FLOODS IN CENTRAL, SOUTHWEST OKLAHOMA

OCTOBER 17-23, 1983

By Leland D. Hauth

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GEOLOGICAL SURVEY
Dallas L. Peck, Director

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Conversion of Inch-Pound Units to International System of Units (SI)

All units of measure used in this report are inch-pound units. The following factors may be used to convert inch-pound units to the International System of Units (SI).

Multiply inch-pound units	By	To obtain SI units
inches (in)	25.4	millimeter (mm)
feet (ft)	0.3048	meter (m)
miles (mi)	1.609	kilometer (km)
square miles (mi^2)	2.590	square kilometer (km^2)
acre-feet (acre-ft)	1,233	cubic meter (m^3)
acre-feet (acre-ft)	1.233 X 10^{-3}	cubic hectometer (hm^3)
cubic feet per second (ft^3/s)	0.02832	cubic meters per second (m^3/s)
gallons (gal)	3.785 X 10^{-3}	cubic meter (m^3)

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".

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ABSTRACT

Storms of October 17-23, 1984 produced as much as 17 inches of rain as a result of Hurricane Tico. Rainfall amounts exceeded the 100-year, 24-hour storm frequency in some areas of the central and southwest parts of Oklahoma. An 11-county area experienced flooding with damages exceeding $12 million. Peak discharges were determined during and after the flood at U.S. Geological Survey gaging stations and one miscellaneous location. Streamflow in some areas exceeded the estimated 100-year flood. Flood hydrographs and rainfall mass curves are presented for gaging stations located in areas of greater precipitation.

INTRODUCTION

Outstanding floods along many major streams occurred in Oklahoma during October 17-23, 1983, as a result of the remnants of hurricane Tico. Storms moving across the State from southwest to northeast during the seven-day period produced from 10 to 17 inches of rainfall in the area. The area flooded includes many of the same counties designated as a drought area by Presidential declaration just prior to the flooding.

Record stages were recorded and flood discharges exceeding the 100-year flood were experienced at some locations. Direct measurements of discharge were made at many sites during the flood to establish the stage-discharge relation or to verify a previously defined relation. Where possible, U.S. Geological Survey hydrologists made stream-flow measurements during flood peaks. Some gaging stations could not be reached following the flooding because of high water, requiring that peak flows be determined by indirect methods.

Purpose and Scope

This report has been prepared to provide peak stage and discharge information collected in Oklahoma during the floods of October 17-23, 1983.

Climatic data collected by the National Weather Service document the meteorological settings associated with the extreme amount and distribution of rainfall. Meteorological data presented in this report include storm-rainfall isohyetal maps and rainfall mass curves for selected locations within the area of flooding.

Streamflow data collected by the U.S. Geological Survey include rates of flow, peak stages and discharges. Analysis of these data includes discharge hydrographs and comparison of measured peak discharges to historic flooding. Elevations are referred to National Geodetic Vertical Datum (NGVD).

Acknowledgments

Total storm-rainfall isohyetal maps, daily rainfall totals and single storm event totals, rainfall mass curves at selected locations, and information on weather system movements were furnished by Eldon Beard of the Oklahoma City office of the National Weather Service.

Information on flood damages were obtained from the Federal Emergency Management Agency offices in Denton, Texas, the U.S. Small Business Administration, the U.S. Farm Home Administration, and the Flood Insurance Administration as reported to the Federal Emergency Management Agency of Denton, Texas. The photograph of Walnut Creek at Purcell was obtained from "The Purcell Register", Purcell, Oklahoma.

DESCRIPTION OF THE FLOOD AREA

The area affected by the October 17-23, 1983 flood included parts of north-central Texas and central and southwestern Oklahoma. This report, however, describes only that flooding which occurred in central and southwestern Oklahoma (fig. 1). Major flooding involved about one-fourth of the State and included the main stem of the Washita River, the Little Washita River, the Walnut Creek basin, the Cache Creek basin, the upper reaches of Little River, the lower reaches of the North Fork Red River, and Deep Fork.

Urban areas most affected by the flood waters within the area included Purcell, Oklahoma City, Guthrie, Chickasha, and Lawton.

Peak flows were determined at U.S. Geological Survey stream-gaging stations and document the extent of flooding both in areal coverage and magnitude. Figure 2 shows the location of stream-gaging stations used to define the extent of flooding.

WEATHER SYNOPSIS

A weak cold front moved into northwestern Oklahoma on Sunday, October 16 during a time when a low level trough moved across northwest Texas into Oklahoma during the nighttime hours between the 16th and 17th. These systems caused rain showers and thundershowers over much of the area with the precipitation ending in eastern portions of Oklahoma on the night of the 17th. The cold front then became stationary, extending from the Red River near south-central Oklahoma to southwestern Arkansas. Moisture continued to be fed northward from the Gulf of Mexico toward the frontal system while high level moisture was being brought in from the remains of the Pacific Ocean Hurricane "Tico". A series of minor low pressure troughs moved across the area during October 19-21 causing widespread rain with the heaviest amounts occurring on the 19th and 20th. As the remains of Hurricane Tico moved northeastward across Oklahoma, precipitation ended (Crawford 1983). The highest rainfall amounts were recorded at the U.S. Department of Agriculture Research Station near Rush Springs (17 inches) and Great Plains Apiaries near Chickasha, Oklahoma (over 14 inches) in the central and southwestern part of the State. Rainfall amounts and intensities are shown for these locations figure 3. Total storm rainfall is shown on the map of figure 4. Rainfall accumulations were recorded continuously at many locations in the flood area.

Based on rainfall-frequency relations developed by Hershfield (1961), the October 1983 rainfall exceeded the 100-year, 24-hour storm frequency (8.5 inches in 24 hours) near Rush Springs and equaled that frequency at the Great Plains Apiaries station. These stations are used here as an example of the overall storm intensities in the areas of greater precipitation depth.

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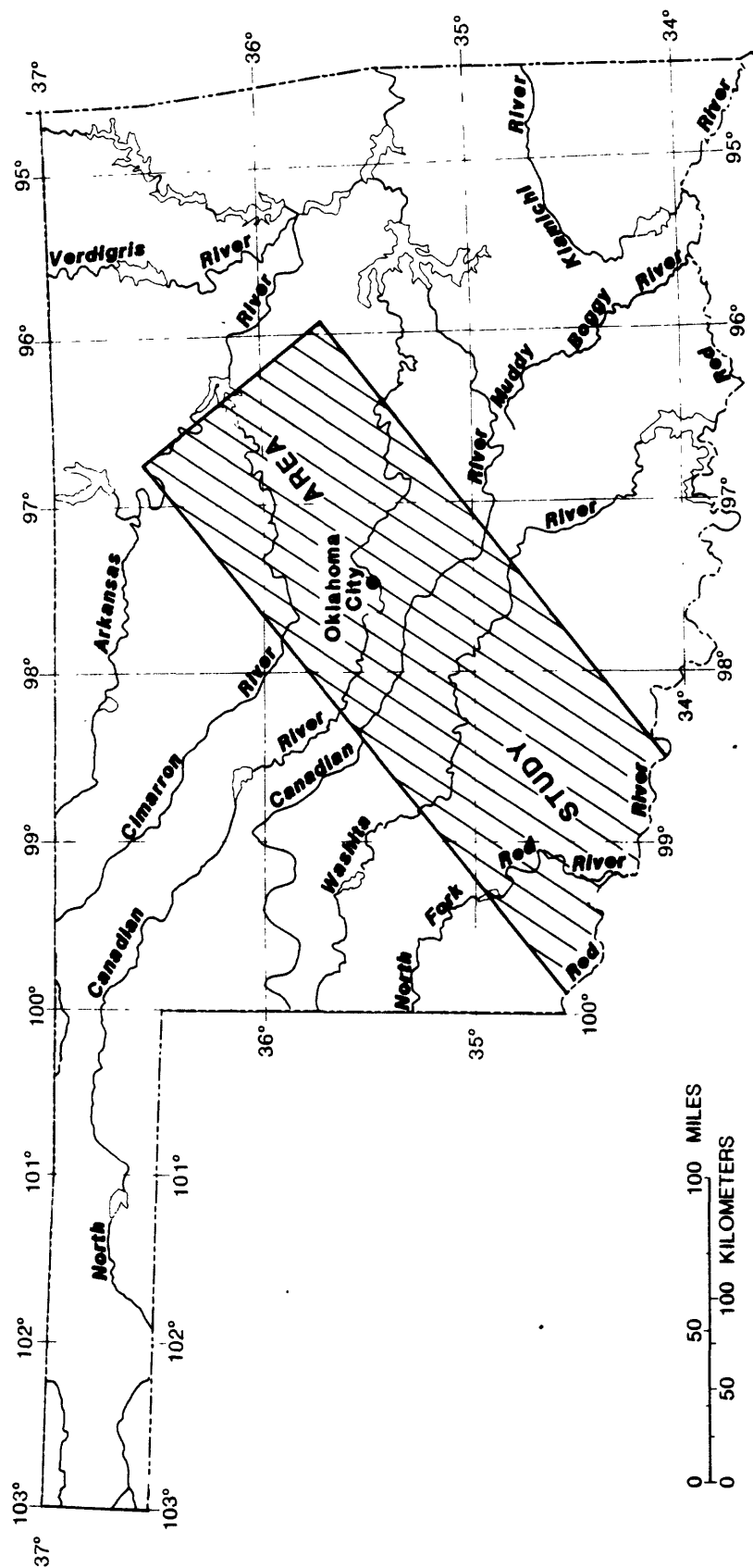
Figure 1.--Location of flooding in Oklahoma, October 17-23, 1983.

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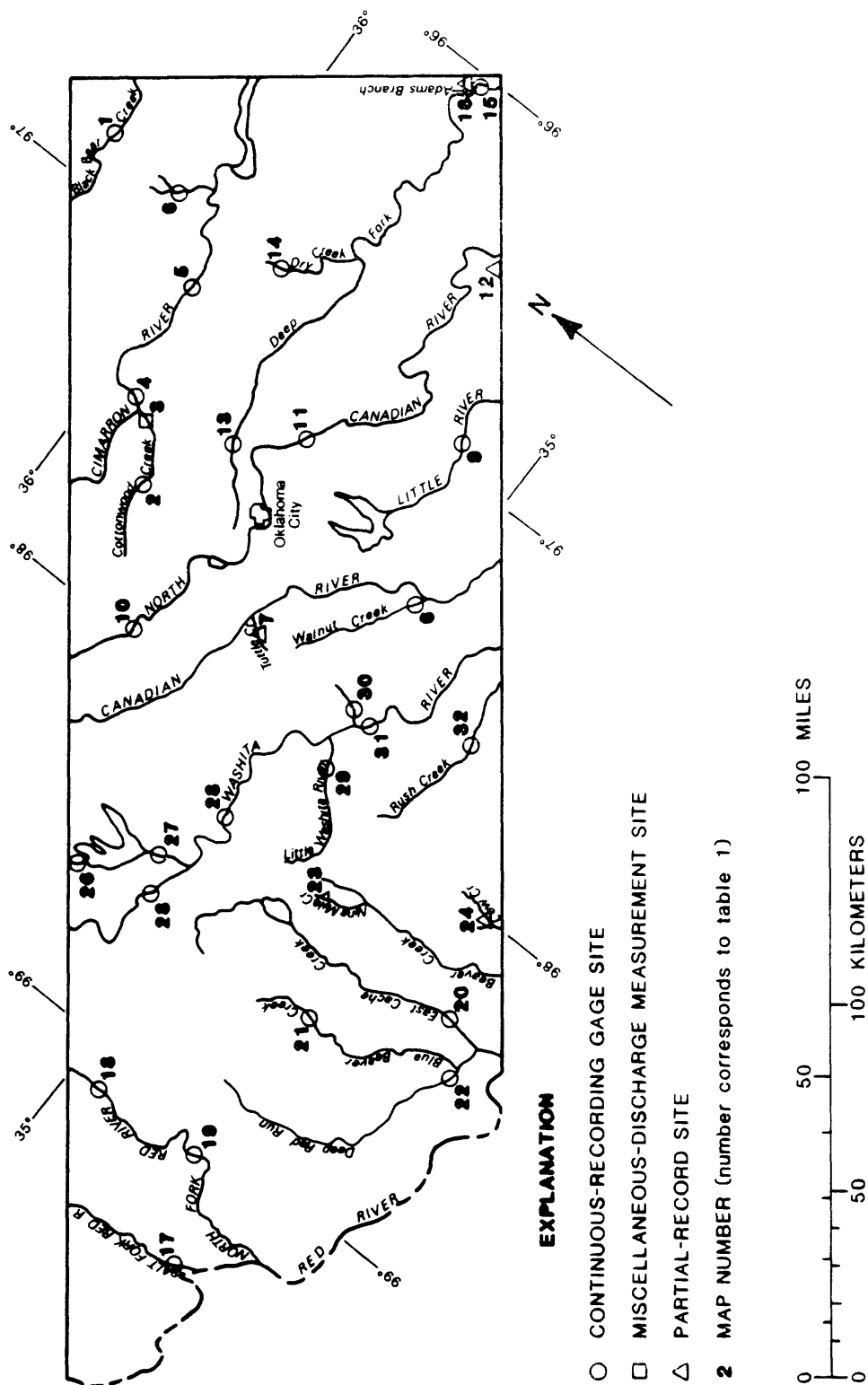
Figure 2.--Study area and location of flood-determination points.

EXPLANATION

○ CONTINUOUS-RECORDING GAGE SITE

□ MISCELLANEOUS-DISCHARGE MEASUREMENT SITE

△ PARTIAL-RECORD SITE

2 MAP NUMBER (number corresponds to table 1)

5
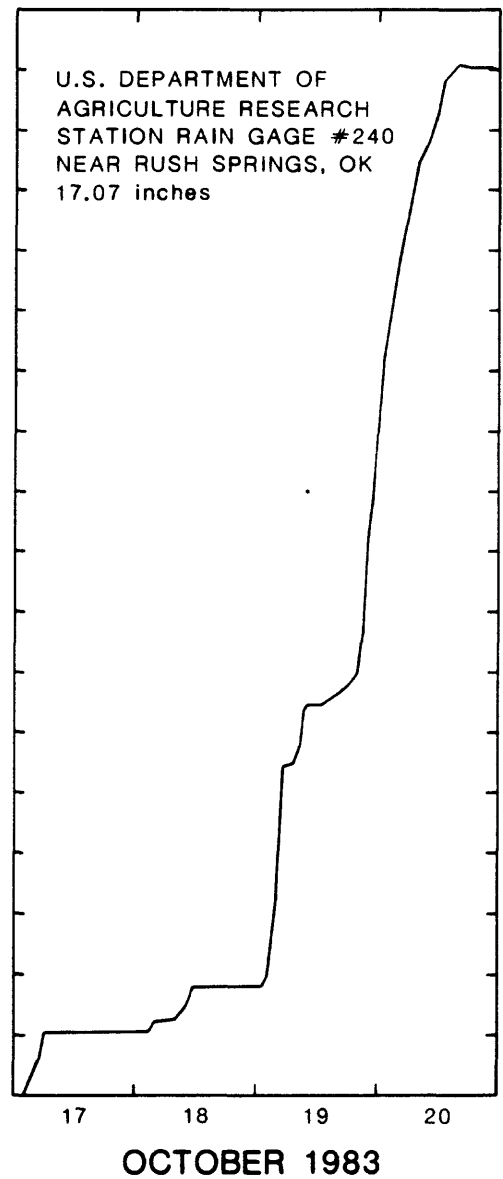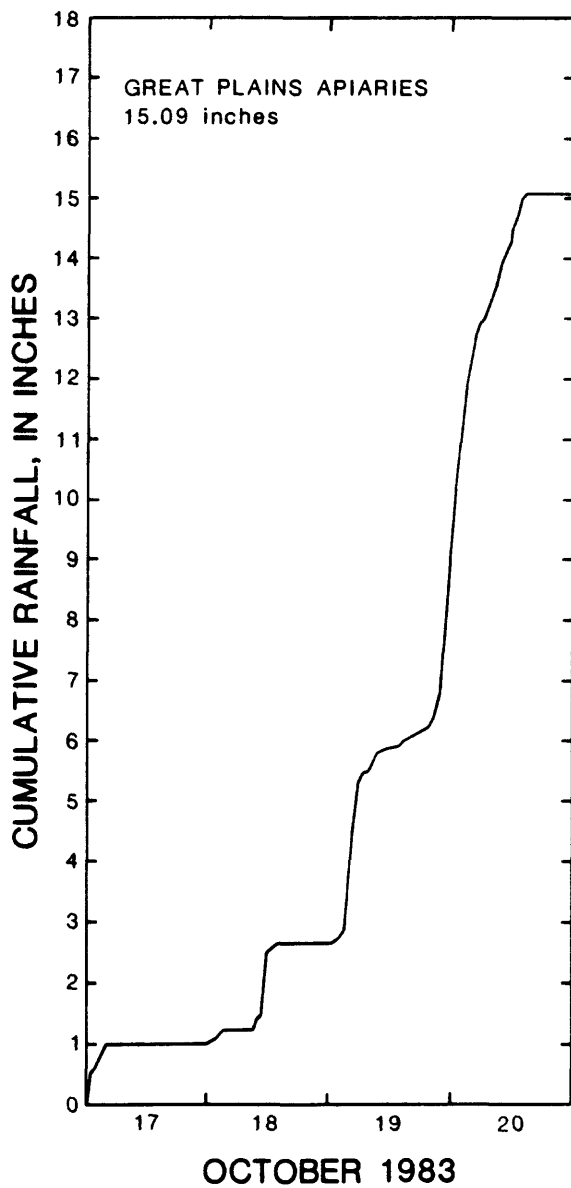
Figure 3.--Mass rainfall curves for selected rain gages for the storm of October 17-23, 1983.
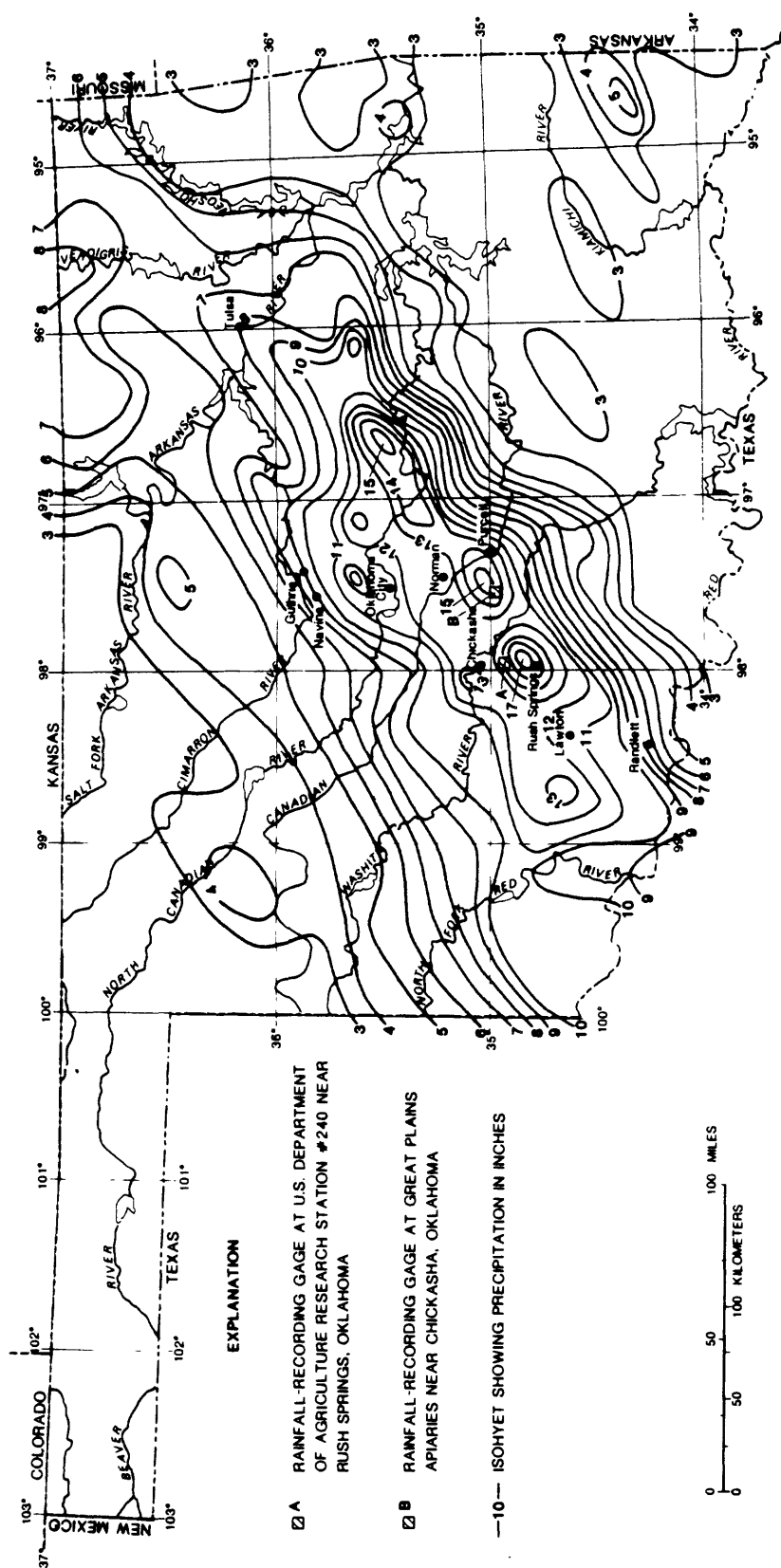
Figure 4.--Map of total storm rainfall of October 17-23, 1983 (from Crawford, 1983).

EXPLANATION

⊠A   RAINFALL-RECORDING GAGE AT U.S. DEPARTMENT
      OF AGRICULTURE RESEARCH STATION #240 NEAR
      RUSH SPRINGS, OKLAHOMA

⊠B   RAINFALL-RECORDING GAGE AT GREAT PLAINS
      APIARIES NEAR CHICKASHA, OKLAHOMA

—10— ISOHYET SHOWING PRECIPITATION IN INCHES

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DESCRIPTION AND MEASUREMENT OF FLOODS

Storm Runoff Distribution

Stream-gaging stations located within the flood area recorded flow data from drainage areas ranging from 5.9 to 17,852 square miles. Stations recording runoff from drainage areas less than 50 square miles within locations of heavy rainfall (greatest storm totals) indicate more discharge per square mile than stations sampling drainage areas greater than 50 square miles. However, high rates of runoff were noted along the main stem of the Washita River, but because of flow regulation by storage reservoirs throughout the basin, unit runoff (discharge per square mile) is not shown. Storm runoff may have been greater in urbanized areas because runoff was not affected by antecedent drought conditions. Unit runoff was not determined in the ubanized areas.

Measurement of Peak Discharges

Hydrologists were in the areas of highest reported rainfall beginning October 19 and began measuring streamflow throughout the range of flood discharges at selected gaging stations. Although stage-discharge relations were previously defined at most gaging-station locations, floodflows at some sites were higher than any previous flood and, therefore, were given priority. In some cases, direct measurements could not be obtained and indirect methods were used. All indirect measurements were made using methods described in "Techniques of Water Resources Investigations of the U.S. Geological Survey", (Dalrymple and Benson, 1967; Matthai, 1967; Bodhaine, 1968; Hulsing, 1968). Data from stage-discharge relations as defined by direct or indirect methods were obtained from 31 gaging stations and one miscellaneous site and are tabulated in table 1. Figure 2 shows the location of the sites and the drainage system.

Table 1 lists the discharge measurement sites in downstream order, size of drainage area in square miles, period of record (water year) (October 1 to September 30), date of maximum stage (in feet above NGVD of 1929) and maximum discharge for both the October 17-23, 1983, flood and any previously known flood for each site. Also included is the unit runoff of the October 1983 flood at each site computed from the ratio of peak discharge to the drainage area above the site, and the recurrence interval of the October 1983 flood in years.

Peak discharge at the Deep Fork near Beggs gage was recorded on October 25, about 4-5 days later than other flood crests, and is included to show the effect of storm movement on flood discharge as it moved to the north and east and dissipated in strength.

Flood Hydrographs

Figures 5-7 show flood hydrographs from stream-gaging stations located in areas having the highest rainfall and runoff amounts. Discharge hydrographs are developed from stream-stage records and from previously defined relationships between stage and stream discharge at each site.

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Table 1.--Summary of peak stages and discharges for floods of October 17-23, 1983

[mi², square mile; ft, feet; sec, second]

Map No.	Permanent station No.	Stream and place of determination	Drainage area (mi²)	Period of record	Maximum previously known flood			Maximum flood of October 17-23, 1983				
					Date	Gage height (ft)[g]	Discharge (ft³/s)	Date (October)	Gage height (ft)	Discharge (ft³/s)	Unit discharge [ft³/s/mi²]	Recurrence interval (years)
1	07153000	Black Bear Creek at Pawnee, Okla.	576	1944-	10-03-59	834.16	30,200	21	814.15	4,130	7.2	<2
2	07159720	Cottonwood Creek nr. Navina, Okla.	247	1978-	05-30-80	984.44	12,300	20	985.94	32,000	130	60
3	-------	Cottonwood Creek nr. Guthrie, Okla.	353	----	05-19-49	(c)	44,000	20	(c)	34,200	96.9	30
4	07160000	Cimarron R. at Guthrie, Okla.	16,892b	1949,53-63,83-	05-17-57	919.08	158,000	20	912.01	47,700	2.8e	(c)
5	07161000	Cimarron R. at Perkins, Okla.	17,852b	1939-	05-17-57	834.41	149,000	21	832.77	36,200	2.0e	(c)
6	07163000	Council Creek nr. Stillwater, Okla.	31.0	1934-	10-02-59	857.18	25,000	20	845.46	2,450	79.0	<5
7	07228930	Worley Creek nr. Tuttle, Okla.	11.2	1965-72,75-	04-12-67	13.35a	1,900	20	16.68a	3,200	286	15
8	07229300	Walnut Creek nr. Purcell, Okla.	202	1965-	05-23-75	1,034	27,200	20	1,038.97	67,700	134	>100
9	07230500	Little River nr. Tecumseh, Okla.	456	1943-	05-25-57	917.36	32,400	20	19.24a	23,000	7e	15
10	07239500	North Canadian River nr. El Reno, Okla.	13,042b	1902-08,37-	10-28-41	1,315.00	15,000	20	1,312.95	5,880	0.4e	(c)
11	07241550	North Canadian River nr. Harrah, Okla.	13,501b	1968-	06-09-74	1,073.83	7,630	21	1,074.63	18,400	1.4e	(c)
12	07241880	Sand Creek nr. Cromwell, Okla.	9.48	1964-	06-02-73	14.64a	2,180	20	15.67c	3,750	396	25
13	07242350	Deep Fork nr. Arcadia, Okla.	105	1969-	11-02-74	968.55	14,300	20	963.97	11,600	110	10
14	07243000	Dry Creek nr. Kendrick, Okla.	69.0	1955-	11-02-74	844.2	18,000	20	837.72	3,500	50.7	2
15	07243500	Deep Fork nr. Beggs, Okla.	2,018	1938-	05-11-43	667.10	66,800	25	687.46	21,800	10.8	5
16	07243550	Adams Creek nr. Beggs, Okla.	5.90	1965-	06-08-74	13.69a	3,390	20	8.16a	606	103	<2
17	07301110	Salt Fork Red River nr. Elmer, Okla.	1,878	1979-	05-30-80	1,273.66	37,900	21	1,270.18	10,180	5.4	<2
18	07304500	Elk Creek nr. Hobart, Okla.	549	1904-08,49-	10-04-55	1,460.15	22,400	20	1,460.20	25,400	46.3e	--
19	07305000	North Fork Red River nr. Headrick, Okla.	4,244	1905-08,37-	05-28-77	1,312.09	35,000	21	1,312.08	30,000	7.1e	--
20	07311000	East Cache Creek nr. Walters, Okla.	675	1938-63,69-	05-18-51	967.92	28,200	20	968.56	38,000	56.3	75
21	07311200	Blue Beaver Creek nr. Cache, Okla.	24.6	1964-	08-28-77	1,233.28	13,600	19	1,229.55	4,010	163	10
22	07311500	Deep Red Run nr. Randlett, Okla.	617	1949-	09-22-69	952.0	48,700	20	953.49	86,400	145	>100
23	07312850	Nine Mile Beaver Creek nr. Elgin, Okla.	6.29	1964-	05-28-78	11.85a	3,740	20	11.83a	3,950	628	50
24	07313600	Cow Creek at Waurika, Okla.	193	1955,66-	05-19-55	884.7	29,000	20	873.74	18,100	93.8	50
25	07325500	Washita River nr. Carnegie, Okla.	3,129	1937-	05-18-49	1,275.44	50,000	20	1,275.93	36,900	11.8e	(c)
26	07325800	Cobb Creek nr. Eakly, Okla.	132	1968-	06-24-75	1,389.03	(c)	20	1,289.03	2,300	17.4	(c)
27	07326000	Cobb Creek nr. Ft. Cobb, Okla.	313	1939-	05-17-49	1,272.29	35,000	20	1,271.88	362	1.2e	(c)
28	07326500	Washita River at Anadarko, Okla.	3,656	1902-08,24-25,35-38,63	05-25-03	1,179.60d	29,000	21	1,175.40	42,000	11.5e	(c)
29	07327490	Little Washita River nr. Ninnekah, Okla.	208	1963-f	05-10-64	1,086.59	7,560	20	1,090.94	9,380	45.1	10
30	07328070	Winter Creek nr. Alex, Okla.	33.0	1964-	05-27-78	1,057.35	6,080	20	1,057.19	5,840	177	10
31	07328100	Washita River at Alex, Okla.	4,787	1964-	05-07-69	1,017.83	9,350	21	1,023.78	23,400	4.9e	(c)
32	07329000	Rush Creek nr. Purdy, Okla.	145	1940-53,82-	05-10-50	1,016.70	30,000	20	1,013.64	7,000	48.3	<2

a -- Arbitrary datum
b -- Total drainage area
c -- Not determined
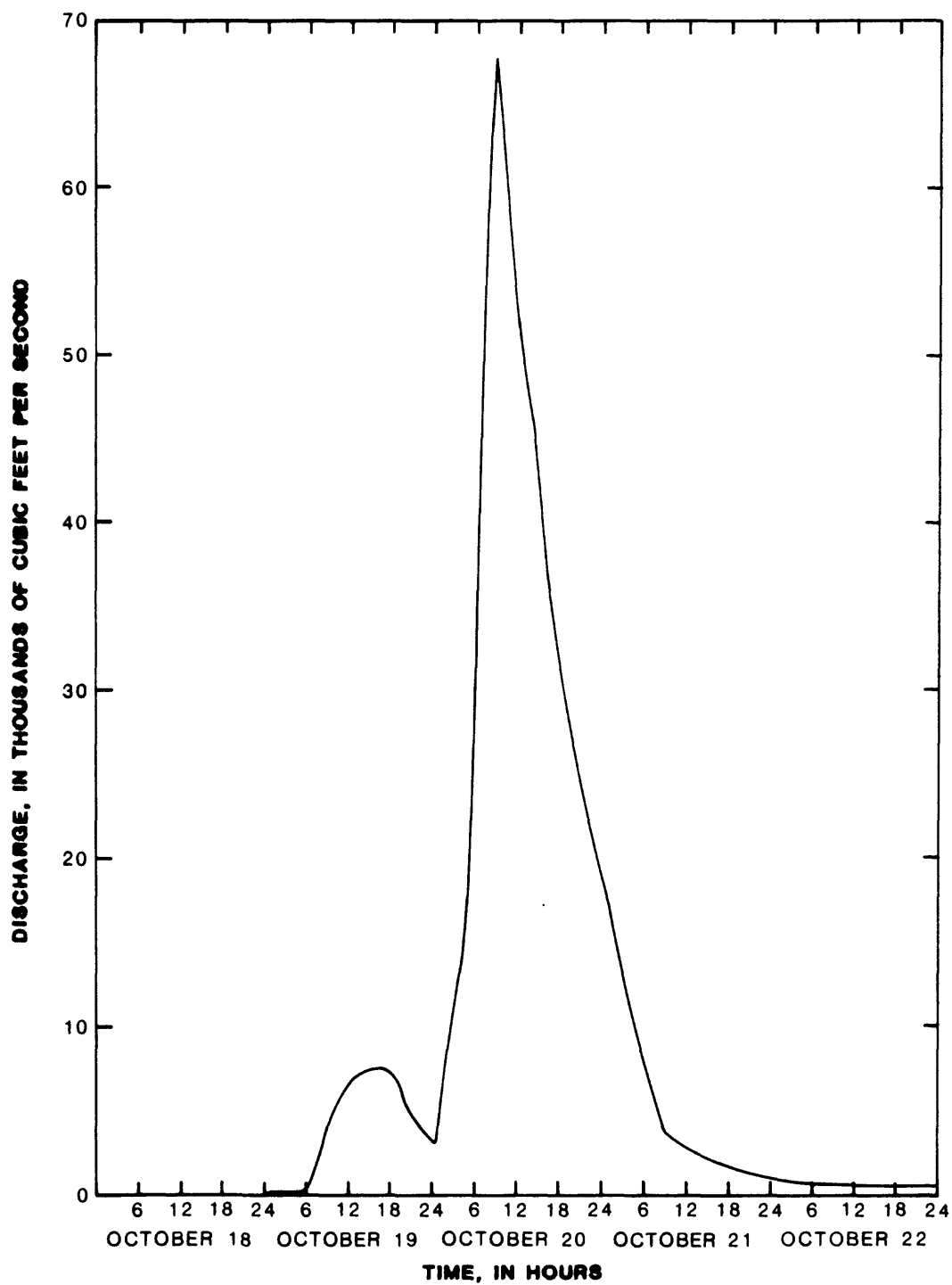d -- Affected by backwater
e -- Affected by regulation or Diversion
f -- Station operated by U. S. Department of Agriculture, Agriculture Research Station
g -- National Geodetic Vertical Datum
> -- Greater than
< -- Less than

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Figure 5.--Discharge hydrograph at U.S. Geological Survey gaging
station at Walnut Creek at Purcell, Oklahoma, flood of
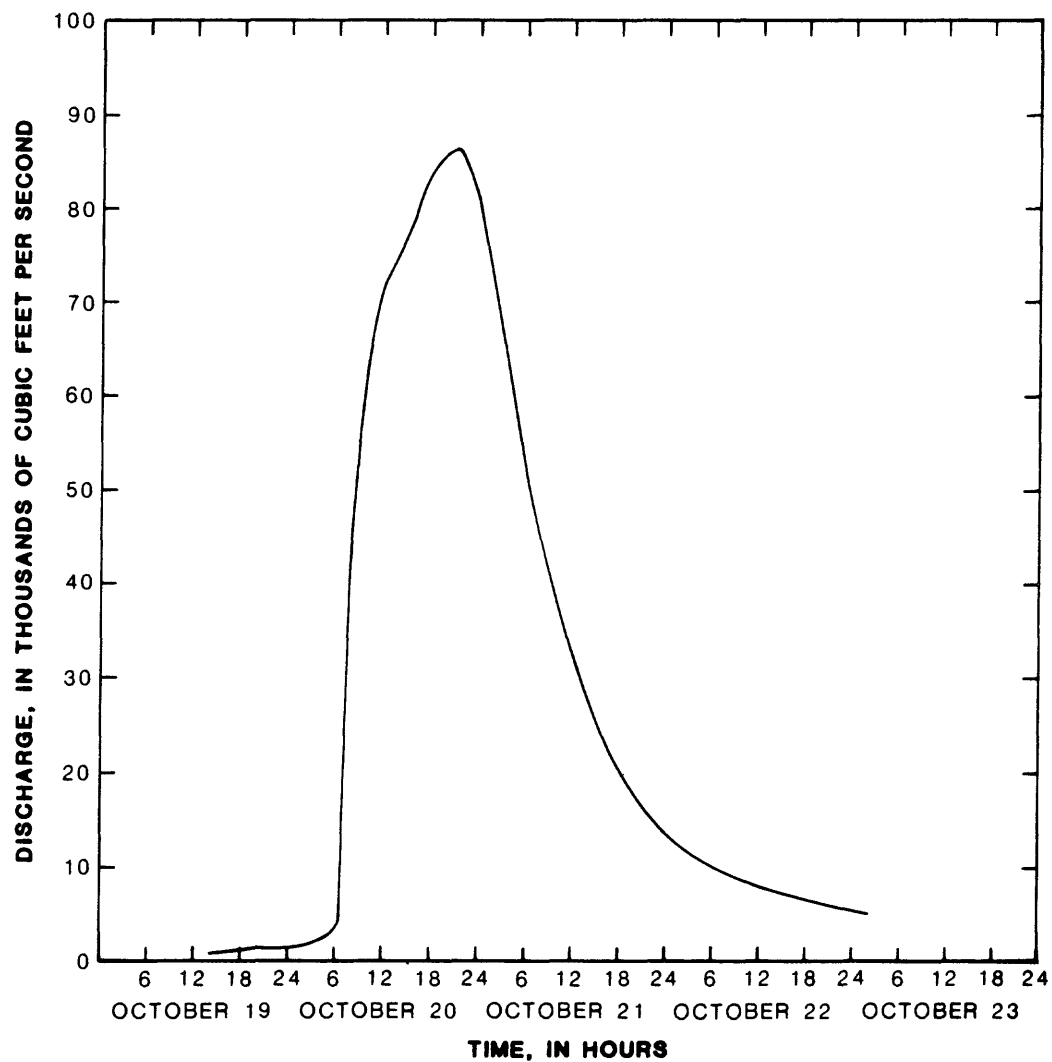October 17-23, 1983.

Figure 6.--Discharge hydrograph at U.S. Geological Survey gaging
station on Deep Red Run at Randlett, Oklahoma, flood
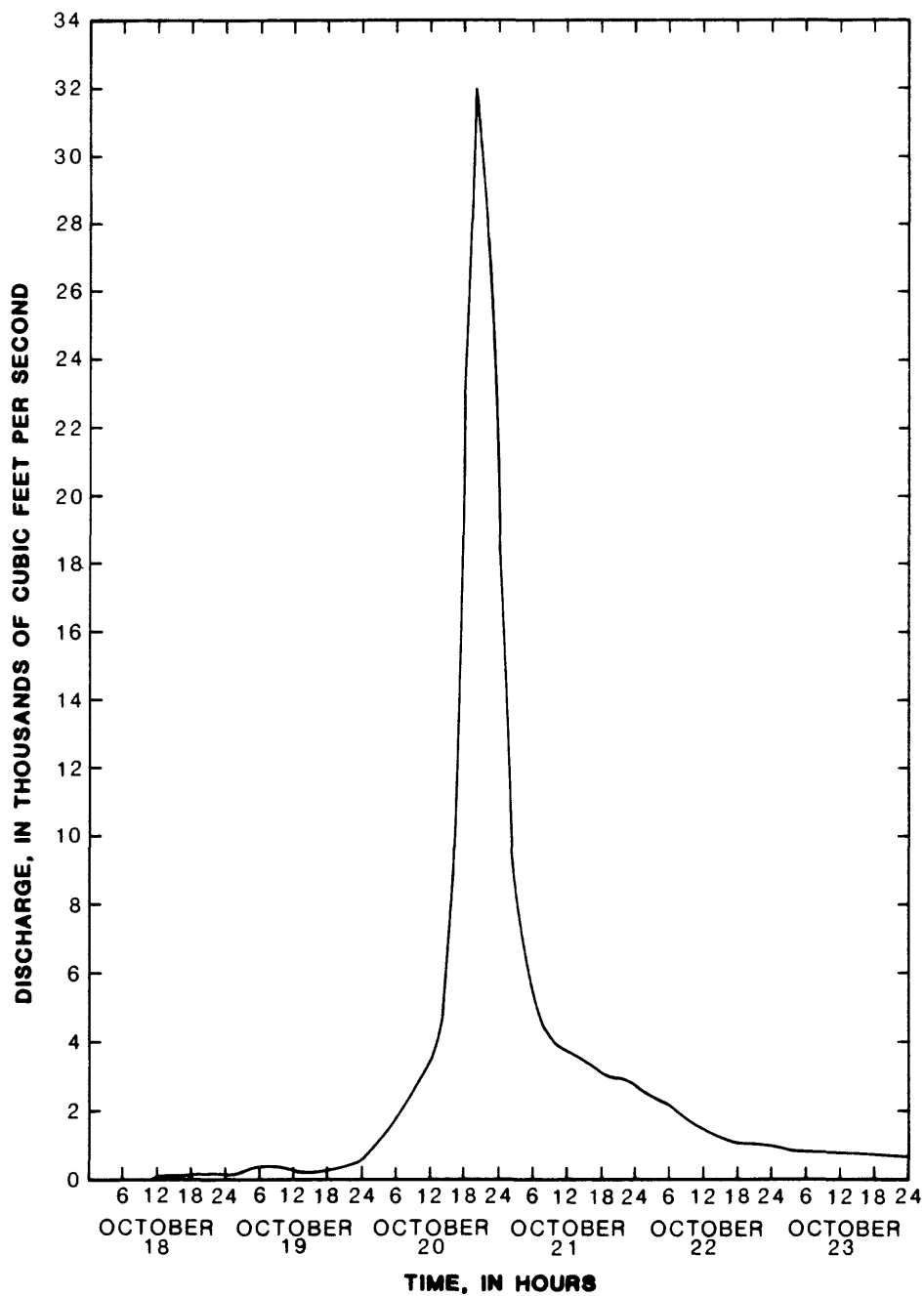of October 17-23, 1983.

Figure 7.--Discharge hydrograph at U.S. Geological gaging station on Cottonwood Creek near Navina, Oklahoma, flood of October 17-23, 1983.

Record high flows were recorded along the main stem of the Washita River below Carnegie. However, because streamflow is regulated at many locations in the Washita River basin by both controlled and uncontrolled spillways, hydrograph data for this basin are not shown.

Hydrograph data given in this report show the stream response to rainfall in specific basins in relation to the rainfall distribution in the study area (fig. 4).

FLOOD DAMAGES

Central and southwest Oklahoma was declared a flood-disaster area shortly after a Presidential declaration for drought-relief assistance over much of the same area. A 16-county area was affected by the floodwaters.

Over 250 families received $580,900 in disaster-relief grants for single-family homes and 98 claims totaling $934,200 were paid through the flood-insurance program. The Small Business Administration reports that 72 loans totaling $622,000 were granted as a result of the flood.

A total of $2,362,900 in loans for farm homes was granted to 120 individuals according to Farm and Home Administration officials in Dallas, Texas. State, county, and local governments received $7,986,400 in disaster loans based on Federal Disaster Assistance Administration reports. These funds were for repairs to roads and bridges lost or damaged during the floods. Figure 8 shows road overflow at U.S. Highway 77 from Walnut Creek in Purcell, Oklahoma on October 20, soon after the flood crest. Floodflows such as these resulted in road closings at numerous locations in the flood area.

One death occurred in Guthrie as a result of the flood. Flood elevations were not measured at Guthrie during this flood; however, flood discharge measured 3 miles upstream was the highest since 1949.

MAGNITUDE AND FREQUENCY OF FLOODING

Knowledge of the magnitude and probable frequency of flood recurrence is useful in the design and location of many types of hydraulic structures and in the development of criteria for flood-plain management.

Techniques for deriving flood-frequency relations are described by the U.S. Water Resources Council (1977) and by Thomas and Corley (1977).

For comparison, peak discharges of the October 17-23, 1983 flood, the August 27-28, 1973 flood in north-central Oklahoma, and other previous outstanding floods in Oklahoma are plotted in figure 9 against their respective drainage areas. Outstanding floods of August 27-28, 1977, documented by Corley and Huntzinger (1977), are included in figure 9 because these floods occurred within the October 1983 flood study area.

A curve developed by Crippen and Bue (1977) on the basis of maximum known floods in the United States defines their approximate upper limit through 1974. The other curve shown here was developed by Crippen and Bue

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Figure 8.--View looking south toward U.S. Highway 77 bridge over Walnut Creek at Purcell, Oklahoma, October 20, 1983. (Photograph courtesy of "The Purcell Register", Purcell, Oklahoma.)
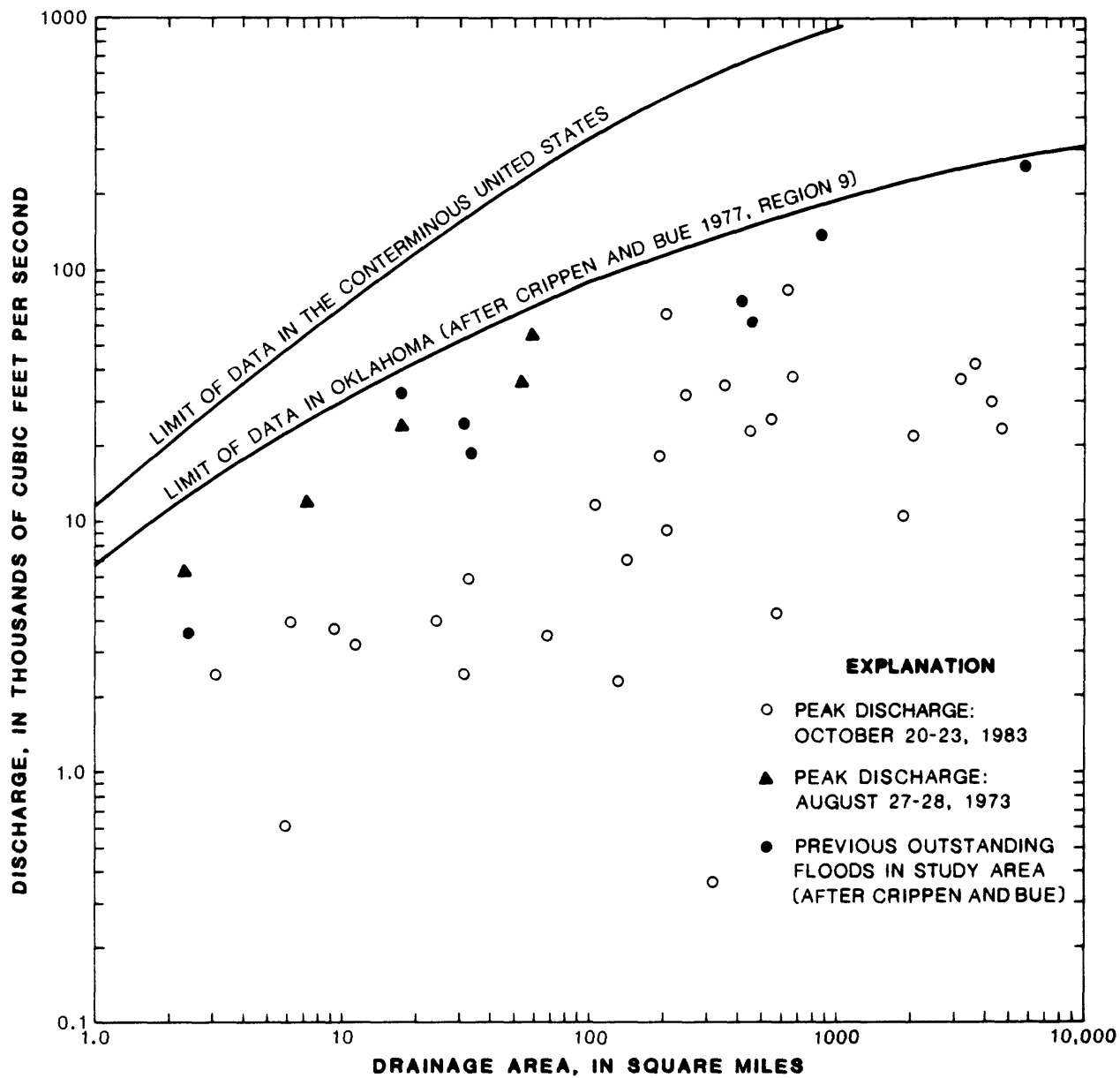
Figure 9.--Comparison of October 17-23, 1983, peak discharges to upper
limits of known floods in Oklahoma-Kansas and in the
United States.

(1977) using maximum floods in the Oklahoma, Texas, Missouri, and Kansas region. Peak discharges from Walnut Creek at Purcell and Deep Red Run near Randlett recorded during the October 17-23, 1983 floods compared in magnitude per square mile with those discharges measured during the August 27-28, 1973 floods. However, floodflows determined at remaining locations (table 1) are less in magnitude than both the August 1973 flood and other previous floods in the study area. Data plotted on figure 9 indicates that only those streams having over 14 inches of rainfall could be considered an outstanding flood. Peak discharges from drainage areas greater than 10,000 square miles controlled by upstream reservoirs were not plotted on figure 9.

SUMMARY

Peak discharges were determined during and after flooding following storms of October 17-23, 1983 in central and southwest Oklahoma. These storms were a result of the remains of Hurricane Tico moving through Oklahoma along a frontal system which became stationary extending from the Red River near south-central Oklahoma to southwestern Arkansas. Rainfall amounts exceeded the 100-year 24-hour storm frequency in some areas and was recorded at the Great Plains Apiaries near Chickasha, Oklahoma.

Measurements of floodflows were made at 31 gaging stations and one miscellaneous site. Continuous river stages were collected at 30 sites and where maximum storm-rainfall depth occurred, discharge hydrographs and rainfall mass curves are provided.

Peak discharges recorded as a result of the October 17-23, 1983 flood were compared with other outstanding floods in Oklahoma. Results show the October 1983 flood can be considered to be outstanding only in the areas of maximum rainfall. When the frequency of the flood magnitude was determined for all the sites measured, only Walnut Creek at Purcell and Deep Red Run at Randlett (located in the area of maximum rainfall) peak discharges were equal to or greater than the 100-year flood.

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