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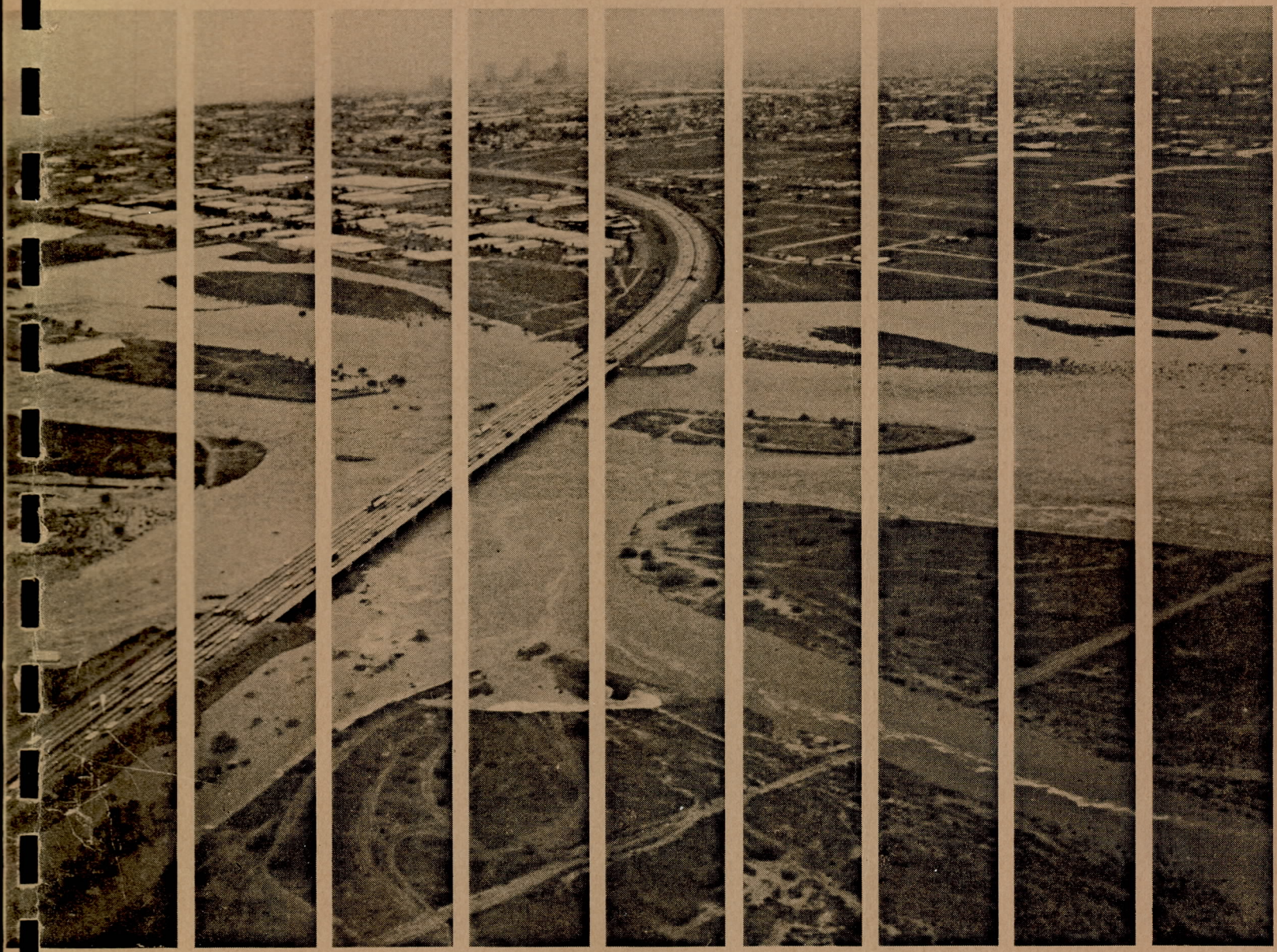
FLOODS OF OCTOBER 1977 IN SOUTHERN ARIZONA AND MARCH 1978 IN CENTRAL ARIZONA



OPEN·FILE REPORT 82·687

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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

FLOODS OF OCTOBER 1977 IN SOUTHERN ARIZONA AND MARCH 1978 IN CENTRAL ARIZONA

By B. N. Aldridge AND J. H. Eychaner

Open-File Report 82-687

Prepared in cooperation with U.S. Bureau of Reclamation; U.S. Army Corps of Engineers, Los Angeles District; Arizona Department of Water Resources; Flood Control District of Maricopa County; and Salt River Valley Water Users' Association

Tucson, Arizona
July 1982

UNITED STATES DEPARTMENT OF THE INTERIOR

JAMES G. WATT, Secretary

GEOLOGICAL SURVEY

Dallas L. Peck, Director

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CONVERSION FACTORS

For those readers who may prefer to use the International System of Units (SI) rather than inch-pound units, the conversion factors for the terms used in this report are listed below:

Multiply inch-pound unit	By	To obtain SI unit
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
acre	0.4047	hectare (ha)
acre-foot (acre-ft)	0.001233	cubic hectometer (hm^3)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
cubic foot per second per square mile [$(ft^3/s)/mi^2$]	0.01093	cubic meter per second per square kilometer [$(m^3/s)/km^2$]
degree Fahrenheit (°F)	(temp °F-32)/1.8	degree Celsius (°C)

National Geodetic Vertical Datum of 1929 (NGVD of 1929): A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called mean sea level.

FLOODS OF OCTOBER 1977 IN SOUTHERN ARIZONA AND MARCH 1978 IN CENTRAL ARIZONA

By

B. N. Aldridge and J. H. Eychaner

ABSTRACT

Major floods occurred in October 1977 and March 1978 in Arizona. As much as 14 inches of rain fell during October 6-9, 1977, over the mountains of southern Arizona and northern Mexico and caused the highest discharge since at least 1892 on the Santa Cruz River upstream from Tucson. The flood inundated areas as much as 4 miles wide, covered at least 16,000 acres of farmland, and caused $15.2 million in damage. Residential losses occurred at Nogales, Amado, Green Valley, and Sahuarita. Severe erosional damage occurred along the Santa Cruz River, Agua Fria Canyon, Potrero Creek, and many small drainages in the Sonoita Creek basin. The peak discharge in Agua Fria Canyon was the highest since before 1900. Less severe flooding occurred along the San Pedro River and the Gila River downstream from the San Pedro.

Widespread rainfall of 3 to 6 inches and 9 to 14 inches in some areas in the central mountains during February 28 to March 3, 1978, caused the highest discharge since 1920 on the Salt River in Phoenix and resulted in three deaths. Flooding along the Salt and Gila Rivers and several lesser streams caused statewide damage totaling $65.9 million, of which about $37 million occurred in Maricopa County. Nine counties were declared disaster areas.

During the flood of March 1978, moderate peak discharges and unusually high volumes of runoff occurred on tributaries to the Salt and Verde Rivers upstream from a system of reservoirs. Flood magnitudes were greater at the main-stem gaging stations than on the tributaries. The peak discharge into Theodore Roosevelt Lake, which was 21 percent full at the start of the flood, was about 155,000 cubic feet per second and is the largest known from 1890 to 1978. The reservoirs stored large quantities of water and greatly reduced the magnitude of the flood. The peak discharge of the Salt River was 125,000 cubic feet per second below Granite Reef Dam and 122,000 cubic feet per second at Phoenix. Discharges in excess of 100,000 cubic feet per second occurred for 8 hours. Without the storage provided by the reservoirs, the peak discharge would have been 260,000 cubic feet per second and the discharge would have exceeded 100,000 cubic feet per second for 66 hours. The Verde River was the principal flood source, but flows at the upstream gaging stations did not indicate the magnitude of the impending flood at Horseshoe Reservoir because large inflow from tributaries immediately upstream from the reservoir caused the river to rise at downstream stations before it rose at upstream stations.

About 17 percent of the water entering the reach from Granite Reef Dam to Gillespie Dam went to recharge, temporary ground-water storage, or evapotranspiration losses. All water was stored at Painted Rock Reservoir and released at a low rate that prevented water from reaching the Gila River near Mohawk gaging station.

INTRODUCTION

Five major floods occurred in Arizona from October 1977 to February 1980. This report, which is planned to be the first in a series, describes the floods of October 1977 in southern Arizona and March 1978 in central Arizona. The flood of October 1977, which originated in the Mexican parts of the Santa Cruz and San Pedro River basins and the adjacent mountains in Arizona (fig. 1), was the largest known in Tucson since at least 1892 and caused $15.2 million in damage in Santa Cruz, Cochise, Pima, and Pinal Counties. The flood of March 1978 resulted from moderately high runoff from a large area in the central mountains of Arizona and caused $65.9 million in damage statewide. The flood affected 13 of the 14 counties in Arizona and 9 counties were declared disaster areas. The discharge of the flood of March 1978 in Phoenix was the largest since 1920 but was exceeded by the floods of December 1978 and February 1980. Maricopa County sustained $37 million in damages.

The purpose of this report is to summarize conditions preceding each of the two floods, give a factual account of the floods, relate them to past events and later events in 1978-80, and show the effects of reservoirs on the discharges in the Salt River. Although the floods occurred as two separate events, some maps and tables and the section entitled "Streamflow Data of Gaging Stations and Miscellaneous Measuring Sites" show data for both floods. Site numbers used in text, tables, and illustrations correspond to site numbers shown on plate 1.

Cooperation and Acknowledgments

The report was prepared in cooperation with the U.S. Bureau of Reclamation (formerly U.S. Water and Power Resources Service); U.S. Army Corps of Engineers, Los Angeles District; Arizona Department of Water Resources (formerly the Arizona Water Commission); Flood Control District of Maricopa County; and Salt River Valley Water Users' Association. The authors wish to express thanks to the personnel of the cooperating agencies who provided data and to personnel from the U.S. Soil Conservation Service, U.S. Forest Service, National Weather Service, International Boundary and Water Commission, National Aeronautics and Space Administration, Arizona Department of Transportation, Arizona Emergency Services, City of Phoenix, Maricopa County Highway Department, and University of Arizona. Special thanks is also extended to U.S. Geological Survey personnel who helped collect and tabulate the streamflow data especially L. L. Werho, S. E. Buell, C. H. Benson, and S. R. Anderson.

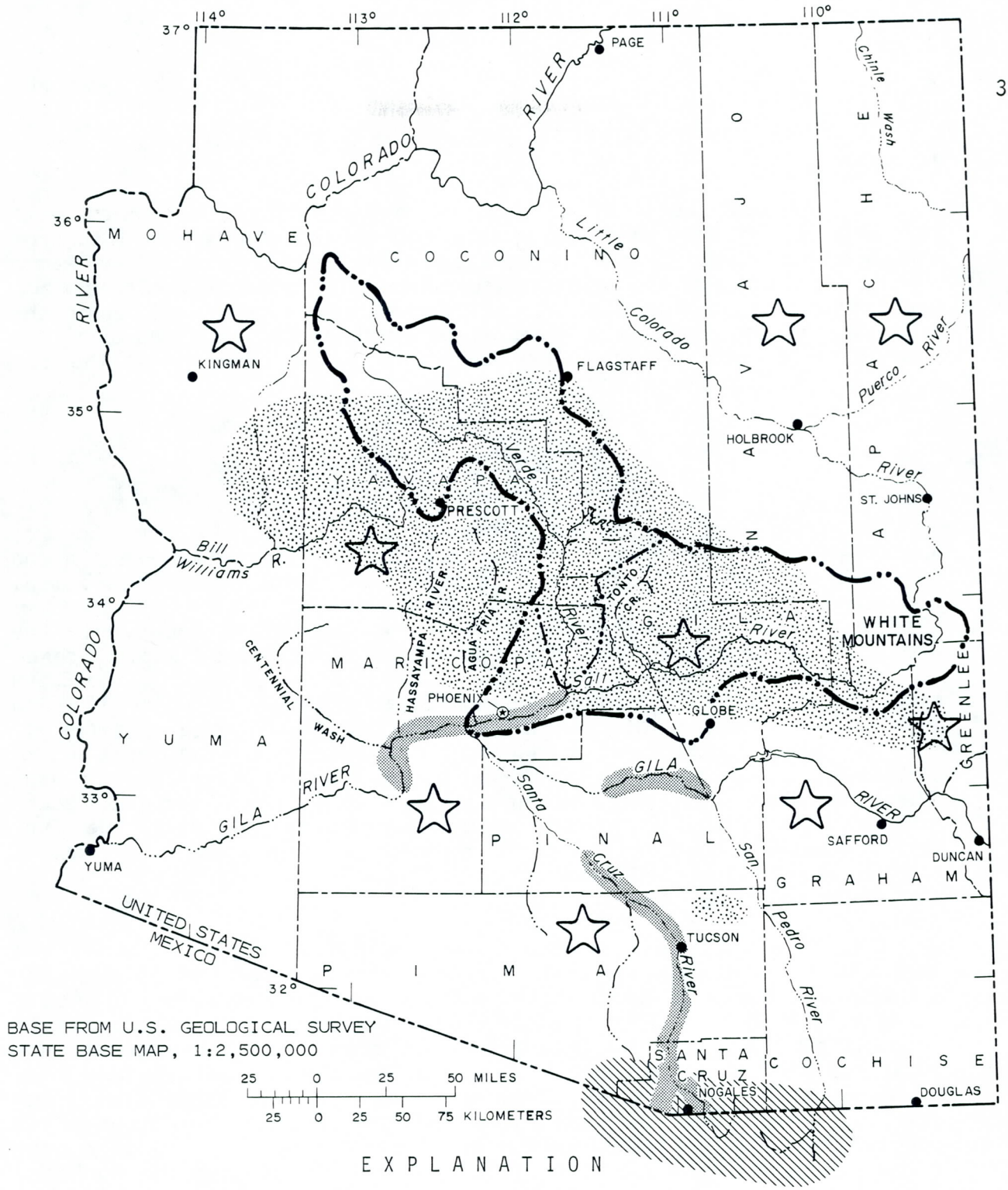


Figure 1.--Areas of high runoff in Arizona and northern Sonora, Mexico, during October 1977 and March 1978.

FLOODS OF OCTOBER 1977 IN SOUTHERN ARIZONA

As much as 14 in. of rain fell in 5 days over the mountains of northern Mexico and southern Arizona and caused the largest discharge known on the Santa Cruz River upstream from Tucson. On the San Pedro River, the flood was the sixth highest since 1913. Damage occurred along major tributaries to the Santa Cruz River south of Tumacacori, along the main stem of the Santa Cruz River as far north as Chuichu, and along the Gila River downstream from the San Pedro River. Damage in the San Pedro River basin was slight.

Geographic Setting

The San Pedro and Santa Cruz Rivers drain from Sonora, Mexico, through Arizona to the Gila River (pl. 1). Drainage areas of the San Pedro River and the Santa Cruz River include 696 and 395 mi^2, respectively, in Mexico. Floods originated mainly in the Mexican parts of the basins and in Arizona within 15 mi of the international boundary. The area is characterized by many mountain ranges of small areal extent broken by low passes and intermontane valleys. Crest altitudes are 5,500 to 6,500 ft above the National Geodetic Vertical Datum of 1929 (NGVD). The San Pedro River heads in the Sierra Mariquita and Sierra Magallenes (pl. 1) near Cananea, Sonora, and flows north into Arizona near the community of Palominas, and then slightly northwest to join the Gila River at Winkelman. The Santa Cruz River heads in the Canelo Hills in Arizona and flows south into Sonora. About 12 mi south of the international boundary, the river turns west and then northwest to re-enter Arizona about 5 mi east of Nogales. From there it flows north to Tucson and northwest to join the Gila River southwest of Phoenix.

The upper part of the Santa Cruz River basin is divided into two distinct parts by a mountain range that trends north-south and consists of the Patagonia Mountains in Arizona and the Sierra de San Antonio in Sonora, Mexico. To the east of these mountains, the drainage pattern is dendritic. Most of the tributaries that drain from the Huachuca and Patagonia Mountains are concentrated in a 6-mile reach near Lochiel, Ariz. Downstream from the concentration of tributaries, the Santa Cruz River flows southward along the eastern toe of the Sierra de San Antonio and then westward through the mountains. The river is joined by only a few minor tributaries in about 14 mi. Six miles downstream from the mountains and 4 mi downstream from San Lazaro, Sonora, three tributaries drain from steep mountains along the south and west sides of the basin and enter the river within a 0.5-mile reach. Although the combined drainage area is less than 50 mi^2, the three tributaries are prime contributors to floods on the Santa Cruz River. In the 40-mile reach between the second concentration of tributaries and Potrero Creek, the Santa Cruz River flows generally through the middle of a rectangular drainage pattern. Tributaries are small; those in Sonora drop sharply from the mountains to the river, and flood runoff concentrates rapidly. Tributaries in Arizona pass over an extensive alluvial deposit, and runoff concentrates more slowly. The

Arizona streams in this reach, therefore, are less effective in producing flood runoff than the streams in Sonora. Beginning at Potrero Creek north of Nogales, five large tributaries—Potrero Creek, Sonoita Creek, Agua Fria Canyon, Peck Canyon, and Josephine Canyon—join the Santa Cruz River in a 10-mile reach. The 487-square-mile drainage area of the five tributaries and an additional 140 mi^2 for small tributaries nearly doubles the drainage area of the river between the upstream and downstream points of the 10-mile reach. The three primary concentrations of tributaries—one near Lochiel, one near San Lazaro, and one north of Nogales—controlled the number, timing, and magnitude of flood crests on the Santa Cruz River.

Meteorology

The rainfall of October 6-10, 1977, occurred when tropical storm Heather, moving to the northeast, met with a cold front and low-pressure system moving to the southeast. Tropical storm Heather developed southwest of Mexico on October 3, briefly reached hurricane strength on October 5, and was downgraded to tropical storm status on October 6. During October 7-10, the storm center moved slowly eastward a short distance south of the international boundary. Circulation around the storm carried a stream of moist tropical air toward Arizona. The cold front moved generally from the northwest to the southeast across Arizona on October 7-8 and collided with the tropical storm over the international boundary late on October 8 or early on October 9. The front remained nearly stationary south of Nogales for 24 to 36 hours before the storm weakened and moved eastward on October 10 (U.S. Army Corps of Engineers, 1978; Arizona State University, 1977, p. 10-14).

Precipitation

A few thundershowers occurred over parts of Arizona on October 5, and widespread precipitation occurred on October 6 and 7. Eleven climatological stations in southern Arizona reported more than 2 in. during October 5-7; the maximum reported was 4.96 in. at Patagonia. Near the international boundary, intermittently heavy rainfall continued through October 9. Only a few stations reported rain on October 10 (U.S. Environmental Data Service, 1977a). Total precipitation during October 6-10 exceeded 6 in. in many areas. Local residents reported 12 to 14 in. in the mountains on both sides of the boundary near Nogales (R. A. Wood, National Oceanic and Atmospheric Administration, written commun., 1977; H. C. Millsaps, U.S. Soil Conservation Service, written commun., 1978).

Generalized isohyets (lines of equal precipitation) of total storm precipitation in southern Arizona and for that part of Sonora for which data are available are shown in figure 2. The large local orographic effects and the few data points preclude an accurate delineation of isohyets, especially in Mexico and in areas where precipitation was less

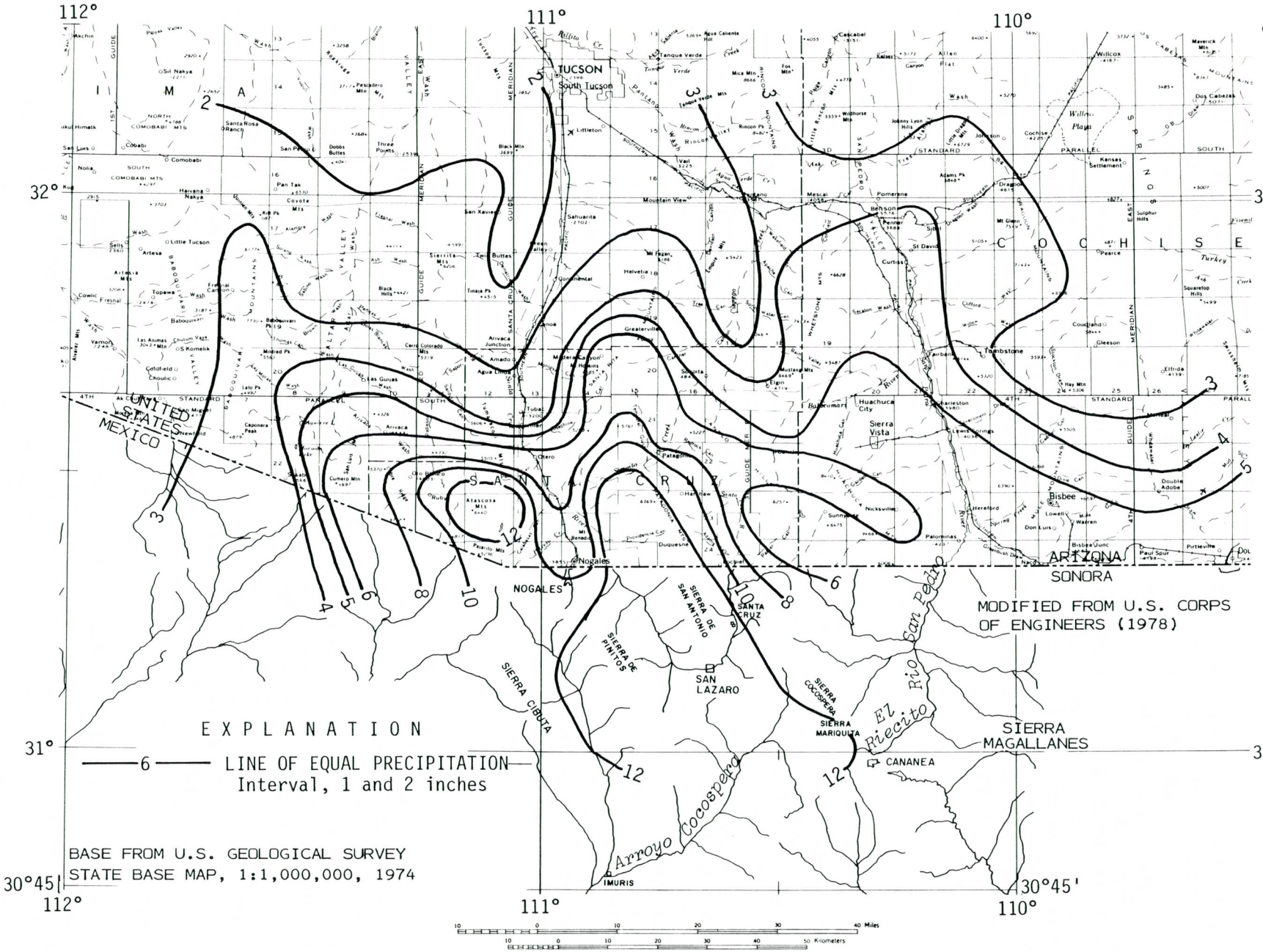


Figure 2.--Total precipitation in southern Arizona and northern Mexico, October 6-10, 1977.

than 6 in. In the low-precipitation areas, rain fell mostly during the early part of the storm (fig. 3). These areas produced little or no runoff during October 8-10. The main flood wave on the Santa Cruz River was produced by intense precipitation on the morning of October 9 as shown by the data for the Nogales weather station (fig. 3) where 2 in. of rain fell in the 4-hour period from 0400 to 0800 hours October 9 (U.S. Environmental Data Service, 1977b). Precipitation in the mountains was apparently more intense. Runoff data indicate that rainfall occurred simultaneously over most of the flood area. The largest amount of precipitation fell in Sonora where precipitation was measured at only a few locations. Most of these measurements indicated 10-14 in. (R. A. Wood, National Oceanic and Atmospheric Administration, written commun., 1977), but only 5.5 in. was reported at San Lazaro (J. J. Ligner, International Boundary and Water Commission, written commun., 1978), which is in a narrow valley surrounded by mountains. The local effect at San Lazaro precludes use of that data in developing isohyets.

Runoff

Streamflow records were obtained at six sites on the Santa Cruz River, five sites on the San Pedro River, and two sites on the Gila River

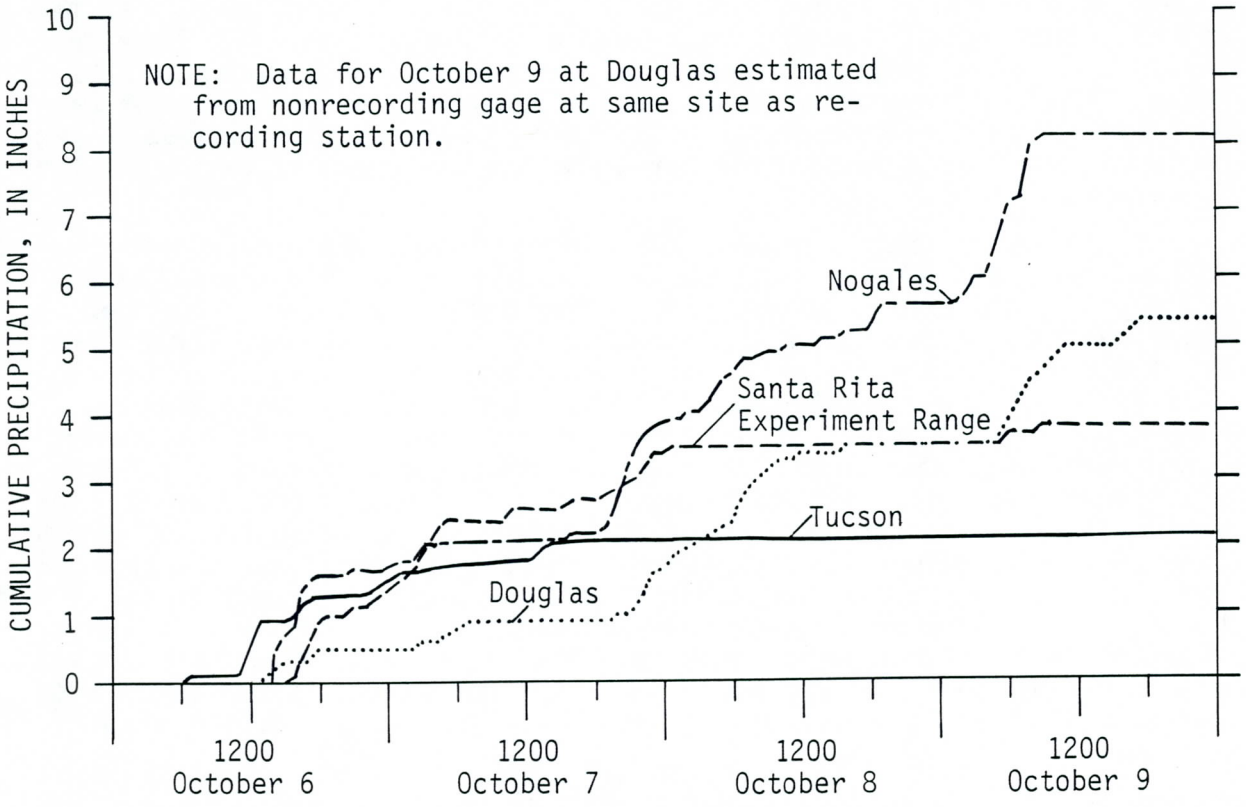


Figure 3.--Cumulative precipitation at four climatological stations in southern Arizona, October 6-9, 1977.

(pl. 1); peak discharges were measured at several miscellaneous sites. Tributary-inflow patterns were defined through indirect measurements, field inspections, and interviews with local residents and government agencies. Peak discharges, discharge-hydrograph data, and daily discharges at individual stations are given in the "Station Data" section at the end of this report.

Santa Cruz River

The Santa Cruz River is gaged 2.7 mi upstream from where it enters Sonora near Lochiel (site 10) and 0.8 mi downstream from where it re-enters Arizona near Nogales (site 11). Streamflow stations are located downstream at Continental, Tucson, Cortaro, and Laveen (sites 26, 27, 29, and 36). Complete stage records were obtained at Lochiel, Continental, Cortaro, and Laveen; the Nogales recorder stopped early on October 9 before the flood crest, and the Tucson station was destroyed. Records for these stations were reconstructed on the basis of observations by U.S. Geological Survey hydrologists and employees of local government agencies. Channel changes at Nogales, Continental, and Cortaro caused the stage-discharge relations at those three stations to be uncertain for most of the flood period.

Rainfall on October 8 caused a fairly high peak discharge at the gaging station near Nogales but not at the other five stations. At the Lochiel, Continental, Tucson, and Cortaro gaging stations, the peak discharge was of a magnitude that would occur on an average of 1 to 5 years. The crest inundated small areas of farmland close to the river, wet the channel as far downstream as Cortaro, but did little damage. The recession provided a fairly high flow on which the crests of October 9 and 10 were superimposed (fig. 4).

Gaging-station records for October 9 show one crest near Lochiel, two near Nogales, and three at Continental. The crests, each of which originated in a different part of the basin, have been identified as A, B, and C, according to the order in which they reached Continental. All three crests were caused by the one intense burst of rainfall between 0400 and 0800 hours on October 9. The crests are separated because of traveltime from the major concentrations of tributaries near Lochiel, Ariz., downstream from San Lazaro, Sonora, and downstream from Potrero Creek, which were described in "Geographic Setting." Crest A occurred at Continental 5 or 6 hours later than crest B occurred near Nogales. A casual observer could mistakenly assume that these were the same crest; however, the time between the crests is not enough for crest B to have traveled the distance between the two gaging stations; the traveltime between these stations generally is more than 10 hours. The short elapsed time between crest B at the Nogales station and crest A at the Continental station indicates that crest A originated between the two gaging stations.

The following analysis identifies the source of each crest, deals mainly with floodflows from the ungaged streams near Nogales, and shows that the second and third crests moved faster than the first one in a manner similar to the type of movement described in a study of flood peaks on Walnut Gulch near Tombstone, Ariz. In that study Osborn and Laursen

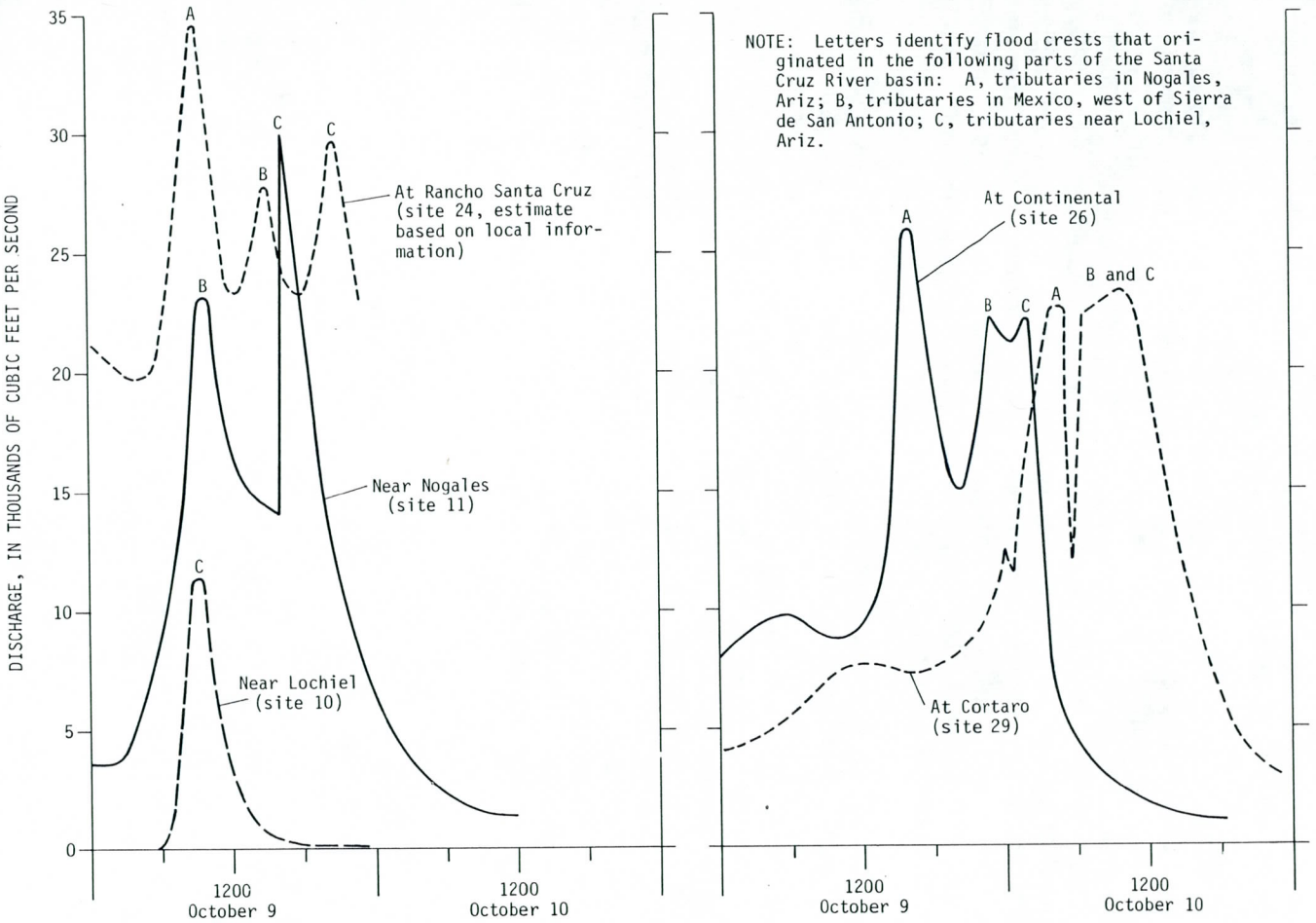


Figure 4.--Discharge at five sites along the Santa Cruz River, October 9-10, 1977.

(1973) state "the greatest abstractions occur with the advancing flood front, and wave fronts of later contributions move more rapidly through the already wetted channel. Contributions from subwatersheds during the same storm tend to accumulate as one peak at the watershed outlet." Their study was conducted on a 57-square-mile basin, but the phenomenon has been observed on several larger streams.

A field inspection, indirect measurements of peak flows on tributaries to the Santa Cruz River, and interviews with government officials and local residents confirmed that crest A was the result of inflow that came mainly from Potrero Creek (site 12, fig. 5), Sonoita Creek (sites 19 and 20), Agua Fria Canyon (site 22), and Peck Canyon (site 23). The maximum discharge at any point along the Santa Cruz River apparently occurred immediately downstream from Peck Canyon where the river is ungaged. The only significant inflow between Peck Canyon and Tucson came from Sopori Wash (site 25), which may have peaked as much as 3 days before the Santa Cruz River.

An analysis of discharges of the Santa Cruz River downstream from Peck Canyon is essential for defining the hydrology of the flood. The analysis relies heavily on information furnished by the owners of Rancho Santa Cruz, which is located 4 mi downstream from Peck Canyon, and on a summation of discharges from upstream points. The owners were on the ranch during most of the flood, and their information was more complete and definitive than any obtained elsewhere. Most of their information was substantiated by other interviews, each of which confirmed part of the Rancho Santa Cruz information. Rancho Santa Cruz (site 24) is 23 mi downstream from the Nogales station and 26 mi upstream from the Continental station. The traveltime is approximately 5 hours from the Nogales station to the ranch and 5 hours from the ranch to the Continental station.

According to the ranch owners, crests occurred on October 9 at 0930 hours, in early afternoon, and in late evening (fig. 4). The owners were able to provide only approximate times when the two later crests occurred. The morning crest (A) was the highest, the afternoon crest (B) was 1 ft lower than crest A, and the evening crest (C) was 0.8 ft lower than crest A. Each crest rose and receded rapidly; the trough between crests was 2.5 to 3 ft lower than the preceding crest. The difference in stage between crest A and crest C was verified by measuring the distance between mudstains left on buildings at the maximum stage reached by each crest. The mudstain from crest B had been washed off by crest C.

Floodmarks—debris lines or mudstains—left by crests A and C were observed at several locations along the Santa Cruz River between Peck Canyon and Sahuarita. The difference generally was less than 1.0 ft except near the Continental bridge where severe channel scour after crest A caused a difference of about 3 ft. A single floodmark was observed at several locations along the river upstream from Agua Fria Canyon. The single floodmark showed that crest C was the highest in that reach of channel and destroyed all floodmarks from crests A and B.

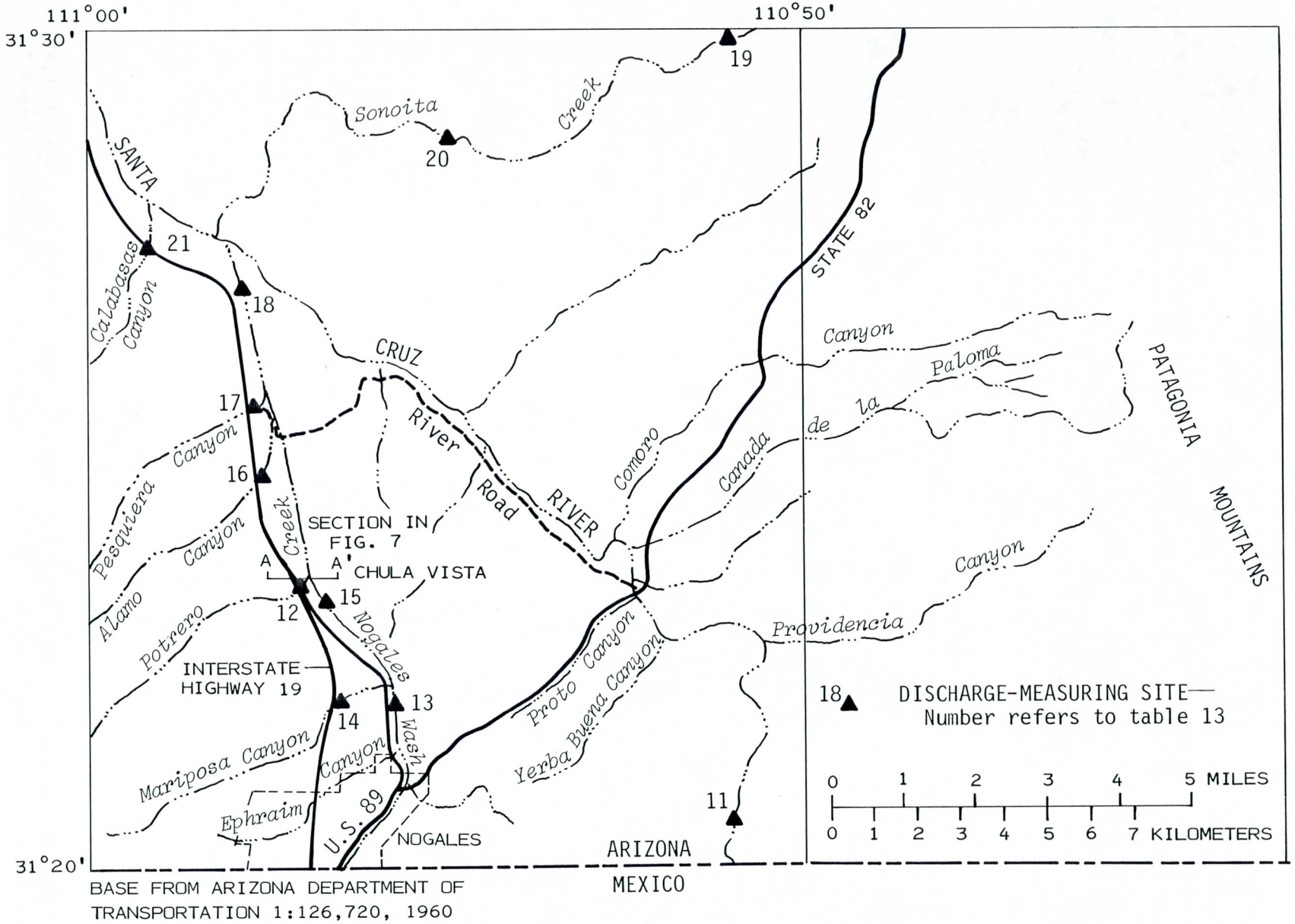


Figure 5.--Location of discharge-measuring sites near Nogales, Ariz., October 9, 1977.

Crest A resulted when extremely high flood crests from Potrero Creek and Agua Fria Canyon and moderate crests from other tributaries to the Santa Cruz River were superimposed on the recession from the crest of October 8. Sonoita Creek, which crested later than the smaller tributaries, was rising at the time. Crests from the tributaries appear to have reached Rancho Santa Cruz within a period of less than 1 hour. The resultant peak discharge at the ranch is a combination of peak discharges from the tributaries, the receding discharge of the Santa Cruz River, and increasing discharge of Sonoita Creek. The summation of discharges is estimated to be about 35,000 ft^3/s. Components of the estimate are given below.

Component	Discharge, in cubic feet per second
Santa Cruz River near Nogales at 0430 hours	7,300
Estimated inflow between Providencia Canyon and Peck Canyon	4,000
Slope-area measurement of peak on Potrero Creek	9,300
Peak at crest-stage gage on Calabasas Canyon	1,200
Estimated inflow from Sonoita Creek	2,500
Contracted opening measurement of peak on Agua Fria Canyon	10,200
Contracted opening measurement of peak on Peck Canyon	2,800
Total	[1]37,300

[1]Rounded downward to 35,000 ft^3/s.

Channel and flood-plain storage reduced the discharge to 26,500 ft^3/s at Continental and 23,700 ft^3/s at Tucson.

No evidence was visible upstream from Rancho Santa Cruz that crest A could have been caused by other than natural runoff. A debris dam that formed at the ranch during the October 8 peak may have caused all crests to reach a higher stage than would have occurred if the channel had been clear, but the peak discharge was not significantly affected.

Along Potrero Creek, the flood of October 9, 1977, is the largest known, but undocumented floods of similar magnitude may have occurred. In Agua Fria Canyon the flood is the largest since before 1900. In Peck Canyon the flood was less severe than that of December 1967 (Aldridge, 1972). Indirect measurements of peak discharge on October 9 were made at several sites in the Potrero Creek basin (fig. 5) and near the mouths of Agua Fria and Peck Canyons. Stage hydrographs for Potrero Creek and Agua Fria Canyon (fig. 6) were developed on the basis of interviews with State and local government employees. Water from Potrero Creek overflowed dikes around the lagoons of the International Boundary and Water Commission wastewater-treatment plant at the mouth of the creek from 0800

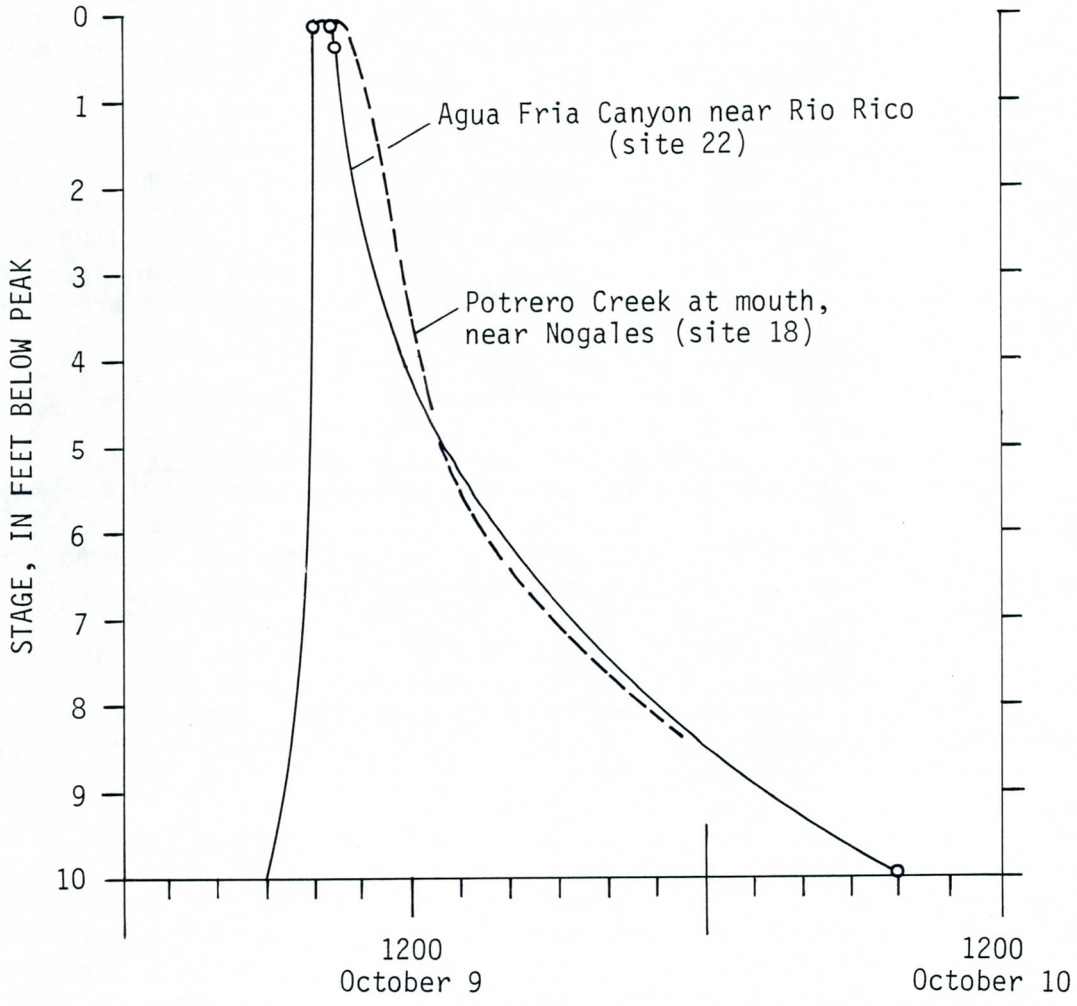


Figure 6.--Estimated stages on Potrero Creek and Agua Fria Canyon, October 9-10, 1977

to 1000 hours. Floodwater from Agua Fria Canyon flowed over Interstate Highway 19 for about 1 hour around 0830 hours according to communication logs furnished by the Arizona Department of Transportation.

The flood on Nogales Wash (fig. 5), the main tributary to Potrero Creek, was about the same magnitude as several earlier floods. The most recent, which occurred in July 1976, was about 0.3 ft higher than the flood of October 1977 above Mariposa Canyon—site 13 in figure 5 (H. C. Millsaps, U.S. Soil Conservation Service, oral commun., 1978). The highest peaks known in many years occurred in Ephraim and Mariposa Canyons and other streams draining from the Pajarito Mountains. Runoff from these streams caused the discharge at the mouth of Potrero Creek to be the highest known in many years.

Total peak inflow to the Santa Cruz River from tributaries between the gaging station near Nogales and Potrero Creek was estimated

during the field inspection to be between 5,000 and 6,000 ft^3/s. In the summation of discharges, the value was reduced to 4,000 ft^3/s to account for possible differences in traveltime. Flows about 1 to 3 ft deep occurred in Providencia, Comoro, Proto, and Yerba Buena Canyons and Canada de la Paloma (fig. 5). The maximum discharge from any one stream was about 2,000 ft^3/s. S. C. Jones (U.S. Geological Survey, oral commun., 1977) reported that these streams crested early on October 9 and that flows had receded to a "mere trickle" by the time he crossed them about 1400 hours on that day. Several small tributaries, each of which drain less than 2 mi^2 from the southwest between State Route (SR) 82 and Potrero Creek, had discharges of 100 to 200 $(ft^3/s)/mi^2$.

Runoff from the three tributaries in the Sonoran part of the basin west of Sierra de San Antonio caused crest B (fig. 4), which reached the Nogales station about 1000 hours and Rancho Santa Cruz about 1400 to 1500 hours on October 9. The stages for crests A, B, and C at Rancho Santa Cruz indicate a peak discharge of about 28,000 ft^3/s for crest B. The same discharge was obtained from a nonprecise summation of discharges from component sources. The discharge decreased to 23,000 ft^3/s at Continental. Crest B is not identifiable at gaging stations downstream from Continental because crests B and C combined into one crest. Crest B was receding when runoff from east of Sierra de San Antonio (crest C) reached the Nogales gaging station at 1630 hours on October 9. This crest apparently originated mainly in and upstream from the concentration of tributaries that enter the river near Lochiel, Ariz.

A field inspection showed that nearly every tributary upstream from the Lochiel gaging station had a moderately large flow during the flood, but none had an extreme runoff. The runoff became severe in the Santa Cruz River only after several tributaries had come together. The same runoff distribution probably occurred on tributaries entering the Santa Cruz River downstream from the Lochiel station, but that part of the basin was not inspected. The peak discharge past the Lochiel gaging station was 12,000 ft^3/s. The drainage area of the river below the concentration of tributaries is 2.5 times that at the station; therefore, the peak discharge downstream from the tributaries may have been in excess of 25,000 ft^3/s. At the Nogales gaging station, crest C was superimposed on the recession from crest B to form the highest peak at that site. The difference between the peak discharge of crest C and the discharge that would have resulted only from the recession of crest B is from 20,000 to 25,000 ft^3/s depending on how the recession is estimated. These values are consistent with the peak discharge estimated downstream from Lochiel.

The peak discharge of crest C at the Nogales station is 31,000 ft^3/s from a slope-area measurement. The crest probably moved from the Nogales station to Rancho Santa Cruz with little attenuation because the flood plain had already been wet by crest B and Sonoita Creek was still contributing 2,000 to 3,000 ft^3/s. Inflow from all other tributaries had receded to an insignificant amount. The estimated peak discharge for crest C at Rancho Santa Cruz is 30,000 ft^3/s.

The traveltime between the Nogales and Continental gaging stations was about 12 to 14 hours for crest B and 9.5 hours for crest C.

Crests B and C combined to form one crest before the flood wave reached Cortaro. At Cortaro the combination of crests B and C lagged crest A by 6 hours. Crest C had lagged crest A by about 10 hours at Rancho Santa Cruz and 9.5 hours at Continental. The traveltime between the Continental and Cortaro gaging stations was 12.5 hours for crest A and 8 hours for crest C. The sudden decrease in discharge at 0500 hours, October 10, at the Cortaro station resulted from several hundred acre-feet of water overflowing into a large gravel pit a short distance upstream from the gaging station. After the pit filled, the flow past the gage returned to the unaffected level.

Downstream from Cortaro, the intensity of the flood, now merged into a single crest, decreased rapidly as the river spread over large expanses of farm and desertland. Where the Santa Cruz River passes through Greene Canal near Eloy, the peak discharge was 5,200 ft^3/s on October 11. The flood had decreased in magnitude by the time it reached the mouth of the Santa Cruz River near Laveen on October 13, where the peak discharge was 2,010 ft^3/s.

San Pedro and Gila Rivers

The San Pedro River is gaged at Palominas 4.5 mi downstream from where it enters Arizona (site 2) and at or near Charleston, Tombstone, Redington, and Winkelman (sites 3, 4, 5, and 7). Almost all runoff during the flood period in the Gila River below the San Pedro River came from the San Pedro; the Gila River is gaged near Kelvin and Laveen (sites 8 and 9). The shape of the runoff hydrograph for the San Pedro River at Palominas differs markedly from that for the Santa Cruz River. The record shows a series of crests spanning a period of 31 hours. Crests on October 8 are only slightly lower than the crest on October 9. The gaging station is too far removed from sources of runoff to allow a reliable determination of contributing areas. The main source of flood runoff, however, appears to have been several tributaries in the first 10 mi of the river's course that drain from the Sierra Mariquita and Sierra Cocospera along the southwestern side of the basin. Small amounts of floodwater probably came from tributaries as far north as those draining from the Mule and Huachuca Mountains in Arizona. After the flood, U.S. Geological Survey personnel inspected tributaries to the San Pedro River between Palominas and Charleston and found that small to moderate peaks had occurred in several tributaries, but they found no evidence of a large amount of inflow (S. C. Jones and L. J. Mann, U.S. Geological Survey, oral commun., 1977). The beds of tributaries hung several feet above the downcut bed of the San Pedro River indicating that runoff in the tributaries preceded most of that coming down the San Pedro River from Sonora. Runoff occurred over much of the San Pedro basin on October 6-7. A gaging station on Walnut Gulch recorded runoff on October 6-7, but it did not record any on October 8-9 (V. A. Ferreirra, U.S. Department of Agriculture, Science and Education Administration, oral commun., 1980). The evidence of flow observed by Jones and Mann may have been from the October 6-7 runoff.

Flood waves occurring late in the flood period moved faster than earlier ones thus causing the discharge to increase as the flood wave moved downstream although there was little inflow. The peak discharge increased from 14,500 ft^3/s at Palominas to 23,700 ft^3/s at Charleston. The traveltime from Palominas to Charleston decreased from 12 or 14 hours for the first crest of October 8 to 6 hours for the last crest of October 9. The duration for the series of crests decreased from 31 hours at Palominas to 24 hours at Charleston. Similar changes in traveltime and duration may have occurred between Charleston and Redington, but the changes cannot be identified because the Redington station was inoperative during the crest. The peak discharge varied less than 3 percent in the reach from Charleston to Redington. Downstream from Redington, both peak and volume decreased gradually. Only about one-sixth of the flow passing the Charleston gaging station reached Laveen, where the peak discharge was 6,360 ft^3/s.

Damage

The U.S. Army Corps of Engineers (1978) estimates total damage from floods in the Santa Cruz River basin and along the Gila River including emergency costs and loss of business at $15.2 million. (See table 1.) Agricultural losses resulting from inundated crops, erosion of

Table 1.--Summary of damage from floods in the Santa Cruz River basin and along the Gila River, October 6-13, 1977

[Data from U.S. Army Corps of Engineers, 1978]

Type of property	Physical damage	Emergency costs and business losses	Total
Agricultural.....	[1]$ 8,993,000	$241,000	$ 9,234,000
Residential.....	331,000	105,000	436,000
Business.....	140,000	17,000	157,000
Golf courses.....	545,000	140,000	685,000
Highways, roads, and streets.....	3,538,000	127,000	3,665,000
Railroad.....	283,000	0	283,000
Flood control.....	144,000	0	144,000
Sewage-treatment facilities.....	409,000	0	409,000
Utilities.....	230,000	0	230,000
Public.....	2,000	0	2,000
Total.....	$14,615,000	$630,000	$15,245,000

[1]Data incomplete.

land, and loss of cattle and equipment amounted to $9.2 million. Transportation losses accounted for $3.9 million of which $2.1 million was from damage to national forest roads. Damage to businesses, residences, utilities, and other service facilities amounted to $2.1 million. Business losses were largely to golf courses at Tubac, Rio Rico, Green Valley, and Tucson. At least 90 homes were flooded. Most were near Nogales; others were in Green Valley and Sahuarita. About 40 homes in the Chula Vista subdivision and a mobile home park were flooded near the confluence of Potrero Creek and Nogales Wash. About 100 acres of farmland along Potrero Creek and Nogales Wash were inundated. Several homes built in the flood plain of a small tributary across Nogales Wash from the mouth of Mariposa Canyon were flooded.

Damage to the Chula Vista subdivision was caused by overflow from Nogales Wash and Potrero Creek. Nogales Wash had run bankfull for some distance upstream from Chula Vista but began to spill over the bank just upstream from the low-lying subdivision. The ground level in the subdivision is as much as 11 ft lower than the bank of Nogales Wash (fig. 7). The bank is formed by a road that parallels the west side of the wash. Water from a small reservoir that failed east of Chula Vista and a large cottonwood tree that fell into Nogales Wash may have contributed to the flooding. The tree blocked a large part of the channel, and floodmarks show that overflow began just upstream from the blockage. Floodwaters from Nogales Wash flowed through the subdivision to join Potrero Creek, which also was overflowing. The combined flow damaged lawns, streets, and fences and flooded homes to depths of more than 2 ft. Damage per structure averaged about $2,000.

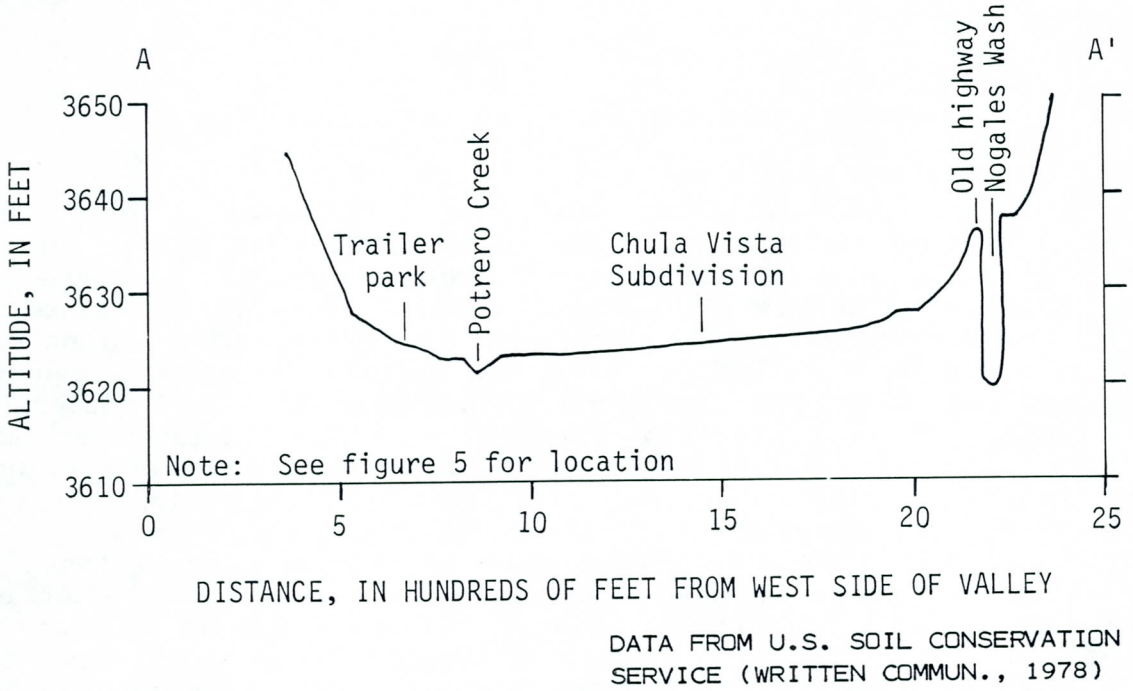


Figure 7.--Profile of ground surface through the Chula Vista subdivision near the mouth of Nogales Wash north of Nogales, Ariz.

High velocities in Potrero Creek destroyed a fence around the International Boundary and Water Commission's wastewater-treatment plant, which is located at the confluence of Potrero Creek and the Santa Cruz River. Damage was estimated at $112,000. Water flowed over dikes and into the treatment lagoons without doing any damage. A pipeline carrying sewage to the plant broke at several locations along Potrero Creek. The monetary damage to the pipeline was not assessed.

Sewer pipes under the Santa Cruz River broke at Green Valley and Tucson; telephone lines and other utilities were damaged. Damage occurred at 12 to 15 bridges, including 6 railroad bridges. In general, the damage was caused by erosion of pilings or abutments, rather than by the force of water flowing over the bridge; two bridges—one on a county road at Amado and one on a street in Tucson—were destroyed.

Throughout most of its length the San Pedro River is confined between high banks; therefore, the flood caused little damage. The river overflowed its banks in a few places near Winkelman. Most of the damage took place along the Gila River downstream from the San Pedro River. Severe flood damage occurred in the community of Riverside when the Gila River overflowed. The inundation was greater during this flood than during past floods of larger discharge because large amounts of brush had grown in the Gila River channel during the past 10 years. A fairly low discharge now causes a rather high stage. Downstream from Riverside at the Kelvin gaging station (site 8), the stage in October 1977 was 2 ft higher than those during the floods of December 1965 and December 1967, but the discharge in 1977 was less than 60 percent of the discharge during the earlier floods.

Extent of Inundation Along the Santa Cruz River

Along the Santa Cruz River, the flood inundated about 3,600 acres of farmland in Santa Cruz County and 12,000 acres in Pima County (pls. 2-4). It also inundated an unmeasured acreage of undeveloped desertland. The outlines of inundated areas on plates 2-4 are based on three sets of vertical aerial photographs, one set of hand-held oblique coverage, and field inspections of selected areas. The vertical coverage included low-altitude black-and-white photographs taken on October 10, low-altitude infrared false-color photographs taken October 13, and National Aeronautics and Space Agency (NASA) high-altitude photography in natural color and infrared false color taken on October 14. Except in local areas, such as dense stands of natural brush, pecan orchards, and some fallow fields, the photographic coverage provided a good record of areas that had been inundated. Although taken several days after the flood, the infrared photography generally showed a distinct boundary of inundation. In places, the infrared coverage of October 13 shows the inundated area more clearly than the black-and-white coverage taken on October 10. The NASA photography was especially useful in defining inundated areas beyond the limits of coverage provided by the two low-altitude flights. A small amount of field checking was done in areas where

the photography did not clearly show the limits of inundation. The outlines of inundated areas were transferred from the aerial photographs to 1:24,000-scale orthophoto maps made from high-altitude photography taken in 1962 and then were transferred to the 1:62,500 base used herein.

From the international boundary to Potrero Creek, the Santa Cruz River inundated a flood plain that generally ranges in width from about 200 to 1,000 ft (pl. 2C). In a few places the inundated width was as much as 2,000 ft. Photographic coverage upstream from SR 82 was inadequate for detailed mapping.

About half a mile downstream from SR 82, the river meanders for 1 mi around a promontory point in the SE¼ sec. 26, T. 23 S., R. 14 E. At the base of the point, the upstream and downstream loops of the meander are less than a quarter of a mile apart, but the water surface in the upstream loop was about 30 ft above the water surface in the downstream loop. Water that flowed over the point was about 3 ft deep around buildings on the ridge that leads to the point.

Downstream from Potrero Creek, the flood plain widens and the inundated area was generally 2,000 to 4,000 ft wide. From Potrero Creek to the U.S. Highway 89 bridge near Sahuarita, inundation generally was continuous across the entire flood plain, and only a few small islands were left dry. In places levees along the river and dikes around fields caused the water-surface elevations on opposite sides of the valley to differ by several feet. Water ponding upstream from dikes caused an extremely irregular water-surface profile.

Flow was confined to the bridge opening on U.S. Highway 89 south of Sahuarita (pl. 2A), but wide areas were inundated immediately upstream and downstream. Between the bridge and a point where a levee along the east side of the main Santa Cruz River channel begins a quarter of a mile north of Helmet Peak Road, about half of the flow left the channel and flowed north through fields along U.S. Highway 89 and the Southern Pacific Railroad tracks. From the south end of the levee to near Pima Mine Road, the levee isolated the overflow from the main channel, which can carry much more water than reached it. Sahuarita was flooded by the overflow that covered an area more than 1 mi wide. More water left the main channel at Pima Mine Road, 3 mi north of Sahuarita, where the capacity of the channel was reduced and a railroad bridge was blocked with debris. The overflow at Pima Mine Road flowed into Lee Moore Wash—a tributary that joins the Santa Cruz River about 8 mi north of Sahuarita. Floodwater was confined to the channel in the 15-mile reach of the Santa Cruz River from Lee Moore Wash to Tucson.

Overbank flooding began again north of Tucson and was more than 4,000 ft wide at one point between Tucson and the community of Rillito (pl. 3B). At one point near Rillito, the stream was confined to a narrow channel where the capacity was just sufficient to carry the flood. A small amount of water left the channel through irrigation canals.

About half a mile downstream from Rillito, the nature of the channel changes drastically. The valley has three distinct levels—an

8-foot-deep main channel, an active flood plain about 2,000 ft wide, and a historic terrace that is as much as 4 mi wide and lies about 15 ft above the active flood plain. The active flood plain consists of recent, easily erodible alluvial deposits. The river changes its course frequently and can meander throughout the active flood plain. From Rillito to Trico Road, the active flood plain was only partially inundated, and no water reached the terrace.

Downstream from Trico Road (pl. 3A), the historic terraces give way to a wide flood plain where water spread over a width of 1 to 4 mi seeking a course of least resistance through diked farmland near Redrock. A small amount of water spread to the north into an unnamed wash that flows around the south side of Picacho Peak. Flow in the wash ceased within 1 or 2 mi from the point of entry. Most of the floodwater flowed west through Greene Canal into the former Greene Reservoir area where water again spread over wide areas along Greene Wash—a continuation of the Santa Cruz River (pl. 4). Near Chuichu, sheetflow covered a strip of land about 3 mi wide and flowed westward into Greene Wash and northward into Santa Cruz Wash—a distributary of Greene Wash. Flooding in this area was much less extensive than in September 1962 (U.S. Army Corps of Engineers, 1963). Greene Wash is channeled for a distance of 8 mi from just upstream of Interstate Highway 8 to its confluence with Santa Rosa Wash near Stanfield; Santa Rosa Wash is channeled for 20 mi downstream from Greene Wash. No overbank flooding occurred along the channeled reaches. Santa Cruz Wash consists of alternate reaches of constructed channel where no flooding occurred and local unchanneled reaches where shallow flooding did occur. Sheetflow occurred along the lower reaches of Santa Cruz and Santa Rosa Washes, which converge about 8 mi north of the town of Maricopa (pl. 1).

Erosion

Bank erosion during the flood caused major damage to flood plains of many mountain streams in the Santa Cruz River basin. In the Pajarito Mountains, the flood plain of Agua Fria Canyon (pl. 2C) downstream from Pena Blanca Lake was badly eroded. After the flood, few remnants remained of the wide gravel flood terraces that formerly bounded each side of the stream channel. Severe erosion also occurred along the flood plains of Walker Canyon, Pena Blanca Canyon above the lake, and Ephraim and Mariposa Canyons (fig. 5), where driveways were destroyed. Flooding in Harshaw Creek—a small tributary to Sonoita Creek from the Patagonia Mountains—caused damage of $1.2 million to national forest roads (U.S. Army Corps of Engineers, 1978).

Bank erosion was also common along the Santa Cruz River. Before the flood, the east riverbank at Tumacacori was lined with large cottonwood trees that were as much as 4 ft in diameter and a dense growth of well-rooted brush. The flood of 1977 removed the trees, brush, and at least 60 ft of cultivated field and left a vertical bank. The strip of land that was removed averaged at least 100 ft wide for nearly half a mile. Local residents reported that trees were falling for several hours after the last flood crest.

Much of the bank erosion in the Tubac-Tumacacori area may have occurred because a dense stand of young cottonwood trees had grown in the streambed in the 8 years preceding the flood. That period was typified by low flood peaks and a nearly perennial supply of nutrient-rich sewage effluent. Photographs taken in 1969 show little growth in the channel. Just before the flood of 1977, trees 8 to 10 in. in diameter and 30 to 40 ft tall were spaced as close as 3 or 4 ft over about 90 percent of the 200-foot-wide streambed (fig. 8). The growth of trees started about 2 mi upstream from Josephine Canyon, extended 7 or 8 mi, and ended near Tubac. Thousands of the young trees were washed out during the flood. Debris deposits as much as 200 ft across formed at several places along the river. At Rancho Santa Cruz, a larger-than-average debris dam 10 to 15 ft high formed across the small part of the channel that had not been overgrown with cottonwoods (fig. 9). A minimum of 6 ft of sand was deposited behind the dam. As a result of the dam, floodwaters were forced to find a new route and, thereby, cut a large bypass channel through the flood plain to the east of the river. At Tubac (pl. 2C), the erosion started by the flood of October 1977 was greatly accentuated by subsequent floods. The east bank had been cut back about 300 ft by February 1979.

Similar bank erosion occurred at other places along the Santa Cruz River. At one location in Tucson, more than 200 ft of bank erosion occurred during the 2 days of highest flow in October 1977, and the channel was widened an average of 75 ft for more than 1 mi as erosion alternated from one bank to the other. At Marana (pl. 3C), sustained flows in February and March 1979 threatened homes by eroding large sections of the active flood plain in N½ sec. 33, T. 11 S., R. 11 E., that had been only partially inundated by the flood of October 1977.

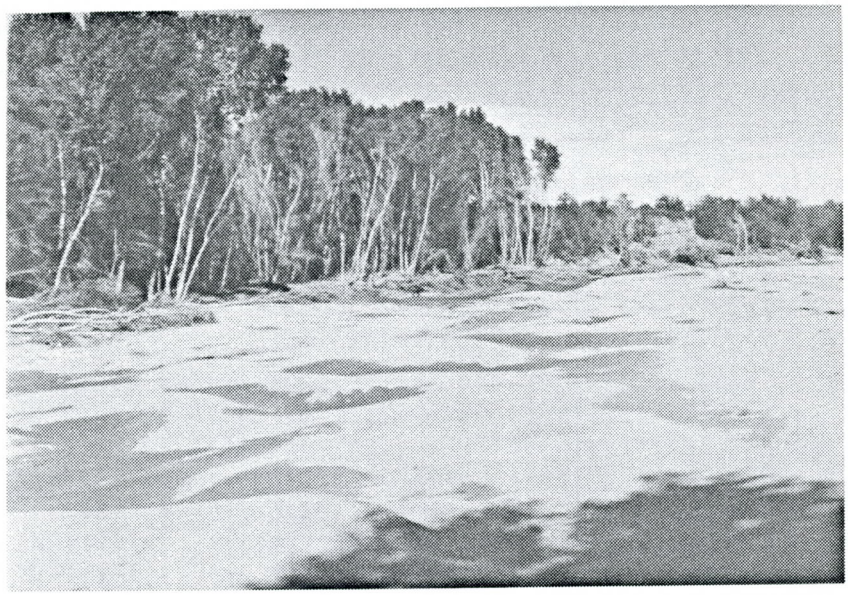


Figure 8.--Six- to eight-year-old cottonwood trees in the channel of the Santa Cruz River. Before the flood of October 1977, trees covered all but about 25 ft of the channel bottom.

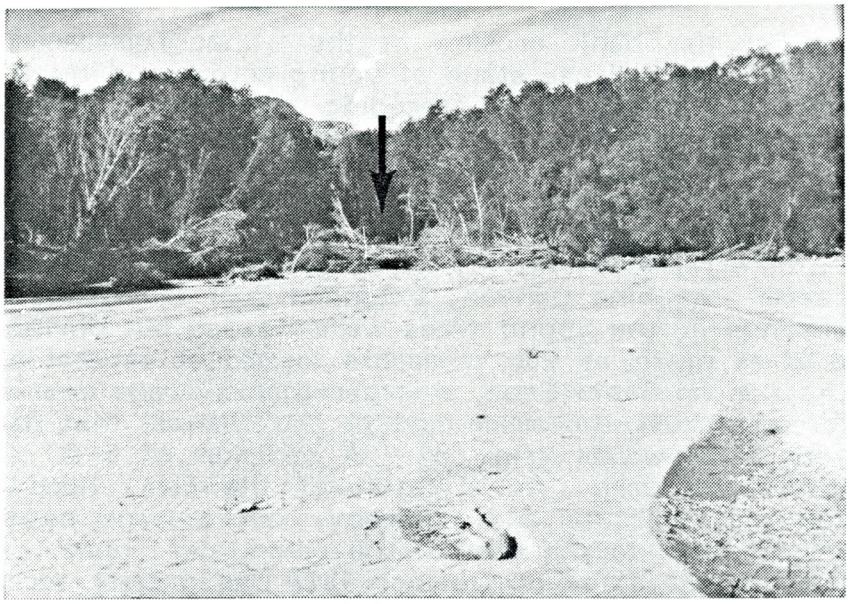


Figure 9.--Debris dam against young cottonwood trees at Rancho Santa Cruz near Tumacocori, Ariz. Beofre the flood of October 1977, the Santa Cruz River flowed through narrow opening indicated by arrow in center of photograph.

Large amounts of bottom scour also occurred. For example, a 10-inch pipeline located 25 ft below the streambed was broken at the Nogales, Ariz., water-pumping station just downstream from SR 82 (pl. 2C). When uncovered after the flood, the pipe was found to be bent downstream at a 90° angle and completely wrapped in barbed wire, power-pole guy lines, and other debris (M. F. Bonorand, plant superintendent, oral commun., 1977). The streambed after the flood was at approximately the same elevation as it was before the flood.

Comparison with Past Floods

Santa Cruz River

Flood peaks for the Santa Cruz River at Tucson have been documented since 1905. Flood records have been obtained near Lochiel since 1949, near Nogales since 1930, at Continental since 1940, and near Cortaro since 1939. At Tucson, the peak discharge during the flood of October 1977 is about 40 percent greater than the previous maximum discharge in the period of record. The Tucson record cannot be used to develop a conclusive history of flooding at the other sites because floods do not necessarily affect the entire length of the Santa Cruz River. Floods from the upper parts of the basin may not reach the lower parts, and floods in the lower part may originate in only a small part of the basin.

Each of the four highest floods at Tucson from 1905 to September 1977 originated in a different part of the basin. The flood of August 1961 (Rostvedt, 1965) originated mainly on the northwestern slopes of the Santa Rita Mountains and was recorded only at Tucson and downstream stations. The flood of September 1964 (Aldridge and Moosburner, 1970) originated largely on the southern and western slopes of the Santa Rita Mountains with some contribution from the Tumacacori and Cerro Colorado Mountains. High flows were recorded at stations downstream from Continental, but not at Lochiel and Nogales. The flood of December 1967 (Aldridge, 1972) resulted from heavy runoff from the Atascosa Mountains and the western part of the Mexican drainage. During that flood, high flows were recorded at all stations except Lochiel. The 1914 peak apparently came mainly from the Mexican drainage.

The five highest floods known by local residents near Nogales in chronological order are those of 1914, 1926, 1967, 1974, and 1977. The flood of 1967 was the highest known in most of the reach from Nogales to Continental at that time. Near Tubac, it was considered to be the highest in a long period of time (Aldridge, 1972) because it deposited mud in old Indian canals that had remained undisturbed for several hundred years. From the international boundary to Cortaro, the flood stage of 1977 exceeded the stage of 1967 by amounts that ranged from 0.5 ft to 4.5 ft (fig. 10). At Canoa Ranch headquarters—6 mi north of Amado (pl. 2B)—a resident reported that the stage of a flood in 1935 exceeded that of the flood of 1967; however, a channel constructed after the flood in 1935 makes the comparison meaningless. At the same location, the flood of 1977 was about 2 ft higher than the flood of 1935.

Channel changes along the Santa Cruz River in the late 19th century and early 20th century must be considered when comparing the flood of 1977 with those in the 19th century. Most of the arroyo-type channel that now exists was formed between 1880 and 1915. Prior to formation of the present channel, the river was a series of swamps, pools, and discontinuous arroyos that would have caused more severe attenuation of peaks than the present channel. Before 1880, the Santa Cruz River flowed along the west side of the flood plain and followed the course of what is now the West Branch Santa Cruz River through the San Xavier Indian Reservation near Tucson (fig. 11). The channel was apparently discontinuous from points B to C; the exact locations are unknown. Floodwaters collected in a pool near San Xavier del Bac Mission, and most of the overflow was used for irrigation within 5 mi of the mission (G. E. P. Smith, Professor Emeritus, University of Arizona, oral commun., 1974). The excess flowed over a wide marshy area.

Channel cutting began during the late 1880's and was greatly accelerated by high flows in August 1890, when a headcut progressed through Tucson in a 2-week period (Hastings and Turner, 1965). The headcut later breached a dam forming Silver Lake, moved upstream, and joined an older arroyo that had formed near Martinez Hill as a result of an 1887 earthquake and a subsequent water-development project (Cooke and Reeves, 1976). By 1904, a distinct channel had developed along the east side of the valley from point A on the Santa Cruz River to point D on a tributary known then as Spring Creek about 2 mi south of Martinez Hill

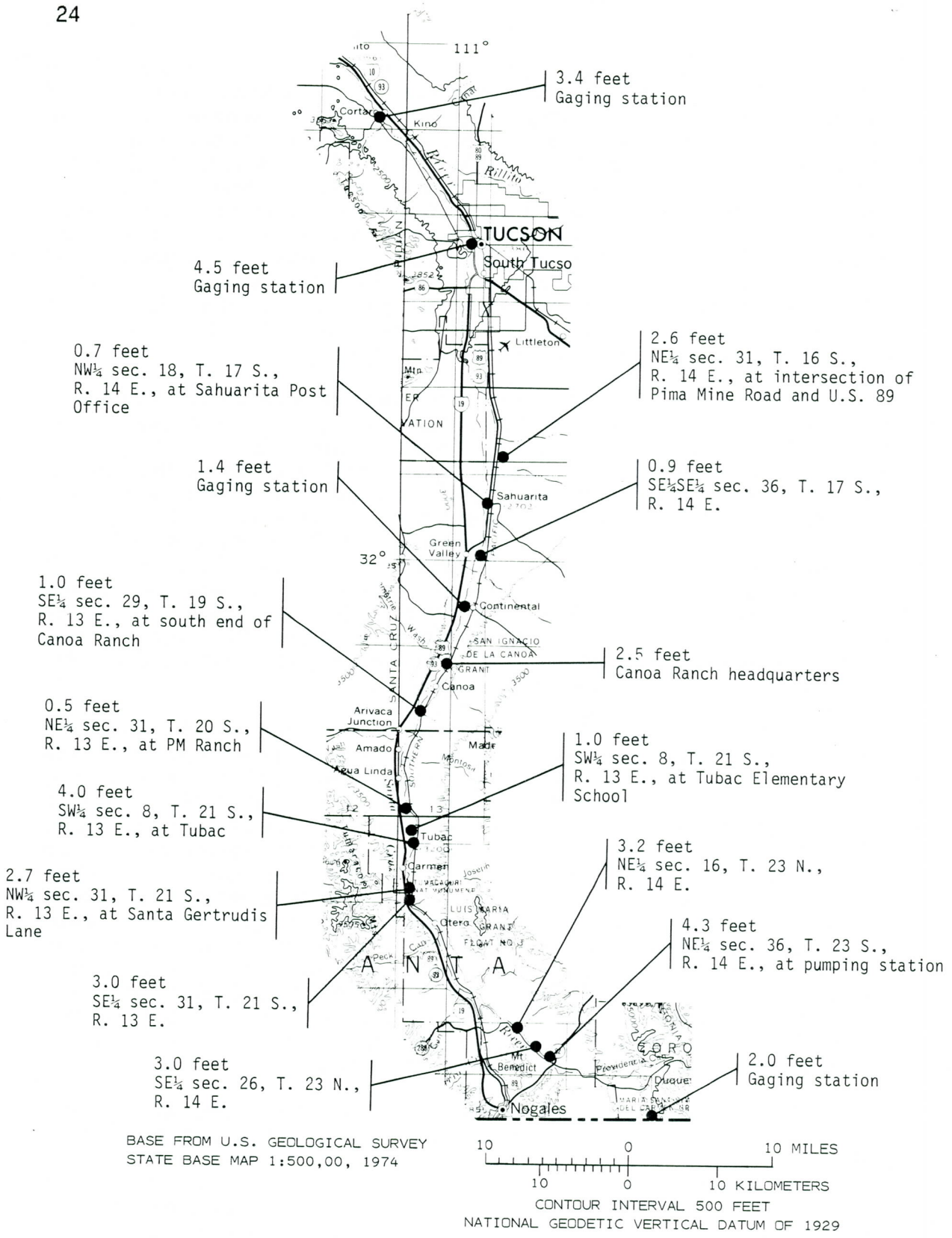


Figure 10.--Difference in stages reached by the Santa Cruz River during floods of December 1967 and October 1977. Map shows the amount in feet by which the flood of October 1977 exceeded the flood of December 1967.

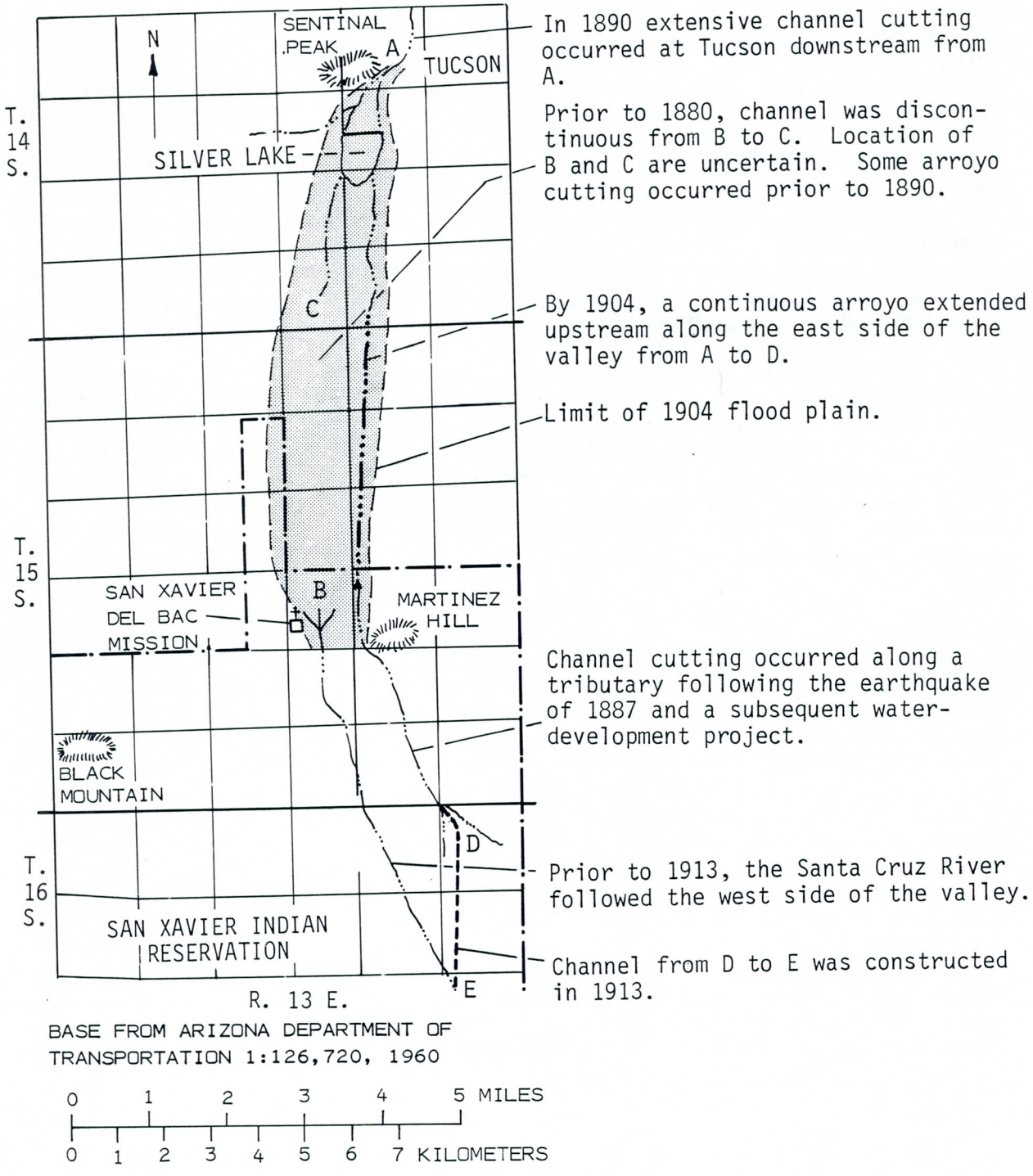


Figure 11.--Development of the Santa Cruz River channel near Tucson, Ariz. from about 1880 to 1913.

(U.S. Geological Survey, 1905). In 1913, the Santa Cruz River was moved to its present (1982) course along line A-D-E through construction of a channel from D to E (Cooke and Reeves, 1976). The channel was constructed to prevent uncontrolled arroyo cutting along the former channel through the San Xavier Indian Reservation.

Aerial photographs show that the river was not fully established at its present location upstream from point E until after 1936. Even after the channel was established, there was continual widening, straightening, and downcutting. The bed of the river is now more than 20 ft below the low swale that still remains of the pre-1913 channel. Severe downcutting has occurred at other places along the river channel. The channel bottom has dropped 10-15 ft since 1946 in the Tucson area.

The preponderance of evidence indicates that the flood of 1977 was the largest since at least 1892 in the reach from the international boundary to Tucson. One or more floods from 1887 to 1892 may have been higher (Hastings and Turner, 1965). The flood of 1977 is probably the largest since at least 1926 in the headwaters area. Sharp, short-duration flood peaks may have exceeded the 1977 flood in small areas. A slight probability also exists that the flood of 1914 may have exceeded the flood of 1977 in some parts of the basin.

The comparison of the flood of 1977 to earlier floods below Rillito Creek is less definitive than the comparison above Rillito Creek. On at least four occasions—July 1887, August 1890, December 1914, and August 1929—large floods occurred in Rillito Creek at approximately the same time as floods in the Santa Cruz River. The combination of flood peaks from the two streams plus possible inflow from Canada del Oro could have caused a greater peak discharge than occurred in 1977. The timing of peaks is not documented sufficiently to allow a reliable estimate of discharge downstream from Canada del Oro. Large floods occurred on Rillito Creek in 1906 and 1908, but nothing is known of the discharge in the Santa Cruz River below Rillito Creek during these floods. The only definite conclusion that can be made about the flood of 1977 below Rillito Creek is that it is the highest since 1929.

Downstream from Los Robles Wash—a continuation of Brawley Wash—the flood of 1977 on the Santa Cruz River was exceeded in 1962, 1964, 1965, and 1967 (Halpenny and Greene, 1968). At Greene Canal, the peak discharge in October 1977 was only 22 percent of the peak discharge in September 1962 (Lewis, 1963).

San Pedro and Gila Rivers

Along the entire San Pedro River, only the peak discharges of 1926 and 1940 are significantly higher than that of 1977; the peak discharge of 1940 was about twice that in 1977, and the peak discharge of 1926 was nearly four times that in 1977. At Palominas, the discharge of 1977 is the fifth highest since 1926 and was last exceeded in 1958; at Charleston, it was the fifth highest since 1916 and was last exceeded in

1940. Several peak discharges of approximately the same magnitude as that in 1977 occurred at the Winkelman station between 1915 and 1941. Downstream from Aravaipa Creek, the peak discharge of October 1977 was exceeded in December 1978. The peak discharge of 1977 on the Gila River dowstream from the San Pedro River has been exceeded ten times since 1930.

Probability of Occurrence

One measure of a flood's severity is the probability of the flood being exceeded by another flood. Probability is expressed as a decimal number less than 1.0 that shows the chance of a flood being exceeded in any given year. Probability can be converted to percent chance by multiplying by 100. The recurrence interval, or average number of years over a long period of time (hundreds of years) between floods of a given magnitude, is the reciprocal of the probability. The relations between probability, percent, and recurrence interval are as follows:

Probability	Percent	Recurrence interval, in years
0.1	10	10
.04	4	25
.02	2	50
.01	1	100
.005	.5	200

For example, there is a 2-percent chance that a flood having a probability of 0.02 will be equaled or exceeded in any given year. A flood of this magnitude would occur on an average of once in 50 years. The recurrence interval is an average and does not indicate the length of time between such floods. Two or more 50-year floods could occur within one year. Probabilities of floods at gaged sites are computed from either a mathematical or graphical distribution of known floods at the site during a specific time period. Records from several gages can be used to produce a regional relation for estimating flood magnitudes. The regional relation smooths out variations due to length of record and frequently produces a better estimate of flood frequencies than does a short record at a gaged site. Probabilities and recurrence intervals discussed in this report are obtained from a combination of regional relations and log-Pearson Type III analyses of station data (U.S. Water Resources Council, 1977).

Probabilities for floods on the Santa Cruz River (main stem) are difficult to determine accurately because floodflows have been considerably less than those that have occurred in neighboring basins. Frequency computations for individual stations indicate that the probability of the flood of 1977 being exceeded in any given year is less than 0.01 at Cortaro and all upstream gaging stations; however, regional relations show probabilities greater than 0.01 for all stations except the Nogales station. The flood had a probability of 0.25 at Santa Cruz River near Laveen. The regional relations are considered more representative than the individual

station computations and are used for computing the probabilities tabulated in the section entitled "Streamflow Data at Gaging Stations and Miscellaneous Measuring Sites."

Summary of October Floods

A 4-hour period of intense rainfall on the morning of October 9, 1977, over a localized area of mountains near the international boundary between Arizona and Sonora, Mexico, followed 4 days of general, widespread rainfall over Arizona and Sonora. Total rainfall during the 5-day period was 12 to 14 in. at several locations. The runoff resulting from the storm caused the Santa Cruz River at Tucson to have the highest discharge known since at least 1892 and caused the San Pedro River to have the highest discharge in 20 to 40 years depending on where the discharge was measured. The probability of a flood equal to that of October 1977 occurring on the Santa Cruz River in any given year ranges from less than 0.01 near Nogales to 0.25 at the mouth. On the San Pedro River, the probability ranges from 0.06 to 0.15. Large floods are known to have occurred on the Santa Cruz River between 1887 and 1890, but these cannot be compared to the flood of 1977. Discharges for the earlier floods are unknown, and extensive channel changes have occurred since 1887.

Variations in traveltime caused runoff from major concentration points along the Santa Cruz River to reach Rancho Santa Cruz near Tumacacori at different times resulting in three distinct crests from the one intense period of rainfall on the morning of October 9. The highest of the three crests originated mainly in Peck Canyon, Agua Fria Canyon, Sonoita Creek, and Potrero Creek and reached Rancho Santa Cruz at 0930 hours October 9. The lowest crest originated in Sonora west of Sierra de San Antonio and reached Rancho Santa Cruz in midafternoon. The third crest originated in tributaries near Lochiel, Ariz., and reached Rancho Santa Cruz late in the evening of October 9. The third crest moved downstream faster than the two earlier ones thus decreasing the elapsed time between the first and third crest from about 10 hours at Rancho Santa Cruz to 6 hours at Cortaro.

The flood in the Santa Cruz River caused severe damage in Santa Cruz and Pima Counties and moderate damage in Cochise and Pinal Counties. Damage occurred along the Gila River downstream from the San Pedro River. The Santa Cruz River inundated more than 15,000 acres of farmland and an unmeasured acreage of undeveloped desertland. The width of the inundated area ranged from 2,000 to 4,000 ft along much of the channel and reached widths of 3 to 4 mi near Redrock and Chuichu. Inundated areas were mapped from aerial photography taken during and after the flood. At least 90 homes were flooded in Santa Cruz County. Large amounts of bank erosion occurred along the Santa Cruz River, Agua Fria Canyon, Sonoita Creek, and tributaries to Sonoita Creek, especially Harshaw Creek. Bank erosion near Tubac and Tumacacori may have been intensified by a dense growth of 8- to 10-year-old cottonwood trees. Total damage was estimated to be $15.2 million, which was distributed as follows: Agricultural, $9.2 million; transportation, $3.9 million; and business, residential, and utilities, $2.1 million.

FLOODS OF MARCH 1978 IN CENTRAL ARIZONA

Intense precipitation during February 28 to March 3, 1978, over the mountains north and east of Phoenix caused the severe flooding. Damage totaled about $37 million in Maricopa County, mainly along the Salt and Gila Rivers, and about $29 million in other counties. The principal source of flooding in Maricopa County was the Verde River, where the volume of runoff greatly exceeded the reservoir storage capacity. The release from Bartlett Dam to the Verde River reached a maximum rate of 101,000 ft^3/s and combined with the release from the Salt River reservoir system and flow from unregulated tributaries to produce a peak discharge of 122,000 ft^3/s in the Salt River at Phoenix, the largest discharge since 1920.

Flooding also occurred along irrigation canals that run through the north side of the metropolitan area, and in tributaries of the Gila River—the Agua Fria River and its tributaries, Queen Creek, Hassayampa River, and Centennial Wash. Fringes of the flood area extended into adjacent counties and nine counties were declared disaster areas (fig. 1). This report deals mainly with flooding from the Verde River, Salt River, and tributaries to the Salt and Gila Rivers between Granite Reef and Painted Rock Dams, although fringe-area flooding is discussed briefly.

The high economic significance of the flood in Phoenix must be distinguished from the moderate hydrologic significance. Several larger floods occurred on the Salt River at Phoenix between 1870 and 1920.

Description of Flood Area

The large amounts of runoff that caused the flood of March 1978 originated mainly in an elongated area that extends along the central mountains of Arizona from Kingman to the foothills of the White Mountains (fig. 1). The major flooding occurred in the basins of the Salt River and other streams that enter the Gila River in Maricopa County. Flooding occurred along a few of the north-flowing tributaries to the Little Colorado River, tributaries to the Bill Williams River, and south-flowing tributaries to the Gila River upstream from San Carlos Reservoir, all of which are included in the fringe area. Damage was most severe in the eight counties along the mountains, all of which were declared disaster areas. Damage in the rural areas was overshadowed by the excessive damage in the densely populated lowland valleys of Maricopa County.

The single most prominent topographic feature in the flood area is the sharp Mogollon Rim escarpment that extends southeastward from Flagstaff to the base of the White Mountains (pl. 1). The base of the escarpment is generally at an altitude of 5,500 to 6,000 ft. The crest of the rim is generally 6,500 to 7,500 ft with some local high points rising above 8,000 ft. Steep, rocky mountain ranges extend southward from the Mogollon Rim and rise sharply from the narrow deeply incised valleys of south-flowing streams. The Mogollon Rim and its lateral ranges cause

severe orographic effects on storms moving northeastward. An extensive area lies above an altitude of 8,000 ft in the White Mountains.

The Salt River is formed by the convergence of the Black and White Rivers that head in the White Mountains. The Black River is considered the head of the Salt River, and in this report the Black and Salt Rivers are considered as one continuous river system. The Salt River flows southwestward to join its main tributary, the Verde River, about 25 mi east of Phoenix. The Verde River drains from the low mountains west of Williams and flows southeastward to the Salt River. As the Verde River flows through the Verde Valley, it is joined by several tributaries from the Mogollon Rim. These tributaries produce a major part of the runoff in the Verde River. At the confluence of the two rivers, the drainage areas of the Salt and Verde Rivers are about 6,300 and 6,600 mi^2, respectively. Downstream from the Verde River, the Salt River flows westward through the center of the highly urbanized part of Maricopa County and joins the Gila River west of Phoenix.

The Agua Fria River heads between Prescott and Camp Verde and flows southward to join the Gila River west of Phoenix 3 mi downstream from the Salt River. The Agua Fria River is joined by New River within the urbanized area. Indian Bend Wash, Cave Creek, and several small tributaries drain the area between New River and the Verde River. The Hassayampa River also heads near Prescott and flows southward through Wickenburg and northwestern Maricopa County to join the Gila River west of Buckeye.

Most of the streams in the mountains flow through well-defined canyons and short reaches of flood plain. The few flood plains are sparsely inhabited and occupied by an occasional small town or community. Significant flood plains exist along the Verde River, East Verde River, Tonto Creek, and the lower reaches of the Hassayampa River. For some distance below the Verde River, the Salt River flows in a broad braided channel about 0.5 to 1 mi wide, but through central Phoenix, the river has a rather well-defined channel. Much of that channel has been developed by manmade and natural causes during the past 15 years. Only a small part of the channel existed prior to the flood of December 1965 (Aldridge, 1970). The Agua Fria and New Rivers flow in broad channels where overflow is limited. Downstream from the Salt and Agua Fria Rivers, the channel of the Gila River is overgrown with dense phreatophytes, and extensive flooding occurs during moderate discharges. Large amounts of channel cutting occurred below the Salt River after March 1978.

Reservoirs and Canals

Four irrigation-storage reservoirs are on the Salt River and two reservoirs are on the Verde River. The principal reservoir is Theodore Roosevelt Lake—hereafter referred to as Roosevelt Lake—on the Salt River just below Tonto Creek. When Roosevelt Dam was completed in 1911, the

storage capacity was 1,284,000 acre-ft. The capacity was increased to 1,626,000 acre-ft by adding spillway gates in 1924. Subsequent sedimentation and gate modification reduced the capacity to 1,382,000 acre-ft at the time of the last sediment survey in 1947. The three downstream reservoirs on the Salt River—Apache Lake above Horse Mesa Dam, Canyon Lake above Mormon Flat Dam, and Saguaro Lake above Stewart Mountain Dam—were constructed between 1923 and 1930 and had a combined capacity of 373,000 acre-ft at the time of the last sediment survey. The two reservoirs on the Verde—Horseshoe and Bartlett—have a combined capacity of 317,700 acre-ft (capacity tables put in use October 1, 1978, show 309,600 acre-ft).

The objective of reservoir operation is to provide maximum storage at the start of the irrigation season with minimum waste of water. During most years, all inflow is stored and released at a slow rate for diversion into irrigation canals that leave the Salt River at Granite Reef Dam 3 mi downstream from the Verde River, but floods have occurred when the inflow to the reservoirs has exceeded the storage capacity.

Arizona Canal, the major diversion from Granite Reef Dam, follows the north edge of the Salt River Valley from the dam to Skunk Creek, a tributary to New River; South Canal diverts to the south side of the valley. Prior to 1979, the Arizona Canal intercepted runoff from Indian Bend Wash, Cave Creek, and other tributaries to the north of the canal. A syphon to pass Indian Bend Wash into its natural channel was completed in 1979. Through Phoenix, Arizona Canal has a capacity to carry less than 1,000 ft^3/s and is designed with flood-relief spillways in the south (downhill) embankment. When the canal was constructed near the end of the 19th century, it was several miles from the metropolitan area. Water that flowed over the spillways seeped harmlessly into the ground before reaching the metropolitan area. The cities of Scottsdale, Phoenix, and Glendale expanded beyond the canal, and housing developments, schools, and shopping centers now are located adjacent to both embankments of the canal. On the downhill side, developments cover swales that convey floodwaters away from the spillways.

Granite Reef Dam on the Salt River and Gillespie Dam on the Gila River south of Buckeye—low-head diversion dams near the upstream and downstream limits of the metropolitan area—are the principal points where streamflow into and out of the metropolitan area is measured. Most of the damage in Maricopa County occurred between the two dams. Streamflow is also measured at Jointhead Dam, which is another low-head diversion dam located in Phoenix 20 mi downstream from Granite Reef Dam. Jointhead Dam was constructed as a diversion dam but has been used only as a gaging-station control for many years.

Floodflows of Cave Creek are stored behind Cave Creek Dam and released at a slow rate through small-capacity gates. During high reservoir levels, some water can bypass the dam. Water from the dam and inflow to Cave Creek downstream from the dam are intercepted by Arizona Canal. After March 1978, another flood-control dam was constructed 2 mi downstream from Cave Creek Dam. Lake Pleasant—an irrigation-storage reservoir above Waddell Dam on the Agua Fria River partially controls floodflows of that river. During most years, all inflow is stored. Water is

released to the Agua Fria River only when the volume of water stored in the reservoir approaches the capacity of the reservoir and the inflow is greater than the amount needed for irrigation.

Flood protection is provided for the lower reaches of the Gila River by Painted Rock Reservoir west of Gila Bend. The reservoir has a capacity of 2.5 million acre-ft, which was great enough to allow complete storage of the flood peak of March 1978.

History of Flooding

The Phoenix metropolitan area has experienced numerous floods from the Salt River, Agua Fria River, Cave Creek, tributaries to the Arizona Canal, and local drainage systems. The history of flooding is fairly well documented since Phoenix was established in 1871. Some of the outstanding floods are those of January 1874, February 1891, and November 1905 on the Salt River; January 1916 and November 1919 on the Agua Fria River; August 1921 on Cave Creek; August 1943 on New River; August 1963 from local drainages in Glendale (Aldridge, 1968); and June 1972 on Indian Bend Wash and other tributaries to the Arizona Canal (U.S. Army Corps of Engineers, 1972). The floods of 1874, 1891, and 1905 inundated large sections of downtown Phoenix.

Salt River floods prior to 1900 are described briefly in the following quote from the Phoenix Gazette, March 3, 1978:

> "Flooding in Phoenix isn't new. This chronology of Phoenix floods during the past 104 years tells the story:
>
> "January 1874—Damage caused by flooding was 'considerable.' Only the most strenuous efforts saved the flour mill of Hellings & Co., at about what now is 40th Street and Roosevelt... The flood came within 200 yards of Goldwater's store and was nearly three miles wide at one point.
>
> "December 29, 1879—An unusually heavy rain caused the Salt River to rise 10 feet in two days.
>
> "December 23, 1883—A dam and canal headgates were ripped out by raging water as heavy rains caused a rise of 14 feet in the Salt River.
>
> "February 22, 1890—The Salt River rose 17 feet, washing out the Tempe bridge and miles of track between Phoenix, Maricopa, and Yuma. Adobe houses were washed away.

> "February 1891—Heavy rain began in the Phoenix area on the 16th. After three days it tapered off, but started again and continued to the 23rd. The river rose one foot higher than the 1890 flood. The Tempe railroad bridge was washed out on the 18th along with telephone and telegraph wires. At some places below the confluence with the Verde, the Salt was eight miles wide. Below Phoenix, it was two to three miles wide. People climbed up onto roofs and into trees to escape the rushing waters."

Davis (1903) and Williams and Crawford (1940, p. 157-158) show data indicating a large flood in March 1893. The discharges of the Salt and Verde Rivers published in those reports were subsequently reduced by a factor of 10 (U.S. Geological Survey, 1947, p. 400-401, 442, 445). In the first 19 years after completion of the existing reservoir system—1945-64—the only water flowing over Granite Reef Dam came from tributaries downstream from the reservoirs. A period of high runoff began in 1965. From 1965 to 1980, excess floodwater was released from the reservoir system in April 1965, December 1965 to January 1966, March 1968, March to April 1973, March 1978, December 1978 to May 1979, and January to June 1980. The peak flow of about 170,000 ft^3/s in the Salt River at Jointhead Dam at Phoenix in February 1980 is the highest since 1905.

The floods described above and other floods between 1890 and 1980 (fig. 12) affected the areas upstream from the reservoirs. Aldridge (1970, p. 26) lists major floods in the Salt River basin from 1890 to 1965 and shows that many more floods would have occurred in Phoenix without the reservoir system on the Salt and Verde Rivers. Since 1965, large floods occurred upstream from the reservoirs in December 1966 (Aldridge, 1971), September 1970 (Roeske and others, 1978), and October 1972. Reservoir releases during those floods were limited to the amounts required for irrigation, and no water was released over the spillways.

Road Construction

Many north-south roads that cross the Salt River connect Mesa, Tempe, and outlying areas on the south side of the river to the large metropolitan area on the north. Prior to 1965, most of these roads crossed the river at grade level, and traffic was rarely interrupted by floodflows. Frequent floodflows in the Salt River after 1965 caused changes in road-building policies. Bridges were built to accomodate medium flow because additional flood protection was anticipated, but this flood protection has not developed. The bridges reduced the frequency and duration of traffic delays; however, damage to the bridges constituted a large part of the total monetary damage of the flood of March 1978. New bridges are being designed for the 100-year flood.

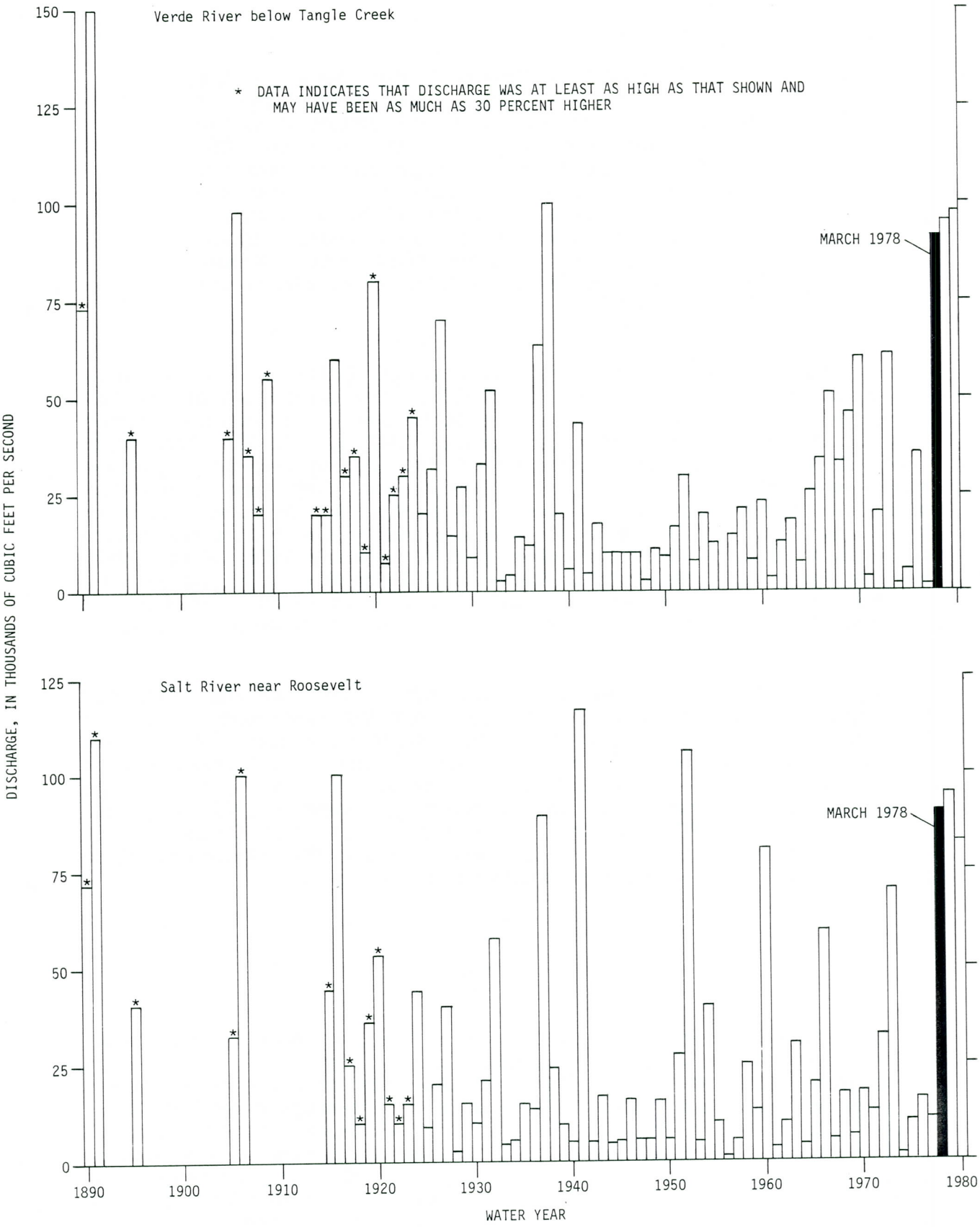


Figure 12.--Peak discharges of Salt and Verde Rivers, 1890-1980.

Antecedent Conditions

The storms in January and February 1978 were unusual because they moved in a track much farther south than the one generally followed by Pacific storms. The U.S. Environmental Data Service (1978a) described the usual track as being "north of Arizona even in mid-winter" and indicated a low probability of storms moving in the anomalous tracks followed by the storms of 1978.

The storms in January and February produced precipitation on about half the days in each month. Large amounts of precipitation and alternate periods of snowfall and snowmelt during January 15-24 and February 6-16, 1978, increased the soil-moisture content in the Salt River basin, produced above-average runoff that nearly filled the reservoirs on the Verde River, and set the stage for the floods of March 1-3, 1978. A 10-day dry spell preceded the heavy rains of February 28 through March 3. Precipitation was more than 5 in. above normal during January and February at 14 stations in central Arizona (table 2). Similar departures above normal probably occurred at other stations. The February values given in table 2 are the totals for the month and include from 1 to 3 in. of precipitation that fell February 27-28 during the early part of the flood period. The total departures for January and February at other mountain stations generally were more than 3 in.

The first snowfall of the season in Arizona was in late December 1977. U.S. Environmental Data Service (1978b) and U.S. Soil Conservation Service (1978a) records show that large amounts of snow fell in the mountains during January 15-24. Even with this snowfall, the snowpack on February 1 in the upper Salt River basin, which supplies runoff to Roosevelt Lake, was only 76 percent of average. The snowpack on the Verde River basin was 130 percent of average.

Additional snow fell during February 6-16 (U.S. Environmental Data Service, 1978c; U.S. Soil Conservation Service, 1978b). The altitude above which snow remained on the ground after this period of precipitation was about 5,000 ft. Schumann and others (1980) shows that 83 percent of the upper Salt River basin and 65 percent of the Verde River basin above Tangle Creek had snow cover on the afternoon of February 16. A 10-day period of melt that followed caused the snow level to rise to about 7,000 ft before the new storm moved into Arizona on February 27. By February 25, snow covered only 28 percent of the upper Salt River basin and 19 percent of the Verde River basin. Fairly extensive amounts of snow existed at high altitudes. On February 27, Hawley Lake (precipitation station 8, altitude 8,180 ft) reported 31 in. of snow on the ground, and Sunrise Mountain (precipitation station 54, altitude 9,370 ft) reported 21 in.

Snow depths and water content measured at U.S. Soil Conservation Service (1978b) snow courses on February 27-28 show above-average water content above 7,000 ft but little or no snow below that altitude. Water content ranged from zero at 7,000 ft to 17.4 in. at Snow Bowl 2 (snow course 34, altitude 11,000 ft). Data for courses in and near the Salt River basin are given in table 3. Daily water contents at Mormon

Table 2.--Precipitation and departures above normal at 14 precipitation stations in central Arizona having total departure of more than 5 inches, January and February 1978

[Data from U.S. Environmental Data Service, 1978g]

Site (See pl. 1)	Station name	January		February		Total	
		Precipitation (inches)	Departure (inches)	Precipitation (inches)	Departure (inches)	Precipitation (inches)	Departure (inches)
4	Bartlett Dam.....	3.91	2.52	5.20	4.23	9.11	6.77
12	Childs	4.20	2.41	4.08	2.84	8.28	5.25
66	Cordes	3.74	2.53	3.71	2.70	7.45	5.23
16	Crown King	9.71	6.73	7.13	4.88	16.84	11.61
18	Flagstaff WSO AP..	4.09	2.20	4.67	3.20	8.76	5.40
20	Gisela	3.57	1.87	5.68	4.50	9.25	6.37
29	Junipine.....	7.95	5.16	8.24	5.97	16.19	11.13
67	Kelvin.....	5.48	4.00	4.08	3.00	9.56	7.00
32	McNary	4.04	1.74	6.26	4.58	10.30	6.32
43	Roosevelt 1WNW ...	4.58	2.80	4.25	3.14	8.83	5.94
47	Sierra Ancha.....	6.21	3.56	7.45	5.39	13.66	8.95
50	Stewart Mountain..	3.67	2.34	4.44	3.56	8.11	5.90
55	Superior.....	6.41	4.26	5.37	3.97	11.78	8.23
63	Walnut Grove.....	4.97	3.42	3.89	2.52	8.86	5.94

Table 3.--Snow depth and water content at snow courses in the central mountains of Arizona, February 27 to March 1, 1978

[Data from U.S. Soil Conservation Service, 1978b]

Snow course (See pl. 1)	Snow-course name	Altitude (feet above NGVD of 1929)	Date of survey	Snow depth (inches)	Water content (inches)
	Upper Salt River basin[1]				
1	Baldy	9,125	3- 1-78	24	6.7
2	Beaver Head	8,000	2-28-78	12	3.7
3	Canyon Creek 2	7,500	2-28-78	20	6.8
4	Canyon Point[2].....	7,600	2-28-78	22	8.3
5	Cheese Springs	8,600	2-27-78	17	4.3
6	Coronado Trail[2]....	8,000	2-28-78	16	6.0
7	Forest Dale	6,430	2-28-78	0	0
8	Ft. Apache	9,160	3- 1-78	26	6.6
9	Hannagan Meadows[2]..	9,090	2-28-78	35	9.8
10	Hawley Lake	8,300	2-28-78	29	9.8
11	Heber	7,600	2-28-78	22	8.4
12	Maverick Fork[2].....	9,050	2-28-78	30	[3]9.5
13	McNary	7,200	2-28-78	5	1.7
14	Milk Ranch	7,000	2-28-78	Trace	0
15	Nutrioso	8,500	2-28-78	6	1.6
16	Sunrise Summit	10,600	2-27-78	33	9.4
17	Wilson Lake[2]	9,000	2-27-78	30	8.3
18	Workman Creek	6,900	3- 1-78	14	5.0
	Verde River basin				
19	Baker Butte[2]	7,300	2-28-78	20	8.1
20	Baker Butte 2	7,700	2-28-78	46	17.1
21	Camp Wood	5,700	2-28-78	0	0
22	Chalender	7,100	3- 1-78	13	4.0
23	Copper Basin Divide[2].....	6,720	2-28-78	2	.8
24	Fort Valley[2]	7,350	2-28-78	15	5.2
25	Gaddes Canyon	7,600	2-27-78	27	7.1
26	Happy Jack	7,630	2-28-78	17	6.1
27	Iron Springs	6,200	2-28-78	0	0
28	Lake Mary	6,970	2-28-78	7	2.1
29	Mingus Mountain[2] ..	7,100	2-27-78	2	.6
30	Mormon Lake	7,350	2-28-78	17	6.0
31	Mormon Mountain[2] ..	7,500	2-28-78	26	10.0
32	Newman Park	6,750	2-28-78	7	2.8
33	Snow Bowl 1	10,260	2-27-78	38	11.8
34	Snow Bowl 2	11,000	2-27-78	57	17.4
35	White Horse Lake Junction[2].....	7,150	2-28-78	21	6.4
36	White Spar.....	6,000	2-28-78	0	0
37	Williams Ski Run...	7,720	2-28-78	43	13.0

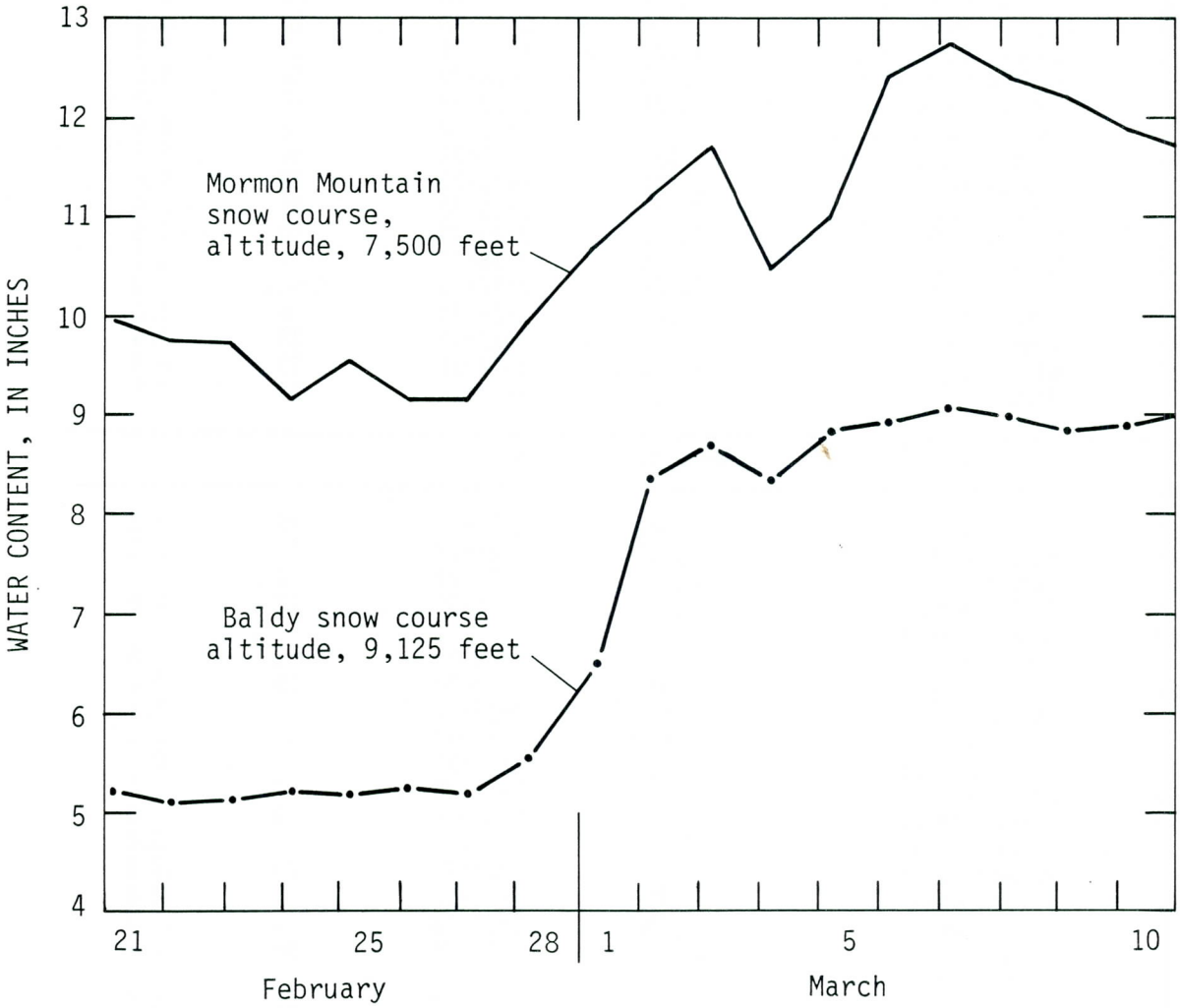
[1]Includes courses in adjacent basins, which are indicative of conditions in the named basin.

[2]Precipitation data for the period, February 27 to March 4, are given in table 4.

[3]Estimated.

Mountain (snow course 31, altitude 7,500 ft) and Baldy (snow course 1, altitude 9,125 ft) snow courses are shown in figure 13. The water content on March 1 was 6.5 in. at Baldy and 10.7 in. at Mormon Mountain. The average water content on March 1 for 1958-72 is 6.8 in. at Baldy and 4.3 in. at Mormon Mountain. Maximum values measured on March 1 at these courses are 12.5 in. and 13.6 in., respectively.

At altitudes of 5,000 to 7,000 ft, daytime temperatures were generally from 40° to 60°F, and nighttime temperatures were from 20° to 35°F. Daytime temperatures caused a gradual snowmelt and a high soil-moisture content but were not high enough to cause extremely high runoff. Nighttime temperatures were just low enough to slow the melt without



Interrogation time, 0630 hours.
Data from U.S. Soil Conservation Service, written commun., 1979.

Figure 13.--Water content of snow at Mormon Mountain and Baldy snow courses in central Arizona, February 21 to March 10, 1978.

causing severe freezing of either the snowpack or soil. More severe conditions existed above 7,000 ft. At several of the high-altitude stations, below-freezing daytime temperatures and near-zero nighttime temperatures occurred on a few days in mid-February.

The large amounts of precipitation and prolonged snowmelt caused above-average soil-moisture content throughout the upper Salt and Verde River basins. The U.S. Soil Conservation Service (1978a, b) measures the field capacity and the soil-moisture content at four sites in the upper Salt River basin and two sites in the Verde River basin. Field capacity is the amount of water a specified depth of soil will retain after gravity drainage. At the six sites, field capacities ranged from 34 to 38 percent of the sampled soil depth. Soil-moisture content is the actual amount of water stored in the soil. At the end of January, the soil-moisture content averaged 78 percent of the field capacity. The soil-moisture content below 7,500 ft was increased by 3 to 7 in. during February. Measurements made on February 27 or 28 show soil-moisture content to be 0.8 to 2.2 in. (6 to 10 percent) above field capacity.

During January, runoff had been below the 1941-70 median at Salt River near Roosevelt but was above the median at Verde River below Tangle Creek. The cumulative runoff for October 1977 through January 1978 at the two gaging stations was 78 and 116 percent, respectively, of the median. By the end of February, the cumulative runoff had increased to 141 and 177 percent, respectively. At 0800 hours February 28, the amount of water stored in the Salt River reservoir system was 37 percent of the reservoir capacity; the amount stored in the Verde River reservoir system was 59 percent of the capacity. The remaining unfilled capacity of the Verde River system was about 129,000 acre-ft. Nearly all the 1,110,000 acre-ft of available storage on the Salt River system was in Roosevelt Lake, which was only 21 percent full. The three downstream reservoirs on the Salt River were 96 percent full.

Storms of February 27-March 5

Showers began Monday, February 27, as a weak low-pressure trough moved across Arizona from the Pacific Ocean again following a track south of the normal track for winter storms (U.S. Environmental Data Service, 1978a). The trough was followed by saturated air moving through through the high-pressure ridge behind the trough. The unusual phenomenon of the moist trailing air and advective currents caused widespread rainfall outside the low-pressure system. Below 7,000 ft, the precipitation fell almost entirely as rain; above 7,000 ft, it fell as a combination of rain and snow, and snow depths increased by 1 to 4 in. on February 27-28.

A strong Pacific storm approached the southern California coast on Tuesday, February 28, and reached Arizona on Wednesday, March 1. Warm, moist, tropical air flowing to the northeast ahead of the main storm collided with cold air over Arizona. The resulting large areas of deep convective action were amplified by the orographic effect of the central mountains of Arizona. Nearly continuous moderate to heavy rainfall

occurred from Monday evening, February 27, until early Friday, March 3 (fig. 14). Many climatological stations reported daily precipitation amounts in excess of 3 in. (table 4).

Precipitation from February 27 through March 3 totaled 3 to 6 in. over most of the flood area (pl. 5) but was 9 to 14 in. in places, mainly near mountain crests. Stations that received more than 6 in. are mainly in a narrow band across the center of the flood area. This band received very intense rainfall on March 2. The rainfall on March 2 was especially intense at Rock Springs where 2.3 in. fell in 2 hours and 5.7 in. fell in a 24-hour period from 1600 hours March 1, to 1600 hours March 2. An extrapolation of intensity-probability data from Miller and others (1973) shows that the 24-hour rainfall at Rock Springs has a return period of about 400 years. In contrast the maximum 1-day rainfall at Payson of 2.36 in. has a return period of 2 years.

Plate 5 is based on daily rainfall data collected by the U.S. Environmental Data Service (1978d, 1978e, 1978f), the U.S. Forest Service (written commun., 1979), and the U.S. Geological Survey and on approximate storm totals from U.S. Soil Conservation Service storage gages. Most of the storage gages were read on February 14, February 28, and March 14. The two early readings were made during periods of general precipitation, and the third reading was made after the rainfall periods of March 5-6 and March 10-13. Precipitation amounts for February 27 through March 3 at the storage gages were obtained by prorating the measured precipitation on the basis of nearby daily stations. The prorated results are considered to have an accuracy of ±1 in.

The shape of the isohyets (lines of equal precipitation) on plate 5 are based, in part, on altitude and a knowledge of high runoff from areas that lack precipitation data. Rainfall data are lacking for a large part of the Fort Apache and San Carlos Indian Reservations east of Cherry Creek. Rainfall of more than 5 in. may have occurred over larger areas than are indicated by the isohyets. Plate 5 does not include precipitation that fell during the March 5-6 storm and, therefore, differs from the isohyetal map presented by the U.S. Army Corps of Engineers (1979). Rainfall on March 5-6 generally was less than 1 in., but a few stations reported 2 to 3 in.

Snowmelt associated with the warm rain pushed the snow level up to about 8,000 ft. By March 7, snow covered 10 percent of the Verde River basin and 15 percent of the upper Salt River basin. However, the snowpack increased in the White Mountains because most of the precipitation fell as snow at altitudes above 8,000 ft.

Runoff

Timing

Runoff from the storm began as a series of crests and troughs that started early February 28 and continued through March 3 (pl. 6A, B,

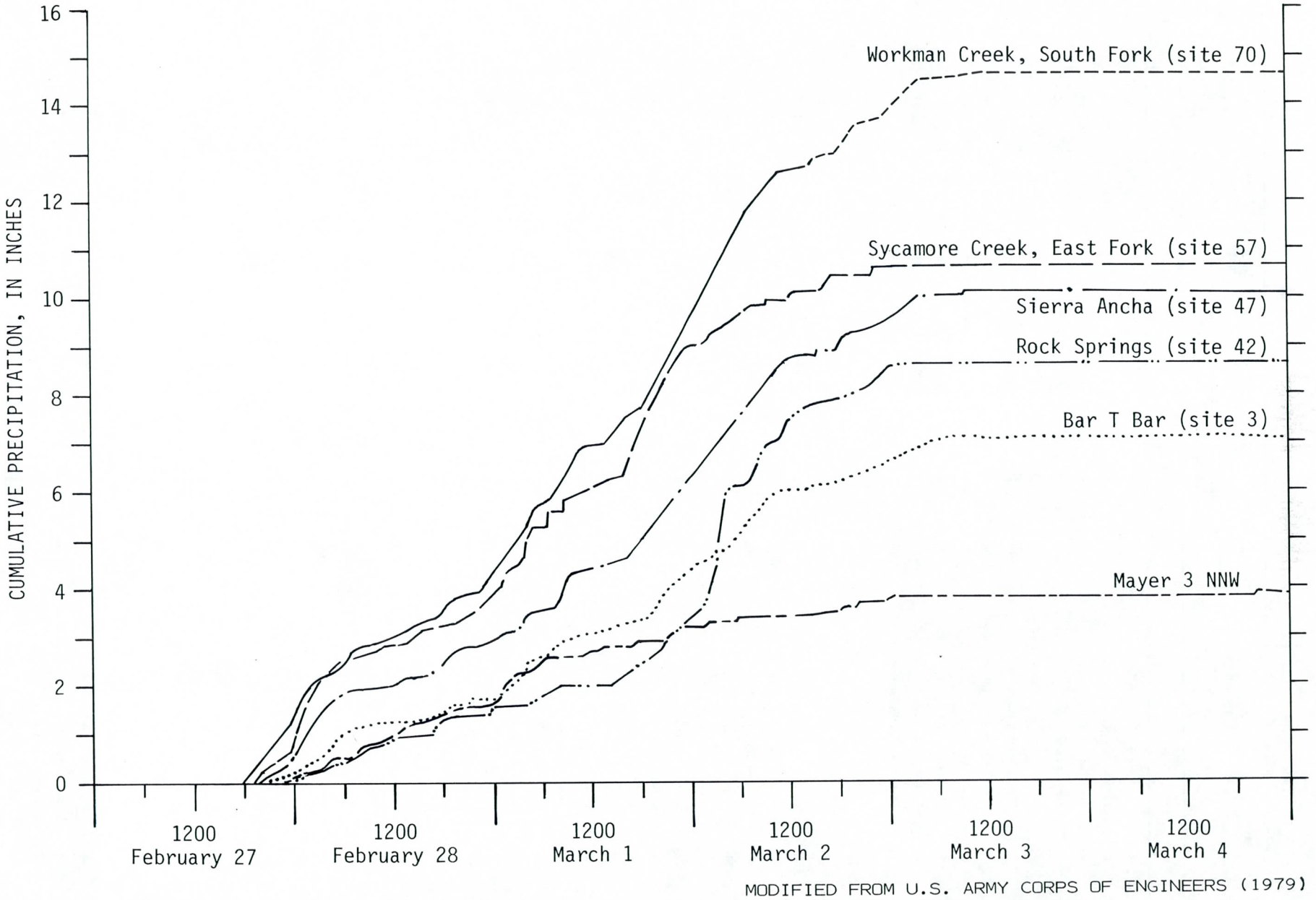


Figure 14.--Cumulative precipitation at six climatological stations in central Arizona, February 27 to March 4, 1978.

Table 4.--Precipitation sites in central Arizona reporting at least 3 inches, February 27 to March 4, 1978

Precipitation site or snow-course number (See pl. 1)	Station name	Time of reading	Precipitation, in inches, on indicated day						Total precipitation (inches)
			February		March				
			27	28	1	2	3	4	
	Precipitation stations								
1	Ash Fork 5 N	0800	----	0.78	1.52	0.41	0.35	0.03	3.09
2	Bagdad	1800	0.57	1.90	3.08	.72	.18	.06	6.51
3	Bar-T-Bar	2400	.20	1.40	2.70	2.20	.50	----	7.00
4	Bartlett Dam	0800	----	1.65	4.12	.25	----	.03	6.05
5	Beardsley	1800	.03	.77	.28	1.87	.06	----	3.01
6	Black Canyon 4 NE	2400	.11	1.15	1.50	3.32	.37	----	6.45
7	Blue Ridge Ranger Station	0800	----	.23	1.60	.82	.90	----	3.55
8	Bumble Bee	1800	.10	.62	.90	2.43	.78	----	4.83
9	Carefree	1700	Trace	1.45	1.73	2.42	1.18	.39	7.17
10	Castle Creek	----	.06	.38	1.80	.62	.30	.01	3.17
11	Castle Hot Springs Hotel	1700	.37	2.68	1.26	2.20	2.26	----	8.77
12	Childs	0800	----	.35	2.20	.76	.70	----	4.01
13	Cibecue	1600	----	1.20	1.80	1.40	.38	.02	4.80
14	Clay Springs	1800	.03	1.14	1.11	.62	.35	.14	3.39
15	Congress	1800	.13	.45	1.53	.43	1.10	.07	3.71
16	Crown King	1300	.23	1.50	4.87	3.38	2.03	----	12.01
17	Deer Valley	2400	.80	.72	2.23	.28	----	----	4.03
18	Flagstaff WSO AP	2400	.28	1.11	1.41	.95	.17	.52	4.44
19	Florence Junction	2400	.20	.90	1.40	.40	.10	----	3.00
20	Gisela	1800	.02	1.60	1.77	2.50	.38	----	6.27
21	Griggs 3 W	0800	Trace	1.20	2.67	.14	----	----	4.01
22	Happy Jack Ranger Station	0800	----	1.30	1.41	1.16	1.17	----	5.04
23	Hawley Lake	0800	.02	1.49	2.32	5.81	1.41	.14	11.19
24	Heber Ranger Station	1600	Trace	.76	1.37	.99	.57	----	3.69
25	Hillside 4 NNE	1800	.15	.74	1.16	.52	.42	.04	3.03
26	Horse Mesa Dam	0800	----	.80	.70	2.16	.47	----	4.13
27	Horseshoe Dam	0700	----	2.18	2.92	.82	----	.11	6.03
28	Irving	1000	----	.48	1.73	1.11	1.04	----	4.36
29	Junipine[1]	1700	.56	2.51	2.74	2.15	1.20	----	9.16
30	Litchfield Park	1700	----	1.37	.35	1.81	----	----	3.53
31	Mayer 3 NNW	2400	.30	1.10	1.80	.50	.10	.10	3.90
32	McNary	0800	----	1.19	1.85	2.05	.80	.04	5.93
33	Miami	0800	----	.64	.96	1.75	.62	----	3.97
34	Mormon Flat Dam	0800	----	.58	.64	1.78	.54	.02	3.56
35	New River	2400	.23	1.62	1.80	.77	----	----	4.42
36	Payson	1700	.05	1.16	1.87	2.36	.88	Trace	6.32
37	Phoenix 11 NNW	2400	.85	.70	2.18	.11	----	----	3.84
38	Pinetop Fish Hatchery	1700	Trace	1.16	1.49	1.25	.64	----	4.54
39	Pleasant Valley Ranger Station	1700	.05	1.17	2.10	1.98	.63	.40	6.33
40	Prescott	0800	----	0.41	1.01	1.09	.50	Trace	3.01
41	Punkin Center	0800	----	1.71	1.34	2.95	.62	.20	6.82
42	Rock Springs	2400	.15	1.31	1.94	5.26	----	----	8.66
43	Roosevelt 1 WNW	0800	----	.99	1.10	4.14	.66	----	6.89
44	Sedona Ranger Station	2400	.50	1.20	1.20	.90	.10	.10	4.00
45	Seligman 13 SSW	0700	----	1.17	1.33	.30	.25	.06	3.11
46	Show Low City	0800	.69	1.23	1.06	.67	.35	----	4.00
47	Sierra Ancha	2400	.40	2.50	3.40	3.20	.60	----	10.10
48	Skull Valley	1700	.51	1.01	1.06	.95	.36	.02	3.91

See footnotes at end of table

Table 4.--Precipitation sites in central Arizona reporting at least 3 inches, February 27 to March 4, 1978--Continued

Precipitation site or snow-course number (See pl. 1)	Station name	Time of reading	Precipitation, in inches, on indicated day						Total precipitation (inches)
			February		March				
			27	28	1	2	3	4	
	Precipitation stations--Continued								
49	Skunk Creek	2400	0.65	0.91	1.59	0.85	----	----	4.00
50	Stewart Mountain Dam	1700	----	.35	.95	2.00	0.32	----	3.62
51	Summit	----	.38	1.54	2.12	1.38	.05	----	5.47
52	Sunflower	2400	1.17	2.53	5.18	1.67	.08	0.03	10.66
53	Sunflower 3 NNW	1800	1.60	1.71	3.66	3.36	1.05	----	11.38
54	Sunrise Mountain	0800	.02	.87	1.35	[2]	5.05	----	7.29
55	Superior	2400	.30	.90	1.60	.90	----	Trace	3.70
56	Superior 2 ENE	0800	.70	.75	1.89	1.16	----	Trace	4.50
57	Sycamore Creek, East Fork	2400	.65	3.00	5.25	1.70	.05	----	10.65
58	Thomas Creek	----	.10	.71	1.49	.92	.34	----	3.56
59	Three Bar C-2	----	.57	3.25	5.73	2.78	.84	----	13.17
60	Thunderbird Airport	2400	.88	.82	2.35	.05	----	----	4.10
61	Tolleson 1 E	1600	.40	1.02	1.50	.20	----	----	3.12
62	Tonto Creek Fish Hatchery	0700	----	1.95	2.05	3.31	1.75	----	9.06
63	Walnut Creek	1800	Trace	1.59	1.93	.29	.35	.05	4.21
64	Whiteriver	2400	.20	1.30	1.80	.90	.30	----	4.50
65	Whitespar A-3	----	.92	1.32	2.44	1.64	----	.08	6.40
66	Wickenburg	0700	----	.38	1.69	1.90	.54	----	4.51
67	Wickenburg	2400	.15	.85	1.75	.91	----	.02	3.68
68	Wikieup	0800	----	1.63	1.91	.43	.13	.06	4.16
69	Willow Creek	----	.20	.87	1.51	1.05	.59	.03	4.25
70	Workman Creek, South Fork	2400	1.20	2.90	5.20	4.70	.85	----	14.85
71	Youngtown	2400	.70	.79	2.29	.10	----	----	3.88
72	Camp Wood	----	----	----	----	----	----	----	5.7
73	Cherry	----	----	----	----	----	----	----	[3]3.4
74	Fish Creek	----	----	----	----	----	----	----	[3]5.5
75	Humboldt Mountain	----	----	----	----	----	----	----	[3]9.8
76	Iron Mountain	----	----	----	----	----	----	----	[3]5.4
	Snow Courses								
19	Baker Butte	----	----	----	----	----	----	----	[4]7.8
4	Canyon Point	----	----	----	----	----	----	----	[4]10.6
23	Copper Basin Divide	----	----	----	----	----	----	----	[4]5.6
6	Coronado Trail	----	----	----	----	----	----	----	[4]3.5
24	Fort Valley	----	----	----	----	----	----	----	[4]3.4
9	Hannagan Meadow	----	----	----	----	----	----	----	[4]4.7
12	Maverick Fork	----	----	----	----	----	----	----	[5]4.4
29	Mingus Mountain	----	----	----	----	----	----	----	[4]4.9
31	Mormon Mountain	----	----	----	----	----	----	----	[5]5.1
38	Sheep Crossing	----	----	----	----	----	----	----	[4]3.6
35	White Horse Lake Junction	----	----	----	----	----	----	----	[4]6.2
17	Wilson Lake	----	----	----	----	----	----	----	[4]4.5

[1]Record represents a localized high that has not been contoured on plate 6A.

[2]No reading taken on this day; amount is included in the figure on the following day.

[3]Obtained by prorating data through March 7 furnished by the U.S. Forest Service.

[4]Obtained by prorating storage-gage data furnished by the U.S. Soil Conservation Service for February 14 to March 14.

[5]Obtained from data transmitted through satellite and is the difference between readings of February 27 and March 4.

and C). On March 5, an additional rise occurred in some streams, and at higher altitudes, the storm runoff was followed by a period of continued snowmelt. See hydrograph for Black River near Maverick (site 37) on plate 6A. Neither the shape of the hydrograph nor the time of maximum crest was consistent among the various stations. The orographic effect of the many mountain groups caused localized rainfall patterns. Differences in altitudes and exposures caused variations in snowmelt, and the direction of storm movement relative to direction of flow in streams caused variations in timing. If the storm moved up a basin, flows from upstream areas lagged those from downstream areas; the result was multiple well-spaced peaks. If the storm moved down a basin, runoff in downstream areas occurred more or less concurrently with the arrival of runoff from upstream areas; the result was closely spaced peaks. Where the flow traveled far enough, several peaks combined to form one high peak.

The timing of crests on tributaries significantly affected the shape of the flood wave and magnitude of the crests on the Salt and Verde Rivers (pl. 6D and E). The hydrographs for the two major streams do not show a typical progression of a flood wave moving downstream. Instead, crests occurred more or less concurrently at all sites with tributary inflow causing the discharge at each station to be higher than the discharge at the preceding upstream station. At several places, the tributary inflow was great enough to cause the crest at the downstream station to precede the crest at the upstream station. A similar pattern has been observed for several earlier floods at these stations.

The crest of the Salt River near Roosevelt (site 49, pl. 6D) during the flood of March 1978 resulted from large tributary inflow added to the rising discharge of the Salt River and occurred several hours before the crest on Salt River near Chrysotile (site 44, pl. 6D), the next upstream station. The crest that passed Chrysotile only caused a flattening of the recession at the station near Roosevelt. No crest at Salt River near Roosevelt can be specifically identified with a corresponding crest at Black River near Fort Apache (site 40). Tonto Creek crested within a few hours of the crest on the Salt River (pl. 6F). The combination of nearly simultaneous crests over a large area caused a single high crest into Roosevelt Lake.

The effects of tributary inflow to the Verde River are illustrated on plate 6E. The rapid rise of Verde River below Tangle Creek (site 72) was concurrent with the rise below East Verde River (site 70) and preceded, by several hours, the rise below Camp Verde (site 67). At the time when the most rapid rise, crest A, began below Camp Verde, the Verde River below Tangle Creek was already cresting at 80,000 ft^3/s because of large tributary inflow between the two stations. Crest A can be traced distinctly from below Camp Verde to below Tangle Creek. Crest B occurred a few hours later and originated downstream from East Verde River. Crest C came from the area between Camp Verde and East Verde River and probably resulted from the same surge of rainfall as crest B, but crest C lagged crest B because of the greater distance traveled.

Two crests (D and E) can be identified at the three most upstream stations but not at the two downstream stations. Rises that may

have occurred due to these crests are obscured by tributary inflow from later rainfall. Crest D probably reached the two downstream stations concurrently with crest C. The flattening on the rising limb of the March 3 crest may be a result of crest E, but this cannot be proven conclusively. Crests D and E are from the same period of rainfall, but crest E was delayed about 15 hours near Paulden (site 60) because of storage in Sullivan Lake, the circuitous route followed by tributaries to Big Chino Wash, and a slow traveltime along this wash, which has a much flatter bed slope than most streams in the Verde River basin. Only crest F, a small rise late in the flood period, can be identified at each station from near Paulden to below Tangle Creek.

The few crests that can be traced from one station to another provide some information on traveltime. From the gaging station near Paulden to the one below Tangle Creek, the average traveltime is about 17 hours. From below Camp Verde to below Tangle Creek, the traveltime is about 5 hours, and from below East Verde River to below Tangle Creek, the travel time is about 2.5 hours. The complex pattern of runoff in the Verde River basin limited the advance warning to reservoir operators of the magnitude of flows entering the Verde River reservoir system to that provided by the gaging station below Tangle Creek, just 4 mi upstream from Horseshoe Reservoir.

Areas of High Runoff in Salt River Basin

Small amounts of water came from the high-altitude parts of the upper Salt River basin and from the Verde River basin above Sullivan Lake, and small amounts of runoff occurred at gaging stations above altitudes of 7,000 ft. See section entitled "Streamflow Data at Gaging Stations and Miscellaneous Measuring Sites." The volume of flow and magnitude of peaks in the upper Salt River and Verde River increased rapidly as streams from the central and lower parts of these basins, especially those draining the Mogollon Rim, entered the main rivers (table 5). A graphic portrayal of increasing runoff is shown in figure 15. For visual aid, the points representing gaging stations have been connected although large increases in drainage area and runoff occurred suddenly at the major tributaries rather than gradually as indicated by the continuous line. In general, the unit discharge associated with the peak (peak rate of discharge per unit of drainage area) increased with increasing drainage area. This is in contrast to the general theory that unit discharge decreases as a flood wave moves downstream. During the flood, the unit discharge decreased in the reach from Black River near Fort Apache (site 40) to Salt River near Chrysotile (site 44) because of low runoff from several hundred square miles of high-altitude drainage in the White River basin. (See "Station Data" for station 09494000.)

Records of change in contents of the Salt River reservoir system indicate that extremely large amounts of runoff came from the 1,250 mi^2 of ungaged area that drains directly into the reservoirs downstream from the inflow stations on Salt River and Tonto Creek. The peak inflow rate from the ungaged area was estimated as 40,000 ft^3/s into Roosevelt

Table 5.--Peak discharges of Black, Salt, Verde, and Agua Fria Rivers during flood of March 1978

Station number	Station name	Drainage area (square miles)	Peak discharge	
			Cubic feet per second	Cubic feet per second per square mile
	Black and Salt Rivers above Verde River			
09489100	Black River near Maverick (head of Salt River).....	315	2,390	7.6
09489500	Black River below pumping plant, near Point of Pines...	560	5,980	10.7
09490500	Black River near Fort Apache....	1,232	33,200	26.9
09497500	Salt River near Chrysotile.....	2,849	46,700	16.4
09498500	Salt River near Roosevelt.....	4,306	89,400	20.8
09500500	Salt River at Roosevelt.....	5,830	[1]155,000	26.6
--------	Salt River above Verde River....	6,300	[1]163,000	25.9
	Verde River			
09503700	Verde River near Paulden.....	2,530	8,080	3.2
09504000	Verde River near Clarkdale.....	3,520	25,000	7.1
09505550	Verde River below Camp Verde....	4,670	41,000	8.8
09508000	Verde River below East Verde River, near Pine.....	5,623	67,600	12.0
09508500	Verde River below Tangle Creek, above Horseshoe Dam.....	5,872	91,400	15.6
09510000	Verde River below Bartlett Dam.....	6,185	[1]102,000	16.5
--------	Verde River at mouth.....	6,600	[1]110,000	16.7
	Agua Fria River			
09512500	Agua Fria River near Mayer.....	588	9,900	16.8
09512800	Agua Fria River near Rock Springs.....	1,130	39,500	35.0
09513000	Agua Fria River at Waddell Dam (inflow to Lake Pleasant)....	1,459	47,700	32.7

[1]Estimated unregulated flow that would have occurred without reservoirs as computed by flood routing.

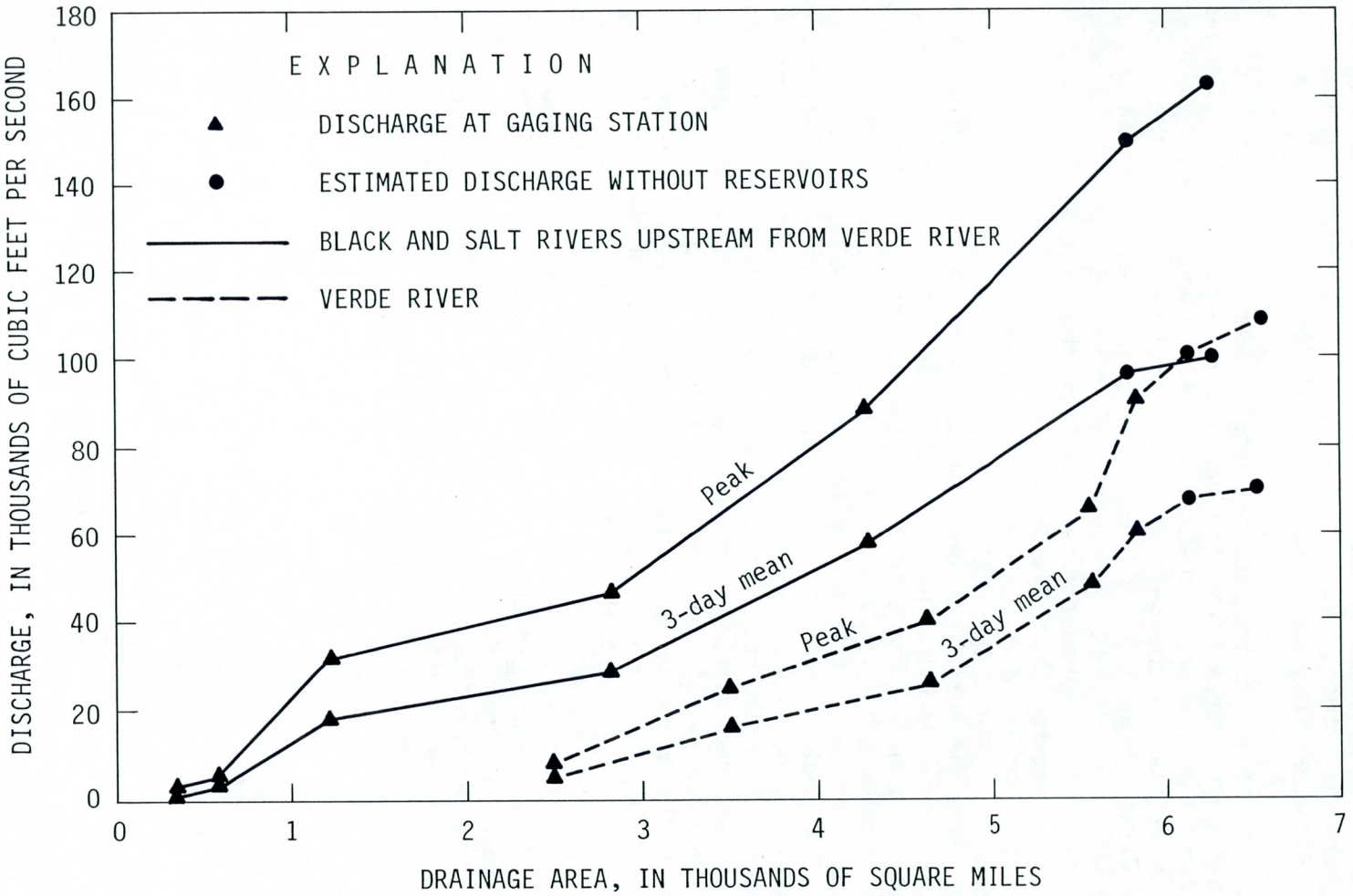


Figure 15.--Relation of discharge to size of drainage area on the Black, Salt, and Verde Rivers during flood of March 1978.

Lake and 20,000 to 30,000 ft^3/s into the three downstream reservoirs. The peak inflow rate to Roosevelt Lake from ungaged tributaries was much greater than at any other time since at least 1917 and probably the greatest since Roosevelt Dam was completed in 1911.

Moderate to large amounts of runoff came from all parts of the Verde River basin downstream from the gage near Paulden, but the largest amount came from the area downstream from Camp Verde. Plate 6e shows large increases in peak discharge and volume of flow between the gaging station below Camp Verde (site 67) and the gaging station below Tangle Creek (site 72). The peak discharge of crest B (pl. 6E), which originated entirely in the area downstream from the East Verde River, is about 20,000 ft^3/s greater than the discharge that would have occurred in a simple recession from crest A.

Slope-area measurements of peak discharges from six tributaries between Tangle Creek and Bartlett Dam show unit discharges that range from 76 to 195 $ft^3/s/mi^2$. The sum of the peak discharges from these six tributaries is about 26,000 ft^3/s from 163 mi^2. If all the streams in the 313-square-mile drainage area tributary to this reach peaked simultaneously at this rate, the peak tributary-inflow rate could have exceeded 50,000 ft^3/s. However, concurrent peaks are unlikely; records for nearby stations indicate that crests could have occurred at several different times. Most of the unmeasured streams are small and head below an altitude of 4,000 ft; whereas three of the measured streams head above 6,000 ft. Discharges from the unmeasured streams, therefore, would be less than the average from the measured streams. Analysis of inflow, outflow, and observed changes in stage of Horseshoe and Bartlett Reservoirs indicate rapid fluctuations of tributary inflow with a possible peak tributary inflow rate of about 20,000 to 30,000 ft^3/s early on March 2. Tributary inflow was computed by subtracting two large quantities from a third (inflow and change in storage subtracted from outflow) and has a large degree of uncertainty. Additional uncertainty comes from variable traveltimes from the various tributaries to Bartlett Dam and storage in the river channel between Horseshoe Dam and Bartlett Reservoir. The total uncertainty is great enough to cause large negative inflow rates to be computed for several time periods.

Magnitude of Peaks Upstream from Salt and Verde River Reservoirs

On small streams in the Salt River basin, the peak discharges during the flood of March 1978 have been exceeded frequently in the past. The accumulation of runoff from tributaries caused the relative magnitude of peaks to increase with increasing drainage area. At seven stations on unregulated streams, the maximum discharge in the period of record occurred during the March flood; however, the longest record at any of these stations is 22 years. Longer records for other stations indicate that higher discharges on these streams probably occurred several times before records began. Higher discharges occurred at most of these stations in December 1978 and February 1980.

The peak discharges of March 1978 on the Salt and Verde Rivers at the points where they enter the reservoir systems have been exceeded several times since 1890. Figure 12, which includes floods through 1980, shows six higher peaks at the Salt River near Roosevelt (site 49) and five higher peaks at the Verde River below Tangle Creek (site 72). The Verde River floods of 1890 and 1920 and some floods between 1871 and 1890 may have exceeded the flood of March 1978. On Tonto Creek, the peak of March 1978 has been exceeded three times since 1940; it probably has not been exceeded more than six times since 1890. The combined discharge from Salt River, Tonto Creek, and the ungaged tributaries appears to have been greater during the flood of March 1978 than during any previous flood. The peak discharge of the Salt River at the former gaging station at Roosevelt (site 55, below Tonto Creek) was computed by flood routing as 155,000 ft^3/s; records of change of contents in Roosevelt Lake indicate a peak inflow of 170,000 ft^3/s. Only the routing computations account for the traveltime in the now-submerged channels through the reservoir; therefore, the value of 155,000 ft^3/s is considered comparable to natural peak discharges before reservoir construction. The peak discharge could be the highest that has occurred there since 1890.

The probabilities of peak discharges at the various gaging stations being equaled or exceeded in a given year were obtained from frequency curves for the individual stations and are listed in the section entitled "Streamflow Data at Gaging Stations and Miscellaneous Measuring Sites." Probabilities for miscellaneous sites were computed from equations developed by Roeske (1978) for relating flood discharges of a given magnitude to measurable basin characteristics. Probability has been explained in a previous section entitled "Probability of Occurrence." At almost all stations upstream from the reservoirs, the probability is greater than 0.05. Peak discharges of this magnitude, therefore, can be expected on an average of once every 20 years or less.

Flood Volumes

The volume of runoff, especially on the Verde River, was an important factor of the flood. The mean discharges for 1, 3, and 7 days are the largest during periods of record dating back to and including the 1905 water year on the Verde River and the 1914 water year on Tonto Creek and are second only to those of 1916 at Salt River near Roosevelt (table 6). At all but two or three stations in the flood area, the 1-, 3-, and 7-day mean discharges are either the highest or second highest during the period of record (table 7). Mean discharges for the years prior to 1975 are summarized by Anderson and White (1979). Data for the Verde River given in table 6 for years prior to 1941 are for sites downstream from Bartlett Dam. The estimated amounts of ungaged tributary inflow in 1978 between the existing and former gage sites are shown in the footnote of table 6. The probability that the 1-, 3-, and 7-day mean discharges recorded in March 1978 would occur in any given year is about 0.015 for the Verde River and Tonto Creek and about 0.03 for the Salt River near Roosevelt.

Table 6.--Highest mean discharge for Salt River, Tonto Creek, and Verde River during periods of 1, 3, and 7 consecutive days in selected water years

[Data are listed for the 15 highest 1-day mean discharges according to the magnitude of the 1-day mean]

Water year	Mean discharge, in cubic feet per second		
	1 day	3 day	7 day
09498500 Salt River near Roosevelt, water years, 1915-78			
1916	91,000	71,800	42,400
1978	77,200	59,200	32,100
1941	60,200	46,600	24,600
1920	56,000	41,500	24,100
1973	53,900	32,100	16,200
1952	46,600	32,100	20,800
1966	45,100	23,400	12,300
1960	41,800	22,700	10,800
1915	37,500	19,700	11,900
1932	35,200	28,800	16,500
1937	35,000	24,200	11,500
1924	32,200	22,100	14,500
1927	31,700	26,400	14,400
1917	23,600	10,600	5,160
1954	23,500	15,200	8,580

See footnotes at end of table.

Table 6.--Highest mean discharge for Salt River, Tonto Creek, and Verde River during periods of 1, 3, and 7 consecutive days in selected water years--Continued

Water year	Mean discharge, in cubic feet per second		
	1 day	3 day	7 day
09499000 Tonto Ceek above Gun Creek, near Roosevelt, water years, 1915-78[1]			
1978	32,200	27,200	15,400
1952	21,200	9,190	4,410
1924	20,000	9,800	5,930
1937	18,000	9,560	4,240
1941	16,500	8,510	4,920
1916	15,800	12,400	7,630
1966	15,300	7,830	4,690
1951	14,700	10,700	4,850
1960	14,300	8,700	4,040
1926	14,000	8,500	4,830
1973	13,700	7,720	3,570
1927	12,600	10,000	5,810
1970	11,100	5,830	2,580
1915	11,000	7,050	4,170
1920	9,880	7,320	4,240

See footnotes at end of table.

Table 6.--Highest mean discharge for Salt River, Tonto Creek, and Verde River during periods of 1, 3, and 7 consecutive days in selected water years--Continued

Water year	Mean discharge, in cubic feet per second		
	1 day	3 day	7 day
09508500 Verde River below Tangle Creek, above Horseshoe Dam, water years, 1906-78[2]			
1978	65,100	61,500	34,900
1906	61,500	26,700	13,100
1938	59,700	29,300	16,600
1916	53,400	42,100	22,100
1909	51,600	24,700	11,800
1927	48,300	40,800	23,100
1920	48,200	39,400	22,500
1973	45,100	27,600	13,500
1967	45,000	22,600	10,900
1952	42,300	18,300	8,780
1932	41,500	32,400	17,800
1924	40,800	26,500	15,600
1937	39,200	26,100	13,100
1907	32,200	16,700	13,100
1941	30,200	21,300	12,200

[1]Data for years prior to 1941 obtained at a site about 7 mi downstream where the drainage area is 24 percent larger than at the present site.

[2]Data for years prior to 1939 obtained at sites below Bartlett Dam, where the drainage area is 5 to 10 percent greater than at the gage below Tangle Creek. Inflow during March 1978 between these sites estimated as 7,000 ft^3/s for 1 day, 5,000 ft^3/s for 3 days, and 3,000 ft^3/s for 7 days.

Table 7.--Highest mean discharge for 1, 3, and 7 consecutive days, February 28 to March 6, 1978

Station number	Station name	Mean discharge, in cubic feet per second		
		1 day	3 day	7 day
09489100	Black River near Maverick.....	1,640	1,320	956
09489500	Black River below pumping plant, near Point of Pines.....	5,740	4,570	2,800
09489700	Big Bonito Creek near Fort Apache....	2,190	1,840	1,050
09490500	Black River near Fort Apache.....	27,000	18,600	10,000
09494000	White River near Fort Apache.....	4,640	3,640	2,080
09496500	Carrizo Creek near Show Low.....	5,210	4,370	2,630
09497500	Salt River near Chrysotile.....	37,600	29,700	16,200
09497800	Cibecue Creek near Chrysotile.....	3,410	2,560	1,630
09497850	Canyon Creek near Globe.....	11,000	7,260	4,110
09497980	Cherry Creek near Globe.....	3,770	2,790	1,670
09498500	Salt River near Roosevelt.....	77,200	59,200	32,100
09498870	Rye Creek near Gisela.....	4,400	3,660	2,300
09499000	Tonto Creek above Gun Creek, near Roosevelt.....	32,200	27,200	15,400
09500500	Salt River at Roosevelt.....	127,800	96,700	------
09502000	Salt River below Stewart Mountain Dam.....	16,100	8,950	4,030
09502800	Williamson Valley Wash near Paulden..	4,320	2,770	1,760
09502800	Verde River near Paulden.....	6,210	4,540	2,590
09504000	Verde River near Clarkdale.....	17,700	15,600	8,880
09504500	Oak Creek near Cornville.....	8,870	6,370	4,080

See footnote at end of table.

Table 7.--Highest mean discharge for 1, 3, and 7 consecutive days, February 28 to March 6, 1978--Continued

Station number	Station name	Mean discharge, in cubic feet per second		
		1 day	3 day	7 day
09505200	Wet Beaver Creek near Rimrock.....	2,920	2,280	1,500
09505250	Red Tank Draw near Rimrock.....	1,260	928	567
09505300	Rattlesnake Canyon near Rimrock.....	813	666	409
09505350	Dry Beaver Creek near Rimrock.....	4,590	3,690	2,800
09505550	Verde River below Camp Verde.....	29,500	25,800	16,000
09505800	West Clear Creek near Camp Verde.....	8,160	5,620	3,350
09507980	East Verde River near Childs.....	7,620	6,190	3,560
09508000	Verde River below East Verde River, near Pine.....	56,200	49,900	28,300
09508300	Wet Bottom Creek near Childs.....	[1]3,200	[1]2,570	[1]1,350
09508500	Verde River below Tangle Creek, above Horseshoe Dam.....	65,100	61,500	34,900
09510000	Verde River below Bartlett Dam.....	67,600	50,200	30,800
09510100	East Fork Sycamore Creek near Sunflower.....	292	174	94
09510170	Camp Creek near Sunflower.....	146	119	69
09510200	Sycamore Creek near Fort McDowell....	8,300	5,500	3,370
09511300	Verde River near Scottsdale.....	79,000	57,000	34,000
0951150	Salt River below Granite Reef Dam....	87,000	66,000	40,000
09512100	Indian Bend Wash at Scottsdale.....	933	379	178
09512170	Salt River at Jointhead Dam.....	80,000	60,300	35,300
09512400	Cave Creek at Phoenix.....	1,620	1,440	1,020

See footnote at end of table.

Table 7.--Highest mean discharge for 1, 3, and 7 consecutive days, February 28 to March 6, 1978--Continued

Station number	Station name	Mean discharge, in cubic feet per second		
		1 day	3 day	7 day
09512500	Agua Fria River near Mayer.....	4,290	2,970	1,570
09512800	Agua Fria River near Rock Springs....	15,100	11,900	6,280
09513000	Agua Fria River at Waddell Dam (inflow to Lake Pleasant).....	25,600	18,200	9,960
09513780	New River near Rock Springs.....	5,080	3,530	2,020
09513800	New River at New River.....	4,990	3,220	1,840
09513835	New River at Bell Road near Peoria...	6,000	3,770	2,010
09513860	Skunk Creek near Phoenix.....	809	572	247
09513970	Agua Fria River at Avondale.....	7,000	4,100	3,560
09515500	Hassayampa River at Box damsite, near Wickenburg.....	6,480	5,040	3,120
09517000	Hassayampa River near Arlington.....	4,540	3,220	------
09517500	Centennial Wash near Arlington.....	3,260	1,160	508
09519500	Gila River below Gillespie Dam.....	80,700	54,100	33,500

[1]Estimated.

The volume of 446,000 acre-ft that passed the Salt River near Roosevelt gaging station in the 7-day period, February 28 to March 6, is equal to about one-third of the capacity of Roosevelt Lake. The 7-day inflow (0800 hours February 28 to 0800 hours March 7) to the lake from the Salt River, Tonto Creek, and ungaged tributaries was 692,000 acre-ft, and was the highest since 1916 when a 7-day inflow of about 700,000 acre-ft occurred. The next highest 7-day inflow was 410,000 acre-ft in March 1941. From 1920 to March 1978, seven other runoff events produced more than 200,000 acre-ft of inflow during a 7-day period.

Streamflow Downstream from the Reservoirs

At the start of the flood, Roosevelt Lake was 21 percent full, but Apache, Canyon, and Saguaro Lakes were 96 percent full. The entire flow into Roosevelt Lake was retained in the lake with no water being released (Salt River Valley Water Users' Association, written commun., 1979). The inflow to the lower three reservoirs was more than the reserve-storage capacity; therefore, water was released from these reservoirs. In this report the term "reserve-storage capacity" is used to designate the difference between the total amount of water that can be stored in a reservoir and the amount that is actually in storage at a given time and is the amount of storage that could be used to control the flooding. The controlled release from Saguaro Lake at Stewart Mountain Dam began at 1600 hours March 1 and reached a maximum of 29,600 ft^3/s at 1000 hours March 2 just 2 hours before the time of maximum release from Bartlett Reservoir (fig. 16).

When the rapid rise of the Verde River below Tangle Creek started about 1700 hours February 28 the combined reserve-storage capacity in Horseshoe and Bartlett Reservoirs was about 126,000 acre-ft. Inflow to Horseshoe Reservoir reached 70,000 ft^3/s about 1000 hours March 1 and remained above 70,000 ft^3/s or 5,800 acre-ft/hr until about 0700 hours March 2. No water was released from Bartlett Dam until 1230 hours March 1 when the reserve-storage capacity was less than 85,000 acre-ft. A controlled release was started at 10,000 ft^3/s and was increased in steps to 60,000 ft^3/s at 0700 hours March 2.

A critical situation developed about 1000 hours March 2 when 60,000 ft^3/s was being released from Bartlett Dam. The reserve-storage capacity in the Verde River reservoir system was down to 13,300 acre-ft; inflow to the reservoir from the Verde River was about 68,000 ft^3/s or 5,400 acre-ft/hr. Records for Verde River below East Verde River, near Pine (site 70) indicated that the river was beginning to rise for the fourth time in about 24 hours (each crest had the potential to be higher than preceding ones), and ungaged tributaries were discharging an extremely large but, at the time, unknown quantity of water directly into the reservoirs. The after-the-fact analysis made for this report indicates that tributary inflow may have been 20,000 to 30,000 ft^3/s. Within the next hour, the outflow was increased from 60,000 to 98,000 ft^3/s. The maximum rate of release is approximately equal to the maximum amount of inflow. The rise at Verde River below East Verde, near Pine did not materialize as

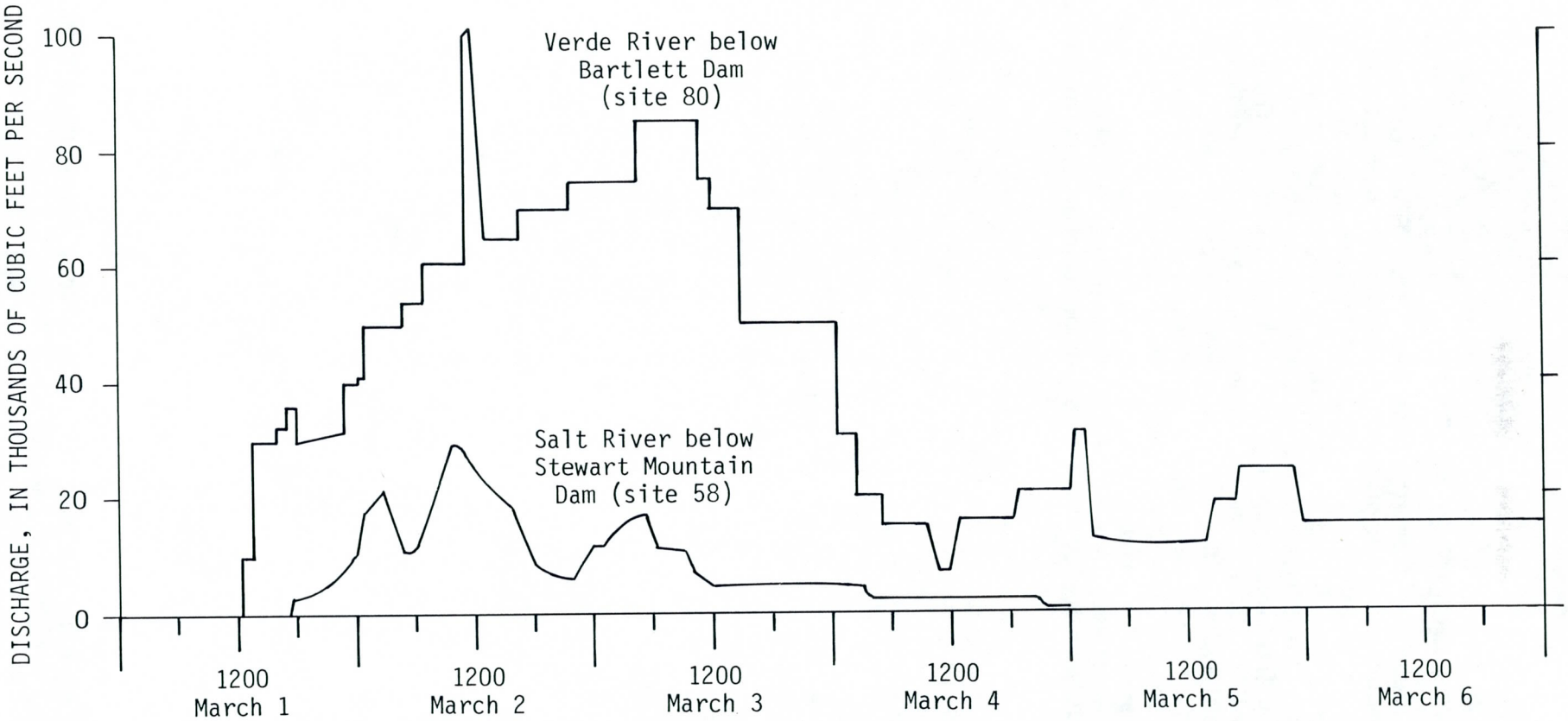


Figure 16.--Discharge released from Stewart Mountain and Bartlett Dams, March 1-6, 1978.

a significant peak at Verde River below Tangle Creek, above Horseshoe Dam, and outflow was reduced to 65,000 ft^3/s by 1230 hours March 2.

The combined flow from the Salt and Verde River reservoirs and tributary inflow produced a peak of about 125,000 ft^3/s below Granite Reef Dam about 1600 hours March 2 (fig. 17). Although a stage record was kept at Granite Reef Dam, the discharge record cannot be computed from that record because the stage-discharge relation is undefined for high flows; therefore, the flow was computed by routing floodflows from Stewart Mountain Dam, Bartlett Dam, and Sycamore Creek in increments of 2 hours. The actual hydrograph of flow below Granite Reef Dam was probably slightly more irregular than indicated by figure 17 because the 2-hour increments smooth the hydrograph considerably. No adjustment was made for diversions to Arizona and South Canals because the amount diverted generally was less than 600 ft^3/s during the flood period. The peak discharge reduced to 122,000 ft^3/s at Jointhead Dam in Phoenix.

The flood on the Salt River combined with inflow from Agua Fria and Hassayampa Rivers and Centennial Wash and flow from the Gila River above Salt River to produce a peak of 92,900 ft^3/s at Gila River below Gillespie Dam (station 111) on March 3. The entire floodflow was stored in Painted Rock Reservoir for release at a controlled rate of a few hundred cubic feet per second. The maximum release rate from Painted Rock Dam during the flood period was 1,060 ft^3/s on March 4. None of this water reached the Gila River near Mohawk gaging station about 50 mi downstream.

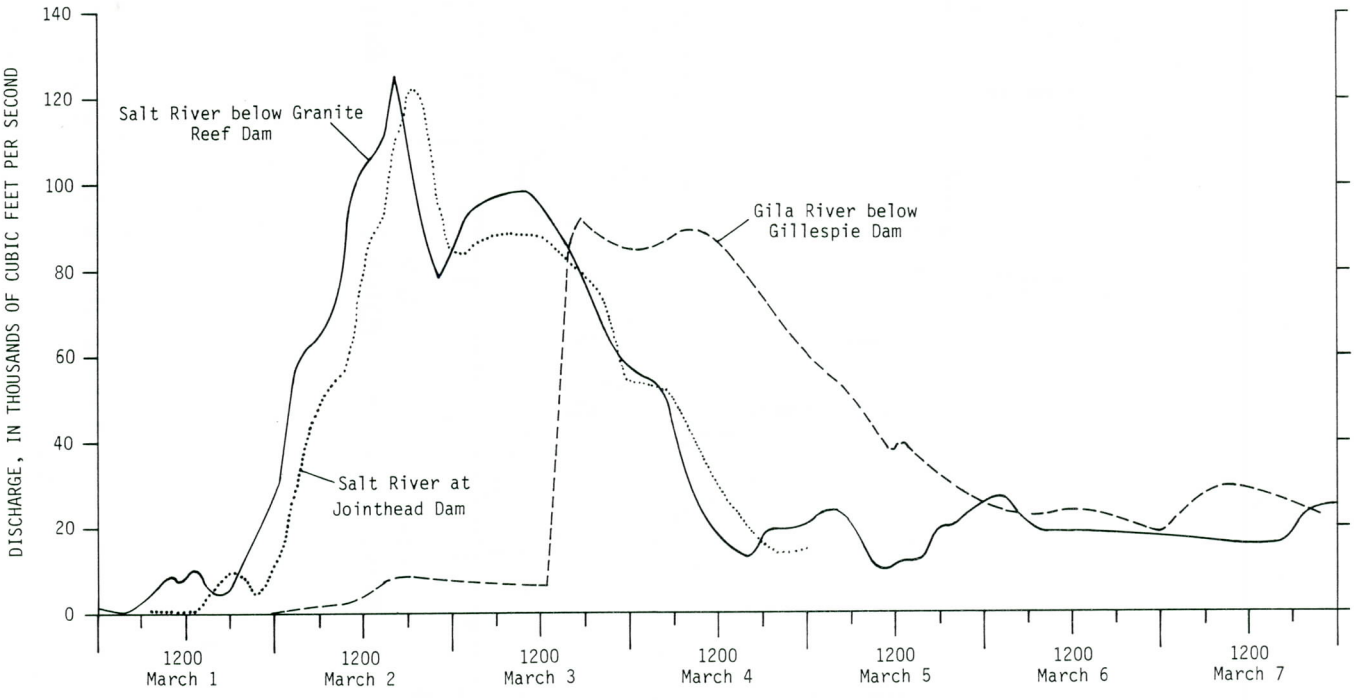


Figure 17.--Discharge of the Salt and Gila Rivers downstream from the Verde River, March 1-7, 1978.

Agua Fria River

In the Agua Fria River basin, a large increase in discharge per square mile in the reach between the gaging stations, Agua Fria River near Mayer (site 94) and Agua Fria River near Rock Springs (site 96), was the result of intense precipitation in the mountains midway in the basin on the morning of March 2. Peak discharges of tributaries in the reach were not determined. Black Canyon Wash reportedly had a crest that is the fourth highest in the past 21 years. The peak was approximately 2 ft lower than that of a subsequent peak in December 1978, for which a peak discharge of 22,300 ft^3/s from 238 mi^2 was determined from a slope-area measurement. On Castle Creek, a tributary to Lake Pleasant, the crest stages of March and December 1978 differed by less than 0.1 ft. The flood of December 1978 was computed as 5,780 ft^3/s from 72 mi^2 from a slope-area measurement.

The inflow and outflow to Lake Pleasant are shown as Agua Fria River at Waddell Dam on plate 6C. Most of the inflow was measured at Agua Fria River near Rock Springs, but there was also inflow from 329 mi^2 of ungaged area. The Maricopa County Municipal Water Conservation District No. 1 (written commun., 1978) computed inflow rates from hourly readings of reservoir levels (dashed line) except during 7 hours early on March 2. The entire inflow during the three major crests was stored in the reservoir. Release from the reservoir (dotted line) began about 1500 hours March 3 when inflow had receded to about 5,000 ft^3/s. The maximum release of 16,300 ft^3/s occurred on March 5 following a secondary inflow crest of 7,500 ft^3/s. This was the most water that had been released since Lake Pleasant was constructed in 1927, but it was considerably less than the 59,900 ft^3/s released in December 1978 and 66,000 ft^3/s released in February 1980.

Cave Creek

The long duration and high volume of runoff filled Cave Creek Reservoir to within a few inches of the top of the dam and caused concern for the safety of the dam. This was the first time that the reservoir had been full since it was built in 1923. The controlled release plus bypass flow was at the maximum possible rate of about 3,000 ft^3/s, whereas the inflow rate probably exceeded 8,000 ft^3/s. The maximum discharge at the Cave Creek at Phoenix gaging station (site 93) was 2,090 ft^3/s. Less than 1 mi downstream from the gaging station at Phoenix, Cave Creek flows into the Arizona Canal. The inflow from Cave Creek was about twice the capacity of the canal, which also was receiving flow from other streams; therefore, excess water flowed over relief spillways in the south embankment of the canal. The excess water did not contribute to flooding along the Gila River because it only flowed a few miles from the points of overflow and was dissipated through depression storage and infiltration.

Fringe Areas

Low to moderate flows occurred on Chevelon and Clear Creeks in the Little Colorado River basin, Santa Maria and Big Sandy Rivers in the Bill Williams River basin, Rillito Creek and its tributaries near Tucson, Gila River above San Carlos Reservoir and its tributaries from the north side, and Queen Creek. Streams in the Gila River basin upstream from San Carlos Reservoir and in the Rillito Creek basin had flowed at low flood stages for several days prior to moderate flood crests of March 1-3. A long sustained period of moderate runoff from the Santa Catalina Mountains near Tucson caused sufficient damage for Pima County to be declared a disaster area. Peak flows in the fringe areas are not significant enough to justify including detailed data in this report. Peak and daily mean discharges of gaged streams are published in the annual data report of the U.S. Geological Survey (1979).

Depletion in Streamflow from Granite Reef Dam to Gillespie Dam

Between Granite Reef Dam on the Salt River and Gillespie Dam on the Gila River is a 74-mile reach of broad alluvial valley. From February 28 to March 10, 573,600 acre-ft entered the Salt River channel at Granite Reef Dam (table 8). Gaged inflow from the Gila River and tributaries to the Salt or Gila River between Granite Reef and Gillespie Dams during that period was 96,600 acre-ft; ungaged inflow was probably a few thousand acre-ft. No distinct cutoff date can be assigned to outflow past Gillespie Dam because water drained out of temporary ground-water storage for several weeks, and outflow was affected by additional inflow after March 10. For purposes of this study, the cutoff date was selected as March 18 when discharge at Gillespie Dam reached a minimum. The total volume of flow reaching Gillespie Dam, including diversions at the dam into Gila Bend and Enterprise Canals, was 558,400 acre-ft. Depletion amounted to 111,800 acre-ft or about 17 percent of the measured inflow in the reach. Much of this depletion occurred as the initial rise was dissipated in depressions and through infiltration to the dry streambed. Part of the depletion went into temporary ground-water storage or was lost to evapotranspiration, but a large part became recharge for the regional ground-water system. In comparison, during the flood of December 1965 to January 1966, the depletion was 175,200 acre-ft or 29 percent of the measured inflow of 611,800 acre-ft (Aldridge, 1970).

Traveltime Through the Metropolitan Area

Since no records are available for traveltime, estimates of traveltime must be based on limited data collected at gaging stations and key observation points. Available basic field data are (1) magnitudes and times of release from Bartlett Reservoir, (2) gage-height records during the initial rise at Verde River near Scottsdale, (3) estimated discharge records of the Salt River below Granite Reef Dam, (4) gage-height records during the flood crest at Jointhead Dam at Phoenix, and (5) gage-height records below Gillespie Dam for the entire flood period.

Table 8.--Depletion of flow in the Salt and Gila Rivers between Granite Reef and Gillespie Dams, February 28 to March 18, 1978

Stream and location	Acre-feet
Inflow	
February 28 to March 10, 1978	
Salt River below Granite Reef Dam	573,600
Indian Bend Wash at Scottsdale	2,500
Gila River near Laveen	12,100
Santa Cruz River near Laveen	5,600
Agua Fria River at Avondale	50,000
Hassayampa River near Arlington	19,300
Centennial Wash near Arlington	7,100
Total inflow	670,200
Outflow	
March 2-18, 1978	
Gila River above diversions, at Gillespie Dam[1]	558,400
Depletion	
Inflow minus outflow	111,800

[1]Sum of Gila River below Gillespie Dam plus diversions in Gila Bend and Enterprise Canals.

Water released from Bartlett Dam reached the mouth of the Verde River 23 mi downstream 7½ hours after the release began and reached Granite Reef Dam about 1 hour later. The crest traveled faster than the front of the flood and reached Granite Reef Dam about 4 hours after the maximum release from Bartlett Dam. Traveltime for the 9-mile reach from Stewart Mountain Dam to Granite Reef Dam cannot be determined from records for the March flood but appears to be about 2 hours.

Traveltime in the 20-mile reach from Granite Reef Dam to Jointhead Dam appears to have been about 4 to 6 hours for the front of the flood wave and 3 hours for the crest (fig. 17). Traveltimes for the 74-mile reach from Granite Reef Dam to Gillespie Dam varied with discharge and cannot be computed precisely because the shape of the hydrograph was modified by tributary inflow, channel losses, and diversions at the two dams. A lapse of 52 hours occurred from the start of flow above Granite Reef Dam to the start of flow below Gillespie Dam, but this may not be a true traveltime because diversions by canals at each end of the reach are not considered. The low flow at the start of the flood wave may have been diverted to the Arizona and South Canals thus causing water to start flowing over Granite Reef Dam later than indicated by the estimated discharge record. Water did not flow over Gillespie Dam until the discharge exceeded the capacity of Gila Bend and Enterprise Canals. From a casual inspection, it could be inferred that a peak below Granite Reef Dam at 1300 hours March 1 caused a peak below Gillespie Dam at 1800 hours March 2, which indicates a traveltime of about 29 hours for that peak.

The peak at Gillespie Dam, however, probably was caused by tributary inflow. The major rise below Gillespie Dam began 42 hours after the corresponding rise below Granite Reef Dam. The initial part of that rise was lost through infiltration. At Gila River below Gillespie Dam, the rise occurred rapidly over 3 hours; whereas at Salt River below Granite Reef Dam, a series of sharp rises, separated by periods of more gradual rise, occurred over 21 hours. The sharp rise below Gillespie Dam lagged the first steep rise below Granite Reef Dam by 38 hours. After the channel was wet, traveltime decreased as discharge increased. Discharges in excess of 70,000 ft^3/s reached Gillespie Dam 26 to 28 hours after passing Granite Reef Dam. Later in the flood period, traveltime again increased as discharge decreased; peak discharges of 20,000 to 30,000 ft^3/s required 30 to 33 hours to travel through the reach, and rises starting from a trough discharge of 10,000 to 20,000 ft^3/s required 37 to 38 hours.

Damage

The flood caused damage in 13 of the 14 counties in Arizona, and 9 were declared disaster areas. A partial list of monetary damages compiled by Arizona Emergency Services (written commun., 1979) shows statewide damage of $65.9 million (table 9). Three deaths were attributed to the flood, and a fourth occurred when a woman waiting to cross a flooded intersection was asphyxiated in her automobile.

More than half the damage—about $37 million—occurred in Maricopa County. The exact figure varies according to the methods used to tabulate the data. The Arizona Emergency Services data indicates $36.9 million without including damage to State highways and Indian Reservations, expenditures by the Red Cross and Small Business Administration, and unemployment. The U.S. Army Corps of Engineers (1979) used $36.7 million for Maricopa County in its report, but totals in tables that break the damage down by several methods differ from this by as much as $4 million (tables 10 and 11). Data used in this report have been taken directly from source documents; no attempt has been made to reconcile differences between the various tabulations. Following the flood, Federal, State, and local agencies provided direct aid of $9.1 million and made loans amounting to $11.5 million in Maricopa County (U.S. Army Corps of Engineers, 1979).

The largest single category of damage was streets and highways, which accounted for more than $20 million statewide. Following the flood, the Arizona Department of Transportation and local governmental agencies applied for Federal assistance to repair 103 sites on Federal-aid highways (D. L. Cornelison, Maintenance Operations Engineer, Arizona Department of Transportation, written commun., 1979). In the Phoenix metropolitan area of Maricopa County, 12 bridges and 13 other river crossings were damaged severely; only 3 crossings of the Salt and Gila Rivers remained open. Highways damaged or closed north and west of Phoenix were Cave Creek Road, Carefree Highway at Cave Creek, Skunk Creek crossings, State Route (SR) 74 at New River, U.S. 60 along the Hassayampa River south of Wickenburg, and U.S. 93 at Big Sandy River near Wickieup.

Table 9.--Statewide damage, by location, flood of March 1978

[Data from Arizona Emergency Services (written commun., 1979). Figures are rounded to the nearest hundred]

Location		Damage
Apache County		$ 161,100
Cochise County		35,000
Coconino County		416,700
Gila County		3,728,400
Graham County		2,387,500
Greenlee County		1,402,300
Maricopa County		36,900,600
Mohave County		899,100
Navajo County		1,161,900
Pima County		1,867,000
Pinal County		419,000
Santa Cruz County		267,100
Yavapai County		930,400
Yuma County		0
Fort McDowell Mohave Apache Indian Reservation		21,000
White Mountain Apache Indian Reservation		69,800
Navajo Indian Reservation		247,600
Hopi Indian Reservation		857,800
San Carlos Apache Indian Reservation		27,300
Statewide:		
Damage to State highways	$5,660,000	
Loans from Small Business Administration	7,295,700	
Public assistance provided by State agencies	822,100	
Aid provided by the Red Cross	188,000	
Unemployment insurance	100,000	
Statewide total		14,065,800
TOTAL		$65,865,400

Near the mouth of the Verde River, SR 87 was closed when the bridge approaches were washed away. Payson and other communities along SR 87 could be reached only through Camp Verde or Flagstaff for several days. This circuitous route added as much as 200 mi to the distance between these communities and Phoenix. Roads to Roosevelt Lake from three directions were closed—SR 88 from Apache Junction, SR 188 from Punkin Center, and SR 288 from Young. Above the Mogollon Rim, SR 277 from Overgaard to Snowflake and SR 260 from Overgaard to Show Low were damaged or closed. Elsewhere in the State, a bridge approach washed out on SR 77 at Aravaipa Creek south of Winkelman. Several secondary roads in Mohave County, four streets crossing Tanque Verde Creek or Rillito Creek in Tucson, and four county bridges over the Gila River in Graham County were damaged or closed.

Table 10.--Damage in Maricopa County, by location, flood of March 1978

[Data from U.S. Army Corps of Engineers, 1979]

Location	Damage
Salt River	
Granite Reef Dam to 48th Street	$ 5,188,000
48th Street to 35th Avenue	17,761,000
35th Avenue to mouth (115th Avenue)	1,142,000
Gila River, downstream from 115th Avenue	6,917,000
Cave Creek	254,000
Glendale and other areas along Arizona Canal	515,000
Other areas	[1]2,765,000
Total	[2]$34,542,000

[1]Uncertain. Table 6 of the U.S. Army Corps of Engineers (1979) report shows $969,000; text of same reference shows $2,765,000.

[2]Does not include $400,000 in transportation delays.

Table 11.--Damage in Maricopa County, by type, flood of March 1978

[Data from U.S. Army Corps of Engineers, 1979]

Type of loss	Physical damage	Business and emergency losses	Total
Agricultural	$3,909,000	$122,000	$4,031,000
Residential	2,806,000	312,000	3,118,000
Business	686,000	59,000	745,000
Industrial:			
Sand and gravel	2,254,000	240,000	2,494,000
Other industrial	5,148,000	188,000	5,336,000
Public:			
Roads and bridges	---	---	12,899,000
Miscellaneous public	3,412,000	11,000	3,423,000
Traffic delay	---	---	400,000
Miscellaneous	1,085,000	7,000	1,092,000
Total			$33,538,000

Residential areas in many parts of the State were threatened or damaged. Near Prescott, three small reservoirs overflowed, and the threatened failure caused officials to evacuate residents from downstream areas. In Verde Valley, hundreds of people were evacuated from Bridgeport, Clarkdale, and surrounding communities where water flowed 6 in. deep through some trailers and was as much as 3 ft deep around some houses. Several families along Oak Creek near Sedona were evacuated. Below the Mogollon Rim, eight communities near Payson were isolated. Water flowed 4 to 6 ft above the banks of East Verde River and Christopher Creek. Christopher Creek was reportedly a quarter of a mile wide and 3 to 4 ft deep upstream from the community of Christopher Creek. North of Phoenix, the communities of Carefree and Cave Creek on Cave Creek were isolated, and the town of New River on New River was evacuated as a precautionary measure. West of Phoenix, Wintersburg was isolated. Two residential subdivisions north of Winslow were flooded by the Little Colorado River because of high runoff from Chevelon Creek and Clear Creek.

In Graham and Greenlee Counties, the town of Duncan and the community of Little Hollywood near Safford received minor flood damage, and several thousand acres of farmland was inundated by the Gila River. Near Tucson in Pima County, considerable bank erosion along Tanque Verde, Sabino, and Rillito Creeks removed many acres of pastureland and threatened several homes and other buildings. Damage along the Gila River and in the Rillito Creek basin was due to long-duration flow rather than extreme discharges. High flows, which preceded the main flood, saturated the streambanks and made the banks unusually susceptible to erosion.

Through Mesa, Tempe, Scottsdale, and Phoenix, flooding along the Salt River extended beyond the braided channel in only a few places where manmade developments encroach far into the flood plain. Severe air-traffic delays occurred because water flowed across about 2,000 ft of runways at Sky Harbor Airport in Phoenix and washed out several hundred feet of the runways. Damage at the airport totaled $3.2 million (U.S. Army Corps of Engineers, 1979). About 200 families were evacuated in south Phoenix, but water did not flood the houses. Damage of about $2.5 million to sand- and gravel-mining operations in the riverbed included loss of equipment and material stockpiles. Flood stages were much lower than those of 1965, although the peak discharge was nearly twice the peak discharge of 1965. The lower stages occurred because the channel was much larger in 1978 than in 1965. A map of areas inundated along the Salt and Gila Rivers is available in the U.S. Army Corps of Engineers (1979) flood-damage report.

Overflow continued along the Gila River downstream from the Salt River where extensive areas of farmland were inundated and residences were surrounded by floodwaters. The residential subdivisions of Holly Acres, located just upstream from the Agua Fria River, and Allenville, located south of Buckeye, sustained severe flood damage. In the 70-acre Holly Acres subdivision, water was about 5 ft deep. All 55

houses were flooded, and most were filled to a depth of 4 ft with water and debris. At Allenville, the Gila River flooded about 60 houses to a depth of 6 ft, and the majority of houses in this low-income community were demolished. The U.S. Department of Housing and Urban Development gave each family a mobile home for a maximum of 14 months and made grants for the families to buy the mobile homes, but would not allow the homes to be moved into Allenville (U.S. Army Corps of Engineers, 1979).

In the northern part of the Phoenix metropolitan area, the flow from Cave Creek and other tributaries to Arizona Canal exceeded the capacity of the canal. Water flowed over spillways in the south embankment of the canal at Cave Creek, at 43rd Avenue, and near 59th Avenue. The overflow from the Cave Creek spillway affected homes as far as 3.5 mi south of the canal. At Glendale Avenue, the flooded area was 0.6 mi wide. Yards were flooded to a depth of 1 ft, but most houses were untouched. The flood damaged Good Samaritan Hospital at 60th and Northern Avenues and businesses and residences along 43rd Avenue, 59th Avenue, and the north side of Grand Avenue. Traffic along 43rd and 59th Avenues was delayed for 4 hours because of flooded intersections. The U.S. Army Corps of Engineers (1979) mapped areas flooded by overflow from the Arizona Canal.

Flooding was not extensive along other streams west of Phoenix. A few unplatted residential developments received slight damage, and some farmland was inundated near the mouth of the Agua Fria River. Damage to farms adjacent to Agua Fria River, New River, Skunk Creek, Trilby Wash, and Hassayampa River was estimated to be $500,000 (U.S. Army Corps of Engineers, 1979).

Reduction of Peaks by Reservoirs

Flooding from the Salt and Agua Fria Rivers would have been much worse without the storage provided in the reservoirs. On the Salt River, the discharge that would have occurred without the reservoirs was estimated by routing flood crests from Salt River near Roosevelt, Tonto Creek above Gun Creek, and Verde River below Tangle Creek to Granite Reef Dam (fig. 18). The routing computations were made using intermediate summation points at Roosevelt Dam on the Salt River and Bartlett Dam on the Verde River and include estimates of inflow from ungaged tributaries. The ungaged inflow to a reach from tributaries was computed as the difference between main-stem discharges at the ends of each reach as adjusted for change in reservoir contents. The ungaged tributary inflow was entered in the computation at the midpoint of each reach. The time distribution of inflow was estimated on the basis of records for nearby streams. The estimates of inflow have a high degree of uncertainty, but the inflow appears to affect the computed discharge below Granite Reef Dam by less than 10 percent. The peak discharge of the Salt River below Granite Reef Dam without the reservoirs would have been 260,000 ft^3/s, and the discharge would have exceeded 100,000 ft^3/s for 66 hours. The peak discharge would have been the third highest peak known on the Salt

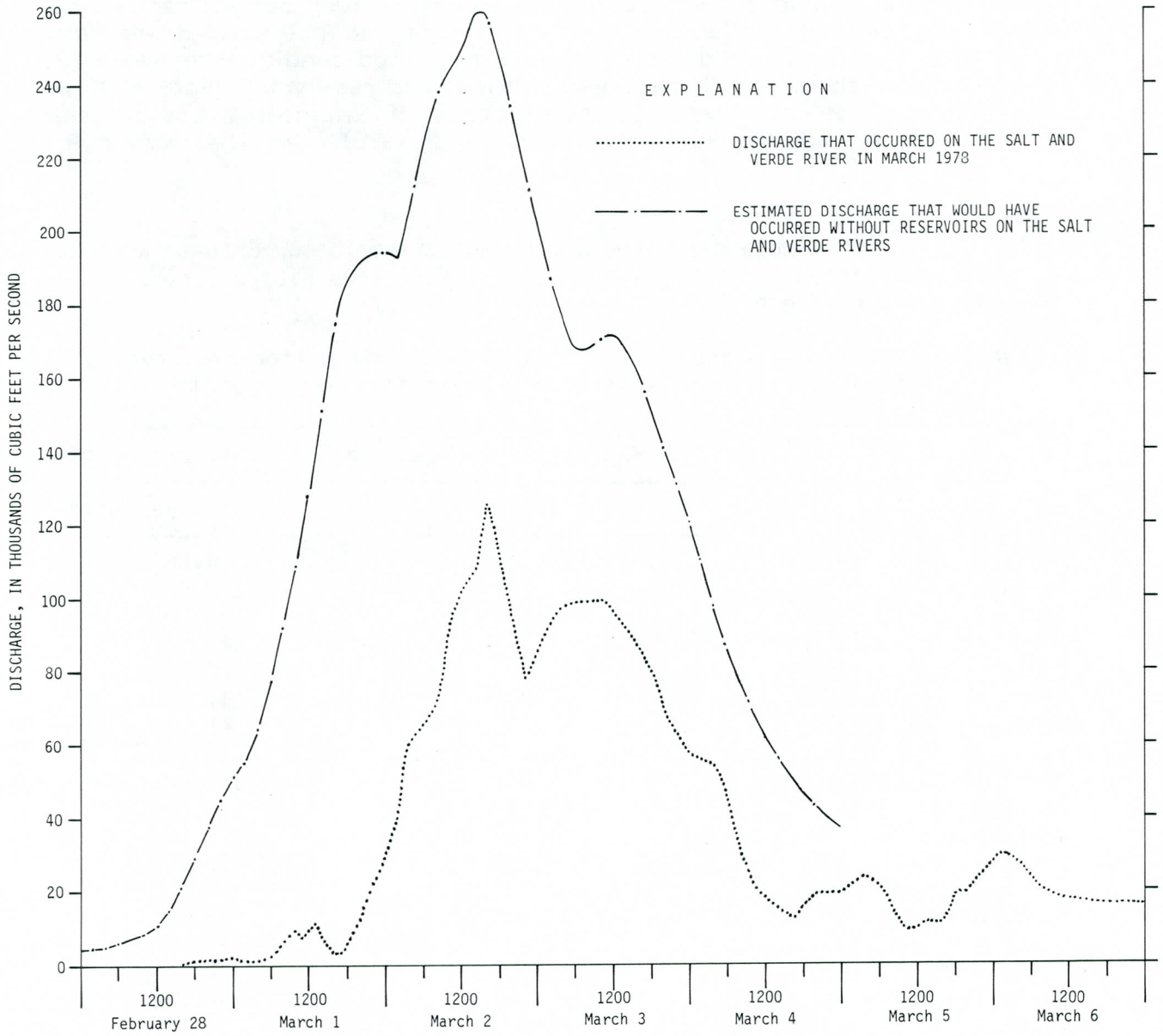


Figure 18.--Discharge of Salt River below Granite Reef Dam compared with the discharge that would have occurred without reservoirs on the Salt and Verde Rivers, February 28 to March 6, 1978.

River since at least 1871. Higher discharges—267,000 and 300,000 ft^3/s—occurred in February 1891. The actual peak discharge in March 1978 was 125,000 ft^3/s, and the discharge was more than 100,000 ft^3/s for 8 hours.

The Salt and Verde River reservoirs have provided similar reductions in peak discharge during many past floods. The approximate discharges that would have occurred on the Salt River below Granite Reef Dam during several earlier floods if reservoirs had not existed are compared with what actually did occur under regulated conditions in table 12. Several of the estimates of discharge without the reservoirs (natural flow) are from a study by the U.S. Army Corps of Engineers, Los Angeles District (N. A. Adelmeyer, written commun., 1979). In that study the

Table 12.-- Approximate discharge of the Salt River below Granite Reef Dam with and without reservoirs on the Salt and Verde Rivers during major floods since 1916

[Table includes all peaks for which the discharge without reservoirs is estimated to be at least 85,000 cubic feet per second]

Flood period	Maximum discharge, in cubic feet per second	
	With reservoirs	Without reservoirs
January 19-20, 1916.....	120,000	[1]164,000
January 29-30, 1916.....	105,000	120,000
February 22-23, 1920.....	130,000	[1]155,000
December 28, 1923.....	-------	[1]124,000
February 17-18, 1927.....	70,000	[1]123,000
February 10-11, 1932.....	50,000	[1]117,000
February 7-8, 1937.....	60,000	[1]145,000
March 4, 1938.....	85,000	115,000
March 14-15, 1941.....	45,000	170,000
December 31, 1951.....	([2])	110,000
January 18-19, 1952.....	([2])	170,000
December 25-26, 1959.....	8,800	110,000
December 22-23, 1965.....	[2]9,530	120,000
December 30-31, 1965.....	67,000	85,000
September 5-6, 1970.....	[2]14,000	135,000
October 19-20, 1972.....	[2]8,000	110,000
March 1-3, 1978.....	125,000	260,000
December 18-19, 1978.....	126,000	[1]234,000

[1] Preliminary figures furnished by the U.S. Army Corps of Engineers, (written commun., 1979).

[2] Flow consists of unregulated flow from tributaries below the reservoirs plus a few hundred cubic feet per second (less than 2,000 ft^3/s) from each of the reservoir systems.

U.S. Army Corps of Engineers isolated periods when spill would have occurred if reservoirs and a predetermined operation schedule had existed. The natural flow was computed for each flood that would have caused spill.

The maximum rate of inflow to Lake Pleasant on the Agua Fria River was estimated to be about 47,000 ft^3/s. If this flow had been unregulated and had combined with that from New River, the peak flow of the Agua Fria River at Avondale would have been about three times the actual peak, and extensive areas would have been inundated.

Summary of March Floods

Although carryover storage in the Salt and Verde River reservoirs from the 1977 irrigation season was below the long-term average, large amounts of runoff during January and February 1978 nearly filled two reservoirs on the Verde River and three reservoirs on the Salt River. The reservoirs could not retain the exceedingly large volume of runoff from the 3 to 6 in. of precipitation that fell over the mountains of central Arizona during March 1-3, 1978. Extremely large amounts of precipitation across an east-west band through the middle of the flood area caused localized precipitation totals of 9 to 14 in.

The antecedent conditions included (1) a wet basin following large amounts of precipitation in January and February, (2) high soil-moisture content, (3) above-average water content in the snowpack at altitudes of more than 7,000 ft, and (4) almost no snow below that altitude. At the start of the flood, the Verde River reservoir system contained 59 percent of its capacity, Roosevelt Lake contained 21 percent, and the other three reservoirs on the Salt River contained 96 percent of capacity. The runoff, most of which originated at altitudes of less than 7,000 ft, came in a series of crests over a period of 3 days. There was little consistency as to shape of the hydrograph or time of the maximum discharge. Hydrographs on the Salt and Verde Rivers did not display a typical pattern of a flood wave moving downstream. Flood peaks occurred more or less concurrently at all gaging stations as tributary inflow caused the discharge at each station to be higher than the discharge at the next upstream station. Tributary inflow in some reaches of channel was great enough to cause the crest to occur earlier at downstream stations than it did at upstream stations. Tributary inflow to the Verde River and reservoirs downstream from the gaging station below Tangle Creek was high enough to cause the maximum inflow to the reservoirs to occur concurrently with the start of the rise at stations farther upstream.

Unusually large amounts of runoff came from ungaged streams that are tributary to the reservoirs or stream channels between the reservoirs and downstream from gaging stations that measure the principal inflows. The ungaged inflow and the total volume of runoff into Roosevelt Lake were the highest since 1916, but no water was released from the lake. The volume of water flowing in the Verde River during the 7 highest days of the flood is about 65 percent greater than during any

other 7-day period during a period of record that dates back to and includes 1905. Peak discharges of individual streams above the reservoirs had a recurrence interval of 20 years or less.

Excess runoff into the Salt River reservoir system was released to the Salt River at Stewart Mountain Dam, and the excess into the Verde River reservoir system was released to the Verde River at Bartlett Dam. Flow from the two streams combined to produce a peak discharge of 125,000 ft^3/s below Granite Reef Dam and 122,000 ft^3/s at Jointhead Dam in Phoenix. The last flood to exceed the flood of March 1978 occurred in 1920 before reservoirs were constructed on the Verde River. Several larger floods occurred between 1871 and 1920, and two larger floods occurred in December 1978 and February 1980.

Approximate traveltimes from Bartlett Dam varied with discharge and ranged from 4 to 8 hours to Granite Reef Dam, 8 to 14 hours to Jointhead Dam in Phoenix, and 28 to 38 hours to Gillespie Dam. The flood caused damage in 13 counties; 9 counties were declared disaster areas. Statewide damage amounted to $65.9 million of which about $37 million occurred in Maricopa County mainly to bridges over the Salt and Gila Rivers. Three deaths resulted from the flood. Many residential areas were threatened or inundated to a shallow depth. Severe damage occurred at Holly Acres and Allenville subdivisions west of Phoenix. Inundated areas in Maricopa County were mapped by U.S. Army Corps of Engineers (1979). About 17 percent of the water passing over Granite Reef Dam infiltrated to the ground or went into temporary surface or bank storage.

Complete storage of inflow to Roosevelt Lake plus partial storage of inflow to the five other reservoirs in the Salt and Verde River systems caused the peak discharge through Phoenix to be less than half of what it would have been without the reservoirs. Without the reservoirs, the peak discharge below Granite Reef Dam would have been about 260,000 ft^3/s or the third highest known on the Salt River. The two highest flood discharges known occurred in 1891. The higher of these two peaks had a discharge of 300,000 ft^3/s.

STREAMFLOW DATA AT GAGING STATIONS AND MISCELLANEOUS MEASURING SITES

Explanation of Station Data

The detailed flood information given in this report for the floods of October 1977 and March 1978 for gaging stations and miscellaneous sites is in addition to that published in the regular annual reports of the Geological Survey. The sites are numbered consecutively in downstream order, and the numbers identify the locations in plate 1 and figure 5. The permanent station numbers for the gaging stations correspond to those used and explained in the annual report of Water Resources Data for Arizona (U. S. Geological Survey, 1979). Records of stage and discharge at gaging stations, contents of reservoirs and reservoir systems, and peak discharges at miscellaneous sites are given.

Summary of Flood Stages and Discharges

Maximum stages and discharges at continuous-recording stations, crest-stage stations, and miscellaneous sites are summarized in table 13. The first column under "maximum previously known" shows the period of known floods prior to October 1977 or February 1978. The period does not necessarily correspond to that in which continuous records of discharge were obtained; where available, records of historical floods are included, and overlapping time periods may be shown. The next three columns give data for the maximum known discharge and gage height. Separate listings are made for stations where the maximum discharge and gage height did not occur concurrently. Separate listings also are given for periods having different degrees of regulation. The last four columns present data for the maximum during one or both of the flood periods discussed in this report.

Data for Individual Sites

The data for each site where flood maxima were determined may include a station description, a table of daily mean discharges for the flood periods, and a table of gage heights and discharges at indicated times during the rise and recession of the flood peak. The station description contains information on location, drainage area, and type and datum of gage. The method used to determine the gage height during the flood period and the definition of the stage-discharge relation are explained. The maximum stage and (or) discharge for the floods of October 1977 or March 1978 and for previous floods are given. The tables of stages and discharges at indicated times contain sufficient data to define stage and discharge hydrographs but are less complete than the data used to compute daily mean discharges.

Table 13.--Summary of flood stages and discharges

Site (See pl. 1 and fig. 5)	Permanent station number	Stream and place of determination	Drainage area (mi^2)	Maximum previously known				Maximum for flood periods			
				Period	Year	Gage height (ft)	Discharge (ft^3/s)	Date	Gage height (ft)	Discharge (ft^3/s)	Probability
1	09470000	Gila River at Winkelman	[1]382	1932-77	1944	[2]18.4	55,000	10- 6-77	11.04	5,020	0.45
2	09470500	San Pedro River at Palominas	741	1906-77 1927-77	1926 1940	23.9 16.16	---------- 22,000	10- 9-77	16.04	14,500	.07
3	09471000	San Pedro at Charleston	1,219	1906-77	1926	[2]21.9	98,000	10- 9-77	10.60	23,700	.06
4	09471550	San Pedro River near Tombstone	1,740	1967-77	1974	10.43	18,500	10- 9-77	11.40	24,200	.08
5	09472000	San Pedro River near Redington	2,939	1906-77	1926	29.0	90,000	10-10-77	21.40	23,000	.09
6	09473000	Aravaipa Creek near Mammoth	541	1931-77	1967	11.86	10,500	10- 6-77	2.86	385	>.99
7	09473500	San Pedro River at Winkelman	4,471	1906-77	1926	----------	85,000	10-10-77	12.93	16,000	.15
8	09474000	Gila River at Kelvin	[1]5,125	1911-77 [3]1928-77	1916 1930	[2]19.5 12.6	132,000 42,800	10-11-77	20.40	16,100	.24
9	09479500	Gila River near Laveen	[1]7,729	1940-77	1941 1965	---------- 10.08	11,900 ----------	10-13-77 3- 6-78	9.64 8.16	6,360 1,930	.14 .35
10	09480000	Santa Cruz River near Lochiel	82.2	1949-77	1965	8.90	4,810	10- 9-77	10.21	12,000	.012
11	09480500	Santa Cruz River near Nogales	533	1927-77	1974	12.94	17,100	10- 9-77	15.5	31,000	<.01
12	--------	Potrero Creek above Nogales Wash, near Nogales	14.4	----------	------	----------	----------	10- 9-77	----------	1,650	.20
13	--------	Nogales Wash above Mariposa Canyon, at Nogales	42.4	----------	------	----------	----------	10- 9-77	----------	3,200	.15
14	--------	Mariposa Canyon at I-19, near Nogales	12.7	----------	------	----------	----------	10- 9-77	----------	600	.50
15	--------	Nogales Wash near mouth, near Nogales	61.0	----------	------	----------	----------	10- 9-77	----------	4,200	.10
16	--------	Alamo Canyon near Nogales	5.5	----------	------	----------	----------	10- 9-77	----------	1,500	.08
17	--------	Pesquiera Canyon near Nogales	8.4	----------	------	----------	----------	10- 9-77	----------	2,000	.08
18	--------	Potrero Creek at mouth, near Nogales	91.4	----------	------	----------	----------	10- 9-77	----------	9,300	.025
19	09481500	Sonoita Creek near Patagonia	209	1930-65	1946	13.0	14,000	10- 9-77	11.42	7,330	.10
20	--------	Sonoita Creek at Lake Patagonia, near Nogales	225	----------	------	----------	----------	10- 9-77	5.2	4,950	----------
21	09481700	Calabasas Canyon near Nogales	10.3	1963-77	1969	5.54	1,000	10- 9-77	6.10	1,200	.07
22	--------	Agua Fria Canyon near Rio Rico	40.2	1900-77	------	----------	----------	10- 9-77	----------	10,200	.01
23	--------	Peck Canyon near Rio Rico	47.8	1900-77	1967	----------	7,000	10- 9-77	----------	2,800	.20
24	--------	Santa Cruz River, at Rancho Santa Cruz, near Tumacacori.	1,090	1914-77	1967	----------	28,500	10- 9-77	----------	[4]35,000	<.01
25	09481750	Sopori Wash at Amado	176	1948-77	1948	12.3	16,000	----------	5.49	2,300	.45

See footnotes at end of table.

Table 13.--Summary of flood stages and discharges--Continued

Site (See pl. 1 and fig. 5)	Permanent station number	Stream and place of determination	Drainage area (mi^2)	Maximum previously known				Maximum for flood periods			
				Period	Year	Gage height (ft)	Discharge (ft^3/s)	Date	Gage height (ft)	Discharge (ft^3/s)	Probability
26	09482000	Santa Cruz River at Continental	1,662	1936-77	1967	15.3	18,000	10- 9-77	16.70	26,500	0.017
27	09482500	Santa Cruz River at Tucson	2,222	1892-77	1961	20.68	16,600	10-10-77	21.7	23,700	.025
28	09486000	Rillito Creek near Tucson	918	1907-77	1929	[2]24.0	24,000	10- 6-77 3- 2-78	---------- 8.86	<2,000 7,500	---------- .40
29	09486500	Santa Cruz River at Cortaro	3,503	1936-77	1940	[2]9.9	17,000	10-10-77	15.6	23,000	.04
30	09486800	Altar Wash near Three Points	460	1965-77	1970	[2]13.85	22,000	[5]10- 6-77	6.80	10,000	.10
31	09487000	Brawley Wash near Three Points	776	1955-77	1970	[2]15.80	13,700	[5]10- 6-77	11.02	7,000	.20
32	09487100	Little Brawley Wash near Three Points	11.9	1955-77	1962	17.87	13,800	[5]10- 6-77	13.20	2,500	.08
33	09487250	Los Robles Wash near Marana	1,170	1885-1977	1962	----------	32,000	[5]10- 6-77	8.10	2,400	.25
34	--------	Santa Cruz River at Greene Canal, near Eloy	5,180	1962-77	1962	----------	24,100	10-11-77	----------	5,200	----------
35	--------	Santa Cruz River above Santa Rosa, near Stanfield	----------	1962-77	1962	----------	7,360	10-12-77	----------	4,700	----------
36	09489000	Santa Cruz River near Laveen	8,581	1940-77	1962	17.50	9,200	10-13-77 3- 6-78	14.59 13.94	2,010 1,570	.25 .35
37	09489100	Black River near Maverick	315	1962-78	1972	8.14	11,100	3- 1-78	4.91	2,390	.30
38	09489500	Black River below pumping plant, near Point of Pines	560	1953-78	1972	18.0	17,900	3- 1-78	10.3	5,980	.05
39	09489700	Big Bonito Creek near Fort Apache	119	1957-78	1972 1972	---------- 8.43	1,870 ----------	3- 1-78 3- 3-78	9.09 ----------	---------- 2,870	---------- .06
40	09490500	Black River near Fort Apache	1,232	1912-78	1916	----------	[4]50,000	3- 2-78	22.33	33,200	.08
41	09492400	East Fork White River near Fort Apache	38.8	1957-78	1961	4.82	663	3- 1-78	2.76	272	.40
42	09494000	White River near Fort Apache	632	1957-78	1971	13.8	8,670	3- 1-78	11.05	7,020	.10
43	09496500	Carrizo Creek near Show Low	439	1951-78	1965	[2]13.0	23,000	3- 1-78	12.04	12,700	.14
44	09497500	Salt River near Chrysotile	2,849	1906-78	1916	18	74,000	3- 2-78	15.10	46,700	.05
45	09497800	Cibecue Creek near Chrysotile	295	1959-78	1977	17.3	22,200	3- 1-78	9.27	6,540	.28
46	09497850	Canyon Creek near Globe	316	1975-78	1977	----------	----------	3- 1-78	18.8	21,100	.05
47	09497900	Cherry Creek near Young	62.1	1963-78	1972	11.0	7,290	3- 1-78	7.20	2,480	.30
48	09497980	Cherry Creek near Globe	200	1965-78	1972	14.0	8,300	3- 1-78	10.91	5,370	.20
49	09498500	Salt River near Roosevelt	4,306	1906-78	1941 1965	---------- 25.8	117,000 ----------	3- 2-78	28.55	89,400	.04
50	09498530	South Fork Workman Creek at Sierra Ancha	.50	1938-78	1972	----------	79	3- 3-78	----------	50	.10

See footnotes at end of table.

Table 13.--Summary of flood stages and discharges--Continued

Site (See pl. 1 and fig. 5)	Permanent station number	Stream and place of determination	Drainage area (mi^2)	Maximum previously known				Maximum for flood periods			
				Period	Year	Gage height (ft)	Discharge (ft^3/s)	Date	Gage height (ft)	Discharge (ft^3/s)	Probability
51	09498540	North Fork Workman Creek at Sierra Ancha	.39	1938-78	1951	----------	67	2-28-78	----------	27	0.17
52	09498550	Workman Creek at Sierra Ancha	1.70	1938-78	1972	----------	289	3- 1-78	----------	188	.07
53	09498870	Rye Creek near Gisela	122	1963-78	1970	14.1	44,400	3- 2-78	6.60	8,220	.10
54	09499000	Tonto Creek above Gun Creek, near Roosevelt	675	1940-78	1970	18.2	53,000	3- 2-78	16.5	45,800	.07
55	09500500	Salt River at Roosevelt	5,824	1888-1978	1891	----------	[4]150,000	3- 2-78	----------	[4]155,000	----------
56	09501000	Reservoir system on Salt River, at and below Roosevelt Dam.	6,211	1910-78	1941	----------	[6]1,764,000	3- 4-78	----------	[6]1,259,000	----------
57	09501300	Tortilla Creek at Tortilla Flat	24.3	1942-78	1971	13.23	7,500	3- 1-78	8.67	3,000	.32
58	09502000	Salt River below Stewart Mountain Dam	[7]6,232	[3]1910-78	1966	22.4	[8]51,600	3- 2-78	17.15	29,600	----------
59	09502800	Williamson Valley Wash near Paulden	255	1965-78	1976	7.58	3,910	3- 1-78	8.22	7,490	.06
60	09503700	Verde River near Paulden	[7]2,530	1963-78	1965	8.48	6,130	3- 1-78	9.66	8,080	.07
61	09504000	Verde River near Clarkdale	[7]3,520	1915-21, 1965-78	1920	[2]19.1	50,600	3- 1-78	16.92	25,000	.13
62	09504500	Oak Creek near Cornville	357	1885-1978 1940-78	1938 1970	[9]23 16.48	---------- 24,700	3- 1-78	14.25	17,400	.07
63	09505200	Wet Beaver Creek near Rimrock	111	1961-78	1970	12.41	7,670	3- 1-78	10.46	4,360	.30
64	09505250	Red Tank Draw near Rimrock	49.4	1957-78	1970	12.69	10,500	3- 1-78	8.74	2,600	.18
65	09505300	Rattlesnake Canyon near Rimrock	24.6	1957-78	1970	11.50	3,590	3- 1-78	9.00	1,610	.24
66	09505350	Dry Beaver Creek near Rimrock	142	1960-78	1970	14.35	26,600	3- 1-78	9.25	8,410	.22
67	09505550	Verde River below Camp Verde	[7]4,670	1970-78	1970	19.0	43,000	3- 1-78	19.41	41,000	.12
68	09505800	West Clear Creek near Camp Verde	241	1964-78	1972	9.61	11,300	3- 1-78	10.15	13,800	.14
69	09507980	East Verde River near Childs	328	1961-78	1970	19.2	23,500	3- 1-78	16.0	15,000	.14
70	09508000	Verde River below East Verde River, near Pine	[7]5,623	1924-78	1938	24.7	110,000	3- 1-78	24.21	67,600	.06
71	09508300	Wet Bottom Creek near Childs	36.4	1967-78	1967 1970	---------- 14.18	5,990 ----------	[5]3- 2-78	15.66	6,660	.09
72	09508500	Verde River below Tangle Creek, above Horseshoe Dam	[7]5,872	1924-78	1938	19.0	[10]100,000	3- 1-78	21.2	91,400	.05
73	--------	Deadman Creek near Horseshoe Dam	36.3	----------	------	----------	----------	[5]3- 2-78	----------	6,620	.05
74	--------	Lime Creek near Horseshoe Dam	41.9	----------	------	----------	----------	[5]3- 2-78	----------	5,180	.1
75	--------	Davenport Creek near Horseshoe Dam	25.5	----------	------	----------	----------	[5]3- 2-78	----------	5,500	.08

See footnotes at end of table.

Table 13.--Summary of flood stages and discharges--Continued

Site (See pl. 1 and fig. 5)	Permanent station number	Stream and place of determination	Drainage area (mi^2)	Maximum previously known				Maximum for flood periods			
				Period	Year	Gage height (ft)	Discharge (ft^3/s)	Date	Gage height (ft)	Discharge (ft^3/s)	Probability
76	--------	Sheep Creek near Horseshoe Dam	34.2	----------	------	----------	----------	[5]3- 2-78	----------	6,660	0.06
77	--------	Canyon Creek near Bartlett Dam	9.2	----------	------	----------	----------	[5]3- 2-78	----------	700	.2
78	--------	Alder Creek near Bartlett Dam	11.3	----------	------	----------	----------	[5]3- 2-78	----------	1,430	.12
79	09509500	Reservoir system on Verde River at and below Horseshoe Dam.	[7]6,185	1939-78	1973	----------	[6]318,000	3- 2-78	----------	[6]304,400	----------
80	09510000	Verde River below Bartlett Dam	[7]6,185	1924-78 [3]1939-78	1938 1941	---------- [2]17.5	[10]95,000 45,800	3- 2-78	25.9	101,000	----------
81	--------	Camp Creek near Bartlett Dam	48.3	----------	------	----------	----------	[5]3- 2-78	----------	1,160	.5
82	09510070	West Fork Sycamore Creek above McFarland Canyon, near Sunflower.	4.58	1959-78	1970	5.50	1,700	[5]3- 2-78	4.81	720	.11
83	09510080	West Fork Sycamore Creek near Sunflower	9.8	1959-78	1970	9.50	3,480	[5]3- 2-78	6.60	700	.15
84	09510100	East Fork Sycamore Creek near Sunflower	4.49	1959-78	1970	9.50	1,940	[5]3- 2-78	6.18	550	.09
85	09510170	Camp Creek near Sunflower	2.6	1963-78	1963	4.96	391	3- 2-78	5.05	402	.10
86	09510200	Sycamore Creek near Fort McDowell	164	1959-78	1970	19.7	24,200	[5]3- 2-78	16.0	17,900	.09
87	09511300	Verde River near Scottsdale	[7]6,600	[3]1939-78	1941	----------	[4]45,000	3- 2-78	18.3	96,000	----------
88	09511500	Salt River below Granite Reef Dam	[7]12,900	1871-1978 [3]1939-78	1891 1965	---------- ----------	300,000 67,000	3- 2-78	----------	125,000	----------
89	09512100	Indian Bend Wash at Scottsdale	[7]62	1922-78	1972	4.90	21,000	3- 2-78	3.50	3,180	.15
90	09512160	Indian Bend Wash at McDowell Road, at Scottsdale	----------	1961-78	1972	----------	14,300	3- 2-78	9.98	3,400	----------
91	09512170	Salt River at Jointhead Dam, at Phoenix	[7]13,500	1871-1978 [3]1939-78	1891 1965	---------- 10.3	300,000 66,000	3- 2-78	12.50	122,400	----------
92	09512300	Cave Creek near Cave Creek	-121	1958-78	1968	8.62	12,400	3- 2-78	7.52	7,500	.11
93	09512400	Cave Creek at Phoenix	-[7]252	1957-78	1967	11.23	4,080	3- 2-78	7.36	2,090	.10
94	09512500	Agua Fria River near Mayer	588	1940-78	1970	14.90	19,800	3- 1-78	10.45	9,900	.20
95	09512700	Agua Fria River tributary No. 2 near Rock Springs.	1.11	1963-78	1964	19.54	1,200	3- 2-78	14.6	920	.07
96	09512800	Agua Fria River near Rock Springs	1,130	1891-1978	1919,	----------	[4]85,000	3- 2-78	24.27	39,500	.11
97	09513000	Agua Fria River at Waddell Dam	1,459	1891-1978, [3]1928-78	1916, 1919, 1941	---------- [2]33.0 ----------	105,000 ([13]) [14]11,100	3- 2-78 3- 5-78	---------- ----------	[12]47,600 [14]16,300	.12 ----------
98	09513500	Lake Pleasant at Waddell Dam	1,459	1928-78	1941 1966	---------- 170.28	[6]178,500 ----------	3- 5-78	[11]168.7	[6]153,000	----------
99	09513650	Agua Fria River at El Mirage	[7]1,637	1963-78	1970	4.60	5,000	3- 6-78	7.95	9,870	----------
100	09513780	New River near Rock Springs	67.3	1960-78	1970	13.5	18,600	3- 2-78	9.40	13,600	.06

See footnotes at end of table.

Table 13.--Summary of flood stages and discharges--Continued

Site (See pl. 1 and fig. 5)	Permanent station number	Stream and place of determination	Drainage area (mi^2)	Maximum previously known				Maximum for flood periods			
				Period	Year	Gage height (ft)	Discharge (ft^3/s)	Date	Gage height (ft)	Discharge (ft^3/s)	Probability
101	09513800	New River at New River	83.3	1960-78	1970	[2]9.98	19,500	3- 2-78	12.34	18,000	0.05
102	09513320	Deadman Wash near New River	11.1	1959-78	1959	7.0	1,850	3- 2-78	5.11	1,400	.12
103	09513835	New River at Bell Road, near Peoria	187	1960-78	1967	13.5	14,600	3- 2-78	11.0	12,500	.10
104	09513860	Skunk Creek near Phoenix	64.6	1960-78	1964 1970	---------- 12.24	11,500 ----------	2-28-78	9.65	3,590	.20
105	09513910	New River near Glendale	323	1943-78	1943	----------	38,000	3- 2-78	9.08	12,300	.12
106	09513970	Agua Fria River at Avondale	[7]2,013	1959-78	1970	11.21	20,600	3- 2-78	5.63	13,100	----------
107	09515500	Hassayampa River at Box damsite, near Wickenburg	417	1891-1978	1970	34.6	58,000	3- 2-78	14.50	16,000	.10
108	09516500	Hassayampa River near Morristown	774	1921-78	1970	19.0	47,500	3- 1-78	12.93	24,000	.05
109	09517000	Hassayampa River near Arlington	1,470	1961-78	1970	8.40	39,000	3- 2-78	5.80	20,400	.07
110	09517500	Centennial Wash near Arlington	1,810	1961-78	1961	4.70	14,500	3- 2-78	4.64	10,900	.10
111	09519500	Gila River below Gillespie Dam	[7]49,650	1891-1978 [3]1939-78	1891 1965	---------- 16.1	[4]250,000 64,200	3- 4-78	16.08	92,900	----------
112	--------	Painted Rock Reservoir at Painted Rock Dam	[7]50,910	1959-78	1973	601.25	[6]439,860	3-12-78	398.13	[6]385,400	----------
113	09519800	Gila River below Painted Rock Dam	[7]50,910	1959-78	1973	10.29	2,860	3- 4-78	6.51	1,060	----------

[1]Contributing drainage area.
[2]Site and datum then in use.
[3]Period of regulation.
[4]Estimated on basis of records at another site.
[5]Probable date.
[6]Contents, in acre-feet; data for 1978 show maximum February 28 to March 10, 1978.
[7]Includes some noncontributing area or discharge is materially affected by storage, regulation, or diversion above station. See Station Data for details.
[8]May have been exceeded in January 1916 when a maximum daily discharge of 50,000 ft^3/s was released from Roosevelt Dam.
[9]At upstream side of bridge.
[10]Peak of February 1891 probably exceeded 150,000 ft^3/s.
[11]Reservoir reached a stage of 170.57 ft on March 23, 1978.
[12]Inflow to Lake Pleasant; see Station Data.
[13]Probably exceeded that of 1916.
[14]Released to Agua Fria River.

Station Data

GILA RIVER BASIN

(1) 09470000 Gila River at Winkelman, Ariz.

Location.--Lat 33°00'06", long 110°45'55", in NW¼NE¼ sec.13, T.5 S., R.15 E., Gila County, Hydrologic Unit 15050100, on right bank 1 mi (1.6 km) north of Winkelman, 2.2 mi (3.5 km) upstream from San Pedro River, and 29 mi (47 km) downstream from Coolidge Dam.

Drainage area.--13,268 mi² (34,364 km²), of which 382 mi² (989 km²) is below Coolidge Dam.

Gage-height record.--Digital water-stage recorder tape. Datum of gage is 1,921.76 ft (585.752 m) National Geodetic Vertical Datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--October 6-11, 1977: Discharge, 5,020 ft³/s (142 m³/s) 2100 hours Oct. 6, gage height, 11.04 ft (3.365 m).
1932 to September 1977: Discharge, 55,000 ft³/s (1,560 m³/s), of which 500 ft³/s (14.2 m³/s) was released by Coolidge Dam, Aug. 9, 1944, gage height, 18.40 ft (5.608 m), from rating curve extended above 2,900 ft³/s (82 m³/s) on basis of slope-area measurement of peak flow.

Remarks.--Flow regulated by San Carlos Reservoir since 1928.

Mean discharge, in cubic feet per second, 1977

Day	Discharge	Day	Discharge	Day	Discharge
Oct. 5	11	Oct. 8	45	Oct. 11	20
6	1,040	9	27		
7	284	10	22		

(2) 09470500 San Pedro River at Palominas, Ariz.

Location.--Lat 31°22'48", long 110°06'38", in SW¼SE¼ sec.33, T.23 S., R.22 E., Cochise County, Hydrologic Unit 15050202, near left bank on downstream side of pier of bridge on State Highway 92, 0.7 mi (1.1 km) east of Palominas, 2.5 mi (4.0 km) upstream from Green Brush Draw, 4.5 mi (7.2 km) downstream from international boundary, and 12 mi (19 km) southwest of Bisbee.

Drainage area.--741 mi² (1,919 km²), of which 649 mi² (1,681 km²) is in Mexico.

Gage-height record.--Digital water-stage recorder tape. Datum of gage is 4,187.62 ft (1,276.387 m) National Geodetic Vertical Datum of 1929 (State Highway Department bench mark).

Discharge record.--Stage-discharge relation defined by current-meter measurements below 4,000 ft³/s (113 m³/s) and extended above on basis of slope-area measurement of peak discharge.

Maxima.--October 1977: Discharge, 14,500 ft³/s (411 m³/s) 1245 hours Oct. 9, gage height, 16.04 ft (4.89 m).
1927 to September 1977: Discharge, 22,000 ft³/s (623 m³/s) Aug. 14, 1940, gage height, 16.16 ft (4.926 m), present datum, from rating curve extended above 5,600 ft³/s (160 m³/s) on basis of slope-area measurement of peak flow.
1906 to September 1977: Gage height, about 23.9 ft (7.28 m), present datum, from floodmarks; Sept. 28, 1926, discharge not determined, probably between 40,000 and 60,000 ft³/s (1,130 and 1,700 m³/s).

(2) 09470500 San Pedro River at Palominas, Ariz.—Continued

Mean discharge, in cubic feet per second, 1977

Day	Discharge	Day	Discharge	Day	Discharge
Oct. 7	8.4	Oct. 10	2,050	Oct. 13	288
8	9,190	11	634	14	140
9	10,300	12	401	15	75

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1977

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Oct. 7			Oct. 8—Con.			Oct. 9—Con.		
2400	4.63	54	2200	15.06	12,400	1600	13.61	9,660
Oct. 8			2400	14.96	12,200	1800	13.02	8,710
0100	6.19	1,040	Oct. 9			1900	13.64	9,700
0300	7.76	2,190	0200	14.57	11,400	2000	13.87	10,100
0600	10.19	4,740	0400	13.17	8,950	2100	13.40	9,320
0800	11.94	7,090	0500	12.04	7,180	2200	12.74	8,260
0900	13.30	9,220	0600	12.34	7,620	2400	10.37	4,900
1200	14.81	11,900	0700	14.28	10,800	Oct. 10		
1315	15.76	13,800	0800	15.37	12,900	0600	8.07	2,430
1400	15.40	13,100	0845	15.62	13,400	1200	7.10	1,620
1545	15.11	12,500	0930	15.57	13,300	1800	6.35	1,110
1645	15.45	13,200	1130	14.40	11,000	2400	5.85	835
1800	14.87	12,000	1200	15.05	12,300	Oct. 11		
2015	15.70	13,700	1245	16.04	14,500	1200	5.46	630
2100	15.51	13,300	1400	15.05	12,300	2400	5.18	462

(3) 09471000 San Pedro River at Charleston, Ariz.

Location.--Lat 31°37'33", long 110°10'26", in NE¼NE¼ sec.11, T.21 S., R.21 E., Cochise County, Hydrologic Unit 15050202, in Spanish land grant of San Juan de las Boquillas y Nogales, at downstream side of pier near center of highway bridge, 0.3 mi (0.5 km) south of Charleston, 1.5 mi (2.4 km) upstream from Charleston damsite, and 9 mi (14 km) upstream from Babocomari River.

Drainage area.--1,219 mi² (3,157 km²), of which 696 mi² (1,803 km²) is in Mexico.

Gage-height record.--Water-stage recorder graph. Datum of gage is 3,954.01 ft (1,205.182 m) National Geodetic Vertical Datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 7,600 ft³/s (215 m³/s).

Maxima.--October 1977: Discharge, 23,700 ft³/s (671 m³/s) 1400 hours Oct. 9, gage height, 10.60 ft (3.231 m).

1906 to September 1977: Discharge, about 98,000 ft³/s (2,780 m³/s) Sept. 28, 1926, gage height, 21.9 ft (6.68 m), site and datum then in use, by slope-area measurement of peak flow.

(3) 09471000 San Pedro River at Charleston, Ariz.—Continued

Mean discharge, in cubic feet per second, 1977

Day	Discharge	Day	Discharge	Day	Discharge
Oct. 6	434	Oct. 9	18,400	Oct. 12	414
7	137	10	5,670		
8	5,870	11	838		

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1977

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Oct. 6			Oct. 8—Con.			Oct. 9—Con.		
0015	2.59	19	1600	7.80	8,900	1700	10.4	22,400
1600	2.53	14	1800	7.80	8,900	1800	10.0	20,000
1830	2.63	20	2000	8.25	11,000	1900	10.4	22,400
1900	5.45	2,300	2100	8.85	13,800	2100	9.8	18,800
1930	6.23	3,980	2400	9.15	15,200	2200	10.2	21,200
2000	6.12	3,700	Oct. 9			2400	9.3	16,000
2200	4.55	955	0030	9.22	15,600	Oct. 10		
2400	3.98	444	0130	9.05	14,800	0130	9.4	16,500
Oct. 7			0300	9.55	17,300	0300	8.7	13,000
0300	3.46	186	0430	9.15	15,200	0600	6.9	6,300
2000	2.83	41	0530	9.40	16,500	1000	5.78	3,420
2300	3.10	88	0630	9.10	15,000	1200	5.40	2,740
2400	4.70	1,130	0730	9.33	16,200	1800	4.80	1,870
Oct. 8			0900	9.00	14,500	2400	4.33	1,310
0500	4.02	470	1200	10.07	20,400	Oct. 11		
0700	5.25	1,920	1400	10.60	23,700	1200	3.79	802
1200	6.26	4,050	1500	10.10	20,600	2400	3.46	552

(4) 09471550 San Pedro River near Tombstone, Ariz.

Location.--Lat 31°45'03", long 110°12'02", in SE¼ sec.28, T.19 S., R.21 E. (unsurveyed), Cochise County, Hydrologic Unit 15050202, in Spanish land grant of San Juan de las Boquillas y Nogales, on right bank 0.5 mi (0.8 km) downstream from Willow Wash, 2.6 mi (4.2 km) north of Fairbank, and 8 mi (13 km) northwest of Tombstone.

Drainage area.--1,740 mi² (4,510 km²) approximately, of which 696 mi² (1,800 km²) is in Mexico.

Gage-height record.--Digital water-stage recorder tape. Altitude of gage is 3,780 ft (1,152 m), from topographic map.

Discharge record.--Average stage-discharge relation defined by current-meter measurements below 4,200 ft³/s (119 m³/s) and extended above on basis of slope-area measurements at 6.23, 8.89, and 11.40 ft (1.899, 2.710, and 3.475 m). Shift adjustment curve used during flood period defined below 300 ft³/s (8.5 m³/s). Record is poor.

Maxima.--October 1977: Discharge, 24,200 ft³/s (685 m³/s) 1530 hours Oct. 9, gage height, 11.40 ft (3.475 m).
1967 to September 1977: Discharge, 18,500 ft³/s (524 m³/s) July 20, 1974, gage height, 10.43 ft (3.179 m).

(4) 09471550 San Pedro River near Tombstone, Ariz.—Continued

Mean discharge, in cubic feet per second, 1977

Day	Discharge	Day	Discharge	Day	Discharge
Oct. 6	430	Oct. 8	5,420	Oct. 10	4,700
7	338	9	17,100	11	810

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1977

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Oct. 6			Oct. 8—Con.			Oct. 9—Con.		
0100	3.80	340	1500	6.86	5,880	2000	10.80	21,300
0300	3.30	64	1800	7.92	8,960	2100	10.74	21,000
1200	2.99	14	2000	8.73	11,700	2200	11.06	22,600
1500	2.99	14	2100	8.81	12,000	2400	9.46	14,700
1700	3.10	26	2200	9.59	15,200	Oct. 10		
2000	4.18	690	2300	9.24	13,800	0100	9.33	14,300
2100	3.95	470	2400	9.66	15,500	0200	9.56	15,200
2200	6.12	3,730	Oct. 9			0300	8.99	12,900
2230	5.91	3,290	0100	9.44	14,600	0600	7.11	6,690
2400	4.75	1,350	0200	9.58	15,200	1200	5.25	2,400
Oct. 7			0300	9.54	15,000	1500	5.05	2,070
0600	3.93	452	0400	8.90	12,500	1800	4.76	1,630
1200	3.63	216	0600	9.46	14,700	2100	4.49	1,260
1800	3.54	156	0700	9.32	14,200	2400	4.42	1,170
2400	3.37	85	0800	9.81	16,400	Oct. 11		
Oct. 8			0900	9.50	14,900	0200	4.34	1,080
0100	3.35	138	1000	9.48	14,800	0500	4.44	1,210
0200	3.36	142	1200	9.11	13,300	1000	4.08	790
0300	4.67	1,450	1400	10.59	20,200	1100	4.12	830
0400	4.45	1,160	1500	10.46	19,600	1200	4.12	830
0600	4.16	820	1530	11.40	24,200	1500	3.94	650
0700	4.31	982	1600	10.8	21,200	1800	3.94	650
0800	4.23	893	1700	10.5	19,700	2100	3.84	551
0900	5.21	2,270	1800	10.56	20,100	2400	3.74	461
1200	6.44	4,820	1900	10.52	19,900			

(5) 09472000 San Pedro River near Redington, Ariz.

Location.--Lat 32°22'50", long 110°26'45", in NE¼NW¼ sec.19, T.12 S., R.19 E., Cochise County, Hydrologic Unit 15050203, on left bank 0.3 mi (0.5 km) upstream from Cochise-Pima County line, 4.3 mi (6.9 km) southeast of Redington, and 30 mi (48 km) north of Benson.

Drainage area.--2,939 mi² (7,612 km²), of which 696 mi² (1,803 km²) is in Mexico.

Gage-height record.--Water-stage recorder graph prior to 1200 hours Oct. 9. Datum of gage is 2,930.04 ft (893.076 m) National Geodetic Vertical Datum of 1929.

Discharge record.--Daily discharges estimated for period of missing record.

(5) 09472000 San Pedro River near Redington, Ariz.—Continued

Maxima.--October 1977: Discharge, 23,000 ft³/s (651 m³/s) Oct. 10, from slope-area measurement of peak flow, gage height, 21.40 ft (6,523 m).

1906 to September 1977: Discharge, about 90,000 ft³/s (2,550 m³/s) Sept. 28, 1926, gage height, 29.0 ft (8.84 m), present site and datum, from floodmark, computed on basis of peak discharges of San Pedro River at Charleston and Gila River at Kelvin.

Mean discharge, in cubic feet per second, 1977

Day	Discharge	Day	Discharge	Day	Discharge
Oct. 6	52	Oct. 9	9,200	Oct. 12	700
7	399	10	15,000		
8	665	11	1,400		

(6) 09473000 Aravaipa Creek near Mammoth, Ariz.

Location.--Lat 32°50'37", long 110°37'07", in NW¼NW¼ sec.9, T.7 S., R.17 E., Pinal County, Hydrologic Unit 15050203, on right bank 6 mi (10 km) upstream from mouth, and 9 mi (14 km) north of Mammoth.

Drainage area.--541 mi² (1,401 km²).

Gage-height record.--Digital water-stage recorder tape. Altitude of gage is 2,350 ft (716 m), from topographic map.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--October 6-11, 1977: Discharge, 385 ft³/s (10.9 m³/s) 1630 hours Oct. 6, gage height, 2.86 ft (0.872 m).

1931 to September 1977: Discharge, 10,500 ft³/s (297 m³/s) Dec. 19, 1967, gage height, 11.86 ft (3.615 m), in gage well, 14.25 ft (4.343 m), from profile past gage, from rating curve extended above 430 ft³/s (12 m³/s) on basis of slope-area measurement at gage height 12.5 ft (3.81 m), from profile past gage.

Outside period of record: A discharge of 20,000 ft³/s (566 m³/s) occurred Aug. 2, 1919, at site of former gaging station 6 mi (10 km) downstream, operated April 1919 to September 1921, gage height, 6.3 ft (1.92 m), from floodmark, site and datum then in use, from rating curve extended above 5,100 ft³/s (140 m³/s) on basis of velocity-area study.

Mean discharge, in cubic feet per second, 1977

Day	Discharge	Day	Discharge	Day	Discharge
Oct. 6	37	Oct. 8	14	Oct. 10	11
7	52	9	17	11	9.6

(7) 09473500 San Pedro River at Winkelman, Ariz.

Location.--Lat 32°58'38", long 110°46'11", in SE¼SW¼ sec.24, T.5 S., R.15 E., Pinal County, Hydrologic Unit 15050203, on right bank 0.7 mi (1.1 km) south of Winkelman, and 1.0 mi (1.6 km) upstream from mouth.

Drainage area.--4,471 mi² (11,580 km²), of which 696 mi² (1,803 km²) is in Mexico.

Gage-height record.--Water-stage recorder graph from manometer gage to 1200 hours Oct. 10. Short periods were reconstructed. Altitude of gage is 1,925 ft (587 m), from topographic map.

(7) 09473500 San Pedro River at Winkelman, Ariz.—Continued

Discharge record.--Stage-discharge relation defined by current-meter measurements below 4,200 ft^3/s (119 m^3/s) and extended above on basis of slope-area measurement for flood of Dec. 22-23, 1965, at site 3.5 mi (5.6 km) upstream, at discharge of 16,800 ft^3/s (476 m^3/s). Discharges estimated for period of no gage-height record.

Maxima.--October 1977: Discharge, 16,000 ft^3/s (453 m^3/s) about 1800 hours Oct. 10, gage height, 12.93 ft (3.941 m), from outside high-water mark near gage.
1906 to September 1977: Discharge, about 85,000 ft^3/s (2,410 m^3/s) Sept. 28, 1926, on basis of interpolation between discharges of San Pedro River at Mammoth and Gila River near Kelvin.

Mean discharge, in cubic feet per second, 1977

Day	Discharge	Day	Discharge	Day	Discharge
Oct. 6	383	Oct. 9	2,070	Oct. 12	558
7	373	10	9,980		
8	219	11	3,000		

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1977

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Oct. 6			Oct. 7—Con.			Oct. 10—Con.		
0015	5.52	2	1830	7.6	985	1200	11.80	7,800
1320	5.50	2	2400	6.85	455	1400	-----	12,000
1330	6.79	419	Oct. 8			1600	-----	14,500
1400	6.32	180	0600	6.65	320	1700	-----	16,000
1530	6.17	117	1200	6.39	206	1800	12.93	16,000
1630	7.9	1,260	1800	6.1	97	2200	-----	16,000
1700	8.80	2,310	2400	5.9	53	2400	-----	13,000
1830	8.00	1,360	Oct. 9			Oct. 11		
2030	6.93	498	0600	5.8	36	0200	-----	9,800
2100	7.15	645	0630	8.15	1,520	0400	-----	6,500
2400	7.60	1,010	0900	8.77	2,210	0600	-----	3,900
Oct. 7			1200	9.15	2,590	0800	-----	2,300
0600	6.05	85	1800	9.65	3,120	1000	-----	1,500
1130	5.78	26	2000	9.65	3,120	1200	-----	1,100
1230	6.11	100	2400	10.00	3,730	1400	-----	950
1330	6.04	83	Oct. 10			1600	-----	870
1400	6.27	162	0300	10.50	4,680	2000	-----	750
1700	6.52	262	0800	11.27	6,420	2400	-----	680
1800	6.44	226	1100	11.75	7,620			

(8) 09474000 Gila River at Kelvin, Ariz.

Location.--Lat 33°06'10", long 110°58'33", in NE¼NW¼ sec.12, T.4 S., R.13 E., Pinal County, Hydrologic Unit 15050100, on left bank at Kelvin, 500 ft (152 m) downstream from Mineral Creek, 18 mi (29 km) downstream from San Pedro River, and 19 mi (31 km) upstream from Ashurst-Hayden Dam.

Drainage area.--18,011 mi^2 (46,648 km^2), of which 5,125 mi^2 (13,274 km^2) is below Coolidge Dam.

(8) 09474000 Gila River at Kelvin, Ariz.—Continued

Gage-height record.--Water-stage recorder graph except 0100 to 1300 hours Oct. 12, which was estimated. Datum of gage is 1,745.02 ft (531.882 m) National Geodetic Vertical Datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--October 1977: Discharge, 16,100 ft^3/s (456 m^3/s) 1000 hours Oct. 11, gage height, 20.40 ft (6.218 m).

1928 to September 1977: Discharge, 42,800 ft^3/s (1,210 m^3/s) Aug. 8, 1930, gage height, 12.6 ft (3.84 m).

1911 to September 1977: Discharge, about 132,000 ft^3/s (3,740 m^3/s) Jan. 20, 1916, gage height, 19.5 ft (5.94 m), from rating curve extended above slope-area measurement for peak flow of Sept. 28, 1926, at gage height 16.2 ft (4.94 m).

Remarks.--Flow partially regulated by San Carlos Reservoir 49 mi (79 km) upstream since Nov. 15, 1928.

Mean discharge, in cubic feet per second, 1977

Day	Discharge	Day	Discharge	Day	Discharge
Oct. 5	8.2	Oct. 9	1,360	Oct. 13	288
6	292	10	3,550	14	158
7	903	11	10,400		
8	317	12	879		

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1977

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Oct. 5			Oct. 8			Oct. 10—Con.		
2400	2.92	7.0	0300	6.30	490	2400	14.3	7,960
Oct. 6			0900	5.54	347	Oct. 11		
1600	3.00	9.0	1500	5.08	248	0100	15.2	9,040
1800	3.50	28	2100	4.69	184	0300	16.5	10,600
1900	5.40	220	2400	4.52	158	0500	17.8	12,200
2000	6.10	415	Oct. 9			0600	18.5	13,200
2100	7.70	1,260	0400	4.38	152	0800	19.7	15,000
2200	8.40	1,830	0900	4.22	129	1000	20.40	16,100
2400	8.80	2,200	1000	7.00	810	1400	18.8	13,700
Oct. 7			1200	8.20	1,610	1600	16.5	10,600
0500	9.00	2,400	1400	8.7	2,030	1800	14.2	7,840
0600	8.10	1,570	1800	8.98	2,280	1900	12.75	6,150
0700	7.20	930	2400	9.30	2,600	2100	10.0	3,500
0800	6.70	660	Oct. 10			2400	8.4	1,770
1000	6.10	450	0800	9.65	2,980	Oct. 12		
1200	5.80	398	1200	9.70	3,050	0600	7.4	1,140
1500	5.30	290	1500	9.85	3,280	1200	6.8	780
1800	5.00	240	1800	10.2	3,600	1800	6.35	566
2100	5.50	334	2100	10.9	4,300	2400	6.00	429
2400	6.70	660	2300	12.75	6,150			

(9) 09479500 Gila River near Laveen, Ariz.

Location.--Lat 33°15'25", long 112°09'59", in SW¼NW¼ sec.16, T.2 S., R.2 E., Pinal County, Hydrologic Unit 15050100, in Gila River Indian Reservation, on left abutment of highway bridge, 2.1 mi (3.4 km) upstream from Santa Cruz River, 2.6 mi (4.2 km) south of Komatke, and 7.3 mi (11.7 km) south of Laveen. Supplementary water-stage recorder on overflow channel at highway bridge 0.2 mi (0.3 km) south.

Drainage area.--20,615 mi² (53,393 km²), of which 696 mi² (1,803 km²) is in Mexico and 7,729 mi² (20,018 km²) is below Coolidge Dam.

Gage-height record.--From two water-stage recorders. Datum of both gages is 1,018.90 ft (310.561 m) National Geodetic Vertical Datum of 1929. Gage heights given are for base gage.

Discharge record.--Both stage-discharge relations defined by current-meter measurements. Records include flow in main and overflow channels.

Maxima.--March 1978: Discharge, 1,930 ft³/s (54.6 m³/s) 1915 hours Mar. 6, gage height, 8.16 ft (2.487 m) at base gage.
October 1977: Discharge, 6,360 ft³/s (180 m³/s) 1545 hours Oct. 13, gage height, 9.64 ft (2.938 m) at base gage.
1940 to September 1977: Discharge, 11,900 ft³/s (337 m³/s) Jan. 2, 1941, gage height, 9.33 ft (2.844 m); gage height, 10.08 ft (3.072 m) Dec. 26, 1965, result of backwater.

Remarks.--Flow partly regulated by storage in San Carlos Reservoir since 1928; discharge represents runoff from area below the reservoir.

Mean discharge, in cubic feet per second, 1977-78

Day	Discharge	Day	Discharge	Day	Discharge
Oct. 10	4.4	Oct. 16	16	Mar. 7	1,310
11	177	Mar. 2	1.5	8	424
12	865	3	437	9	141
13	2,940	4	973	10	26
14	1,160	5	1,120	11	1.4
15	52	6	1,690		

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1977

Hour	[a]Gage height	[b]Discharge	Hour	[a]Gage height	[b]Discharge	Hour	[a]Gage height	[b]Discharge
Oct. 11			Oct. 12—Con.			Oct. 14		
0015	3.86	1.9	2400	7.89	1,050	0400	8.49	2,090
1300	3.87	2.6	Oct. 13			0800	8.23	1,510
1400	3.97	18	0300	7.92	1,090	1000	8.12	1,280
1500	5.49	293	0800	7.99	1,210	1200	8.00	1,040
1600	6.31	343	1230	8.12	1,420	1300	7.85	903
2000	7.23	476	1300	8.19	1,760	1400	7.58	699
2300	7.41	562	1400	9.07	4,740	1500	7.28	521
2400	7.42	609	1500	9.48	6,060	1600	6.95	394
Oct. 12			1545	9.64	6,360	1700	6.52	360
0300	7.51	690	1800	9.56	5,910	2000	5.38	292
1200	7.72	882	2100	9.20	4,580	2400	4.44	203
1900	7.85	1,000	2400	8.84	2,530			

a Gage height for main channel.
b Total of main channel and overflow channel.

(10) 09480000 Santa Cruz River near Lochiel, Ariz.

Location.--Lat 31°21'19", long 110°35'20", in SW¼ sec.11, T.24 S., R.17 E. (unsurveyed), Santa Cruz County, Hydrologic Unit 15050301, on south border of Spanish land grant of San Rafael, near left bank on downstream side of pier of bridge on county road, 1.7 mi (2.7 km) upstream from international boundary, and 2.5 mi (4.0 km) northeast of Lochiel.

Drainage area.--82.2 mi² (212.9 km²).

Gage-height record.--Digital water-stage recorder tape. Altitude of gage is 4,620 ft (1,408 m), from topographic map.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 1,600 ft³/s (45 m³/s) and extended above on basis of slope-area measurements of peak flows at gage heights of 8.90 and 10.21 ft (2.712 and 3.112 m).

Maxima.--October 1977: Discharge, 12,000 ft³/s (340 m³/s) 0930 hours Oct. 9, gage height, 10.21 ft (3.112 m).
1949 to September 1977: Discharge, 4,810 ft³/s (136 m³/s) Sept. 12, 1965, gage height, 8.90 ft (2.713 m).

Mean discharge, in cubic feet per second, 1977

Day	Discharge	Day	Discharge	Day	Discharge
Oct. 7	1.1	Oct. 10	78	Oct. 13	14
8	349	11	33		
9	1,710	12	19		

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1977

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Oct. 7			Oct. 8—Con.			Oct. 9—Con.		
1200	2.15	0.7	1100	5.67	1,180	1000	9.74	9,160
1600	2.14	.6	1130	5.69	1,190	1030	9.38	7,230
2000	2.20	.9	1200	5.48	1,050	1100	9.01	5,600
2200	2.47	3.5	1400	4.48	521	1200	7.72	3,250
2300	2.55	4.8	1600	3.85	296	1300	6.38	1,750
2400	2.47	3.5	2000	3.20	140	1400	5.35	967
Oct. 8			2400	2.81	77	1500	4.62	582
0045	2.46	40	Oct. 9			1600	4.10	374
0115	2.81	77	0400	2.66	60	1800	3.65	242
0430	2.63	57	0600	2.72	67	2000	3.48	200
0600	3.11	123	0630	4.34	463	2400	3.19	138
0700	3.87	301	0700	5.76	1,240	Oct. 10		
0715	4.17	398	0730	8.00	3,660	0600	2.96	106
0800	4.09	370	0800	9.40	7,320	1200	2.75	77
0900	5.20	878	0830	9.79	9,460	1800	2.62	58
0930	5.56	1,110	0900	10.09	11,400	2400	2.54	46
1045	5.56	1,110	0930	10.21	12,000			

(11) 09480500 Santa Cruz River near Nogales, Ariz.

Location.--Lat 31°20'40", long 110°51'03", in NW¼ sec.18, T.24 S., R.15 E. (unsurveyed), Santa Cruz County, Hydrologic Unit 15050301, in Spanish land grant of Maria Santisima del Carmen, on left bank 0.8 mi (1.3 km) downstream from international boundary, and 5.5 mi (8.8 km) east of Nogales.

Drainage area.--533 mi² (1,380 km²), of which 348 mi² (901 km²) is in Mexico.

Gage-height record.--Water-stage recorder graph prior to 0600 hours Oct. 9. Gage-height record reconstructed on basis of flood marks of two crests, observation of the trough between peaks, a short record of stage at highway bridge 5 mi (8 km) downstream, and staff-gage reading on Oct. 10. Datum of gage is 3,702.54 ft (1,128.534 m) National Geodetic Vertical Datum of 1929 (levels by International Boundary and Water Commission).

Discharge record.--Stage-discharge relation poorly defined by current-meter measurements below 17,000 ft³/s (481 m³/s) and extended above on basis of slope-area measurement of peak flow.

Maxima.--October 1977: Discharge, 31,000 ft³/s (878 m³/s) 1630 hours Oct. 9, gage height, 15.5 ft (4.72 m).
1927 to September 1977: Discharge, 17,100 ft³/s (484 m³/s) Aug. 1, 1974, from slope-area measurement of peak flow. Gage height, 13.71 ft (4.179 m) Aug. 20, 1955.

Mean discharge, in cubic feet per second, 1977

Day	Discharge	Day	Discharge	Day	Discharge
Oct. 6	8.1	Oct. 9	13,200	Oct. 12	298
7	214	10	1,910		
8	10,200	11	504		

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1977

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Oct. 6			Oct. 8—Con.			Oct. 9—Con.		
2400	3.76	0.2	1400	11.5	15,800	1000	13.6	23,400
Oct. 7			1500	11.5	15,800	1200	11.8	16,800
1700	3.75	.2	1600	11.9	17,200	1400	11.1	14,500
2000	3.90	1.3	1730	12.5	19,300	1600	11.0	14,200
2020	4.15	98	1900	12.1	17,900	1630	15.5	31,000
2040	4.00	64	2200	10.7	13,300	1730	13.8	24,200
2100	5.70	1,760	2300	8.9	8,260	1900	12.2	18,200
2130	5.55	1,530	2400	7.65	5,330	2100	10.1	11,500
2230	5.80	1,920	Oct. 9			2400	8.1	6,340
2400	5.20	1,060	0030	7.2	4,400	Oct. 10		
Oct. 8			0045	6.4	2,920	0400	6.4	2,920
0230	5.50	1,460	0100	7.3	4,600	0800	5.7	1,760
0430	5.50	1,460	0130	7.3	4,600	0830	5.35	1,530
0600	7.30	4,600	0145	7.9	5,880	1000	5.65	1,680
0700	8.7	7,780	0200	6.8	3,640	1200	5.45	1,390
0800	9.2	9,020	0300	6.9	3,820	1800	5.05	880
1000	9.75	10,500	0430	8.5	7,300	2400	4.87	690
1130	9.95	11,100	0530	8.55	7,420			
1300	10.30	12,100	0800	11.5	14,200			

(12) Potrero Creek above Nogales Wash near Nogales, Ariz.

(Miscellaneous site)

Location.--Lat 31°23'35", long 110°57'20", in SW¼ sec.30, T.23 S., R.14 E., Santa Cruz County, Hydrologic Unit 15050301, at U.S. Highway 89, 3 mi (4.8 km) north of Nogales city limits.

Drainage area.--14.4 mi² (37.3 km²).

Maximum.--October 1977: Discharge, 1,650 ft³/s (46.7 m³/s) about 0730 hours Oct. 9, from contracted-opening measurement of peak flow. Data furnished by Soil Conservation Service.

(13) Nogales Wash above Mariposa Canyon at Nogales, Ariz.

(Miscellaneous site)

Location.--Lat 31°22'00", long 110°55'45", in SE¼ sec.5, T.24 S., R.14 E., Santa Cruz County, Hydrologic Unit 15050301, 0.25 mi (0.4 km) upstream from Mariposa Canyon, 1.2 mi (1.9 km) downstream from Nogales city limits.

Drainage area.--42.4 mi² (110 km²).

Maximum.--October 1977: Discharge, 3,200 ft³/s (90.6 m³/s) Oct. 9, from slope-area measurement of peak flow. Data furnished by Soil Conservation Service.

(14) Mariposa Canyon at Interstate Highway 19 at Nogales, Ariz.

(Miscellaneous site)

Location.--Lat 31°21'55", long 110°56'40", in SE¼ sec.6, T.24 S., R.14 E., Santa Cruz County, Hydrologic Unit 15050301, at Interstate Highway 19 crossing, 1.0 mi (1.6 km) north of Nogales city limits.

Drainage area.--12.7 mi² (33.0 km²).

Maximum.--October 1977: Discharge, 600 ft³/s (17.0 m³/s) Oct. 9, from culvert measurement of peak flow. Data furnished by Water Development Corporation.

(15) Nogales Wash near mouth near Nogales, Ariz.

(Miscellaneous site)

Location.--Lat 31°23'30", long 110°57'00", in NE¼ sec.31, T.23 S., R.14 E., Santa Cruz County, Hydrologic Unit 15050301, 0.3 mi (0.5 km) upstream from mouth, and 3.0 mi (4.8 km) north of Nogales city limits.

Drainage area.--61.0 mi² (158 km²).

Maximum.--October 1977: Discharge, 4,200 ft³/s (119 m³/s) Oct. 9, from slope-area measurement of peak flow. Data furnished by Soil Conservation Service.

(16) Alamo Canyon near Nogales, Ariz.

(Miscellaneous site)

Location.--Lat 31°24'30", long 110°57'40", in SE¼ sec.13, T.23 S., R.13 E., Santa Cruz County, Hydrologic Unit 15050301, at Interstate Highway 19, 0.3 mi (0.5 km) upstream from mouth, and 4.2 mi (6.8 km) north of Nogales city limits.

Drainage area.--5.5 mi^2 (14.2 km^2).

Maximum.--October 1977: Discharge, about 1,500 ft^3/s (42.5 m^3/s) Oct. 9, estimated on basis of hand-level survey of peak flow at concrete box culvert.

(17) Pesquiera Canyon near Nogales, Ariz.

(Miscellaneous site)

Location.--Lat 31°25'20", long 110°57'50", in SE¼ sec.13, T.23 S., R.13 E., Santa Cruz County, Hydrologic Unit 15050301, at U.S. Highway 89, 0.25 mi (0.4 km) upstream from mouth, and 5.2 mi (8.4 km) north of Nogales city limits.

Drainage area.--8.4 mi^2 (21.8 km^2).

Maximum.--October 1977: Discharge, about 2,000 ft^3/s (56.6 m^3/s) Oct. 9, estimated on basis of hand-level survey of peak flow at concrete box culvert.

(18) Potrero Creek at mouth near Nogales, Ariz.

(Miscellaneous site)

Location.--Lat 31°26'40", long 110°57'40", in NE¼ sec.12, T.23 S., R.13 E., Santa Cruz County, Hydrologic Unit 15050301, at the international sewage treatment plant, 0.25 mi (0.4 km) upstream from mouth, and 5.6 mi (9.0 km) north-northwest of Nogales.

Drainage area.--91.4 mi^2 (237 km^2).

Maximum.--October 1977: Discharge, 9,300 ft^3/s (264 m^3/s) about 0830 hours Oct. 9, from slope-area measurement of peak flow.

Remarks.--Information relative to time of peak and stages at other times obtained from treatment-plant operator.

(19) 09481500 Sonoita Creek near Patagonia, Ariz.

(Discontinued gaging station)

Location.--Lat 31°30'00", long 110°49'00", in SE¼SW¼ sec.21, T.22 S., R.15 E., Santa Cruz County, Hydrologic Unit 15050301, on left abutment of former railroad bridge, 5 mi (8 km) downstream from Patagonia.

Drainage area.--209 mi^2 (541 km^2).

Gage-height record.--Water-stage recorder graph until 1400 hours Oct. 9 when float came to rest on mud. Datum of gage is 3,818.09 ft (1,163.753 m) National Geodetic Vertical Datum of 1929, supplementary adjustment of 1959. Record furnished by University of Arizona.

(19) 09481500 Sonoita Creek near Patagonia, Ariz.—Continued

Discharge record.--Discharges computed from rating curve in use at time station was discontinued in 1972. Discharges are approximate especially below 900 ft³/s (25 m³/s) because low-water control is subject to shifting.

Maxima.--October 1977: Discharge, 7,380 ft³/s (209 m³/s) 0900 hours Oct. 9, gage height, 11.42 ft (3.481 m),
1930 to October 1965: Discharge, 14,000 ft³/s (396 m³/s) Sept. 30, 1946, gage height, 13.0 ft (3.96 m), from rating curve extended above 1,500 ft³/s (42.5 m³/s) on basis of slope-area measurement of peak flow.

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1977

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Oct. 9			Oct. 9—Con.			Oct. 9—Con.		
0300	4.4	1	0700	10.8	6,100	1200	8.0	1,700
0400	4.7	7	0800	11.42	7,380	1400	7.6	1,400
0500	7.0	910	0900	10.9	6,300			
0600	9.4	3,600	1000	9.8	4,400			

(20) Sonoita Creek at Patagonia Lake near Nogales, Ariz.

Location.--Lat 31°29'35", long 110°52'15", in SE¼ sec.25, T.22 S., R.14 E., Santa Cruz County, Hydrologic Unit 15050301, at spillway of Patagonia Lake 10 mi (16 km) northeast of Nogales.

Drainage area.--225 mi² (583 km²).

Gage-height record.--Water-stage recorder graph. Zero of gage is at low point of spillway.

Discharge record.--Stage-discharge relation defined by model study for spillway crest. Discharge furnished by University of Arizona.

Maximum.--October 1977: Discharge, 4,950 ft³/s (140 m³/s) 1600 hours Oct. 9, gage height, 5.2 ft (1.58 m), above crest of spillway.

Remarks.--Peak discharge at mouth of Sonoita Creek estimated by field inspection to be between 6,000 and 8,000 ft³/s (170 and 227 m³/s) about 1200 hours Oct. 9. The peak apparently originated in Fresno Canyon; the peak from Patagonia Lake reached mouth of Sonoita Creek about midnight Oct. 9.

Mean discharge, in cubic feet per second, 1977

Day	Discharge	Day	Discharge	Day	Discharge
Oct. 6	31	Oct. 9	2,020	Oct. 12	50
7	146	10	471	13	30
8	859	11	80		

(20) Sonoita Creek at Patagonia Lake near Nogales, Ariz.—Continued

Discharge, in cubic feet per second, at indicated time, 1977

Hour	Discharge	Hour	Discharge	Hour	Discharge
Oct. 6		Oct. 8—Con.		Oct. 9—Con.	
2000	0	1200	880	1400	3,700
2400	250	1400	1,600	1500	4,800
Oct. 7		1500	1,820	1600	4,950
0100	270	1600	1,870	1700	4,870
0600	160	1700	1,880	1800	4,500
1200	140	1800	1,800	2000	3,500
1800	100	2000	1,550	2200	2,300
2400	80	2400	870	2400	1,350
Oct. 8		Oct. 9		Oct. 10	
0200	80	0300	640	0600	620
0500	160	0600	490	1200	350
0800	350	0900	450	1800	180
1000	520	1200	1,020	2400	120

(21) 09481700 Calabasas Canyon near Nogales, Ariz.

(Discontinued crest-stage station)

Location.--Lat 31°27'25", long 110°59'09", in SE¼NW¼ sec.2, T.23 S., R.13 E., Santa Cruz County, Hydrologic Unit 15050301, at U.S. Highway 89, 8.5 mi (13.7 km) north of Nogales.

Drainage area.--10.3 mi² (26.7 km²).

Maxima.--October 1977: Discharge, 1,200 ft³/s (34.0 m³/s) Oct. 9, gage height, 6.10 ft (1.86 m), from rating defined by computations of discharge through culverts.
1963 to September 1977: Discharge, 1,000 ft³/s (28.3 m³/s) September 1969, gage height, 5.54 ft (1.688 m).

(22) Agua Fria Canyon near Rio Rico, Ariz.

(Miscellaneous site)

Location.--Lat 31°28'40", long 111°00'02", in SW¼SE¼ sec.27, T.22 S., R.13 E., Santa Cruz County, Hydrologic Unit 15050301, at Interstate Highway 19, 0.4 mi (0.6 km) upstream from mouth, 1 mi (1.6 km) northwest of Rio Rico, and 12 mi (19.3 km) north of Nogales.

Drainage area.--40.2 mi² (104 km²).

Maximum.--October 1977: Discharge, 10,200 ft³/s (289 m³/s) 0815 hours Oct. 9, from contracted-opening measurement of peak flow. Flood is maximum known since before 1900.

Remarks.--Information on stage and time of peak obtained from Arizona Department of Transportation communication logs. Water flowed over northbound lanes of Interstate Highway 19 from ~320 to 0910 Oct. 9.

(23) Peck Canyon near Rio Rico, Ariz.

(Miscellaneous site)

Location.--Lat 31°30'40", long 111°00'46", in SE¼ sec.16, T.22 S., R.13 E., Santa Cruz County, Hydrologic Unit 15050301, at Interstate Highway 19, at mouth 3.5 mi (5.6 km) northwest of Rio Rico and 14 mi (22.5 km) north of Nogales.

Drainage area.--47.8 mi² (124 km²).

Maxima.--October 1977: Discharge, 2,800 ft³/s (79.3 m³/s) about 0800 Oct. 9, from contracted-opening measurement of peak flow.
About 1900 to September 1977: Discharge, 7,000 ft³/s (198 m³/s) Dec. 19, 1967, from contracted-opening measurement of peak flow.

(24) Santa Cruz River near Tumacacori, Ariz.

(Miscellaneous site)

Location.--Lat 31°32'45", long 111°02'25", in SW¼ sec.5, T.22 S., R.13 E., Santa Cruz County, Hydrologic Unit 15050301, at Rancho Santa Cruz Guest Ranch 0.3 mi (0.5 km) upstream from Josephine Canyon, 2 mi (3.2 km) south of Tumacacori National Monument, and 15 mi (24 km) north of Nogales.

Drainage area.--1,090 mi² (2,823 km²).

Maxima.--October 1977: Discharge, about 35,000 ft³/s (1,000 m³/s) 0900 hours Oct. 9, estimated from summation of upstream flows.
1914 to September 1977: Discharge, 28,500 ft³/s (807 m³/s), from slope-area measurement of peak flow downstream from Josephine Canyon. (Drainage area, 1,178 mi² or 3,050 km²).

Remarks.--The October 1977 peak described above was followed by two other peaks estimated as about 28,000 and 32,000 ft³/s (800 and 850 m³/s). Flow at this site is equivalent to the 1967 site because there was no flow from Josephine Canyon during the 1967 flood. Josephine Canyon had a fairly large flow in 1967.

(25) 09481750 Sopori Wash at Amado

(Discontinued crest-stage station)

Location.--Lat 31°43'25", long 111°03'40", in NE¼NE¼ sec.1, T.20 S., R.12 E., Santa Cruz County, Hydrologic Unit 15050301, at former State Highway 89 bridge 1.1 mi (1.8 km) north of Amado.

Drainage area.--176 mi² (456 km²).

Discharge record.--Stage-discharge relation defined by slope-area measurements made during period of station operation.

Maxima.--October 1977: Discharge, 2,300 ft³/s (65.1 m³/s) date unknown, could have been Oct. 6 or Oct. 9, gage height, 5.49 ft (1.670 m), from floodmark at highway bridge.
1948 to September 1977: Discharge, 16,000 ft³/s (453 m³/s) Aug. 15, 1948, gage height, 12.3 ft (3.75 m), at present site and datum.

(26) 09482000 Santa Cruz River at Continental, Ariz.

Location.--Lat 31°51'12", long 110°58'40", in NE¼NE¼ sec.23, T.18 S., R.13 E. (unsurveyed), Pima County, Hydrologic Unit 15050301, in Spanish land grant of San Ignacio de la Canoa, near left bank on downstream side of pier of highway bridge at Continental.

Drainage area.--1,662 mi² (4,305 km²), of which 395 mi² (1,023 km²) is in Mexico.

Gage-height record.--Water-stage recorder graph to 1600 hours Oct. 10. Datum of gage is 2,832.28 ft (863.279 m) National Geodetic Vertical Datum of 1929.

Discharge record.--Average stage-discharge relation is poorly defined by current-meter measurements below 16,000 ft³/s (453 m³/s). Large positive shifts after 1000 hours Oct. 8, required because of bottom scour and road washout, were estimated. Daily discharges estimated Oct. 11-15.

Maxima.--October 1977: Discharge, 26,500 ft³/s (750 m³/s) 1530 hours Oct. 9, gage height, 16.7 ft (5.09 m).

1936 to September 1977: Discharge, 18,000 ft³/s (510 m³/s) Dec. 20, 1967, gage height, 15.3 ft (4.66 m), from rating curve extended above 6,000 ft³/s (170 m³/s) on basis of slope-area measurement of main channel at gage height 14.13 ft (4.307 m) and partial discharge measurement of main channel with contracted-opening measurement of bypass channel at gage height 15.3 ft (4.66 m).

Mean discharge, in cubic feet per second, 1977

Day	Discharge	Day	Discharge	Day	Discharge
Oct. 4	65	Oct. 8	3,810	Oct. 12	190
5	23.7	9	13,200	13	10
6	441	10	4,720	14	1.0
7	499	11	450	15	0

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1977

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Oct. 5			Oct. 8—Con.			Oct. 9—Con.		
2400	-----	0	0130	5.22	1,270	1830	13.6	17,900
Oct. 6			0330	4.77	768	1900	12.5	15,500
1500	-----	0	0400	6.15	2,320	1930	12.3	15,000
1530	6.68	2,710	0630	6.75	2,850	2100	12.0	14,200
1600	6.10	2,130	0900	6.43	2,540	2200	13.0	17,500
1700	4.90	930	1000	6.00	2,200	2300	14.3	22,500
1800	4.58	632	1200	6.05	2,650	2400	13.2	21,500
1830	4.52	578	1500	7.15	4,280	Oct. 10		
1900	6.40	2,430	1800	7.90	5,780	0030	12.40	21,000
2000	5.70	1,730	2130	8.38	7,130	0100	11.50	20,500
2100	4.75	785	2230	8.28	7,690	0130	12.90	21,600
2400	4.48	544	2400	8.45	7,930	0200	13.40	23,000
Oct. 7			Oct. 9			0230	12.00	20,000
0030	5.72	1,750	0200	9.0	8,700	0300	10.20	16,300
0130	5.70	1,730	0500	9.7	9,680	0330	8.40	11,600
0200	5.40	1,430	0700	9.7	9,470	0400	6.70	8,980
0300	4.90	930	0900	9.0	8,700	0430	4.50	5,900
0500	4.42	496	1000	8.7	8,280	0500	3.20	4,340
0700	4.34	435	1200	9.2	8,980	0600	2.90	4,000
1300	3.78	68	1300	9.7	9,540	0700	2.25	3,350

(26) 09482000 Santa Cruz River at Continental, Ariz.—Continued

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1977

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Oct. 7—Con.			Oct. 9—Con.			Oct. 10—Con.		
1520	3.57	10	1400	10.3	10,500	0900	1.83	2,460
1530	4.98	1,010	1500	14.0	19,500	1200	1.4	1,560
1700	4.48	544	1530	16.7	26,500	1800	1.0	880
1900	4.34	435	1600	16.4	25,500	2400	.8	580
2400	4.00	196	1630	16.0	24,500			
Oct. 8			1700	15.4	23,500			
0030	4.57	568	1800	14.9	19,100			

(27) 09482500 Santa Cruz River at Tucson, Ariz.

Location.--Lat 32°13'16", long 110°58'52", in NE¼NE¼ sec.14, T.14 S., R.13 E., Pima County, Hydrologic Unit 15050301, on downstream side of center pier of Congress Street Bridge in Tucson.

Drainage area.--2,222 mi² (5,755 km²), of which 395 mi² (1,023 km²) is in Mexico, adjusted for 15.2 mi² (39.4 km²) of Tucson Arroyo drainage area contributing to this station effective July 1956.

Gage-height record.--Estimated Oct. 9-10 on basis of floodmarks, periodic measurements from a reference point, observations by Tucson City Engineering Department at site 6 mi (9.6 km) upstream, and shape of graph for Santa Cruz River at Cortaro and Continental. Datum of gage is 2,317.82 ft (706.472 m) National Geodetic Vertical Datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 4,000 ft³/s (120 m³/s) and extended above on basis of slope-area measurement of peak flow. Discharge estimated during period of no gage-height record..

Maxima.--October 1977: Discharge, 23,700 ft³/s (671 m³/s) about 0100 hours Oct. 10, gage height, 21.7 ft (6.61 m), from floodmark on the banks.
1905 to September 1977: Discharge, 16,600 ft³/s (470 m³/s) Aug. 23, 1961, gage height, 20.68 ft (6.303 m), present datum, from rating curve extended above 4,200 ft³/s (120 m³/s) on basis of slope-area measurement of peak flow, and partial discharge measurement at gage height 18.4 ft (5.61 m), present datum.

Mean discharge, in cubic feet per second, 1977

Day	Discharge	Day	Discharge	Day	Discharge
Oct. 5	0	Oct. 8	530	Oct. 11	700
6	800	9	6,360	12	100
7	650	10	11,200	13	3

(27) 09482500 Santa Cruz River at Tucson, Ariz.—Continued

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1977

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Oct. 8			Oct. 9—Con.			Oct. 10—Con.		
2400	9.4	2,660	2000	12.4	6,320	0700	21.5	23,200
Oct. 9			2100	13.8	8,400	0830	21.0	22,100
0400	10.8	4,210	2300	21.0	22,100	0920	17.1	14,200
0800	12.0	6,320	2400	21.6	23,500	1005	15.6	11,300
1000	12.4	6,820	Oct. 10			1040	14.5	9,500
1200	11.2	4,700	0100	21.7	23,700	1340	10.5	3,850
1500	10.8	4,210	0200	21.2	22,500	2100	7.3	1,000
1700	11.0	4,450	0600	21.2	22,500	2400	6.5	530

(28) 09486000 Rillito Creek near Tucson, Ariz.

(Flood-hydrograph station)

Location.--Lat 32°17'41", long 110°59'00", in SW¼SE¼ sec.14, T.13 S., R.13 E., on right bank 600 ft (183 m) downstream from Pima Wash, 1,800 ft (549 m) downstream from U.S. Highway 89, 5 mi (8 km) above mouth, and 5.4 mi (8.6 km) north of Tucson city hall.

Drainage area.--918 mi² (2,378 km²).

Gage-height record.--Crest stage only. Datum of gage is 2,280.16 ft (694.993 m) National Geodetic Vertical Datum of 1929, supplementary adjustment of 1954.

Maxima.--February to March 1978: Discharge, 7,500 ft³/s (212 m³/s) 1100 hours Mar. 2, gage height, 8.86 ft (2.70 m).

October 1977: Discharge not determined. Stage did not reach minimum recordable on gage. About 2,000 ft³/s (56 m³/s) could pass gage without being recorder.

1908 to September 1977: Discharge, 24,000 ft³/s (680 m³/s) Sept. 23, 1929, gage height, 24 ft (7.31 m), from floodmarks at site 800 ft (244 m) upstream at different datum.

(29) 09486500 Santa Cruz River at Cortaro, Ariz.

Location.--Lat 32°21'04", long 111°05'38", in NW¼NW¼ sec.35, T.12 S., R.12 E., Pima County, Hydrologic Unit 15050302, on downstream side of left bridge pier 0.5 mi (0.8 km) southwest of Cortaro, 2.6 mi (4.2 km) downstream from Canada del Oro, and 3.7 mi (6.0 km) downstream from Rillito Creek. Supplemental gage on right bank.

Drainage area.--3,503 mi² (9,073 km²), of which 395 mi² (1,023 km²) is in Mexico.

Gage-height record.--Two water-stage recorder graphs to 1200 hours Oct. 10. One recorder graph from 1200 hours Oct. 10 to 2400 hours Oct. 11. Datum of gages is 2,133.13 ft (650.178 m) National Geodetic Vertical Datum of 1929 (State Highway Department bench mark).

Discharge record.--Stage-discharge relation defined by current-meter measurement. Discharge estimated for period of missing gage-height record. Flow of less than about 50 ft³/s (1.4 m³/s) is waste water from sewage-disposal plant.

(29) 09486500 Santa Cruz River at Cortaro, Ariz.—Continued

Maxima.--October 1977: Discharge, 23,000 ft³/s (651 m³/s) 1000 hours Oct. 10, gage height, 15.6 ft (4.770 m).

1936 to September 1977: Discharge, 17,000 ft³/s (481 m³/s) Aug. 14, 1940, gage height, 9.9 ft (3.02 m), site and datum then in use.

Mean discharge, in cubic feet per second, 1977

Day	Discharge	Day	Discharge	Day	Discharge
Oct. 5	22	Oct. 9	6,540	Oct. 13	50
6	885	10	12,600	14	15
7	672	11	1,210		
8	544	12	275		

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1977

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Oct. 5			Oct. 7—Con.			Oct. 9—Con.		
2400	4.49	27	1730	5.95	201	2200	12.30	9,000
Oct. 6			2130	5.76	151	2300	12.70	10,200
0200	4.48	26	2200	5.86	176	2400	13.10	13,200
0500	4.35	17	2400	5.68	135	Oct. 10		
0800	4.22	10	Oct. 8			0100	12.43	10,600
1100	4.38	19	0600	5.54	125	0200	13.65	15,500
1130	4.78	40	1130	5.30	66	0400	15.3	22,500
1200	4.80	42	1200	6.50	390	0430	15.55	22,700
1300	5.05	74	1400	7.62	1,070	0500	15.15	22,400
1430	4.78	40	1500	7.78	1,200	0530	12.45	10,700
1530	7.40	900	1600	7.70	1,130	0600	14.45	16,000
1630	9.78	3,810	1700	7.31	837	0630	15.35	22,600
1730	8.90	2,460	1730	7.10	700	0900	15.25	21,900
1830	10.35	4,910	1930	7.07	682	1000	15.65	23,000
2000	8.70	2,180	2200	7.75	1,180	1200	14.75	20,400
2130	7.45	935	2400	8.55	2,000	1500	12.7	11,600
2230	7.65	1,090	Oct. 9			1700	11.50	7,740
2400	8.80	2,320	0500	9.83	3,890	1900	9.9	4,020
Oct. 7			0600	10.58	5,420	2100	9.2	2,880
0130	8.16	1,560	0700	10.45	5,130	2400	8.8	2,320
0300	8.68	2,160	0900	11.78	7,960	Oct. 11		
0500	7.82	1,240	1130	11.23	6,740	0500	8.48	1,920
0800	6.75	505	1300	11.60	7,640	0930	8.26	1,180
0830	7.07	682	1700	11.75	7,980	1200	8.00	970
0930	7.05	670	1800	11.42	7,280	1800	7.75	795
1200	6.23	286	1900	11.70	7,740	2400	7.50	390
1700	5.72	142	2030	11.78	7,960			

(30) 09486800 Altar Wash near Three Points, Ariz.

(Crest-stage station)

Location.--Lat 31°50'10", long 111°24'11", in SE¼NE¼ sec.27, T.18 S., R.9 E., Pima County, Hydrologic Unit 15050304, on downstream side of left abutment of bridge on State Highway 286, 0.1 mi (0.2 km) downstream from Chiltipines Wash, and 18 mi (29 km) south of Three Points.

(30) 09486800 Altar Wash near Three Points, Ariz.—Continued

Drainage area.--463 mi² (1,200 km²).

Gage-height record.--Crest stage only from high-water mark in well. Altitude of gage is 2,980 ft (908 m), from topographic map.

Discharge record.--Stage-discharge relation poorly defined.

Maxima.--October 1977: Discharge, 10,100 ft³/s (286 m³/s) probably Oct. 6, gage height, 8.83 ft (2.691 m).
1955 to September 1977: Discharge, 22,000 ft³/s (623 m³/s) Sept. 4, 1970, gage height, 13.85 ft (4.221 m), at site and datum then in use.

(31) 09487000 Brawley Wash near Three Points, Ariz.

(Crest-stage station)

Location.--Lat 32°04'39", long 111°20'08", in NW¼SW¼ sec.33, T.15 S., R.10 E., Pima County, Hydrologic Unit 15050304, 0.25 mi (0.4 km) downstream from State Highway 86, 1.6 mi (2.6 km) west of Three Points (Robles Junction), and 23 mi (37 km) west of Tucson.

Drainage area.--776 mi² (2,010 km²).

Gage-height record.--Crest stage only. Datum of gage is 2,532.85 ft (772.013 m) National Geodetic Vertical Datum of 1929 (levels by U.S. Coast and Geodetic Survey).

Discharge record.--Stage-discharge relation defined by slope-area measurements of peak flows.

Maxima.--October 1977: Discharge, 7,300 ft³/s (207 m³/s) probably Oct. 6, gage height, 11.02 ft (3.359 m).
1955 to September 1977: Discharge, 13,200 ft³/s (374 m³/s) Sept. 4, 1970, gage height, 15.8 ft (4.82 m), from high-water profile, at former highway bridge.

(32) 09487100 Little Brawley Wash near Three Points, Ariz.

(Crest-stage station)

Location.--Lat 32°07'25", long 111°19'45", in SE¼NW¼ sec.16, T.15 S., R.10 E., Pima County, Hydrologic Unit 15050304, 3.4 mi (5.5 km) north of Three Points.

Drainage area.--11.9 mi² (30.8 km²).

Gage-height record.--Crest stage only.

Discharge record.--Stage-discharge relation defined by slope-area measurements of peak flows.

Maximum.--October 1977: Discharge, 2,500 ft³/s (70.8 m³/s) probably Oct. 6, gage height, 13.20 ft (4.023 m).
1955 to September 1977: Discharge 13,800 ft³/s (390 m³/s) Sept. 26, 1962, from slope-area measurement of peak discharge, gage height, 17.87 ft (5.447 m) from floodmarks.

(33) 09487250 Los Robles Wash near Marana, Ariz.

(Crest-stage station)

Location.--Lat 32°26'16", long 111°18'13", in SE¼SE¼ sec.27, T.11 S., R.10 E., Pima County, Hydrologic Unit 15050304, at Trico Road 0.75 mi (1.2 km) downstream from confluence of Brawley Wash and China Draw, 3 mi (5 km) upstream from Blanco Wash, and 5 mi (8 km) southwest of Marana.

Drainage area.--1,170 mi² (3,030 km²).

Gage-height record.--Crest stage only. Datum of gage is 1,907.76 ft (581.485 m) National Geodetic Vertical Datum of 1929 (levels by U.S. Coast and Geodetic Survey).

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--October 1977: Discharge, 2,400 ft³/s (68.0 m³/s) probably Oct. 6, gage height, 8.10 ft (2.469 m).
1885 to September 1977: Discharge, 32,000 ft³/s (906 m³/s) Sept. 26, 1962, estimated from slope-area measurements at sites upstream and downstream from station.

(34) Santa Cruz River at Greene Canal, near Eloy, Ariz.

(Miscellaneous site)

Location.--Lat 32°35'45", long 111°36'20", in NE¼ sec.34, T.9 S., R.7 E., Pinal County, Hydrologic Unit 15050303, 3.5 mi (5.6 km) southwest of Friendly Corners, and 11 mi (17.7 km) southwest of Eloy.

Drainage area.--5,180 mi² (13,410 km²).

Maxima.--October 1977: Discharge, 5,200 ft³/s (147 m³/s) 0800 hours Oct. 11, from conveyance-slope estimate of peak flow. Data furnished by Soil Conservation Service.
1962 to September 1977: Discharge, 24,100 ft³/s (683 m³/s) Sept. 26, 1962, from slope-area measurement of peak flow.

Remarks.--Other fairly large flows occurred in September 1964, (discharge unknown) December 1965 (discharge estimated to be about 6,500 ft³/s or 184 m³/s), and December 1967 (discharge estimated to be about 10,000 ft³/s or 283 m³/s).

(35) Santa Cruz River above Santa Rosa Wash near Stanfield, Ariz.

(Miscellaneous site; combination of flows in Greene Wash and Santa Cruz Wash)

Location.--Greene Wash: Lat 32°52'15", long 111°56'50", in NW¼ sec.28, T.6 S., R.4 E., Pinal County, Hydrologic Unit 15050303, 0.5 mi (0.8 km) south of State Highway 84, and 2 mi (3.2 km) southeast of Stanfield.
Santa Cruz Wash: Lat 32°54', long 32°51', in S½ sec.17, T.6 S., R.5 E., Pinal County, Hydrologic Unit 15050303, 2 mi (3.2 km) downstream from State Highway 84, and 7 mi (11 km) east of Stanfield.

Drainage area.--Not determined.

(35) Santa Cruz River above Santa Rosa Wash near Stanfield, Ariz.—Continued

Maxima.--October 1977: Combined discharge, 4,700 ft^3/s (133 m^3/s) probably Oct. 12, from slope-conveyance estimates of peak discharges in the two washes. Data furnished by U.S. Soil Conservation Service.
1962 to September 1977: Discharge, 7,360 ft^3/s (208 m^3/s) Sept. 26, 1962, from indirect measurements at several places along highway. Total discharge past highway including Santa Rosa Wash, 15,800 ft^3/s (447 m^3/s).

Remarks.--Other high floods occurred in September 1964 (discharge unknown), December 1965 (discharge, about 7,000 ft^3/s or 200 m^3/s, from U.S. Soil Conservation Service), and December 1967 (discharge, 7,200 ft^3/s or 204 m^3/s, from Water Development Corporation).

(36) 09489000 Santa Cruz River near Laveen, Ariz.

Location.--Lat 33°13'56", long 112°10'08", in NE¼NE¼ sec.29, T.2 S., R.2 E., Pinal County, Hydrologic Unit 15050303, in Gila River Indian Reservation, on downstream side of highway bridge, 3.4 mi (5.5 km) upstream from mouth, 4.3 mi (6.9 km) south of Komatke, and 9 mi (14 km) south of Laveen.

Drainage area.--8,581 mi^2 (22,225 km^2).

Gage-height record.--Digital water-stage recorder tape. Datum of gage is 1,020.86 ft (311.158 m) National Geodetic Vertical Datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--March 1978: Discharge, 1,570 ft^3/s (44.5 m^3/s) 0845 hours Mar. 6, gage height, 13.94 ft (4.249 m).
October 1977: Discharge, 2,010 ft^3/s (56.9 m^3/s) 1430 hours Oct. 13, gage height, 14.59 ft (4.447 m).
1940 to September 1977: Discharge, 9,200 ft^3/s (261 m^3/s) Sept. 29, 1962, gage height, 17.50 ft (5.334 m).

Mean discharge, in cubic feet per second, 1977-78

Day	Discharge	Day	Discharge	Day	Discharge
Oct. 9	0	Oct. 16	17	Mar. 5	790
10	47	17	2.9	6	932
11	141	Feb. 28	.7	7	395
12	751	Mar. 1	24	8	40
13	1,780	2	21	9	.4
14	929	3	36		
15	123	4	561		

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1977

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Oct. 10			Oct. 12—Con.			Oct. 14—Con.		
1400	-----	0	2400	13.65	1,400	1800	11.48	556
1700	9.17	69	Oct. 13			2400	10.69	348
2400	9.89	182	0600	14.09	1,660	Oct. 15		
Oct. 11			1200	14.48	1,940	0600	10.04	164
0100	9.89	182	1430	14.59	2,010	1200	9.47	96
1330	8.99	61	1600	14.55	1,980	1800	9.00	55

(36) 09489000 Santa Cruz River near Laveen, Ariz.

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1977

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Oct. 11—Con.			Oct. 13—Con.			Oct. 15—Con.		
2400	10.36	275	1800	14.48	1,940	2400	8.67	30
Oct. 12			2400	14.05	1,640	Oct. 16		
0600	10.93	407	Oct. 14			1200	8.06	16
1200	12.01	727	0600	13.42	1,300	2400	7.56	5.4
1800	12.89	1,060	1200	12.47	888			

(37) 09489100 Black River near Maverick, Ariz.

Location.--Lat 33°42'27", long 109°26'48", in SW¼ sec.30, T.4 N., R.28 E., Apache County, Hydrologic Unit 15060101, in Apache National Forest, on right bank 1.0 mi (1.6 km) downstream from Fish Creek, 1.1 mi (1.8 km) upstream from Conklin Creek, and 6 mi (10 km) southeast of Maverick.

Drainage area.--315 mi^2 (816 km^2).

Gage-height record.--Digital water-stage recorder tape. Altitude of gage is 6,850 ft (2,088 m), from topographic map.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--February to March 1978: Discharge, 2,390 ft^3/s (67.7 m^3/s) 1700 hours Mar. 1, gage height, 4.91 ft (1.497 m).
1962 to January 1978: Discharge, 11,100 ft^3/s (314 m^3/s) Oct. 20, 1972, gage height, 8.99 ft (2.740 m) present datum, from rating curve extended above 2,100 ft^3/s (59 m^3/s) on basis of slope-area measurement of peak flow.

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	130	Mar. 2	1,240	Mar. 5	749
28	577	3	1,090	6	611
Mar. 1	1,640	4	784	7	471

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 27			Mar. 1—Con.			Mar. 4		
2400	1.95	151	1600	4.69	2,040	0900	3.17	662
Feb. 28			1700	4.91	2,390	1700	3.34	777
0400	2.08	183	1800	4.69	2,040	1900	3.47	877
0800	2.51	321	2000	4.56	1,770	2400	3.36	798
1200	3.13	636	2400	4.16	1,470	Mar. 5		
1600	3.49	892	Mar. 2			1200	3.18	668
2000	3.40	826	0400	3.88	1,210	1800	3.35	784

(37) 09489100 Black River near Maverick Ariz.—Continued

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 28—Con.			Mar. 2—Con.			Mar. 5—Con.		
2400	3.56	945	0800	3.70	1,060	2400	3.22	695
Mar. 1			1200	3.60	976	Mar. 6		
0400	3.64	1,010	1600	3.89	1,220	0900	3.04	580
0600	3.65	1,020	2000	4.12	1,430	1800	3.07	599
0800	3.92	1,240	2400	4.02	1,340	2400	2.92	505
1000	4.25	1,560	Mar. 3			Mar. 7		
1200	4.55	1,760	0900	3.63	1,000	0900	2.73	410
1300	4.70	2,060	1800	3.74	1,100	2000	2.90	494
1400	4.65	2,000	2400	3.49	892	2400	2.85	467
1500	4.63	1,970						

(38) 09489500 Black River below pumping plant, near Point of Pines, Ariz.

Location.--Lat 33°28'36", long 109°45'48", in W½ sec.32, T.2 N., R.25 E. (unsurveyed), Graham County, Hydrologic Unit 15060101, in San Carlos Indian Reservation on left bank 0.9 mi (1.4 km) downstream from Phelps Dodge Corp. pumping plant, 1.3 mi (2.1 km) downstream from Freezeout Creek, 8 mi (13 km) northwest of Point of Pines, and 63 mi (101 km) upstream from confluence with White River.

Drainage area.--560 mi² (1,450 km²).

Gage-height record.--Digital water-stage recorder tape except 0300 to 1500 hours Mar. 2, when gage height was estimated. Float on debris in well after 0200 hours Mar. 3. Gage-height record corrected for effects of debris.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 4,000 ft³/s (113 m³/s) and a slope-area measurement at 9.5 ft (2.895 m); extended above by logarithmic plotting.

Maxima.--February to March 1978: Discharge, 5,980 ft³/s (169 m³/s) 1915 hours Mar. 1, gage height, 10.30 ft (3.139 m).
1953 to January 1978: Discharge, 17,900 ft³/s (507 m³/s) Oct. 19, 1972, gage height, 18.0 ft (5.49 m), from floodmarks.

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	242	Mar. 2	5,740	Mar. 5	1,490
28	737	3	3,870	6	1,320
Mar. 1	4,110	4	1,960	7	1,120

(38) 09489500 Black River below pumping plant, near Point of Pines, Ariz.—Continued

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 27			Mar. 2			Mar. 3—Con.		
2400	3.33	244	0200	10.28	5,960	2000	7.4	2,930
Feb. 28			0400	10.0	5,620	2400	7.2	2,700
0400	3.35	250	0900	10.1	5,740	Mar. 4		
0800	3.42	273	1200	10.2	5,860	0600	6.85	2,260
1200	3.75	392	1600	9.96	5,520	1200	6.09	1,840
1600	4.67	837	1800	10.0	5,620	1800	5.78	1,610
2000	5.82	1,540	2000	10.0	5,620	2400	5.78	1,610
2400	6.46	2,030	2300	10.2	5,860	Mar. 5		
Mar. 1			2400	10.0	5,620	0600	5.75	1,580
0400	6.78	2,380	Mar. 3			1200	5.55	1,440
0800	6.95	2,520	0100	9.5	5,060	1800	5.45	1,380
1000	7.58	3,090	0200	9.7	5,280	2400	5.56	1,440
1200	8.28	3,780	0300	9.7	5,280	Mar. 6		
1300	9.04	4,550	0400	9.8	5,390	0200	5.60	1,480
1400	9.79	5,380	0600	9.4	4,950	1200	5.31	1,290
1530	10.26	5,930	0800	9.1	4,620	1800	5.22	1,240
1800	10.05	5,680	1000	8.7	4,210	2400	5.28	1,270
1915	10.30	5,980	1200	8.2	3,710	Mar. 7		
2100	10.09	5,730	1600	7.7	3,200	1200	4.97	1,090
2400	10.24	5,910	1800	7.5	3,040	2400	4.92	1,060

(39) 09489700 Big Bonito Creek near Fort Apache, Ariz.

Location.--Lat 33°40'02", long 109°50'46", in NE¼ sec.28, T.4 N., R.24 E. (unsurveyed), Apache County, Hydrologic Unit 15060101, in Fort Apache Indian Reservation, near right bank on downstream side of pier of highway bridge, 1.9 mi (3.1 km) upstream from Tonto Creek, 3.7 mi (6.0 km) southeast of Chino Springs, and 12 mi (19 km) southeast of Fort Apache.

Drainage area.--119 mi^2 (308 km^2).

Gage-height record.--Digital water-stage recorder tape. Record 0600 hours Feb. 28 to 0500 hours Mar. 1 affected by backwater from logging road bridge. Altitude of gage is 5,910 ft (1,801 m), by barometer.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 600 ft^3/s (17.0 m^3/s) and extended above on basis of slope-area measurements at gage heights 7.11 and 7.77 ft (2.167 and 2.368 m). Discharge during period of backwater computed by applying graduated shift.

Maxima.--February to March 1978: Discharge, 2,870 ft^3/s (81.3 m^3/s) 0015 hours Mar. 3. Gage height, 9.09 ft (2.771 m) at 0345 hours Mar. 1, result of backwater.
1957 to January 1978: Discharge, 1,870 ft^3/s (53.0 m^3/s) Oct. 20, 1972. Gage height, 8.43 ft (2.569 m) Oct. 20, 1972 (result of backwater).

(39) 09489700 Big Bonito Creek near Fort Apache, Ariz.—Continued

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	94	Mar. 2	2,190	Mar. 5	394
28	584	3	1,500	6	324
Mar. 1	1,820	4	569	7	259

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 27			Mar. 1—Con.			Mar. 2—Con.		
2400	2.70	92	0500	6.18	1,440	1200	6.95	2,050
Feb. 28			0630	6.12	1,390	1500	7.10	2,190
0600	3.38	204	1000	7.12	2,210	1700	7.03	2,120
1300	7.67	424	1300	6.20	1,450	1900	7.20	2,280
1500	8.35	1,010	1500	7.55	2,630	2230	6.91	2,020
1600	7.94	800	1700	7.11	2,200	2400	7.69	2,780
1730	8.25	956	2000	6.98	2,080	Mar. 3		
1900	8.16	918	2300	6.56	1,720	0015	7.77	2,870
2200	8.78	1,280	2400	6.58	1,740	0300	7.39	2,470
2400	8.76	1,300	Mar. 2			0600	6.80	1,920
Mar. 1			0300	6.95	2,050	1200	5.85	1,210
0100	9.04	1,450	0500	7.00	2,100	1800	5.50	1,000
0200	9.05	1,450	0700	7.55	2,630	2400	5.12	800
0300	8.94	1,390	0800	7.60	2,690			
0345	9.09	1,450	0900	7.22	2,300			

(40) 09490500 Black River near Fort Apache, Ariz.

Location.--Lat 33°42'46", long 110°12'40", in NW¼ sec.12, T.4 N., R.20 E. (unsurveyed), Gila County, Hydrologic Unit 15060101, on downstream side of first pier from right on highway bridge, 5 mi (8 km) upstream from confluence with White River, and 14 mi (23 km) west of Fort Apache.

Drainage area.--1,232 mi² (3,191 km²).

Gage-height record.--Digital water-stage recorder tape. Altitude of gage is 4,345 ft (1,324.4 m), from river-profile map.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 8,900 ft³/s (250 m³/s) and extended above on basis of slope-area measurements at gage heights 14.70 and 22.33 ft (4.481 and 6.806 m).

Maxima.--February to March 1978: Discharge, 33,200 ft³/s (940 m³/s) 0530 hours Mar. 2, gage height, 22.33 ft (6.806 m).

1957 to January 1978: Discharge, 28,400 ft³/s (804 m³/s) Oct. 20, 1972, gage height, 21.40 ft (6.523 m).

1912 to January 1978: Discharge, probably in excess of 50,000 ft³/s (1,420 m³/s) Jan. 19. 1916, from correlation with Salt River near Chrysotile.

(40) 09490500 Black River near Fort Apache, Ariz.—Continued

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	609	Mar. 2	†27,000	Mar. 5	3,170
28	†2,460	3	†14,900	6	3,440
Mar. 1	†14,000	4	†5,190	7	2,740

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 27			Mar. 1—Con.			Mar. 2—Con.		
2400	3.98	595	1200	14.82	12,900	2400	17.60	19,500
Feb. 28			1600	17.90	20,200	Mar. 3		
0600	4.05	622	1800	17.63	19,600	0800	17.75	19,900
1200	5.97	1,590	2100	18.30	21,200	1200	16.87	17,700
1400	8.18	3,380	2400	19.31	23,800	1800	14.40	12,100
1800	8.28	3,480	Mar. 2			2400	12.04	8,160
2400	11.75	7,720	0530	22.33	33,200	Mar. 4		
Mar. 1			1200	20.73	27,900	0600	10.74	6,070
0200	12.04	8,160	1500	21.13	29,100	1200	9.80	5,240
0600	13.52	10,300	1800	19.95	25,600	2400	8.57	3,770

† Revised.

(41) 09492400 East Fork White River near Fort Apache, Ariz.

Location.--Lat 33°49'20", long 109°48'50", in SE¼ sec.16, T.5 N., R.24 E. (unsurveyed), Apache County, Hydrologic Unit 15060102, in Fort Apache Indian Reservation, on left bank 600 ft (180 m) downstream from highway bridge, 0.1 mi (0.2 km) upstream from Rock Creek, and 10 mi (16 km) east of Fort Apache.

Drainage area.--38.8 mi² (100.5 km²).

Gage-height record.--Digital water-stage recorder tape. Altitude of gage is 6,050 ft (1,844 m), by barometer.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--February to March 1978: Discharge, 272 ft³/s (7.70 m³/s) 1400 hours Mar. 1, gage height, 2.76 ft (0.841 m).
1957 to January 1978: Discharge, 663 ft³/s (18.8 m³/s) Aug. 17, 1961, gage height, 4.82 ft (1.469 m), present site and datum, from floodmark, from rating curve extended above 170 ft³/s (4.8 m³/s) on basis of slope-area measurement of peak flow.

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	29	Mar. 2	204	Mar. 5	71
28	106	3	140	6	62
Mar. 1	217	4	88	7	60

(42) 09494000 White River near Fort Apache, Ariz.

Location.--Lat 33°44'11", long 110°09'58", in SE¼ sec.32, T.4½ N., R.21 E. (unsurveyed), Gila County, Hydrologic Unit 15060102, in Fort Apache Indian Reservation, on right bank 2,200 ft (670 m) downstream from highway bridge, 4.5 mi (7.2 km) upstream from confluence with Black River, and 11 mi (18 km) west of Fort Apache.

Drainage area.--632 mi² (1,637 km²).

Gage-height record.--Digital water-stage recorder tape except 0015 to 0315 hours Mar. 1, when gage-height graph was reconstructed. Datum of gage is 4,365.99 ft (1,330.754 m) National Geodetic Vertical Datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 4,100 ft³/s (120 m³/s) and above on basis of slope-area measurements at gage heights 9.8 and 15.71 ft (2.80 and 4.788 m).

Maxima.--February to March 1978: Discharge, 7,020 ft³/s (199 m³/s), revised, 1830 hours Mar. 1, gage height, 11.05 ft (3.368 m).
1957 to January 1978: Discharge, 8,670 ft³/s (246 m³/s) Aug. 12, 1971, from slope-area measurement of peak flow, gage height, 13.8 ft (4.21 m).

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	197	Mar. 2	4,640	Mar. 5	928
28	222	3	2,820	6	793
Mar. 1	3,470	4	1,250	7	630

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 28			Mar. 1—Con.			Mar. 3		
2400	-----	300	2300	10.30	6,110	0400	8.80	4,410
Mar. 1			2400	9.62	5,310	0800	8.56	4,160
0300	-----	1,500	Mar. 2			1200	7.66	3,090
0400	6.04	1,540	0200	9.01	4,630	1600	7.01	2,380
0500	6.37	1,820	0900	9.40	5,070	2000	6.85	2,220
0900	6.22	1,700	1200	9.18	4,820	2400	6.70	2,090
1200	6.54	1,950	1600	8.64	4,250	Mar. 4		
1400	9.58	5,270	1800	8.56	4,160	0800	6.04	1,540
1600	9.88	5,610	2100	8.88	4,490	1600	5.76	1,320
1830	11.05	7,020	2400	8.64	4,250	2400	5.79	1,350
2200	10.27	6,070						

(43) 09496500 Carrizo Creek near Show Low, Ariz.

Location.--Lat 33°59'09", long 110°16'52", in sec.24, T.7 N., R.19 E. (unsurveyed), Gila County, Hydrologic Unit 15060104, in Fort Apache Indian Reservation, on right bank 500 ft (152 m) upstream from newly constructed U.S. Highway 60, 1 mi (2 km) downstream from Corduroy Creek, 23 mi (37 km) southwest of Show Low, and 24 mi (39 km) upstream from mouth.

Drainage area.--439 mi² (1,137 km²).

(43) 09496500 Carrizo Creek near Show Low, Ariz.—Continued

Gage-height record.--Digital water-stage recorder tape and (or) graph except 0900 to 1400 hours Mar. 1 and 0900 to 1600 hours Mar. 2. Gage heights during missing periods estimated. Datum of gage is 4,750.53 ft (1,447.98 m) National Geodetic Vertical Datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 160 ft^3/s (4.53 m^3/s) and at 4,300 and 5,800 ft^3/s (122 and 164 m^3/s) and extended above on basis of slope-area measurement of peak flow. Above 160 ft^3/s (4.53 m^3/s) rating is shaped through measurements by step-backwater analysis.

Maxima.--February to March 1978: Discharge, 12,700 ft^3/s (360 m^3/s) 1515 hours Mar. 1, gage height, 12.07 ft (3.670 m).

1951 to January 1978: Discharge, about 23,000 ft^3/s (650 m^3/s) Dec. 30, 1965, gage height, 13.0 ft (3.96 m), from floodmarks at site and datum then in use, from rating curve extended above 2,000 ft^3/s (57 m^3/s) on basis of slope-area measurement at gage height, 12.08 ft (3.682 m).

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	154	Mar. 2	4,060	Mar. 5	1,100
28	1,760	3	3,830	6	1,040
Mar. 1	5,210	4	1,410	7	668

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 27			Mar. 1—Con.			Mar. 4—Con.		
2400	2.49	162	2000	9.02	7,170	1200	4.37	1,300
Feb. 28			2200	8.14	5,760	1800	4.05	1,040
0400	2.61	204	2400	7.39	4,630	2400	3.86	890
0600	2.96	345	Mar. 2			Mar. 5		
0800	5.07	1,910	0300	7.05	4,150	0600	3.83	864
1000	5.68	2,520	0600	6.61	3,610	1400	3.77	819
1200	5.77	2,610	0800	6.43	3,400	1800	4.63	1,500
1600	5.63	2,470	1200	6.79	3,830	2100	4.89	1,730
2000	5.48	2,320	1800	7.44	4,700	2400	4.78	1,620
2400	5.57	2,410	2400	7.63	4,960	Mar. 6		
Mar. 1			Mar. 3			0600	4.22	1,180
0200	5.62	2,460	0200	7.73	5,110	1200	3.93	944
0600	5.47	2,310	0600	7.59	4,910	1800	3.81	848
0800	5.52	2,360	1200	7.35	4,570	2400	3.89	912
1000	6.2	3,120	1400	6.71	3,730	Mar. 7		
1200	7.5	4,780	1700	6.10	3,000	0600	3.35	545
1400	10.9	10,300	2100	5.84	2,690	1200	3.21	470
1515	12.07	12,700	2400	5.54	2,380	1800	3.17	450
1600	11.81	12,100	Mar. 4			2400	3.12	425
1800	10.36	9,510	0600	4.86	1,700			

(44) 09497500 Salt River near Chrysotile, Ariz.

Location.--Lat 33°47'53", long 110°29'57", in sec.25, T.5 N., R.17 E. (unsurveyed), Gila County, Hydrologic Unit 15060103, in San Carlos Indian Reservation, on left bank 1,200 ft (366 m) upstream from bridge on U.S. Highway 60, 5.7 mi (9.2 km) northeast of Chrysotile, 8 mi (13 km) upstream from Cibecue Creek, and 33 mi (53 km) downstream from confluence of Black and White Rivers.

Drainage area.--2,849 mi² (7,379 km²).

Gage-height record.--Digital water-stage recorder tape. Datum of gage is 3,354.57 ft (1,022.473 m) National Geodetic Vertical Datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--February to March 1978: Discharge, 46,700 ft³/s (1,320 m³/s), revised, 0715 hours Mar. 2, gage height, 15.10 ft (4.602 m), revised.

1906 to January 1978: Discharge, 74,000 ft³/s (2,100 m³/s) occurred prior to 1924 and is believed to be the peak of Jan. 19, 1916, gage height, 18 ft (5.5 m), from floodmarks, from rating curve extended above 52,000 ft³/s (1,500 m³/s).

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	935	Mar. 2	37,600	Mar. 5	5,270
28	4,270	3	23,600	6	5,600
Mar. 1	27,800	4	9,450	7	4,380

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 27			Mar. 1—Con.			Mar. 3—Con.		
2400	2.93	1,040	2130	14.97	45,700	2030	9.71	16,900
Feb. 28			2315	14.69	43,700	2400	8.84	13,600
0615	3.11	1,190	2400	14.8	44,700	Mar. 4		
0900	4.47	2,760	Mar. 2			0800	7.89	10,470
1500	4.30	2,520	0300	14.70	43,800	1400	7.24	8,520
1615	4.70	3,110	0715	15.10	46,700	2000	6.69	7,080
1715	6.46	6,510	0945	14.64	43,400	2400	6.36	6,290
1830	7.52	9,320	1245	13.90	38,400	Mar. 5		
1930	7.83	10,200	1645	13.32	34,800	0400	6.08	5,680
2100	8.12	11,100	1915	13.21	34,200	1200	5.85	5,200
2145	8.44	12,200	2015	12.71	31,300	1800	5.69	4,880
2245	8.31	11,700	2200	12.48	30,000	2400	5.87	5,240
2400	8.38	12,000	2400	12.21	28,500	Mar. 6		
Mar. 1			Mar. 3			0600	6.20	5,940
0200	9.07	14,400	0030	12.34	29,200	0800	6.37	6,310
0315	9.74	17,000	0130	12.17	28,300	1400	6.35	6,270
0600	10.43	19,900	0545	12.07	27,800	2400	5.90	5,300
0815	11.41	24,400	0730	12.40	29,600	Mar. 7		
1200	11.69	25,800	1030	11.75	26,100	0600	5.90	5,300
1530	12.87	32,200	1400	11.34	24,100	2400	5.19	3,920
1700	13.62	36,600	1700	10.86	21,800			

(45) 09497800 Cibecue Creek near Chrysotile, Ariz.

Location.--Lat 33°50'35", long 110°33'25", in E½ sec.8, T.5 N., R.17 E. (unsurveyed), Gila County, Hydrologic Unit 15060103, in Fort Apache Indian Reservation, on right bank 0.5 mi (0.8 km) upstream from mouth, and 7 mi (11 km) north of Chrysotile.

Drainage area.--295 mi² (764 km²).

Gage-height record.--Digital water-stage recorder tape. Record faulty after 0100 hours Mar. 4. Altitude of gage is 3,200 ft (975 m), from topographic map.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 2,200 ft³/s (62 m³/s), and extended above on basis of slope-area measurements at gage heights 7.70, 10.50, and 17.3 ft (2.35, 3.20, and 5.27 m). Daily discharges estimated during period of faulty record.

Maxima.--February to March 1978: Discharge, 6,540 ft³/s (185 m³/s) 1200 hours Mar. 1, gage height, 9.27 ft (2.825 m).
1959 to January 1978: Discharge, 22,200 ft³/s (629 m³/s) Sept. 2, 1977, gage height, 17.3 ft (5.27 m).

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	58	Mar. 2	2,520	Mar. 5	1,020
28	1,050	3	1,740	6	700
Mar. 1	3,410	4	950	7	500

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 27			Mar. 1—Con.			Mar. 2—Con.		
2400	1.88	61	0545	5.00	1,740	0745	5.80	2,520
Feb. 28			1000	6.09	2,830	0830	5.74	2,450
0345	2.34	145	1115	8.43	5,480	0945	6.35	3,090
0430	3.34	500	1200	9.27	6,540	1100	6.17	2,900
0515	4.56	1,320	1445	7.74	4,660	1115	6.42	3,170
0615	4.02	880	1645	7.02	3,830	1300	5.73	2,440
0845	3.44	550	1745	6.52	3,280	1430	5.20	1,930
1215	3.38	520	1830	7.14	3,980	1800	4.53	1,290
1300	4.60	1,350	2000	6.98	3,800	2045	4.59	1,340
1515	5.00	1,740	2015	6.56	3,320	2200	4.98	1,720
1645	4.61	1,360	2130	7.07	3,890	2400	5.13	1,860
1845	4.44	1,200	2300	7.88	4,830	Mar. 3		
2015	5.43	2,150	2345	7.72	4,650	0300	5.68	2,400
2045	5.94	2,660	2400	7.53	4,420	0800	5.34	2,060
2215	5.07	1,810	Mar. 2			1145	5.12	1,850
2400	4.87	1,610	0015	8.05	5,010	1915	4.35	1,120
Mar. 1			0300	6.81	3,590	2400	4.10	936
0130	4.89	1,630	0515	6.60	3,360			
0215	5.12	1,850	0600	6.21	2,950			

(46) 09497850 Canyon Creek near Globe, Ariz.

Location.--Lat 33°49'47", long 110°39'50", in sec.17, T.6 N., R.16 E. (unsurveyed), Gila County, Hydrologic Unit 15060103, on left bank 1.9 mi (3.1 km) upstream from mouth, 10 mi (16 km) northwest of Seneca, and 31 mi (50 km) north of Globe.

Drainage area.--316 mi^2 (818 km^2).

Gage-height record.--Digital water-stage recorder tape except 1000 hours Feb. 28 to 1200 hours Mar. 2. Altitude of gage is 3,080 ft (940 m), from topographic map.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 4,200 ft^3/s (119 m^3/s) and extended above on basis of slope-area measurement of peak flow and step-backwater analysis. Discharge estimated for period of missing gage-height record.

Maxima.--February to March 1978: Discharge, 21,100 ft^3/s (598 m^3/s), probably about 1400 hours Mar. 1, gage height, 18.8 ft (5.73 m) from floodmark.
1975 to January 1978: Not determined.

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	50	Mar. 3	3,170	Mar. 7	918
28	2,800	4	1,380	8	708
Mar. 1	11,000	5	1,430	9	614
2	7,600	6	1,370		

(47) 09497900 Cherry Creek near Young, Ariz.

(Discontinued gaging station)

Location.--Lat 34°04'58", long 110°55'25", in SE¼NE¼ sec.32, T.9 N., R.14 E., Gila County, Hydrologic Unit 15060103, on left bank 0.3 mi (0.5 km) downstream from Deadman Canyon, and 2 mi (3 km) southeast of Young.

Drainage area.--62.1 mi^2 (161 km^2).

Gage-height record.--Crest stage only. Altitude of gage is 4,950 ft (1,509 m), from topographic map.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 110 ft^3/s (3.1 m^3/s) and extended above on basis of slope-area measurements at gage heights 7.97 and 11.00 ft (2.429 and 3.353 m).

Maxima.--February to March 1978: Discharge, 2,480 ft^3/s (70.2 m^3/s) Mar. 1, gage height, 7.20 ft (2.195 m), from high-water mark in well.
1963 to January 1978: Discharge, 7,290 ft^3/s (206 m^3/s) Oct. 19, 1972, gage height, 11.00 ft (3.353 m), present datum.

(48) 09497980 Cherry Creek near Globe, Ariz.

Location.--Lat 33°49'40", long 110°51'20", in SW¼ sec.30, T.6 N., R.15 E. (unsurveyed), Gila County, Hydrologic Unit 15060103, in Tonto National Forest, on left bank 0.2 mi (0.3 km) upstream from Devils Chasm, 13 mi (21 km) upstream from mouth, and 30 mi (48 km) north of Globe.

(48) 09497980 Cherry Creek near Globe, Ariz.—Continued

Drainage area.--200 mi² (518 km²).

Gage-height record.--Digital water-stage recorder tape except 0430 to 0715 hours Feb. 28, 1630 hours Feb. 28 to 0930 hours Mar. 1, and 2200 hours Mar. 2 to 0430 hours Mar. 3. Altitude of gage is 3,200 ft (980 m), from topographic map.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 330 ft³/s (9.3 m³/s) and extended above on basis of slope-area measurements at gage heights 5.85, 6.70, 8.70, and 12.3 ft (1.783, 2.042, 2.652, and 3.75 m). Discharge estimated during periods of missing gage height.

Maxima.--February to March 1978: Discharge, 5,370 ft³/s (152 m³/s) 1200 hours Mar. 1, gage height, 10.91 ft (3.325 m), inside; 12.8 ft (3.90 m), from outside floodmark.
1965 to January 1978: Discharge, 8,300 ft³/s (235 m³/s) Oct. 19, 1972, gage height, 14.0 ft (4.27 m), from floodmarks.

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	87	Mar. 2	3,680	Mar. 5	750
28	1,310	3	1,920	6	520
Mar. 1	2,700	4	729	7	380

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 27			Mar. 1—Con.			Mar. 2—Con.		
2400	1.55	118	1000	5.63	1,660	1030	10.87	5,330
Feb. 28			1015	9.87	4,490	1330	9.81	4,450
0415	1.65	139	1130	10.18	4,710	1515	8.05	3,140
0715	4.30	1,030	1200	10.91	5,370	1800	7.12	2,530
0900	5.31	1,500	1400	9.72	4,470	2300	-----	3,500
1000	8.21	3,250	1800	7.31	2,650	2400	-----	3,100
1200	7.69	2,900	2100	7.72	2,920	Mar. 3		
1500	5.55	1,620	2400	9.42	4,140	0300	-----	3,500
1800	5.01	1,360	Mar. 2			0700	6.85	2,360
2100	-----	1,100	0200	8.88	3,730	0900	6.84	2,360
2400	-----	1,300	0400	9.95	4,560	1300	5.34	1,520
Mar. 1			0600	8.81	3,680	2400	3.96	885
0800	-----	900	0800	8.76	3,640			

(49) 09498500 Salt River near Roosevelt, Ariz.

Location.--Lat 33°37'10", long 110°55'15", in SE¼NE¼ sec.9, T.3 N., R.14 E. (unsurveyed), Gila County, Hydrologic Unit 15060103, in Tonto National Forest on left bank 100 ft (30 m) downstream from bridge on State Highway 288, 0.3 mi (0.5 km) downstream from Pinal Creek, 1 mi (2 km) upstream from diversion dam for power canal, 14 mi (23 km) east of village of Roosevelt, and 17 mi (27 km) upstream from Roosevelt Dam.

Drainage area.--4,306 mi² (11,153 km²).

Gage-height record.--Water-stage recorder graph. Datum of gage is 2,177.14 ft (663.592 m) National Geodetic Vertical Datum of 1929.

(49) 09498500 Salt River near Roosevelt, Ariz.—Continued

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--February to March 1978: Discharge, 89,400 ft³/s (2,530 m³/s) 0300 hours Mar. 2, gage height, 28.55 ft (8.702 m).

1906 to January 1978: Discharge, 117,000 ft³/s (3,310 m³/s) Mar. 14, 1941, from rating curve extended above 55,000 ft³/s (1,600 m³/s) on basis of velocity-area studies and float-area measurements at 66,000 ft³/s (1,870 m³/s) and 102,000 ft³/s (2,890 m³/s). Gage height, 25.8 ft (7.86 m) Dec. 23, 1965.

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	1,160	Mar. 2	77,200	Mar. 5	9,480
28	8,260	3	49,400	6	9,680
Mar. 1	51,000	4	19,700	7	7,200

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 27			Mar. 1—Con.			Mar. 4—Con.		
2400	8.89	1,190	0900	21.15	40,400	1100	16.20	18,800
Feb. 28			1130	24.00	56,800	1700	14.95	14,700
0500	8.95	1,240	1530	26.10	70,900	2400	14.00	11,900
0800	9.22	1,510	2000	25.15	64,300	Mar. 5		
0930	9.80	2,280	2400	26.40	73,000	0600	13.20	9,710
1100	11.20	4,660	Mar. 2			1200	12.80	8,610
1200	12.05	6,620	0300	28.55	89,400	1800	12.70	8,320
1330	14.00	11,900	1100	27.30	79,600	2200	13.20	9,710
1530	15.30	15,400	1600	27.15	78,500	2400	13.70	11,000
1800	15.00	14,400	1900	25.55	67,000	Mar. 6		
2000	15.20	15,000	2400	24.60	60,600	0300	13.60	10,800
2200	15.05	14,600	Mar. 3			0700	13.20	9,710
2400	17.15	22,300	1100	23.05	51,000	1300	13.10	9,450
Mar. 1			1500	22.70	48,900	1700	13.20	9,710
0100	18.05	25,800	2400	19.80	33,600	2400	12.67	8,210
0500	18.70	28,600	Mar. 4					
0700	19.85	33,800	0500	17.90	25,200			

(50) 09498530 South Fork Workman Creek at Sierra Ancha near Roosevelt, Ariz.

(U.S. Forest Service)

Location.--Lat 33°49', long 110°56', in SW¼ sec.33, T.6 N., R.14 E., Gila County, Hydrologic Unit 15060103, 16 mi (26 km) northeast of Roosevelt.

Drainage area.--0.50 mi² (1.30 km²).

Gage-height record.--Water-stage recorder. Altitude of gage is 6,700 ft (2,042 m), from topographic map.

Discharge record.--Stage-discharge relation defined by model studies for 90° V-notch weir. Discharges furnished by U.S. Forest Service, Rocky Mountain Forest and Range Experiment Station.

(50) 09498530 South Fork Workman Creek at Sierra Ancha near Roosevelt, Ariz.—Continued

Maxima.--February to March 1978: Discharge, 37 ft³/s (1.05 m³/s) 1200 hours Mar. 2, gage height, 2.92 ft (0.890).
1938 to January 1978: Discharge, 79 ft³/s (2.237 m³/s) Oct. 19, 1972.

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	0.70	Mar. 2	26.9	Mar. 5	2.9
28	17.5	3	8.4	6	1.6
Mar. 1	20.3	4	2.2	7	1.3

(51) 09498540 North Fork Workman Creek at Sierra Ancha near Roosevelt, Ariz.

(U.S. Forest Service)

Location.--Lat 33°49', long 110°56', in SW¼ sec.33, T.6 N., R.14 E., Gila County, Hydrologic Unit 15060103, 16 mi (26 km) northeast of Roosevelt.

Drainage area.--0.39 mi² (1.01 km²).

Gage-height record.--Water-stage recorder. Altitude of gage is 6,700 ft (2,042 m), from topographic map.

Discharge record.--Stage-discharge relation defined by model studies for 90° V-notch weir. Discharges furnished by U.S. Forest Service, Rocky Mountain Forest and Range Experiment Station.

Maxima.--February to March 1978: Discharge, 35 ft³/s (0.99 m³/s) 0500 hours Mar. 1, gage height, 2.85 ft (0.869 m).
1938 to January 1978: Discharge, 67 ft³/s (1.897 m³/s) Dec. 30, 1951.

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	1.3	Mar. 2	26.9	Mar. 5	3.3
28	14.5	3	8.0	6	1.8
Mar. 1	15.8	4	2.3	7	1.6

(52) 09498550 Workman Creek at Sierra Ancha near Roosevelt, Ariz.

(U.S. Forest Service)

Location.--Lat 33°49', long 110°56', in SW¼ sec.33, T.6 N., R.14 E., Gila County, Hydrologic Unit 15060103, 16 mi (26 km) northeast of Roosevelt.

Drainage area.--1.70 mi² (4.40 km²).

Gage-height record.--Water-stage recorder. Altitude of gage is 6,600 ft (2,012 m), from topographic map.

Discharge record.--Stage-discharge relation defined by model studies for Cippoletti weir. Discharges furnished by U.S. Forest Service, Rocky Mountain Forest and Range Experiment Station.

(52) 09498550 Workman Creek at Sierra Ancha near Roosevelt, Ariz.—Continued

Maxima.--February to March 1978: Discharge, 188 ft³/s (5.32 m³/s) 0900 hours Mar. 2, gage height 5.59 ft (1.704 m).
1938 to January 1978: Discharge, 289 ft³/s (8.184 m³/s) Oct. 19, 1972.

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	3.3	Mar. 2	127	Mar. 5	14
28	55	3	54	6	7.4
Mar. 1	86	4	14	7	6.0

(53) 09498870 Rye Creek near Gisela, Ariz.

Location.--Lat 34°01'57", long 111°17'26", in SW¼ sec.13, T.8 N., R.10 E., Gila County, Hydrologic Unit 15060105, in Tonto National Forest, on right bank, 0.5 mi (0.8 km) upstream from mouth, 0.8 mi (1.3 km) downstream from bridge on county road, and 4.8 mi (7.7 km) south of Gisela.

Drainage area.--122 mi² (316 km²).

Gage-height record.--Water-stage recorder graph. Altitude of gage is 2,730 ft (832 m), from topographic map.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 850 ft³/s (24 m³/s) and extended above on basis of slope-area measurements at gage heights 9.0 and 14.1 ft (2.74 and 4.30 m), present datum.

Maxima.--February to March 1978: Discharge, 8,220 ft³/s (233 m³/s) 0900 hours Mar. 2, gage height, 6.60 ft (2.012 m).
1963 to January 1978: Discharge, 44,400 ft³/s (1,260 m³/s) Sept. 5, 1970, gage height, 14.1 ft (4.30 m), in gage well, 18.7 ft (5.70 m), from profile past gage.

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	37	Mar. 2	4,780	Mar. 5	1,370
28	1,230	3	3,430	6	1,320
Mar. 1	2,920	4	1,220	7	714

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 27			Mar. 1—Con.			Mar. 4—Con.		
2400	1.79	42	2200	5.90	5,610	0200	2.60	1,440
Feb. 28			2400	4.50	2,910	1400	2.32	1,180
0400	2.08	92	Mar. 2			2400	1.97	888
0500	2.56	245	0400	4.05	2,400	Mar. 5		
0700	3.20	547	0800	4.85	3,770	0400	1.88	821
0730	4.10	1,250	0900	6.60	8,220	1030	1.85	800
0900	4.85	2,130	1300	5.50	5,480	1200	2.45	1,300
1000	4.25	1,550	1600	4.95	4,380	500	2.60	1,390

(53) 09498870 Rye Creek near Gisela, Ariz.—Continued

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 28—Con.			Mar. 2—Con.			Mar. 5—Con.		
1200	4.35	1,710	1900	5.20	5,020	1600	3.12	1,970
1700	3.75	1,250	2200	4.95	4,580	1800	3.23	2,100
2200	4.60	2,260	2300	5.15	5,020	1900	3.12	1,970
2400	4.20	1,820	2400	4.50	3,770	2100	3.50	2,400
Mar. 1			Mar. 3			2400	3.05	1,820
0400	4.90	2,830	0100	4.15	3,150	Mar. 6		
0600	5.50	3,960	0230	5.50	6,100	0300	2.82	1,570
0800	6.30	5,850	0400	6.00	7,180	0500	3.10	1,830
0900	5.50	4,060	0700	4.90	4,910	1000	2.60	1,300
1000	4.60	2,610	1200	3.50	2,540	1600	2.42	1,090
1300	4.00	1,940	1800	3.20	2,130	2400	2.23	941
1600	3.70	1,650	2400	2.75	1,600	Mar. 7		
2000	4.90	2,070	Mar. 4			1200	1.95	698
2100	5.50	3,870	0100	2.75	1,600	2400	1.69	518

(54) 09499000 Tonto Creek above Gun Creek, near Roosevelt, Ariz.

Location.--Lat 33°58'48", long 111°18'10", in SW¼NE¼ sec.2, T.7 N., R.10 E., Gila County, Hydrologic Unit 15060105, in Tonto National Forest, on left bank 600 ft (183 m) upstream from Gun Creek, 17 mi (27 km) upstream from high-water line of Roosevelt Lake, and 24 mi (39 km) northwest of Roosevelt.

Drainage area.--675 mi² (1,750 km²).

Gage-height record.--Water-stage recorder graph. Datum of gage is 2,523.14 ft (769.053 m) National Geodetic Vertical Datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Large shift adjustments required.

Maxima.--February to March 1978: Discharge, 57,200 ft³/s (1,620 m³/s), revised, 1030 hours Mar. 2, gage height, 16.5 ft (5.029 m).
1940 to January 1978: Discharge, 53,000 ft³/s (1,500 m³/s) Sept. 5, 1970, gage height, 18.2 ft (5.55 m), from rating curve extended above 27,000 ft³/s (765 m³/s) on basis of slope-area measurement of peak flow.
Historic: Peak of September 1970 is probably the highest since at least 1905.

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	279	Mar. 2	32,200	Mar. 5	7,820
28	8,560	3	20,900	6	6,090
Mar. 1	28,600	4	3,280	7	2,940

(54) 09499000 Tonto Creek above Gun Creek, near Roosevelt, Ariz.—Continued

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 27			Mar. 1—Con.			Mar. 4—Con.		
2400	5.23	284	2000	10.40	21,800	1200	6.25	2,710
Feb. 28			2200	12.00	28,100	2400	5.70	1,330
0430	5.40	381	2400	14.10	36,200	Mar. 5		
0745	6.36	1,340	Mar. 2			0900	5.50	972
0915	8.00	5,830	0230	12.50	30,200	1100	5.70	1,330
1000	9.30	10,200	0330	11.50	26,400	1300	6.80	4,710
1145	11.20	17,600	0500	12.00	28,100	1430	8.06	11,000
1400	10.40	14,400	0800	15.00	40,400	1600	9.20	16,600
1600	10.45	14,600	1030	16.50	45,500	1730	10.30	21,400
2000	9.20	9,880	1400	13.80	35,200	2100	9.20	16,600
2400	10.75	15,800	1600	12.00	28,100	2400	8.35	12,600
Mar. 1			1930	10.80	23,500	Mar. 6		
0115	10.94	16,500	2400	11.80	27,500	0400	7.50	8,460
0230	10.80	16,000	Mar. 3			1500	6.70	4,340
0300	10.91	16,400	0500	14.00	36,000	1900	6.45	3,550
0330	10.70	15,600	0815	12.00	28,100	2400	6.50	3,740
0530	12.00	20,900	1100	10.10	20,500	Mar. 7		
0700	14.50	32,000	1800	8.20	11,900	0500	6.35	3,460
0930	16.20	44,300	2400	7.35	7,600	1700	5.75	2,520
1400	14.00	36,000	Mar. 4			2400	5.50	2,160
1600	12.00	28,100	0600	6.70	4,240			

(55) 09500500 Salt River at Roosevelt, Ariz.

(Former gaging station)

Location.--Lat 33°40'30", long 111°09'30", in sec.20, T.4 N., R.12 E. (unsurveyed), Gila County, Hydrologic Unit 15060103, at Roosevelt Dam, about 0.5 mi (0.8 km) downstream from Tonto Creek, and 1 mi (1.6 km) west of Roosevelt.

Drainage area.--5,824 mi^2 (15,100 km^2).

Discharge record.--Computed by routing the flow from Salt River near Roosevelt, Tonto Creek below Gun Creek near Roosevelt, and tributary inflow to Roosevelt Dam.

Maxima.--February to March 1978: Discharge, 155,000 ft^3/s (4,390 m^3/s) about 1200 hours Mar. 1.
1888 to January 1978: Discharge, about 150,000 ft^3/s (4,250 m^3/s) Feb. 22-23, 1891, estimated on basis of records for Salt River at McDowell.

Remarks.--The computed discharge represents the flow that would have reached the site without Roosevelt Lake and may differ from inflow to the reservoir because the computations account for traveltime. Maximum average discharge over a 2-hour period from hourly readings of reservoir level is about 170,000 ft^3/s (4,810 m^3/s) about 1000 hours Mar. 2.

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 28	16,900	Mar. 2	128,000	Mar. 4	27,100
Mar. 1	84,800	3	77,400		

(55) 09500500 Salt River at Roosevelt, Ariz.—Continued

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 27			Mar. 1—Con.			Mar. 2—Con.		
2400	-----	1,450	1400	-----	116,000	2400	-----	97,400
Feb. 28			1600	-----	115,000	Mar. 3		
0600	-----	1,860	1800	-----	109,000	0200	-----	93,900
0800	-----	2,630	2200	-----	96,000	0600	-----	93,600
1000	-----	5,590	2400	-----	101,100	0800	-----	91,200
1400	-----	25,500	Mar. 2			1200	-----	79,200
1600	-----	33,200	0400	-----	123,000	1800	-----	64,100
1800	-----	35,500	0800	-----	138,000	2400	-----	48,700
2200	-----	30,900	1000	-----	149,000	Mar. 4		
2400	-----	32,500	1200	-----	155,000	0600	-----	38,400
Mar. 1			1400	-----	145,000	1200	-----	24,600
0600	-----	55,600	1800	-----	126,000	1800	-----	18,700
1000	-----	90,600	2000	-----	117,000	2400	-----	15,200
1200	-----	109,000	2200	-----	104,000			

(56) 09501000 Reservoir system on Salt River at and below Roosevelt Dam, Ariz.

Location.--This system comprises four storage reservoirs created by four separate dams on Salt River: Roosevelt Lake, formed by Roosevelt Dam, in sec.20, T.4 N., R.12 E. (unsurveyed), on State Highway 88; Apache Lake, formed by Horse Mesa Dam, 17 mi (27 km) downstream from Roosevelt Dam; Canyon Lake, formed by Mormon Flat Dam, 27 mi (43 km) downstream from Roosevelt Dam; and Saguaro Lake, formed by Stewart Mountain Dam, 37 mi (60 km) downstream from Roosevelt Dam. Hydrologic Unit 15060106. Contents given herein are combined contents of the four reservoirs.

Drainage area.--6,211 mi^2 (16,086 km^2), at Stewart Mountain Dam.

Maxima.--February to March 1978: Contents recorded, 1,586,000 acre-ft (1,950 hm^3) 0800 hours Mar. 31.
1910 to January 1978: Contents, 1,764,000 acre-ft (2,180 hm^3) May 22, 1941.

Remarks.--Total capacity of the four reservoirs is 1,755,000 acre-ft (2,160 hm^3), divided as follows: Roosevelt Lake, 1,382,000 acre-ft (1,700 hm^3); Apache Lake, 245,000 acre-ft (302 hm^3); Canyon Lake, 58,000 acre-ft (71.5 hm^3); and Saguaro Lake, 70,000 acre-ft (86.3 hm^3). Dead storage negligible. Dams forming these reservoirs were built as follows: Roosevelt, 1905-11; Horse Mesa, 1924-27; Mormon Flat, 1923-26; and Stewart Mountain, 1928-30. Since 1910, spill over Roosevelt Dam because of capacity or near-capacity storage has occurred in 1915, 1916, 1917, 1920, 1941, 1965, 1966, 1968, and 1973.

Contents, in thousands of acre-feet, at 0800 hours of indicated day, 1978

Day	Contents	Day	Contents	Day	Contents
Feb. 27	640.9	Mar. 3	1,133	Mar. 7	1,338
28	645.5	4	1,234	8	1,357
Mar. 1	701.6	5	1,268	9	1,371
2	923.4	6	1,307	10	1,381

(57) 09501300 Tortilla Creek at Tortilla Flat, Ariz.

(Crest-stage station)

Location.--Lat 33°31'38", long 111°23'13", in NW¼ sec.13, T.2 N., R.9 E. (unsurveyed), Maricopa County, Hydrologic Unit 15060106, 600 ft (180 m) upstream from State Highway 88 and Tortilla Flat store, and 3.7 mi (6.0 km) southeast of Mormon Flat Dam.

Drainage area.--24.3 mi² (62.9 km²).

Gage-height record.--Crest stages only. Altitude of gage is 1,755 ft (535 m), from topographic map.

Discharge record.--Stage-discharge relation defined by computations of peak flow over the weir.

Maxima.--February to March 1978: Discharge, 3,000 ft³/s (84.7 m³/s) probably Mar. 2, gage height, 8.67 ft (2.643 m).
1942 to January 1978: Discharge, 7,500 ft³/s (213 m³/s) Sept. 1, 1971, gage height, 13.23 ft (4.033 m).

(58) 09502000 Salt River below Stewart Mountain Dam, Ariz.

Location.--Lat 33°33'10", long 111°34'33", in NW¼NW¼ sec.6, T.2 N., R.8 E. (unsurveyed), Maricopa County, Hydrologic Unit 15060106, on left bank 3.5 mi (5.6 km) downstream from Stewart Mountain Dam, and 6 mi (10 km) upstream from Verde River.

Drainage area.--6,232 mi² (16,141 km²), of which 21 mi² (54 km²) is below Stewart Mountain Dam.

Gage-height record.--Water-stage recorder graph. Altitude of gage is 1,370 ft (418 m), from topographic map.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 14,900 ft³/s (422 m³/s) and extended above on basis of computation of flow over dam at gage height 22.4 ft (6.83 m).

Maxima.--February to March 1978: Discharge, 29,600 ft³/s (838 m³/s) 1000 hours Mar. 2, gage height, 17.15 ft (5.227 m).
1910 to January 1978: Discharge recorded, 51,600 ft³/s (1,460 m³/s) Jan. 1, 1966, gage height, 22.4 ft (6.83 m), from floodmarks, may have been higher in January 1916 when a maximum daily discharge of 50,000 ft³/s (1,420 m³/s) was released from Roosevelt Dam.

Remarks.--Flow regulated by four reservoirs above station. (See station 09501000).

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	0	Mar. 2	16,100	Mar. 5	54
28	0	3	8,460	6	20
Mar. 1	1,290	4	2,300	7	12

(58) 09502000 Salt River below Stewart Mountain Dam, Ariz.—Continued

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 28			Mar. 2—Con.			Mar. 3—Con.		
2400	0.75	1	0700	11.00	12,500	0630	10.45	11,000
Mar. 1			0800	14.00	20,000	0930	10.25	10,500
1730	.94	5	0900	15.75	25,200	1000	9.00	7,600
1800	6.20	3,120	1000	17.15	29,600	1200	7.60	5,160
1900	6.38	3,340	1100	16.70	28,100	2400	7.50	5,000
2130	6.42	3,390	1300	14.80	22,400	Mar. 4		
2200	8.00	5,800	1600	13.75	19,400	0100	7.50	5,000
2230	9.35	8,300	1700	11.50	13,700	0200	7.00	4,200
2400	9.40	8,400	1900	8.35	6,430	0300	6.90	4,060
Mar. 2			2230	8.15	6,070	0400	5.40	2,230
0100	12.75	17,400	2400	10.60	11,400	0700	5.28	2,110
0200	13.97	19,900	Mar. 3			2100	5.25	2,080
0300	14.10	20,300	0100	10.67	11,600	2200	4.30	1,010
0400	12.50	16,200	0200	11.55	13,800	2300	3.10	226
0500	10.30	10,600	0300	12.20	15,800	2400	2.85	152
0600	10.10	10,200	0530	12.45	16,600			

(59) 09502800 Williamson Valley Wash near Paulden, Ariz.

Location.--Lat 34°52'00", long 112°36'45", in SE¼SE¼ sec.7, T.17 N., R.3 W., Yavapai County, Hydrologic Unit 15060201, on left bank 3.6 mi (5.8 km) north of Simmons, and 8.5 mi (13.7 km) west of Paulden.

Drainage area.--255 mi² (660 km²).

Gage-height record.--Digital water-stage recorder tape. Datum of gage is 4,455 ft (1,357.9 m) National Geodetic Vertical Datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 500 ft³/s (14 m³/s) and extended above on basis of slope-area measurements at gage heights 7.38 and 8.22 ft (2.249 and 2.505 m).

Maxima.--February to March 1978: Discharge, 7,490 ft³/s (212 m³/s) 0815 hours Mar. 1, gage height, 8.22 ft (2.505 m).
1965 to January 1978: Discharge, 3,910 ft³/s (111 m³/s) Feb. 9, 1976, gage height, 7.58 ft (2.310 m).

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	2.6	Mar. 2	1,850	Mar. 5	1,160
28	1,540	3	1,740	6	648
Mar. 1	4,180	4	318	7	242

(59) 09502800 Williamson Valley Wash near Paulden, Ariz.—Continued

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 27			Mar. 1—Con.			Mar. 4		
2400	2.79	3.2	2000	6.86	3,790	1200	3.58	302
Feb. 28			2200	7.20	4,580	2400	3.40	235
0900	3.01	9.4	2400	6.71	3,460	Mar. 5		
1100	5.77	1,700	Mar. 2			0600	3.80	391
1200	6.63	2,650	0300	6.09	2,320	0700	3.94	459
1330	7.32	3,540	0600	5.98	2,150	0800	4.01	498
1500	7.04	3,160	1200	5.91	2,050	1000	5.29	1,630
1600	6.71	2,750	1800	5.18	1,180	1130	6.52	3,620
1800	6.62	2,640	2200	5.26	1,260	1200	6.52	3,620
1900	6.80	2,860	2400	5.79	1,890	1500	5.60	2,040
2400	5.84	1,760	Mar. 3			1800	4.97	1,270
Mar. 1			0230	7.14	5,080	2100	4.63	955
0400	5.46	1,400	0400	6.86	4,410	2400	4.37	744
0500	5.86	2,030	0500	6.51	3,640	Mar. 6		
0600	7.41	4,700	0700	5.91	2,540	0700	4.13	573
0815	8.22	7,490	0900	5.54	1,980	1000	4.60	930
1000	7.77	6,080	1200	5.00	1,320	1600	4.22	633
1200	7.34	4,910	1800	4.33	729	2000	4.03	510
1500	7.35	4,940	2400	3.99	498	2400	3.84	410
1800	6.81	3,660						

(60) 09503700 Verde River near Paulden, Ariz.

Location.--Lat 34°53'40", long 112°20'32", in SW¼SW¼ sec.35, T.18 N., R.1 W., Yavapai County, Hydrologic Unit 15060201, in Prescott National Forest, on right bank 0.3 mi (0.5 km) upstream from Verde Valley Ranch, 7 mi (11 km) east of Paulden, 8 mi (13 km) upstream from Hell Canyon, 8 mi (13 km) downstream from Granite Creek, and 10 mi (16 km) downstream from Sullivan Lake.

Drainage area.--2,530 mi^2 (6,550 km^2), approximately (includes 373 mi^2 or 966 km^2 in Aubrey Valley Playa, a closed basin).

Gage-height record.--Water-stage recorder tape. Altitude of gage is 4,117 ft (1,255 m), from topographic map.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--February to March 1978: Discharge, 8,080 ft^3/s (229 m^3/s) 1530 hours Mar. 1, gage height, 9.66 ft (2.944 m).
1963 to January 1978: Discharge, 6,130 ft^3/s (174 m^3/s) Dec. 30, 1965, gage height, 8.48 ft (2.585 m).

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	23	Mar. 2	6,210	Mar. 5	1,030
28	227	3	3,400	6	1,610
Mar. 1	4,000	4	1,130	7	722

(60) 09503700 Verde River near Paulden, Ariz.—Continued

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 27			Mar. 2—Con.			Mar. 4		
2400	1.76	23	0600	9.54	7,710	0600	6.24	1,560
Feb. 28			0715	9.65	8,040	1200	5.63	1,050
2100	1.89	32	0745	9.64	8,010	1800	5.06	694
2200	5.78	1,530	1100	9.38	7,240	2400	4.71	524
2230	6.29	1,990	1400	9.25	6,870	Mar. 5		
2400	6.54	2,290	1600	9.07	6,390	1200	4.41	403
Mar. 1			1800	8.85	5,830	1600	5.06	694
0100	6.47	2,200	2100	8.11	4,180	1800	6.93	2,330
0400	6.64	2,420	2400	7.46	3,050	1900	7.24	2,740
0600	6.55	2,300	Mar. 3			2000	7.25	2,760
1200	5.84	1,580	0300	7.22	2,720	2400	6.40	1,720
1300	6.36	2,070	0500	7.25	2,760	Mar. 6		
1530	9.66	8,080	0700	7.80	3,610	0300	5.92	1,270
1600	9.66	8,080	0800	8.37	4,710	0600	5.90	1,260
1800	9.14	6,570	0900	8.69	5,440	1000	6.27	1,590
2100	8.84	5,800	1000	8.84	5,800	1400	6.41	1,730
2400	8.85	5,830	1200	8.61	5,260	1800	6.63	1,970
Mar. 2			1500	7.88	4,600	2400	6.03	1,370
0100	8.70	5,470	1800	7.16	2,640	Mar. 7		
0300	8.94	6,050	2100	6.68	2,030	1200	4.95	637
0400	9.26	6,900	2400	6.47	1,790	2400	4.27	354

(61) 09504000 Verde River near Clarkdale, Ariz.

Location (revised).--Lat 34°51'08", long 112°03'55", in NW¼SE¼ sec.17, T.17 N., R.3 E., Yavapai County, Hydrologic Unit 15060202, in Prescott National Forest, on left bank 1.7 mi (2.7 km) downstream from Sycamore Creek, and 5.6 mi (9.0 km) north of Clarkdale.

Drainage area.--3,520 mi² (9,120 km²), approximately (includes 373 mi² or 966 km² in Aubrey Valley Playa, a closed basin).

Gage-height record.--Digital water-stage recorder tape. Altitude of gage is 3,500 ft (1,070 m), from bench mark at gage.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--February to March 1978: Discharge, 25,000 ft³/s (708 m³/s) 1030 hours Mar. 1, gage height, 16.92 (5.157 m).

1915-21, 1965 to January 1978: Discharge, 50,600 ft³/s (1,430 m³/s) Feb. 21, 1920, gage height, 19.1 ft (5.82 m), site and datum then in use, from rating curve extended above 2,500 ft³/s (71 m³/s) on basis of float-area measurement at 35,000 ft³/s (990 m³/s).

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	287	Mar. 2	17,800	Mar. 5	5,280
28	5,800	3	13,400	6	5,940
Mar. 1	18,100	4	3,330	7	3,200

(61) 09504000 Verde River near Clarkdale, Ariz.—Continued

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 27			Mar. 1—Con.			Mar. 4—Con.		
2400	2.21	275	2400	14.83	19,800	2400	5.51	1,450
Feb. 28			Mar. 2			Mar. 5		
0100	2.22	258	0600	13.55	16,700	0200	5.54	1,480
0200	3.74	939	1015	14.04	17,900	0400	6.75	2,880
0700	4.50	1,510	1200	14.65	19,300	0600	6.95	3,160
1100	6.91	4,240	1430	14.47	18,900	0900	6.87	3,030
1200	7.14	4,560	1845	13.51	16,600	1100	8.29	3,870
1500	8.71	6,950	2400	13.96	17,700	1300	8.38	5,440
2000	11.65	12,500	Mar. 3			1430	9.48	7,460
2215	12.38	14,100	0230	14.89	19,900	1630	9.01	6,570
2400	11.78	12,800	0700	13.08	15,600	1830	9.98	8,560
Mar. 1			1100	11.73	12,400	2100	9.77	8,040
0315	10.30	9,810	1300	11.93	12,800	2230	10.21	9,640
0700	14.07	17,900	1700	10.88	10,300	2400	9.95	9,710
0930	16.68	24,400	2400	9.07	6,690	Mar. 6		
1030	16.92	25,000	Mar. 4			0500	8.47	7,330
1215	16.19	23,200	0400	7.97	4,750	1000	7.03	5,190
1315	15.23	20,800	0800	7.45	3,910	1700	6.78	4,850
1730	13.32	16,200	1200	6.96	3,170	2400	6.79	4,860
2130	15.01	20,200	1800	6.15	2,150			

(62) 09504500 Oak Creek near Cornville, Ariz.

Location.--Lat 34°45'56", long 111°53'24", in NW¼SE¼ sec.23, T.16 N., R.4 E., Yavapai County, Hydrologic Unit 15060202, near left bank on downstream side of pier of county highway bridge, 0.2 mi (0.3 km) upstream from Page Springs, 4 mi (6 km) northeast of Cornville, and 15 mi (24 km) upstream from mouth.

Drainage area.--357 mi² (925 km²).

Gage-height record.--Water-stage recorder tape except 2230 hours Mar. 1 to 1215 hours Mar. 3. Altitude of gage is 3,470 ft (1,058 m), from topographic map.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Discharges estimated during period of no gage-height record.

Maxima.--February to March 1978: Discharge, 17,400 ft³/s (493 m³/s) 0845 hours Mar. 1, gage height, 14.25 ft (4.343 m).

1940 to January 1978: Discharge, 24,700 ft³/s (700 m³/s) Sept. 5, 1970, gage height, 16.48 ft (5.023 m).

1885 to January 1978: Gage height, 23 ft (7.0 m) in March 1938, from floodmarks at upstream side of bridge.

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	372	Mar. 2	5,770	Mar. 5	2,780
28	4,780	3	4,460	6	2,040
Mar. 1	11,100	4	1,090	7	924

(62) 09504500 Oak Creek near Cornville, Ariz.—Continued

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 26			Mar. 1—Con.			Mar. 3—Con.		
2400	4.07	326	0800	14.07	16,800	2400	6.70	1,920
Feb. 27			0845	14.25	17,400	Mar. 4		
2000	3.89	267	1200	13.82	16,000	1200	5.51	985
2100	3.98	296	1300	13.41	14,700	2400	5.08	734
2200	4.37	435	1400	12.37	11,700	Mar. 5		
2400	5.99	1,340	1600	11.69	9,960	0200	5.09	784
Feb. 28			1800	11.49	9,660	0600	6.54	1,840
0400	7.17	2,420	2000	10.76	7,980	0800	6.47	1,780
0800	7.20	2,460	2230	11.00	8,520	1300	9.24	5,400
1200	8.05	3,440	2400	-----	7,000	1600	7.82	3,260
1400	8.17	3,600	Mar. 2			2100	7.92	3,390
1600	9.76	6,040	0600	-----	5,000	2300	7.56	2,890
1800	10.68	7,900	1600	-----	4,500	2400	7.91	3,370
2100	11.69	10,100	2400	-----	10,000	Mar. 6		
2400	10.99	8,450	Mar. 3			0600	6.67	1,870
Mar. 1			0300	-----	7,000	1200	5.93	1,250
0300	9.88	6,280	0600	-----	7,000	1800	5.64	1,050
0500	11.35	9,180	1300	8.01	3,400	2400	5.66	1,070
0600	12.73	12,800	1900	6.93	2,150			

(63) 09505200 Wet Beaver Creek near Rimrock, Ariz.

Location.--Lat 34°40'29", long 111°40'17", in NW¼SW¼ sec.24, T.15 N., R.6 E., Yavapai County, Hydrologic Unit 15060202, in Coconino National Forest, on right bank 4.5 mi (7.2 km) northeast of Rimrock, and 5.7 mi (9.2 km) upstream from Red Tank Draw.

Drainage area.--111 mi² (287 km²).

Gage-height record.--Digital water-stage recorder tape. Altitude of gage is 4,020 ft (1,225 m), from topographic map.

Discharge record.--Stage-discharge relation for concrete control defined by current-meter measurements.

Maxima.--February to March 1978: Discharge, 4,360 ft³/s (123 m³/s) 0930 Mar. 1, gage height, 10.46 (3.188 m).
1961 to January 1978: Discharge, 7,670 ft³/s (217 m³/s) Sept. 5, 1970, gage height, 12.41 ft (3.783 m).

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	110	Mar. 2	1,930	Mar. 5	1,100
28	1,990	3	1,550	6	634
Mar. 1	2,920	4	349	7	303

(63) 09505200 Wet Beaver Creek near Rimrock, Ariz.—Continued

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 27			Mar. 1—Con.			Mar. 4—Con.		
2400	5.31	321	2030	8.78	2,490	2400	5.04	250
Feb. 28			2100	8.59	2,310	Mar. 5		
0300	6.37	728	2400	7.80	1,650	0645	5.29	318
0700	6.74	928	Mar. 2			0815	6.21	660
0930	7.75	1,610	0130	7.57	1,480	1045	6.52	816
1000	8.14	1,910	0300	7.64	1,530	1115	6.84	1,000
1100	8.22	1,980	0500	8.39	2,140	1215	8.46	2,210
1400	8.31	2,060	0600	8.58	2,310	1400	7.48	1,420
1515	8.26	2,010	0700	8.48	2,220	1500	7.43	1,390
1700	9.08	2,770	1200	7.68	1,560	1600	7.66	1,550
1900	9.89	3,650	1600	7.27	1,270	1845	8.51	2,250
1945	9.78	3,530	1700	7.33	1,310	2100	7.82	1,680
2045	9.90	3,660	1830	8.11	1,900	2400	7.15	1,200
2100	10.02	3,800	2030	8.57	2,300	Mar. 6		
2200	9.95	3,720	2230	9.67	3,410	0600	6.04	584
2400	8.89	2,590	2330	9.73	3,480	1300	5.37	343
Mar. 1			2400	9.56	3,290	1400	5.48	378
0230	7.94	1,760	Mar. 3			1800	6.73	934
0500	9.33	3,040	0100	9.21	2,920	1900	6.78	964
0615	9.62	3,360	0230	9.00	2,700	2200	6.38	743
0800	9.62	3,360	0400	9.62	3,360	2400	6.03	580
0900	10.41	4,300	0600	8.78	2,490	Mar. 7		
0930	10.46	4,360	0800	7.98	1,790	0600	5.22	280
1100	10.23	4,070	1000	7.39	1,350	1200	4.82	181
1200	10.14	3,960	1200	6.96	1,070	1800	4.97	227
1400	9.71	3,460	1800	6.45	774	2100	5.66	416
1600	9.37	3,090	2400	6.08	596	2400	5.58	388
1800	8.75	2,460	Mar. 4					
1930	8.82	2,530	1200	5.27	310			

(64) 09505250 Red Tank Draw near Rimrock, Ariz.

Location.--Lat 34°41'43", long 111°42'49", in SE¼NE¼ sec.16, T.15 N., R.6 E., Yavapai County, Hydrologic Unit 15060202, in Coconino National Forest, on left bank 2.5 mi (4.0 km) downstream from confluence of Rarick and Mullican Canyons, and 3.5 mi (5.6 km) northeast of Rimrock.

Drainage area.--49.4 mi² (128 km²).

Gage-height record.--Digital water-stage recorder tape except 0800 to 1530 hours Mar. 2. Altitude of gage is 3,920 ft (1,195 m), from topographic map.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 1,100 ft³/s (31 m³/s) and extended above on basis of slope-area measurement at gage height 12.69 ft (3.868 m). Discharge estimated during period of no gage-height record.

(64) 09505250 Red Tank Draw near Rimrock, Ariz.—Continued

Maxima.--February to March 1978: Discharge, 2,600 ft³/s (73.6 m³/s) 0945 hours Mar. 1, recorded gage height, 8.74 ft (2.664 m).
1957 to January 1978: Discharge, 10,500 ft³/s (297 m³/s) Sept. 5, 1970, recorded gage height, 12.69 ft (3.868 m), outside stage about 13.3 ft (4.05 m), from profile past gage.

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	46	Mar. 2	600	Mar. 5	342
28	924	3	584	6	205
Mar. 1	1,260	4	52	7	78

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 27			Mar. 1—Con.			Mar. 3—Con.		
2400	5.40	400	1900	6.50	840	2400	4.18	98
Feb. 28			2200	6.14	670	Mar. 4		
0300	6.17	683	2400	5.80	534	1200	3.78	48
0600	5.92	580	Mar. 2			2400	3.58	29
1100	6.41	794	0400	5.54	438	Mar. 5		
1300	6.33	755	0800	5.38	383	0600	3.60	30
1600	6.90	1,060	1300	----	350	0800	4.23	104
1800	7.56	1,510	1530	6.46	814	0900	5.02	274
1900	7.36	1,360	1715	6.98	1,100	1030	5.28	348
2100	7.66	1,580	1930	6.70	941	1130	6.60	881
2200	7.60	1,540	2015	7.48	1,440	1300	6.04	620
2400	7.09	1,180	2145	8.33	2,160	1500	5.60	456
Mar. 1			2300	8.05	1,900	1600	5.54	434
0100	6.82	1,020	2400	7.56	1,500	1830	5.92	572
0200	7.04	1,150	Mar. 3			2000	5.84	542
0400	8.00	1,870	0115	7.14	1,200	2400	5.48	413
0700	7.02	1,140	0300	7.54	1,490	Mar. 6		
0800	7.00	1,120	0400	7.62	1,550	0600	4.80	217
0900	7.82	1,710	0600	6.80	997	1200	4.36	125
0945	8.74	2,600	0800	6.19	688	1600	4.34	122
1100	8.21	2,054	1000	5.78	523	2000	4.90	242
1300	7.38	1,380	1200	5.38	383	2400	4.70	194
1500	7.00	1,120	1600	4.78	214			
1700	6.98	1,110	2000	4.40	134			

(65) 09505300 Rattlesnake Canyon near Rimrock, Ariz.

Location.--Lat 34°46'01", long 111°40'23", in NW¼SW¼ sec.24, T.16 N., R.6 E., Yavapai County, Hydrologic Unit 15060202, in Coconino National Forest, on left bank 2.6 mi (4.2 km) upstream from mouth, 7 mi (11 km) northeast of Beaver Creek Ranger Station, and 9 mi (14 km) northeast of Rimrock.

Drainage area.--24.6 mi² (63.7 km²).

Gage-height record.--Digital water-stage recorder tape. Altitude of gage is 4,870 ft (1,484 m), from topographic map.

(65) 09505300 Rattlesnake Canyon near Rimrock, Ariz.—Continued

Discharge record.--Stage-discharge relation for concrete control defined by current-meter measurements below 1,100 ft^3/s (31 m^3/s) and extended above on basis of computation of peak flow over weir at gage height 8.50 ft (2.591 m) and slope-area measurement at gage height 11.50 ft (3.505 m).

Maxima.--February to March 1978: Discharge, 1,610 ft^3/s (45.6 m^3/s) 1015 hours Mar. 1, gage height, 9.00 ft (2.743 m).
1957 to January 1978: Discharge, 3,590 ft^3/s (102 m^3/s) Sept. 5, 1970, gage height, 11.50 ft (3.505 m).

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	93	Mar. 2	545	Mar. 5	322
28	639	3	329	6	135
Mar. 1	813	4	80	7	60

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 26			Mar. 1—Con.			Mar. 3—Con.		
2400	3.06	30	0800	7.07	773	0400	7.03	760
Feb. 27			0900	7.98	1,110	0600	6.25	528
1700	2.84	19	1015	9.00	1,610	0900	5.24	288
1800	2.92	23	1115	8.20	1,210	1200	4.74	208
2000	5.30	300	1200	7.70	994	2400	4.04	111
2100	5.38	317	1400	7.13	791	Mar. 4		
2200	5.34	307	1500	6.79	688	1200	3.68	76
2400	6.15	499	1700	6.82	697	1800	3.57	66
Feb. 28			2000	6.22	519	2000	3.56	66
0115	6.72	668	2400	5.50	342	2400	3.84	91
0200	6.73	671	Mar. 2			Mar. 5		
0500	6.01	461	0300	5.35	311	0100	4.43	161
0600	5.30	466	0600	5.65	374	0400	4.24	134
0830	6.72	668	0900	5.70	385	0600	5.12	266
1200	6.10	485	1300	5.57	357	0700	5.88	427
1600	6.84	703	1400	5.80	408	0900	5.50	342
1730	7.32	855	1500	6.62	638	1000	5.57	357
1915	6.74	674	1630	7.67	982	1100	6.66	651
2030	7.16	801	1800	7.24	828	1300	5.43	328
2100	7.49	915	1900	7.05	766	1500	5.04	252
2200	7.25	831	2130	8.18	1,200	1800	6.42	577
2300	6.81	694	2200	7.90	1,080	2000	5.55	353
2400	6.75	677	2300	7.52	926	2400	4.71	203
Mar. 1			2400	6.98	745	Mar. 6		
0130	6.59	628	Mar. 3			1200	3.82	89
0300	7.52	926	0100	6.54	613	1400	4.33	146
0430	8.41	1,310	0200	6.65	647	2000	4.45	164
0600	7.68	986	0300	7.31	852	2400	3.95	102

(66) 09505350 Dry Beaver Creek near Rimrock, Ariz.

Location.--Lat 34°43'43", long 111°46'30", in NE¼NW¼ sec.1, T.15 N., R.5 E., Yavapai County, Hydrologic Unit 15060202, in Coconino National Forest, on left upstream abutment of abandoned highway bridge, 400 ft (122 m) upstream from present State Highway 179, and 5.5 mi (8.8 km) north of Rimrock.

Drainage area.--142 mi² (368 km²).

Gage-height record.--Digital water-stage recorder tape. Datum of gage is 3,694.38 ft (1,126.047 m) National Geodetic Vertical Datum of 1929 (Arizona Highway Department bench mark).

Discharge record.--Stage-discharge relation for concrete control defined by current-meter measurements below 6,000 ft³/s (170 m³/s) and extended above on basis of computations of peak flow over weir at gage heights 9.07 and 9.69 ft (2.765 and 2.954 m) and slope-area measurement at gage height 14.35 ft (4.374 m).

Maxima.--February to March 1978: Discharge, 8,410 ft³/s (238 m³/s) 0515 hours Mar. 1, gage height, 9.25 ft (2.819 m).
1960 to January 1978: Discharge, 26,600 ft³/s (753 m³/s) Sept. 5, 1970, gage height, 14.35 ft (4.374 m).

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	393	Mar. 2	3,660	Mar. 5	1,570
28	2,830	3	1,840	6	672
Mar. 1	4,590	4	505	7	307

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 26			Mar. 1—Con.			Mar. 3		
2400	3.63	226	0600	8.87	7,510	0200	6.76	3,390
Feb. 27			0700	8.17	6,040	0330	6.96	3,730
1800	3.35	134	0800	7.66	5,000	0800	5.76	1,970
1900	3.40	148	0900	7.62	4,920	1200	5.14	1,290
2100	5.16	1,310	1100	8.52	6,770	2400	4.58	777
2400	5.74	1,950	1200	8.34	6,400	Mar. 4		
Feb. 28			1400	7.60	4,880	1200	4.12	461
0100	5.88	2,120	1600	7.21	4,160	2400	3.92	352
0300	6.24	2,600	2000	6.60	3,140	Mar. 5		
0600	5.90	2,150	2400	6.06	2,360	0100	3.98	383
0700	6.18	2,520	Mar. 2			0200	4.70	877
1200	6.03	2,320	0400	5.97	2,240	0600	4.67	852
1400	5.93	2,180	0600	6.32	2,720	0900	5.80	2,020
1600	6.63	3,190	0800	6.17	2,500	1100	6.26	2,630
1800	7.05	3,890	1100	6.47	2,940	1200	6.64	3,200
2030	6.57	3,100	1300	6.56	3,080	1400	5.48	1,650
2200	7.08	3,940	1500	6.39	2,820	1500	5.36	1,510
2400	6.62	3,170	1730	8.15	6,000	1830	5.99	2,260
Mar. 1			2000	7.72	5,110	2100	5.40	1,560
0300	6.74	3,360	2230	8.62	6,970	2400	5.14	1,290
0400	8.02	5,720	2400	7.70	5,070			
0515	9.25	8,410						

(67) 09505550 Verde River below Camp Verde, Ariz.

Location.--Lat 34°33'02", long 111°51'02", in SW¼NW¼ sec.5, T.13 N., R.5 E., Yavapai County, Hydrologic Unit 15060203, on downstream side of bridge on county highway, 0.5 mi (0.8 km) southeast of Camp Verde, and 2.2 mi (3.5 km) downstream from Beaver Creek.

Drainage area.--4,670 mi² (12,100 km²), approximately (includes 373 mi² or 966 km² in Aubrey Valley Playa, a closed basin).

Gage-height record.--Water-stage recorder tape. Datum of gage is 3,045.10 ft (928.146 m) National Geodetic Vertical Datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--February to March 1978: Discharge, 41,000 ft³/s (1,160 m³/s) 1715 hours Mar. 1, gage height, 19.41 ft (5.916 m).

1970 to January 1978: Discharge, 43,000 ft³/s (1,220 m³/s) Sept. 5-6, 1970, gage height, 19.0 ft (5.79 m).

Outside period of record: A peak discharge of 97,000 ft³/s (2,750 m³/s) was recorded at former gaging station at site 8.5 mi (13.7 km) downstream (below West Clear Creek) on Mar. 3, 1938, and is the highest since at least 1924.

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	881	Mar. 2	25,800	Mar. 5	8,730
28	7,240	3	23,500	6	10,100
Mar. 1	29,000	4	8,670	7	5,450

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 27			Mar. 1—Con.			Mar. 4		
2400	5.64	800	1600	18.73	37,600	0600	11.68	10,600
Feb. 28			1715	19.41	41,000	1200	10.85	8,500
0300	5.65	591	1815	19.12	39,600	2400	9.44	5,520
0345	6.72	1,530	1845	19.15	39,700	Mar. 5		
0900	9.22	5,170	2200	17.17	30,300	0745	8.77	4,310
1145	9.56	5,820	2400	16.20	27,700	1045	9.67	5,990
1415	10.78	8,340	Mar. 2			1445	11.12	9,150
1745	11.09	9,080	0145	16.07	27,000	1615	12.41	12,700
1915	11.41	9,900	0430	16.17	27,500	1800	12.67	13,500
2045	12.28	12,400	0830	15.70	25,500	1945	12.64	13,400
2230	13.54	16,400	1045	15.68	25,400	2230	12.87	14,100
2345	14.11	18,400	1330	15.16	23,300	2400	12.83	14,000
2400	14.14	18,500	1730	15.41	24,300	Mar. 6		
Mar. 1			2130	16.23	27,700	0730	12.58	13,200
0100	14.46	19,500	2400	16.28	27,900	1200	11.53	10,200
0245	15.19	22,300	Mar. 3			1430	10.75	8,280
0545	15.16	22,100	0315	17.19	32,500	1930	10.10	6,900
0730	15.49	23,500	0815	17.10	32,000	2400	10.23	7,160
0915	16.20	26,400	1045	16.36	28,200	Mar. 7		
1015	16.55	27,800	1445	14.48	19,900	0600	10.09	6,880
1230	16.58	28,000	1700	13.55	16,400	2400	8.13	3,330
1315	16.76	28,700	2000	13.26	15,400			
1430	17.82	33,400	2400	12.64	13,400			

(68) 09505800 West Clear Creek near Camp Verde, Ariz.

Location.--Lat 34°32'19", long 111°41'36", in NW¼NW¼ sec.11, T.13 N., R.6 E., Yavapai County, Hydrologic Unit 15060203, in Coconino National Forest, on left bank at Bull Pen Ranch, 9 mi (14 km) upstream from mouth, and 9 mi (14 km) east of Camp Verde.

Drainage area.--241 mi² (624 km²).

Gage-height record.--Digital water-stage recorder tape. Altitude of gage is 3,630 ft (1,106 m), from topographic map.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 2,700 ft³/s (60 m³/s) and extended above on basis of slope-area measurements at gage heights 8.3 and 10.15 ft (2.53 and 3.094 m).

Maxima.--February to March 1978: Discharge, 13,800 ft³/s (374 m³/s) 1315 hours Mar. 1, gage height, 10.15 ft (3.094 m).
1964 to January 1978: Discharge, 11,300 ft³/s (320 m³/s) Oct. 19, 1972, gage height, 9.61 ft (2.929 m).

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	279	Mar. 2	4,440	Mar. 5	1,730
28	2,980	3	4,250	6	1,040
Mar. 1	8,160	4	846	7	673

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 27			Mar. 2			Mar. 5		
2400	4.13	267	0200	7.48	4,320	0600	4.56	430
Feb. 28			0400	7.60	4,600	0800	4.94	650
0500	4.65	478	0700	8.32	6,550	1030	5.21	860
0700	4.86	589	0800	8.09	5,860	1115	5.90	1,590
1100	6.80	2,940	0900	8.05	5,750	1200	7.13	3,570
1300	6.94	3,200	1100	7.76	4,890	1300	7.28	3,880
1500	7.52	4,420	1130	7.11	3,530	1315	6.84	3,010
1600	7.48	4,320	1600	6.75	2,850	1500	6.56	2,530
1800	7.91	5,380	1700	6.90	3,120	1600	7.07	3,450
1900	7.78	5,040	1915	7.50	4,370	1730	7.12	3,550
2200	8.23	6,200	2130	7.42	4,190	1830	6.78	2,910
2300	8.04	5,620	2300	7.63	4,670	2100	6.61	2,620
2400	7.86	5,240	2400	8.39	6,770	2400	6.25	2,060
Mar. 1			Mar. 3			Mar. 6		
0100	7.69	4,820	0115	8.49	7,080	0600	5.56	1,220
0400	7.81	5,120	0130	8.64	7,580	1200	5.11	793
0500	8.22	5,950	0145	8.44	6,920	1600	4.97	684
0600	8.74	7,920	0230	8.41	6,830	1800	5.10	785
0700	9.00	8,850	0415	8.90	8,490	2100	5.10	785
0900	9.11	9,270	0430	9.05	9,040	2400	5.38	1,030
1100	9.73	11,800	0615	8.60	7,440	Mar. 7		
1200	9.60	11,300	0800	8.00	5,610	0200	5.56	1,230
1315	10.15	13,800	1130	7.19	3,690	0600	5.23	905

(68) 09505800 West Clear Creek near Camp Verde, Ariz.—Continued

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Mar. 1—Con.			Mar. 3—Con.			Mar. 7—Con.		
1400	9.75	11,900	1400	6.93	3,180	1200	4.84	606
1500	9.57	11,100	1700	6.15	1,920	1800	4.54	436
1600	9.13	9,350	2400	5.86	1,540	2400	4.40	368
1700	9.12	9,310	Mar. 4					
2000	8.66	7,650	0600	5.45	1,100			
2200	8.19	5,860	1200	5.05	745			
2400	7.70	4,840	2400	4.61	467			

(69) 09507980 East Verde River near Childs, Ariz.

Location.--Lat 34°17'00", long 111°38'50", in sec.21, T.11 N., R.7 E. (unsurveyed), Gila County, Hydrologic Unit 15060203, in Tonto National Forest, on left bank 1.3 mi (2.1 km) upstream from mouth, and 6 mi (10 km) southeast of Childs.

Drainage area.--328 mi² (850 km²).

Gage-height record.--Water-stage recorder graph. Altitude of gage is 2,500 ft (760 m), from topographic map.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 960 ft³/s (27 m³/s) and extended above on basis of slope-area measurements at gage heights 8.82 and 19.2 ft (2.688 and 5.85 m).

Maxima.--February to March 1978: Discharge, 15,000 ft³/s (424 m³/s) 1000 hours Mar. 1, gage height, 16.0 ft (4.877 m).
1961 to January 1978: Discharge, 23,500 ft³/s (666 m³/s) Sept. 5, 1970, gage height, 19.2 ft (5.85 m), from profile past gage.

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	100	Mar. 2	6,890	Mar. 5	1,560
28	2,240	3	4,410	6	1,350
Mar. 1	7,260	4	1,230	7	695

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 27			Mar. 1—Con.			Mar. 4		
2400	3.00	100	1700	10.40	6,420	1200	4.95	1,150
Feb. 28			1900	10.80	6,920	2400	4.60	884
0600	3.10	122	2200	10.20	6,160	Mar. 5		
0900	3.22	150	2400	10.30	6,290	0600	4.50	807

(69) 09507980 East Verde River near Childs, Ariz.—Continued

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 28—Con.						Mar. 5—Con.		
1000	4.40	660	Mar. 2			1100	4.70	968
1100	5.50	1,450	0100	10.50	6,550	1300	5.40	1,510
1200	6.45	2,260	0400	10.30	6,290	1400	6.30	2,080
1300	6.30	2,120	0600	10.40	6,420	1500	5.80	1,820
1600	6.30	2,120	0800	11.60	8,080	1600	6.60	2,510
1700	10.70	7,100	1100	11.80	8,360	1700	6.30	2,250
1900	8.70	4,420	1300	10.20	6,160	1800	7.00	2,850
2200	9.50	5,300	1600	11.10	7,380	2000	6.60	2,510
2400	9.14	4,860	2100	10.20	6,160	2400	6.10	2,080
Mar. 1			2400	10.50	6,550	Mar. 6		
0200	8.50	4,200	Mar. 3			0600	5.45	1,550
0600	10.00	5,900	0400	12.00	8,650	1200	5.15	1,320
0700	12.00	8,650	0600	11.10	7,380	1800	4.80	1,050
0800	13.00	10,200	0800	10.00	5,900	2400	4.60	884
0900	14.00	11,600	1000	8.65	4,420	Mar. 7		
1000	16.00	15,000	1300	7.35	3,110	1000	4.40	723
1100	14.00	11,600	1500	6.65	2,340	2400	4.12	541
1200	12.00	8,650	1800	6.25	2,200			
1500	10.30	6,290	2400	5.70	1,740			

(70) 09508000 Verde River below East Verde River, near Pine, Ariz.

Location.--Lat 34°16', long 111°41', in sec.30, T.11 N., R.7 E. (unsurveyed), Yavapai County, Hydrologic Unit 15060203, on right bank 2.5 mi (4.0 km) downstream from East Verde River, and 15 mi (24 km) southwest of Pine.

Drainage area.--5,623 mi^2 (14,560 km^2), approximately (includes 373 mi^2 or 966 km^2 in Aubrey Valley Playa, a closed basin).

Gage-height record.--Water-stage recorder graph to 1300 hours Mar. 4. Gage height estimated until 2400 hours Mar. 4. No gage height thereafter. Datum of gage is 2,401.6 ft (732.0 m) National Geodetic Vertical Datum of 1929.

Discharge record.--Stage-discharge relation extended above 40,000 ft^3/s (1,130 m^3/s). Daily discharges estimated Mar. 5-7 on basis of records for Verde River below Tangle Creek.

Maxima.--February to March 1978: Discharge, 67,600 ft^3/s (1,914 m^3/s) 2000 hours Mar. 1, gage height, 24.1 ft (7.35 m).
1924 to January 1978: Discharge, 110,000 ft^3/s (3,115 m^3/s) Mar. 3, 1938, gage height, 24.7 ft (7.52 m), from rating curve extended above 27,000 ft^3/s (765 m^3/s), on basis of slope-area measurement of peak flow, verified by comparison with records for other stations on Verde River.

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	1,380	Mar. 2	49,200	Mar. 5	9,000
28	11,600	3	44,200	6	14,000
Mar. 1	56,200	4	14,000	7	7,000

(70) 09508000 Verde River below East Verde River, near Pine, Ariz.—Continued

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 27			Mar. 1—Con.			Mar. 3		
2400	8.00	1,380	1000	23.4	63,700	0600	22.85	60,700
Feb. 28			1100	23.9	67,000	0900	22.0	56,000
0600	8.00	1,380	1200	23.3	63,200	1200	20.7	49,000
1000	8.20	1,520	1500	22.7	60,100	1500	19.0	40,500
1200	10.1	5,550	1900	23.8	66,300	1800	17.2	29,200
1400	13.5	16,300	2000	24.1	67,600	2100	15.7	25,300
1700	14.5	20,300	2400	23.3	63,200	2200	15.4	24,100
1900	15.25	23,300	Mar. 2			2400	15.1	22,900
2200	16.6	29,200	0430	19.8	45,700	Mar. 4		
2400	16.8	30,100	0800	21.8	54,900	0200	14.5	19,600
Mar. 1			1200	21.0	50,500	0600	13.6	16,500
0100	16.8	30,100	1400	19.8	44,500	1200	12.3	13,000
0300	18.0	35,500	1700	19.2	41,500	2400	10.8	9,220
0600	21.0	50,500	2400	21.1	51,000			
0800	22.15	56,800						

(71) 09508300 Wet Bottom Creek near Childs, Ariz.

Location.--Lat 34°09'39", long 111°41'32", in sec.36, T.9½ N., R.6 E. (unsurveyed), Gila County, Hydrologic Unit 15060203, in Tonto National Forest, on right bank 1.4 mi (2.3 km) upstream from mouth, and 13 mi (21 km) south of Childs.

Drainage area.--36.4 mi² (94.3 km²).

Gage-height record.--Digital water-stage recorder tape except 0800 hours Mar. 1 to 1400 hours Mar. 4. Altitude of gage is 2,320 ft (707 m), from topographic map.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 3,000 ft³/s (85.0 m³/s) and extended above on basis of slope-area measurement at gage heights 9.77, 11.00, 14.18, and 15.66 ft (2.978, 3.353, 4.322, and 4.773 m). Discharge during period of missing gage height estimated on basis of records for nearby streams.

Maxima.--February to March 1978: Discharge, 6,660 ft³/s (188 m³/s) about 0700 hours Mar. 2, gage height, 15.66 ft (4.773 m), from high-water mark in well.
1967 to January 1978: Discharge, 5,990 ft³/s (170 m³/s) Dec. 19, 1967. Gage height, 14.18 ft (4.322 m) Sept. 5, 1970, from high-water mark in gage well.

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	15	Mar. 2	3,200	Mar. 5	332
28	911	3	2,000	6	286
Mar. 1	2,400	4	300	7	154

(71) 09508300 Wet Bottom Creek near Childs, Ariz.—Continued

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 27			Feb. 28—Con.			Mar. 2		
2400	4.24	15	2400	7.26	1,140	0200	-----	1,500
Feb. 28			Mar. 1			0400	-----	2,400
0745	4.43	21	0200	6.85	869	0600	-----	4,500
0815	7.76	1,510	0345	7.19	1,090	0700	15.66	6,660
1030	7.41	1,250	0430	7.73	1,490	1000	-----	4,300
1115	8.67	2,350	0500	9.69	3,490	1400	-----	2,400
1145	8.43	2,120	0545	11.23	5,710	1700	9.35	3,100
1300	7.59	1,380	0600	10.87	5,130	2000	-----	2,400
1600	6.94	923	0700	9.29	3,020	2400	-----	2,400
1700	7.25	1,130	0745	8.83	2,520	Mar. 3		
1800	7.29	1,160	1400	-----	1,500	0200	-----	2,700
1915	7.17	1,070	1700	-----	2,100	0400	-----	4,800
2100	8.45	2,140	2000	-----	4,800	0700	-----	3,300
2200	7.79	1,540	2200	-----	2,700	1200	-----	1,500
2300	7.47	1,290	2400	-----	1,800	2400	-----	600

(72) 09508500 Verde River below Tangle Creek, above Horseshoe Dam, Ariz.

Location.--Lat 34°04'23", long 111°42'56", in sec.35, T.9 N., R.6 E. (unsurveyed), Yavapai County, Hydrologic Unit 15060203, in Tonto National Forest, on right bank 1.3 mi (2.1 km) downstream from Tangle Creek, and 9 mi (14 km) upstream from Horseshoe Dam.

Drainage area.--5,872 mi² (15,208 km²), includes 373 mi² (966 km²) in Aubrey Valley Playa, a closed basin.

Gage-height record.--Water-stage recorder graph. Datum of gage is 2,029.0 ft (618.44 m) National Geodetic Vertical Datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--February to March 1978: Discharge, 91,400 ft³/s (2,590 m³/s) 2230 hours Mar. 1, gage height, 21.2 ft (6.462 m).

1924 to January 1978: Discharge, 100,000 ft³/s (2,830 m³/s) Mar. 3, 1938, based on comparison with peak discharge at other stations on Verde River, gage height, 19.0 ft (5.79 m), from floodmarks.

1888 to January 1978: Discharge not determined, probably about 150,000 ft³/s (4,250 m³/s) Feb. 24, 1891, estimated from records for Salt River above and below Verde River.

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	1,720	Mar. 2	64,700	Mar. 5	13,400
28	10,100	3	54,700	6	18,800
Mar. 1	65,100	4	17,400	7	10,200

(72) 09508500 Verde River below Tangle Creek, above Horseshoe Dam, Ariz.—Continued

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 27			Mar. 1—Con.			Mar. 4—Con.		
2400	5.93	1,560	2400	21.18	91,100	0730	13.96	19,600
Feb. 28			Mar. 2			1200	13.38	16,800
0600	6.15	1,720	0400	19.72	70,000	1800	12.50	13,100
0900	6.15	1,720	0500	20.52	81,100	2400	12.00	11,400
1000	7.50	2,880	0600	20.62	82,500	Mar. 5		
1100	8.60	4,060	1100	19.12	62,400	1100	10.90	8,360
1200	9.02	4,520	1200	19.22	63,700	1400	11.65	10,400
1330	9.48	5,050	1500	18.82	58,900	1600	13.10	15,600
1500	9.30	4,830	1700	17.97	49,700	1800	13.60	17,800
1600	10.72	7,900	1800	18.12	51,200	2000	14.00	19,800
1700	13.01	15,400	2100	17.97	49,700	2200	14.25	21,200
1800	14.50	22,600	2130	17.74	47,400	2400	14.80	24,300
1900	14.74	24,000	2400	18.32	53,300	Mar. 6		
2100	15.45	28,500	Mar. 3			1200	13.93	19,500
2400	15.88	31,500	0130	19.20	63,400	2400	12.25	12,300
Mar. 1			0700	19.90	72,400	Mar. 7		
0200	16.13	33,400	0730	19.72	70,000	0400	11.80	10,800
0230	16.03	32,600	0930	19.70	69,700	1200	11.88	11,100
0500	17.08	41,200	1000	19.45	66,500	2400	10.62	7,700
0600	17.83	48,300	1200	19.00	61,000	Mar. 8		
0800	18.93	60,200	1600	17.83	48,300	1200	9.38	5,270
1000	19.88	72,100	1800	17.85	48,500	2400	8.80	4,350
1100	19.88	72,100	2000	16.20	33,900	Mar. 9		
1330	20.50	80,800	2200	15.55	29,200	1500	7.70	3,020
1530	19.93	72,800	2400	15.05	25,900	2400	7.95	3,290
1800	19.93	72,800	Mar. 4					
2230	21.20	91,400	0200	14.75	24,000			
2300	21.00	88,300	0300	14.75	24,000			

(73) Deadman Creek near Horseshoe Dam, Ariz.

(Miscellaneous site)

Location.--Lat 34°01'33", long 111°39'04", in Yavapai County, Hydrologic Unit 15060203, 3.9 mi (6.2 km) upstream from mouth, 4.4 mi (7.1 km) northeast of Horseshoe Dam.

Drainage area.--36.3 mi^2 (92.9 km^2).

Maximum.--February to March 1978: Discharge, 6,620 ft^3/s (187 m^3/s) probably Mar. 2 (revised), from slope-area measurement of peak flow.

Remarks.--Tributary to Horseshoe Reservoir from the northeast.

(74) Lime Creek near Horseshoe Dam, Ariz.

(Miscellaneous site)

Location.--Lat 33°59'11", long 111°45'03", in sec.4, T.7 N., R.6 E. (unsurveyed) in Maricopa County, Hydrologic Unit 15060203, 0.5 mi (0.8 km) upstream from mouth at maximum reservoir level, 2.5 mi (4.0 km) west of Horseshoe Dam.

Drainage area.--41.9 mi^2 (109 km^2).

Maximum.--February to March 1978: Discharge, 5,180 ft^3/s (147 m^3/s) probably Mar. 2 (revised), from slope-area measurement of peak flow.

Remarks.--Tributary to Horseshoe Reservoir from the northwest.

(75) Davenport Creek near Horseshoe Dam, Ariz.

(Miscellaneous site)

Location.--Lat 33°59'54", long 111°38'32", in sec.32, T.8 N., R.7 E. (unsurveyed), Maricopa County, Hydrologic Unit 15060203, 4.2 mi (6.7 km) upstream from mouth, 4 mi (6.4 km) east of Horseshoe Dam.

Drainage area.--25.5 mi^2 (66.0 km^2).

Maximum.--February to March 1978: Discharge, 5,500 ft^3/s (156 m^3/s) probably Mar. 2 (revised), from slope-area measurement of peak flow.

Remarks.--Tributary to Verde River from the northeast between Horseshoe and Bartlett Reservoirs.

(76) Sheep Creek near Horseshoe Dam, Ariz.

(Miscellaneous site)

Location.--Lat 33°55'24", long 111°38'12", in sec.28, T.7 N., R.7 E. (unsurveyed), in Maricopa County, Hydrologic Unit 15060203, 1 mi (1.6 km) upstream from mouth at maximum reservoir level, and 6 mi (9.6 km) southeast of Horseshoe Dam.

Drainage area.--34.2 mi^2 (88.6 km^2).

Maximum.--February to March 1978: Discharge, 6,660 ft^3/s (189 m^3/s) probably Mar. 2 (revised), from slope-area measurement of peak flow.

Remarks.--Tributary to Bartlett Reservoir from the northeast.

(77) Canyon Creek near Bartlett Dam, Ariz.

(Miscellaneous site)

Location.--Lat 33°53'25", long 111°36'40", in SW½ sec.2, T.6 N., R.7 E. (unsurveyed), Maricopa County, Hydrologic Unit 15060203, 0.1 mi (0.16 km) upstream from mouth at maximum reservoir level, 5.0 mi (8 km) northeast of Bartlett Dam, and 8.5 mi (13.7 km) southeast of Horseshoe Dam.

Drainage area.--9.2 mi^2 (23.8 km^2).

(77) Canyon Creek near Bartlett Dam, Ariz.—Continued

Maximum.--February to March 1978: Discharge, 700 ft^3/s (19.8 m^3/s) probably Mar. 2 (revised), from slope-area measurement of peak flow.

Remarks.--Tributary to Bartlett Reservoir from the east.

(78) Alder Creek near Bartlett Dam, Ariz.

(Miscellaneous site)

Location.--Lat 33°51'50", long 111°34'28", in sec.13, T.6 N., R.7 E., Maricopa County, Hydrologic Unit 15060203, 1 mi (1.6 km) upstream from mouth at maximum reservoir level, 3 mi (4.8 km) northeast of Bartlett Dam, and 6.2 mi (10 km) west of Sunflower.

Drainage area.--11.3 mi^2 (29.7 km^2).

Maximum.--February to March 1978: Discharge, 1,430 ft^3/s (40.5 m^3/s) probably Mar. 2 (revised), from slope-area measurement of peak flow.

Remarks.--Tributary to Bartlett Reservoir from the east.

(79) 09509500 Reservoir system on Verde River at and below Horseshoe Dam, Ariz.

Location.--This system comprises two storage reservoirs created by Horseshoe and Bartlett Dams on Verde River. Gages on Horseshoe Reservoir, formed by Horseshoe Dam, lat 33°59'05", long 111°42'35", in sec.2, T.7 N., R.6 E. (unsurveyed); and Bartlett Reservoir, formed by Bartlett Dam, lat 33°49'05", long 111°37'52", in sec.34, T.6 N., R.7 E. (unsurveyed), Maricopa County, Hydrologic Unit 15060203.

Drainage area.--6,185 mi^2 (16,019 km^2), at Bartlett Dam.

Gage-height record.--Water-stage recorder graphs. Datum of gage on Horseshoe Reservoir is 1,900.00 ft (579.120 m) and on Bartlett Reservoir, 1,599.46 ft (487.515 m) National Geodetic Vertical Datum of 1929.

Maxima.--February 27 to March 10, 1978: Contents, 304,400 acre-ft (375 hm^3) 1000 hours Mar. 2.
1939 to January 1978: Contents, 318,000 acre-ft (392 hm^3) May 9, 1973.

Cooperation.--Capacity tables furnished by Salt River Valley Water Users' Association.

Remarks.--Horseshoe Reservoir is formed by earthfill and rockfill dam; dam completed and storage began Nov. 15, 1945. Bartlett Reservoir is formed by concrete multiple-arch dam; dam completed May 1939 and storage began Feb. 5, 1939. Total capacity of the two reservoirs is 317,700 acre-ft (392 hm^3) divided as follows: Horseshoe Reservoir, 139,200 acre-ft (172 hm^3) at elevation 2,026.0 ft (617.52 m)—top of spillway gates and Bartlett Reservoir, 178,500 acre-ft (220 hm^3) at elevation 1,787.46 ft (544.818 m)—top of spillway gates. Capacities given here are from tables used through September 1978 and are approximately 8,100 acre-ft greater than those from tables put in use Oct. 1, 1978. Since 1939, spill has occurred in the 1941, 1965, 1966, 1973, 1978, 1979, and 1980 water years.

(79) 09509500 Reservoir system on Verde River at and below Horseshoe Dam, Ariz.—Continued

Contents, in acre-feet, at 2400 hours on indicated day, 1978

Day	Contents	Day	Contents	Day	Contents
Feb. 27	170,400	Mar. 3	274,800	Mar. 7	263,600
28	188,600	4	275,200	8	252,600
Mar. 1	276,000	5	273,000	9	261,000
2	289,800	6	281,600	10	268,000

(80) 09510000 Verde River below Bartlett Dam, Ariz.

Location.--Lat 33°48'30", long 111°39'09", in NW¼ sec.5, T.5 N., R.7 E. (unsurveyed), Maricopa County, Hydrologic Unit 15060203, in Tonto National Forest, on right bank 2.1 mi (3.4 km) downstream from Bartlett Dam, 4.0 mi (6.4 km) upstream from Camp Creek, and 18 mi (29 km) east of town of Cave Creek.

Drainage area.--6,185 mi² (16,019 km²).

Gage-height record.--Water-stage recorder graph after 1100 hours Mar. 4. Datum of gage is 1,572.34 ft (479.249 m) National Geodetic Vertical Datum of 1929. Prior to Mar. 1, 1978, gage was 1.9 mi (3.1 km) upstream and 1,300 ft (400 m) downstream from Bartlett Dam.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Discharges during period of missing gage-height record furnished by Salt River Valley Water Users' Association and computed from gate openings at Bartlett Dam. Not adjusted for time of travel from dam to gage.

Maxima.--February to March 1978: Discharge, 101,000 ft³/s (2,860 m³/s) 1200 hours Mar. 2, gage height, 25.9 ft (7.894 m).
1939 to January 1978 (regulated): Discharge, 45,800 ft³/s (1,300 m³/s) Mar. 15, 1941.
1888 to 1939 (unregulated): Discharge not determined, probably over 150,000 ft³/s (4,250 m³/s) Feb. 24, 1891. Floods of Nov. 27, 1905, and Mar. 4, 1938, reached maximum discharges of 96,000 ft³/s (2,720 m³/s) and 95,000 ft³/s (2,690 m³/s), respectively.

Remarks.--Flow regulated by Bartlett and Horseshoe Reservoirs (see sta 09509500).

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	190	Mar. 3	67,600	Mar. 7	18,400
28	63	4	18,400	8	12,400
Mar. 1	14,400	5	17,600	9	100
2	64,500	6	14,600	10	50

(80) 09510000 Verde River below Bartlett Dam, Ariz.—Continued

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Mar. 1			Mar. 2—Con.			Mar. 4—Con.		
1230	-----	0	1630	-----	65,600	2400	13.53	20,400
1230	-----	10,000	1630	-----	70,000	Mar. 5		
1330	-----	10,000	2150	-----	70,000	0030	15.70	30,800
1330	-----	30,000	2150	-----	75,000	0145	15.70	30,800
1600	-----	30,000	2400	-----	75,000	0230	10.80	12,000
1600	-----	32,400	Mar. 3			0800	10.65	11,600
1700	-----	32,400	0100	-----	75,000	1330	10.65	11,600
1700	-----	36,000	0445	-----	75,000	1430	13.30	19,500
1800	-----	36,000	0445	-----	85,000	1700	13.30	19,500
1800	-----	30,400	1100	-----	85,000	1730	14.38	24,100
1900	-----	29,400	1100	-----	75,000	2300	14.35	24,000
2000	-----	30,200	1200	-----	75,000	2400	11.93	14,800
2100	-----	30,800	1200	-----	70,000	Mar. 6		
2200	-----	31,400	1500	-----	70,000	1200	11.95	14,900
2300	-----	31,400	1500	-----	50,000	2400	11.92	14,800
2300	-----	40,000	2400	-----	50,000	Mar. 7		
2400	-----	40,400	Mar. 4			1400	11.95	14,900
Mar. 2			0040	-----	50,000	1500	14.40	24,200
0100	-----	41,100	0040	-----	30,000	2100	14.23	23,400
0200	-----	41,100	0240	-----	30,000	2400	14.25	23,500
0200	-----	50,000	0240	-----	20,000	Mar. 8		
0445	-----	50,000	0520	-----	20,000	0530	14.27	23,600
0445	-----	54,000	0520	-----	15,000	1130	14.15	23,100
0700	-----	54,000	0945	-----	15,000	1300	5.00	2,100
0700	-----	60,000	1100	7.77	6,100	1530	4.00	900
1000	-----	60,000	1200	7.70	6,000	1830	3.48	436
1100	-----	98,000	1300	12.30	16,000	2400	3.34	320
1200	25.9	101,000	1830	12.35	16,100			
1230	21.1	65,000	1900	13.58	20,600			

(81) Camp Creek near Bartlett Dam, Ariz.

(Miscellaneous site)

Location.--Lat 33°46'56", long 111°40'33", in NW¼ sec.18, T.5 N., R.7 E., Maricopa County, Hydrologic Unit 15060203, 1 mi (1.6 km) upstream from mouth, 3.6 mi (5.8 km) southwest of Bartlett Dam, and 10 mi (16 km) north of Fort McDowell.

Drainage area.--48.3 mi² (125 km²).

Maximum.--February to March 1978: Discharge, 1,160 ft³/s (32.9 m³/s), probably Mar. 2 (revised), from slope-area measurement of peak flow.

Remarks.--Tributary to Verde River downstream from Bartlett Dam from the northwest.

(82) 09510070 West Fork Sycamore Creek above McFarland Canyon near Sunflower, Ariz.

(Discontinued station)

Location.--Lat 33°57'38", long 111°29'12", in SE¼SW¼ sec.12, T.7 N., R.8 E. (unsurveyed), Maricopa County, Hydrologic Unit 15060203, in Tonto National Forest, on left bank 0.2 mi (0.3 km) upstream from McFarland Canyon, and 6.8 mi (10.9 km) north of Sunflower.

Drainage area.--4.58 mi² (11.9 km²).

Gage-height record.--Crest stage only. Altitude of gage is 4,380 ft (1,335 m), from topographic map.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 28 ft³/s (0.79 m³/s) and extended above on basis of weir and critical depth measurements of peak flows.

Maxima.--February to March 1978: Discharge, 720 ft³/s (20.4 m³/s) probably Mar. 2, gage height, 4.81 ft (1.466 m), from high-water mark in well.
1959 to January 1978: Discharge, 1,700 ft³/s (48.1 m³/s) Sept. 5, 1970, gage height, 5.50 ft (1.676 m).

(83) 09510080 West Fork Sycamore Creek near Sunflower, Ariz.

(Discontinued station)

Location.--Lat 33°56'45", long 111°29'05", in SE¼ sec.13, T.7 N., R.8 E., Maricopa County, Hydrologic Unit 15060203, in Tonto National Forest, on right bank 1.2 mi (1.9 km) upstream from confluence with East Fork, and 5.7 mi (9.2 km) north of Sunflower.

Drainage area.--9.8 mi² (25.4 km²).

Gage-height record.--Crest stage only. Altitude of gage is 4,000 ft (1,200 m), from topographic map.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 420 ft³/s (11.9 m³/s) and extended above on basis of slope-area measurements of peak flows at 6.7 and 9.50 ft (2.04 and 2.896 m).

Maxima.--February to March 1978: Discharge, 660 ft³/s (18.7 m³/s) probably Mar. 2, gage height, 6.60 ft (2.011 m), from high-water mark in well.
1959 to January 1978: Discharge, 3,480 ft³/s (98.6 m³/s) Sept. 5, 1970, gage height, 9.50 ft (2.896 m).

(84) 09510100 East Fork Sycamore Creek near Sunflower, Ariz.

Location.--Lat 33°56'58", long 111°27'39", in NE¼SE¼ sec.18, T.7 N., R.9 E., Maricopa County, Hydrologic Unit 15060203, in Tonto National Forest, on left bank 1.7 mi (2.7 km) upstream from confluence with West Fork, and 6.0 mi (9.7 km) north of Sunflower.

Drainage area.--4.49 mi² (11.6 km²).

Gage-height record.--Water-stage recorder graph to 1700 hours Feb. 28, after which, several ranges in stage were recorded between sporatic short periods of operation. Gage-height record for Mar. 1-2 reconstructed on basis of recorded ranges in stage with times estimated from records for nearby stations. Altitude of gage is 4,140 ft (1,262 m), from topographic map.

(84) 09510100 East Fork Sycamore Creek near Sunflower, Ariz.—Continued

Discharge record.--Stage-discharge relation defined by current-meter measurements below 130 ft³/s (3.7 m³/s) and extended above on basis of slope-area measurement at gage height 9.50 ft (2.896 m). Daily discharges for Mar. 3-7 estimated on basis of records for Camp Creek near Sunflower.

Maxima.--February to March 1978: Discharge, 550 ft³/s (15.6 m³/s) about 0600 hours Mar. 2, gage height, 6.18 ft (1.88 m), from high-water mark in well.
1959 to January 1978: Discharge, 1,940 ft³/s (54.9 m³/s) Sept. 5, 1970, gage height, 9.50 ft (2.896 m), from profile past gage.

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	1.9	Mar. 2	180	Mar. 5	40
28	50	3	50	6	30
Mar. 1	†245	4	20	7	20

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 27			Mar. 1			Mar. 2		
1000	1.35	1.0	0100	2.8	63	0200	4.75	292
2100	1.45	2.6	0300	2.9	73	0300	4.88	308
2400	1.60	4.6	0600	6.18	550	0600	3.6	154
Feb. 28			0700	5.10	334	0700	3.90	190
0300	2.35	30	0830	6.03	516	1200	3.3	118
0500	2.75	58	1200	4.5	262	1700	3.83	182
0630	2.75	58	1600	2.92	75	1900	3.4	130
1200	2.60	46	2130	4.5	262	2000	3.49	141
1400	2.53	41	2230	4.3	238	2400	3.0	83
1700	2.70	54	2400	5.30	370			
2400	2.56	43						

† Revised.

(85) 09510170 Camp Creek near Sunflower, Ariz.

(Crest-stage station)

Location.--Lat 33°45'35", long 111°29'44", in SW¼ sec.24, T.5 N., R.8 E., Maricopa County, Hydrologic Unit 15060203, on right bank at upstream side of culvert on State Highway 87, 0.5 mi (0.8 km) upstream from mouth, and 7 mi (11 km) south of Sunflower.

Drainage area.--2.6 mi² (6.73 km²).

Gage-height record.--Water-stage recorder graph. Datum of gage is 2,186.61 ft (666.479 m) Arizona State Highway datum.

Discharge record.--Stage-discharge relation defined by current-meter measurements and field estimates below 27 ft³/s (0.76 m³/s) and extended above on basis of computations of flow through culvert.

(85) 09510170 Camp Creek near Sunflower, Ariz.—Continued

Maxima.--February to March 1978: Discharge, 402 ft³/s (11.4 m³/s) 0200 hours Mar. 2, gage height, 5.05 ft (1.554 m).
1963 to January 1978: Discharge, 391 ft³/s (11.1 m³/s) Aug. 16, 1963, gage height, 4.96 ft (1.512 m).

Remarks.--Tributary to Sycamore Creek from the east.

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	0	Mar. 2	146	Mar. 5	43
28	81	3	44	6	28
Mar. 1	131	4	13	7	9.6

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 27			Mar. 1—Con.			Mar. 3—Con.		
2400	0.55	1.0	1600	1.58	58	0700	1.50	52
Feb. 28			1800	2.15	104	1500	1.32	38
0130	.95	10	2000	2.50	132	1900	1.19	27
0200	1.50	52	2100	4.30	313	2400	1.10	20
0230	3.00	176	2230	3.90	269	Mar. 4		
0300	4.50	336	2400	4.85	378	1200	.98	12
0400	3.25	201	Mar. 2			2400	.89	7.6
0500	2.33	118	0100	5.00	396	Mar. 5		
0530	2.15	104	0130	4.87	382	0600	.86	6.4
0830	1.72	70	0200	5.05	402	1130	.87	6.8
1300	1.44	47	0300	4.10	291	1230	1.25	32
1700	1.38	42	0400	3.20	196	1300	2.60	140
1830	2.25	112	0500	2.85	162	1330	3.60	236
2230	1.57	58	0630	2.88	165	1400	3.08	184
2400	1.52	54	0900	2.27	114	1500	2.22	110
Mar. 1			1100	2.20	108	1600	1.95	88
0030	1.67	66	1400	1.86	81	2200	1.31	37
0400	1.88	82	1500	2.15	104	2400	1.30	36
0530	2.68	147	1700	2.02	94	Mar. 6		
0700	2.02	94	1800	1.85	80	0200	1.26	33
0800	2.52	134	1930	2.03	94	0600	1.40	44
0830	3.40	216	2400	1.62	62	1200	1.19	27
0900	2.75	154	Mar. 3			1800	1.09	19
1100	2.10	100	0300	1.78	74	2400	1.00	14

(86) 09510200 Sycamore Creek near Fort McDowell, Ariz.

Location.--Lat 33°41'39", long 111°32'28", in sec.16, T.4 N., R.8 E. (unsurveyed), Maricopa County, Hydrologic Unit 15060203, in Tonto National Forest, on right bank 0.7 mi (1.1 km) southwest of Sugarloaf Mountain, 9 mi (14 km) northeast of Fort McDowell, 10 mi (16 km) upstream from mouth, and 25 mi (40 km) northeast of Scottsdale.

Drainage area.--164 mi² (425 km²).

(86) 09510200 Sycamore Creek near Fort McDowell, Ariz.—Continued

Gage-height record.--No gage-height record. Datum of gage is 1,759.33 ft (536.244 m) National Geodetic Vertical Datum of 1929.

Discharge record.--Discharges estimated on basis of slope-area measurement of peak flow, relation of past peaks to daily discharges, records of upstream stations, and field estimates.

Maxima.--February to March 1978: Discharge, 17,900 ft^3/s (507 m^3/s) probably Mar. 2 from slope-area measurement of peak flow, gage height, 16.0 ft (4.88 m) from profile past gage.
1959 to January 1978: Discharge, 24,200 ft^3/s (685 m^3/s) Sept. 5, 1970 (gage height, 19.7 ft or 6.00 m, from profile past gage) from rating curve extended above 3,600 ft^3/s (102 m^3/s) on basis of slope-area measurements at gage heights 15.0 and 19.7 ft (4.57 and 6.00 m).

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	100	Mar. 2	8,300	Mar. 5	1,800
28	2,600	3	2,600	6	1,900
Mar. 1	5,600	4	800	7	600

(87) 09511300 Verde River near Scottsdale, Ariz.

Location.--Lat 33°34'52", long 111°40'12", in NE¼ sec.30, T.3 N., R.7 E., Maricopa County, Hydrologic Unit 15060203, on pier near left bank on downstream side of bridge on State Highway 87, in Fort McDowell Indian Reservation, 2.5 mi (4.0 km) upstream from mouth, 3.8 mi (6.1 km) downstream from Fort McDowell, and 16 mi (26 km) northeast of Scottsdale.

Drainage area.--6,600 mi^2 (17,090 km^2), approximately.

Gage-height record.--Hourly radio readings from water-stage recorder prior to 0200 hours Mar. 2. Datum of gage is 1,351.35 ft (411.891 m) National Geodetic Vertical Datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 32,000 ft^3/s (906 m^3/s). Discharges during period of missing gage-height record obtained by routing flows from "below Bartlett Dam."

Maxima.--February to March 1978: Discharge, 96,000 ft^3/s (2,730 m^3/s) 1800 hours Mar. 2, estimated by flood routing, gage height, 18.3 ft (5.58 m), from profile past gage.
1939 to January 1978: Discharge, about 45,000 ft^3/s (1,280 m^3/s) Mar. 15, 1941, estimated on basis of flow below Bartlett Dam.

Remarks.--Flow regulated by Bartlett Reservoir since 1939 and by Horseshoe Reservoir since 1945 (see sta 09509500).

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	195	Mar. 3	79,000	Mar. 7	19,000
28	1,660	4	26,000	8	20,000
Mar. 1	8,000	5	17,000	9	2,000
2	67,000	6	20,000	10	500

(87) 09511300 Verde River near Scottsdale, Ariz.—Continued

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 28			Mar. 2—Con.			Mar. 5—Con.		
0200	2.6	190	0400	-----	40,000	1400	-----	11,500
0400	4.1	1,170	0600	-----	49,000	1600	-----	11,800
0500	4.4	1,420	1200	-----	72,000	2000	-----	20,000
0600	4.0	1,090	1600	-----	93,000	2200	-----	24,000
0800	5.7	2,660	1800	-----	96,000	2400	-----	26,000
1000	6.4	3,420	2000	-----	85,000	Mar. 6		
1200	5.5	2,440	2200	-----	74,000	0200	-----	27,500
1400	5.1	2,030	2400	-----	76,000	0400	-----	26,500
1600	4.7	1,710	Mar. 3			0800	-----	18,700
1800	4.5	1,510	0200	-----	80,000	1000	-----	18,000
2000	4.5	1,510	0600	-----	82,000	1600	-----	17,400
2200	4.9	1,890	1000	-----	90,000	1800	-----	17,500
2400	5.8	2,780	1200	-----	92,000	2200	-----	17,500
Mar. 1			1400	-----	90,000	2400	-----	17,400
0200	5.4	2,340	1600	-----	84,000	Mar. 7		
0400	4.9	1,890	2000	-----	65,000	1200	-----	16,500
0600	6.0	2,890	2400	-----	53,000	1400	-----	16,500
1000	9.0	8,800	Mar. 4			1600	-----	17,500
1100	8.6	7,600	0400	-----	51,000	2000	-----	24,300
1200	9.2	9,400	0600	-----	43,000	2200	-----	26,500
1300	9.6	10,800	1000	-----	19,500	2400	-----	26,000
1500	7.6	5,160	1400	-----	12,500	Mar. 8		
1700	6.7	3,600	1600	-----	10,500	0600	-----	25,800
1900	8.8	8,200	2000	-----	17,500	1200	-----	25,800
2200	11.7	21,900	2200	-----	17,500	1400	-----	27,800
2300	11.6	21,100	2400	-----	18,000	2000	-----	4,000
2400	11.8	22,700	Mar. 5			2200	-----	700
Mar. 2			0400	-----	23,000	2400	-----	400
0100	11.8	30,000	0800	-----	14,300			
0200	11.9	36,000	1000	-----	9,500			

(88) 09511500 Salt River below Granite Reef Dam, Ariz.

(Discontinued gaging station)

Location.--Lat 33°30'57", long 111°41'28", in SE¼ sec.13, T.2 N., R.6 E., Maricopa County, Hydrologic Unit 15060106, at Granite Reef Dam, 3.4 mi (5.5 km) downstream from Verde River, and 10.7 mi (17.2 km) northeast of Mesa city hall.

Drainage area.--12,926 mi² (33,400 km²).

Discharge record.--Discharge computed by combining the flow for Salt River below Stewart Mountain Dam and Verde River near Scottsdale. Elevation of crest of dam is 1,310.0 ft (398.50 m) National Geodetic Vertical Datum of 1929.

(88) 09511500 Salt River below Granite Reef Dam, Ariz.—Continued

Maxima.--February to March 1978: Discharge, about 125,000 ft³/s (3,540 m³/s) about 1600 hours Mar. 2.
1939 to October 1965: Discharge, 67,000 ft³/s (1,900 m³/s) Dec. 31, 1965.
1888 to January 1978: Discharge, 300,000 ft³/s (8,500 m³/s) Feb. 24, 1891, computed from weir formula for Arizona Dam.

Remarks.--Records not adjusted for diversion by Arizona and South Canals, which was generally less than 600 ft³/s (m³/s) during the flood period. Flow regulated by reservoirs on the Salt River since 1910 (see sta 09502000) and by reservoirs on the Verde River since 1939 (see sta 09509500).
A gaging station was operated at the former Arizona Dam 2.5 mi (4 km) upstream from Granite Reef Dam 1888-91 and 1895-96. Records published as "at Arizona Dam" and as "below Verde River."

(89) 09512100 Indian Bend Wash at Scottsdale, Ariz.

Location.--Lat 33°32'19", long 111°54'57", in SW¼SE¼ sec.2, T.2 N., R.4 E., Maricopa County, Hydrologic Unit 15060106, on upstream side of ford on Indian Bend Road, in Scottsdale.

Drainage area.--62 mi² (161 km²), approximately, since October 1975. Prior to October 1975, 139 mi² (360 km²); reduction caused by cutoff of upper portion of basin by diversion canal and detention dike (also see Remarks).

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,280.29 ft (390.232 m) National Geodetic Vertical Datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--February to March 1978: Discharge, 3,180 ft³/s (90.0 m³/s) 0300 hours Mar. 2, gage height, 3.50 ft (1.067 m).
1922 to January 1978: Discharge, 21,000 ft³/s (595 m³/s) June 22, 1972, gage height, 4.90 ft (1.494 m), from rating curve extended above 7,000 ft³/s (200 m³/s) on basis of partial discharge measurement at gage height 4.2 ft (1.28 m) and slope-conveyance computation at gage height 4.90 ft (1.494 m).

Remarks.--Natural flow of wash affected by urbanization and partly regulated by artificial lakes upstream. Upper portion of basin (about 77 mi² or 199 km²) cut off by diversion canal and detention dike in October 1975.

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	0	Mar. 2	933	Mar. 5	12
28	52	3	22	6	64
Mar. 1	158	4	3.7	7	41

(89) 09512100 Indian Bend Wash at Scottsdale, Ariz.—Continued

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 28			Mar. 1			Mar. 2		
0100	0.76	0	0600	1.35	110	0100	3.17	2,340
0230	.98	2.1	1200	1.37	120	0300	3.50	3,180
0600	.92	.9	1245	1.44	155	0600	3.00	2,000
1030	.88	.6	1500	1.35	110	0900	2.27	840
1200	1.20	38	2000	1.30	95	1100	1.82	390
1300	1.28	88	2200	1.55	208	1330	1.52	196
1500	1.32	103	2300	1.95	480	1600	1.35	115
1830	1.38	88	2400	2.50	1,140	2200	1.25	80.4
2400	1.40	135				2400	1.23	73

(90) 09512160 Indian Bend Wash at McDowell Road, at Scottsdale, Ariz.

(Crest-stage station)

Location.--Lat 33°27'57", long 111°54'54", in SW¼ sec.35, T.2 N., R.4 E., Maricopa County, Hydrologic Unit 15060106, at McDowell Road, 0.6 mi (1.0 km) east of Scottsdale Road in Scottsdale.

Drainage area.--Undetermined.

Gage-height record.--Crest stage only. Altitude of gage is 1,200 ft (366 m), from topographic map.

Discharge record.--Stage-discharge relation poorly defined by indirect computations of peak flow.

Maxima.--February to March 1978: Discharge, about 3,400 ft^3/s (96.3 m^3/s) Mar. 2, gage height, 9.99 ft (3.045 m).
1961 to January 1978: Discharge, 14,300 ft^3/s (405 m^3/s) June 22, 1972, at Thomas Road 1 mi (1.6 km) upstream, result of slope-area measurement of peak flow. Data collected above Arizona Canal indicates that peak is probably the highest since at least 1922.

(91) 09512170 Salt River at Jointhead Dam, Phoenix, Ariz.

Location.--Lat 33°26'25", long 111°58'22", in SW¼ sec.8, T.1 N., R.4 E., Maricopa County, Hydrologic Unit 15060106, 1,500 ft (460 m) upstream from 48th Street in Phoenix, 1.7 mi (2.7 km) downstream from Tempe bridge, and 5.8 mi (9.3 km) east of Phoenix Post Office.

Drainage area.--13,225 mi^2 (35,000 km^2).

Gage-height record.--Water-stage recorder graph 1200 hours Mar. 2 to 0600 hours Mar. 4 and Mar. 17-31. Gage-height record estimated from 0600 to 2400 hours Mar. 4. Record furnished by the Salt River Valley Water Users' Association. Altitude of gage is 1,130 ft (350 m) from topographic map.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Discharge estimated for periods of no gage-height record.

(91) 09512170 Salt River at Jointhead Dam, Phoenix, Ariz.—Continued

Maxima.--February to March 1978: Discharge, about 122,000 ft³/s (3,455 m³/s) 1900 hours Mar. 2, gage height, 12.50 ft (3.81 m).
1939 to January 1978: Discharge, 66,000 ft³/s (1,870 m³/s) Dec. 31, 1965, gage height, 10.3 ft (3.177 m) from slope-area measurement of peak flow.
1888 to January 1978: Discharge, about 300,000 ft³/s (8,500 m³/s) Feb. 24, 1891, estimated on basis of records for former station at Arizona Dam.

Remarks.--Flow regulated by reservoirs on the Salt River since 1910 (see sta 09502000) and by reservoirs on the Verde River since 1939 (see sta 09509500).

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 28	0	Mar. 11	100	Mar. 22	1,100
Mar. 1	3,000	12	50	23	4,900
2	70,000	13	50	24	6,600
3	80,000	14	0	25	2,200
4	31,000	15	0	26	1,700
5	15,000	16	200	27	1,200
6	17,000	17	1,200	28	400
7	15,000	18	1,000	29	100
8	19,000	19	1,300	30	0
9	5,700	20	1,300	31	0
10	200	21	1,300		

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Mar. 1			Mar. 2—Con.			Mar. 3		
0500	-----	0	0400	-----	40,000	0200	10.60	82,300
0600	-----	100	0600	-----	50,000	0600	10.90	88,000
1000	-----	300	1000	-----	60,000	1300	11.05	87,000
1400	-----	1,000	1200	10.55	80,000	2000	10.10	73,200
1800	-----	10,000	1400	11.00	90,000	2400	8.90	53,800
2000	-----	8,000	1600	11.80	106,000	Mar. 4		
2100	-----	5,000	1800	12.45	121,000	0600	8.65	50,200
2400	-----	10,000	1900	12.50	122,000	1000	7.55	35,900
Mar. 2			2000	12.35	119,000	1600	5.90	19,300
0200	-----	22,000	2200	11.30	96,000	2000	5.05	13,500
0300	-----	30,000	2400	10.75	85,100	2400	5.20	14,500

(92) 09512300 Cave Creek near Cave Creek, Ariz.

(Crest-stage station)

Location.--Lat 33°47'07", long 112°00'24", in SW¼ sec.12, T.5 N., R.3 E., Maricopa County, Hydrologic Unit 15060106, on left bank 200 ft (61 m) upstream from power transmission line, 4.75 mi (7.6 km) southwest of the town of Cave Creek, and 5.0 mi (8.0 km) upstream from Cave Creek Dam.

Drainage area.--121 mi² (314 km²).

(92) 09512300 Cave Creek near Cave Creek, Ariz.—Continued

Gage-height record.--Crest stage only. Altitude of gage is 1,800 ft (550 m), from topographic map.

Discharge record.--Peak discharge from stage-discharge relation defined by current-meter measurements below 720 ft^3/s (20.4 m^3/s) and extended above on basis of slope-area measurements at gage heights 6.79 and 8.62 ft (2.094 and 2.656 m).

Maxima.--February to March 1978: Discharge, 7,500 ft^3/s (212 m^3/s) probably Mar. 2, gage height, 7.52 ft (2.292 m).
1958 to January 1978: Discharge, 12,400 ft^3/s (351 m^3/s) Dec. 19, 1967, gage height, 8.62 ft (2.627 m).

Remarks.--Flow stored in Cave Creek Reservoir and released slowly to prevent flooding in Phoenix. Maximum stage in Cave Creek Reservoir during flood period was 0.5 ft (0.15 m) below crest of dam.

(93) 09512400 Cave Creek at Phoenix, Ariz.

Location.--Lat 33°34'56", long 112°06'43", in SW¼ sec.24, T.3 N., R.2 E., Maricopa County, Hydrologic Unit 15060106, on downstream side of bridge at Peoria Avenue in Phoenix, 0.7 mi (1.1 km) upstream from Arizona Canal.

Drainage area.--252 mi^2 (653 km^2).

Gage-height record.--Digital water-stage recorder tape except 0100 hours Mar. 7 to 0700 hours Mar. 9. Gage height reconstructed during period of missing record. Datum of gage is 1,236.37 ft (376.846 m) National Geodetic Vertical Datum of 1929 (from Salt River Valley Water Users' Association temporary bench mark).

Discharge record.--Stage-discharge relation defined by current-meter measurements below 1,500 ft^3/s (42.5 m^3/s) and extended above on basis of slope-area measurements at gage heights 7.36 and 9.3 ft (2.243 and 2.83 m).

Maxima.--February to March 1978: Discharge, 2,090 ft^3/s (59.2 m^3/s) 0200 hours Mar. 2, gage height, 7.36 ft (2.243 m).
1957 to January 1978: Discharge, 4,080 ft^3/s (116 m^3/s)—including 345 ft^3/s (9.77 m^3/s) released from Cave Creek Dam—Dec. 19, 1967, gage height, 11.23 ft (3.423 m), present datum.
Outside period of record: Peak of Aug. 3, 1943, estimated as 9,000 ft^3/s (255 m^2/s) from U.S. Army Corps of Engineers.

Remarks.--Peak flow from 161 mi^2 (417 km^2) regulated by Cave Creek Dam 12 mi (19 km) upstream.

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	2.8	Mar. 3	1,540	Mar. 7	400
28	57	4	1,150	8	300
Mar. 1	494	5	1,110	9	270
2	1,620	6	820		

(93) 09512400 Cave Creek at Phoenix, Ariz.—Continued

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 28			Mar. 2—Con.			Mar. 5		
2400	2.74	46.0	0800	5.84	1,220	0500	5.72	1,150
Mar. 1			1000	6.02	1,310	0900	5.67	1,130
0200	3.28	269	1500	6.09	1,350	0915	5.67	1,130
0800	3.88	330	1800	6.94	1,830	1200	5.90	1,250
0900	4.16	439	1900	7.03	1,890	1315	5.96	1,280
1100	4.08	407	2400	6.78	1,740	1630	5.81	1,200
1230	4.70	669	Mar. 3			1700	5.51	1,050
1400	4.23	468	0400	6.51	1,580	2400	5.35	968
1600	3.84	315	0800	6.39	1,510	Mar. 6		
1800	3.85	319	1000	6.44	1,540	1000	5.19	892
2000	4.49	576	1300	6.77	1,730	1600	4.90	756
2200	5.75	1,170	1400	6.77	1,730	2100	4.81	716
2300	6.14	1,370	1800	6.35	1,490	2400	4.24	472
2400	7.04	1,890	2400	5.88	1,240			
Mar. 2			Mar. 4					
0200	7.36	2,090	1500	5.62	1,100			
0500	6.81	1,750	2400	5.78	1,190			

(94) 09512500 Agua Fria River near Mayer, Ariz.

Location.--Lat 34°18'55", long 112°03'48", in NW¼SE¼ sec.20, T.11 N., R.3 E., Yavapai County, Hydrologic Unit 15070102, on left bank at Sycamore damsite, 700 ft (210 m) downstream from Big Bug Creek, and 12 mi (19 km) southeast of Mayer.

Drainage area.--588 mi² (1,523 km²).

Gage-height record.--Water-stage recorder graph except 0030 hours Mar. 4 to 0900 hours Mar. 5 and after 2300 hours Mar. 5. Datum of gage is 3,434 ft (1,046.7 m), Maricopa County Municipal Water Conservation District No. 1 datum.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 1,600 ft³/s (45 m³/s) and extended above on basis of five slope-area measurements at stages from 9.1 to 14.9 ft (2.77 to 4.54 m). Discharges estimated during period of missing gage heights

Maxima.--February to March 1978: Discharge, 9,900 ft³/s (280 m³/s) 0900 hours Mar. 1, gage height, 10.45 ft (3.185 m).
1940 to January 1978: Discharge, 19,800 ft³/s (561 m³/s) Sept. 5, 1970, gage height, 14.90 ft (4.542 m) on basis of slope-area measurement of peak flow.

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	10	Mar. 2	2,710	Mar. 5	1,100
28	484	3	1,910	6	350
Mar. 1	4,260	4	140	7	175

(94) 09512500 Agua Fria River near Mayer, Ariz.—Continued

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 27			Mar. 1—Con.			Mar. 3		
2400	3.47	10.0	1000	10.01	9,220	0300	6.81	3,880
Feb. 28			1200	8.01	5,580	0430	7.41	4,720
1045	3.49	11.7	1300	7.31	4,580	0600	6.91	4,020
1100	3.66	32.9	1500	6.83	3,910	1000	5.26	1,470
1230	3.73	50	1600	7.11	4,300	1200	4.91	978
1430	4.69	882	1800	6.56	3,450	1500	4.69	695
1600	4.56	695	2100	6.11	2,760	2400	4.32	321
1730	4.55	673	2200	5.95	2,620	Mar. 4		
1800	4.90	1,210	2400	6.06	2,690	1200	-----	90
1930	4.82	1,070	Mar. 2			2400	-----	60
2030	4.90	1,210	0200	6.17	2,850	Mar. 5		
2130	4.88	1,180	0300	6.51	3,380	0800	-----	50
2300	5.40	1,910	0630	7.46	4,790	0930	4.46	418
2400	5.10	1,500	0800	7.01	4,160	1100	4.81	846
Mar. 1			0900	6.41	3,200	1130	4.76	774
0230	4.76	990	1030	6.01	2,610	1230	6.01	2,610
0400	5.21	1,640	1230	5.25	1,460	1300	6.91	4,020
0500	8.04	5,620	1300	5.29	1,510	1400	7.01	4,160
0600	7.61	5,000	1500	5.06	1,190	1530	6.01	2,760
0700	8.26	5,970	1900	5.12	1,270	1800	5.01	1,380
0730	8.04	5,620	2100	5.61	1,990	2000	4.75	1,040
0800	10.01	9,020	2200	6.61	3,530	2300	4.61	858
0900	10.45	9,900	2330	6.84	3,930	2400	4.59	834
0930	9.81	8,640	2400	7.17	4,390			

(95) 09512700 Agua Fria River Tributary No. 2 near Rock Springs, Ariz.

(Crest-stage station)

Location.--Lat 34°02'00", long 112°08'42", in SW¼ sec.15, T.8 N., R.2 E., Maricopa County, Hydrologic Unit 15070102, at State Highway 69, 1 mi (0.6 km) south of Rock Springs.

Drainage area.--1.11 mi^2 (2.87 km^2).

Gage-height record.--Crest-stage record only. Altitude of gage is 2,010 ft (613 m), from topographic map.

Discharge record.--Stage-discharge relation defined by culvert computations.

Maxima.--February to March 1978: Discharge, 920 ft^3/s (26.1 m^3/s) probably Mar. 2, gage height, 14.6 ft (4.45 m).
1963 to January 1978: Discharge, 1,200 ft^3/s (34.0 m^3/s) Aug. 2, 1964, gage height, 19.54 ft (5.956 m).

(96) 09512800 Agua Fria River near Rock Springs, Ariz.

Location.--Lat 34°00'56", long 112°10'02", in NW¼NW¼ sec.28, T.8 N., R.2 E., Yavapai County, Hydrologic Unit 15070102, on right bank 2.5 mi (4.0 km) southwest of Rock Springs, and 10 mi (16 km) upstream from Lake Pleasant.

Drainage area.--1,130 mi² (2,930 km²), approximately.

Gage-height record.--Digital water-stage recorder tape. Altitude of gage is 1,800 ft (549 m), from topographic map.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 20,000 ft³/s (567 m³/s) and extended on basis of slope-area measurements at gage heights 25.3 and 28.2 ft (7.71 and 8.60 m).

Maxima.--February to March 1978: Discharge, 39,500 ft³/s (1,120 m³/s) 0700 hours Mar. 2, gage height, 24.27 ft (7.462 m).
1970 to January 1978: Discharge, 40,100 ft³/s (1,140 m³/s) Sept. 5, 1970, gage height, 25.3 ft (7.71 m), present site and datum, from profile past gage.
1891 to January 1978: Discharge estimated as 85,000 ft³/s (2,410 m³/s) Nov. 27, 1919, on basis of records at Waddell Dam.

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	42	Mar. 2	16,600	Mar. 5	4,000
28	1,090	3	11,500	6	2,800
Mar. 1	11,500	4	2,900	7	1,700

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 28			Mar. 2			Mar. 3—Con.		
1100	7.67	470	0300	15.88	10,900	0230	20.90	25,700
1300	9.05	1,350	0400	17.06	13,700	0300	20.77	25,200
1800	9.54	1,670	0500	19.78	21,700	0400	21.10	26,400
2100	10.36	2,330	0600	23.04	34,100	0600	18.99	19,400
2200	11.96	3,980	0700	24.27	39,500	0800	16.80	13,600
2400	11.68	3,760	0730	24.12	38,800	1200	14.39	8,570
Mar. 1			0900	20.57	24,500	1600	12.64	5,740
0300	11.61	3,680	1000	18.89	19,100	1800	12.23	5,180
0500	13.63	6,520	1130	17.55	15,500	2400	11.30	4,030
0700	16.15	11,500	1200	18.00	16,700	Mar. 4		
1000	19.49	20,800	1300	17.57	15,600	1200	10.07	2,710
1200	19.20	19,800	1400	17.05	14,300	2400	9.51	2,210
1300	18.80	18,600	1700	15.68	11,200	Mar. 5		
1500	16.33	11,900	2100	15.17	10,200	1000	9.78	2,450
1700	15.08	9,180	2300	15.76	11,400	1700	13.66	7,320
1900	15.23	9,480	2400	17.68	15,800	1745	13.37	6,840
2300	16.92	13,300	Mar. 3			1845	14.05	7,670
2400	16.73	12,900	0100	18.23	17,300	2400	11.69	5,930

(97) 09513500 Lake Pleasant at Waddell Dam, Ariz.

Location.--Lat 33°51'20", long 112°15'58", in SW¼ sec.16, T.6 N., R.1 E., Maricopa County, Hydrologic Unit 15070102, at left upstream end of Waddell Dam on Agua Fria River.

Drainage area.--1,459 mi² (3,779 km²).

Gage-height record.--Nonrecording gage read hourly 0800 hours Mar. 2 to 0800 hours Mar. 6 and less frequently before and after. Datum of gage is 1,431.2 ft (436.53 m) National Geodetic Vertical Datum of 1929.

Maxima.--February 27 to March 6, 1978: Contents, 153,000 acre-ft (189 hm³) 1400 to 1800 hours Mar. 5, gage height, 168.7 ft (51.42 m).
1928 to January 1978: Contents, 178,500 acre-ft (220 hm³) Apr. 19, 1941. Gage height, 170.28 ft (51.901 m) Feb. 9, 1966.

Remarks.--Lake is formed by concrete multiple-arch dam; dam completed and storage began in 1927. Capacity, 157,600 acre-ft (194 hm³), of which 86,870 acre-ft (107 hm³) is at gage height 146.0 ft or 44.50 m (crest of spillway) and 70,730 acre-ft (87.2 hm³) between gage heights 146.0 ft or 44.50 m and 170.0 ft or 51.82 m (top of spillway gates). Figures given herein represent usable contents in Lake Pleasant (based on 1965 capacity table). Contents of small reservoir formed by diversion dam downstream from Waddell Dam is not included. Lake reached a level of 170.57 ft (51.990 m) on Mar. 23, 1978.

Cooperation.--Gage-height record furnished by Maricopa County Municipal Water Conservation District No. 1.

Contents, in acre-feet, at 1700 hours on indicated day, 1978

Day	Contents	Day	Contents	Day	Contents
Feb. 27	43,400	Mar. 4	152,000	Mar. 9	155,000
28	44,300	5	153,000	10	156,000
Mar. 1	68,700	6	152,000	11	157,000
2	119,000	7	153,000	12	157,000
3	152,000	8	154,000	13	157,000

(98) 09513000 Agua Fria River at Waddell Dam, Ariz.

Location.--Lat 33°51'20", long 112°15'58", in SW¼ sec.16, T.6 N., R.1 E., Maricopa County, Hydrologic Unit 15070102, at left upstream end of Waddell Dam, and 22 mi (35 km) northwest of Glendale.

Drainage area.--1,459 mi² (3,779 km²).

Gage-height record.--Nonrecording gage on Lake Pleasant, read hourly 0800 Mar. 2 to 0800 hours Mar. 6 and less frequently before and after, and staff gage at diversion dam below Waddell Dam.

Discharge record.--Figures given herein represent flow into Lake Pleasant and release to Agua Fria River below diversion dam. Inflow computed on basis of three factors as follows: 1. Change in contents of Lake Pleasant and in contents of small reservoir behind diversion dam 1.5 mi (2.4 km) downstream from Lake Pleasant. 2. (a) Release from Lake Pleasant, computed from twice-daily readings by Clausen-Pierce weir rule in Beardsley Canal, checked by current-meter measurements by U.S. Geological Survey. (b) Spill from Lake Pleasant, measured over diversion dam based on staff-gage readings. 3. Effect of rainfall and evaporation on lake; evaporation assumed as 0.85 of that measured once daily in 3-ft-square (0.9-m-square) land pan buried 1.5 ft (0.5 m) in ground near left end of Waddell Dam. Effect of bank storage and bank release in Lake Pleasant is not taken into account.

(98) 09513000 Agua Fria River at Waddell Dam, Ariz.—Continued

Maxima.--February to March 1978: Inflow, 47,700 ft³/s (1,350 m³/s) 0900 hours Mar. 2; outflow, 16,300 ft³/s (460 m³/s) 2045 hours Mar. 5.
1927 to January 1978: Inflow not determined. Outflow, 11,100 ft³/s (316 m³/s) Mar. 15, 1941.
1891 to January 1978: Recorded discharge, about 105,000 ft³/s (2,970 m³/s) Jan. 28, 1916 (gage height, 30 ft or 9.1 m, datum then in use, from floodmarks); from rating curve extended above 13,000 ft³/s (370 m³/s) on basis of velocity-area studies. Gage height, 33 ft (10.1 m), Nov. 27, 1919, to same datum as in 1916, from floodmarks; discharge believed to be greater than that of 1916.

Remarks.--Records furnished by Maricopa County Municipal Water Conservation District No. 1. Since Waddell Dam was constructed in 1927, spill has occurred in 1941, 1966, 1968, 1978, 1979, and 1980 water years. The spill that started Mar. 3, 1978, continued to Apr. 11, 1978.

Mean discharge into Lake Pleasant, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	150	Mar. 4	4,200	Mar. 9	1,080
28	423	5	3,290	10	872
Mar. 1	12,200	6	5,950	11	480
2	25,600	7	1,790	12	847
3	16,900	8	938	13	1,260

Mean discharge released to Agua Fria River below Waddell Dam, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Mar. 2	0	Mar. 6	6,100	Mar. 10	150
3	478	7	1,460	11	150
4	3,890	8	640	12	640
5	3,100	9	595	13	1,420

(99) 09513650 Agua Fria River at El Mirage, Ariz.

(Crest-stage station)

Location.--Lat 33°36'24", long 112°18'14", in NW¼NW¼ sec.18, T.3 N., R.1 E., Maricopa County, Hydrologic Unit 15070102, at Grand Avenue 0.75 mi (1.2 km) southeast of El Mirage.

Drainage area.--1,637 mi² (4,240 km²), of which 1,459 mi² (3,779 km²) is above Lake Pleasant.

Gage-height record.--Crest stage only. Datum of gage is 1,113.00 ft (339.242 m) Arizona Highway Department datum.

Maxima.--February to March 1978: Discharge, 9,870 ft³/s (280 m³/s) probably Mar. 6, from slope-area measurement of peak flow, gage height, 7.95 ft (2.423 m).
1963 to January 1978: Discharge, 5,000 ft³/s (142 m³/s) Sept. 5, 1970, gage height, 4.60 ft (1.402 m).

Remarks.--Flow regulated by Lake Pleasant since 1927 (see sta 09513500). Excess floodwater released from McMicken Dam on Trilby Wash may enter Agua Fria River upstream from station.

(100) 09513780 New River near Rock Springs, Ariz.

Location.--Lat 33°58'27", long 112°05'54", in SW¼SW¼ sec.6, T.7 N., R.3 E., Maricopa County, Hydrologic Unit 15070102, on right bank 180 ft (55 m) upstream from road crossing, and 6 mi (10 km) southeast of Rock Springs.

Drainage area.--67.3 mi² (174 km²).

Gage-height record.--Water-stage recorder graph. Altitude of gage is 2,310 ft (704 m), from topographic map.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 380 ft³/s (11 m³/s) and extended above on basis of five slope-area measurements at gage heights 3.6 to 13.5 ft (1.10 to 4.11 m).

Maxima.--February to March 1978: Discharge, 13,600 ft³/s (385 m³/s) 0630 hours Mar. 2, gage height, 9.40 ft (2.865 m).
1960 to January 1978: Discharge, 18,600 ft³/s (527 m³/s) Sept. 5, 1970, gage height, 13.5 ft (4.11 m), from profile past gage.

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	8.1	Mar. 2	5,070	Mar. 5	617
28	1,920	3	1,730	6	568
Mar. 1	3,670	4	246	7	207

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 27			Mar. 1—Con.			Mar. 3—Con.		
2400	1.17	19	1900	6.72	5,650	1600	3.51	634
Feb. 28			2000	7.13	6,630	2400	3.15	375
0100	1.24	25	2200	6.02	4,170	Mar. 4		
0200	1.26	27	2300	6.30	4,740	1200	2.88	246
0400	1.62	73	2400	6.20	4,530	2400	2.66	164
0500	1.57	66	Mar. 2			Mar. 5		
0530	1.60	70	0300	6.17	4,470	0700	2.61	147
0540	3.50	780	0400	6.40	4,950	1200	2.88	249
0615	5.15	2,630	0530	7.97	8,880	1300	3.78	932
0800	4.40	1,610	0630	9.40	13,600	1430	4.46	1,680
0900	4.75	2,040	0700	9.00	12,140	1600	3.96	1,150
0945	4.65	1,900	0900	7.20	6,800	1800	3.51	647
1030	5.11	2,570	1200	5.80	3,760	1830	3.68	820
1400	3.63	884	1400	5.65	3,490	1930	3.49	628
1800	6.47	5,100	1600	5.70	3,580	2130	4.26	1,460
2100	5.17	2,660	1730	6.05	4,230	2400	3.85	1,010
2400	4.37	1,580	2000	5.45	3,140	Mar. 6		
Mar. 1			2200	5.20	2,710	0130	3.65	780
0200	5.49	3,210	2300	5.40	3,050	0300	3.82	972
0400	5.80	3,760	2400	5.08	2,520	0630	3.48	622
0500	5.69	3,560	Mar. 3			0730	3.55	682
0730	7.00	6,310	0130	4.68	1,940	0930	3.51	647
0830	6.57	5,310	0230	5.35	2,960	1030	3.38	538
1200	4.60	1,840	0430	6.80	5,830	1800	3.09	343
1530	4.30	1,500	0700	5.20	2,710	1900	3.27	450
1700	4.67	1,930	1000	4.18	1,380	2400	2.99	294

(101) 09513800 New River at New River, Ariz.

Location.--Lat 33°54'41", long 112°08'26", in NW¼NE¼ sec.34, T.7 N., R.2 E., Maricopa County, Hydrologic Unit 15070102, near center of downstream side of bridge on east frontage road of Interstate Highway 17, 0.5 mi (0.8 km) southwest of village of New River, and 10 mi (16 km) south of Rock Springs.

Drainage area.--83.3 mi² (215.7 km²).

Gage-height record.--Water-stage recorder graph prior to 2400 hours Mar. 6. Gage-height record estimated Mar. 7-8. Datum of gage is 1,984.02 ft (604.729 m) National Geodetic Vertical Datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 1,300 ft³/s (37 m³/s) and extended above on basis of slope-area measurement of peak flow and step-backwater computations.

Maxima.--February to March 1978: Discharge, 18,000 ft³/s (510 m³/s) 0900 hours Mar. 2, gage height, 12.34 ft (3.761 m).

1960 to January 1978: Discharge, 19,500 ft³/s (552 m³/s) Sept. 5, 1970, gage height, 9.98 ft (3.042 m), at site and datum then in use, from rating curve extended above 1,300 ft³/s (37 m³/s) on basis of slope-area measurements at gage heights 5.57, 7.33, 9.12, and 9.98 ft (1.698, 2.234, 2.780, and 3.042 m).

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	8	Mar. 2	4,840	Mar. 5	660
28	1,630	3	1,550	6	751
Mar. 1	3,040	4	300	7	330

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 27			Mar. 1—Con.			Mar. 4—Con.		
2400	2.72	9.8	2400	7.48	4,800	2400	3.65	218
Feb. 28			Mar. 2			Mar. 5		
0330	2.78	15	0045	7.15	4,220	0800	3.63	208
0445	3.67	226	0130	7.25	4,400	0830	4.02	424
0800	3.06	49	0400	6.95	3,850	1100	3.75	265
0900	5.68	2,110	0700	7.67	5,150	1330	3.84	314
0930	5.72	2,150	0730	9.40	8,970	1430	4.85	1,180
1045	5.38	1,750	0800	10.65	12,600	1520	5.33	1,690
1130	5.55	1,950	0900	12.34	18,000	1900	4.42	795
1230	5.42	1,790	1000	9.70	9,740	1930	4.58	912
1315	5.72	2,150	1100	8.20	6,200	2030	4.43	804
1530	4.84	1,170	1300	6.95	3,890	2230	5.15	1,409
1545	5.20	1,550	1500	6.55	3,260	2330	5.06	1,400
1645	4.85	1,180	1800	6.82	3,680	2400	5.16	1,510
1730	5.92	2,400	1900	6.50	3,190	Mar. 6		
2000	7.53	4,890	2100	5.85	2,310	0240	4.52	876
2200	6.55	3,260	2300	5.60	2,010	0400	4.70	1,030

(101) 09513800 New River at New River, Ariz.—Continued

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 28—Con.			Mar. 2—Con.			Mar. 6—Con.		
2400	5.54	1,940	2330	5.83	2,290	0800	4.40	777
Mar. 1			2400	5.75	2,190	0845	4.47	831
0230	5.09	1,430	Mar. 3			1915	3.96	466
0500	6.25	2,840	0230	5.30	1,660	1945	4.17	615
0630	6.38	3,020	0400	6.05	2,560	2400	3.93	452
0715	6.28	2,880	0515	7.53	4,890	Mar. 7		
0830	6.85	3,930	0700	6.05	2,650	1200	3.70	332
1000	7.58	4,980	0900	5.30	1,660	2400	3.60	285
1200	6.35	2,980	1200	4.70	1,030	Mar. 8		
1500	5.48	1,870	1800	4.30	660	1200	3.58	280
1700	5.24	1,530	2400	4.04	438	2400	3.52	250
1900	6.18	2,740	Mar. 4					
2130	7.50	4,840	0600	3.88	388			
2230	8.15	6,100	1600	3.71	245			

(102) 09513820 Deadman Wash near New River, Ariz.

(Crest-stage station)

Location.--Lat 33°50'30", long 112°08'40", in NW¼ sec.27, T.6 N., R.2 E., Maricopa County, Hydrologic Unit 15070102, at State Highway 69, 4.5 mi (7.2 km) south of New River.

Drainage area.--11.1 mi² (28.7 km²).

Gage-height record.--Crest stages only. Datum of gage is 1,720.82 ft (524.506 m) National Geodetic Vertical Datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 60 ft³/s (1.7 m³/s) and extended above on basis of slope-area measurements at gage heights 5.58 and 5.92 ft (1.701 and 1.804 m) and field estimates.

Maxima.--February to March 1978: Discharge, 1,400 ft³/s (39.6 m³/s) Mar. 2, gage height, 5.11 ft (1.558 m).
1959 to January 1978: Discharge, 1,850 ft³/s (52.4 m³/s) Dec. 25, 1959, gage height, 7.0 ft (2.13 m), from floodmarks.

(103) 09513835 New River at Bell Road, near Peoria, Ariz.

Location.--Lat 33°38'18", long 112°14'22", in NE¼NE¼ sec.3, T.3 N., R.1 E., Maricopa County, Hydrologic Unit 15070102, on downstream side of bridge at Bell Road, 1.6 mi (2.6 km) upstream from Skunk Creek, 3.1 mi (5.0 km) north of Peoria, and 9 mi (14 km) upstream from mouth.

Drainage area.--187 mi² (484 km²).

Gage-height record.--Water-stage recorder graph prior to 0200 hours Mar. 2. Datum of gage is 1,190.00 ft (362.712 m), Arizona State Highway Department datum.

(103) 09513835 New River at Bell Road, near Peoria, Ariz.—Continued

Discharge record.--Stage-discharge relation defined by current-meter measurements below 1,800 ft^3/s (51 m^3/s) and extended above on basis of slope-area measurement at gage height 13.5 ft (4.11 m). Discharges Mar. 2-7 computed by flood routing of discharges from New River near New River.

Maxima.--February to March 1978: Discharge, 12,500 ft^3/s (354 m^3/s) about 1400 hours Mar. 2, gage height, 11.0 ft (3.35 m).
1960 to January 1978: Discharge, 14,600 ft^3/s (413 m^3/s) Dec. 19, 1967, gage height, 13.5 ft (4.11 m).

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	0	Mar. 2	6,000	Mar. 5	550
28	881	3	2,000	6	950
Mar. 1	3,320	4	400	7	300

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 28			Mar. 1—Con.			Mar. 3—Con.		
0015	3.91	0	1930	6.10	2,050	2400	----	600
1530	3.91	0	2145	6.90	3,260	Mar. 4		
1535	5.60	1,100	2230	7.80	4,860	0400	----	470
1700	5.90	1,770	2300	8.40	6,020	1600	----	340
1830	6.38	2,470	2400	8.80	6,820	2400	----	280
2000	6.07	2,010	Mar. 2			Mar. 5		
2100	6.02	1,940	0230	9.35	7,970	1200	----	200
2210	6.90	3,260	0500	8.20	5,620	1400	----	340
2300	7.40	4,140	1000	----	4,000	1600	----	280
2400	7.72	4,720	1200	----	7,000	2000	----	1,800
Mar. 1			1400	----	12,500	2400	----	900
0100	7.80	4,860	1600	----	7,000	Mar. 6		
0300	6.90	3,260	2000	----	3,300	0400	----	1,700
0400	6.37	2,460	2300	----	3,700	0800	----	1,000
0500	6.00	1,910	2400	----	3,300	1500	----	800
0700	5.82	1,670	Mar. 3			2300	----	480
1020	6.90	3,260	0400	----	2,100	2400	----	500
1200	7.10	3,600	0700	----	1,800	Mar. 7		
1430	7.90	5,040	1000	----	4,000	0100	----	580
1615	6.90	3,260	1400	----	1,700	1400	----	230
1800	6.25	2,280	1900	----	900	2400	----	170

(104) 09513860 Skunk Creek near Phoenix, Ariz.

Location.--Lat 33°43'44", long 112°07'12", in SE¼ sec.35, T.5 N., R.2 E., Maricopa County, Hydrologic Unit 15070102, on downstream side of right end of bridge on east frontage road of Interstate Highway 17, 3 mi (5 km) north of Adobe, and 20 mi (32 km) north of city hall in Phoenix.

Drainage area.--64.6 mi^2 (167.3 km^2).

(104) 09513860 Skunk Creek near Phoenix, Ariz.—Continued

Gage-height record.--Water-stage recorder graph prior to 2200 hours Mar. 2. Datum of gage is 1,459.95 ft (444.993 m) National Geodetic Vertical Datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 560 ft^3/s (16 m^3/s) and extended above on basis of slope-conveyance estimates at gage heights of 6.55 and 8.75 ft (1.996 and 2.667 m). Discharge for Mar. 3 estimated on basis of field estimate made that day.

Maxima.--February to March 1978: Discharge, 3,590 ft^3/s (102 m^3/s) 2100 hours Mar. 1, gage height, 9.65 ft (2.941 m).
1960 to January 1978: Discharge, 11,500 ft^3/s (326 m^3/s) Aug. 1, 1964, from rating curve extended above 6,200 ft^3/s (180 m^3/s). Gage height, 12.24 ft (3.731 m) Sept. 5, 1970.

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	0	Mar. 1	560	Mar. 3	14
28	347	2	809	4	0

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 28			Mar. 1—Con.			Mar. 3—Con.		
0100	----	0	1100	6.33	345	0830	6.32	340
1600	----	0	1400	5.66	94	0930	6.65	510
1630	5.65	92	1700	5.29	34	1000	8.25	1,840
1730	5.37	43	1800	5.72	108	1100	7.45	1,080
1735	6.68	528	1900	6.70	540	1200	6.90	670
1800	6.58	470	1930	7.75	1,340	1300	6.30	330
1830	7.98	1,560	2030	7.20	888	1400	5.95	180
1900	9.50	3,380	2100	9.65	3,590	1600	5.82	136
2000	8.75	2,400	2200	8.95	2,640	1830	5.82	136
2100	7.55	1,160	2300	9.40	3,240	1930	6.32	340
2200	6.85	635	2330	8.92	2,610	2200	5.70	103
2300	6.20	280	2400	8.95	2,640	2400	----	53
2400	5.95	180	Mar. 2			Mar. 4		
Mar. 1			0200	9.40	3,240	0400	----	25
0200	5.55	70	0300	8.70	2,340	1000	----	12
0500	5.30	35	0400	7.90	1,480	2200	----	0
0900	5.22	29	0500	7.30	960			
1030	5.23	30	0630	6.60	480			

(105) 09513910 New River near Glendale, Ariz.

(Crest-stage station)

Location.--Lat 33°32'12", long 112°16'52", in NE¼NW¼ sec.8, T.2 N., R.1 E., Maricopa County, Hydrologic Unit 15070102, on downstream side of bridge at Glendale Avenue, 2 mi (3 km) upstream from mouth, 4 mi (6 km) southwest of Peoria, and 6 mi (10 km) west of Glendale.

Drainage area.--323 mi^2 (837 km^2).

(105) 09513910 New River near Glendale, Ariz.—Continued

Gage-height record.--Crest stage only. Datum of gage is 1,046.20 ft (318.882 m) National Geodetic Vertical Datum of 1929.

Discharge record.--Stage-discharge relation poorly defined by current-meter measurements below 9,000 ft^3/s (255 m^3/s) and extended above on basis of averaging slope-area measurements of peak flow at 9.1 and 10.4 ft (2.77 and 3.17 m).

Maxima.--February to March 1978: Discharge, 12,300 ft^3/s or 348 m^3/s (time unknown) Mar. 2, gage height, 9.08 ft (2.768 m).
1943 to January 1978: Discharge, 38,000 ft^3/s (1,080 m^3/s) August 1943, from U.S. Army Corps of Engineers.

(106) 09513970 Agua Fria River at Avondale, Ariz.

Location.--Lat 33°26'06", long 112°19'59", in NW¼ sec.14, T.1 N., R.1 W., Maricopa County, Hydrologic Unit 15070102, on downstream side of bridge on U.S. Highway 80, 0.5 mi (0.8 km) east of Avondale, and 3 mi (5 km) upstream from mouth.

Drainage area.--2,013 mi^2 (5,214 km^2), of which 1,459 mi^2 (3,779 km^2) is above Lake Pleasant. Floodwater from drainage area of 247 mi^2 (640 km^2) above McMicken Dam on Trilby Wash was diverted into Agua Fria River basin above station.

Gage-height record.--Water-stage recorder graph prior to 2400 hours Mar. 1. Datum of gage is 952.92 ft (290.450 m), Arizona Highway Department datum.

Discharge record.--No stage-discharge relation during flood period; discharge computed by flood-routing flows from Agua Fria River at Waddell Dam, New River at New River, and Skunk Creek near Phoenix on 1-hour time increments.

Maxima.--February to March 1978: Discharge, 13,100 ft^3/s (371 m^3/s) about 1900 hours Mar. 2, gage height, 5.63 ft (1.716 m), from profile past gage, from slope-area measurement of peak flow.
1959 to January 1978: Discharge, 20,600 ft^3/s (583 m^3/s) Sept. 6, 1970, gage height, 11.21 ft (3.417 m), from rating curve extended above 1,500 ft^3/s (42 m^3/s) on basis of slope-area measurement of peak flow.

Remarks.--Flow partly regulated by Lake Pleasant, 35 mi (56 km) upstream. (See sta 09513500.)

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	0	Mar. 3	2,200	Mar. 7	1,600
28	200	4	2,400	8	600
Mar. 1	3,100	5	1,900	9	100
2	7,000	6	6,200	10	0

(106) 09513970 Agua Fria River at Avondale, Ariz.—Continued

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 27			Mar. 2—Con.			Mar. 5—Con.		
2400	----	0	2400	----	3,500	2400	----	3,100
Feb. 28			Mar. 3			Mar. 6		
1800	----	0	0300	----	3,200	0200	----	5,800
2000	----	400	1200	----	1,500	0400	----	8,000
2200	----	1,200	1500	----	3,000	0700	----	10,000
2400	----	2,100	2300	----	700	1000	----	8,000
Mar. 1			2400	----	1,000	1600	----	4,500
0500	----	4,800	Mar. 4			2000	----	3,300
1100	----	1,600	0200	----	2,000	2400	----	2,800
1800	----	4,000	0500	----	3,000	Mar. 7		
2400	----	2,000	1600	----	2,400	0800	----	2,500
Mar. 2			2400	----	1,800	1000	----	1,100
0400	----	7,600	Mar. 5			2400	----	1,000
0700	----	9,500	0600	----	3,300	Mar. 8		
1400	----	4,000	1200	----	1,500	0900	----	950
1900	5.63	13,100	1600	----	1,400	1200	----	400
2200	----	4,500	2100	----	1,700	2400	----	350

(107) 09515500 Hassayampa River at Box damsite, near Wickenburg, Ariz.

Location.--Lat 34°02'42", long 112°42'33", in SW¼SE¼ sec.7, T.8 N., R.4 W., Yavapai County, Hydrologic Unit 15070103, on right bank at Box damsite, 5.5 mi (8.8 km) northeast of Wickenburg.

Drainage area.--417 mi² (1,080 km²).

Gage-height record.--Water-stage recorder graph. Datum of gage is 2,236.12 ft (681.569 m) National Geodetic Vertical Datum of 1929.

Discharge record.--Average rating curve defined by four slope-area measurements between gage heights of 9.0 and 34.6 ft (2.743 and 10.55 m). Shifts to average curve defined by current meter measurements below 400 ft³/s (11.3 m³/s). Records are poor.

Maxima.--February to March 1978: Discharge, 16,000 ft³/s (453 m³/s) 0530 hours Mar. 2, gage height, 14.50 ft (4.419 m).

1891 to January 1978: Discharge, 58,000 ft³/s (1,640 m³/s) Sept. 5, 1970, gage height, 34.6 ft (10.55 m), from profile past gage, by slope-area measurement of peak flow. Relation to flood in February 1890 that was caused by failure of dam near Wagoner is unknown.

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	176	Mar. 3	†3,870	Mar. 7	1,660
28	744	4	1,240	8	1,480
Mar. 1	5,030	5	2,000	9	1,400
2	†6,100	6	1,830	10	1,300

†Revised.

(107) 09515500 Hassayampa River at Box damsite, near Wickenburg, Ariz.—Continued

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Feb. 27			Mar. 1—Con.			Mar. 2—Con.		
2400	5.77	188	1500	9.72	5,690	2400	9.80	7,170
Feb. 28			1800	9.23	4,740	Mar. 3		
1330	5.87	240	2130	9.65	5,540	0130	9.00	5,400
1345	6.13	392	2400	9.22	4,720	0300	10.50	8,010
1500	6.33	549	Mar. 2			0400	13.30	13,700
1700	6.47	672	0130	8.82	3,980	0500	11.77	10,600
1900	7.38	1,770	0230	8.97	4,240	0600	10.27	7,950
2030	7.34	1,700	0400	9.97	6,210	0700	8.97	5,910
2200	7.55	2,000	0430	10.97	8,460	0800	7.77	4,360
2330	8.22	2,990	0500	12.57	12,100	0900	7.07	3,400
2400	8.20	2,940	0530	14.50	16,000	1000	6.57	2,840
Mar. 1			0630	12.50	12,000	1100	6.10	2,320
0430	7.53	1,980	0800	12.00	11,000	1200	5.87	2,100
0700	10.66	7,710	0900	11.00	9,200	1500	5.35	1,600
0900	9.95	6,160	1000	9.30	6,330	1800	5.07	1,330
1000	9.90	6,040	1200	7.80	4,330	2100	4.92	1,200
1030	9.62	5,990	1500	6.90	3,220	2400	4.88	1,160
1300	10.57	7,500	1800	8.20	4,860			
1400	9.57	5,500	2100	7.30	3,690			

(108) 09516500 Hassayampa River near Morristown, Ariz.

(Crest-stage station)

Location.--Lat 33°53'06", long 112°39'41", in SW¼SE¼ sec.3, T.6 N., R.4 W., Maricopa County, Hydrologic Unit 15070103, 3.0 mi (5.0 km) northwest of Morristown, and 7 mi (11 km) southeast of Wickenburg.

Drainage area.--774 mi² (2,005 km²).

Gage-height record.--Crest stage only. Datum of gage is 1,831.16 ft (558.138 m) National Geodetic Vertical Datum of 1929, supplemental adjustment of 1965.

Discharge record.--Stage-discharge relation based on estimated flows and slope-area measurements. Record is poor.

Maxima.--February to March 1978: Discharge, 24,000 ft³/s (680 m³/s) Mar. 2, gage height, 12.93 ft (3.941 m).
1921 to January 1978: Discharge, 47,500 ft³/s (1,350 m³/s) Sept. 5, 1970 (gage height, 19.0 ft or 5.79 m, from high-water profile) from slope-area measurement of peak flow.

(109) 09517000 Hassayampa River near Arlington, Ariz.

Location.--Lat 33°20'50", long 112°43'30", in NW¼ sec.13, T.1 S., R.5 W., Maricopa County, Hydrologic Unit 15070104, at former U.S. Highway 80, 1.8 mi (2.9 km) upstream from mouth, and 2.8 mi (4.5 km) northeast of Arlington.

Drainage area.--1,470 mi² (3,810 km²), approximately.

Gage-height record.--Water-stage recorder. Datum of gage is 831.87 ft (253.443 m) National Geodetic Vertical Datum of 1929.

Discharge record.--Determined by shifting two current-meter measurement of less than 420 ft³/s (11.9 m³/s) and slope-area measurement of peak flow to base rating defined by step-backwater computations. Record is poor.

Maxima.--February to March 1978: Discharge, 20,400 ft³/s (578 m³/s) 0100 hours Mar. 2, gage height, 5.80 ft (1.768 m), result of slope-area measurement of peak flow.
1961 to January 1978: Discharge, 39,000 ft³/s (1,100 m³/s) Sept. 5, 1970, gage height, 8.40 ft (2.560 m), result of slope-area measurement of peak flow.

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	0	Mar. 1	2,700	Mar. 3	2,430
28	0	2	4,540	4	50

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Mar. 1			Mar. 2—Con.			Mar. 3		
1100	----	0	0200	4.31	10,600	0100	2.30	1,900
1430	0.45	822	0400	3.11	4,600	0500	1.70	453
1500	2.00	4,000	0730	1.98	885	0600	2.55	2,720
1530	2.90	6,720	1000	2.16	1,350	0730	2.80	3,590
1830	2.05	4,100	1200	3.41	5,800	0830	2.60	2,890
2030	2.75	6,130	1330	3.81	7,850	1030	4.00	9,190
2130	2.60	5,700	1600	3.16	4,800	1200	3.50	6,500
2300	4.00	11,500	1900	2.16	1,370	1500	2.40	2,200
2400	5.15	17,100	2230	1.91	529	1700	1.80	613
Mar. 2			2400	2.16	1,370	2400	1.40	137
0100	5.80	20,400						

(110) 09517500 Centennial Wash near Arlington, Ariz.

Location.--Lat 33°16'12", long 112°47'50", in sec.7, T.2 S., R.5 W., Maricopa County, Hydrologic Unit 15070104, on upstream side of ford on former U.S. Highway 80, 3.0 mi (4.8 km) upstream from Gillespie Dam, and 4.4 mi (7.1 km) southwest of Arlington.

Drainage area.--1,810 mi² (4,690 km²), approximately.

Gage-height record.--Water-stage recorder graph. Datum of gage is 773.22 ft (235.677 m) National Geodetic Vertical Datum of 1929.

(110) 09517500 Centennial Wash near Arlington, Ariz.—Continued

Discharge record.--Stage-discharge relation defined by current-meter measurements below 1,100 ft³/s (160 m³/s) and extended above on basis of slope-conveyance estimate at 4.38 ft (1.335 m).

Maxima.--February to March 1978: Discharge, 10,900 ft³/s (309 m³/s) 0930 hours Mar. 2, gage height, 4.64 ft (1.414 m).
1961 to January 1978: Discharge, 14,500 ft³/s (411 m³/s) July 23, 1961, from rating curve extended above 5,500 ft³/s (160 m³/s). Gage height, 4.71 ft (1.436 m) Sept. 5, 1970.

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	0	Mar. 2	3,260	Mar. 5	0
28	0	3	215	6	0
Mar. 1	0	4	1.2	7	83

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Mar. 2			Mar. 3			Mar. 7		
0530	----	0	0400	3.34	424	0430	----	0
0600	3.98	2,720	0800	3.25	307	0500	2.51	31
0700	4.28	5,580	1200	3.06	145	0600	3.09	166
0800	4.49	8,440	1500	2.95	97	0800	3.22	274
0900	4.61	10,400	1800	2.88	78	1000	3.19	241
0930	4.64	10,900	2100	2.77	56	1500	2.82	66
1000	4.62	10,600	2400	2.42	25	1800	2.40	25
1200	4.41	7,100	Mar. 4			1900	1.75	4
1800	3.63	1,040	0200	1.60	2	2000	----	0
2100	3.46	599	0400	----	0			
2400	3.39	480						

(111) 09519500 Gila River below Gillespie Dam, Ariz.

Location.--Lat 33°13'45", long 112°46'00", in SE¼NE¼ sec.28, T.2 S., R.5 W., Maricopa County, Hydrologic Unit 15070101, at left end of Gillespie Dam, 8 mi (13 km) downstream from Hassayampa River.

Drainage area.--49,650 mi² (128,600 km²).

Gage-height record.--Digital water-stage recorder tape. Datum of gage is 743.51 ft (226.622 m) National Geodetic Vertical Datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--February to March 1978: Discharge, 92,900 ft³/s (2,630 m³/s) 1730 hours Mar. 4, gage height, 16.08 ft (4.901 m).
1939 to January 1978: Discharge, 64,200 ft³/s (1,820 m³/s) Jan. 2, 1966, gage height, 16.1 ft (4.91 m).
1891 to January 1978: Discharge estimated as 250,000 ft³/s (7,100 m³/s) in February 1891.

(111) 09519500 Gila River below Gillespie Dam, Ariz.—Continued

Remarks.--Flow partially regulated by San Carlos Reservoir on the Gila River since 1928, by a system of reservoirs on the Salt River since 1910 (see sta 09501000), by a system of reservoirs on the Verde River since 1939 (see sta 09509500), and by Lake Pleasant on the Agua Fria since 1927 (see sta 09513500).

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Feb. 27	70	Mar. 6	23,000	Mar. 13	1,210
28	110	7	25,400	14	778
Mar. 1	113	8	20,100	15	620
2	4,920	9	24,100	16	522
3	39,500	10	12,400	17	472
4	80,700	11	3,270	18	428
5	40,800	12	1,700	19	428

Gage height, in feet, and discharge, in cubic feet per second, at indicated time, 1978

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
Mar. 1			Mar. 3—Con.			Mar. 5—Con.		
1945	10.04	0	2000	15.93	89,300	2400	12.69	25,200
2100	10.06	58	2400	15.76	85,200	Mar. 6		
2400	10.17	30	Mar. 4			0500	12.54	22,900
Mar. 2			0400	15.81	86,400	1300	12.65	24,600
1200	10.81	3,680	0600	15.87	87,900	2400	12.31	19,700
1500	11.39	8,730	0800	15.96	90,000	Mar. 7		
1800	11.47	9,550	1300	15.78	85,700	0300	12.49	22,200
2400	11.27	7,550	1800	15.26	73,700	0800	12.95	29,200
Mar. 3			2400	14.65	60,500	1600	12.75	26,100
1300	11.19	6,810	Mar. 5			2400	12.46	21,800
1400	13.36	35,900	0600	14.18	51,000	Mar. 8		
1500	15.40	76,900	1200	13.48	38,000	1200	12.33	20,000
1600	15.80	86,200	1300	13.58	39,800	2400	12.28	19,300
1730	16.08	92,900	1400	13.47	37,800			

(112) Painted Rock Reservoir at Painted Rock Dam, Ariz.

Location.--Lat 33°04'30", long 113°00'50", in SE¼ sec.18, T.4 S., R.7 W., Maricopa County, Hydrologic Unit 15070201, at Painted Rock Dam, 19 mi (31 km) northeast of Sentinel.

Drainage area.--50,910 mi² (131,860 km²), approximately.

Gage-height record.--Water-stage recorder graph. Record furnished by U.S. Army Corps of Engineers, Los Angeles District. Datum of gage is 0.0 ft (0.0 m) National Geodetic Vertical Datum of 1929.

Reservoir-contents record.--Furnished by U.S. Army Corps of Engineers, Los Angeles District.

Maxima.--February to March 1978: Contents, 385,400 acre-ft (475 hm³) 1200 hours Mar. 12, gage height, 398.13 ft (121.350 m).
1959 to January 1978: Contents, 439,[illegible]30 acre-ft (542 hm³) May 21, 1973, gage height, 601.25 ft (183.261 m).

(112) Painted Rock Reservoir at Painted Rock Dam, Ariz.—Continued

Contents, in acre-feet, at 2400 hours on indicated day, 1978

Day	Contents	Day	Contents	Day	Contents
Mar. 3	0	Mar. 9	355,600	Mar. 15	379,300
4	137,500	10	379,700	16	376,800
5	224,600	11	385,000	17	374,500
6	259,100	12	385,200	18	372,700
7	293,800	13	383,900	19	370,800
8	323,900	14	382,300	20	369,200

(113) 09519800 Gila River below Painted Rock Dam, Ariz.

Location.--Lat 33°04'30", long 113°00'50", in SE¼ sec.18, T.4 S., R.7 W., Maricopa County, Hydrologic Unit 15070201, on left bank 0.3 mi (0.5 km) downstream from Painted Rock Dam, and 19 mi (31 km) northeast of Sentinel.

Drainage area.--50,910 mi^2 (131,860 km^2), approximately.

Gage-height record.--Water-stage recorder graph. Datum of gage is 518.69 ft (158.097 m) National Geodetic Vertical Datum of 1929 (levels by U.S. Army Corps of Engineers).

Discharge records.--Stage-discharge relation defined by current-meter measurements.

Maxima.--February to March 1978: Discharge, 1,060 ft^3/s (30.0 m^3/s) 1945 hours Mar. 4, gage height, 6.51 ft (1.984 m).
1959 to January 1978: Discharge, 2,860 ft^3/s (81.0 m^3/s) Apr. 5, 1973, gage height, 10.29 ft (3.136 m).

Mean discharge, in cubic feet per second, 1978

Day	Discharge	Day	Discharge	Day	Discharge
Mar. 3	0	Mar. 5	365	Mar. 7	259
4	504	6	310	8	292

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UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

OPEN-FILE REPORT 82-687
PLATE 1

BASE FROM U.S. GEOLOGICAL SURVEY
STATE BASE MAP, 1:1,000,000, 1974

Scale 1:1,000,000
1 inch equals Approximately 16 miles

EXPLANATION

▲72 DISCHARGE-MEASURING SITE—Number refers to table 13

◇36 SNOW COURSE—Number refers to table 3

◆55 PRECIPITATION STATION—Number refers to table 4

LOCATIONS OF DISCHARGE-MEASURING SITES, SNOW COURSES, AND PRECIPITATION STATIONS IN ARIZONA FOR FLOODS OF OCTOBER 1977 AND MARCH 1978

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

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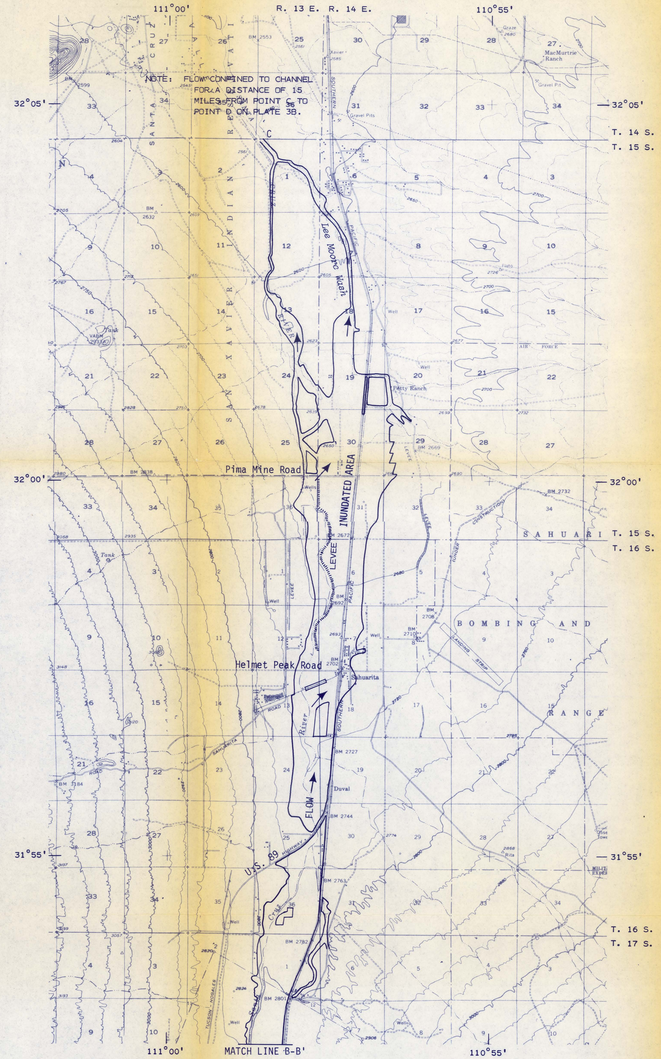
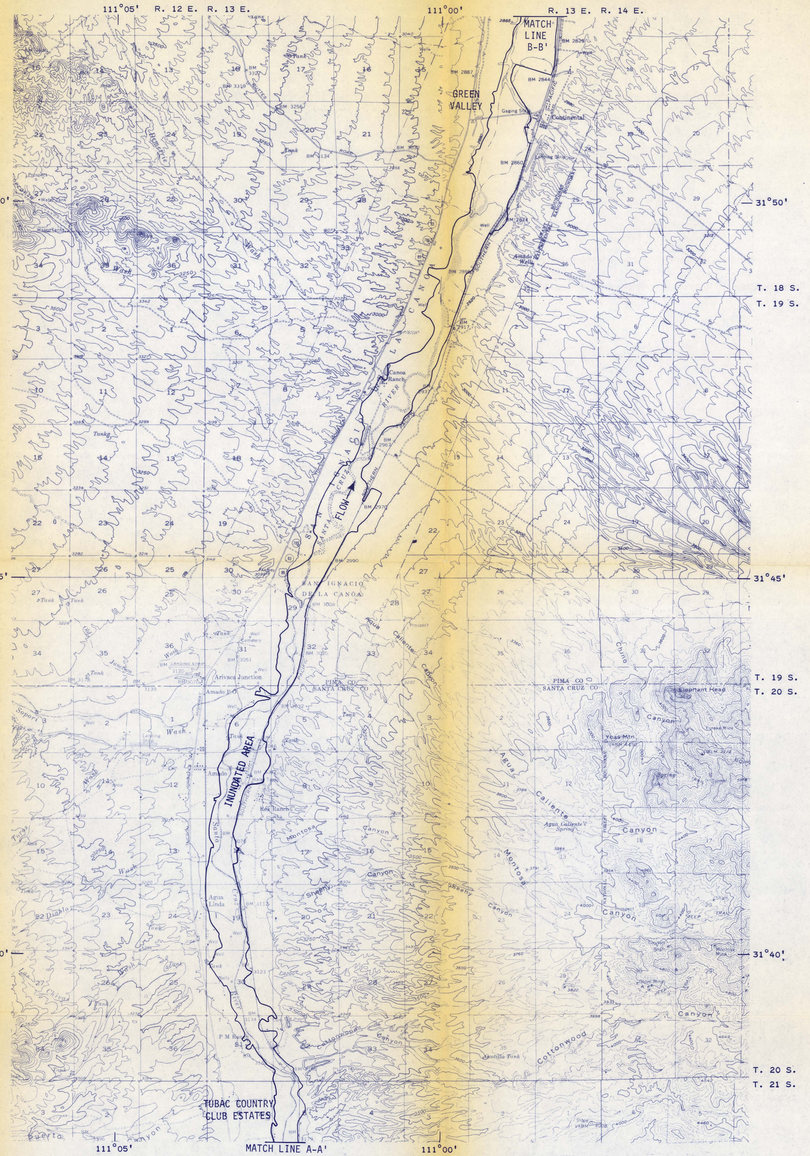
PLATE 2



BASE FROM U.S. GEOLOGICAL SURVEY, 1:62,500
SAHUARITA, 1958; SAN XAVIER MISSION, 1940-57;
TUCSON, 1946-57; TWIN BUTTES, 1939-57

A. GREEN VALLEY TO SAN XAVIER INDIAN RESERVATION

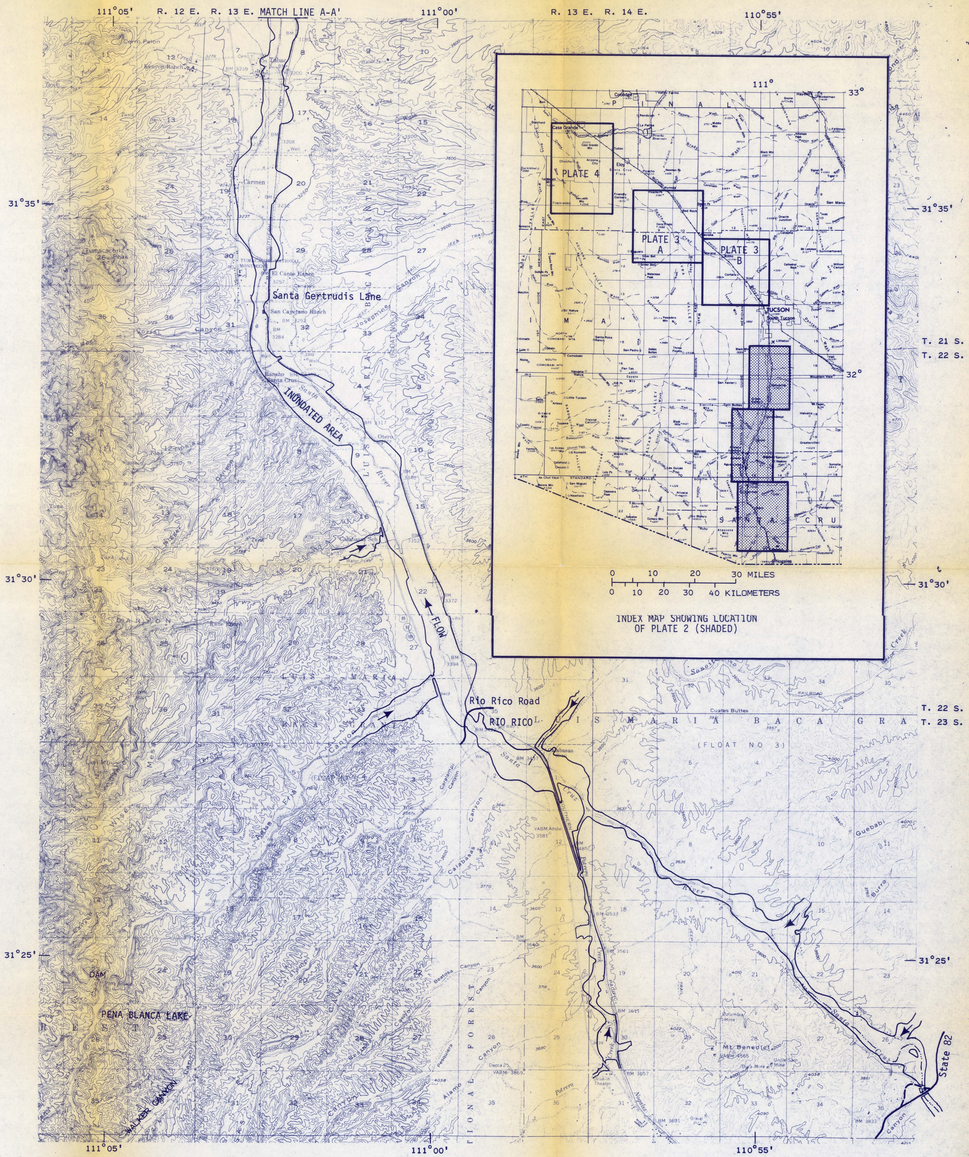


BASE FROM U.S. GEOLOGICAL SURVEY, 1:62,500
MT. WRIGHTSON, 1958; SAHUARITA, 1958;
TUBAC, 1939-57; TWIN BUTTES, 1939-57

1 ½ 0 1 2 3 4 MILES
1 .5 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL, IN FEET, IS VARIABLE
NATIONAL GEODETIC VERTICAL DATUM OF 1929

B. TUBAC COUNTRY CLUB ESTATES TO GREEN VALLEY



BASE FROM U.S. GEOLOGICAL SURVEY, 1:62,500
MT. WRIGHTSON, 1958; NOGALES, 1958;
RUBY, 1939-57; TUBAC, 1939-57

C. STATE ROUTE 82 TO TUBAC COUNTRY CLUB ESTATES

AREA INUNDATED BY SANTA CRUZ RIVER AND MAJOR TRIBUTARIES FROM STATE ROUTE 82 NEAR NOGALES, ARIZ., TO SAN XAVIER INDIAN RESERVATION NEAR SAHUARITA, ARIZ., OCTOBER 9-10, 1977

UNITED STATES DEPARTMENT OF THE INTERIOR
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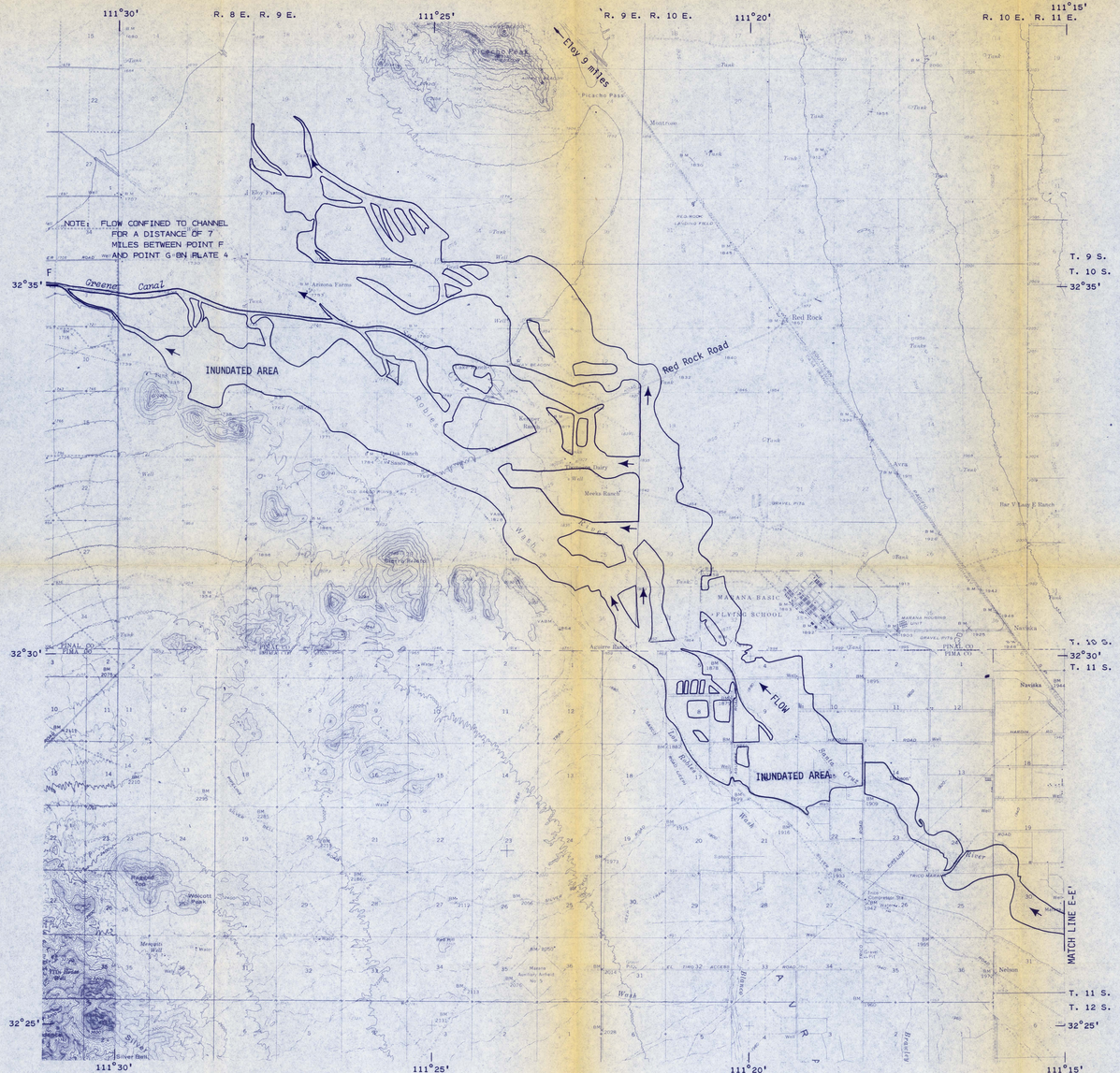
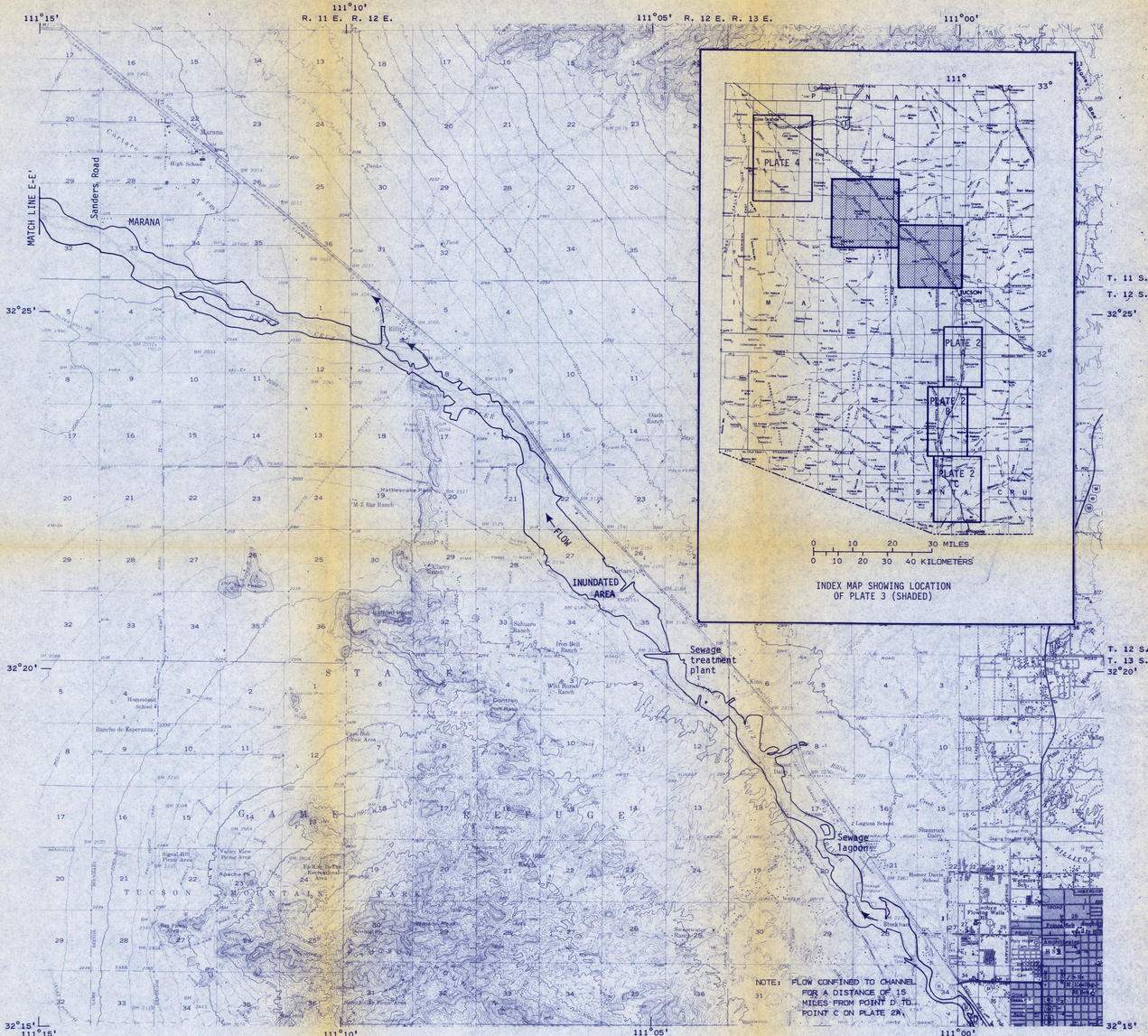
PLATE 3



BASE FROM U.S. GEOLOGICAL SURVEY, 1:62,500
ELOY, 1946-63; RED ROCK, 1946-63; SILVER BELL PEAK, 1959; VACA HILLS, 1959

A. DOWNSTREAM FROM MARANA TO GREENE CANAL



INDEX MAP SHOWING LOCATION OF PLATE 3 (SHADED)

BASE FROM U.S. GEOLOGICAL SURVEY, 1:62,500
CORTARO, 1957; MT. LEMMON, 1957

1 ½ 0 1 2 3 4 MILES
1 .5 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL, IN FEET, IS VARIABLE
NATIONAL GEODETIC VERTICAL DATUM OF 1929

B. TUCSON TO DOWNSTREAM FROM MARANA

AREA INUNDATED BY SANTA CRUZ RIVER FROM TUCSON, ARIZ., TO GREENE CANAL SOUTH OF ELOY, ARIZ., OCTOBER 10-12, 1977.

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

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PLATE 4

NOTE: GREENE WASH JOINS SANTA ROSA WASH 8 MILES DOWNSTREAM FROM INTERSTATE 8. SANTA ROSA WASH AND SANTA CRUZ WASH JOIN 8 MILES NORTH OF MARICOPA (SEE PL. 1), ONLY LOCAL INUNDATION ALONG GREENE WASH, SANTA ROSA WASH, AND SANTA CRUZ WASH.

INUNDATED AREA

FLOW

NOTE: FLOW CONFINED TO CHANNEL FOR A DISTANCE OF 7 MILES BETWEEN POINT G AND POINT F ON PLATE 3A.

Former site of Greene Reservoir

INDEX MAP SHOWING LOCATION OF PLATE 4 (SHADED)

PLATE 3 A

PLATE 3 B

PLATE 2 A

PLATE 2 B

PLATE 2 C

BASE FROM U.S. GEOLOGICAL SURVEY
CASA GRANDE MOUNTAINS 1:24,000, 1965; CHUICHU 1:24,000, 1965; ELOY 1:62,500, 1946-63; SILVER REEF MOUNTAINS 1:62,500, 1940-63

CONTOUR INTERVAL, IN FEET, IS VARIABLE
NATIONAL GEODETIC VERTICAL DATUM OF 1929

AREA INUNDATED BY GREENE WASH (CONTINUATION OF SANTA CRUZ RIVER) AND SANTA CRUZ WASH NEAR CHUICHU, ARIZ., OCTOBER 12-13, 1977.

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

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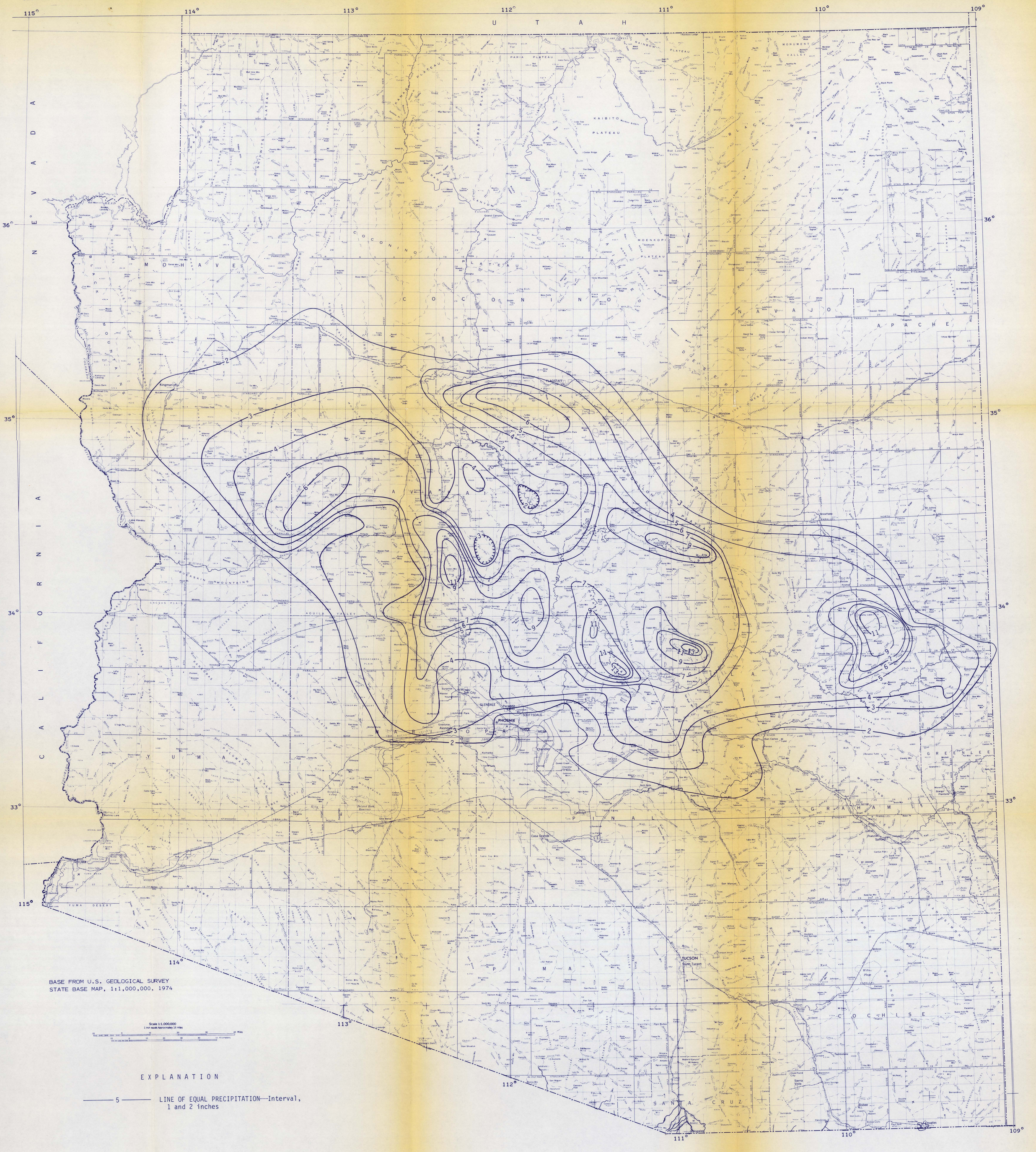
PLATE 5



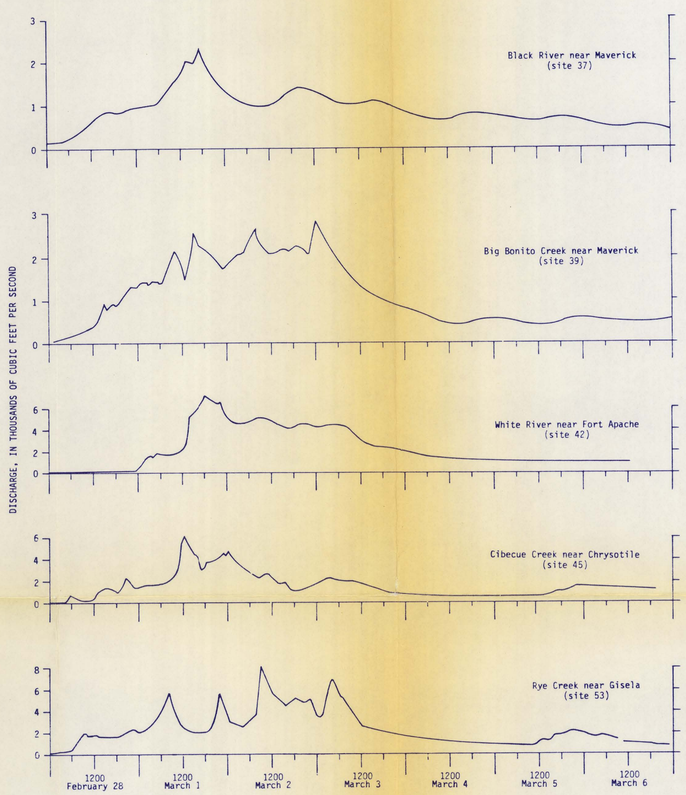
BASE FROM U.S. GEOLOGICAL SURVEY
STATE BASE MAP, 1:1,000,000, 1974

Scale 1:1,000,000
1 inch equals Approximately 16 miles
40 Miles
40 Kilometers

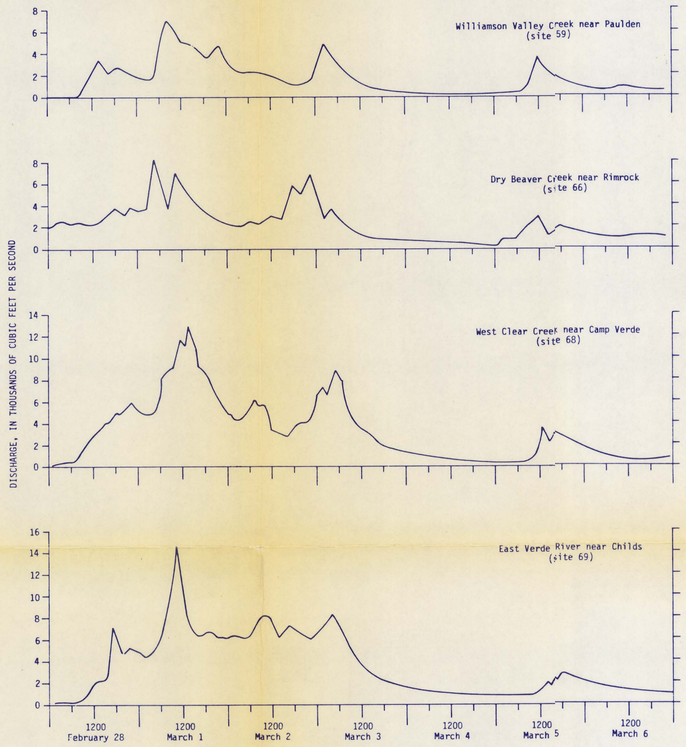
EXPLANATION

5 — LINE OF EQUAL PRECIPITATION—Interval, 1 and 2 inches

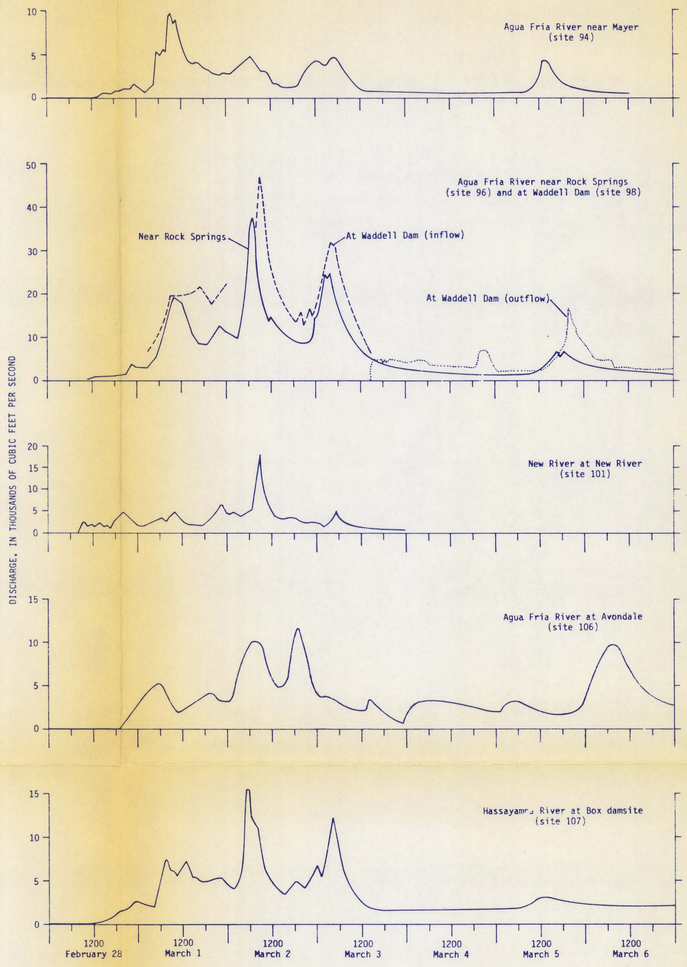
PRECIPITATION IN CENTRAL ARIZONA, FEBRUARY 27 TO MARCH 3, 1978.



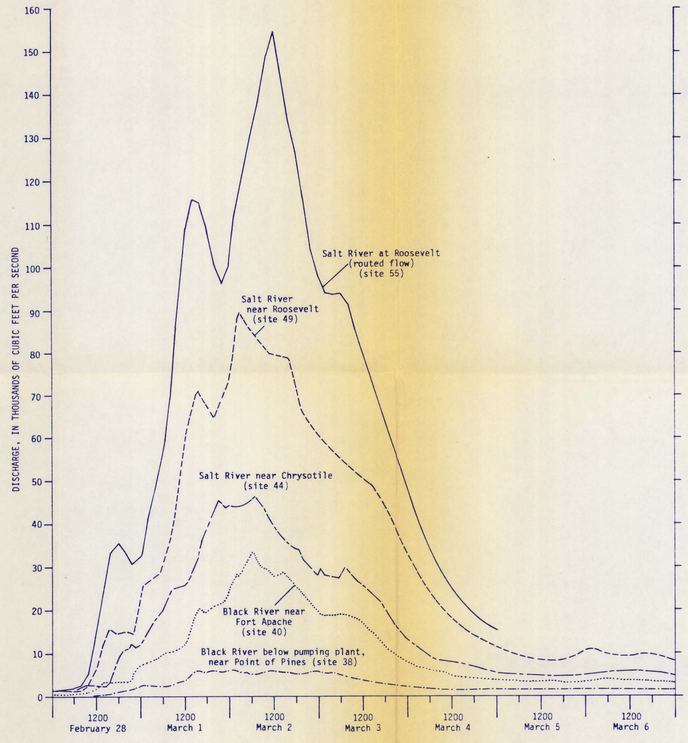
A. Tributaries to the Salt River upstream from Roosevelt Dam.



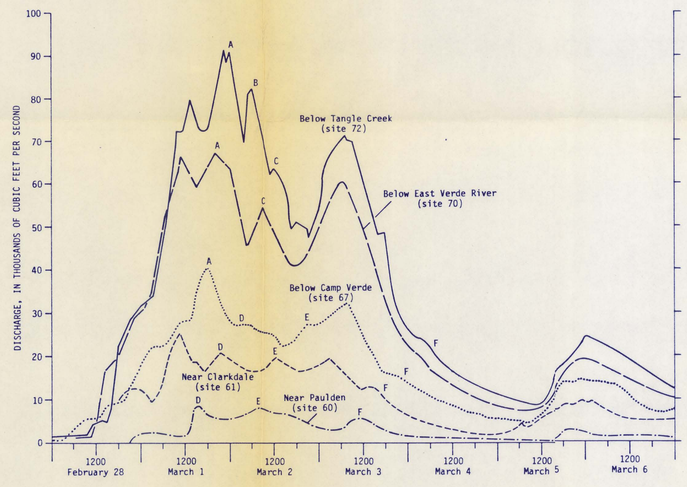
B. Tributaries to the Verde River.



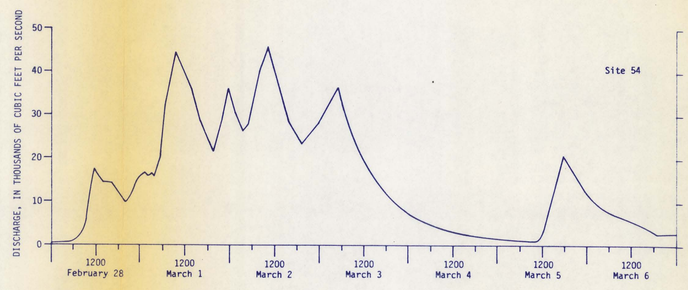
C. Agua Fria and Hassayampa River basins.



D. Black and Salt Rivers upstream from Roosevelt Dam.



E. Verde River upstream from Horseshoe Reservoir.



F. Tonto Creek above Gun Creek, near Roosevelt.

PEAK DISCHARGES AT SELECTED STREAMFLOW STATIONS, FEBRUARY 28 TO MARCH 6, 1978.