FLOOD DAMAGE REPORT

JANUARY 1980

SOUTHCENTRAL ARIZONA AND SOUTHWESTERN NEW MEXICO DECEMBER 1978 FLOOD

PUBLISHED BY

U. S. ARMY CORPS OF ENGINEERS

LOS ANGELES DISTRICT

JANUARY 1980

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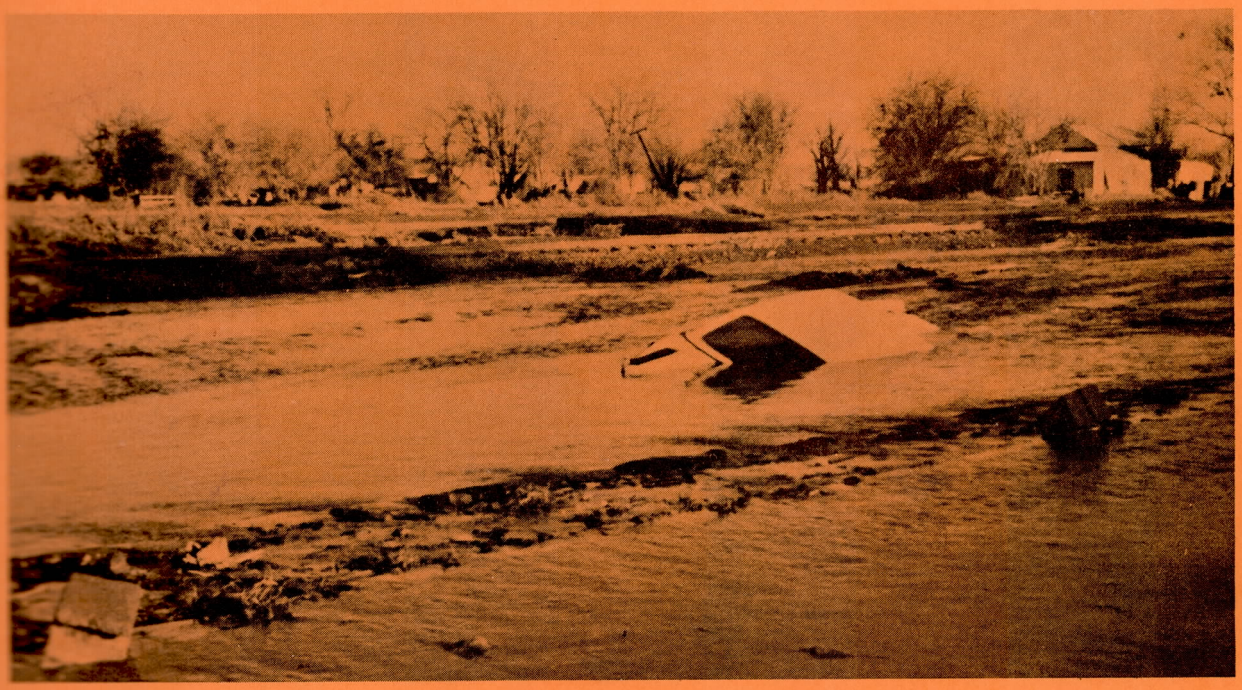
Flood Damage Report

Southcentral Arizona and Southwestern New Mexico December 1978 Flood

January 1980



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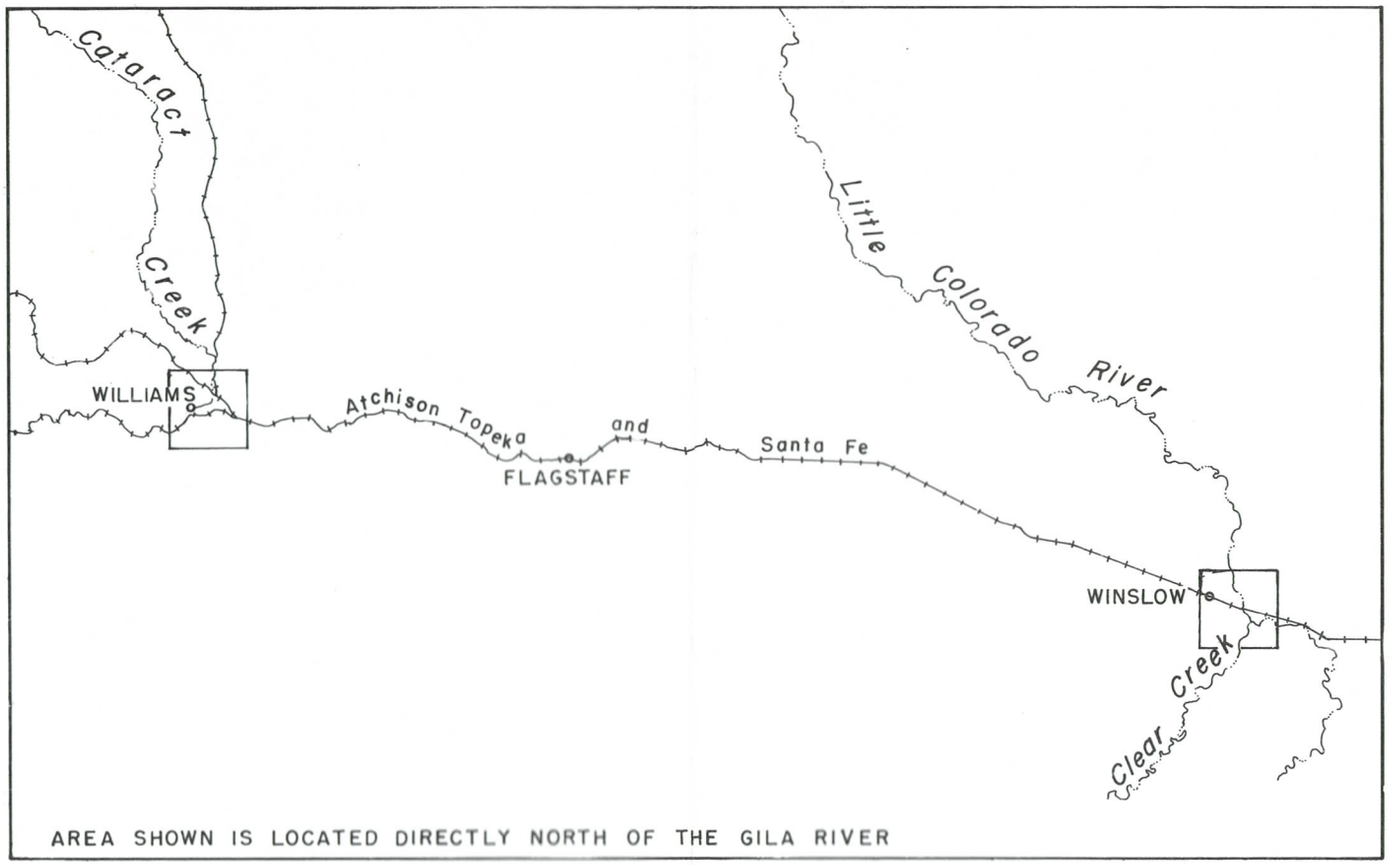

Cataract
Creek
WILLIAMS
Atchison Topeka and Santa Fe
FLAGSTAFF
Little Colorado River
WINSLOW
Clear Creek
AREA SHOWN IS LOCATED DIRECTLY NORTH OF THE GILA RIVER

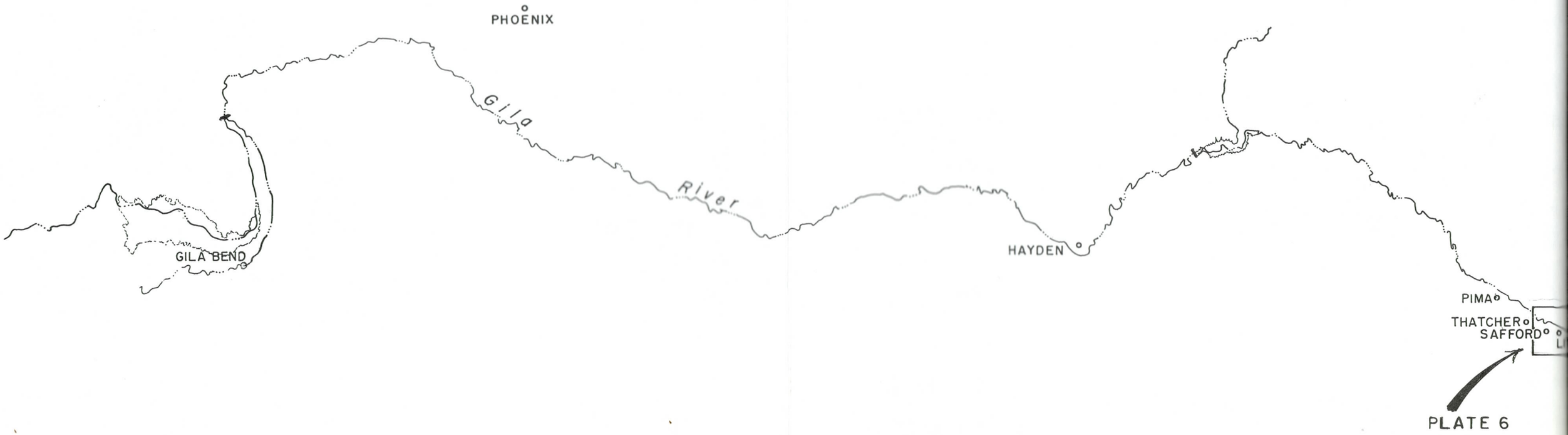
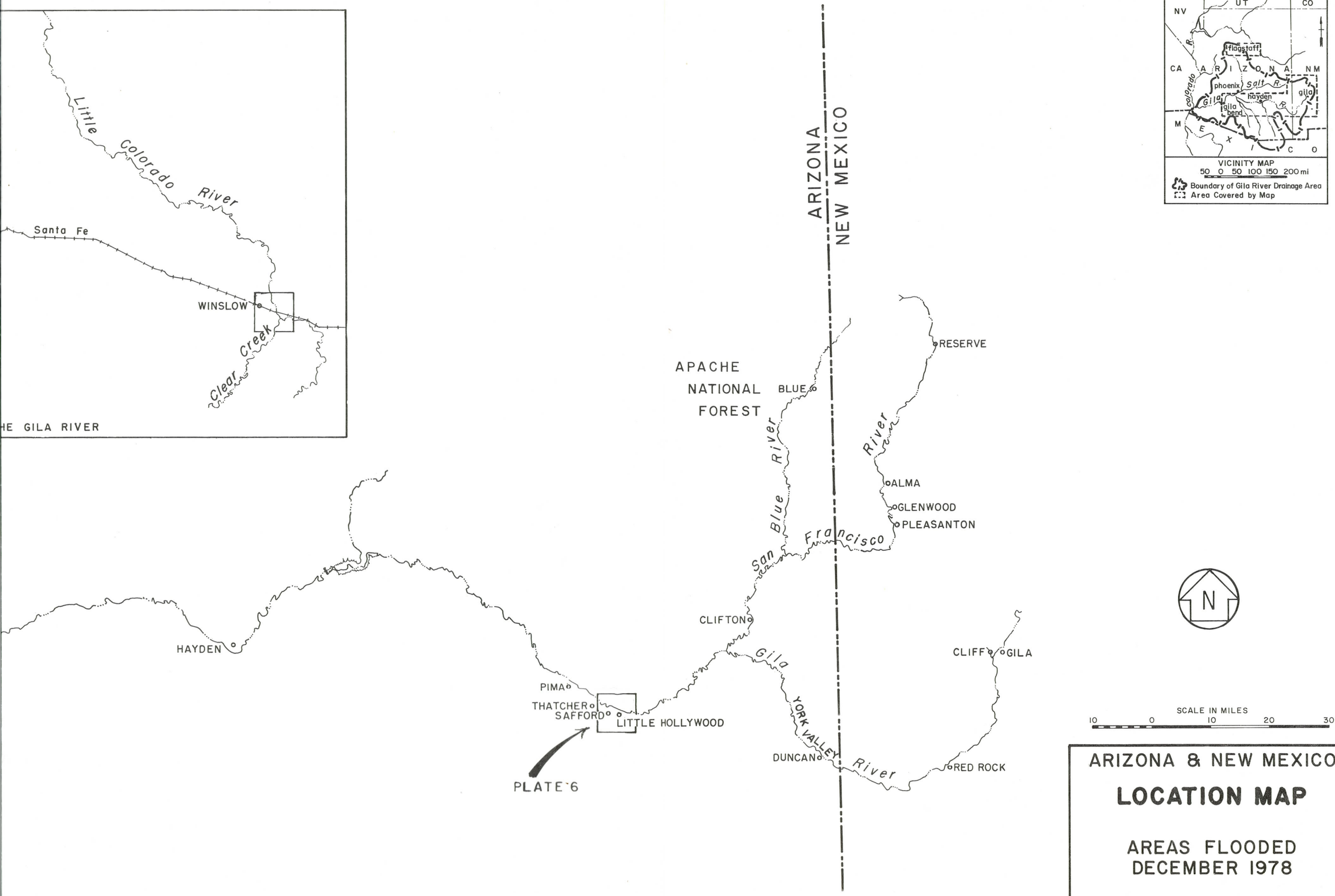

PHOENIX
Gila
River
GILA BEND
HAYDEN
PIMA
THATCHER
SAFFORD

PLATE 6



ARIZONA & NEW MEXICO

LOCATION MAP

AREAS FLOODED
DECEMBER 1978

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1. AUTHORITY. This report was prepared under the continuing authority provided the Corps of Engineers in Section 206 of the 1960 Flood Control Act (Public Law 86-645) as amended.

2. SCOPE. A description of the storm and associated flooding during the period 16-20 December 1978 in Northcentral Arizona, and Southwestern New Mexico is provided in this report. Damages reported are restricted to those caused by inundation or erosion by floodwater, or by flood-transported debris. Wind and rain damages are excluded.

Damages are described for the following areas in the upper Gila River Basin which are identified in Plate 1.

- Safford Valley; Graham County, AZ
- Southwestern New Mexico; Catron, Hidalgo, and Grant Counties, NM
- Duncan and York Valleys; Greenlee County, AZ
- Blue River Region; Greenlee County, AZ
- Clifton; Greenlee County, AZ

Also described are damages to Winslow, Arizona in the Little Colorado River Basin; Williams, Arizona in Coconino County; and outlying agricultural areas near Gila Bend in the lower Gila River Basin; Maricopa County, Arizona.

Three types of damages; physical damages, income losses, and emergency costs are documented. Damages are also categorized by type of land use as follows: residential, commercial, industrial, agricultural[1/] and public. Damages are summarized in tabular format by basin/runoff area and geographical location for each type of land use.

More detailed information is provided on specific topics such as the meteorological and hydrological aspects of the storm, stream gauge measurements, and emergency relief provided in the flood damaged areas.

The damages projected in this report do not include the Metropolitan Phoenix area. These damages will be reported in Flood Damage Report, Phoenix Metropolitan Area (September 1979).

1/ Agricultural Flood Damage estimates for the upper Gila River Basin in Arizona were provided by the Greenlee and Graham County Agricultural Stabilization and Conservation Service offices.

3. DESCRIPTION OF METEOROLOGICAL AND HYDROLOGICAL ASPECTS OF THE STORM

STORMS OF DECEMBER 16-20 1978

A. METEOROLOGY. The period of November 1978 through January 1979 was characterized by a series of upper level low pressure centers which developed off the west coast of Baja California and which moved northeastward into the southwestern United States, giving most of Arizona unusually heavy, warm rains. The most intense of these lows began to approach the coast on December 15 and 16, at the same time that a deep low pressure trough was dropping southward from the Gulf of Alaska. As these two lows combined just off the California coast, the circulation around the resulting system brought a strong flow of very warm, moist tropical air from the equatorial Pacific Ocean northward into Arizona and triggered heavy rainfall through most of the State. Where this strong flow encountered mountain ranges, such as the Bradshaws, Mazatzals, Sierra Anchas, and the Mogollon Rim, the orographic uplift of the air resulted in even much heavier precipitation than that which occurred in the valleys. Because of the tropical nature of the air mass, the snow levels throughout most of the storm were generally 7,000 to 8,000 feet above sea level in the northwestern portions of Arizona and as high as 10,000 to 11,000 feet in southeast Arizona and western New Mexico. Near the end of the storm the snow levels generally dropped several thousand feet. A more detailed meteorological description of this storm and an evaluation of the National Weather Service forecasts issued at the time of the event can be found in "Report on the Arizona Floods of December 16-20, 1978," prepared by the U.S. Department of Commerce, NOAA, National Weather Service, Salt Lake City, Utah, May 18, 1979.

B. PRECIPITATION. Total precipitation in the storm of December 16-20, 1978 ranged from less than 1 inch in the northeastern and far southwestern portions of Arizona to nearly 10 inches in the Mazatzal Mountains northeast of Phoenix. A large area of the central mountains of Arizona received over 5 inches. Plate 2 in an isohyetal map of the total precipitation in Arizona during the period December 16-20, 1978. This plate was reproduced and slightly modified for updated data, with permission of the National Weather Service, from their "Report on the Arizona Floods of December 16-20, 1978" (U.S. Department of Commerce, NOAA, National Weather Service, May 18, 1979). A tabulation of total rainfall in this storm at selected National Weather Service stations can be found in Appendix 1 of that NOAA report.

Plate 3 contains mass rainfall curves for two U.S. Forest Service stations and two U.S. Geological Survey stations for the storm period. Light rain began in parts of Arizona late December 16, but did not become significant until the morning of December 17. As can be seen in Plate 3, the heaviest rainfall at most stations occurred between approximately noon December 17 and late evening December 18. Few if any extreme intensities over short durations (such as in the heaviest summer thunderstorms) occurred during this December 1978 storm, but rates of .25 to .5 inch per hour were relatively common throughout the foothill and mountain areas of central

Arizona on December 17 and 18. Precipitation tapered off rapidly by the early hours of December 19, with only a few light rain or snow showers lingering into December 20.

C. RUNOFF. Runoff from the storm of December 16-20, 1978 was heavy throughout most of Arizona and western New Mexico. The main stems of the Gila, Salt, Verde, Agua Fria, Bill Williams, and Little Colorado Rivers, as well as a number of major tributaries to these rivers, experienced especially large discharges, some of which are the greatest ever recorded, according to preliminary U.S. Geological Survey data.

A list of available peak discharges at stations along the main stems and major tributaries to the Gila, Agua Fria, Bill Williams, and Little Colorado Rivers, can be found in Table 1. It must be cautioned that these figures are approximate and represent preliminary U.S. Geological Survey data which are subject to revision. Most of the values are taken from regular USGS gaging stations, although some are from partial-record USGS stations, and a few represent special slope-area measurements made by the USGS.

The flood crests began traveling down the smaller tributaries early December 18, reaching the larger creeks and rivers late December 18, and continuing down the main stems of the major rivers from December 19 through December 22. Most of the rivers experienced a single major crest, although some rivers experienced two prominent crests of nearly equal magnitude, separated in time by 12 to 36 hours--one crest from runoff on the main stem and the other from major tributary inflow (such as was seen on the Gila River below the mouth of the San Francisco River). Regulated releases from reservoirs further complicated these travel patterns on some streams. Plates 4 and 5 contain preliminary hydrographs of the discharges on the Salt and Verde Rivers, respectively. On Plate 4 the solid line represents the total combined inflow to Roosevelt Lake, including runoff from the Salt River, Tonto Creek, and the ungaged area. The peak of this combined inflow (computed by the U.S. Corps of Engineers from preliminary data furnished by the U.S. Geological Survey and the Salt River Project) occurred at 2200 hours December 18, with a calculated value of 152,300 cubic feet per second (cfs). The dashed line on Plate 4 represents the release from Stewart Mountain Dam (the lowest of the four Salt River Project dams on the Salt River). On Plate 5 the solid line represents the discharge on the Verde River below Tangle Creek, just upstream from Horseshoe Reservoir, while the dashed line depicts the releases from Bartlett Dam (the lower of the two Salt River Project dams on the Verde River).

The preliminary peak discharge of 123,000 cfs for the Verde River below Tangle Creek (as shown on Plate 5, and as listed in Table 1) was reported by the U.S. Geological Survey in their summary of preliminary peaks for December 1978. However, the peak of the preliminary hydrograph--92,400 cfs--results from implementation of the March 1979 rating curve. U.S. Army Corps of Engineers personnel, working with data from the December

1978 flood and implementing the shift used in computing the peak, were unable to justify the subsequent volume for the hydrograph of the Verde River below Tangle Creek. Discussions with the USGS, addressing this issue, led to a suggestion that the prior rating curve be used to establish the hydrograph shape and volume. As a result, the preliminary hydrograph was depicted on Plate 5, using a previous rating curve, although the USGS measurement indicates that the actual peak, as discussed previously, may have been greater than 100,000 cfs. No final decision has yet been made, but the hydrograph shown should be a good indication of the shape and volume of the December 1978 flood from the Verde River below Tangle Creek. If the peak discharge of 123,000 cfs should subsequently be confirmed, it would represent the discharge of record at that location (a value, however, which may have been exceeded during the flood of February 1891).

The heavy runoff of December 17-23, 1978 resulted in considerable flooding in many parts of Arizona. Detailed descriptions of the flooding and flood damges in Arizona can be found elsewhere in this report and in the Corps of Engineers,* (See below) as well as the National Weather Service "Report on the Arizona Floods of December 16-20, 1978."

There are a number of reasons for the heavy runoff in Arizona during December 1978. The most important of these include:

(1) Unusually heavy antecedent precipitation throughout most of Arizona and western New Mexico during November 1978 tended to saturate the ground and render it highly conducive to runoff.

(2) Very cold weather during early December 1978 froze the ground in many higher elevation areas, rendering it even more conducive to immediate and near total runoff.

(3) Moderate snowfall down to elevations below 5,000 feet in early December 1978 provided a snowpack of sufficient depth to significantly contribute to the runoff as it melted during the warm, heavy rain of December 16-20. (The snowpack was not so deep, however, that it was able to absorb the December 16-20 rainfall, except at the very highest elevations.)

(4) The very high snow levels of the December 16-20 storm combined with the other factors to result in a high proportion of runoff to incident precipitation at elevations up to 8,000-9,000 feet.

*"Flood Damage Report, Phoenix Metropolitan Area, December 1978 Flood."

(5) Relatively high intensities of rainfall were widespread in area, extent occurred during the period and lasted (sometimes on and off) from midday December 17 through late December 18.

(6) Heavy rainfall and runoff throughout the winter of 1977-1978 (especially February and March of 1978) and again in November 1978 resulted in abnormally large storages in the Salt River Project and Carl Pleasant Reservoirs. Because of these conditions, there was very little available storage space in these reservoirs at the beginning of the December 16-20, 1978 storms; and therefore, large flood releases down the Salt, Verde, and Agua Fria Rivers became necessary, beginning December 18. Through a careful monitoring of existing and predicted rainfall and watershed conditions, however, it was possible for the operators of these reservoirs to mitigate the flood peaks on the downstream portions of these rivers, and consequently on the Gila River downstream from the mouth of the Salt River. Farther upstream on the Gila River, conditions were not so critical in December 1978. Because of a large amount of available storage space in San Carlos Reservoir in December 1978, the entire volume of the late 1978 and early 1979 runoff from the upper Gila was stored in the reservoir, and none of this water reached the downstream areas. (San Carlos Reservoir finally filled and spilled slightly--for the first time in its history--during the late spring of 1979.)

TABLE 1

PEAK DISCHARGES, FLOOD OF DECEMBER 1978
Preliminary Data from U.S. Geological Survey

Gage Number	Gage Location	Drainage Area (sq mi)	Date	Time (MST)	Peak Discharge (cfs)
	NEW MEXICO				
4305	Gila River near Gila	1,864	12/18	2300	32,400*
4315	Gila River near Redrock	2,829	12/19	0700	48,900*
4320	Gila River below Blue Creek, near Virden	3,203	12/19	0900	58,700*
4430	San Francisco River near Alma	1,546	12/18	2100	42,500
4440	San Francisco River near Glenwood	1,653	12/18		20,500
	ARIZONA				
4420	Gila River near Clifton	4,010	12/19	2100	53,000*
4442	Blue River near Clifton	506	12/18	1345	12,500
4450	San Francisco River at Clifton	2,766	12/19	0030	56,000
4470	Eagle Creek above Pumping Plant, near Morenci	613	12/18	2200	24,500*
4485	Gila River at Head of Safford Valley, near Solomon	7,896	12/19	0300	100,000
4665	Gila River at Calva	11,470	12/19	2100	100,000*
4685	San Carlos River near Peridot	1,027	12/18	1100	22,500
5125	Agua Fria River near Mayer	588	12/18[a]		18,300
5128	Agua Fria River near Rock Springs	1,130	12/18		52,800*
4244.5	Big Sandy River near Wikieup	2,800			28,000
4244.7	Kirkland Creek near Kirkland	109	12/18	1900	1,800
4249	Santa Maria River near Bagdad	1,210	12/18	1500	17,000
3905	Show Low Creek near Lakeside	68.6	12/18	1615	5,000
3920	Show Low Creek below Jaques Dam, near Show Low	73.0	12/18	1630	2,000
3935	Silver Creek near Snowflake	886	12/18		7,400
3945	Little Colorado River at Woodruff	8,100	12/18		9,320
3961	Puerco River near Chambers	2,160	12/18	2230[a]	9,620
3973	Little Colorado River near Joseph City	12,200	12/19	1000	25,000*
	Chevelon Creek below Wildcat Creek	275	12/18		19,900*
	Chevelon Creek near Winslow	794			31,000*[b]
3985	Clear Creek below Willow Creek, near Winslow	321	12/18	1930	18,000*
3990	Clear Creek near Winslow	607	12/19	0420	35,000
	Little Colorado River at Winslow	16,100	12/19	1100[a]	60,800[b]

* indicates peak discharge of record
[a] approximately
[b] indicates slope-area measurement taken by U.S. Geological Survey

Date for this table was supplied by U.S. Geological Survey offices in Tucson, Arizona; Flagstaff, Arizona; and Albuquerque, New Mexico.

Fig. 1. View of flood damage on Gila River at Pima-Bryce crossing.

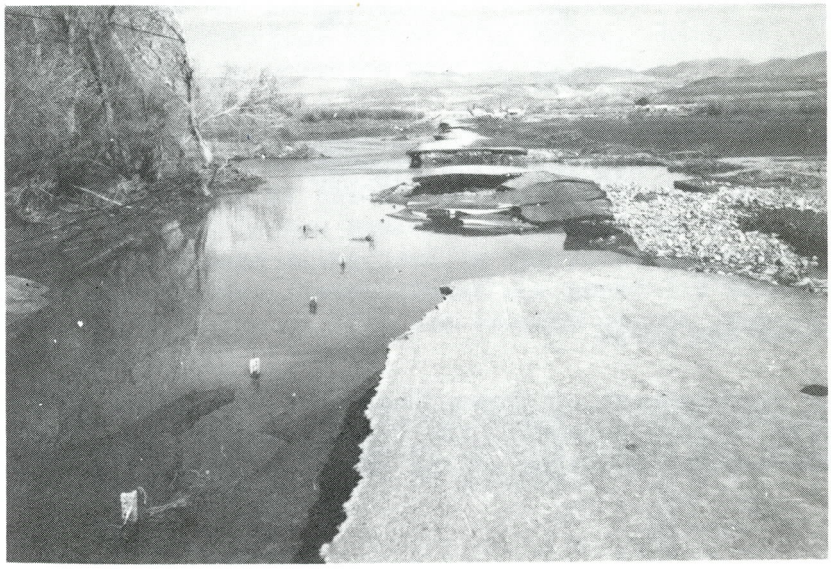


Fig. 2. Exploded view of Southern approach to Pima-Bryce crossing.

4. EMERGENCY RELIEF ACTIVITIES. Following and during the December 1978 flood government agencies and private charitable organizations at all levels provided assistance to the flood victims. This assistance took many forms including:

- o provision of immediate necessities and food to flood victims;
- o payment to Federal Insurance Administration Policy holders;
- o funding to repair damaged roadways, and other public facilities, and
- o loans to repair or replace damaged businesses, fields, etc.

It is estimated that over 132 million dollars in Disaster Relief Funds were issued by various state and federal agencies in Arizona.

Other emergency relief was provided by the American Red Cross. Table 2 below summarizes costs incurred by the American Red Cross during the December 1978 flood.

TABLE 2

AMERICAN RED CROSS DIRECT AID TO FLOOD VICTIMS

Type of Aid	Greenlee County	Graham County	Winslow	Northwest Arizona
Emergency Mass Care	$ 5,600	$ 600	$ 400	$ 300
Food, Clothing & Maintenance	11,600	9,400	6,800	1,700
Emergency/Minor Home Repair	0	0	0	0
Household Furniture & Appliances	200	100	5,500	100
Emergency Health Services	900	*	100	300
Occupational Supplies & Equipment	100	100	0	0
	$18,400	$10,200	$12,800	$2,400

* amount below $50.00

Source: American Red Cross

While the disbursement of these funds does not relate directly to the damages reported in this document, the funds committed to disaster relief provide an alternative indicator of the extent of damages sustained.

5. DESCRIPTION OF DRAINAGE AREA. This report describes damages that occurred in two river basin areas and one creek runoff area. The Gila River Basin was hardest hit by flooding, followed in destruction by the Little Colorado River Basin in Winslow, and Cataract Creek in Williams, Arizona.

A. Gila River Basin. The Gila River Basin has the largest drainage area of any of the Colorado River sub-basins. The Gila River Basin contains approximately 53,000 square miles, and encompasses 3 counties in Southwestern New Mexico, and 9 counties in eastern, central, and southern Arizona. Elevations range from 530 feet at Sentinel to 12,670 feet at Humphrey's Peak in the San Francisco Mountains. Extremes in temperatures occur in the mountainous regions; but the major portion of the drainage basin is characterized by arid conditions and moderate to high temperatures. Vegetation in the drainage basin includes forestation at higher elevations, dense phreatophyte in the flood plains, and desert vegetation between the two.

The portion of the Gila River Basin above San Carlos Reservoir (Coolidge Dam) is the primary area under consideration for purposes of this report.[2/] The area contains close to 12,900 square miles, of which 85 percent is located in mountainous regions, and the remaining 15 percent in stream valleys. Elevations in the upper Gila River Basin range from 2,300 to 11,000 feet above sea level.

There are three major tributaries to the Gila River above San Carlos Reservoir. They are the San Carlos river, which flows directly into the San Carlos Reservoir; the San Simon River, which is tributary to the Gila River near Solomon, Arizona; and the San Francisco River, which enters the Gila River about 19 miles upstream from Solomon. Damages documented in this report include those resulting from overflow of the San Francisco and Gila Rivers in Arizona and Southwestern New Mexico. Also reported are damages resulting from overflow of the Blue River, which is tributary to the San Francisco River in Greenlee County, Arizona.

B. Little Colorado River Basin. The Little Colorado River Basin encompasses portions of 3 counties in northern Arizona and 4 counties in New Mexico. Approximately 81 percent of the basin lies in Arizona, with the remaining 19 percent in New Mexico. The basin has a drainage area of approximately 27,000 square miles, and is characterized by plateau uplands with mountainous landscape. Temperatures are generally moderate; however, extreme summer temperatures of 107° and extreme winter temperatures of -19° have been reported.

Although the December storm caused damage in areas throughout the Little Colorado River Basin, estimates in this report are confined to major damages occurring in the City of Winslow.

2/ Damages to agricultural property in the outlying areas of Gila Bend are also reported; however, this property is located in the lower Gila River drainage area.

C. Cataract Creek Runoff Area. Cataract Creek is located in the Bill Williams Mountain Watershed area. The creek originates on the northern slopes of Bill Williams Mountain and runs approximately 5.1 miles from the mountain to Havasu Creek, which subsequently flows into the Colorado River. Cataract Creek has a drainage area of 6.6 square miles. The stream is ephemeral, flowing in response to snow melt and rainfall. The average precipitation on the watershed ranges from 21 to 30 inches yearly, with 80 percent of the annual runoff occurring between the months of December and April. Overflow of Cataract Creek in December 1978 caused minor flood damages to the community of Williams, Arizona.

6. OVERFLOW AREA AND SUMMARY OF ALL FLOOD DAMAGES. The overflow area from the December flood along the upper Gila River extended upstream nearly 160 miles from San Carlos Reservoir in Arizona, to the Cliff Gila Valley in New Mexico. The Little Hollywood District near Safford, Arizona, and major portions of the community of Duncan, Arizona, were engulfed by flood waters. Prime agricultural property along the upper and lower Gila River was severely damaged.

Overflow from the San Francisco River in Clifton affected three residential areas in the town, as well as many businesses in the downtown district. San Francisco overflow also affected the Reserve, Alma, Glenwood, and Pleasanton areas in western New Mexico.

The Blue River overflow in eastern Arizona affected a main thoroughfare and agricultural property in the Apache National Forest. Overflow from the Little Colorado River in Navajo County, Arizona and Cataract Creek in Coconino County, Arizona, affected residential areas in the communities of Winslow and Williams respectively.

Damages resulting from the overflows in Arizona and New Mexico totalling $39.8 million, are summarized on Table 3. Agricultural damages at over $25 million far exceeded damages to all other land use categories combined. Public losses at $9.7 million were the next greatest, followed in magnitude by residential, commercial, and industrial "other" damages.

TABLE 3

SUMMARY OF FLOOD DAMAGES OUTLYING AREAS ARIZONA AND SOUTHWESTERN NEW MEXICO
DECEMBER 1978 FLOOD
(1000's)

Land Use	Physical Damage	Income Losses	Emergency Costs	Total
Agricultural	$ 24,750	$ 447	$ --	$ 25,197
Residential	2,584	--	4	2,588
Commercial	2,037	137	1	2,175
Industrial:				
Sand & Gravel	--	--	--	--
Other	10	--	--	10
Public:				
Roads & Bridges	6,737	--	387	7,124
Other	2,636	25	95	2,756
TOTAL	$ 38,754	$ 609	$ 487	$ 39,850

7. DESCRIPTION OF FLOOD DAMAGES. The December 1978 flood was of sufficient magnitude to warrant presidential disaster declarations in several counties in Arizona and Southwestern New Mexico. Arizona's Graham, Greenlee, Navajo and Maricopa Counties were declared disaster areas Thursday, December 21, 1978. Coconino County was declared a disaster area Tuesday, December 26, 1978. Similar declarations were made for Catron, Hidalgo and Grant Counties in New Mexico on January 29, 1979.

A very real loss which has been excluded from damage estimates is the loss of life directly attributable to the flooding. Twelve deaths occurred statewide. Of these, one occurred within the study area. The death resulted as a Greenlee County man died shortly after having been rescued from a tree he had climbed in an attempt to escape rushing flood waters.

A presentation of flood damages resulting from the storm of 16-22 December 1978 follows. Damages estimates are presented by basin or runoff area for locations relevant to the scope of this study. The greatest dollar loss took place in the Gila River Basin followed in magnitude by the Little Colorado River Basin and the Cataract Creek runoff area.

A. Gila River Basin. Heavy rains on a saturated, partially snow covered, and partially frozen watershed caused serious flooding throughout the Gila River Basin. Six principal geographic areas were subject to extreme flood disaster. They include: (1) The Safford Valley (2) Southwestern New Mexico (3) The Duncan/York Valleys (4) The Blue River Region (5) Clifton and (6) Gila Bend. Flood-related damages in each geographic area are discussed below. Table 4 summarizes all flood damages to the Gila River Basin.

(1) Safford Valley. The Safford Valley is the most extensively developed region in the Gila River Basin above San Carlos Reservoir. The valley is located in Graham County and extends from San Carlos Reservoir to a short distance upstream from Solomon, Arizona. Agriculture is the main land use in the valley. Small farm towns including Pima, Thatcher, Safford, Little Hollywood, and Solomon dot the valley; and fortunately, all the communities but Little Hollywood are outside the flood plain.

The city of Safford, located 40 miles west of Duncan, Arizona, is the largest community in the valley. Although floodwaters did not reach homes directly, residents were affected, as 2,000 people were evacuated in response to flood warnings. The warnings resulted when water was noticed leaking from the Graveyard Wash Flood Retention Dam late December 18. The earthen dam is located two miles south of Safford at the base of Mt. Graham. City and county workers discovered a crack, 18 feet long in the middle of the dam. A crew of 40 worked for more than three hours bulldozing reinforced earth to repair the dam. A second major leak was discovered midafternoon Tuesday, December 19. It, too, was repaired,

sparing Safford serious flood damage. Had the retaining dam given way, local sources feel the entire community of Safford would have been engulfed by 6 feet of water.

Agricultural damages in this valley far exceeded those of any other location along the Gila River. Approximately 125 farmers reported damages in excess of $14 million. Much prime agricultural land was damaged. The prime crop in the valley is cotton, followed in production by sorghum. December's flood came near the end of the harvesting season; however, about 25 percent of the farmers were unable to get into fields for inital harvesting due to water soaking from a previous flood in November. In these instances, the entire crop production was lost. Other agricultural damages included destruction of wells, fences, machinery, irrigation ditches, farm structures and property. Damages to property ranged from total erosion to silt deposits of up to seven feet. Some of the eroded land can never be replaced because it is part of the new channel cut by the Gila River. Also sustaining damages was the privately owned Gila River Irrigation District at $7.5 million. The system was completely destroyed.

The occurrence of two major floods within a year's period has farmers discouraged. They are concerned that future flood events involving a much lower cfs flow could again cause large scale destruction.

Second to losses in the agricultural sector are losses to the public sector which totalled over $2.5 million. Of these, 68 percent or $1.7 million were in road and bridge damage. The five major Gila River crossings of Bylas, Thatcher, Pima, 8th Avenue and Solomon were washed out, leaving 400 residents on the north side of the river isolated. The National Guard hauled in food and drinking water to the stranded community members. In addition to having transportation routes out, residents on the north side of the river were left without phones and electricity for 12 hours. Two public facilities in Little Hollywood also sustained considerable damage. One, a church of plywood construction, was totally destroyed while the other, a Head Start Center, sustained damages of $11,000.

Residential damages in the Safford Valley were concentrated in the hamlet of Little Hollywood. Little Hollywood is located about 2 miles east of Safford and is the only community bordering the Gila River in the Safford Valley that sustained major flood damages. Little Hollywood previously experienced major flood destruction in October 1972 at which time many families vowed never to return. Twenty families did not, but 51 were residing in Little Hollywood at the time of the flooding in December 1978. Over 68 percent of the units were totally destroyed. Remains of personal belongings, furniture and automobiles were scattered throughout the area. Floodwaters swirled through homes twisting and lifting some off foundations. Of the homes that weren't totally destroyed, most had inside water and silt depths of four feet and outside depths from 4 to 6 feet.

Most homes in Little Hollywood were adobe or wood frame construction with an average pre-flood unit value of $4,000. Approximately 5 homes were constructed of higher grade materials with a pre-flood value of $25,000 per unit. Total residential damages for Little Hollywood are estimated at $400,000. Damages to farm houses throughout the valley account for the remaining $113,000 in residential losses.

Just one commercial establishment in the Safford Valley reported damages from the December 1978 flood. A meat packing business located on the north side of the Gila River experienced losses as a power outage spoiled meat stored in freezers, and bridge washouts made trade during the busy Christmas season impossible.

Worth noting is that the San Carlos Indian Reservation, although not directly affected by floodwaters of the Gila River, sustained damages in excess of $1.8 million.[3/] The Reservation is located in the Safford Valley portion of the Gila River drainage basin above San Carlos Reservoir and covers an area of 2,855 square miles. Plate 6 shows the area of inundation for the Safford and Little Hollywood area along the Gila River during the storm of December 1978.

3/ Loss estimates to the San Carlos Indian Reservation are not included because the damages were not a result of Gila River overflow.

Fig. 3. The effects of redistribution of top soil, and the destruction of prime agricultural land in the Gila flood plain.

Fig. 4. The destruction of hay crops and the erosion as results of November and December storms along the Gila River flood plain.

Fig. 5. One of several stacks of hay ruined near Solomon Crossing in Safford Valley, Arizona.

Fig. 6. Damage to the approach road at south abutment to the Cork-Eden bridge.

Fig. 7. Siltation and transport of top soil in Safford Valley.

Fig. 8. Soil erosion and siltation in Safford Valley.

Fig. 9. Transport and redeposition of top soil, Safford Valley

Fig. 10. Debris accumulation as a result of storm on Gila River, Safford Valley.

Clifton, Arizona

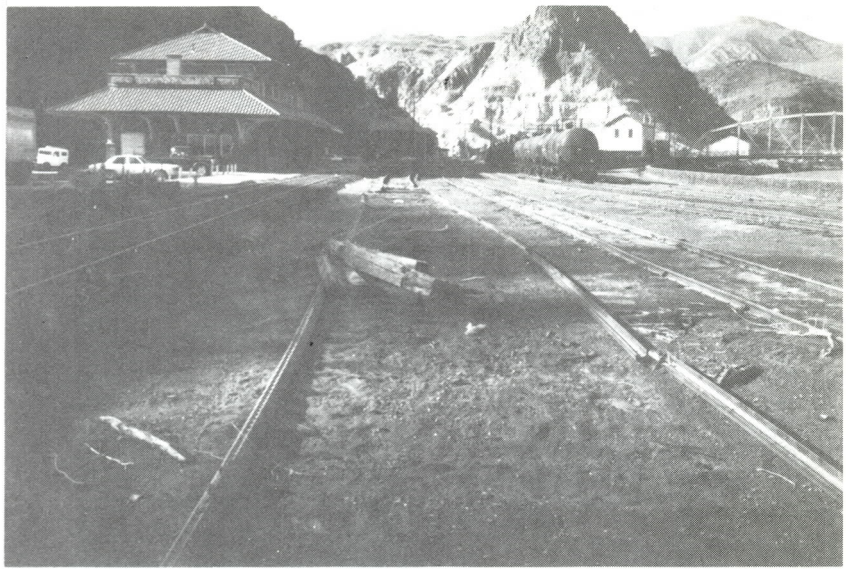


Fig. 11. Damage to railroad bed at Clifton Arizona as a result of storm of December 1978 along the Gila River.

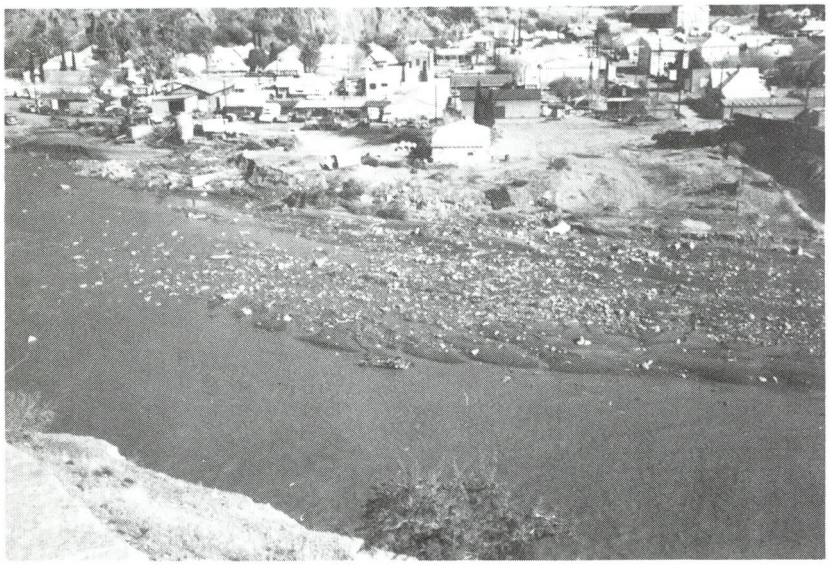


Fig. 12. View of storm damage in the city of Clifton Arizona along the Gila River.

(2) Southwestern New Mexico. Flood damage information for southwestern New Mexico was provided by the U.S. Army Corps of Engineers Albuquerque District Office. The information was gathered with respect to PL-84-99 guidelines. The damage data is supplemented by field surveys conducted by personnel from the Federal Disaster Assistance Administration and interviews with county officials.

Flood damages in New Mexico resulted from overflow of the Gila and San Francisco Rivers. Overflow from the Gila River occurred in the Cliff-Gila Valley, the New Mexico portion of the Duncan Valley near Virden, and the Red Rock Valley. Along the San Francisco River damages occurred near the towns of Reserve, Alma, Pleasanton, and Glenwood.

(a) Gila River Overflow. The National Weather Service in Albuquerque, New Mexico, reported 2 inches of rainfall on the Gila River watershed during the three-day period from December 17 through December 19, 1978. Heavy runoff was caused by a combination of warm air and rain originating from the Pacific falling on 10 inches of snow in the higher elevations of the watershed. The high flows of the Gila River severely damaged the privately constructed levee systems built around the New Mexico portion of the Gila River. The levees were designed as flood control structures to protect agricultural property. The majority of Gila River damages, at $2.7 million took place in the Cliff-Gila Valley, followed in magnitude by the Virden Valley at almost $1.3 million, and the Red Rock Valley at $984,000.

Cliff and Gila are small farming communities located in the mountainous valleys of the Gila River watershed. Cliff is the largest community in the area with an estimated population of 3,500. The principle losses in the valley occurred in the agricultural sector. Over 1,500 acres of alfalfa, barley, oats and pasture land were damaged. The floods devastated levees constructed on agricultural property. Residential property and public roads and bridges also sustained damages. Residents were greatly inconvenienced as floodwaters damaged primary transportation networks, electricity and telephone lines.

The Virden Valley is located in Hidalgo County, New Mexico near the New Mexico/Arizona border. The valley contains many acres of premium agricultural land. The dominant crop in the valley is cotton. Over 1,200 acres of crop land were flooded. The flooding resulted from runoff from the Gila Wilderness area east of the valley.

Red Rock, New Mexico is located north of Lordsburg on Highway 464. Flood damages were primarily agricultural, however, damages to the public and industrial sectors were reported. The Game and Fish Hatchery near Red Rock sustained public damages in excess of $131,000 to hatchery spoil banks. Also reported as damaged was the TS 185 road system.

(b) San Francisco River Overflow. Flooding of the San Francisco River resulted as 2 inches of rain fell on the San Francisco watershed December 17-19, 1978. The Alma, Glenwood, and Pleasanton areas sustained the greatest amount of damages on the New Mexico portion of the San Francisco River and are estimated at nearly $3.2 million. The majority of damages occurred in the agricultural sector. Characteristic of damages were destroyed levees, damaged irrigation systems, land erosion and silt deposits. Some minor damages were also reported for residential, commercial, and public property. Damages to public roads and bridges caused great inconvenience to local motorists and residents.

The second greatest amount of damages on the San Francisco watershed in New Mexico occurred in Reserve which is located 32 miles north of Alma along state Highway 12. Damages to ten acres of agricultural pasture land and one levee system were reported. Nineteen residences and one commercial establishment also suffered flood damages. The fairgrounds and Forest Service in Reserve at $19,000 accounts for most public damages other than roads and bridges. Flood damages totalled $29,000 for this area.

(3) Duncan/York Valley. The Arizona portion of the Duncan Valley stretches from the New Mexico state line downstream of the Gila River to a point approximately 20 miles northwest of Duncan. The York Valley is a 5 mile appendage on the downstream end of the Duncan Valley. The upstream portion of the Valley extends seven miles eastward from the Arizona line into New Mexico.

The community of Duncan suffered the single greatest amount of damages in the Duncan/York Valley region, with damages for the community alone estimated at $3.51 million. The remaining $1.65 million in damages can be explained by losses to agricultural property in the Duncan and York Valleys.

Disaster in Duncan began as waters from the rising Gila River spilled over the two mile long dike on the town's northeast side early December 20th. The weight of the water and debris forced large openings in the dike, sending a wall of silt and water throughout the community. Floodwaters destroyed residents' homes and businesses. Also damaged were many public facilities, including the town's water treatment plant.

State and local organizations pooled together to provide disaster relief to the flood-stricken community. Five helicopters and a number of trucks transported Arizona National Guard troops into Duncan with water, food, clothing and medical supplies. The American Red Cross established an emergency shelter which provided food for 350 persons and shelter for 45 residents. Some community members who were lucky enough to escape floodwaters offered their homes and assistance to flood victims. A spokesperson for the Greenlee County Health Department said that rescuers were using boats, helicopters and 4-wheel drive vehicles to get persons out of the flood stricken area.

Most damage to residences in the Duncan/York Valley region occurred in the town of Duncan, where damages were reported at $1.5 million. Other residential damages of $195,000 occurred to farm structures in the Duncan and York Valleys. In Duncan, floodwater depths averaged 2-1/2 feet outside and 1 foot inside most units; however, inside and outside water depths of 6 feet were reported for homes near Railroad Avenue. Characteristics of residential damages were buckled floor boards, peeled tiles, water soaked walls, chipped paint, and destroyed carpet, furnishings and valuables. Approximately 75 homes were totally destroyed by floodwaters. The magnitude of damage to personal belongings and contents could have been reduced had residents heeded flood warnings. Residents had 18 hours warning prior to the flood to take emergency precaution. The majority apparently felt, however, that since two "50 year" flood disasters had just occurred within the past year, another major flood was unlikely. Many failed to move household contents and valuables to higher ground.

Even though the majority of residents did not engage in emergency preparation work, most evacuated their homes upon notice of imminent flood disaster. Approximately 400 persons received food and/or shelter assistance. The evacuation situation was intensified as outbreaks of measles, cold and flu occurred in the temporary assistance shelters. Also worsening the situation was the cold, damp weather and the proximity of the disaster to the holiday season.

Immediately following the flood, 250 persons were provided with temporary housing. Seventy-two families were still living in temporary housing provided by HUD up to six months after the flood. Nineteen families have moved away from flood prone Duncan since December.

Residents of Duncan experienced severe flooding in March 1978 and October 1972. After experiencing perhaps the worst flood in the town's history in December 1978, community members are growing weary of flood fighting. Relocation of portions of the community from the flood plain, reconstruction of the dike, or rechannelization of the river are three measures being considered as mitigation against flood hazards.

Damage to agricultural property at $1.65 million accounted for the second greatest economic loss in the Duncan/York Valley region. Damages to cotton, milo, alfalfa and pasture land were reported. Over 4,100 agricultural acres were damaged. In addition to crop damages, 50 head of cattle and 20 hogs were lost. Damages of $.5 million to fences, cement ditches, land and property improvements were also reported. Much of the loss to agricultural land was a result of extensive erosion or heavy siltation. Thousands of acres of rich farm land were washed away. In instances where erosion occurred, the land can never be replaced, as it is now part of the new river channel.

All damage to commercial property in the Duncan/York Valleys occurred in the town of Duncan. The dike bordering the Gila River broke near the downtown district, sending bursts of floodwaters throughout the main business area. Businesses were closed approximately 3 to 6 weeks for clean-up and reparation work. Total damage to commercial property is estimated at $954,000, of this amount, $63,000 was reported as income losses. The income losses are most likely understated because the entire local economy was at a virtual standstill.

Many of the businesses that experienced flood damage in December 1978 were also hit in the February-March flood of 1978, and in the October 1972 flood. Although the present downtown location is subject to the most extreme flood hazards, shop owners are dependent on the major thoroughfare, State Route 70, for business. Relocation has been discussed as a flood mitigation measure for Duncan's commercial district, but the extent to which businesses depend on Highway 70 traffic further complicates the already complex issue of relocation.

Shop owners are caught in a bind. If relocation occurs, much of the business from travelers will be lost, but if nothing is done to reduce flood hazards, the businesses will be operating under the constant threat of inundation.

Damages in the public sector in the Duncan/York Valleys totalled $820,000 of which $70,000 was to public roads and bridges. All transportation networks into and out of the city were rendered impassable after the dike gave way Wednesday, December 20. Other public damages included losses to Duncan's city hall, library, fire house, and dike. Damages to Duncan's General Utilities, Inc. and Valley Electric Cooperative totalled $7,000 and $21,000, respectively. Although newspaper accounts reported the community went without gas, electricity, and water for a number of days, the mayor of Duncan assures that this is not the case.

(4) Blue River Region. The Blue River region is located in the Apache National Forest, Greenlee County, Arizona. The region is primarily Forest Service land; however, the tiny community of Blue, Arizona is within the region.

Widespread flooding occurred as rain and snowmelt triggered a flow in excess of 40,000 cfs on the Blue River. This marks the highest cfs flow recorded since 1941-42, when 30,000 cfs was documented. Other previous highs were in October 1972 at 22,000 cfs, March 1978 at 14,000 cfs, and November 1978 at 20,000 cfs.[4/]

[4/] Detailed estimates separating the damages from the November and December floods were not available; hence estimates provided in this report represent those occurring in November and December 1978. Because the cfs flow in December was double the November flow, it was assumed the majority of the damage resulted from the December flood.

Flood damages in the Blue River region were confined to the public and agricultural sectors. The majority of public damages, nearly $5 million dollars, was to roads, as the Blue River destroyed 35 miles of the 281 road system. Two hundred thousand dollars were spent in emergency road repair work. It is estimated an additional $4.8 million will be necessary for permanent road repairs. Damage began at the headwaters of the Blue and paralleled the river downstream for 35 miles. Other public losses occurred in the community of Blue, where local officials filed Damage Survey Report forms with the Federal Disaster Assistance Administration in the amount of $49,000. A more detailed explanation of damages was not available.

Agricultural damages in the region were minor. The Greenlee County Agricultural Stabilization and Conservation Service office received 8 applications for loans to repair flood damaged property totalling to $32,500.

Fig.13. Residential damage in the community of Duncan Arizona. The area borders the Gila River.

Fig.14. Expanded view of residential damage in the community of Duncan Arizona.

Fig. 15. Debris distribution, siltation and flooding in the city of Duncan Ariz. Electric Cooperative, Inc. Note-- water marks of front of building.

Fig. 16. Erosion, siltation, immersion and general flood damage in the Duncan/York valley area. Note-- car in foreground, nearly submerged in flood waters.

Fig. 17. Inundation of Duncan High School playing field, sltation and redefinition of natural water course along boundary lines of school property.

Fig. 18. Inundation of the Richins and Son commercial building in the city of Duncan, Arizona.

Fig. 19. Inundation of other commercial buildings in downtown Duncan, Ariz. Note--National guard assistance in flood emergency.

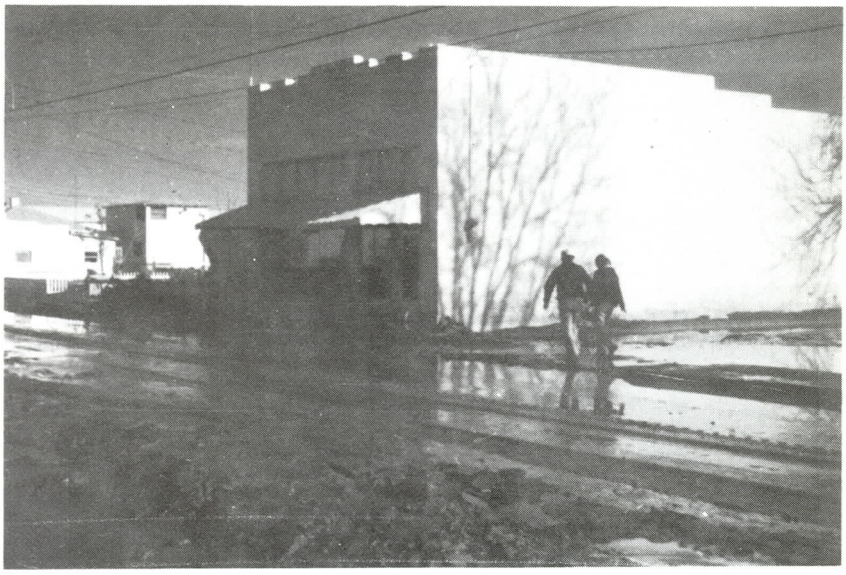


Fig. 20. View of results of flooding and its effect on the Post office at Duncan Ariz.

Fig. 21. The effects of flooding on the local stock and feed building located on the main highway in Duncan, Ariz.

Fig. 22. Cleanup operation near Duncan branch of Arizona National Bank in Duncan Arizona.

There were losses to 300 acres of property, 4 miles of fencing, and 4 private irrigation systems reported. Damage due to water-borne trees, sand and silt characterize property damage. Minor land erosion was also reported.

(5) Clifton. Flood damages from the San Francisco River inside Arizona were concentrated in the community of Clifton, 30 miles north of Duncan. This mining community, with an estimated population of 5,100 stretches along the banks of the river, crowded into the narrow flood plain by steep cliffs on either side.

The community experienced flooding in November and December of 1978 as well as extensive damages in a flood that occurred October 18-21, 1972. The November 1978 flood scoured the river channel, facilitating accommodations of a higher flow in December 1978. Officials feel that had the November flood not occurred, losses from the flood in December would have been much greater.

Damages in Clifton took place in the commercial, public and residential sectors. Commercial land use received the majority of damages, followed in magnitude by public and residential sectors. Commercial losses totaled $1 million, which is 56 percent of the total Clifton flood damages. Approximately 22 businesses experienced flooding. The majority of the establishments border the San Francisco River to the east and west. Income losses to all establishments totaled $38,000, with the largest losses suffered by enterprises such as liquor stores, bars, and clothing stores where trade is markedly increased during the holiday season. The bulk of physical damage, by contrast, occurred at the Coronado Lodge and El Ranchito Manufacturing Company. Buckled floor boards and minor water soaking of carpet and contents typify physical damages to the other commercial establishments.

Damages to public facilities totaled $914,000, of which $319,000 was permanent reparation work to roads, bridges, and street drains. Emergency street repair and water removal conducted by the Fire, Police, and Street Departments totaled $17,000. The Phelps-Dodge Corporation provided trucks and person-power to aid in the emergency work. The greatest amount of public damage other than to roads and bridges was to sewers, utilities and the Southern Pacific Railroad. Eight hundred linear feet of 14 inch diameter sewer main was washed away. In addition, 300 feet of sewer line had to be cleared in South Clifton, and 600 feet of line in North Clifton. Losses to utilities of $77,000 were due to power pole and line damages, while the Southern Pacific Railroad received damage to rails, cars, and stockpiled materials.

Damages to residential units of $79,000 were minor compared to damages of $384,000 which occurred in the flood in October 1972. Three areas of town were affected by December's floodwaters. The areas were River Street, Patterson's Addition, and an area adjacent to Patterson's Addition on the east side of the San Francisco River. About twenty homes were flooded, with the average damage per household estimated at $3,800. Although only a small portion of the total units were directly hit by

floodwaters, more than 30 percent of the residents were affected, as evacuation took place in response to flood warnings. Evacuees stayed at the high school, Elks Club, Catholic church, or with relatives and friends.

A number of flood control alternatives for Clifton were studied in 1975 by the U.S. Army Corps of Engineers. Alternatives included construction of:

- o a dam on the San Francisco River;
- o a floodwall along the San Francisco River;
- o 20 floodgates at various levels in town;
- o flood warning devices on the San Francisco and Blue Rivers; or
- o the relocation of the community.

At present, no flood mitigation alternative has been selected.

(6) Gila Bend. Gila Bend, population 2,400, is located 64 miles southwest of Phoenix. The area, at 737 feet above sea level is characterized by mild winters and hot summers. Although December's floodwaters did not reach the urban area in Gila Bend, agricultural property near Gila Bend sustained $227,000 in damage. Damaged irrigation ditches, fences, equipment, wells, and pumps were reported. Destruction of crops accounted for 51 percent of all losses. Crops were fully matured at the time of flooding and had, for the most part, been picked once. In many instances, future crop revenues will also be lost because the extreme property damage makes it impossible to prepare fields for the upcoming growing season. A summary of flood damages of agricultural areas near Gila Bend is provided with all flood damages in Table 4.

B. Little Colorado River Basin-Winslow. Heavy rains on a snow-packed watershed caused floods throughout the Little Colorado River Basin. Particularly hard hit were the Navajo Indian Reservation and the city of Winslow. Two earthen dams on the Reservation collapsed, isolating 39 families without food, fuel, and vital suppplies.[5/] The urban area of Winslow suffered the most extensive monetary losses.

5/ Estimates of the cost of flood damages on the Navajo Indian Reservation were not available.

Winslow is a community of approximately 8,000 persons and encompasses an area of 9.1 square miles. The city, at an elevation of 4,880 feet, experiences cold winters and snowfall, and warm summers. Flooding in December 1978 occurred as waters spilled over and eroded through one of two dikes bordering the Little Colorado River.

Flood damages were confined to residential and public sectors. The residential flood damages occurred in the Winslow Plaza subdivision. The subdivision is located in southeastern Winslow. Most homes are from 5 to 10 years old and are valued at about $50,000. Households in the subdivision suffered water soaking and silt deposits in yards, as well as some interior damage. Damages averaged $2,300 per household, for a total of $136,000. No flood damage estimates are provided for the Bushman and Ames Acres subdivisions which are located outside the Winslow city limits. Units in these two subdivisions are from 30 to 40 years old and are valued at $17,000. Water marks 5 feet high could be seen on some houses.

Damages to the public sector totaled $178,000. Of this, $20,000 were costs incurred for emergency roadway or silt and water removal in residential areas. Also included in emergency costs were $2,400 expended for emergency evacuations. Approximately 1,700 people were evacuated from the Ames Acres, Bushman Acres, and Winslow Plaza subdivisions. Evacuees stayed in private households, churches, or local motels. Patients in the Winslow Hospital were evacuated to the higher elevated Indian Health Service Hospital. No additional illness was reported, even though persons fled their homes quickly on a cold and wet December evening. The city park and sewage treatment plant access road in Winslow sustained minor public damages. Also requiring attention was a log jam on Clear Creek Reservoir. The log jam, in combination with heavy runoff, caused waters to spill over the top of the retaining dam. Luckily, the integrity of the structure remained intact and the precipitation stopped; alleviating the potential for disaster. Local officials feel that had the dam given way, the entire city of Winslow would have been flooded. Flood damages occurring in the Little Colorado River Basin (Winslow) are summarized in Table 5.

C. Cataract Creek Runoff Area - Williams. Rainfall and mild temperatures melted snow to the 10,000 foot level causing heavy runoff in the Bill Williams Mountain Watershed area and flooding of Cataract Creek in Williams, Arizona.

The town of Williams, located in northern Arizona, sustained minor flood damages as a result of overflow of Cataract Creek. However, community residents were close to disaster when water and ice spilled from a large crack and sag in the center of 1 of 4 retaining dams constructed at the base of Bill Williams Mountain. In response to these conditions, approximately 100 families and downtown businesses were evacuated. The U.S. Army Corps of Engineers and local persons bulldozed mounds of earth

to repair the breach in the dam. Fortunately, no major disaster occurred. According to local officials the dam will be torn down because it fails to meet federal standards.

Damages in Williams occurred in the public, residential and commercial sectors. Nearly 44 percent of the public damages were to streets and roads. Roads were damaged as clogged culverts and heavy creek runoff made it necessary for street crews to break open crossings, thereby facilitating waterflow through the creek channel.

One death nearly occurred as a 10-year-old girl was swept into the creek. The town manager and mayor witnessed the incident and ran to catch the little girl. They caught her by the jacket and held on briefly in neck high waters. The young girl's jacket slipped off, and she went tumbling down the creek. Three blocks downstream 3 police officers caught the child, and hung on until relief was provided. The girl was taken to Williams Hospital and pronounced to be in good condition. Miraculously, no serious harm had come to her, even though her trip down the creek included passage through four 60-foot long culverts.

Other public damages to the community swimming pool, ball park, and sewage treatment system totaled $39,000.

Approximately 84 of the residential units sustained damage. Destruction resulted primarily from overflow of Cataract Creek; however, damages also occurred as the clogged culverts and creek channel restricted the flow of water, causing backed up water to spill onto residential property. The most serious flooding took place between 5th and 6th Streets from McPherson to Grant Avenues. Also sustaining damages were units in northwestern Williams between 2nd and 5th Streets from Edison to Morse Avenues.

Almost every home in these two areas suffered water damage to yards; however, floodwaters entered only two units. Commercial losses, by contrast, were minor in Williams. Damage occurred to establishments located on Bill Williams Avenue between 2nd and 5th Streets. Most losses were due to business closing rather than to water seepage. Total commercial losses were estimated at $2,000. Damages resulting from the December 1978 flood in the Cataract Creek Runoff Area (Williams) are summarized on Table 6.

TABLE 4
GILA RIVER BASIN
FLOOD DAMAGES 16-20 DECEMBER 1978
(1000's)

Safford Valley:

Land Use	Physical Damages	Income Losses	Emergency Costs	Total
Agricultural	$ 14,652	$ 332	$ --	$ 14,984
Residential	513	--	--	513
Commercial	1	36	--	37
Industrial:				
Sand & Gravel	--	--	--	--
Other	--	--	--	--
Public:				
Roads & Bridges	1,532	--	148	1,680
Other	863	--	9	872
TOTAL	$ 17,561	$ 368	$ 157	$ 18,086

Southwestern New Mexico:

Agricultural	$ 7,945	$ --	$ --	$ 7,945
Residential	81	--	--	81
Commercial	40	--	--	40
Industrial:				
Sand & Gravel	--	--	--	--
Other	10	--	--	10
Public:				
Roads & Bridges	91	--	25	116
Other	238	--	19	257
TOTAL	$ 8,405	$	$ 44	$ 8,449

TABLE 4 (Continued)

Duncan/York Valleys:

Land Use	Physical Damages	Income Losses	Emergency Costs	Total
Agricultural	$ 1,604	$ 54	$ --	$ 1,658
Residential	1,730	--	3	1,733
Commercial	890	63	1	954
Industrial:				
Sand & Gravel	--	--	--	--
Other	--	--	--	--
Public:				
Roads & Bridges	68	--	2	70
Other	715	--	35	750
TOTAL	$ 5,007	$ 117	$ 41	$ 5,165

Blue River Region:

Agricultural	$ 33	$ --	$ --	$ 33
Residential	--	--	--	--
Commercial				
Industrial:				
Sand & Gravel	--	--	--	--
Other	--	--	--	--
Public:				
Roads & Bridges	4,800	--	200	5,000
Other[a]	49	--	--	49
TOTAL	$ 4,882	$ --	$ 200	$ 5,082

[a] As reported to FDAA, no funds rewarded as of 7/1/79

TABLE 4 (Continued)

Clifton:

Land Use	Physical Damages	Income Losses	Emergency Costs	Total
Agricultural	$ --	$ --	$ --	$ --
Residential	89	*	*	89
Commercial	1,104	38	--	1,142
Industrial:				
Sand & Gravel	--	--	--	--
Other	--	--	--	--
Public:				
Roads & Bridges	177	--	9	186
Other	577	--	15	592
TOTAL	$ 1,947	$ 38	$ 24	$ 2,009

Gila Bend:

Agricultural	$ 516	$ 61	$ --	$ 577
Residential	6	--	--	6
Commercial	--	--	--	--
Industrial:				
Sand & Gravel	--	--	--	--
Other				
Public:				
Roads & Bridges	--	--	--	--
Other	--	--	--	--
TOTAL	$ 522	$ 61	$ --	$ 583

* amount below $500

TABLE 5

LITTLE COLORADO RIVER BASIN
FLOOD DAMAGES 16-20 December 1978
(1000's)

Winslow:

Land Use	Physical Damages	Income Losses	Emergency Costs	Total
Agricultural	$ --	$ --	$ --	$ --
Residential	148	*	1	149
Commercial	--	--	--	--
Industrial:				
Sand & Gravel	--	--	--	--
Other	--	--	--	--
Public:				
Roads & Bridges	3	--	3	6
Other	155	--	17	172
TOTAL	$ 306	$ *	$ 21	$ 327

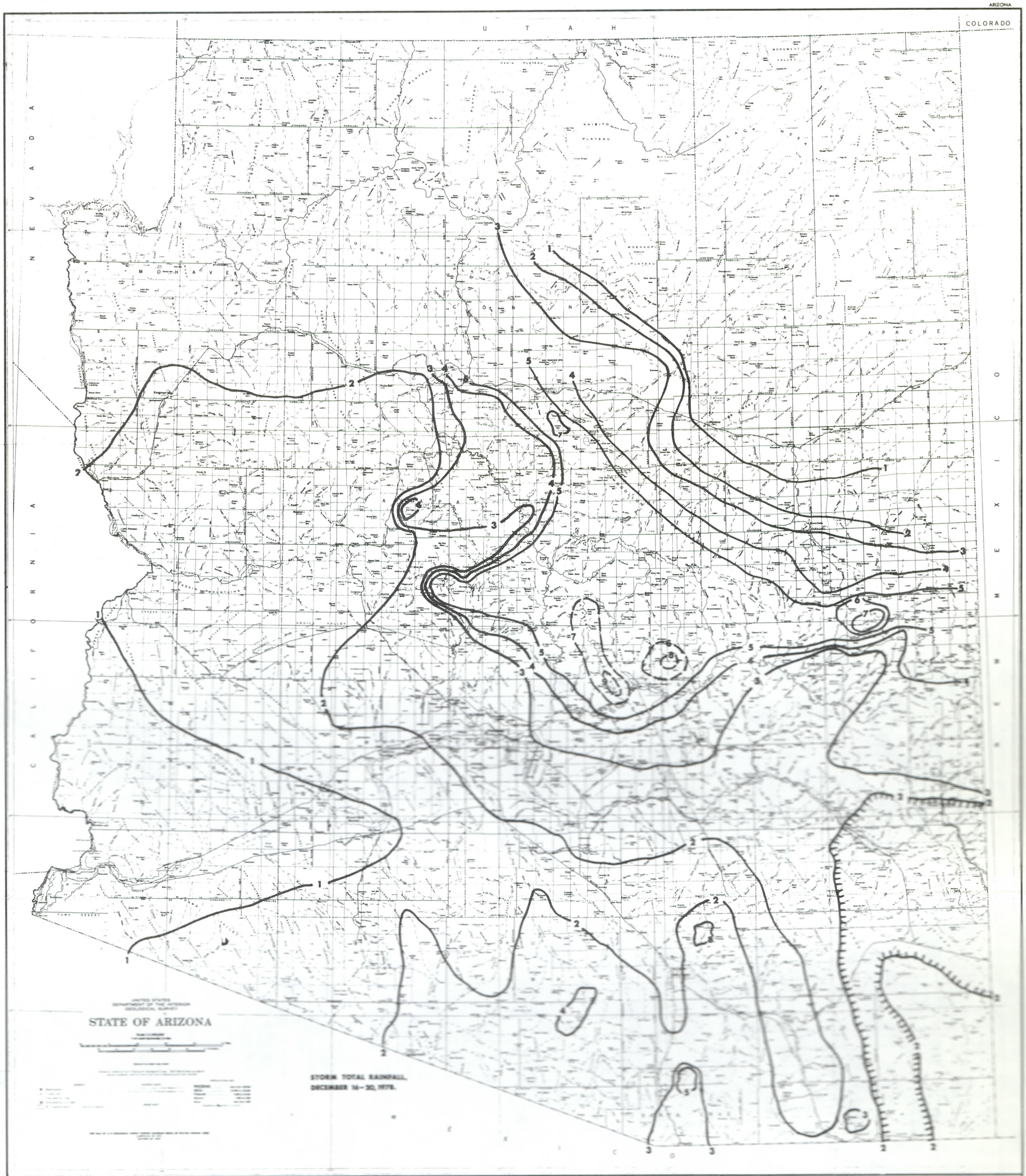
* amount below $500

TABLE 6
CATARACT CREEK RUNOFF AREA
FLOOD DAMAGES 16-20 DECEMBER 1978
(1000's)

Williams:

Land Use	Physical Damages	Income Losses	Emergency Costs	Total
Agricultural	$ --	$ --	$ --	$ --
Residential	17	--	*	17
Commercial	2	*	--	2
Industrial:				
Sand & Gravel	--	--	--	--
Other	--	--	--	--
Public:				
Roads & Bridges	66	--	--	66
Other	39	25	--	64
TOTAL	$ 124	$ 25	$ *	$ 149

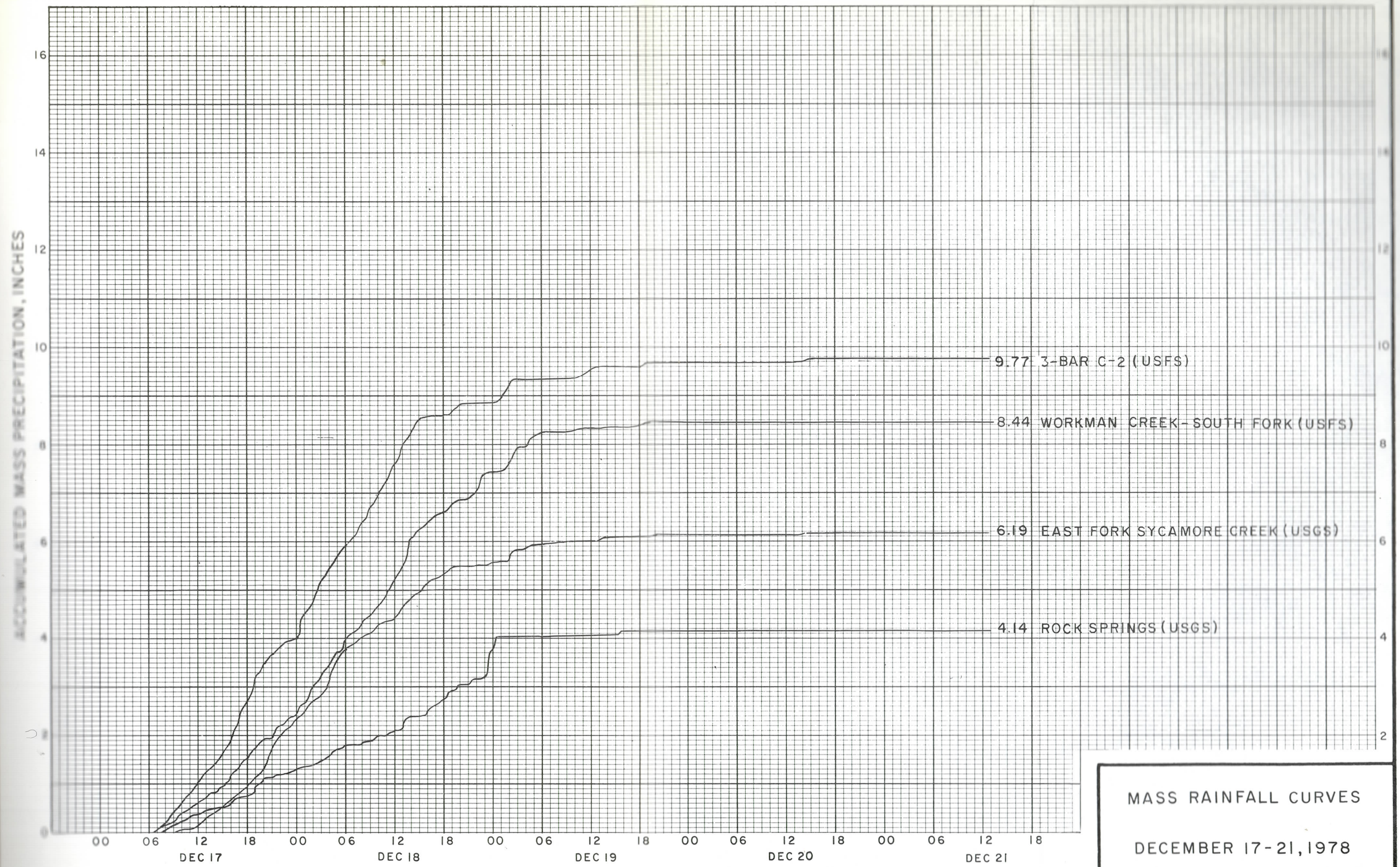
* amount below $500



This plate was reproduced and modified, with permission of the National Weather Service, from Figure 2 of the "Report on the Arizona Floods of December 16-20, 1978," by U. S. Dept. of Commerce, NOAA, National Weather Service, May 18, 1979. The modifications are denoted here as dashed isohyets which have been added in the Mazatzal and Sierra Ancha Mountains northeast of Phoenix on the basis of unpublished U. S. Forest Service and U. S. Geological Survey precipitation data which were not available at the time that the original National Weather Service map was prepared.

ISOHYETAL MAP

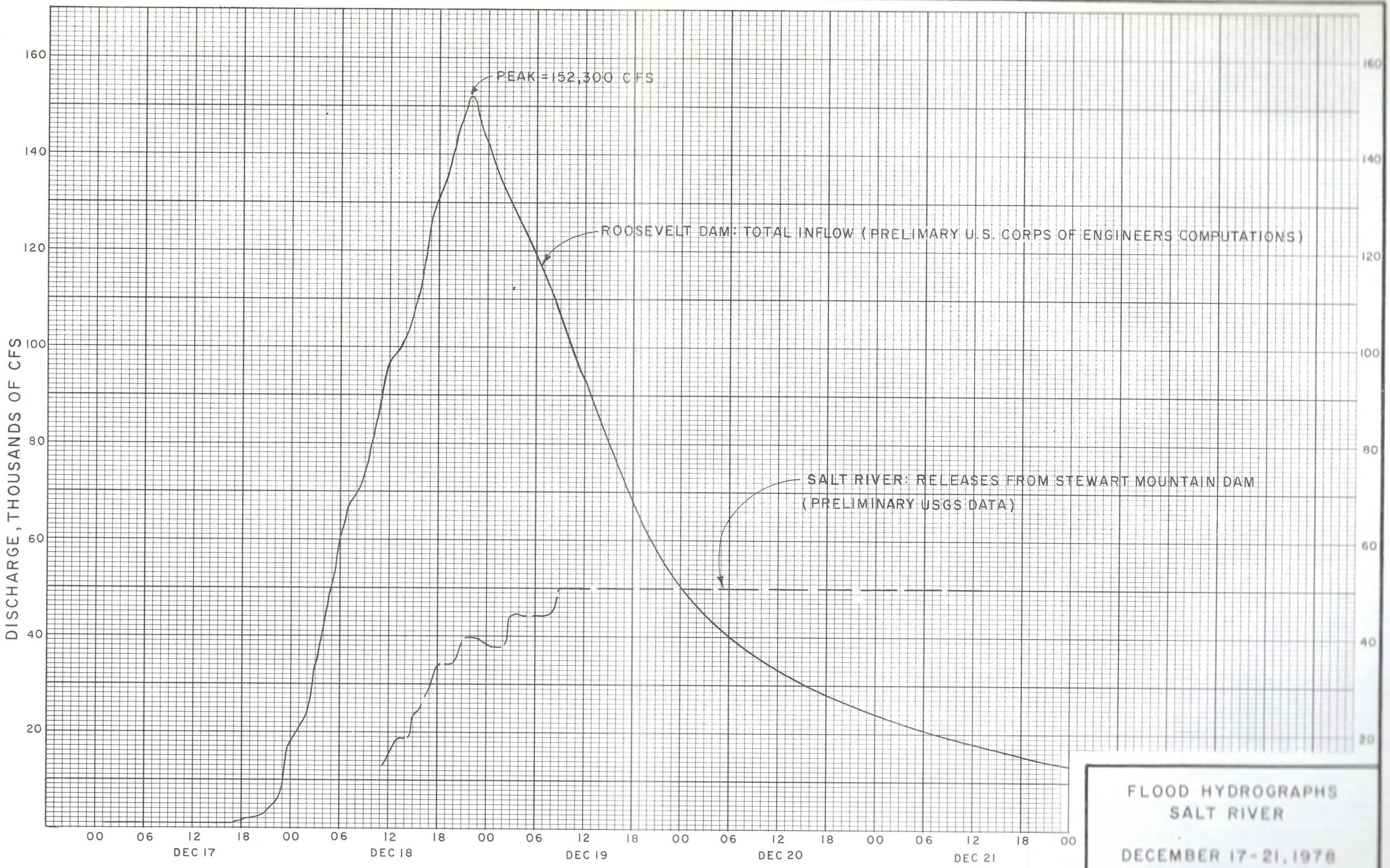
STORM TOTAL RAINFALL
DECEMBER 16-20, 1978



MASS RAINFALL CURVES

DECEMBER 17-21, 1978

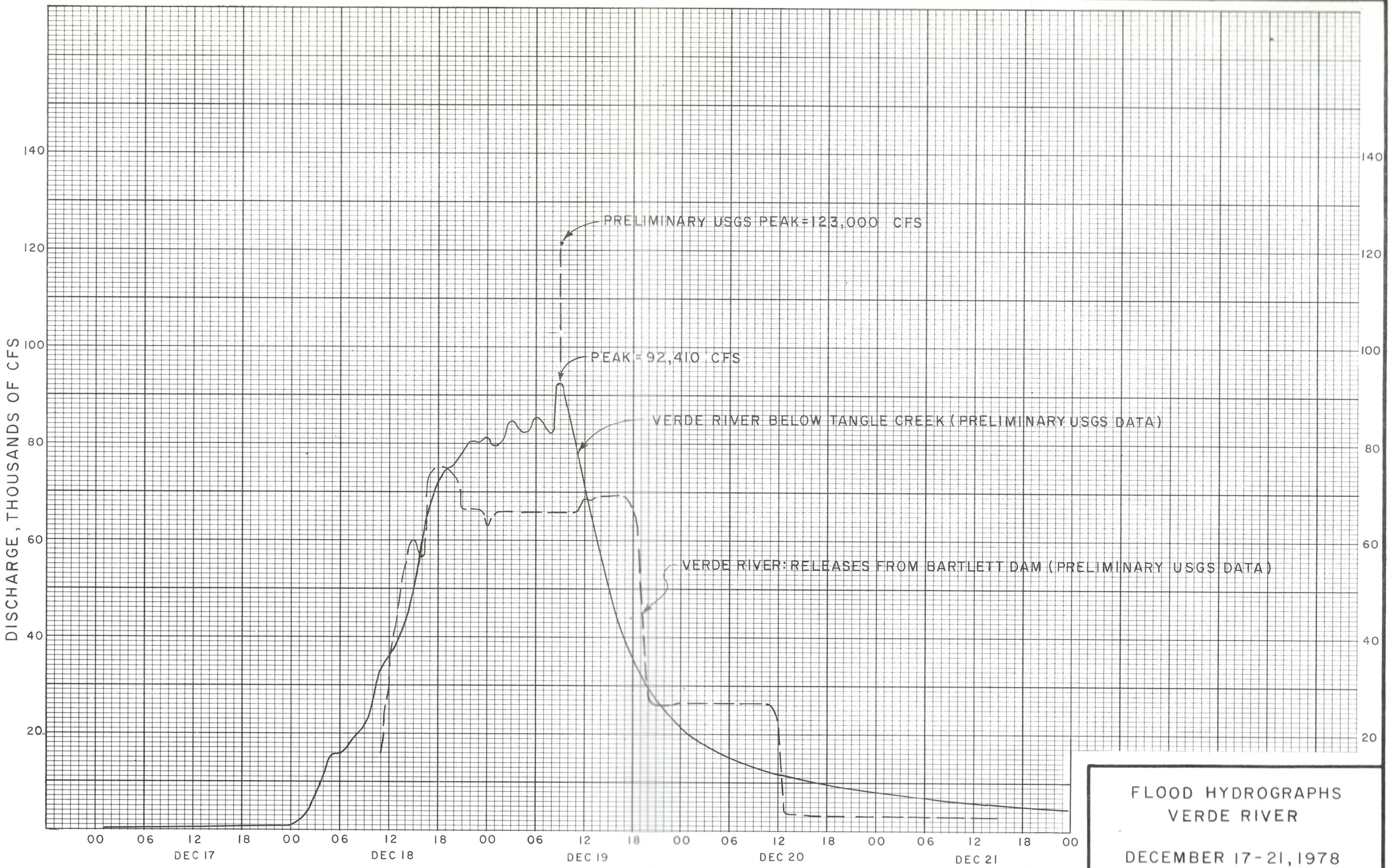
U. S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS



FLOOD HYDROGRAPHS
SALT RIVER

DECEMBER 17-21, 1978

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



FLOOD HYDROGRAPHS
VERDE RIVER

DECEMBER 17-21, 1978

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

GILA
FLOW
N
SAFFORD
U.S. 70
FLOODED AREA

GILA RIVER BASIN ABOVE
SAN CARLOS RESERVOIR
ARIZONA AND NEW MEXICO

STORM AND FLOOD OF DEC. 1978
FLOODED AREA

SAFFORD, ARIZONA
GILA RIVER

SCALE AS SHOWN SHEET 1 OF 1

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