDS.
2. DURING CALENDAR YEARS 1959 AND 1960, MAXIMUM MEAN DAILY DISCHARGES WERE 530 C. F. S. AND 580 C. F. S., RESPECTIVELY.

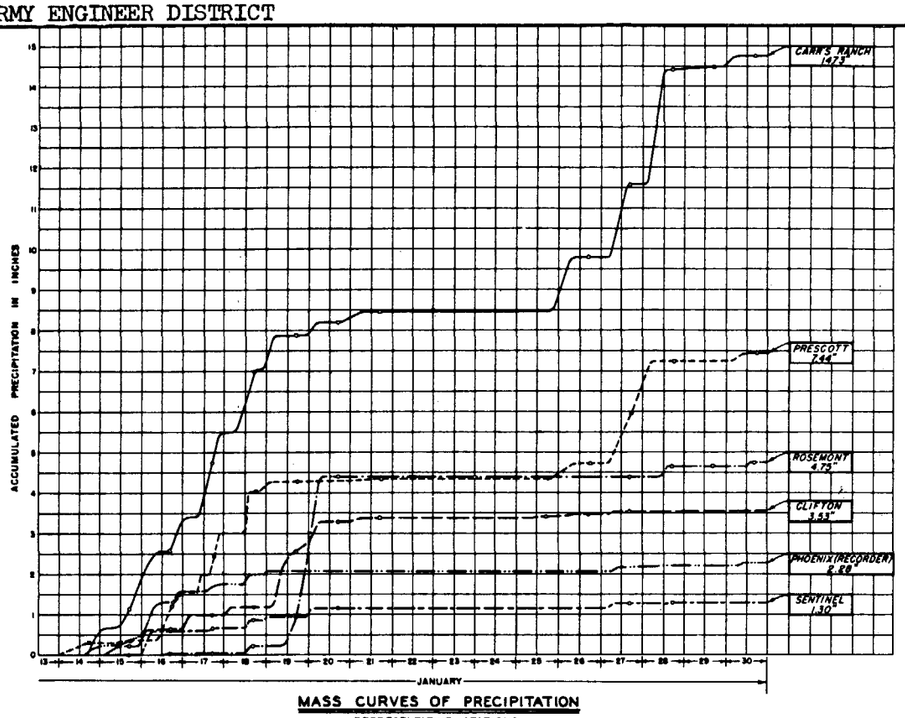
Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

HYDROGRAPHS
1937-58

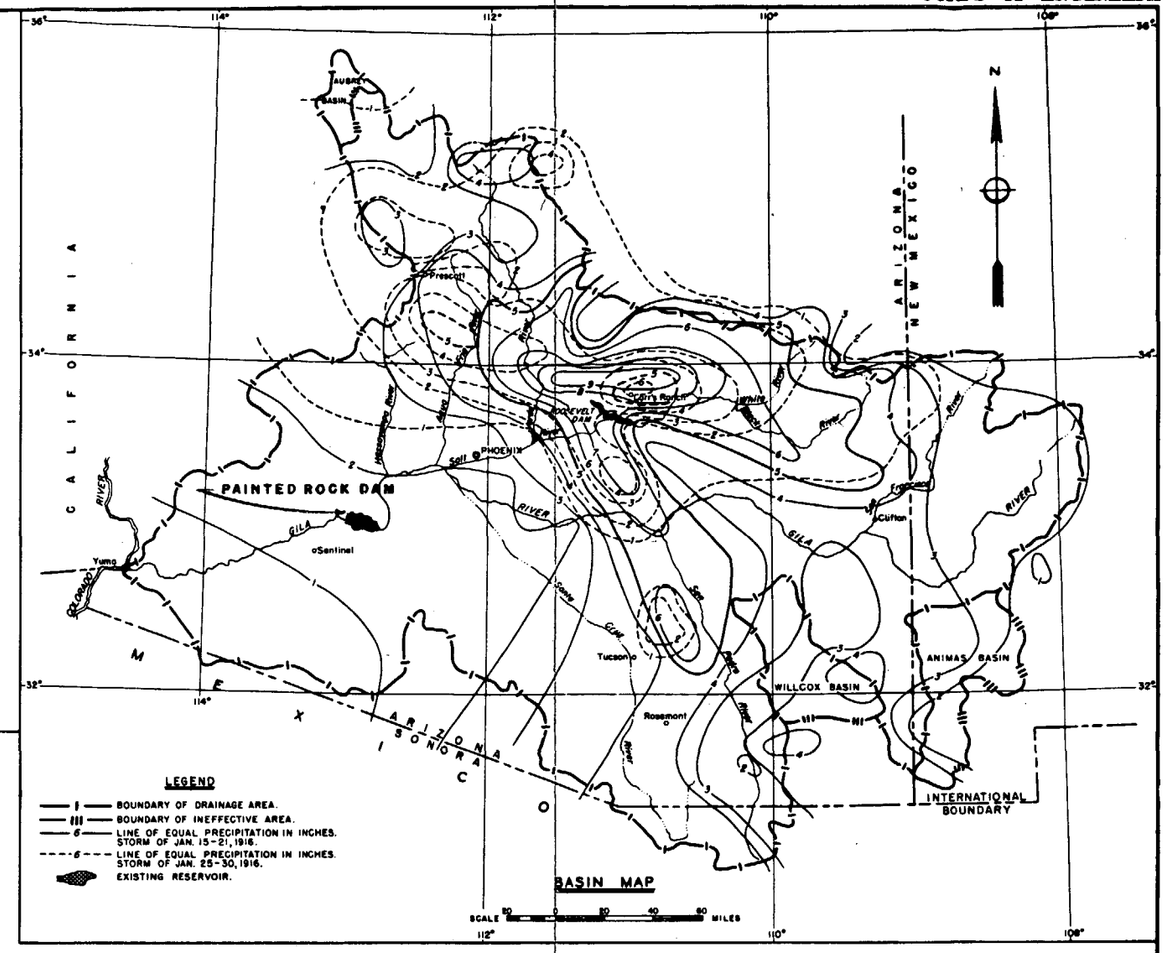
Gila River Below Gillespie Dam

U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

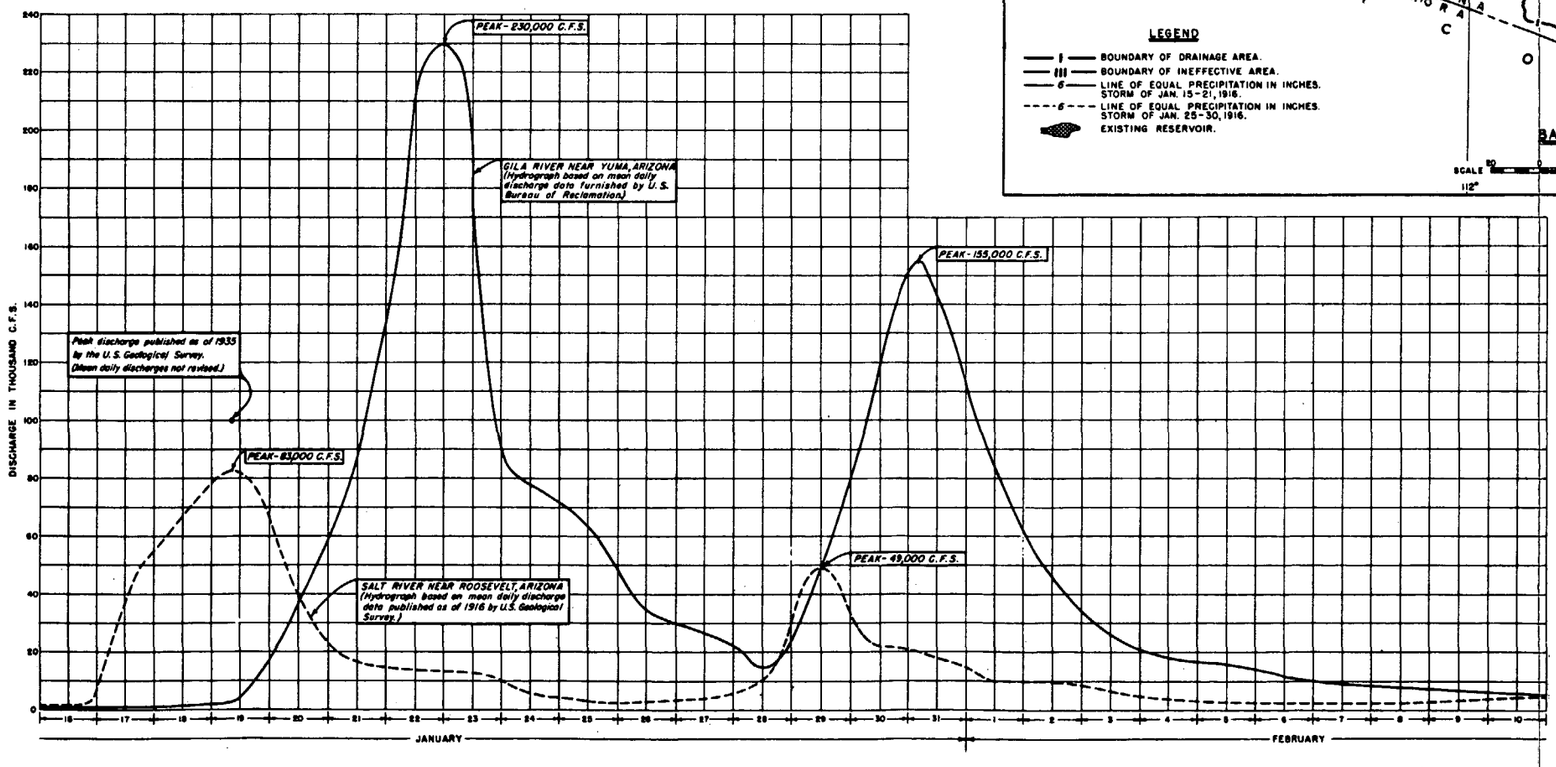
PLATE 8



MASS CURVES OF PRECIPITATION
REPRESENTATIVE STATIONS
JANUARY 14-30, 1916



BASIN MAP



HYDROGRAPHS

Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

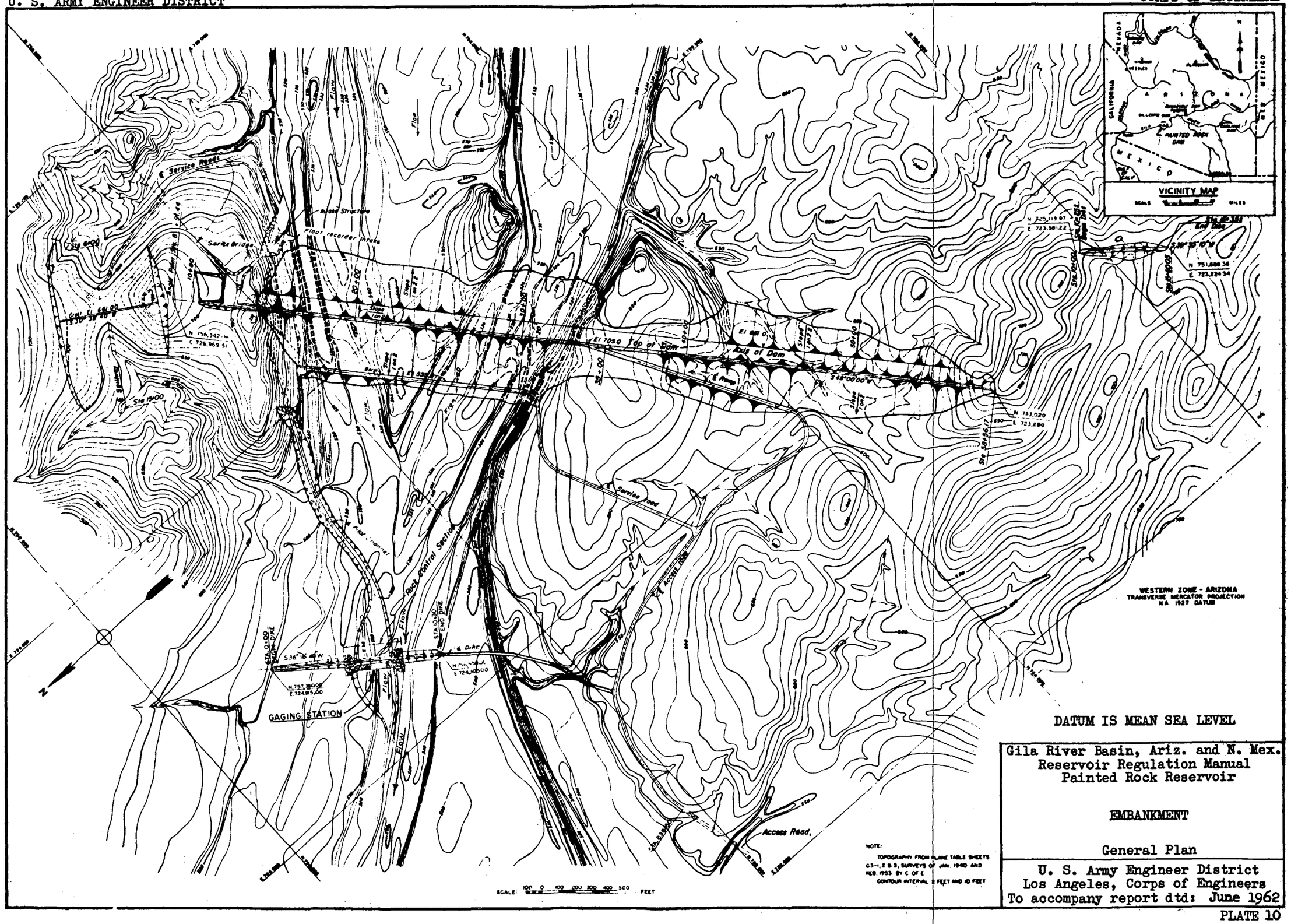
HYDROLOGIC DATA

Floods of January 1916

U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

U. S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS



NOTE:
TOPOGRAPHY FROM PLANE TABLE SHEETS G3-1, 2 & 3, SURVEYS OF JAN. 1940 AND FEB. 1953 BY C OF E
CONTOUR INTERVAL 5 FEET AND 10 FEET

DATUM IS MEAN SEA LEVEL

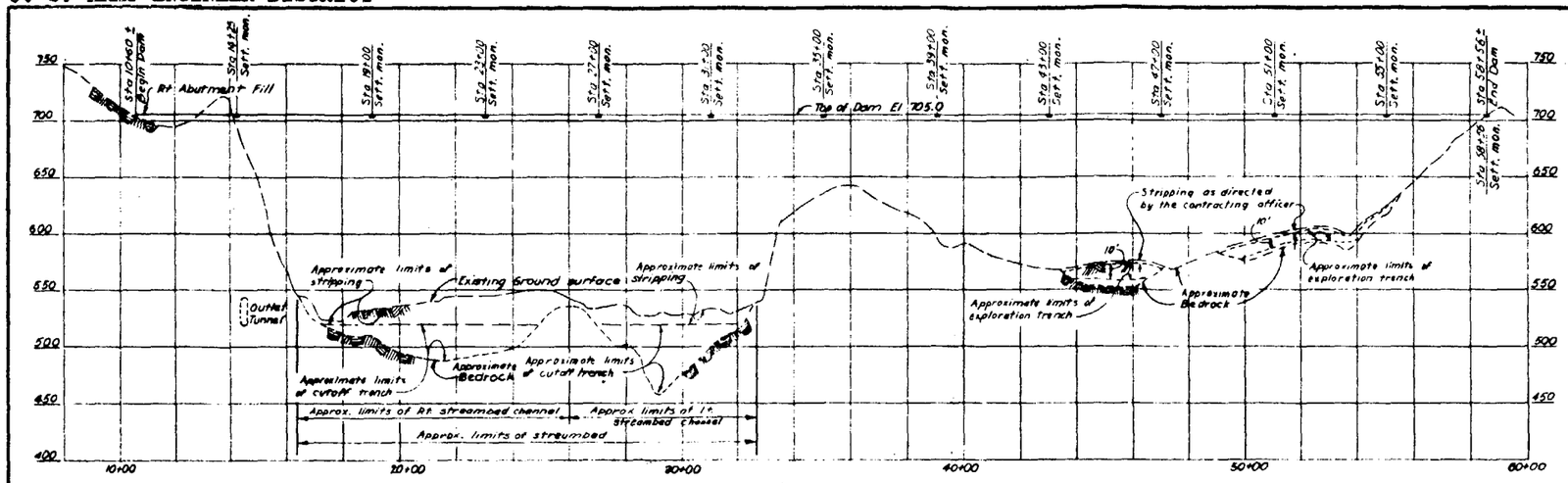
Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

EMBANKMENT

General Plan

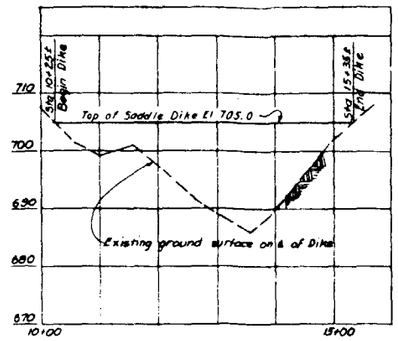
U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

PLATE 10



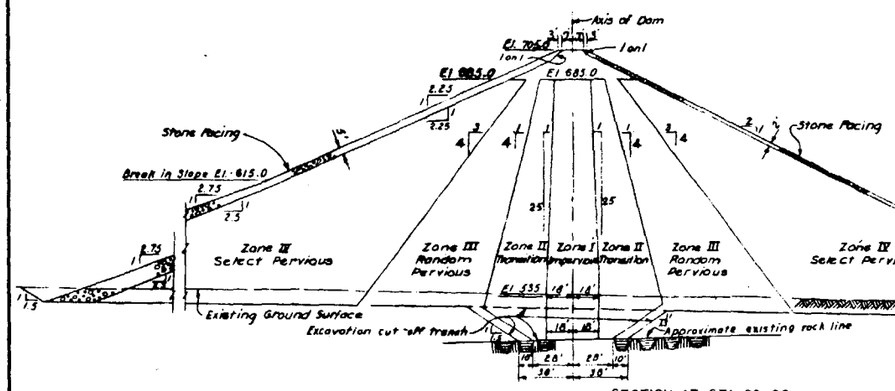
EMBANKMENT PROFILE

SCALE: HORIZ 1 IN = 200 FT (100 0 100 200 300 400 500)
VERT 1 IN = 50 FT (50 0 50 100 150)



PROFILE LT ABUT SADDLE DIKE

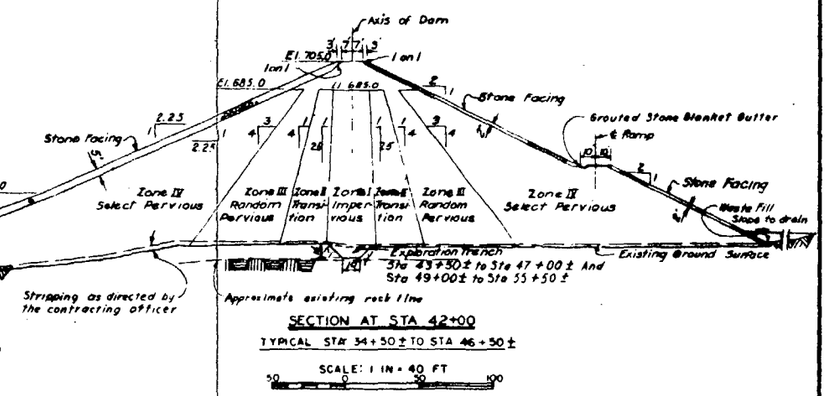
SCALE: HORIZ 1 IN = 100 FT
VERT 1 IN = 10 FT



SECTION AT STA 20+00

TYPICAL STA 16+50 ± TO STA 32+50 ±

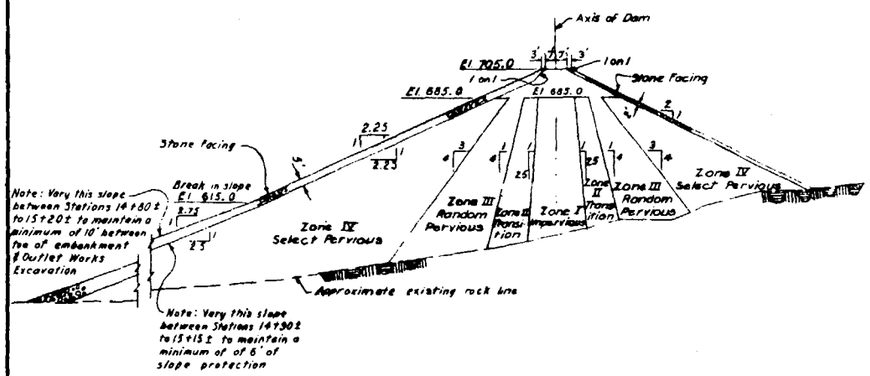
SCALE: 1 IN = 40 FT



SECTION AT STA 42+00

TYPICAL STA 34+50 ± TO STA 46+50 ±

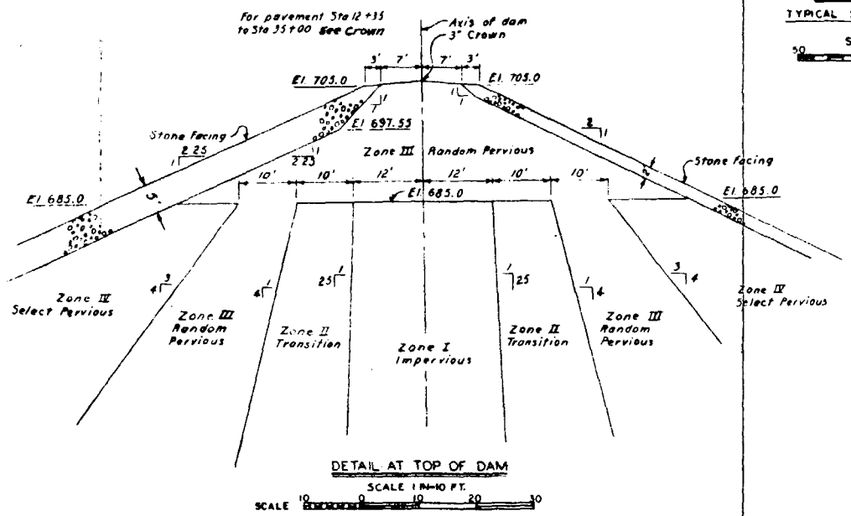
SCALE: 1 IN = 40 FT



SECTION AT STA 15+50

TYPICAL: STA 14+00 ± TO STA 16+50 ±
STA 32+50 ± TO STA 34+50 ±
STA 46+50 ± TO STA 58+56 ±

SCALE: 1 IN = 40 FT



DETAIL AT TOP OF DAM

SCALE 1 IN = 10 FT (10 0 10 20 30)

DATUM IS MEAN SEA LEVEL

Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

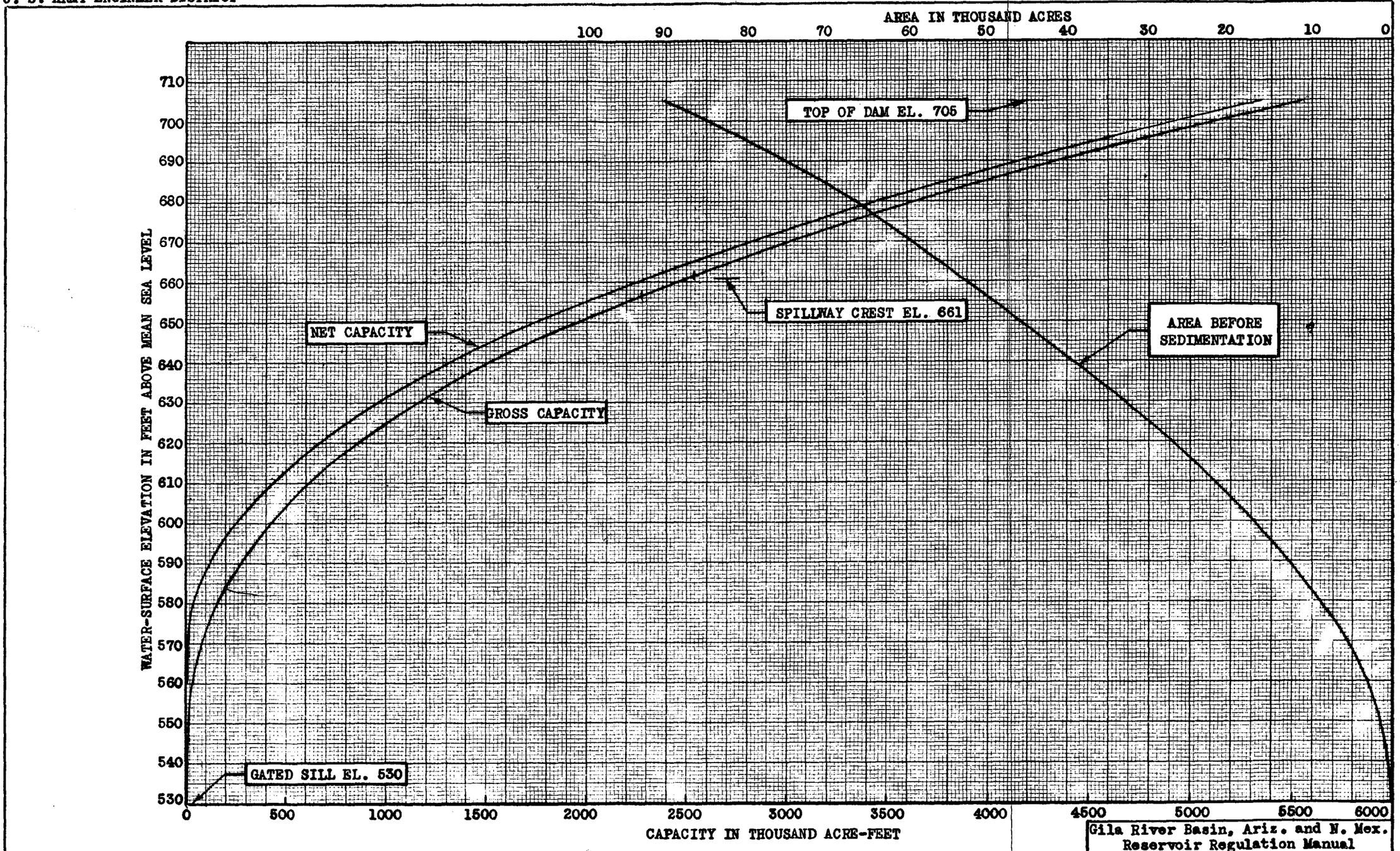
EMBANKMENT

Profile, Sections and Details

U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

U. S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS



NOTE.--CURVES COMPUTED FROM DATA BASED ON AERIAL SURVEY OF MARCH 1953.

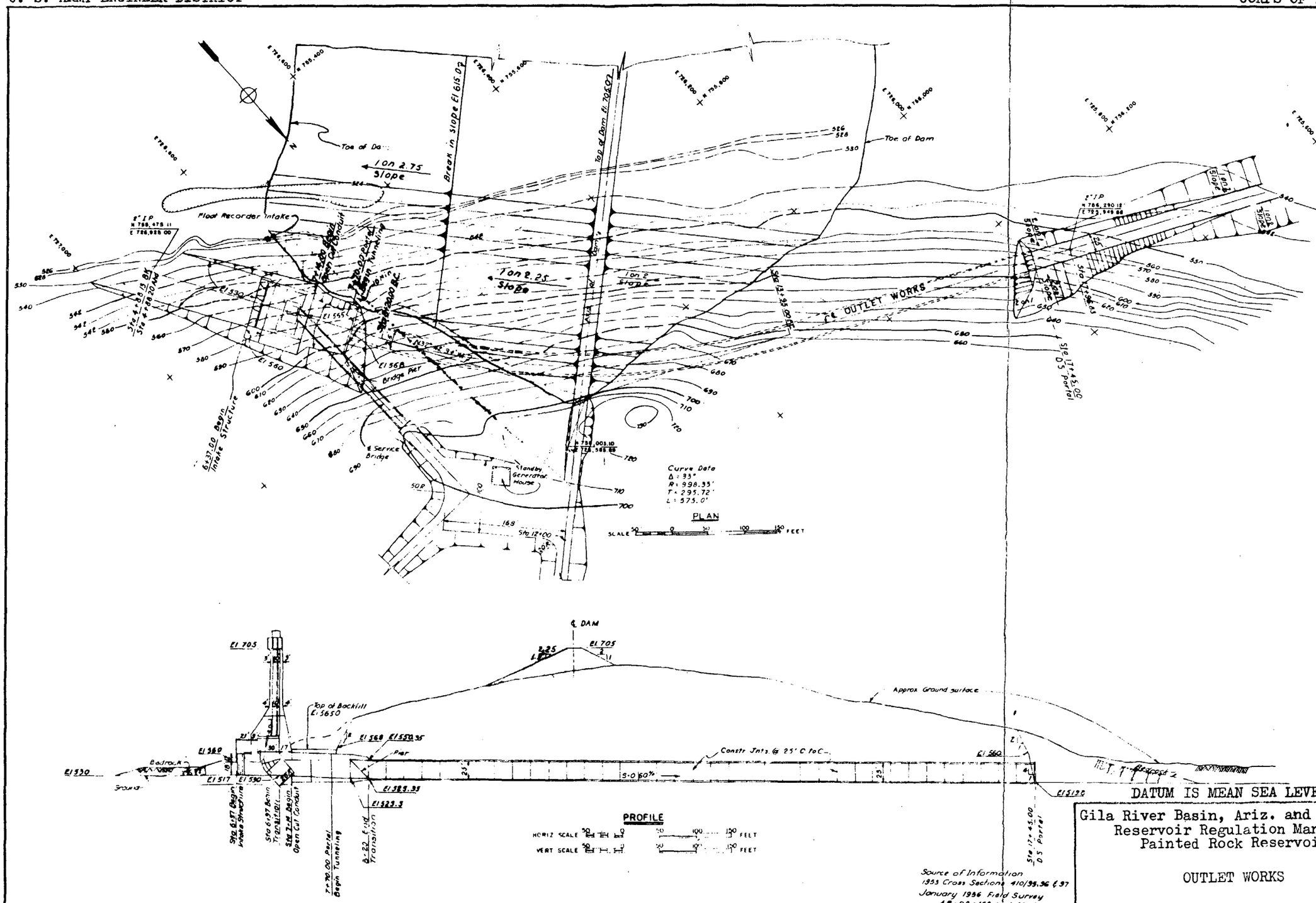
Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

AREA AND CAPACITY CURVES
FOR PAINTED ROCK RESERVOIR

Survey of March 1953

U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

PLATE 12



DATUM IS MEAN SEA LEVEL

Source of Information
1953 Cross Sections 410/95.36 & 97
January 1986 Field Survey
AR-09-189 and AR-09-133
Contour Interval is 5 and 10 feet

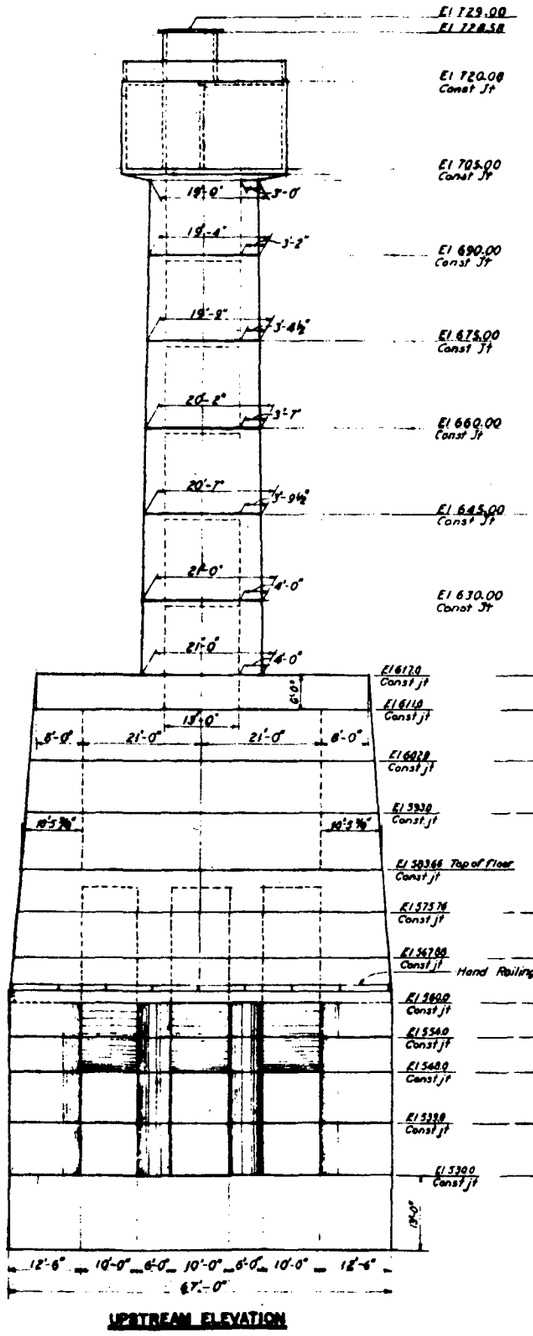
Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

OUTLET WORKS

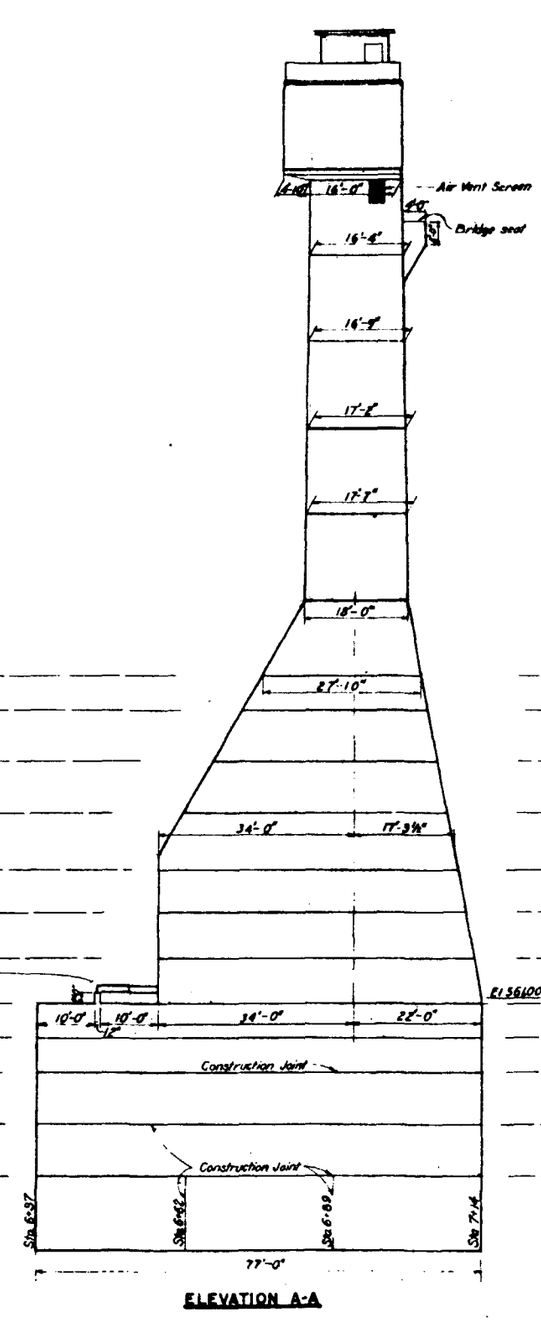
Plan and Profile

U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

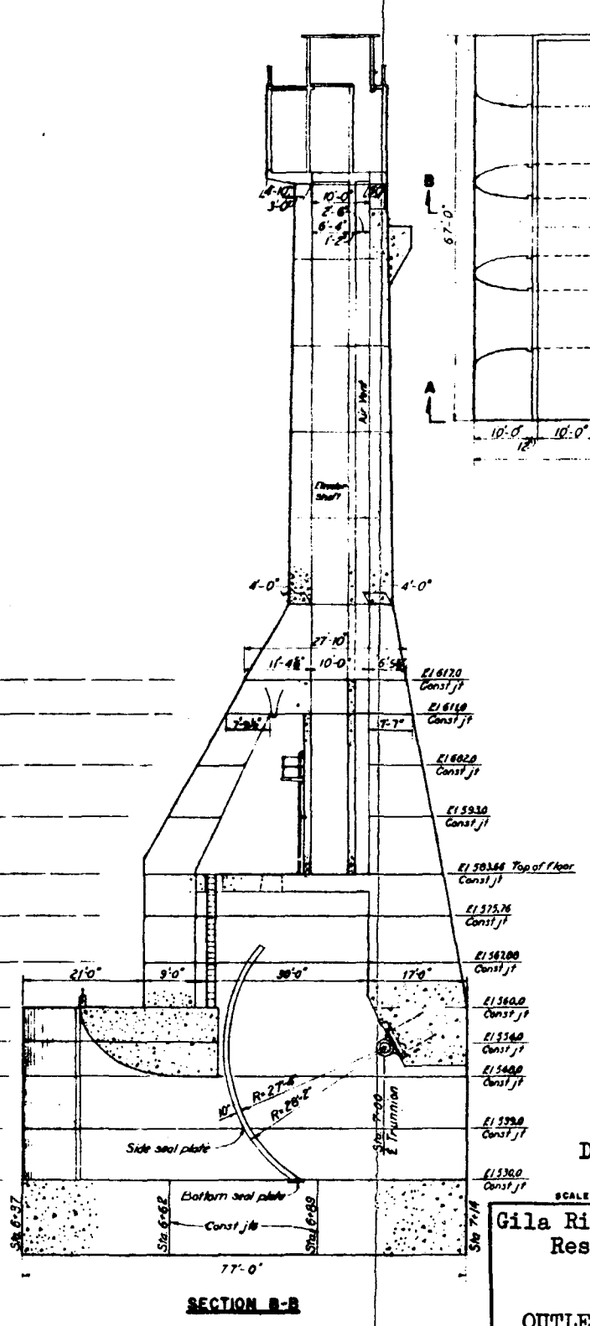
PLATE 13



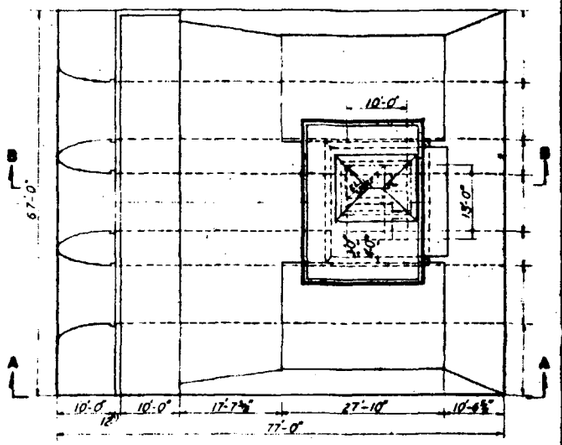
UPSTREAM ELEVATION



ELEVATION A-A



SECTION B-B



PLAN

DATUM IS MEAN SEA LEVEL

SCALE 1 IN = 10 FT FEET

Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

OUTLET WORKS - INTAKE STRUCTURE

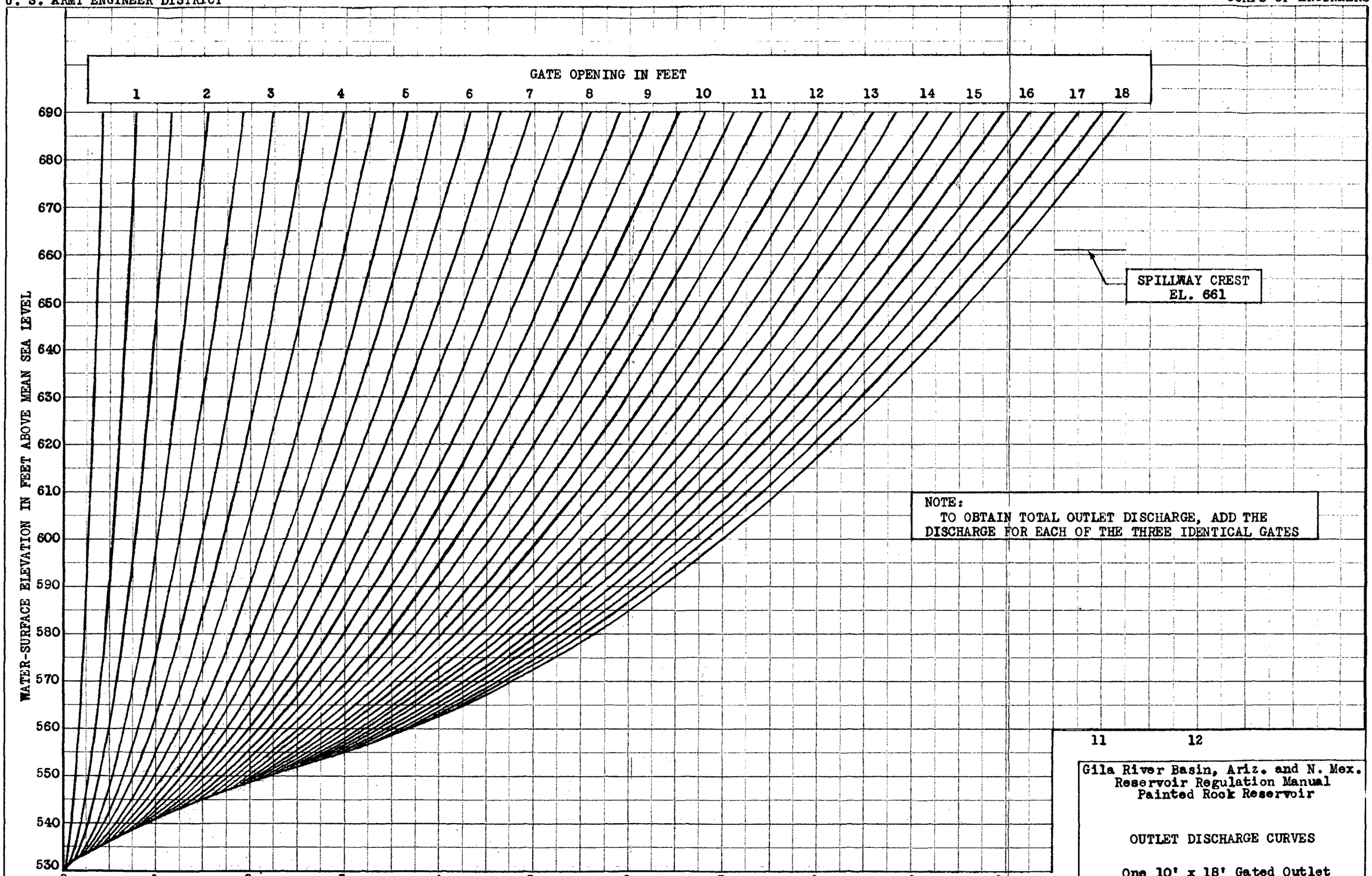
Plan, Section and Elevations

U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

PLATE 14

U. S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS



NOTE:
TO OBTAIN TOTAL OUTLET DISCHARGE, ADD THE DISCHARGE FOR EACH OF THE THREE IDENTICAL GATES

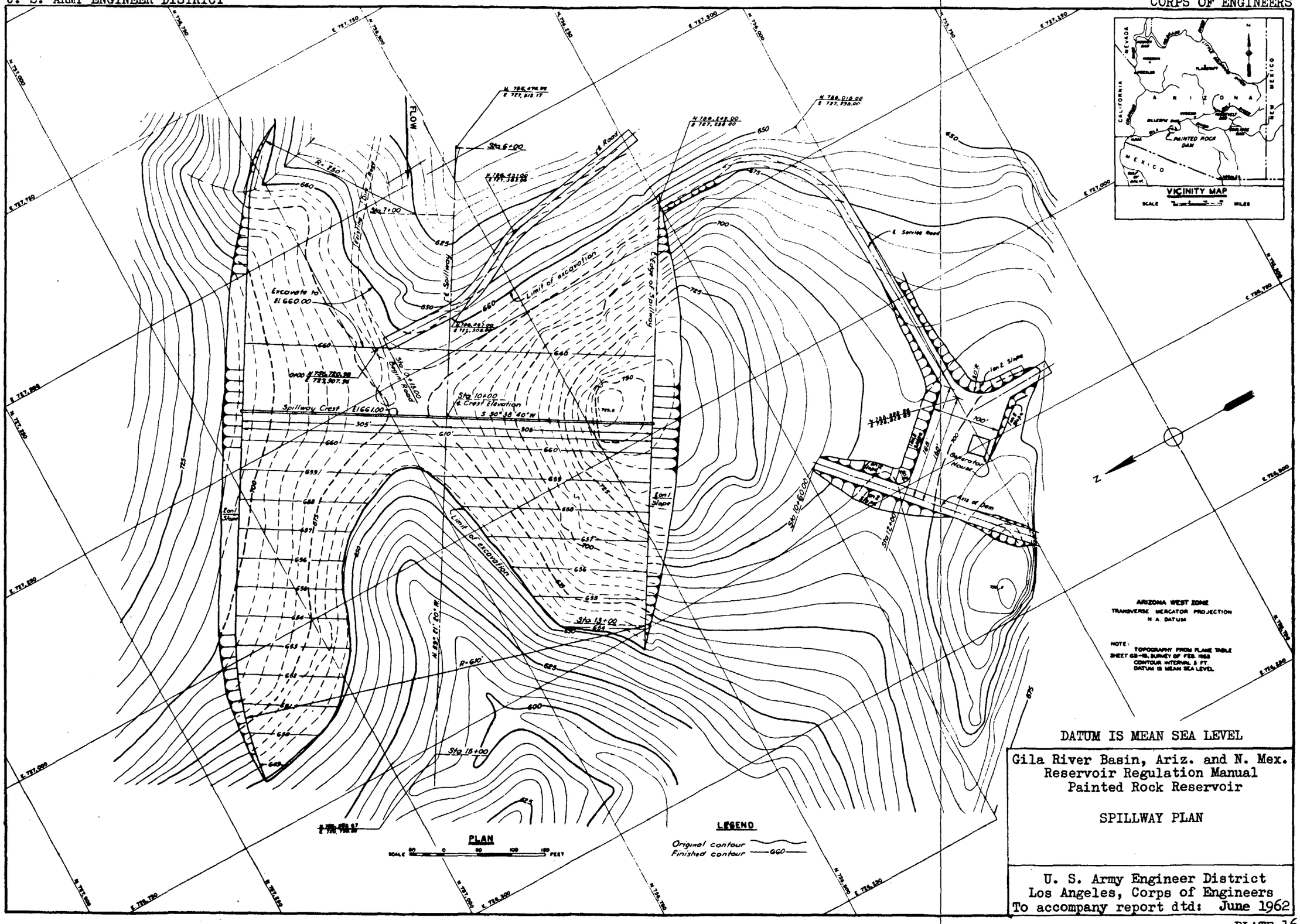
Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

OUTLET DISCHARGE CURVES

One 10' x 18' Gated Outlet

U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

PLATE 15



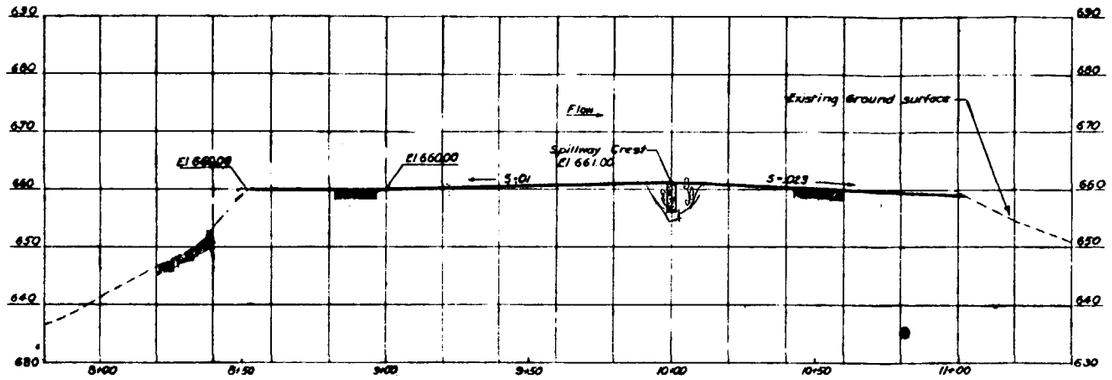
DATUM IS MEAN SEA LEVEL

Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

SPILLWAY PLAN

U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

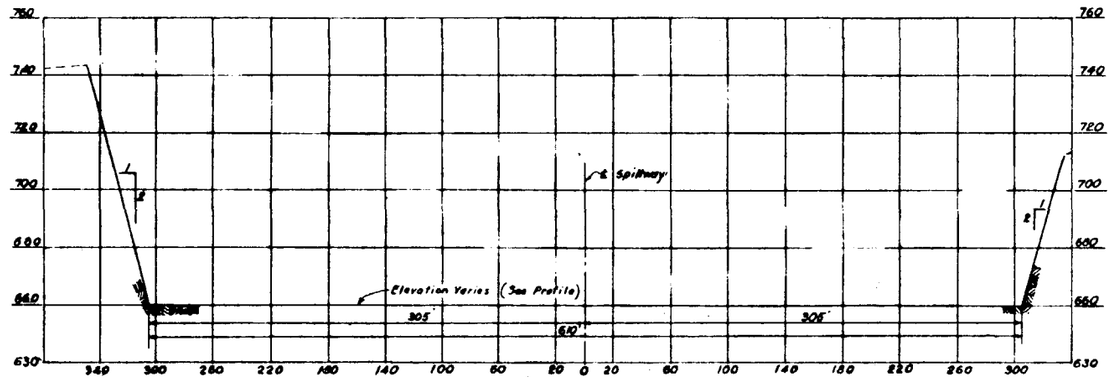
PLATE 16



℄ PROFILE

HOR SCALE 10 0 10 20 30 40 50 FEET

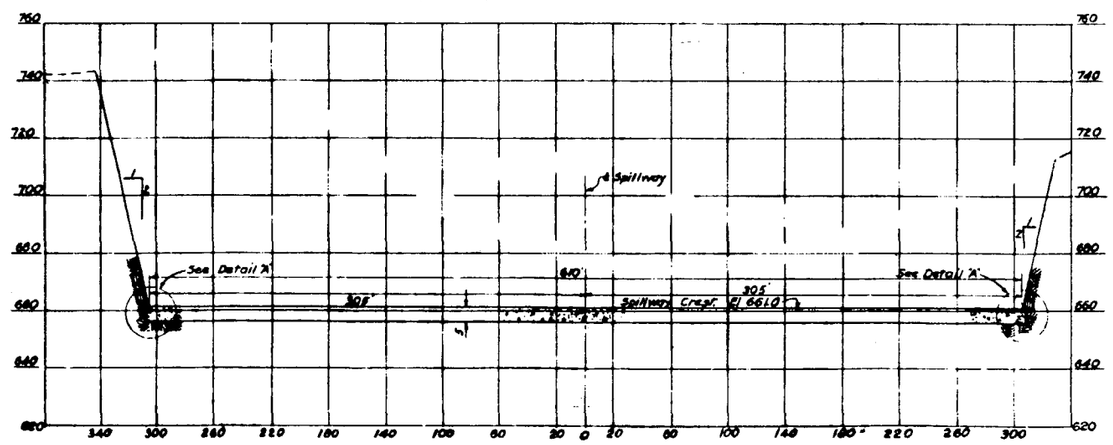
VERT SCALE 10 0 10 20 30 FEET



TYPICAL SECTION

HOR SCALE 50 0 50 100 FEET

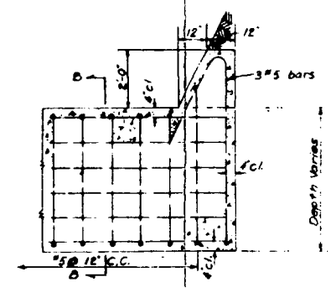
VERT SCALE 10 0 10 20 30 40 50 FEET



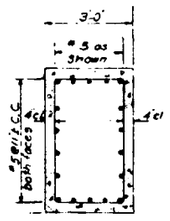
SECTION AT CREST

HOR SCALE 50 0 50 100 FEET

VERT SCALE 10 0 10 20 30 40 50 FEET



DETAIL 'A'



SECTION B-B

REINFORCEMENT DETAILS

SCALE: 1/2 IN = 1 FT

SCALE 0 1 2 3 FEET

DATUM IS MEAN SEA LEVEL

Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

SPILLWAY

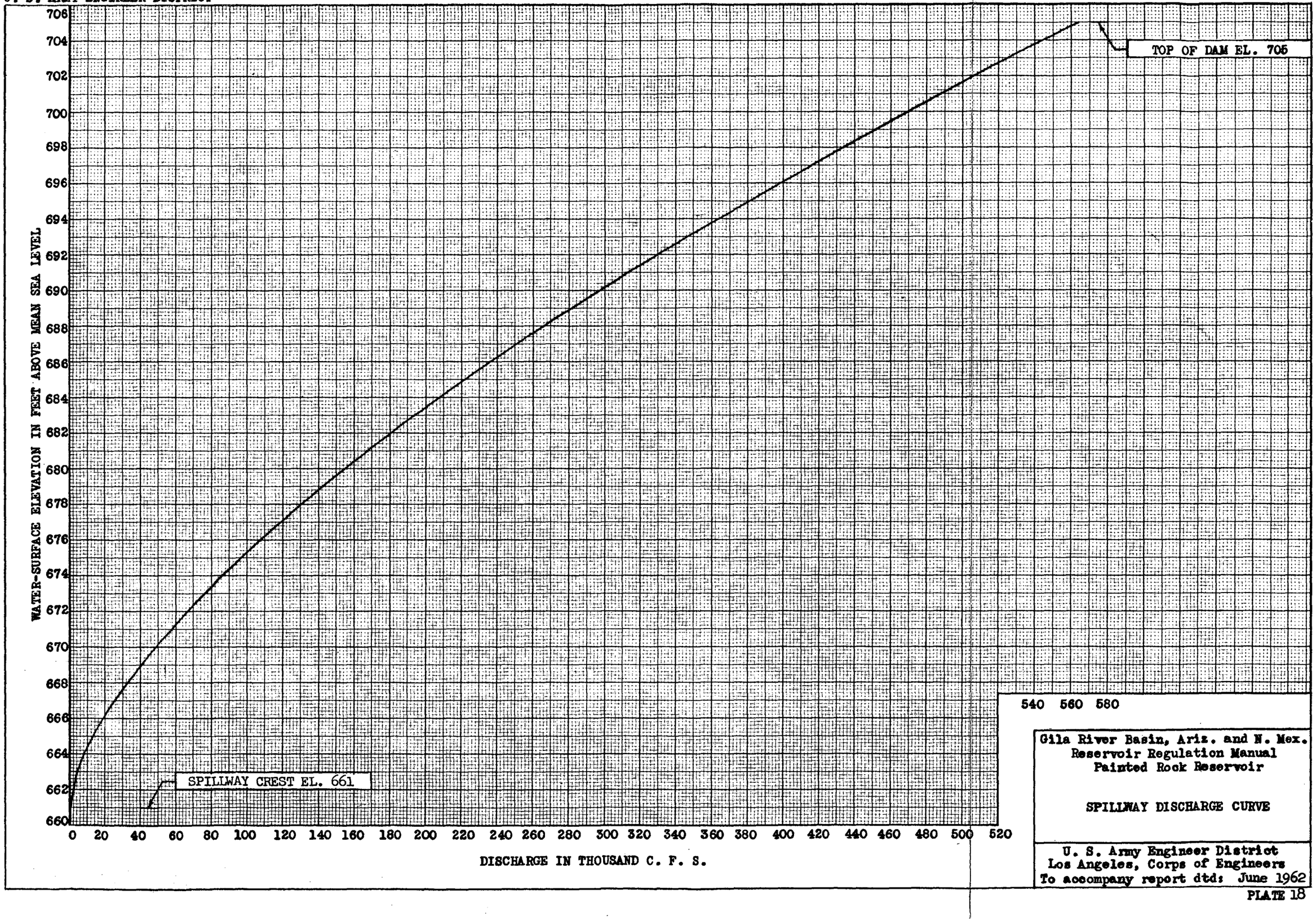
Profile, Sections and Details

U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

PLATE 17

U. S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS



Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

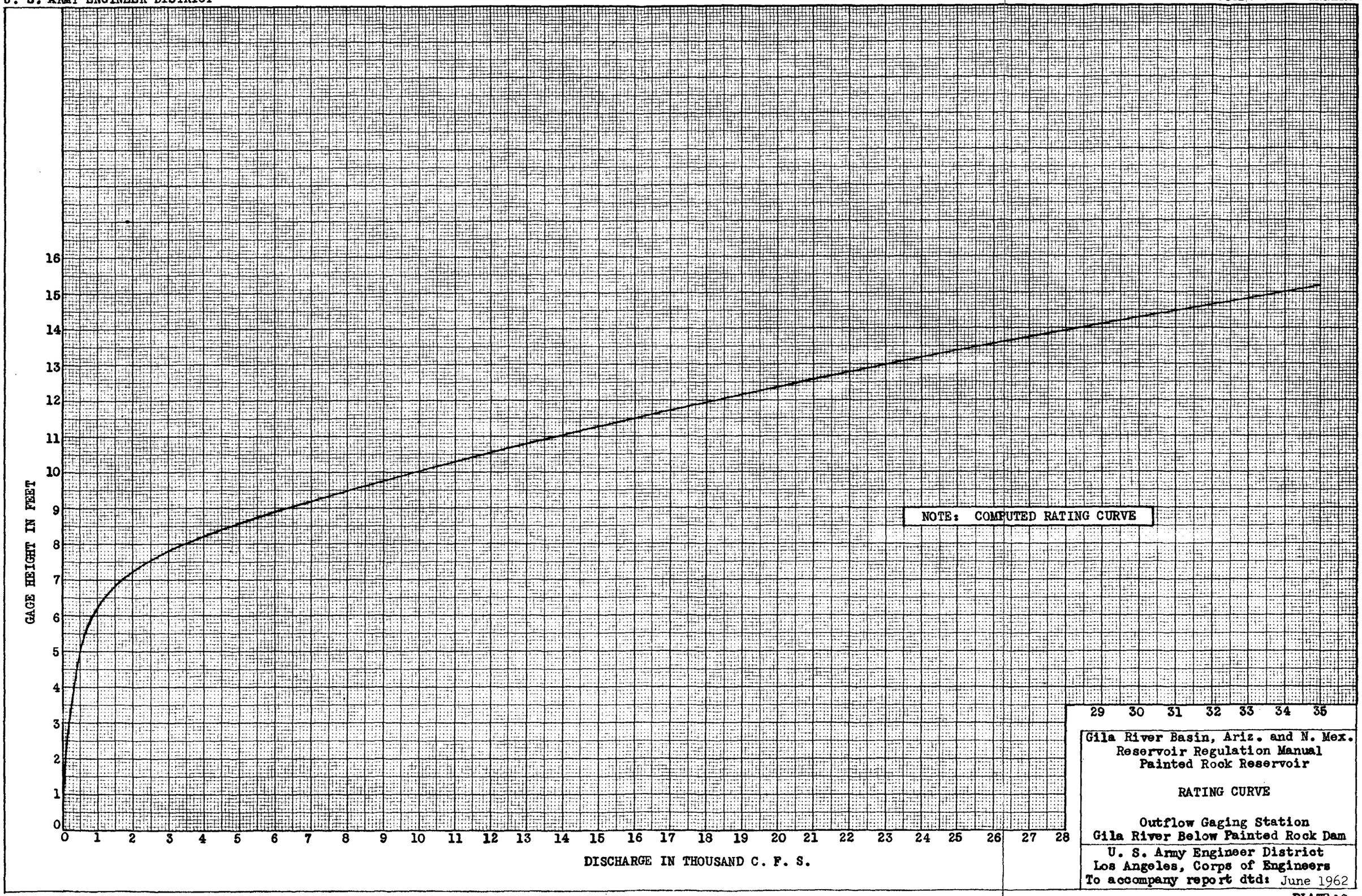
SPILLWAY DISCHARGE CURVE

U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

PLATE 18

U. S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS



Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

RATING CURVE

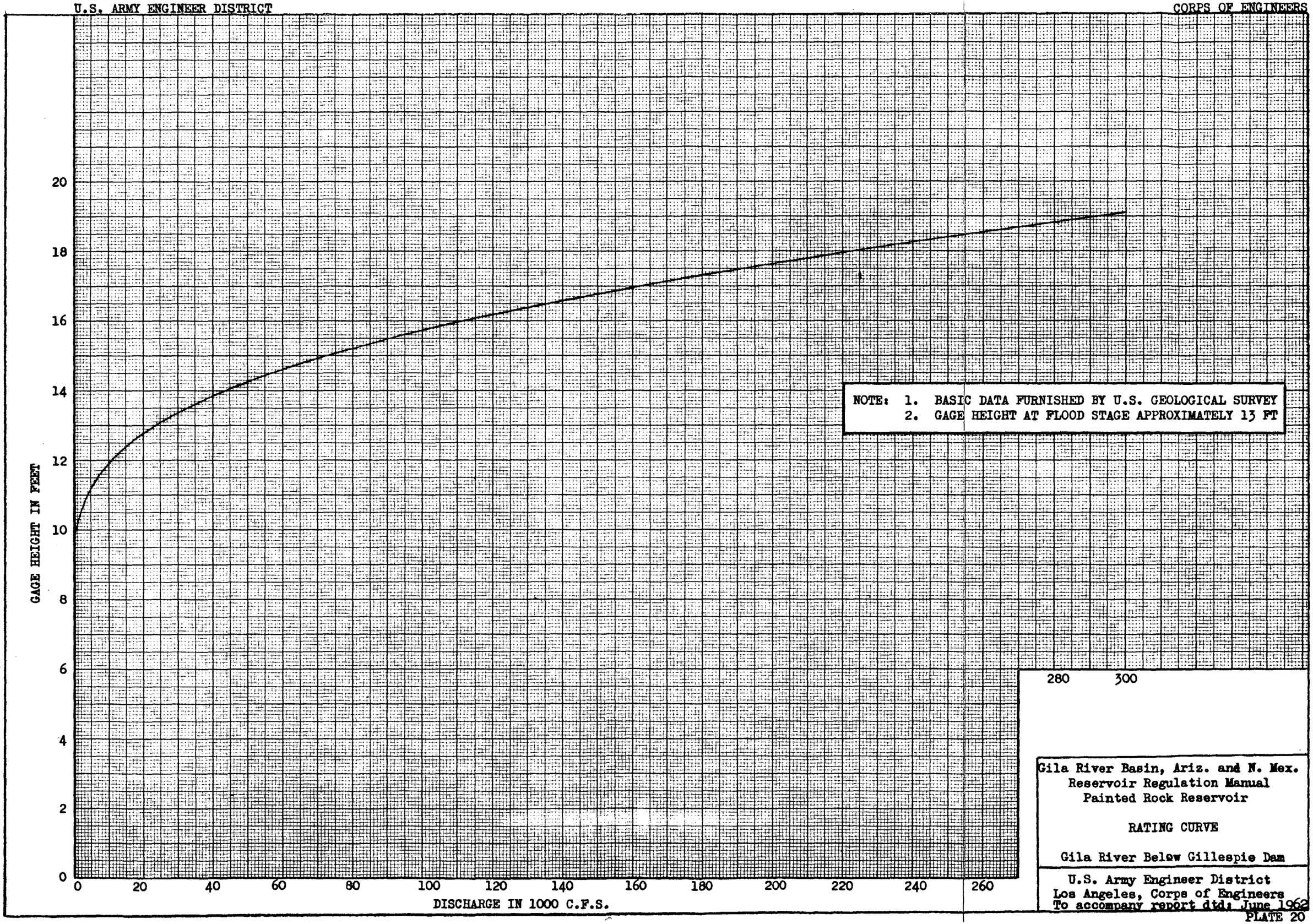
Outflow Gaging Station
Gila River Below Painted Rock Dam

U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

PLATE 19

U.S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS



NOTE: 1. BASIC DATA FURNISHED BY U.S. GEOLOGICAL SURVEY
2. GAGE HEIGHT AT FLOOD STAGE APPROXIMATELY 13 FT

Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

RATING CURVE

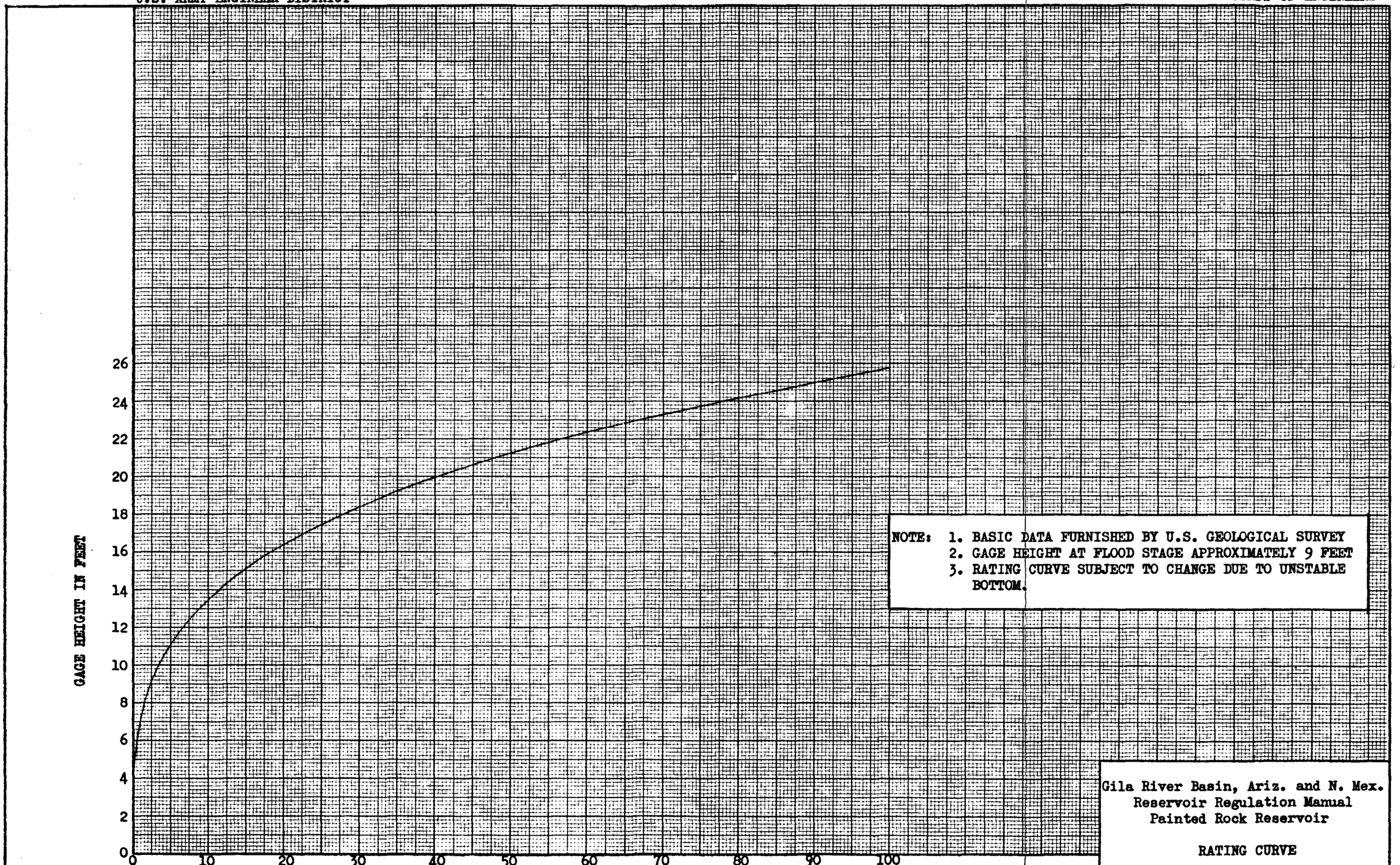
Gila River Below Gillespie Dam

U.S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

PLATE 20

U.S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS



NOTE:
1. BASIC DATA FURNISHED BY U.S. GEOLOGICAL SURVEY
2. GAGE HEIGHT AT FLOOD STAGE APPROXIMATELY 9 FEET
3. RATING CURVE SUBJECT TO CHANGE DUE TO UNSTABLE BOTTOM.

Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

RATING CURVE

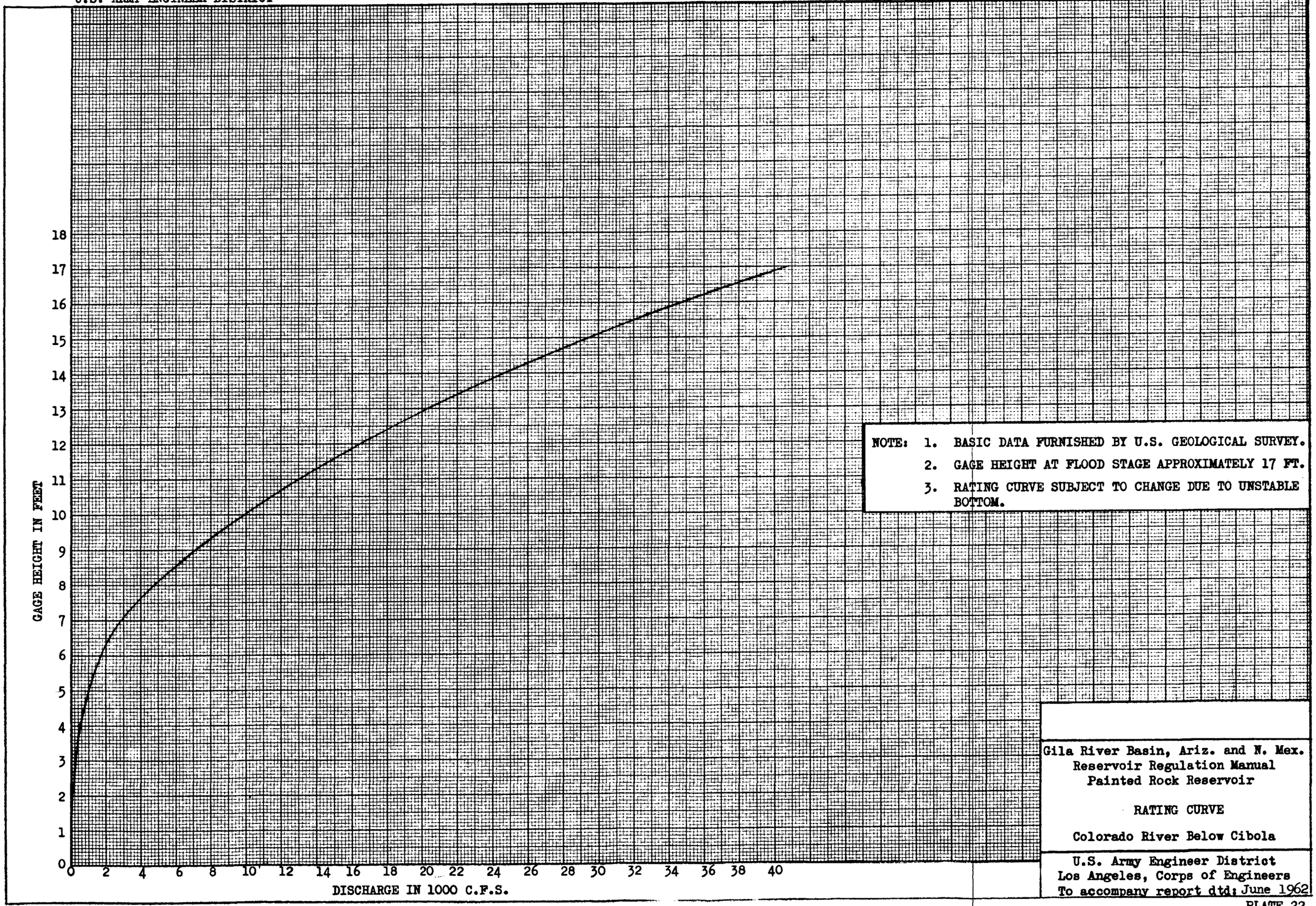
Gila River Near Dome

U.S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

PLATE 21

U.S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS



NOTE:
1. BASIC DATA FURNISHED BY U.S. GEOLOGICAL SURVEY.
2. GAGE HEIGHT AT FLOOD STAGE APPROXIMATELY 17 FT.
3. RATING CURVE SUBJECT TO CHANGE DUE TO UNSTABLE BOTTOM.

Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

RATING CURVE

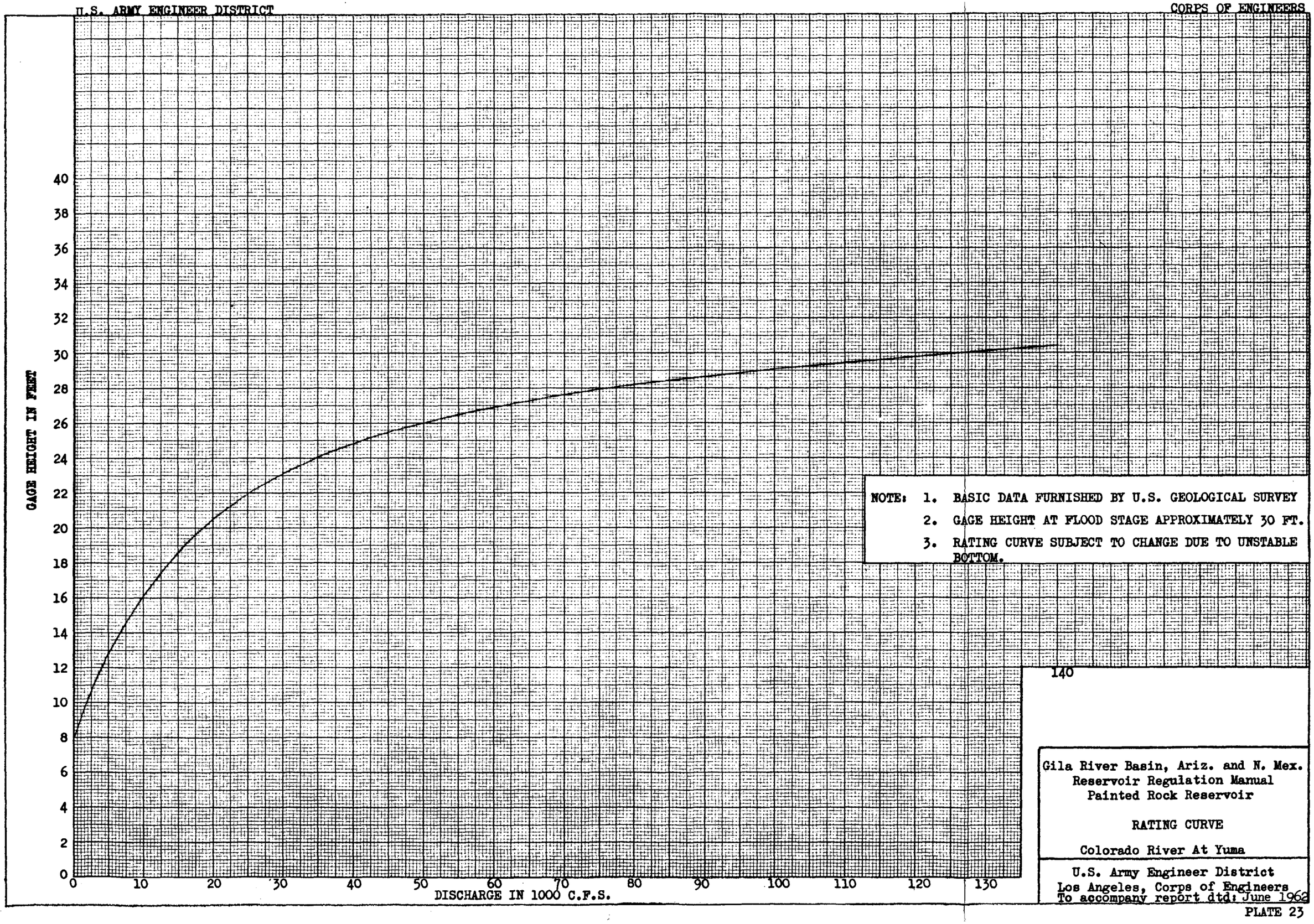
Colorado River Below Cibola

U.S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

PLATE 22

U.S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS



NOTE: 1. BASIC DATA FURNISHED BY U.S. GEOLOGICAL SURVEY

2. GAGE HEIGHT AT FLOOD STAGE APPROXIMATELY 30 FT.

3. RATING CURVE SUBJECT TO CHANGE DUE TO UNSTABLE BOTTOM.

Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

RATING CURVE

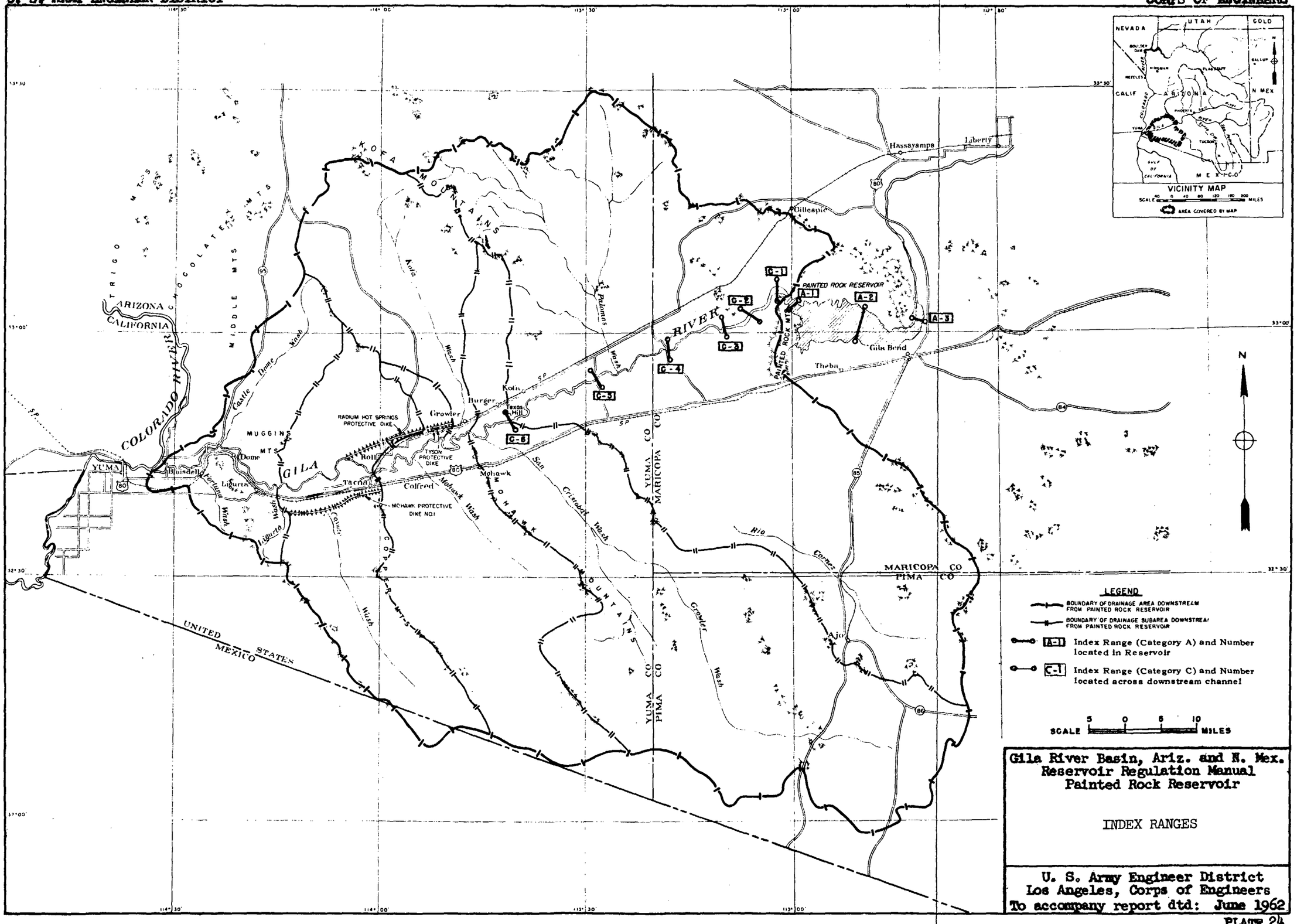
Colorado River At Yuma

U.S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

PLATE 23

U. S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS

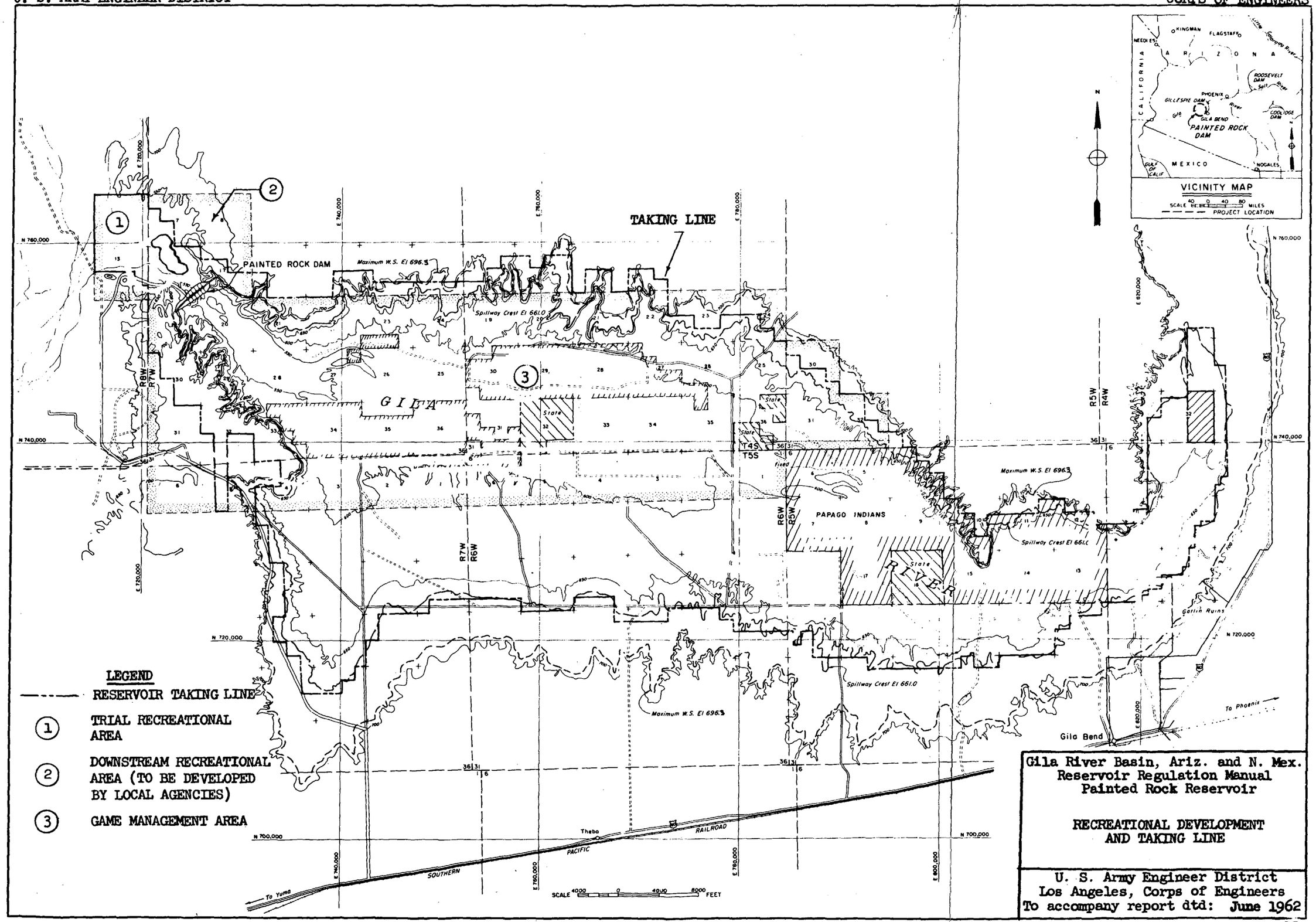


Gila River Basin, Ariz. and N. Mex. Reservoir Regulation Manual Painted Rock Reservoir

INDEX RANGES

U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

PLATE 24



LEGEND

RESERVOIR TAKING LINE

① TRIAL RECREATIONAL AREA

② DOWNSTREAM RECREATIONAL AREA (TO BE DEVELOPED BY LOCAL AGENCIES)

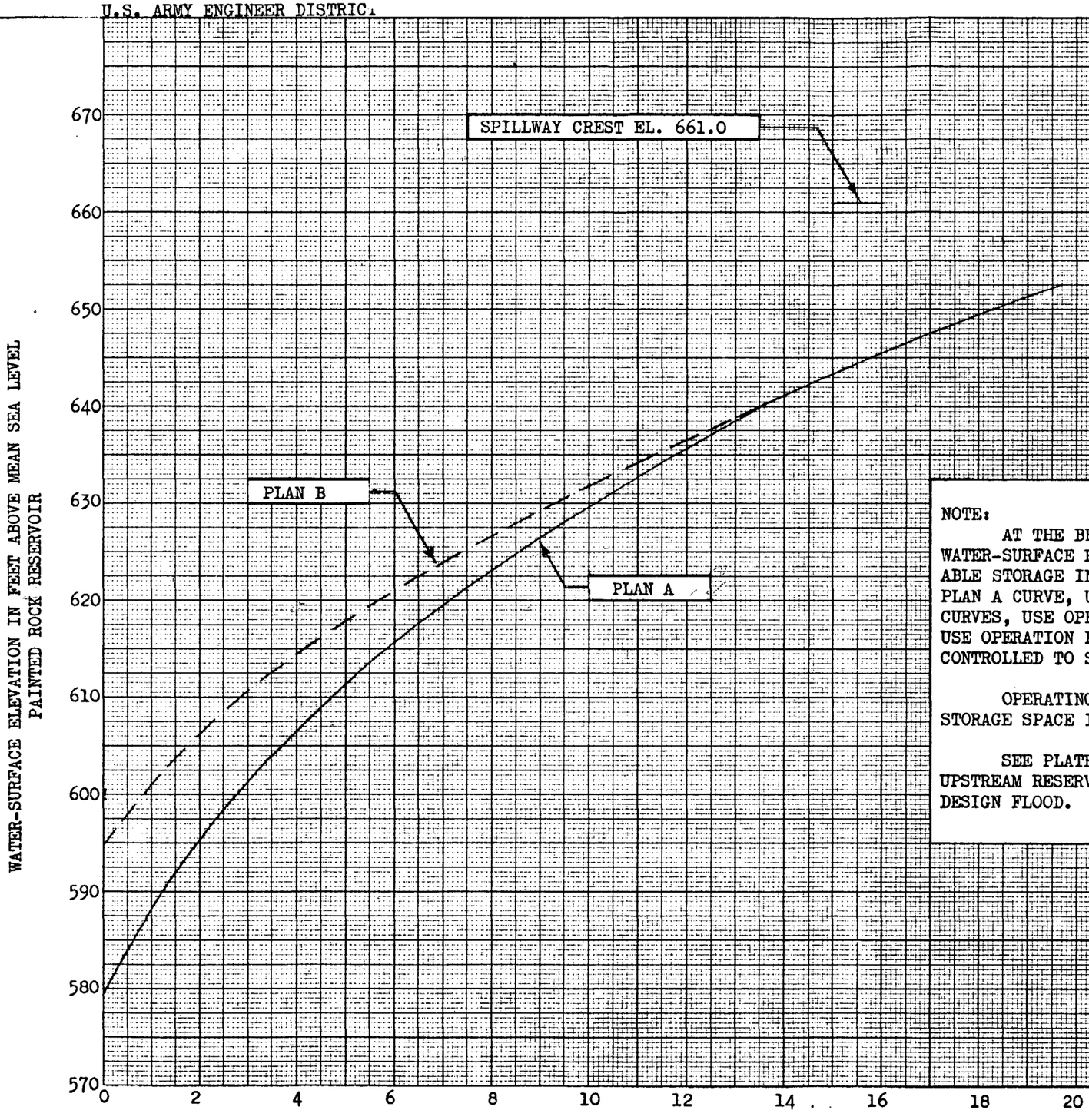
③ GAME MANAGEMENT AREA

Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

RECREATIONAL DEVELOPMENT AND TAKING LINE

U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

PLATE 25



NOTE:

AT THE BEGINNING OF A FLOOD, IF THE POINT DETERMINED BY THE WATER-SURFACE ELEVATION IN PAINTED ROCK RESERVOIR AND THE AVAILABLE STORAGE IN UPSTREAM RESERVOIRS LIES: (a) TO THE RIGHT OF PLAN A CURVE, USE OPERATION PLAN A, (b) BETWEEN PLAN A AND B CURVES, USE OPERATION PLAN B, AND (c) TO THE LEFT OF PLAN B CURVE, USE OPERATION PLAN B (THE RESERVOIR DESIGN FLOOD CANNOT BE CONTROLLED TO SPILLWAY CREST IN THIS INSTANCE).

OPERATING CURVES INCLUDE A SAFETY FACTOR OF 10 PERCENT FOR STORAGE SPACE IN UPSTREAM RESERVOIRS.

SEE PLATE 27 FOR INFORMATION ON MAXIMUM STORAGE SPACE IN UPSTREAM RESERVOIRS THAT CAN BE USED TO CONTROL THE RESERVOIR DESIGN FLOOD.

Gila River Basin, Ariz. and N.Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

CURVES FOR DETERMINING
OPERATION PLAN

U.S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

Existing dams above Painted Rock Reservoir
Maximum storage space that can be used to control a reservoir design flood

Time:	Date:

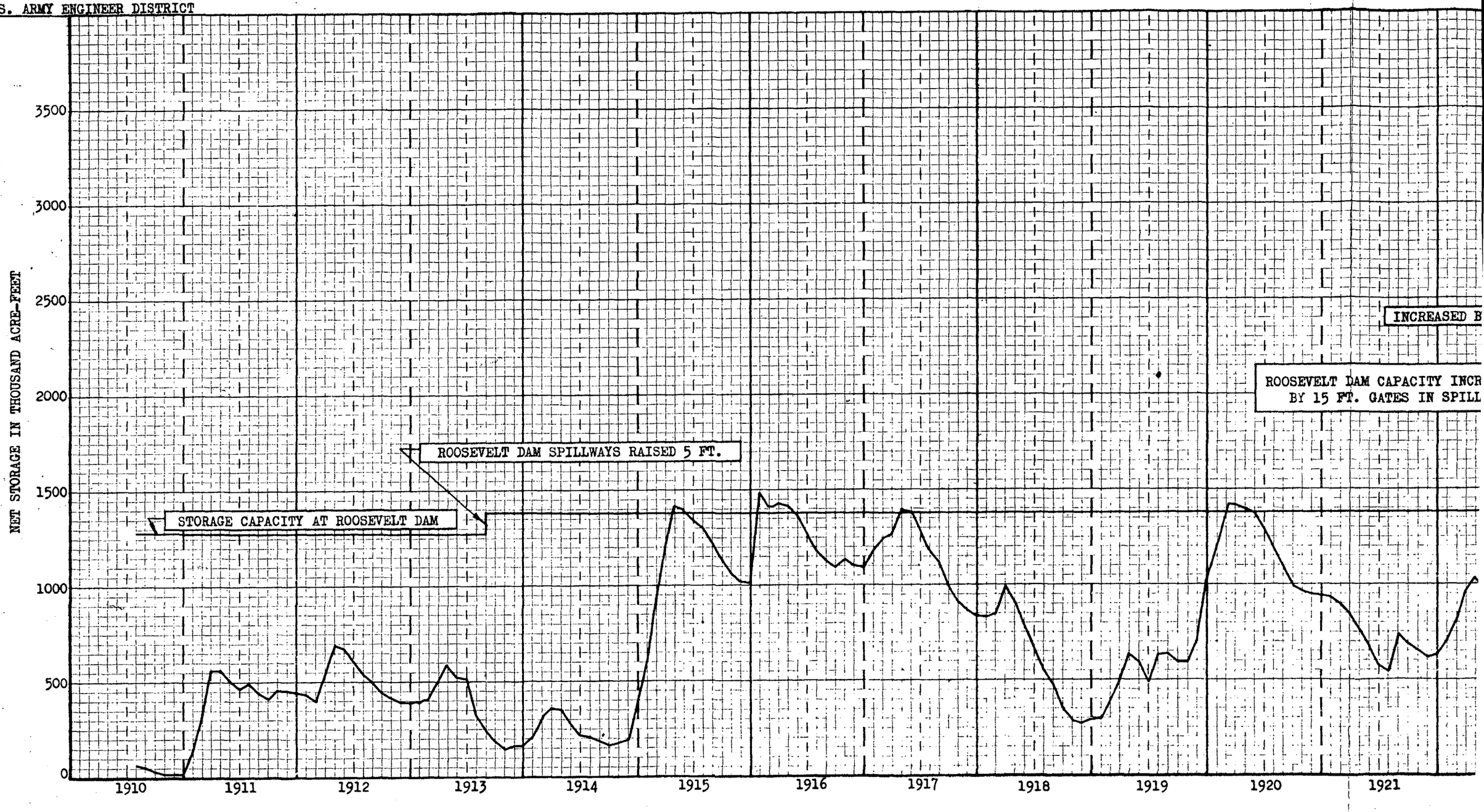
River system and dam	Usable storage space below spillway crest	Net storage in reservoir	Available storage space	Storage space in system above indicated dam that can be used to control a reservoir design flood	
				Accumulated storage space	Maximum useable accumulated storage space*
	Acre-feet	Acre-feet	Acre-feet	Acre-feet	Acre-feet
Gila:					
Coolidge.....	1,205,000				769,900
Salt:					
Roosevelt.....	1,382,000				758,500
Horse Mesa.....	245,000				768,800
Mormon Flat.....	58,000				783,600
Stewart Mt.....	70,000				793,900
Verde:					
Horseshoe.....	142,800				142,800
Bartlett.....	179,500				322,300
Agua Fria:					
Lake Pleasant.....	163,800				89,400
Total storage space above Coolidge, Stewart Mountain, Bartlett, and Lake Pleasant Dams, available to control reservoir design flood					1,975,500

* Based on portion of standard project flood originating above indicated dam.

Note: Of the 50,800 sq. miles in the drainage area above Painted Rock Reservoir, 26,742 sq. miles are controlled by upstream reservoirs. Of the 2,800,000 ac.-ft. of volume in the reservoir design flood, 1,975,500 ac.-ft. can be stored in upstream reservoirs.

PLATE 27

U. S. ARMY ENGINEER DISTRICT



NOTE:

SEE
AVAIL
UPSTR

CORPS OF ENGINEERS

INCREASED BY STEWART MT. DAM

INCREASED BY COOLIDGE DAM

INCREASED BY LAKE PLEASANT DAM

INCREASED BY HORSE MESA DAM

ED BY MORMON FLAT DAM

INCREASED
SPILLWAY

CAPACITY OF RESERVOIR SYSTEM
TO SPILLWAY CREST (GATES RAISED)

DECREASED BY DEDUCTION FOR SILT

STORAGE IN RESERVOIR SYSTEM

1922 1923 1924 1925 1926 1927 1928 1929 1930 1931 1932 1933 1934 1935

TE:

SEE TABLE 1 FOR DETAILS ON
AILABLE STORAGE SPACE IN
STREAM RESERVOIRS.

Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

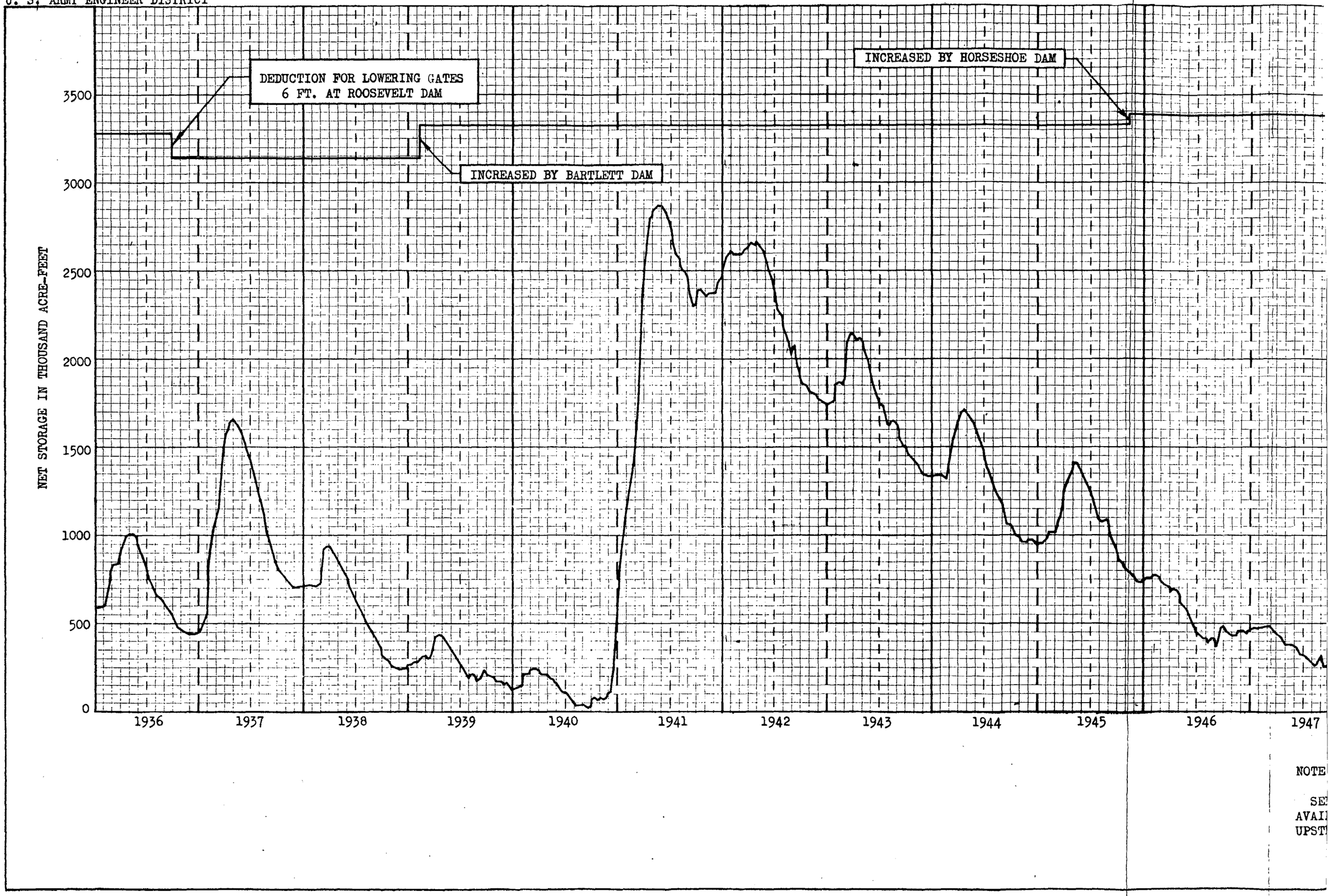
STORAGE IN UPSTREAM
RESERVOIR SYSTEM

August 1910 Through December 1935

U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

PLATE 28

U. S. ARMY ENGINEER DISTRICT



NOTE

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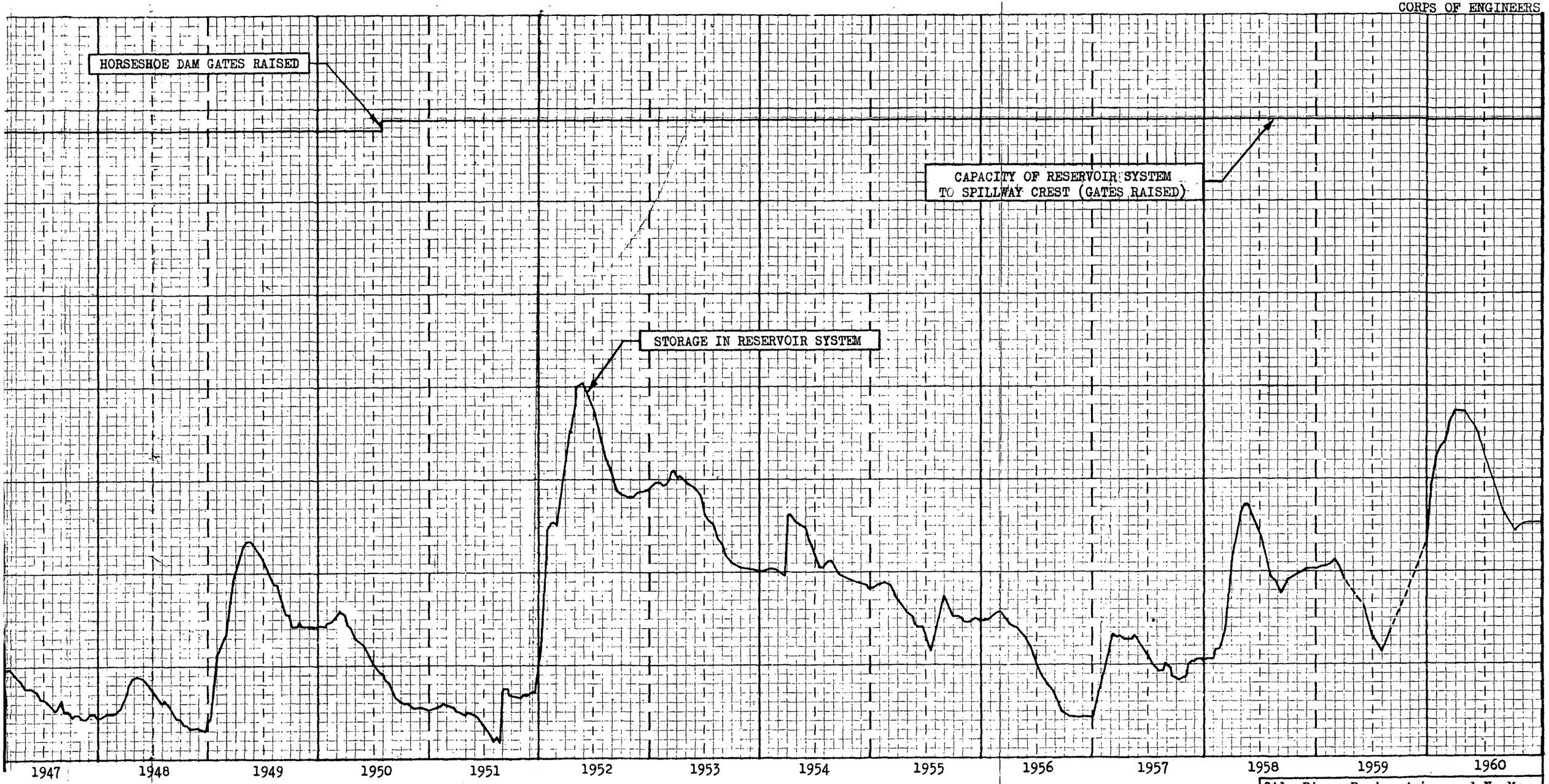


NOTE:

SEE TABLE 1 FOR DETAILS ON AVAILABLE STORAGE SPACE IN UPSTREAM RESERVOIRS.

Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

STORAGE IN UPSTREAM RESERVOIR SYSTEM

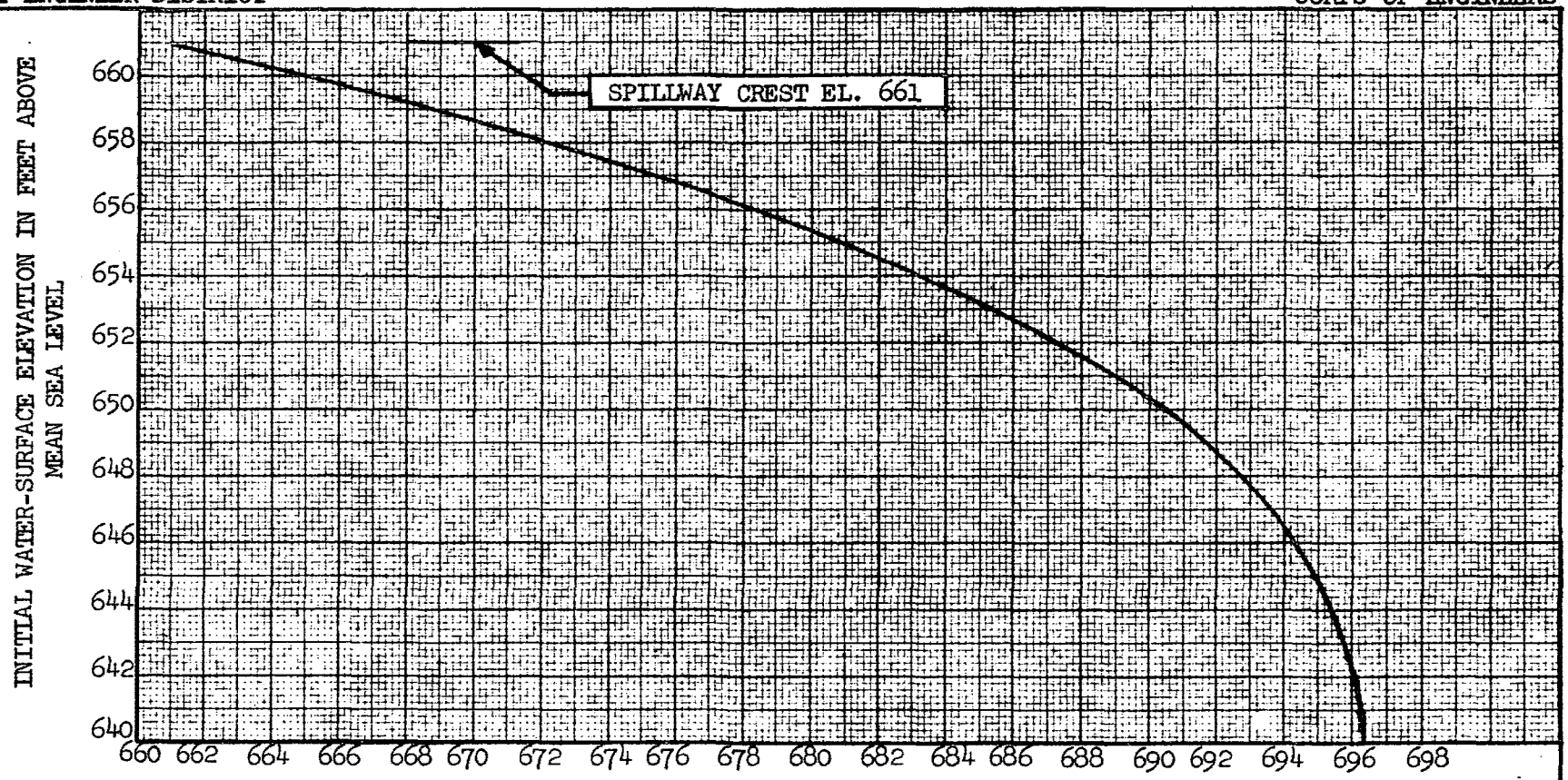
January 1936 Through December 1960

U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

PLATE 29

U. S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS



ELEVATION AT WHICH OUTLET GATES MUST BE FULLY OPENED TO CONTROL SPILLWAY FLOOD TO ELEVATION 696.3

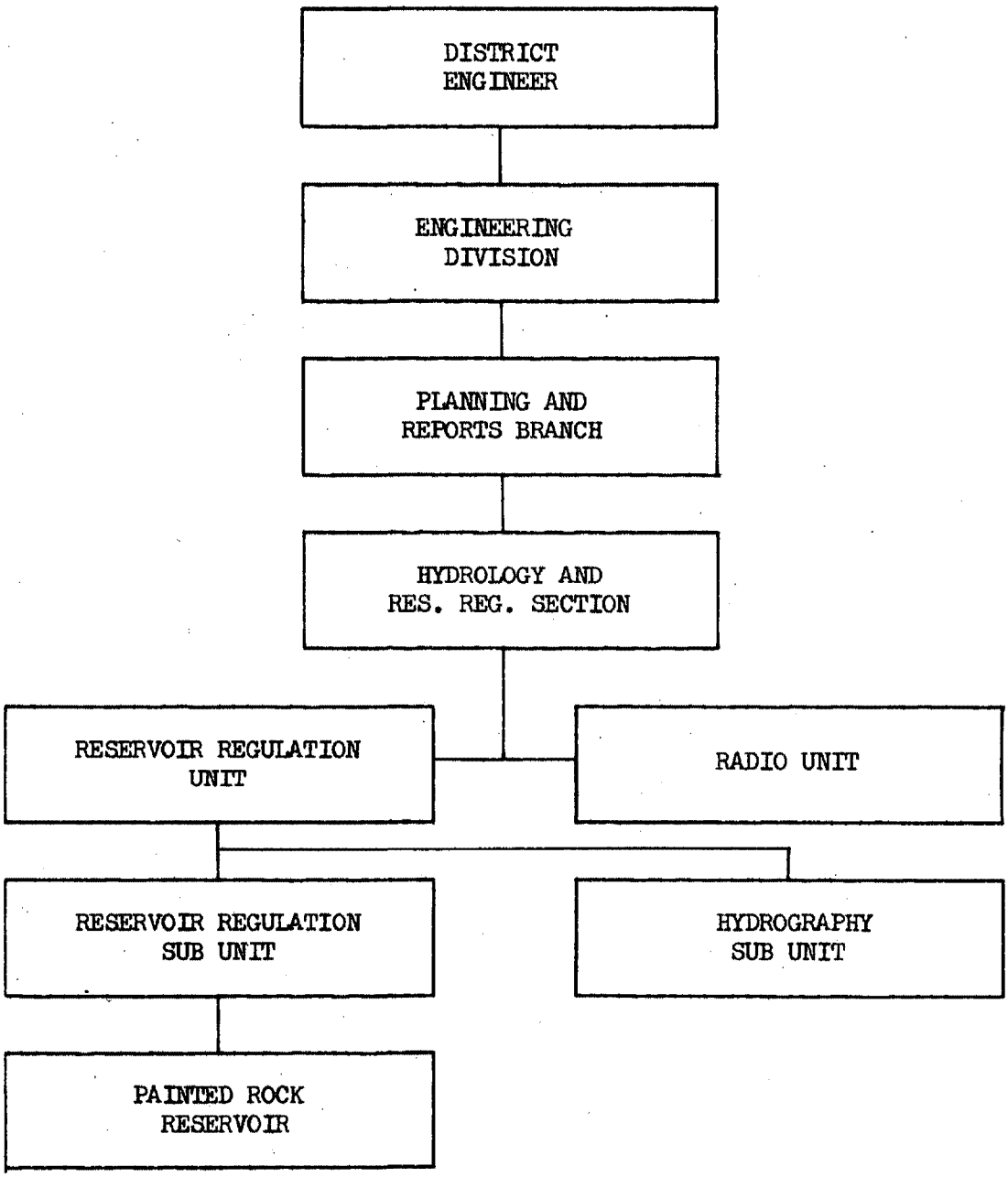
NOTE.--IF A SPILLWAY FLOOD SHOULD OCCUR WHEN THE INITIAL RESERVOIR WATER-SURFACE ELEVATION IS 640 OR HIGHER, THE OUTLET GATES MUST BE FULLY OPENED AT THE ELEVATION SHOWN TO CONTROL THE FLOOD TO MAXIMUM WATER-SURFACE ELEVATION 696.3.

Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

CURVE FOR DETERMINING OPERATION ABOVE SPILLWAY CREST

U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

PLATE 30



NOTE:

SEE PLATE 32 FOR NAMES AND TELEPHONE NUMBERS

Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

ORGANIZATION FOR NORMAL OPERATION

U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

PLATE 31

U. S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS

TITLE	NAME	OFFICE TELEPHONE	HOME TELEPHONE
District Engineer	Peacock, E. G., Col.	623-1311 Ext 353 After duty hours: 623-4760 Los Angeles, Calif.	243-0251 Glendale, Calif.
Chief, Engineering Division	Koehm, E.	623-1311 Ext 493 Los Angeles, Calif.	288-4248 San Gabriel, Calif.
Chief, Planning & Reports Branch	Cramer, S..F.	623-1311 Ext 502 Los Angeles, Calif.	769-2422 No. Hollywood, Calif.
Chief, Hydrology & Res. Reg. Section	Tatum, F. E.	623-1311 Ext 491 After duty hours: 623-5141 Los Angeles, Calif.	241-4772 Glendale, Calif.
Chief, Reservoir Regulation Unit *	Levin, G. B.*	623-1311 Ext 345 After duty hours 623-5142 Los Angeles, Calif.	280-9879 Monterey Park, Calif.
Chief, Radio Unit	Robinson, D. A.	623-1311 Ext 344 After duty hours: 623-5141	288-0721 Monterey Park, Calif.
Chief, Hydrography Sub Unit	Oviatt, D. M.	623-1311 Ext 347 After duty hours: 623-5142 Los Angeles, Calif.	398-5973 Los Angeles, Calif.
Dam Operator, Painted Rock Reservoir	Hett, J.	MUtual 3-2592 Gila Bend, Ariz.	MUtual 3-2592 Gila Bend, Ariz.

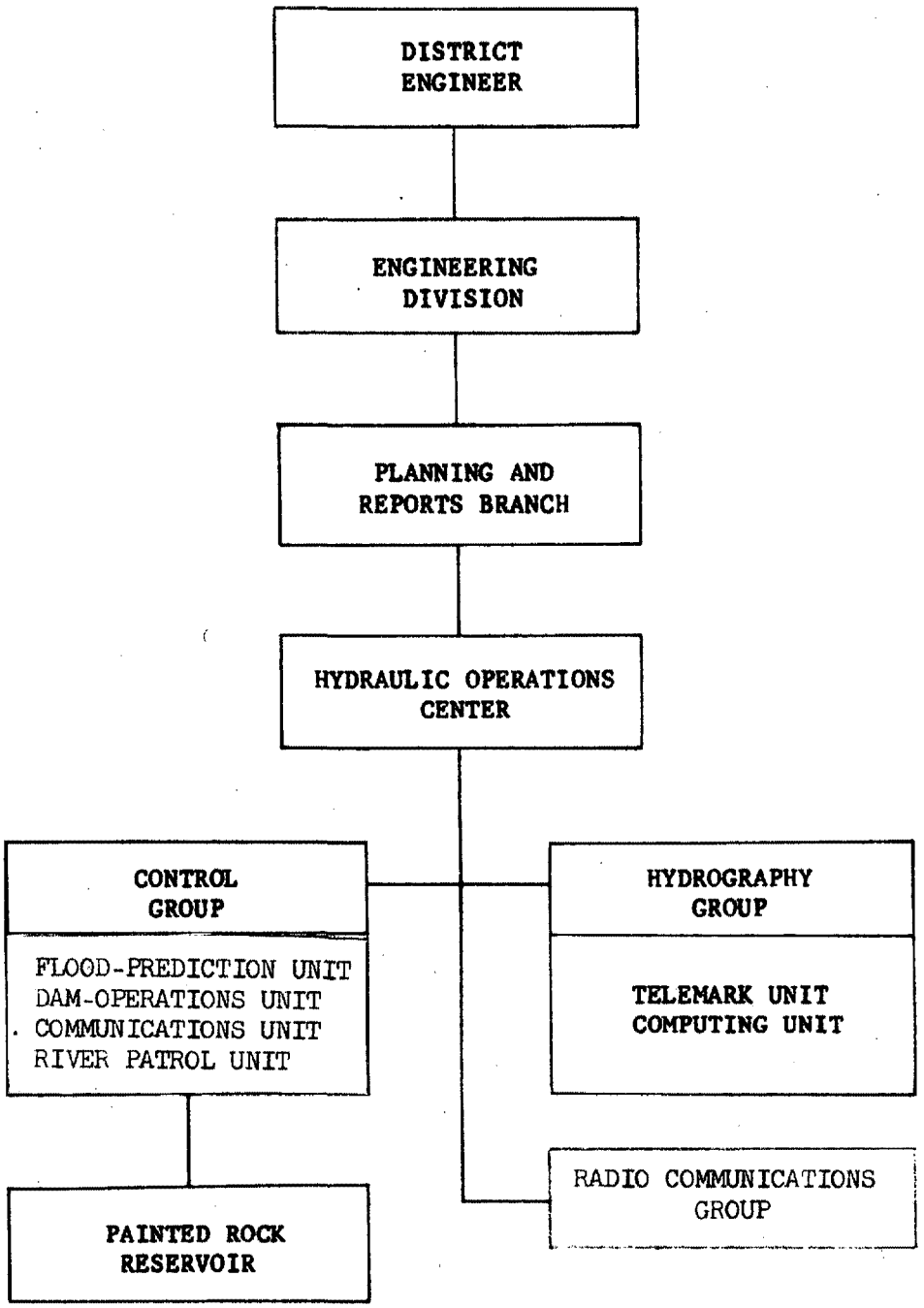
* Dual assignment, also Chief, Reservoir Regulation Sub Unit

Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

KEY PERSONNEL
FOR NORMAL OPERATION

U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

PLATE 32



NOTE:

SEE PLATE 34 FOR NAMES AND TELEPHONE NUMBERS.

Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

ORGANIZATION
FOR FLOOD-EMERGENCY OPERATION

U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

PLATE 33

TITLE	NAME	OFFICE TELEPHONE	HOME TELEPHONE
District Engineer	Peacock, E. G., Col.	623-1311 Ext 353 After duty hours: 623-4760 Los Angeles, Calif.	243-0251 Glendale, Calif.
Chief, Engineering Division	Koehm, E.	623-1311 Ext 493 Los Angeles, Calif.	288-4248 San Gabriel, Calif.
Chief, Planning & Reports Branch	Cramer, S. F.	623-1311 Ext 502 Los Angeles, Calif.	769-2422 No. Hollywood, Calif.
Chief, Hydraulic Operations Center	Tatum, F. E.	623-1311 Ext 491 After duty hours: 623-5141 Los Angeles, Calif.	241-4772 Glendale, Calif.
Chief, Control Group	Levin, G. B.	623-1311 Ext 345 After duty hours: 623-5142 Los Angeles, Calif.	280-9879 Monterey Park, Calif.
Chief, Radio Communications Group	Robinson, D. A.	623-1311 Ext 344 After duty hours: 623-5142 Los Angeles, Calif.	288-0721 Monterey Park, Calif.
Chief, Hydrography Group	Oviatt, D. M.	623-1311 Ext 347 After duty hours: 623-5142 Los Angeles, Calif.	398-5973 Los Angeles, Calif.
Dam Operator, Painted Rock Reservoir	Hett, J.	MUtual 3-2592 Gila Bend, Ariz.	MUtual 3-2592 Gila Bend, Ariz.

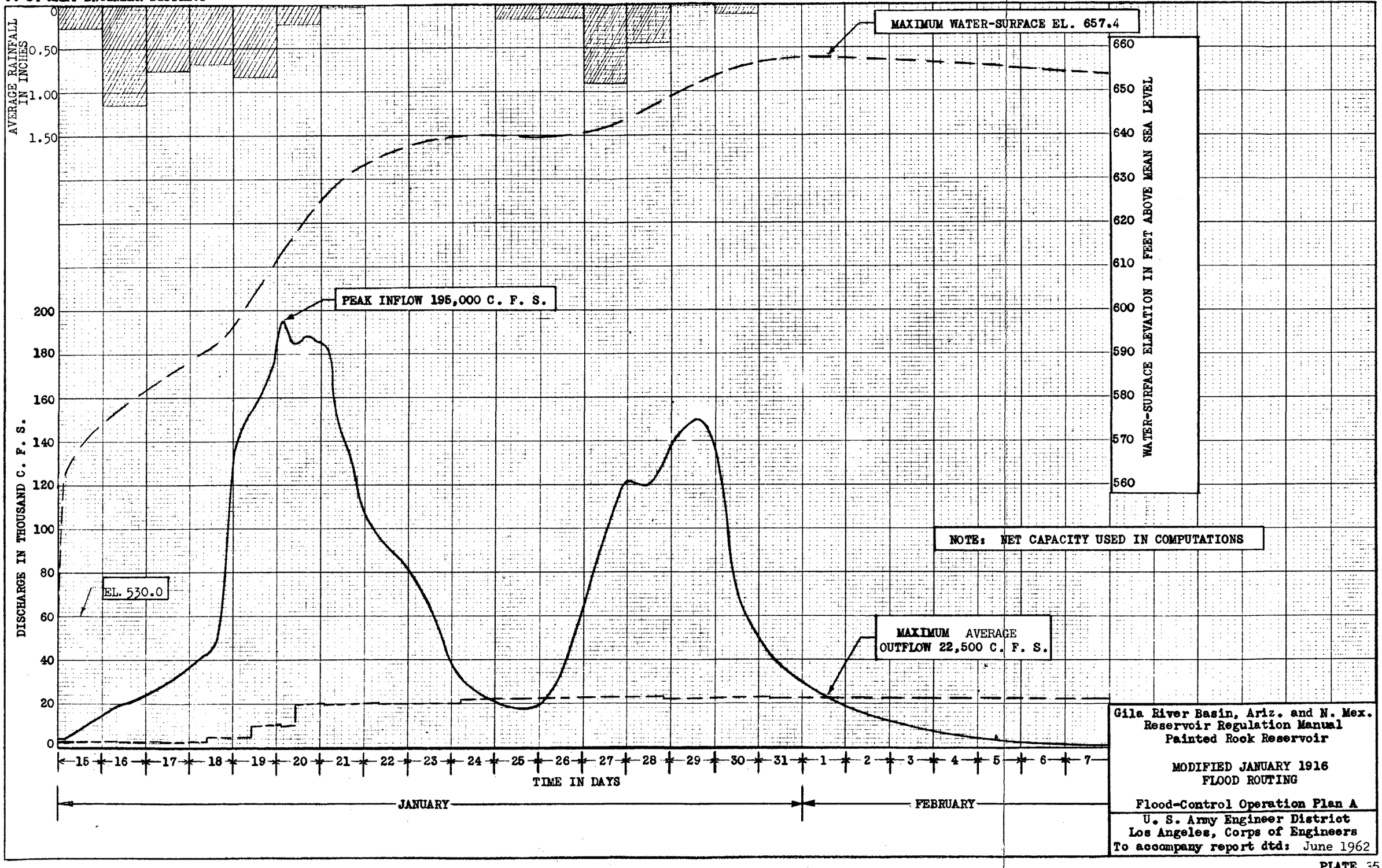
Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

KEY PERSONNEL
FOR FLOOD-EMERGENCY OPERATION

U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

U. S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS



Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

MODIFIED JANUARY 1916
FLOOD ROUTING

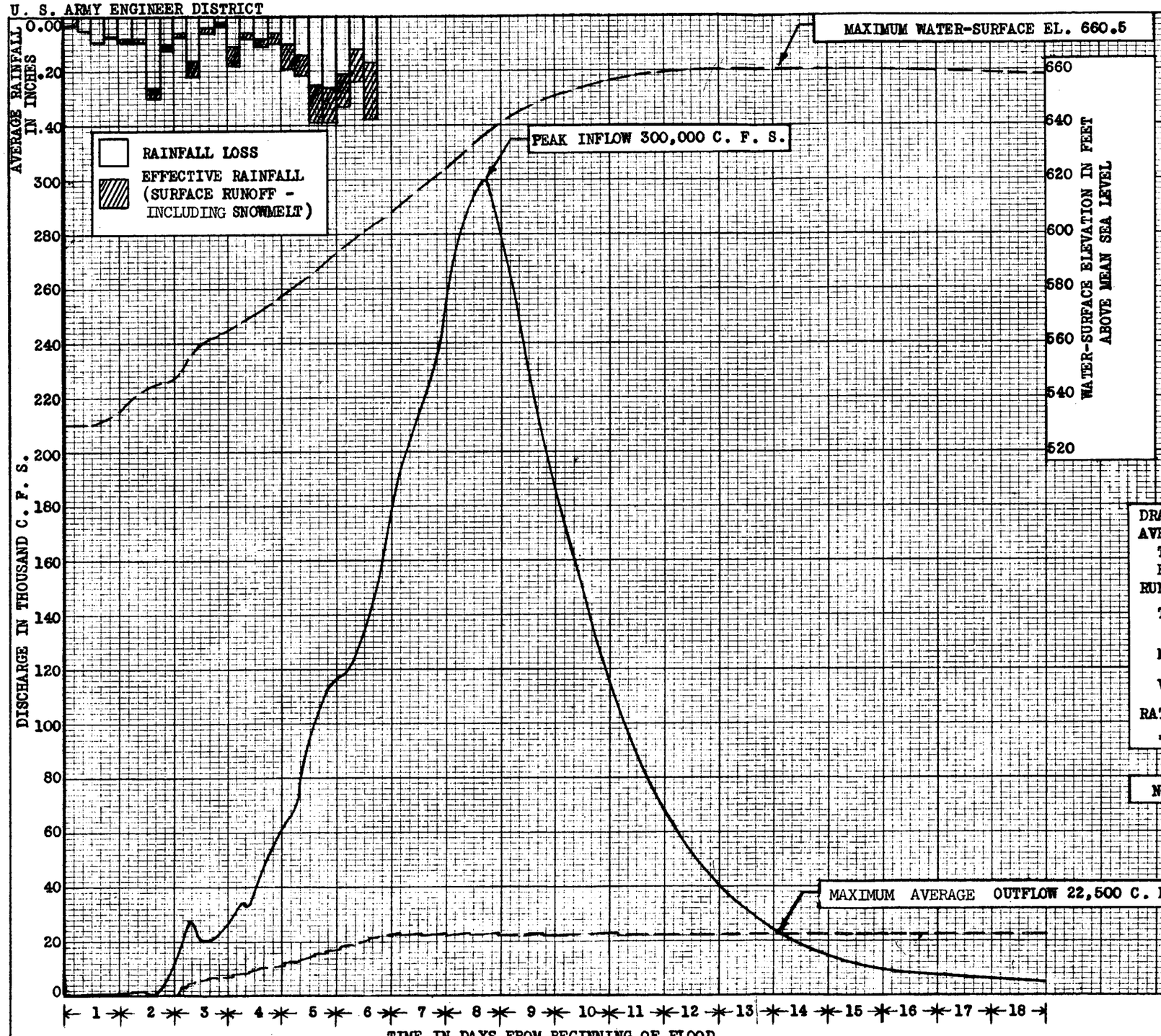
Flood-Control Operation Plan A

U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

PLATE 35

U. S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS



DRAINAGE AREA	*50,800 SQ. MI.
AVERAGE RAINFALL DEPTH OVER AREA:	
TOTAL STORM	3.83 INCHES
EFFECTIVE, TOTAL STORM RUNOFF:	1.27 INCHES
TOTAL FLOOD VOLUME	2,800,000 AC.-FT. / 1.03 INCHES
MAXIMUM 8-DAY VOLUME	2,490,000 AC.-FT. / 0.92 INCH
VOLUME OVER 22,500 C. F. S.	2,200,000 AC.-FT. / 0.81 INCH
RATIO OF RUNOFF TO RAINFALL	27 PERCENT

* EXCLUDES WILLCOX AND ANIMAS CLOSED DRAINAGES.

NOTE: NET CAPACITY USED IN COMPUTATIONS

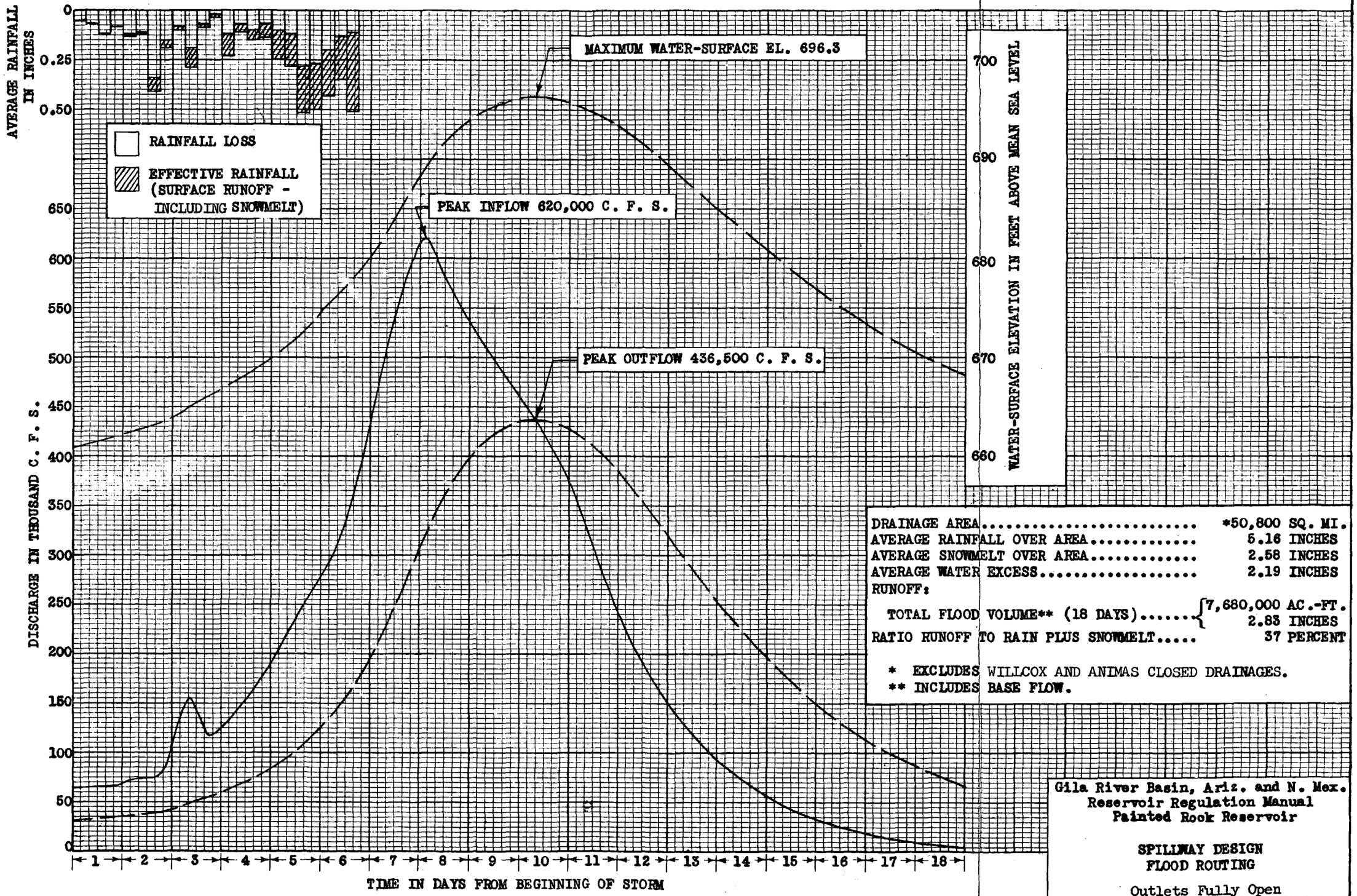
Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

RESERVOIR DESIGN
FLOOD ROUTING

Flood-Control Operation Plan B

U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

PLATE 36



DRAINAGE AREA.....	*50,800 SQ. MI.
AVERAGE RAINFALL OVER AREA.....	5.16 INCHES
AVERAGE SNOWMELT OVER AREA.....	2.58 INCHES
AVERAGE WATER EXCESS.....	2.19 INCHES
RUNOFF:	
TOTAL FLOOD VOLUME** (18 DAYS).....	7,680,000 AC.-FT.
	2.83 INCHES
RATIO RUNOFF TO RAIN PLUS SNOWMELT.....	37 PERCENT

* EXCLUDES WILLCOX AND ANIMAS CLOSED DRAINAGES.
** INCLUDES BASE FLOW.

NOTE: NET CAPACITY USED IN COMPUTATIONS.

Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

SPILLWAY DESIGN
FLOOD ROUTING

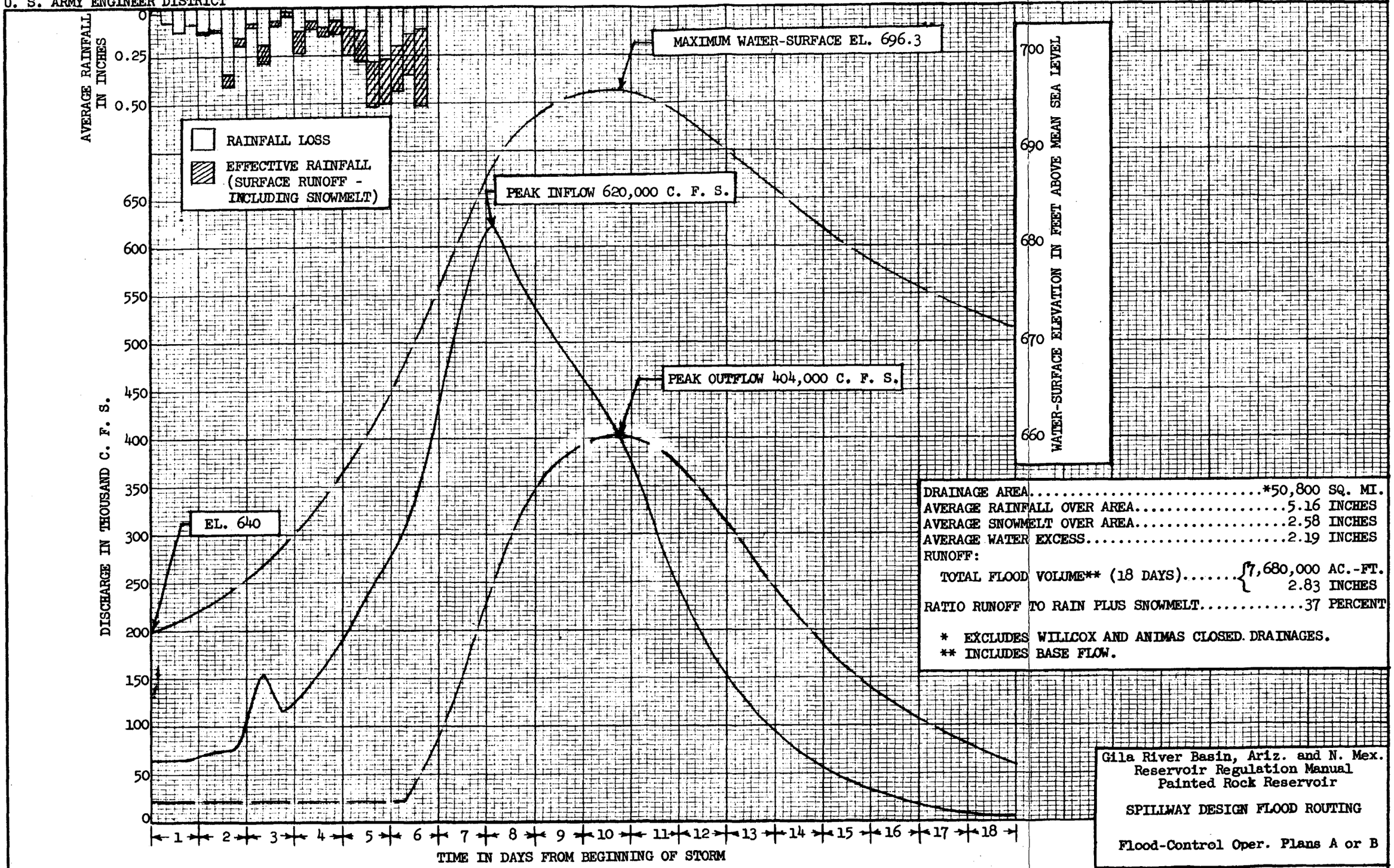
Outlets Fully Open

U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

PLATE 37

U. S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS



DRAINAGE AREA	*50,800 SQ. MI.
AVERAGE RAINFALL OVER AREA	5.16 INCHES
AVERAGE SNOWMELT OVER AREA	2.58 INCHES
AVERAGE WATER EXCESS RUNOFF:	2.19 INCHES
TOTAL FLOOD VOLUME** (18 DAYS)	7,680,000 AC.-FT.
	2.83 INCHES
RATIO RUNOFF TO RAIN PLUS SNOWMELT	37 PERCENT

* EXCLUDES WILLCOX AND ANIMAS CLOSED DRAINAGES.
** INCLUDES BASE FLOW.

NOTE: 1. NET CAPACITY USED IN COMPUTATIONS.
2. FLOOD-CONTROL OPERATION PLANS A AND B IDENTICAL ABOVE ELEVATION 640.

Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

SPILLWAY DESIGN FLOOD ROUTING

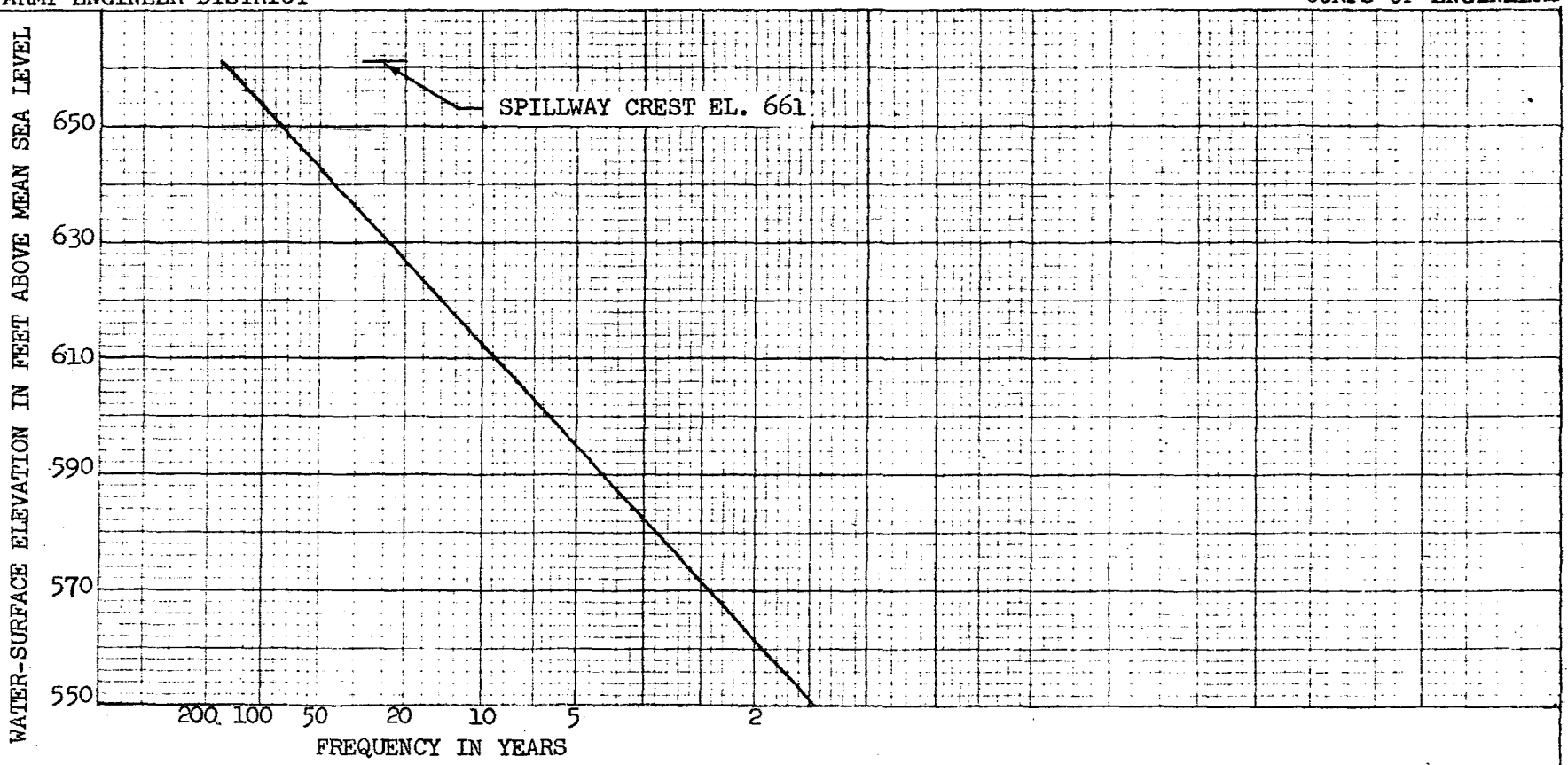
Flood-Control Oper. Plans A or B

U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

PLATE 38

U. S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS



NOTE:

NET CAPACITY USED IN COMPUTATIONS.

Gila River Basin, Ariz. and N. Mex.
Reservoir Regulation Manual
Painted Rock Reservoir

FILLING FREQUENCY CURVE

Flood-Control Operation Plan A

U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: June 1962

PLATE 39

FLOOD CONTROL BASIN OPERATION REPORT

Name | **Month** | **Year**

Day	Reservoir W.S.Elev			Outlet channel		Gate operation																	OPERATOR
	Time	Type of Gage	Gage reading in feet	Time	Gage height in feet	Time	Gate opening in feet																
							No.1	No.2	No.3	No.4	No.5	No.6	No.7	No.8	No.9	No.10	No.11	No.12	No.13	No.14	No.15	No.16	

REMARKS:

SPL FORM 19 1 Mar 55 Reinstating SPL Form 19 — 25 Jun 52 ARMY — C. of E. — Los Angeles

RAINFALL REPORTING NETWORK

OBSERVER'S DAILY REPORTS

Station:						Month:		Year:	
Day	Normal time	Exact time	Reading	Emp-tied	Seasonal total	Temperature Wet	Temperature Dry	Observer	Remarks
1	0800								
2	0800								
3	0800								
4	0800								
5	0800								
6	0800								
7	0800								
8	0800								
9	0800								
10	0800								
11	0800								
12	0800								
13	0800								
14	0800								
15	0800								
16	0800								
17	0800								
18	0800								
19	0800								
20	0800								
21	0800								
22	0800								
23	0800								
24	0800								
25	0800								
26	0800								
27	0800								
28	0800								
29	0800								
30	0800								
31	0800								
TOTAL									

SPL Form 31
1 Sep 51

ARMY - C. of E. - Los Angeles

PLATE 41

RESERVOIR OPERATION REPORT

DATE

TIME OF REPORT

RADIO CALL SIGN	DAM	TIME OF READING	RESERVOIR WATER-SURFACE ELEVATION	OUTFLOW GAGE HEIGHT	RAINFALL		GATES AT STEP NO.	GATE SETTINGS *
					SINCE LAST REPORT	SEASON TOTAL		
		HRS.	FT. MSL	FEET	INCHES	INCHES		
WUK 424	Sepulveda							Gates Open 9.0 ft. ☐
WUK 410	Hansen							Gates Closed ☐
WUK 423	Santa Fe							Gates Closed ☐
WUK 405	Brea							Gates Open 1.0 ft. ☐
WUK 431	Fullerton							Gates Open 0.2 ft. ☐
WUK 426	Carbon Canyon							Gates Closed ☐
WUK 419	Prado							Gate No. ___ Open 2.0 ft. ☐
WUK 415	San Antonio							Gates Closed ☐
WUK 417	Whittier Narrows — Rio Hondo Pool		W. Pit E. Pit Comb.					LACFCD Diversion Gate Open ____ ft. Gate 1 Open ___ ft. Gates 2,3, & 4 Open ___ ft. ☐
	Whittier Narrows — Mission Creek Pool				X X X	X X X		Upper Gate Open ____ ft. Lower Gate Open ____ ft.
	Whittier Narrows — San Gabriel Pool		W. Staff E. Staff Comb.		X X X	X X X		Gates 1,4,6 & 9 Open ____ ft. ☐
	Lopez				X X X	X X X	X X X	Gate Open _____ ft. ☐
WUK 429	Painted Rock			Gillespie P. Rock Dome				Gates Open 0.5 ft. ☐

Printed values show initial settings of gates prior to flood runoff

REMARKS

PLATE 42

5PL FORM MAY 62 424 (REPLACES LA FORM 283 (TEMP) WHICH MAY BE USED

RESERVOIR COMPUTATIONS

☐ HOURLY ☐ DAILY

DAM	TIME OF READING (IF DAILY)	DATE

COMPUTED BY	CHECKED BY	DATA SOURCE

HR.	DA.	WATER SURFACE ELEV. FT.	STORAGE AC. FT.	GATE STEP NO.	INST. OUTFLOW			HRS.	STORAGE CHANGE		AV. OUTFLOW CFS	AV. INFLOW CFS	GATE SETTINGS FT.
					OUTLETS CFS	DOWNSTREAM G. HT. FT.	DOWNSTREAM FLOW CFS		ACRE-FEET	CFS			
PREVIOUS REPORT													
0100	1												
0200	2												
0300	3												
0400	4												
0500	5												
0600	6												
0700	7												
0800	8												
0900	9												
1000	10												
1100	11												
1200	12												
1300	13												
1400	14												
1500	15												
1600	16												
1700	17												
1800	18												
1900	19												
2000	20												
2100	21												
2200	22												
2300	23												
2400	24												
	25												
	26												
	27												
	28												
	29												
	30												
	31												
TOTAL													
MEAN													

REMARKS

SPL FORM 27 JUN 58 30 PREVIOUS EDITIONS MAY BE USED; REPLACES SPL FORM 29 WHICH MAY BE USED

ARMY - C. OF E. - LOS ANGELES

PLATE 43

FLOOD SITUATION REPORT

GILA RIVER BASIN	Date	Report Time	By

RESERVOIR DATA

Dams	Drainage Area Sq. Mi.	Time of Obs. Hrs.	W.S. Elev. Ft.	Instant Outflow C.F.S.	Average Inflow hrs	Average Inflow C.F.S.	Storage Ac. Ft.	Storage at Spwy Crest Ac. Ft.	Remarks
Coolidge	12,886							1,205,000	
Ashurst-Hayden Div.	-							-	
Roosevelt	5,830							1,382,000	
Horse-Mesa	5,940							245,000	
Mormon Flat	6,100							58,000	
Stewart Mountain	6,211							70,000	
Horseshoe	5,991							142,800	
Bartlett	6,185							179,500	
Lake Pleasant	1,460							163,800	
Painted Rock	50,800							2,491,700	
Parker	178,800							619,400	
Imperial Div.	-							-	

STREAMFLOW DATA

Stream	Location	Time of Obs. Hrs.	Discharge C.F.S.	Gage Height Ft.	Max. Disch. of Record	Max. Gage Height of Record	Remarks
Gila River	Below Gillespie Dam				85,000	16.0	
Gila River	Near Dome				20,700	16.8	
Salt River	Near Roosevelt				117,000	24.4	
Verde River	Below Tangle Creek				81,600	17.6	
Colorado River	Below Cibola Valley				21,800	13.6	

PRECIPITATION DATA

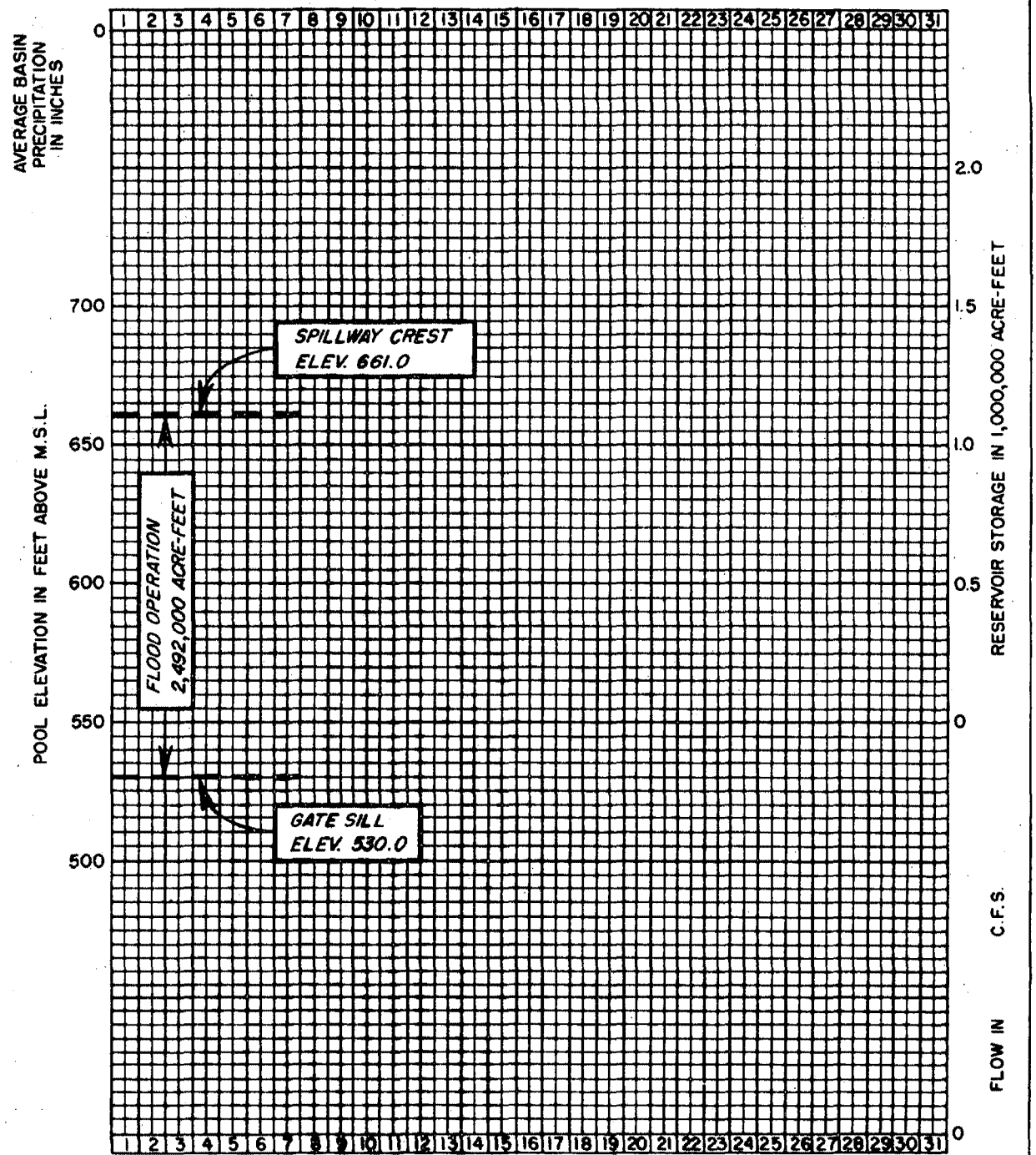
Station	Station Elev. Ft.	Mean Seasonal In.	Time of Obs. Hrs.	Amt. Since Last Obs. In.	Storm Total In.	Season Total In.	Snow on Ground In.	Remarks
Painted Rock Dam	572	5.6						
Tucson	2,584	10.7						
Flagstaff	6,993	18.5						
Yuma	199	4.0						
Ajo	1,763	9.1						
Phoenix	1,109	7.2						
Showlow	6,382	21.0						
Clifton	3,465	12.6						
Payson	4,848	21.4						
Wickenburg	2,070	10.8						
Prescott	5,014	16.0						
Jerome	5,245	16.0						
Cliff, N. Mex.	4,600	15.5						
Lake Pleasant Dam	1,600	16.0						
Roosevelt Dam	2,200	16.0						
Horse Mesa Dam	2,000	20.0						
Mormon Flat Dam	1,715	14.0						
Stewart Mountain Dam	1,422	12.4						
Horseshoe Dam	2,020	19.0						
Bartlett Dam	1,650	16.0						
Coolidge Dam	3,300	12.9						
Ashurst-Hayden Div.	1,638	10.9						
Parker Dam	425	4.7						
Imperial Div.	167	4.0						

SNOWFALL DATA

Station	Station Elev. Ft.	Date	Snow on Ground In.	Water Content In.	Avg. Water Content on Indicated Dates: 15 Jan.	1 Feb.	1 Mar.	1 Apr.	Remarks
Nutrioso	8,500				1.4	2.0	1.7	0.5	
Beaver Head	8,000				2.1	2.9	2.3	.7	
Fort Apache	9,160				4.4	6.1	6.8	6.4	
Baldy	9,125				3.6	5.5	5.9	3.4	
Mormon Mountain	7,500				3.0	5.1	4.6	2.4	
Mingus Mountain	7,100				.8	1.7	1.1	0	
Gaddes Canyon	7,600				1.3	3.4	2.7	1.6	
Bear Wallow	8,100				2.2	3.0	2.6	.9	

PLATE 44

ENGCW-E-6



RESERVOIR STORAGE BASED ON SURVEY DATED MAR. 1953

MONTH OF 19

	ELEV.	GROSS STORAGE (ACRE-FT.)
Conservation Pool		NONE
Full Pool	661	2,492,000

Outlet Capacity at Full Pool 30,500 c.f.s.

MONTHLY RESERVOIR OPERATION

PAINTED ROCK FLOOD-CONTROL BASIN

GILA RIVER BASIN, ARIZ. AND NEW MEXICO

DRAINAGE AREA 50,800 SQ. MILES

SOUTH PACIFIC DIVISION

LOS ANGELES DISTRICT

FILE NO. RO 04/

PLATE 45