UNITED STATES DEPARTMENT OF THE INTERIOR

TEXAS FLOODS OF 1938 AND 1939

GEOLOGICAL SURVEY WATER-SUPPLY PAPER 914

UNITED STATES DEPARTMENT OF THE INTERIOR
Harold L. Ickes, Secretary

GEOLOGICAL SURVEY
W. E. Wrather, Director

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TEXAS FLOODS OF 1938 AND 1939

BY

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TEXAS FLOODS OF 1938 AND 1939

By SETH D. BREEDING and TATE DALRYMPLE

ABSTRACT

In January, June, and July 1938, and June 1939 parts of Texas experienced floods that exceeded previously recorded stages at many places and that were unusually high over reaches of several hundred miles on the streams of the State.

The floods were caused by heavy rainstorms that covered a total area of about 30,000 square miles in three widely separated parts of the State. These storms occurred in northeast Texas, in the Panhandle-plains region of north Texas, and in the upper Colorado River Basin in northwest-central Texas.

Heavy rains occurred in January 1938 over an area from Texas to Tennessee. In east Texas the maximum precipitation recorded for a 24-hour period was 5.35 inches and for a 7-day period was 10.73 inches. Higher stages occurred on the Sulphur River than any previously known on that river. The resulting peak discharge at Darden, for instance, was 92,900 second-feet from a drainage area of 2,754 square miles, or 33.7 second-feet per square mile. High but not record-breaking stages occurred on Cypress Creek and the upper Sabine River.

A cloudburst rain that lasted from 1 to 4 hours during the night of June 15, 1938, fell in Lake Creek Basin in the Panhandle-plains regions and amounted to 14 inches at one place. The flood was the greatest known in Lake Creek: the peak discharge as determined near Hedley was 64,700 second-feet from a drainage area of 68.5 square miles, or 945 second-feet per square mile.

During July 16–25, 1938, heavy rains fell in the upper Colorado River Basin and centered in the watershed of the San Saba and South Concho Rivers, with 30 inches of rain reported from one place and 20 inches or more from about 70 places. More than 15 inches fell in an area of 5,700 square miles. The greatest 1-day rain reported was 13 inches; one observer reported 5.50 inches of rain fell in 1 hour.

The resulting flood in the Colorado River was the greatest on record from the mouth of the San Saba River to Buchanan Dam, and the peak discharge just below the San Saba River was 224,000 second-feet.

The rainfall over the 434 square miles of the South Concho River Basin above Christoval averaged 19.7 inches. A peak discharge of 100,000 second-feet was determined at the Christoval gage, where the stage was about 1 foot lower than in August 1906.

The 3,100 square miles drained by the San Saba River received a rain of from 12 to 25 inches that averaged 18.8 inches over the basin. Richland Creek, tributary to the San Saba River, received a rain of from 20.5 to 22.5 inches that averaged 21.1 inches over the area. The maximum discharge measured on the San Saba River was 203,000 second-feet at San Saba. The peak discharge of Richland Creek near Richland Springs was 61,000 second-feet from a drainage area of 72.4 square miles, or 843 second-feet per square mile. The floods in the San Saba River exceeded any since 1899 and were the greatest known at many places on streams in the San Saba River Basin.

Measurements of the silt content of the Colorado River during the flood of July 1938 show a maximum 24-hour load at Austin of 2,383,000 tons and a total load for the flood period of 8,030,600 tons.

Studies of the rainfall and the associated direct runoff at river-measurement stations in the Colorado River Basin show that for the storm of July 1938 an average of about 19 inches of rain fell on several areas and the maximum direct runoff was 5.05 inches. The difference between the total rainfall and the direct runoff, or the basin retention, averaged 14.9 inches for those basins receiving more than 18 inches of rain and 10.0 inches for those receiving from 11 to 15 inches.

In June 1939 a rain of from 4 to 19 inches fell in from 4 to 10 hours on an area of about 1,000 square miles in the upper Colorado River Basin. The resulting flood in the Colorado River at Colorado, had a peak discharge of 72,800 second-feet and was the greatest known at that station.

This report presents records of precipitation at several hundred places; 10 isohyetal maps; records of peak stages and discharges and of daily mean discharges during the flood period at more than 30 river-measurement stations; hydrographs of discharge at 19 stations; records of suspended matter transported in stream channels by the flood; results of studies of rainfall and runoff; records of past floods in the Red, Sabine, and Colorado River Basins; and other data pertinent to the floods in Texas.

INTRODUCTION

Almost every year some part of Texas experiences a flood of exceptional magnitude that usually results from intense rainfall over a relatively small area, which may at times act in conjunction with a more widespread storm condition. The exceptional floods that occurred in Texas in 1938 and 1939 and that are described in this report resulted from intense rains in four areas, as shown in figure 1, namely, Sulphur River, Cypress Creek, and the upper Sabine River Basins in east Texas; Lake Creek Basin in the Panhandle-plains region; Concho, San Saba, and other river basins tributary to the Colorado River in the Edwards Plateau region of central and west-central Texas; and the upper Colorado River Basin just below the Cap Rock, in northwest-central Texas. These floods occurred in January, June, and July, 1938, and July 1939, respectively. At least 12 lives were lost, and damage of over $5,350,000 was caused to property.

The flood of January 1938 in east Texas was caused by heavy precipitation that was part of a general rain covering a large section of several States. The maximum precipitation recorded for a 24-hour period during this storm was 5.35 inches and for a 7-day period 10.73 inches. The floods of June and July 1938 were caused by so-called cloudburst storms, for 14 inches of rain was reported to have fallen in from 1 to 4 hours at one place during the June storm, and 13 inches in 24 hours at two places and 5.5 inches in 1 hour at another place in the July storm.

Cloudburst floods are difficult to describe satisfactorily. Intense rains occur usually where there are no rain gages and almost always where there is no recording rain gage to give accurate information as to intensities. Rainfall information must therefore be compiled from available sources, and although it may be reasonably reliable it is generally not highly accurate as to quantity and fails to give the intensity of precipitation for short periods.

As there is often no river-measurement station on the stream most affected and as there is seldom an opportunity for direct measurements of stage or discharge, the rates of discharge frequently must be computed by indirect methods, such as by formulas for flow over dams, by

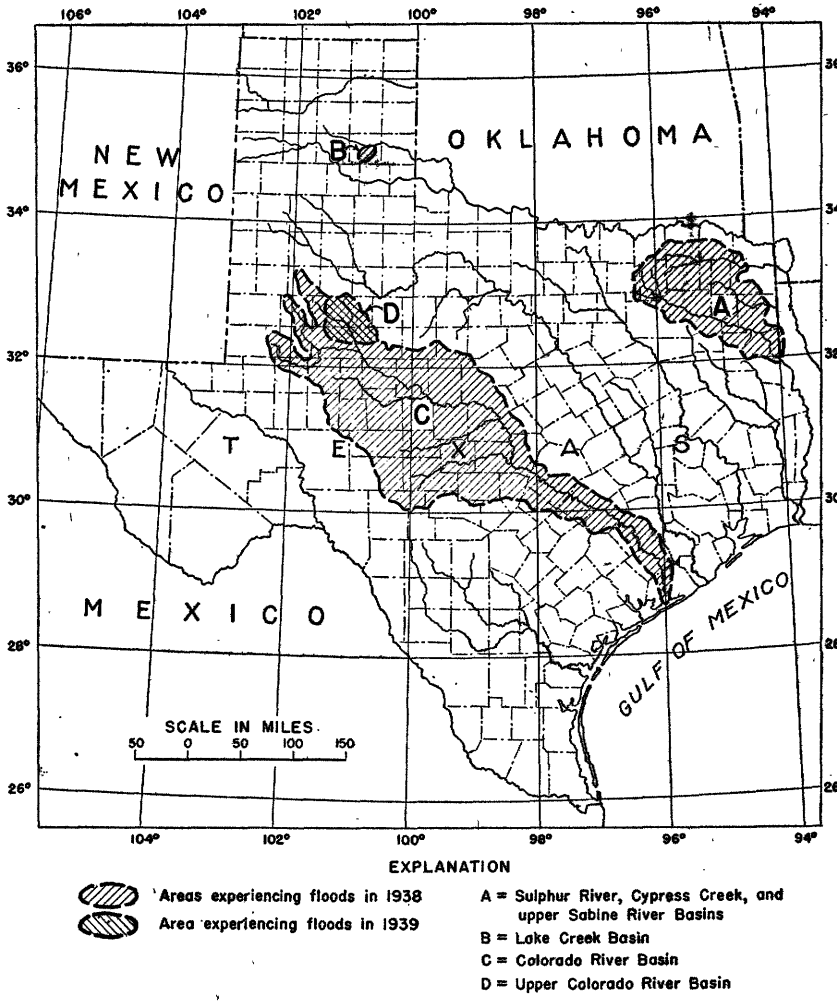


FIGURE 1.—Map of Texas showing areas experiencing floods described in this report.

the draw-down at contracted openings, or, most commonly, by open channel slope formulas.

Although the resulting reports may be inadequate in many respects, any available information of cloudburst floods is valuable because such floods are especially disastrous in creeks and small rivers, in which they cause record stages and discharges. A record of the magnitude of these floods and a study of the history of previous floods are of value in designing engineering structures such as dams, bridges, levees,

and other controlling works, and in planning the complete utilization of the water resources of a region.

The most disastrous floods of 1938 and 1939 originated in the relatively small areas of the South Concho and San Saba Rivers in the Colorado River Basin. These floods were especially interesting and instructive as a test of the effect of recently completed storage works marking the beginning of a comprehensive effort toward ultimate complete control and utilization of the waters of the Colorado River.

This report presents information that greatly exceeds in scope and detail the information customarily obtained under the regular river-measurement program. Considerable effort has been expended in gathering and analysing rainfall data and in determining the peak discharge at places other than regular gaging stations. The report includes a tabulation of past flood peaks obtained from records that have been gathered at river-measurement stations and miscellaneous places in the basins experiencing unusual floods in 1938 and 1939.

The Public Works Administration, acting in accordance with the National Industrial Recovery Act of 1933, allotted funds that aided the Geological Survey considerably in conducting the work incident to this report.

ADMINISTRATION AND PERSONNEL

The field and office work of preparing this report was performed by the Water Resources Branch of the Geological Survey under the general administrative direction of N. C. Grover, chief hydraulic engineer up to the time of his retirement from the Government service on January 31, 1939; then under C. G. Paulsen, acting chief hydraulic engineer until October 17, 1939; and finally under G. L. Parker, chief hydraulic engineer thereafter. The major part of the work was performed during Mr. Paulsen's incumbency. The assembling of the report, as well as some special work, was carried on by the Division of Water Utilization under the general technical direction of R. W. Davenport, chief. The field work and the collection and tabulation of basic information with respect to stages and discharges were done under the direction of C. E. Ellsworth, district engineer.

Data relative to the flood on Lake Creek in June were collected and analyzed by W. H. Goines; records for Salt Fork of the Red River at Mangum, Okla., were computed by the office of the Survey at Fort Smith, Ark., J. L. Saunders, district engineer. The special data relative to the floods in the Colorado River Basin were obtained and analyzed under the immediate direction of S. D. Breeding. Special studies and the writing of text were done by Mr. Breeding and Tate Dalrymple.

ACKNOWLEDGMENTS

The river-measurement work of the Geological Survey is performed in Texas in cooperation with the State Board of Water Engineers, consisting of C. S. Clark, chairman, A. H. Dunlap, and J. W. Pritchett.

Acknowledgment is made to the United States Weather Bureau for many of the data on rainfall and for the discussion of weather conditions during the storm period in July; and to the Corps of Engineers, United States Army, for many of the supplemental data on rainfall.

Most of the data relative to Buchanan Reservoir, and other information concerning the flood in the Colorado River, were furnished by the Lower Colorado River Authority.

Many miscellaneous rainfall records were obtained from local observers to whom no individual acknowledgment is made but to whom special credit is due, for these data have added materially to the knowledge of the rainfall.

Information in this report has been obtained from many sources, including individuals, corporations, city, county, and State officials, and newspapers. So far as practicable, acknowledgments for individual contributions are given at appropriate places in the report.

DETERMINATION OF FLOOD DISCHARGES

The general method employed in determining discharge at river-measurement stations consists in determining a stage-discharge relation by means of current-meter measurements of discharge at various stages from low water to high water and applying this relation to the records of stage. The records of stage, unless otherwise noted, are obtained either from readings on nonrecording gages or from graphs of continuous water-stage recorders.

Plate 1, *A*, shows a river-measurement station in Texas equipped with a water-stage recorder installed in a concrete stilling well.

The determining of flood discharges in many places is very difficult, as the accuracy of such discharges often depends on surveys, analyses, and computations by various indirect methods for extending the curve of stage-discharge relation beyond the range covered by current-meter measurements.

At places other than regular river-measurement stations, peak discharges are nearly always determined by some indirect method. It is usually impossible at such places to obtain sufficient basic information from which the total quantity of water discharged during the flood may be computed.

The methods employed in determining the maximum discharge of floods described in this report are extension of rating curves for river-measurement stations, computation of flow over dams, computation of flow through contracted openings, and computation of flow by the slope-area method. These methods are outlined in standard text-

books and manuals on hydraulics [1] and have been discussed in previous reports of the Geological Survey.[2]

FLOODS OF JANUARY 1938 IN EAST TEXAS

A period of heavy precipitation, from about January 20 to 25, 1938, centered over Arkansas and western Tennessee and extended southwestward to eastern and central Texas. In general, light to moderate floods resulted, but on Sulphur River, tributary to Red River, stages occurred that were higher than any previously known. High but not record-breaking floods also occurred in Cypress Creek and the upper Sabine River. The damage done by the floods has been estimated by the Weather Bureau as $39,500 for Sulphur River Basin and $8,150 for Cypress Creek Basin.[3]

East Texas is a relatively low forested area of rolling topography and sandy soil. The average annual precipitation of about 45 inches has developed a well-defined drainage system. Owing to flat gradients and resulting low velocities, stream channels are not eroded appreciably even during floods. Streams in this area rise and recede slowly, in contrast to the flashy rises of streams in the western part of the State that are subject to cloudburst floods.

PRECIPITATION

The available rainfall data for east Texas for the period January 19–25, 1938, are given in table 1. No records were obtained at places other than regular Weather Bureau stations, which are scattered. However, as the rains were fairly steady and covered an extensive region, a good indication of the total precipitation over the area is obtained. Figure 2 is a map of the Sulphur River, Cypress Creek, and the upper part of the Sabine River Basins, showing isohyetal lines of total precipitation January 19–25, 1938.

STAGES AND DISCHARGES AT RIVER-MEASUREMENT STATIONS

Discharge records for Sulphur River near Darden, Cypress Creek near Jefferson, and Sabine River near Gladewater, Tex., and at Logansport, La., are presented, as all the river-measurement stations in the area of heavy rainfall. The locations of these stations are shown

[1] King, H. W., Handbook of hydraulics, 3d ed., McGraw-Hill Book Co., 1939.

[2] See Johnson, Hollister, The New York State flood of July 1935: U. S. Geol. Survey Water-Supply Paper 773-E, pp. 251–254, 1936. Dalrymple, Tate, and others, Major Texas floods of 1935: U. S. Geol. Survey Water-Supply Paper 796-G, pp. 229–232, 252–256, 1939. Grover, N. C., and others, The floods of March 1936, Part 1, New England rivers: U. S. Geol. Survey Water-Supply Paper 798, pp. 70–77, 1937. Dalrymple, Tate, and others, Major Texas floods of 1936: U. S. Geol. Survey Water-Supply Paper 816, pp. 12–18, 1937, and Troxell, H. C., and others, The floods of March 1938 in southern California: U. S. Geol. Survey Water-Supply Paper 844, 1942 [1943].

[3] Monthly Weather Rev., p. 21, January 1938.

in figure 2. Table 2, which is a summary of peak discharges at these stations, also gives, for purposes of comparison, the maximum discharge previously known. Hydrographs of discharge, plotted from

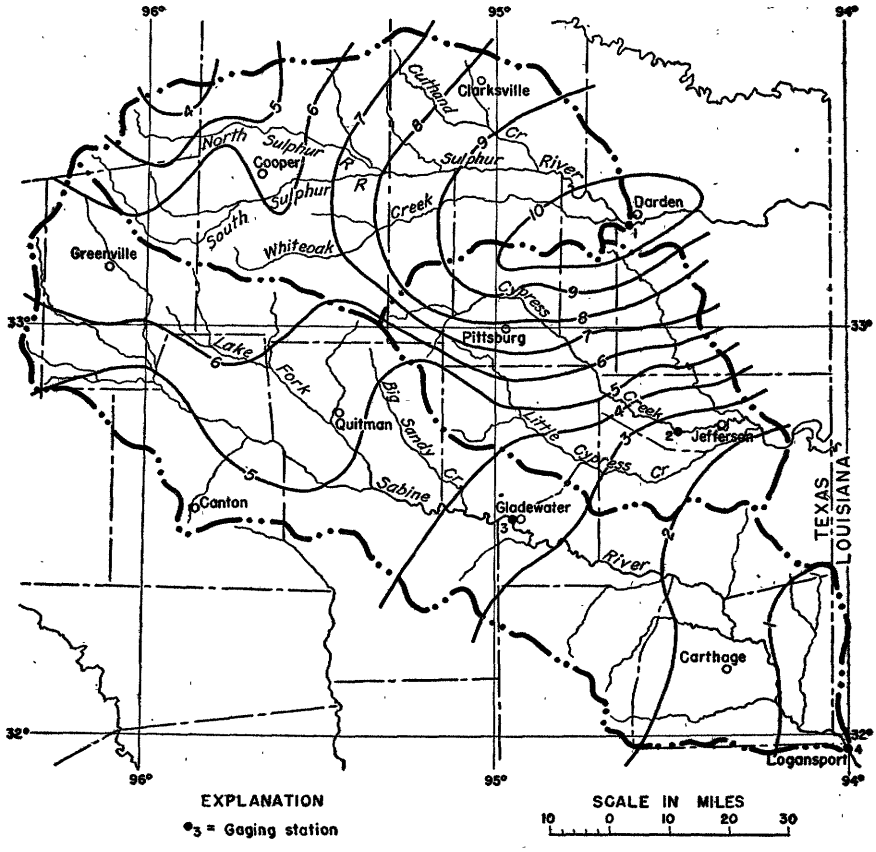


FIGURE 2.—Map of Sulphur River and Cypress Creek Basins and upper part of Sabine River Basin, showing isohyetal lines of total precipitation January 19–25, 1938, and places at which discharge records were obtained.

the station records, are shown in figure 3. For an explanation of the station records, see the section of this report on stages and discharges at river-measurement stations in the description of the floods of July 1938 in Colorado River Basin.

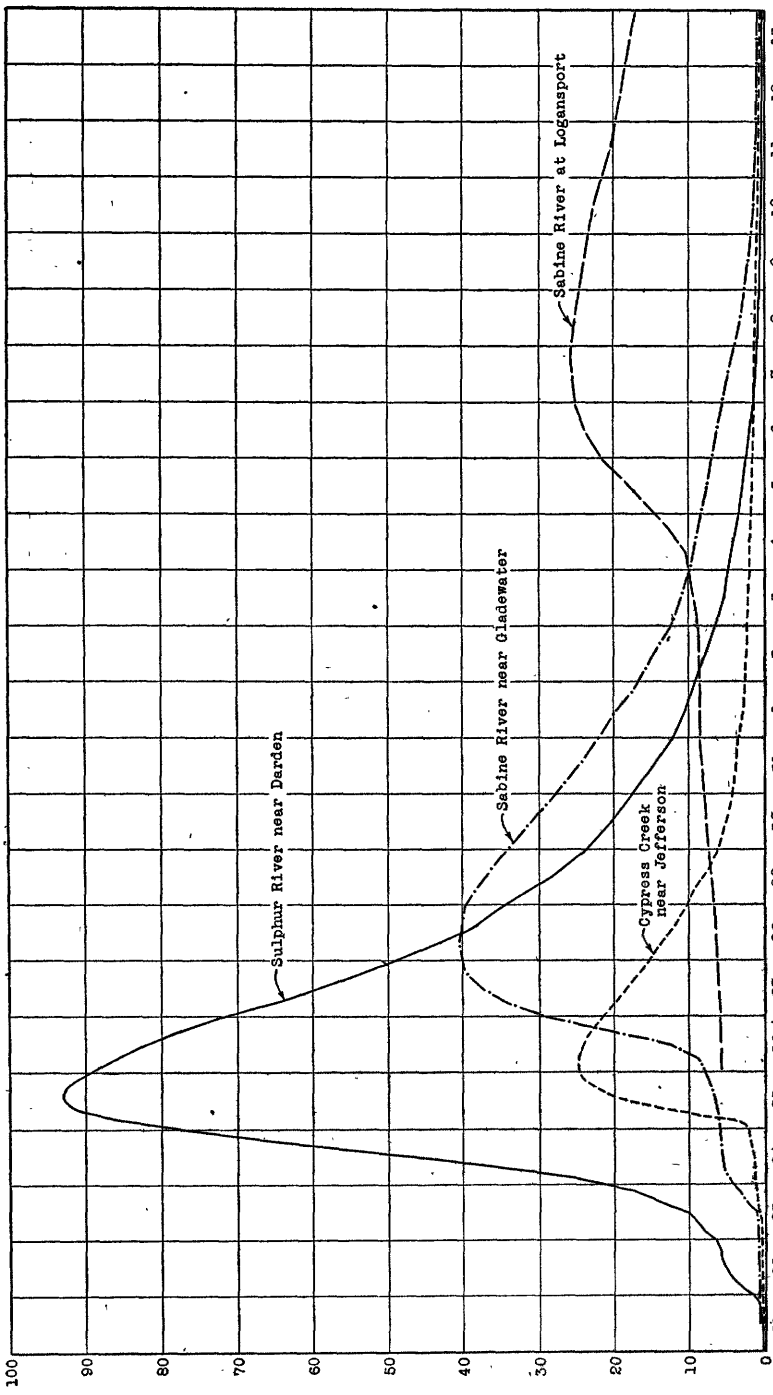


FIGURE 3.—Hydrographs of discharge of Sulphur River near Darden, Cypress Creek near Jefferson, Sabine River near Gladewater, and Sabine River at Logansport, January 21 to February 13, 1938.

TABLE 1.—*Rainfall, in inches, at certain Weather Bureau stations in east Texas, January 19–25, 1938*

[T=less than 0.01 inch]

Station	Latitude	Longitude	January							
			19	20	21	22	23	24	25	19–25
	° ′	° ′								
Arthur City [a]	33 53	95 30	------	0.01	1.66	0.62	0.77	1.07	------	4.13
Bonham [a]	33 34	96 11	------	------	1.25	1.20	1.48	.55	------	4.48
Bronson [a]	31 20	94 01	------	------	.06	.15	.12	.95	------	1.28
Clarksville [b]	33 36	95 02	------	1.44	2.38	2.80	------	1.84	------	8.46
Dallas [c]	32 47	96 47	------	.78	3.12	.37	1.38	.01	T	5.66
Flint [b]	32 11	95 22	------	.23	------	------	3.60	------	------	3.83
Gilmer [a]	32 45	94 57	------	.13	.32	------	3.59	------	------	4.04
Greenville [a]	33 08	96 07	------	------	1.14	4.00	1.25	.44	------	6.83
Honey Grove [b]	33 35	95 55	------	.99	.92	.20	1.39	T	------	3.50
Jefferson [a]	32 45	94 21	------	------	.27	------	------	1.98	------	2.25
Kaufman [a]	32 35	96 20	------	T	.10	1.12	1.20	1.15	------	3.57
Lindale [b]	32 30	95 25	------	------	.21	.21	1.14	3.15	------	4.71
Logansport, La. [a]	31 58	94 00	------	T	.02	T	------	------	0.34	.36
Longview [b]	32 30	94 45	------	------	------	.55	.30	1.95	.10	2.90
Marshall [b]	32 33	94 24	------	------	.25	------	.94	.25	------	1.44
Mount Pleasant [a]	33 09	94 58	------	------	.53	4.26	1.81	3.55	------	10.15
Nacogdoches [a]	31 36	94 40	------	------	.02	.17	.06	1.46	------	1.71
Naples [a]	33 12	94 40	------	------	.38	5.35	.60	4.40	------	10.73
Paris [a]	33 39	95 35	------	------	1.42	1.82	.95	1.15	T	5.34
Ringo Crossing [a]	33 22	95 17	------	------	1.10	2.40	3.15	1.68	------	8.33
Sulphur Springs [b]	33 08	95 37	3.05	.66	2.51	------	------	------	------	6.22
Texarkana, Ark. [a]	33 26	94 02	------	1.03	5.30	.75	1.85	.10	------	9.03

[a] Measured in the morning.
[b] Measured at sunset.
[c] Midnight to midnight.

TABLE 2.—*Summary of peak discharges at certain river-measurement stations in Red and Sabine River Basins, January–February 1938*

No. on fig. 2	Stream and place of determination	Drainage area (square miles)	Period of record	Maximum discharge previously known		Maximum discharge, 1938		
				Date	Second-feet	Time	Second-feet	Second-feet per square mile
	Red River Basin							
1	Sulphur River near Darden, Tex	2,754	1909–38	May 19, 1930	67,200	Jan. 25, 1–3 p. m	92,900	33.7
2	Cypress Creek near Jefferson, Tex	848	1924–38	May 20, 1930	26,100	Jan. 26, 4 a. m	24,800	29.2
	Sabine River Basin							
3	Sabine River near Gladewater, Tex	2,846	1932–38	January 1932	48,500	Jan. 28, 9:30 a. m	40,600	14.3
4	Sabine River at Logansport, La	4,858	1903–38	May 5, 1915 [a]	[b] 47,000	Feb. 7, 7 p. m	25,700	5.3

[a] A stage 2.5 feet higher occurred May 1884; discharge not determined.

[b] Maximum observed.

SULPHUR RIVER NEAR DARDEN, TEX.

LOCATION.—Lat. 33°15′, long. 94°37′, at bridge on U. S. Highway 67, 0.5 mile upstream from St. Louis Southwestern Ry. bridge and 1 mile southwest of Darden, Bowie County. Zero of gage is 220.6 feet above mean sea level.

DRAINAGE AREA.—2,754 square miles.

GAGE-HEIGHT RECORD.—Water-stage recorder graph except 1 a. m. Jan. 25 to 4 p. m. Jan. 26, when it was determined from graph based on two outside gage readings and elevation of peak stage shown by watermark in gage well. Gage heights used to tenths.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements below 66,200 second-feet; extended to peak stage. Discharge Jan. 21–23 and Feb. 2–11 determined by using rate of change of stage as a factor.

MAXIMA.—1938: Discharge, 92,900 second-feet between 1 and 3 p. m. Jan. 25 (gage height, 34.9 feet).

1909–37:[4] Discharge, 67,200 second-feet May 19, 1930 (gage height, about 33.3 feet at present site, revised 1937).

REMARKS.—No diversions or regulation.

Mean discharge, in second-feet, and runoff, in acre-feet, 1938

Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet
Jan. 21	425	843	Jan. 30	20,300	40,260	Feb. 7	945	1,870
22	4,780	9,480	31	14,500	28,760	8	685	1,360
23	11,800	23,400	Feb. 1	10,300	20,430	9	480	952
24	47,100	93,420	2	7,700	15,270	10	412	817
25	89,600	177,700	3	5,250	10,410	11	332	659
26	80,800	160,300	4	3,400	6,740	12	325	645
27	60,000	119,000	5	2,520	5,000	13	295	585
28	40,200	79,740	6	1,530	3,030	14	275	545
29	29,000	57,520				15	255	506

Runoff, in acre-feet, for period Jan. 21, to Feb. 15 859,200

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
Jan. 21			*Jan. 23*			*Jan. 26*		
1 a. m.	5.12	201	4 a. m.	24.34	8,060	6 a. m.	34.30	86,300
7	5.08	197	8	24.87	8,970	12 m.	33.90	81,900
8	5.13	204	12 m.	25.38	10,300	6 p. m.	33.48	77,500
9	5.27	262	3 p. m.	26.00	13,000	12	32.95	72,000
10	5.47	338	6	26.39	15,000			
12 m.	5.92	395	9	26.80	17,300	*Jan. 27*		
3 p. m.	6.54	462	12	27.36	20,900			
6	7.22	565				8 a. m.	32.25	63,200
9	7.85	653	*Jan. 24*			4 p. m.	31.50	56,000
10	8.50	730				12	30.80	49,000
11	10.65	1,050	3 a. m.	28.05	25,000			
12	12.50	1,380	6	28.83	31,400	*Jan. 28*		
Jan. 22			9	29.67	38,600			
1 a. m.	14.50	1,830	12 m.	30.50	46,000	8 a. m.	30.17	43,000
2	16.00	2,280	3 p. m.	31.35	55,000	4 p. m.	29.65	37,800
3	17.40	2,780	6	32.15	63,200	12	29.15	34,600
4	18.45	3,200	9	32.90	70,900			
5	19.05	3,490	12	33.50	77,500	*Jan. 29*		
6	19.65	3,800						
7	20.20	4,000	*Jan. 25*			12 m.	28.45	28,200
8	20.65	4,370				12 p. m.	27.84	23,600
10	21.33	4,780	4 a. m.	34.15	85,200			
12 m.	21.87	5,160	8	34.72	90,700	*Jan. 30*		
3 p. m.	22.33	5,520	12 m.	34.88	92,700			
6	22.71	5,870	2 p. m.	34.90	92,900			
9	23.12	6,350	6	34.86	92,500	12 m.	27.30	20,300
12	23.67	6,440	12	34.64	89,600	12 p. m.	26.80	17,300

[4] U. S. Weather Bur. record, 1909–22.

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938—Continued

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
Jan. 31			*Feb. 6*			*Feb. 11*		
12 m.	26.30	14,500	8 a. m.	17.68	1,650	12 m.	6.94	347
12 p. m.	25.85	12,000	4 p. m.	16.67	1,420	12 p. m.	6.65	336
Feb. 1			12	15.62	1,210	*Feb. 12*		
12 m.	25.42	10,300	*Feb. 7*			12 m.	6.42	325
12 p. m.	25.01	9,000	8 a. m.	14.54	1,020	12 p. m.	6.22	305
Feb. 2			4 p. m.	13.51	870	*Feb. 13*		
12 m.	24.58	7,700	12	12.51	750	12 m.	6.08	295
12 p. m.	24.12	6,250	*Feb. 8*			12 p. m.	5.96	285
Feb. 3			8 a. m.	11.61	730	*Feb. 14*		
12 m.	23.55	5,150	4 p. m.	10.82	645	12 m.	5.86	275
12 p. m.	23.03	4,450	12	10.10	570	12 p. m.	5.77	265
Feb. 4			*Feb. 9*			*Feb. 15*		
12 m.	22.25	3,430	12 m.	9.12	470	12 p. m.	5.60	245
12 p. m.	21.24	3,030	12 p. m.	8.37	435			
Feb. 5			*Feb. 10*					
8 a. m.	20.43	2,670	12 m.	7.77	408			
4 p. m.	19.58	2,380	12 p. m.	7.28	358			
12	18.65	2,100						

CYPRESS CREEK NEAR JEFFERSON, TEX.

LOCATION.—Lat. 32°45′, long. 94°29′, at Farrell bridge on Jefferson-Harleton highway, 8 miles west of Jefferson, Marion County, and 14 miles upstream from mouth of Black Cypress Creek.

DRAINAGE AREA.—848 square miles.

GAGE-HEIGHT RECORD.—Water-stage recorder graph. Gage heights used to half tenths between 2.9 and 4.9 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements below 15,700 second-feet; extended to peak stage. Discharge for Jan. 21 to 9 a. m. Jan. 23 determined by use of shifting-control method.

MAXIMA.—1938: Discharge, 24,800 second-feet 4 a. m. Jan. 26 (gage height, 24.94 feet).

1924–37: Discharge 26,100 second-feet May 20, 1930 (gage height, 25.37 feet, from floodmarks).

REMARKS.—No diversions or regulations.

Mean discharge, in second-feet, and runoff, in acre-feet, 1938

Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet
Jan. 21	376	746	Jan. 30	5,100	10,120	Feb. 7	1,150	2,280
22	400	793	31	3,720	7,380	8	958	1,900
23	752	1,490				9	828	1,640
24	1,500	2,980	Feb. 1	2,820	5,590	10	708	1,400
25	15,600	30,940	2	2,310	4,580	11	632	1,250
26	24,000	47,600	3	1,970	3,910	12	564	1,120
27	18,500	36,690	4	1,720	3,410	13	516	1,020
28	12,600	24,990	5	1,520	3,010	14	484	960
29	8,000	15,870	6	1,330	2,640	15	456	904

Runoff, in acre-feet, for period Jan. 21 to Feb. 15 215,200

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
Jan. 21			*Jan. 27*			*Feb. 5*		
1 a. m.	7.13	388	6 a. m.	23.12	20,000	12 m.	11.78	1,520
6 p. m.	7.03	364	12 m.	22.48	18,500	12 p. m.	11.45	1,410
12	7.04	376	6 p. m.	21.86	17,000	*Feb. 6*		
Jan. 22			12	21.23	15,300	12 m.	11.12	1,330
8 a. m.	7.15	388	*Jan. 28*			12 p. m.	10.77	1,250
4 p. m.	7.39	414				*Feb. 7*		
12	7.67	456	8 a. m.	20.46	13,600	12 m.	10.40	1,150
Jan. 23			4 p. m.	19.70	11,700	12 p. m.	10.02	1,050
9 a. m.	7.98	564	12	19.03	10,100	*Feb. 8*		
12 m.	8.13	650	*Jan. 29*			12 m.	9.65	958
4 p. m.	8.93	808	8 a. m.	18.51	8,980	12 p. m.	9.30	890
8	9.67	981	4 p. m.	17.72	7,230	*Feb. 9*		
12	10.38	1,150	12	17.15	6,230	12 m.	8.98	828
Jan. 24			*Jan. 30*			12 p. m.	8.68	768
6 a. m.	11.09	1,330	12 m.	16.45	4,960	*Feb. 10*		
12 m.	11.64	1,460	12 p. m.	15.92	4,270	12 m.	8.41	708
6 p. m.	12.16	1,650	*Jan. 31*			12 p. m.	8.18	668
12	13.21	2,010	12 m.	15.42	3,720	*Feb. 11*		
Jan. 25			12 p. m.	14.92	3,200	12 m.	7.97	632
2 a. m.	14.20	2,600	*Feb. 1*			12 p. m.	7.78	596
4	16.15	4,670	12 m.	14.49	2,820	*Feb. 12*		
6	18.36	8,750	12 p. m.	14.10	2,520	12 m.	7.62	564
8	20.00	12,400	*Feb. 2*			12 p. m.	7.47	548
10	21.32	15,200	12 m.	13.75	2,310	*Feb. 13*		
12 m.	22.28	18,000	12 p. m.	13.40	2,100	12 m.	7.33	516
3 p. m.	23.42	20,800	*Feb. 3*			12 p. m.	7.20	500
6	24.14	22,600	12 m.	13.08	1,970	*Feb. 14*		
9	24.60	24,000	12 p. m.	12.75	1,860	12 m.	7.09	484
12	24.82	24,500	*Feb. 4*			12 p. m.	7.00	470
Jan. 26			12 m.	12.42	1,720	*Feb. 15*		
4 a. m.	24.94	24,800	12 p. m.	12.10	1,620	12 p. m.	6.82	442
8	24.85	24,600						
12 m.	24.70	24,200						
6 p. m.	24.26	23,100						
12	23.73	21,600						

SABINE RIVER NEAR GLADEWATER, TEX.

LOCATION.—Lat. 32°32′, long. 94°57′, at bridge on U. S. Highway 271, 1 mile southwest of Gladewater, Gregg County. Zero of gage is 243.85 feet above mean sea level. (Texas Reclamation Department bench mark based on Geological Survey datum).

DRAINAGE AREA.—2,846 square miles.

GAGE-HEIGHT RECORD.—Water-stage recorder graph. Gage heights used to half tenths between 6.9 and 7.3 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements below 39,800 second-feet; extended above to peak stage. Discharge Feb. 1–15 determined from backwater curve.

MAXIMA.—1938: Discharge, 40,600 second-feet 9:30 a. m. Jan. 28 (gage height, 38.34 feet).

October 1932 to 1937: Discharge, 16,000 second-feet June 24, 1935 (gage height, 34.0 feet).

Maximum discharge known, 48,500 second-feet January 1932 (gage height, 39.4 feet, from floodmarks).

REMARKS.—Flood flow not affected by diversions or regulations.

Mean discharge, in second-feet, and runoff, in acre-feet, 1938

Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet
Jan. 21	610	1,210	Jan. 30	31,000	61,490	Feb. 8	3,020	5,990
22	676	1,340	31	24,500	48,600	9	1,900	3,770
23	1,750	3,470	Feb. 1	19,000	37,690	10	1,220	2,420
24	5,450	10,810	2	14,600	28,960	11	850	1,690
25	6,680	13,250	3	11,000	21,820	12	727	1,440
26	14,800	29,360	4	8,900	17,650	13	677	1,340
27	36,300	72,000	5	7,550	14,980	14	642	1,270
28	40,600	80,530	6	6,230	12,360	15	625	1,240
29	37,100	73,590	7	4,660	9,240			

Runoff, in acre-feet, for period Jan. 21 to Feb. 15 557,500

Gage-height, in feet, and discharge, in second-feet, at indicated time, 1938

Time	Feet	Second-feet
Jan. 21		
12 m	7.55	632
12 p. m	7.52	610
Jan. 22		
12 m	7.80	676
4 p. m	7.92	698
8	7.90	698
12	7.85	676
Jan. 23		
4 a. m	7.82	676
6	7.98	720
9	8.00	720
10	8.10	743
11	8.70	881
12 m	9.80	1,150
1 p. m	11.3	1,520
2	12.5	1,820
3	13.8	2,150
4	14.9	2,470
5	15.6	2,680
6	16.2	2,860
7	16.8	3,040
8	17.3	3,200
9	17.7	3,340
10	18.2	3,530
11	19.1	3,890
12	20.0	4,250
Jan. 24		
2 a. m	21.3	4,780
4	22.0	5,100
6	22.4	5,280
8	22.7	5,420
10	22.9	5,500
12 m	23.1	5,600
2 p. m	23.2	5,640
4	23.3	5,680
6	23.4	5,730
8	23.6	5,820
10	23.7	5,860
12	23.9	5,960
Jan. 25		
2 a. m	24.1	6,040
6	24.5	6,220
10	25.0	6,450
2 p. m	25.7	6,760
4	26.0	6,900
6	26.5	7,120
8	26.9	7,300
10	27.4	7,550
12	27.9	7,800
Jan. 26		
2 a. m	28.5	8,100
4	29.0	8,350
6	29.7	8,700
8	30.5	9,220
10	31.4	10,400
12 m	32.3	12,500
Jan. 26—Continued		
2 p. m	33.3	15,200
4	34.0	17,800
5	34.4	19,400
6	34.8	21,000
7	35.1	22,200
8	35.4	23,600
9	35.6	24,500
10	35.9	26,000
12	36.4	28,600
Jan. 27		
2 a. m	36.8	31,000
4	37.1	32,800
6	37.3	34,000
8	37.4	34.600
10	37.6	35,800
12 m	37.75	37,100
4 p. m	38.0	38,500
8	38.18	39,900
12	38.26	40,200
Jan. 28		
4 a. m	38.32	40,400
9:30	38.34	40,600
12 m	38.33	40,400
12 p. m	38.15	39,900
Jan. 29		
4 a. m	38.02	38,500
8	37.88	37,800
12 m	37.76	37,100
4 p. m	37.62	35,800
8	37.46	35,200
12	37.30	34,000
Jan. 30		
6 a. m	37.05	32,200
12 m	36.80	31,000
6 p. m	36.50	29,200
12	36.22	27,500
Jan. 31		
6 a. m	35.94	26,000
12 m	35.65	24,500
6 p. m	35.35	23,600
12	35.07	22,200
Feb. 1		
6 a. m	34.8	21,000
12 m	34.5	19,500
6 p. m	34.2	18,000
12	34.0	16,700
Feb. 2		
6 a. m	33.7	15,600
12 m	33.4	14,500
6 p. m	33.2	13,800
12	32.8	12,400
Feb. 3		
6 a. m	32.6	11,800
12 m	32.3	10,900
6 p. m	32.1	10,400
12	31.8	9,800
Feb. 4		
6 a. m	31.6	9,600
12 m	31.3	8,900
6 p. m	31.0	8,550
12	30.7	8,200
Feb. 5		
12 m	29.9	7,550
12 p. m	29.0	6,920
Feb. 6		
12 m	28.0	6,250
12 p. m	26.8	5,450
Feb. 7		
12 m	25.6	4,700
12 p. m	24.0	3,870
Feb. 8		
12 m	22.1	3,050
12 p. m	19.8	2,330
Feb. 9		
12 m	17.3	1,900
12 p. m	14.8	1,520
Feb. 10		
12 m	12.4	1,200
12 p. m	10.6	990
Feb. 11		
12 m	9.4	840
12 p. m	8.8	776
Feb. 12		
12 m	8.4	730
12 p. m	8.15	695
Feb. 13		
12 m	8.00	675
12 p. m	7.87	660
Feb. 14		
12 m	7.78	645
12 p. m	7.70	632
Feb. 15		
12 m	7.65	620
12 p. m	7.60	617

SABINE RIVER AT LOGANSPORT, LA.

LOCATION.—Lat. 31°58′, long. 94°00′, at Houston East & West Texas (Southern Pacific) Railway bridge in Logansport, De Soto Parish. Zero of gage is 147.72 feet above mean sea level (general adjustment of 1929).

DRAINAGE AREA.—4,858 square miles.

GAGE-HEIGHT RECORD.—Graph drawn on basis of one daily reading of chain gage during low stages and several readings daily during higher stages. Gage heights used to tenths. Gage heights Feb. 17–20 possibly affected by backwater.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements below 35,000 second-feet; extended above to peak stage. Discharge Jan. 26 to Feb. 6 and Feb. 17–20 determined by shifting-control method.

MAXIMA.—1938: Discharge, 25,700 second-feet 7 p. m. Feb. 7 (gage height, 31.36 feet, from graph based on gage readings).

1903–37: Discharge observed, 47,000 second-feet May 5, 1915 (gage height, 36.9 feet).

Maximum stage known, 39.4 feet, present datum, in May 1884.

REMARKS.—Flood flow not affected by diversions or regulations.

Mean discharge, in second-feet, and runoff, in acre-feet, 1938

Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet
Jan. 26	5,730	11,370	Feb. 3	9,200	18,250	Feb. 12	18,800	37,290
27	6,060	12,020	4	11,700	23,210	13	17,400	34,510
28	6,620	13,130	5	17,900	35,500	14	16,200	32,130
29	7,220	14,320	6	23,800	47,210	15	14,800	29,360
30	7,700	15,270	7	25,400	50,380	16	12,900	25,590
31	8,120	16,110	8	25,000	49,590	17	9,800	19,440
Feb. 1	8,360	16,580	9	23,800	47,210	18	7,700	15,270
2	8,600	17,060	10	22,200	44,030	19	6,620	13,130
			11	20,400	40,460	20	6,390	12,670

Runoff, in acre-feet, for period Jan. 26 to Feb. 20 691,100

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Time	Feet	Second-feet
Jan. 26		
1 a. m.	16.30	5,730
8	16.24	5,680
12 m.	16.27	5,730
12 p. m.	16.48	5,840
Jan. 27		
12 m.	16.85	6,060
12 p. m.	17.35	6,280
Jan. 28		
8 a. m.	17.64	6,500
4 p. m.	17.95	6,740
12	18.25	6,860
Jan. 29		
8 a. m.	18.55	7,100
4 p. m.	18.84	7,280
12	19.10	7,460
Jan. 30		
8 a. m.	19.32	7,640
4 p. m.	19.55	7,760
12	19.78	7,880
Jan. 31		
12 m.	20.08	8,120
12 p. m.	20.30	8,240
Feb. 1		
12 m.	20.48	8,360
12 p. m.	20.70	8,480
Feb. 2		
12 m.	20.90	8,600
12 p. m.	21.16	8,780
Feb. 3		
8 a. m.	21.40	8,920
4 p. m.	21.80	9,360
12	22.30	9,800
Feb. 4		
4 a. m.	22.60	10,100
8	23.00	10,600
12 m.	23.45	11,200
2 p. m.	23.75	11,500
4	24.15	12,000
6	24.60	12,600
Feb. 4—Continued		
8 p. m.	24.95	13,100
10	25.35	13,600
12	25.75	14,300
Feb. 5		
2 a. m.	26.10	14,800
4	26.50	15,300
6	26.90	16,000
8	27.25	16,600
10	27.65	17,200
12 m.	28.00	18,000
2 p. m.	28.30	18,600
4	28.60	19,200
6	28.85	19,700
8	29.15	20,400
10	29.40	20,900
12	29.65	21,600
Feb. 6		
2 a. m.	29.90	22,200
4	30.08	22,400
6	30.26	23,000
8	30.42	23,600
10	30.55	23,800
12 m.	30.65	23,800
4 p. m.	30.85	24,400
8	31.00	24,700
12	31.10	25,000
Feb. 7		
4 a. m.	31.20	25,000
8	31.26	25,400
12 m.	31.32	25,400
4 p. m.	31.35	25,600
7	31.36	25,700
12	31.34	25,400
Feb. 8		
12 m.	31.20	25,000
12 p. m.	31.02	24,400
Feb. 9		
12 m.	30.78	23,800
12 p. m.	30.50	23,000
Feb. 10		
12 m.	30.20	22,200
12 p. m.	29.90	21,400
Feb. 11		
12 m.	29.50	20,400
12 p. m.	29.18	19,700
Feb. 12		
12 m.	28.86	19,000
12 p. m.	28.50	18,200
Feb. 13		
12 m.	28.12	17,400
12 p. m.	27.80	16,800
Feb. 14		
12 m.	27.46	16,200
12 p. m.	27.15	15,700
Feb. 15		
12 m.	26.75	15,000
12 p. m.	26.30	14,100
Feb. 16		
12 m.	25.70	13,100
12 p. m.	24.85	11,700
Feb. 17		
4 a. m.	24.45	11,200
8	24.05	10,500
12 m.	23.65	9,900
4 p. m.	23.20	9,360
8	22.65	8,920
12	22.15	8,540
Feb. 18		
4 a. m.	21.80	8,240
8	21.50	8,000
12 m.	21.20	7,820
4 p. m.	20.80	7,580
8	20.40	7,340
12	20.00	7,100
Feb. 19		
4 a. m.	19.65	6,860
8	19.36	6,740
12 m.	19.20	6,620
4 p. m	19.00	6,500
8	18.90	6,440
12	18.80	6,340
Feb. 20		
8 a. m.	18.70	6,390
4 p. m.	18.65	6,390
12	18.66	6,390

FLOOD OF JUNE 1938 ON LAKE CREEK, DONLEY COUNTY, TEX.

From 1 to 5 inches of rain fell on Donley County between 5 and 12 p. m., June 14. As the ground was dry previous to this rain, very little runoff resulted. On the night of June 15 a heavy rain, amounting to 14 inches at one place, fell on Lake Creek Basin, in Donley County. This rain is reported to have fallen in from 1 to 4 hours, with an average time of about 2 hours. The resulting flood on Lake Creek was greater than any known to have occurred on that creek.

Lake Creek drains a rolling area along the east edge of the high plains of the Texas Panhandle. The sandy stream channels are usually dry except during periods of rain. As the average annual rainfall of about 23 inches has not developed a well-defined drainage system, much of the country forms shallow depressions that fill with water during rains and form small lakes. It is difficult to determine accurately the watersheds of the streams as no sharply defined divides exist. There are very few outcroppings of rock or other hard material that would tend to cause rapid runoff. Terraces designed to hold a 5-inch rain had been built on part of the drainage basin. It is believed that by failure of the terraces the peak discharge on Lake Creek was increased over what the normal peak would have been.

Several persons reported having seen in Lake Creek at the highway bridge near Lelia Lake a wall of water about 4 feet high, which in part may have been caused by breaking of terraces.

The Donley County Leader, published at Clarendon, Tex., reported in the issue of June 16, 1938:

> The Government [rain] gage showed a [rain] fall of 2.65 [inches] last night. The [rain] fall the day before was 1.3 [inches]. * * *
>
> Heavy rains fell over the county, but no serious damage was done except by hail near Ashtola and near Hedley. * * *
>
> Lightning put the local power plant out of commission after it had disabled the high line. * * * Out at the S. A. Pierce farm * * * a bolt followed the radio line into the home, doing quite a damage. A short time later, a bolt set fire to the batbroom, burning the paper from one wall and the ceiling. * * *
>
> High wind destroyed the windmill on the Kinch Leathers farm. No other wind damage was noted except to shade trees, limbs being torn away. * * *
>
> East of town the greatest damage was noted. The S. W. Butler home was marooned on an island for the first time since the home was built more than 20 years ago. Practically the entire acreage was under water. * * *
>
> Lakes were formed in new places for the first time in years. Lister ridges were leveled and gulleys washed across fields that a few hours before showed fine crops on comparatively level ground. * * *
>
> Traffic between Hedley and Clarendon was virtually at a standstill this morning as creeks and lakes went over the road following the deluge which was estimated to bring the 2-day total in Lelia Lake to within 14 inches.
>
> Train service for Clarendon was expected to be halted for at least 48 hours as section crews worked rapidly to repair at least 2 miles of washed-up track. Bridge abutments and low fills were leveled by torrents. * * *

The heavy rains covered most of the county, causing an erosion damage running well into thousands of dollars. Salt Fork is said to have been out of its normal banks about 2 a. m. * * *

The first major tragedy on the Denver and Northern came last night when a train reached the Salt Fork Bridge between Wellington and Shamrock. The engine went through the bridge weakened by flood waters, carrying with it the engineer and fireman, who are still missing. [The] brakeman * * * was rescued from the river bank 5 miles below the scene of the wreck. * * *

When the raging waters coming down Windy Valley, some 5 miles south of Lelia Lake, reached the windows at the Roy Darnell home, Mr. and Mrs. Darnell grabbed quilts and made for a large tree in the yard. An improvised platform made from a table enabled them to spend the remainder of the night high above flood waters in a tree top.

The muddy waters and treacherous sands of east Lelia Lake Creek refused to give up its dead late today as hundreds of searchers probed deep pools and tangled underbrush for the bodies of three victims, supposedly drowned when their car was swept from the bridge about 11 o'clock last night. * * * Information from Wichita Falls said the victims had left there about 5 o'clock yesterday afternoon. They were within a mile of Lelia [Lake] when the wall of water, which reached 5 feet above the car bridge, struck them.

PRECIPITATION

Measurements and estimates of rainfall were obtained at a number of farms and ranches, but part of the area covered by the heavy rain is ranch property on which there were no residents to observe the precipitation.

The information obtained from farmers and ranchers is consistent. Many people spent a sleepless night, partly in storm cellars, and were able to note accurately the time the rain began and ended. The Weather Bureau rain gage at Clarendon (the only one in the vicinity of the storm) and the two gages of the Soil Conservation Service in the Windy Valley area, about 10 miles southeast of Lelia Lake, were outside the area of most intense precipitation.

All available rainfall data are given in table 3. Figure 4 is a map of Lake Creek Basin and adjacent area showing the location of the rainfall stations listed in table 3, location of places at which the peak discharge was determined, and isohyetals for the precipitation of June 15. Owing to inadequate coverage of the area by rain gages, the isohyetals shown are subject to considerable error over much of the area.

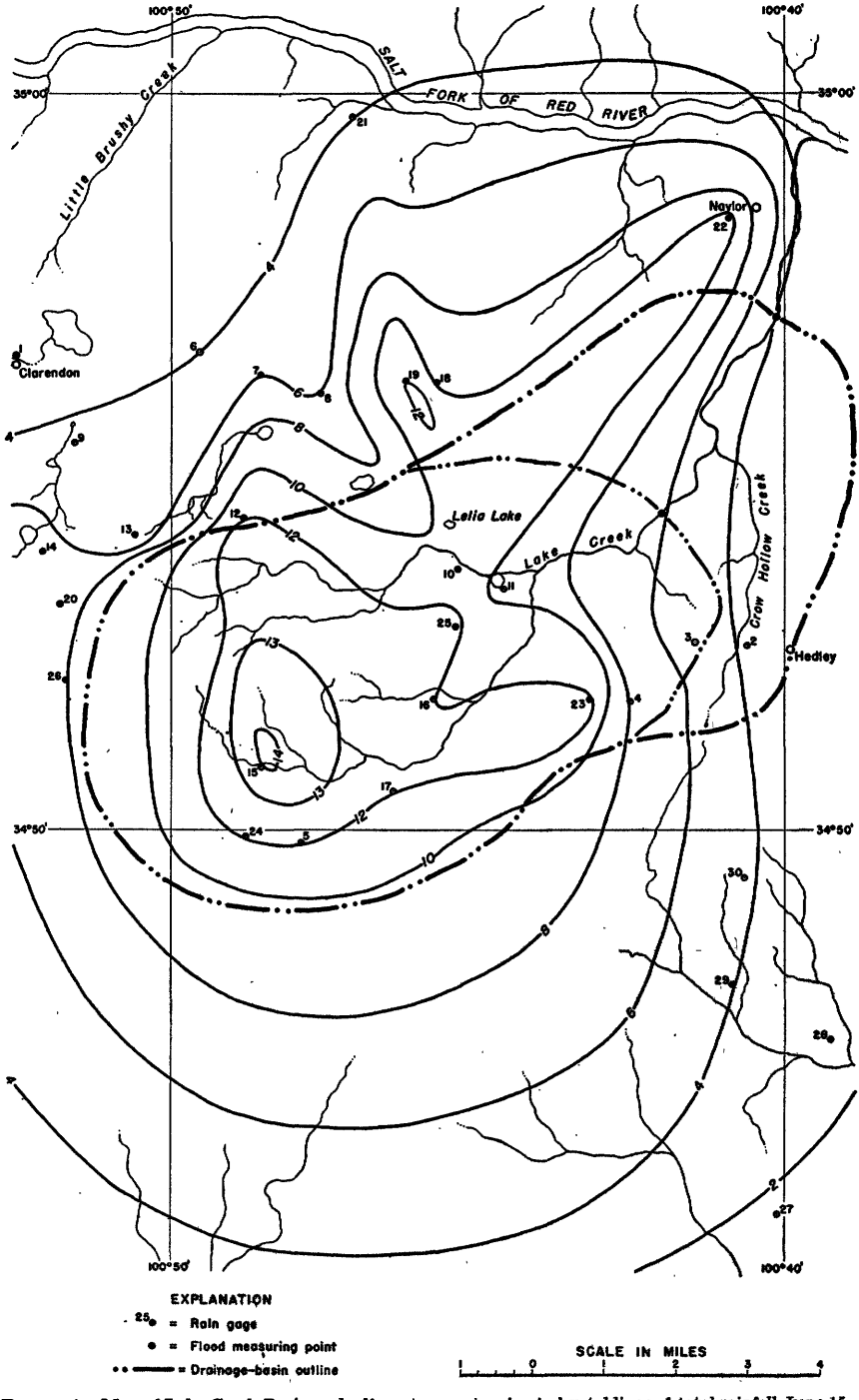


FIGURE 4.—Map of Lake Creek Basin and adjacent area, showing isohyetal lines of total rainfall June 15, 1938, location of rain gages, and places at which the peak discharge was determined.

TABLE 3.—*Rainfall in Lake Creek Basin and adjacent area, June 1938*

No. on fig. 4	Location [a]	Type of gage	Rainfall			
			June 14 (inches)	June 15		
				Inches	Time	Remarks
1	Clarendon	U. S. Weather Bureau standard	1.30	2.55	9 p. m. to 11 p. m.	
2	Hedley, 0.8 mile west	Can on post 6 feet above ground	2.5	3.5	8 or 9 p. m. to 11 or 12 p. m.	Measured with scale.
3	Hedley, 1.5 mile west	No. 2 wash tub	2 to 3	6±	8:30 p. m. to 12 p. m.[b]	Estimated.
4	Hedley, 2.5 miles south of west		3	8		Do.
5	W. W. Williams Survey, sec. 1	Straight-sided can	[c] 4	12	8 p. m. to 2 a. m., June 16	Measured with scale.
6	Block C 6, sec. 36		1	4		Estimated.
7	Block C 6, sec. 37	6-inch straight-sided bucket	[c] 3	6+		Bucket ran over.
8	Block C 6, sec. 39		[c] 5 or 6	6	8 p. m. to 12 p. m.	Estimated.
9	Block C 6, sec. 43			4.5		Do.
10	Block C 6, sec. 64	Stock water tank	[c] 3	11	8–8:30 p. m. to 11–12 p. m.	Tank has small leak.
11	Block C 6, sec. 66, NW. corner	3-gallon crock	4	9.75	9:15 p. m. to 2:15 a. m., June 16	Measured with scale.
12	Block C 6, sec. 71, NW¼	7½-inch coffee can	[d]	12	9–10 p. m. to 11 p. m.	Estimated; can ran over.
13	Block C 6, sec. 73		2	4.5		Estimated; poor.
14	Block C 6, sec. 74	Lard can and No. 1 wash tub		7	5 p. m. to ?	
15	Block C 6, sec. 84	Wash tub	[c] 1	14	9 p. m. to 11:30 p. m.	Approximate amount.
16	Block C 6, sec. 87, SW¼	Stock water tank	1	12	9 p. m. to 11 p. m.[e]	Measured with scale.
17	Block C 6, sec. 93	5-gallon can		12		Do.
18	Block C 6, sec. 108	25-pound grease can, 9-inch capacity	[c] 5	10	8 p. m. to 9:45 p. m.	Estimated; 1 inch ran over.
19	0.5 mile west of preceding location	20-gallon wash pot, 18 inches high		12±		Observed morning of June 16.
20	Block C 6, sec. 133	9-inch straight-sided can	[c] 1 to 1.5	7	10 p. m. to 1 a. m., June 16	Measured with scale.
21	Block C 7, sec. 14	Straight-sided can	[c] 1	4	During night	Do.
22	Block C 7, sec. 28		4	10+		Estimated.
23	Block E, sec. 130			12	8 p. m. to 11 p. m.[f]	Do.
24	Block E, sec. 153			12		Do.
25	Block G, sec. 13	No. 3 wash tub, straight sides	[c] 1.5 to 2	12.5	9 p. m. to 12:30 a. m., June 16	Measured with scale.
26	Block G 7, sec. 20		1	8		Estimated.
27	Block 20, sec. 28 or 29	Made by C. C. C.	.60	1.50		Written record.
28	Block 20, sec. 48		[c] 2.9	3.5		Estimated.
29	Block 20, sec. 52	Made by C. C. C., 3-inch capacity	2.4	4.0	10 p. m. to 11:30 p. m.	Estimated; gage ran over.
30	Block 20, sec. 72	1-gallon crock, straight sides		4+		Estimated.

[a] See Texas Land Office map of Donley County.
[b] Hardest rain 9 to 11 p. m.
[c] Estimated.
[d] Good rain.
[e] Most of rain fell in 1 hour.
[f] About three-fourths of rain fell from 8 to 9:15 p. m.

DISCHARGE RECORDS

No stream-measurement station is located in the Lake Creek Basin, but two slope-area measurements of peak discharge were made at reaches located as shown on figure 4. Results of those measurements, drainage areas, and other data are given in table 4.

Records for the river-measurement station on Salt Fork of the Red River at Mangum, Okla., about 70 miles downstream from Lake Creek, give some indication of the flow from the creek. Rainfall in other parts of the basin was light, and most of the water passing the Mangum station probably came from Lake Creek.

TABLE 4.—*Maximum discharge of Lake Creek, June 1938*

Location	Latitude	Longitude	Drainage area (square miles)	Maximum discharge		
				Time	Second-feet	Second-feet per square mile
	° ′	° ′				
Near Lelia Lake	34 53	100 43	48.6	June 15, about 12 p. m.	40,800	840
Near Hedley	34 56	100 42	68.5	June 15, about 12 p. m.	64,700	945

SALT FORK OF RED RIVER AT MANGUM, OKLA.

LOCATION.—Lat. 34°52′, long. 99°31′, in SW¼SE¼ sec. 34, T. 5 N., R. 22 W., at bridge on State Highway 34, half a mile south of Mangum. Zero of gage is 1,490.78 feet above mean sea level (general adjustment of 1929).

DRAINAGE AREA.—1,390 square miles.

GAGE-HEIGHT RECORD.—Wire-weight gage read twice daily to hundredths.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements below 6,530 second-feet; extended to peak stage. Stream channel unstable.

MAXIMUM.—1938: Discharge, not determined, occurred 12 m. June 16 (gage height, 14.7 feet observed).

REMARKS.—Records poor.

Mean discharge, in second-feet, and runoff, in acre-feet, 1938

Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet
June 14	14	28	June 18	664	1,320	June 22	181	359
15	1,850	3,670	19	301	597	23	133	264
16	11,100	22,020	20	249	494	24	100	198
17	1,390	2,760	21	235	466			

Runoff in acre-feet for period June 14-24 32,180

FLOODS OF JULY 1938 IN COLORADO RIVER BASIN

Destructive floods occurred in the Colorado River Basin in late July and early August 1938. Portions of 12 counties were inundated, 6 people were reported drowned, and property and crop losses have been estimated at $5,000,000.[5]

The floods were caused by heavy rains that centered over the watershed of the San Saba and South Concho Rivers and Brady Creek. The heaviest 1-day rain reported was 13 inches at two places, 8 and 10 miles north of Eldorado, on July 23. The heaviest 1-day rain recorded by the Weather Bureau was 8.47 inches at Sloan, also on July 23; the total rain July 16–25 at this place was 21.49 inches. Thirty inches of rain was reported for the period July 16–25 at a gage near Eldorado, and 20 inches or more at about 70 places for the same period. The rainfall, though rather general over the upper Colorado River Basin from July 19 to 24, was intense during several periods.

Small streams rose rapidly and caused considerable damage to highways, bridges, and crops. Stages in the lower Colorado River rose more slowly; the peak did not occur at Eagle Lake until July 29. Probably 90 percent of the losses from the flood occurred along the Colorado River below Austin, where the stream passes through the relatively flat coastal plain and a large part of the abutting land is under cultivation.

Record-breaking floods occurred in the South Concho and San Saba River Basins and in the Colorado River from the mouth of the San Saba to the mouth of the Llano; below the Llano River stages were lower than in 1935. Especially severe floods occurred on the San Saba River and on Brady Creek, a tributary, with stages much higher than those known to have occurred in the past.

The reservoir formed by Buchanan Dam, located on the Colorado River a few miles above the Llano River, was well filled prior to the flood. The heavy rains fell from 50 to 75 miles above the reservoir, and the floods passed down the stream channels so rapidly that little time was available for lowering the reservoir. Although a number of gates were opened, no great amount of storage space was available when the flood reached the reservoir.

METEOROLOGIC CONDITIONS

The following discussion of heavy rains in central Texas has been prepared by Mr. C. E. Norquest, senior meteorologist, United States Weather Bureau, at Houston:

Phenomenally heavy rainfall occurred in central Texas during the week of July 19–25, 1938. Rainfall, in inches, as reported by stations of the United States Weather Bureau, equipped with standard rain gages and manned by experienced

[5] Monthly Weather Rev., p. 297. September 1938.

observers, is as follows: Brackettville, Kinney County, 10.06; Substation No. 14, Sutton County, 12.55; Menard, Menard County, 14.13; Eden, Concho County, 16.44; Brady, McCulloch County, 13.61; Llano, Llano County, 10.19; Sloan, San Saba County, 21.24; Goldthwaite, Mills County, 12.39.

The causes of this prolonged and torrential downpour are not readily discernible on the surface weather maps—no strongly developed center of disturbance crossed the country during this period; no tropical storm moved inland from the Gulf or was present on the Gulf; pressure gradients were for the most part very flat.

However, from July 18 to 22 a broad, rather shallow depression trough extended from the Middle Atlantic States southwestward across Texas into northern Mexico. At the same time a field of high pressure made its appearance in the Canadian northwest and moved slowly southward along the eastern slope of the Rocky Mountains. This combination set in motion one of the most effective processes for the condensation and precipitation of atmospheric moisture about which anything is known—the raising of a mass of moisture-laden air and thus reducing its temperature and carrying capacity. Meteorological observations indicate a persistent flow of tropical air for the period July 18–25, and soundings of the uppper air show that this air was moist and convectively unstable.

A helpful discussion of air-mass properties and movements is found in Civil Aeronautics Bulletin No. 25, "Meteorology for Pilots," by B. C. Haynes.

PRECIPITATION

Immediately after the storm an extensive search was made for information regarding rainfall in areas remote from official gages. As a result of several years of effort and experience in obtaining additional rainfall information many persons are known who regularly maintain rain gages. Many of these gages are of standard United States Weather Bureau type or are vessels that are suitable for reasonably accurate measurement of the rainfall. Many measurements made in cans, tubs, troughs, washpots, stock water-tanks, or other vessels are perhaps not highly accurate, but they may be used with confidence when several such measurements in the same locality are found to agree satisfactorily.

The available records of rainfall for the storm period are given in tables 5 and 6. Table 5 contains the records for the Weather Bureau stations and for others having daily records of rainfall. The stations for which only the total rainfall for the period July 16–25 is available are given in table 6.

TABLE 5.—*Daily and total rainfall, in inches, July 16–25, 1938, at points in central Texas*

[T=less than 0.01 inch]

Station	Latitude	Longitude	July										
			16	17	18	19	20	21	22	23	24	25	16–25
U. S. Weather Bureau													
Brazos River Basin:	° ′	° ′											
Abilene [a]	32 27	99 43	------	T	0.73	------	3.18	0.13	1.02	0.59	1.80	T	7.45
Comanche [b]	31 54	98 36	------	------	T	0.38	------	.44	.50	1.58	2.18	1.72	6.80
Copperas Cove [b]	31 07	97 54	------	------	------	.69	------	.45	2.76	2.62	.26	.20	6.98
Dublin [c]	32 05	98 20	------	------	------	.33	.09	.24	.34	.60	1.24	1.34	4.18
Eastland [c]	32 24	98 48	------	------	T	1.10	.10	.07	T	2.35	1.30	1.20	6.12
Gatesville [b]	31 26	97 45	------	------	------	2.35	------	.27	2.58	3.92	.14	.27	9.53
Hamilton [c]	31 43	98 07	------	------	------	1.62	------	.27	1.24	1.32	1.12	.98	6.55
Hico [b]	31 59	98 01	------	------	.13	.60	------	.26	.67	1.40	.29	1.47	4.82
Lampasas [c]	31 04	98 10	------	------	------	------	.92	.32	1.11	1.46	3.23	.96	8.00
Putnam [b]	32 23	99 12	------	0.63	1.55	------	1.02	------	2.18	.22	1.24	.12	6.96
Roscoe [b]	32 27	100 31	------	------	1.35	T	.54	------	.31	.18	.43	T	2.81
Colorado River Basin:													
Austin [a]	30 16	97 44	------	------	------	------	.06	.13	.39	.62	.06	T	1.26
Ballinger [c]	31 44	99 56	------	------	.10	T	T	T	.10	.70	T	.28	1.18
Big Spring [c]	32 14	101 28	------	------	T	2.56	.09	1.31	.06	.15	.61	.49	5.27
Brady [c]	31 08	99 20	------	------	.04	.02	1.42	2.63	4.39	3.54	1.10	.51	13.65
Brownfield [b]	33 11	102 16	------	------	------	------	------	------	.16	.10	------	------	.26
Brownwood [c]	31 43	98 59	------	------	1.23	.89	.21	.46	1.02	1.15	3.50	1.50	9.96
Coleman [b]	31 50	99 25	------	.45	.23	------	------	.32	.21	.70	3.50	1.40	6.81
Columbus [b]	29 42	96 33	------	------	------	------	------	1.26	------	.06	------	.23	1.55
Eden [c]	31 13	99 51	------	.48	.45	2.10	1.60	1.58	1.39	6.89	2.86	.02	17.37
Fairland [b]	30 39	98 17	------	------	------	T	T	.67	.28	2.20	.05	.27	3.47
Gail [b]	32 45	101 27	------	------	------	.44	.80	------	------	------	1.04	------	2.28
Garden City [b]	31 52	101 29	------	------	------	------	.10	------	.25	.75	.90	.75	2.75
Goldthwaite [b]	31 27	98 34	------	------	T	1.50	.06	1.50	2.37	4.37	.83	1.76	12.39
Knapp (near) [b]	32 34	101 23	------	------	.10	.12	.71	------	.45	.36	2.50	.34	4.58
La Grange [b]	29 55	96 52	------	------	------	------	.88	------	.40	------	.15	.10	1.53
Lamesa [c]	32 44	101 56	0.15	.05	.25	.20	.02	2.80	.05	.03	.05	.04	3.64
Llano [c]	30 45	98 40	------	------	------	T	.13	2.00	.51	.10	.70	6.75	10.19
Marble Falls [c]	30 34	98 17	------	------	------	------	------	------	.01	1.70	.59	.14	2.44
Menard [b]	30 55	99 47	------	------	------	------	2.02	4.40	4.00	1.93	1.59	.19	14.13
Morris ranch [b]	30 13	99 04	------	------	------	.04	.50	.90	.10	.07	.06	.85	2.52
Paint Rock [b]	31 30	99 55	------	1.34	.19	3.93	.07	.63	.21	1.51	.90	.05	8.83
San Angelo [c]	31 28	100 26	------	------	.28	T	1.32	.49	.13	.83	.36	.29	3.61
Seminole [b]	32 42	102 31	------	T	.63	T	.12	.39	.02	.37	T	1.62	3.15
Sloan [b]	31 07	98 57	------	------	.25	1.37	.70	3.70	3.92	8.47	.22	2.86	21.49

See footnotes at end of table.

TABLE 5.—*Daily and total rainfall, in inches, July 16–25, 1938, at points in central Texas*—Continued

[T=less than 0.01 inch]

Station	Latitude	Longitude	July										
			16	17	18	19	20	21	22	23	24	25	16–25
U. S. Weather Bureau—Continued													
Colorado River Basin—Continued.	° ′	° ′											
Smithville [b]	30 01	97 10	------	------	------	------	------	0.61	0.43	1.64	T	T	2.68
Snyder [c]	32 44	100 55	------	------	------	------	0.07	.92	.06	.21	1.47	0.32	3.05
Sterling City [b]	31 51	100 59	------	------	0.20	0.10	------	.30	.60	2.15	.10	1.75	5.20
Wharton [c]	29 19	96 07	1.05	0.03	------	------	------	------	.09	.55	.37	1.43	3.52
Miscellaneous basins:													
Blanco [c]	30 05	98 25	------	------	------	------	------	------	.15	.20	.40	.10	.85
Brackettville [a]	29 18	100 25	------	------	------	------	------	------	.37	3.69	5.92	.08	10.06
Kerrville [c]	30 01	99 07	------	------	------	------	------	.47	.13	.14	.72	.12	1.58
Montell [b]	29 32	100 01	------	------	------	------	.26	T	.70	1.42	2.04	.50	4.92
Sonora [c]	30 34	100 38	------	------	------	------	.12	.34	4.39	4.22	.44	3.04	12.55
Supplementary													
Colorado River Basin:													
Art	30 44	99 07	(d)	(d)	.37	.37	(d)	1.62	(d)	3.00	(d)	(d)	9
Bangs, 2 miles east	31 43	99 05	------	.25	------	.75	------	1.00	.50	1.37	4.00	2.00	9.87
Brady-Hext road, 2½ miles east of and north of San Saba River	30 57	99 23	------	------	------	.62	2.00	7.50	8.50	1.50	------	------	20.12
Brownwood, 5 miles east on Highway 67	31 42	98 54	------	------	------	.25	------	1.12	2.75	2.75	2.75	1.25	10.87
Carlsbad, 1½ miles southeast on Highway 87	31 36	100 36	.10	------	.20	.10	.24	.20	.84	.70	1.30	.10	3.78
Christoval	31 13	100 29	------	.25	1.37	------	1.37	.88	1.12	3.00	.50	T	8.49
Eldorado	30 52	100 35	(d)	(d)	(d)	(d)	1.30	2.2	1.90	5.00	(d)	(d)	12.0
Elkins, on old San Saba-Brownwood road	31 35	98 53	------	------	------	3.62	2.00	1.50	2.75	3.50	2.00	2.00	17.37
Fort McKavett, at Herbert Mears [c]	30 51	100 02	------	------	------	1.44	2.00	2.00	4.37	3.61	1.56	------	14.98
Fredonia, ¾ mile west and 5 miles north	31 00	99 08	------	------	.37	1.50	2.25	2.30	4.37	.75	1.00	.50	13.04
Hext	30 53	99 32	------	------	------	------	2.0	6.00	6.00	1.00	.50	------	[f] 15.5
Junction, 23 miles southwest on Highway 29	30 12	100 05	------	------	------	------	3.00	3.00	.87	.37	.50	------	7.74
Lone Grove, 3 miles south, at mouth of Little Llano River	30 46	98 33	------	------	------	.18	.50	1.38	.80	1.50	2.90	------	7.34
Mason	30 44	99 14	------	------	------	10.10	.48	1.38	4.20	.21	.29	.30	16.96
Melvin	31 12	99 34	2.5	1.5	------	1.5	2.5	3.5	3.50	3.50	3.5	------	22
Menard [c]	30 56	99 46	------	------	------	.85	1.30	5.50	6.05	2.55	.35	------	16.60
Menard, north of, on Dry Creek [c]	31 01	99 45	------	------	------	2.84	3.48	4.40	4.85	7.13	.63	------	23.33
Mullin	31 33	98 40	------	------	------	3.25	------	1.75	3.50	4.00	1.5	1.50	15.5
Richland Springs	31 16	98 57	------	------	.25	2.00	1.50	3.25	2.25	8.50	1.50	------	19.25
Rock Springs, 2 miles northeast	30 03	100 12	------	------	------	------	3.00	3.0	3.00	4.00	.5	------	13.5
San Angelo, 12 miles southeast on Highway 87	31 22	100 18	------	------	1.06	.45	------	.76	.89	.60	.10	------	3.86
San Saba [c]	31 12	98 44	------	------	.35	1.80	2.00	2.30	2.00	6.00	------	4.20	18.65
San Saba	31 12	98 44	(d)	(d)	(d)	1.80	2.00	3.30	(d)	7.00	(d)	(d)	17.75

San Saba, 2 miles north on Highway 81	31	13	98	44	-------	-------	-------	3.00	.75	3.50	3.00	5.50	.25	5.75	[f] 21.75
San Saba, 10 miles northwest on Regency Road	31	19	98	49	-------	-------	-------	2.75	.75	2.90	2.80	7.00	1.75	5.75	23.7
Speck ranch, northwest corner Menard County	31	04	100	04	-------	-------	3.00	1.5	8.0	8.00	1.0	1.00	1.0	-------	23.5
Streeter, 3 miles west on Highway 29	30	44	99	25	-------	-------	-------	-------	.75	3.12	4.25	.75	-------	-------	8.87
Whiteland [e]	31	10	99	30	-------	-------	1.75	1.25	4.0	4.0	5.0	4.00	-------	-------	20
Winchell	31	29	99	09	(d)	(d)	(d)	3.50	(d)	(d)	4.25	4.25	1.50	1.50	16.37
Miscellaneous:															
Lometa	31	13	98	23	-------	-------	-------	1.00	.25	.75	2.25	2.87	2.75	2.62	12.49
Sonora	30	33	100	38	-------	-------	.35	.05	-------	3.84	3.47	1.75	-------	3.12	12.58

[a] Midnight to midnight.
[b] Measured at sunset.
[c] Measured in the morning.
[d] Daily rainfall not measured.
[e] Record furnished by Corps of Engineers, U. S. Army.
[f] Doubtful.

TABLE 6.—*Total rainfall at miscellaneous points in central Texas, July 16–25, 1938*

Station	Latitude	Longitude	Rainfall (inches)
Colorado River Basin			
Concho River Basin:	° ′	° ′	
Broome	31 45	100 52	3.5
Christoval, 6½ miles south on Highway 277	31 06	100 31	18
Christoval, 20 miles southeast on divide	30 59	100 24	25
Eden, 4½ miles west on Highway 87	31 14	99 57	21
Eden, 9 miles north on Highway 83	31 19	99 53	17.5
Eldorado, 3 miles north on Highway 277	30 55	100 35	16
Eldorado, 4 miles north on Highway 277	30 56	100 36	17
Eldorado, 5 miles northwest on Mertzon road	30 56	100 39	26
Eldorado, 7 miles north on Highway 277	30 58	100 36	14
Eldorado, 8 miles north on Highway 277	30 59	100 36	[a] 29
Eldorado, 10 miles north on Highway 277	31 01	100 35	[b] 30
Eldorado, 11 miles north on Highway 277	31 02	100 34	14
Eldorado, 15 miles northwest on Mertzon road	31 02	100 44	16
Mereta	31 27	100 08	3.5
Mertzon	31 15	100 48	10
Mertzon, 2 miles south on Highway 67	31 13	100 49	10
Mertzon, 7 miles northeast	31 17	100 44	6
Mertzon, 10 miles south on Eldorado road	31 08	100 47	14
Paint Rock, 8 miles south on Highway 83	31 24	99 54	12
San Angelo, 7 miles south on Highway 277	31 21	100 26	2.5
Water Valley	31 40	100 44	5.5
San Saba River Basin:			
Algerita, 1½ miles southwest	31 12	98 52	22.5
Brady, 7 miles northwest [c]	31 12	99 25	19.75
Brady-Mason highway bridge, 3 miles west of, on San Saba River [c]	30 59	99 13	13
Calf Creek, south of, on San Saba River [c]	30 56	99 26	20
Calf Creek, southeast of, on San Saba River [c]	30 57	99 25	20
Camp San Saba, 2 miles south [c]	30 58	99 15	26
Camp San Saba, 4 miles west [c]	30 59	99 19	20
Camp San Saba, 6 miles west [c]	30 57	99 20	13.5
Camp San Saba, 7 miles west [c]	30 55	99 20	9.5
Camp San Saba, 7 miles northeast [c]	31 02	99 12	18
Eden, 5 miles southeast [c]	31 10	99 47	16.5
Eden, 2 miles south and 5 miles west	31 10	99 56	17.62
Eden, 10 miles southeast [c]	31 04	99 51	20
Eden, 10 miles southeast [c]	31 04	99 49	24
Eden, 4 miles south and 10 miles west	31 08	100 01	22
Eden, 12–14 miles west	31 09	100 01	[d] 25
Eden, 15 miles southeast [c]	31 04	99 39	21
Eden, 18 miles west	31 04	100 05	24
Eldorado, 1 mile south and 5 miles east	30 51	100 31	20
Eldorado, 6½ miles south on Highway 277	30 46	100 37	13
Fort McKavett	30 49	100 06	20
Fort McKavett [c]	30 50	100 06	16
Fort McKavett, 4 miles east [c]	30 50	100 01	20
Fort McKavett, 4½ miles southwest [c]	30 47	100 08	24
Fort McKavett, 6 miles east	30 51	100 02	[e] 22
Fort McKavett, 7 miles north and of 14 miles west of Menard	30 54	100 03	23
Fort McKavett, 9 miles northeast	30 56	100 03	21
Fort McKavett, 11 miles north of, on Rocky Creek	30 58	100 06	19
Fort McKavett, 15 miles north [c]	30 59	100 16	24
Fort McKavett, northwest of [c]	31 01	100 13	23
Fredonia, 3 miles east, and 4½ miles north [d]	31 00	99 04	17
Harkeyville, 2 miles south [c]	31 10	98 48	18
Hext [c]	30 53	99 33	15
Hext, 3 miles northwest [c]	30 54	99 33	13
Hext, 6 miles northeast [c]	30 55	99 28	15
Katemcy [c]	30 55	99 15	24
Katemcy	30 54	99 15	12
Kimble-Kerr County line on Highway 27	30 16	99 31	[e] 16
Mason, 5½ miles north on Highway 87	30 49	99 15	14
Mason, 12 miles north on Highway 87	30 55	99 16	16
Melvin [c]	31 11	99 36	28
Melvin, south of, at Lightner [c]	31 06	99 31	(f)
Melvin, 4 miles north [c]	31 15	99 36	(g)
Melvin, 4 miles south at Marco	31 08	99 36	[h] 15.5
Melvin, 12 miles southwest [c]	31 11	99 36	(i)
Menard, ½ mile west [c]	30 56	99 46	17
Menard, north of [c]	30 56	99 45	15
Menard, north of [c]	30 56	99 44	18
Menard, 4 miles east [c]	30 55	99 45	20
Menard, 4½ miles east [c]	30 56	99 43	15
Menard, 5 miles east [c]	30 55	99 43	20
Menard, 6 miles southwest of, on Menard-Junction highway	30 51	99 53	[j] 16.75
Menard, 6½ miles southeast [c]	30 54	99 44	18
Menard, 9 miles east [c]	30 53	99 42	20
Menard, 9.6 miles west on Fort McJavett road	30 55	99 55	[e] 23
Menard, 10 miles east [c]	30 53	99 41	20

See footnote at end of table.

TABLE 6.—*Total rainfall at miscellaneous points in central Texas, July 16–25, 1938*—Continued

Station	Latitude	Longitude	Rainfall (inches)
Colorado River Basin—Continued			
San Saba River Basin—Continued.	° ′	° ′	
Menard, 10 miles southeast °	30 52	99 41	14
Menard, 11 miles east °	30 52	99 40	17
Menard, 14 miles east °	30 53	99 37	15
Menard, 15 miles northwest °	31 00	100 03	23
Menard, 16 miles east °	30 54	99 33	15
Menard, northwest of, on Dry Creek °	31 03	99 45	28
Placid, 1 mile south	31 19	99 11	• 20
Richland Springs, west of, near Hall	31 18	99 03	• 20. 25
Rochelle	31 14	99 12	20. 50
Rochelle, 5 miles southwest	31 11	99 15	20. 00
Rochelle, 7 miles southwest °	31 10	99 13	18
Rochelle, 7 miles east on Highway 190	31 14	99 05	20
Rochelle, 12 miles east on Highway 190	31 18	99 02	25
San Saba, 3 miles west °	30 59	99 18	20
San Saba, 3½ miles northeast	31 14	98 42	21
San Saba, 4 miles west °	31 11	98 48	18
San Saba, 4½ miles north ½ mile west of old Brownwood road	31 15	98 46	22
San Saba, 5 miles west °	31 12	98 48	20
San Saba, 5 miles east and 1 mile south	31 10	98 39	17
San Saba, 5 miles southwest, on Wallace Creek	31 11	98 49	• 18
San Saba, 6 miles southwest, on Wallace Creek	31 10	98 48	17. 5
San Saba, 16 miles southwest, C. C. Pool ranch	31 04	98 55	19
San Saba River, 1 mile south of and 1 mile west of Colorado River °	31 15	98 38	14
San Saba River, 1 mile north on Highway 87	31 01	99 15	16
Sonora, 17 miles northeast	30 42	100 22	13. 62
Voca, 1 mile west °	31 00	99 11	15
Voca, 1 mile north °	31 01	99 10	16
Voca, 1½ miles northeast °	31 02	99 09	18
Voca, 2 miles south °	30 59	99 10	11. 5
Voca, 3 miles east and 4 miles north °	31 04	99 07	20
Voca, southeast corner McCulloch County	31 01	99 11	15
Voca, 11 miles northeast °	31 05	99 00	17. 5
San Saba, northeast of, at mouth San Saba River °	31 13	98 37	k 20
Wellview °	31 14	99 44	21
Whiteland, 7 miles southeast °	31 05	99 25	18
Whiteland, 8 miles southeast °	31 03	99 29	17
Llano River Basin:			
Cleo, 1½ miles northwest on Highway 83	30 37	99 53	10
Cold Creek, head of, 35 miles northwest of Mason	30 57	98 56	• 20
Copperas Creek, 2½ miles north of Highway 290 and northeast of Roosevelt	30 33	100 01	11
Doss	30 26	99 06	2. 35
Fort McKavett, 12 miles south on Junction road	30 39	100 05	7. 5
Fort McKavett, 18 miles south on Junction road	30 34	100 08	14
Fort Terrett Service Station, 13 miles west of Roosevelt	30 28	100 12	12. 75
Junction, 8½ miles southwest on Highway 29	30 25	99 49	7. 5
Junction, 11 miles northeast on Highway 29	30 37	99 37	7
Junction, 14 miles northeast on Highway 29	30 38	99 36	10. 75
Junction, 16 miles southeast on Highway 27	30 21	99 32	4
Llano, 6 miles north on Highway 81	30 50	98 40	• 12
Llano, 8 miles north on Highway 81	30 52	98 40	13
Llano, 17 miles east on Burnet Road	30 42	98 29	• 10
London	30 39	99 35	13
Mason, 12 miles northwest on Highway 151	30 51	99 24	12
Noxville	30 21	99 23	5
Pontotoc	30 55	98 59	• 20
Rock Springs, 9 miles northwest on Highway 55	30 05	100 21	20
Rock Springs, 5 miles north and 9 miles northwest	30 08	100 20	21. 5
Rock Springs, 20 miles northwest on Highway 55	30 11	100 29	15
Roosevelt	30 29	100 02	14
Segovia	30 23	99 37	5
Streeter	30 45	99 22	• 9. 5
Sonora, 12½ miles east on Highway 290	30 32	100 26	24
Sonora, 32 miles east	30 38	100 14	11. 75
Streeter, 6½ miles west on highway 29	30 43	99 28	16
Telegraph	30 19	99 55	9
West Copperas Creek, head of, at northeast corner Sutton County	30 36	100 15	18
Miscellaneous basins:			
Bangs, 5 miles south	31 39	99 08	15. 37
Brady, 18 miles north on Highway 16	31 23	99 21	15
Brady, 19 miles north on Highway 16	31 24	99 21	24
Brownwood, 5 miles southwest on old Brady road	31 39	99 01	24
Brownwood, 8 miles southwest on old Brady road	31 36	99 02	• 20
Brownwood, 14 miles southwest on Placid road	31 32	99 07	• 20
Click	30 33	98 33	4. 0
Chappel	31 04	98 35	17. 5
Chappel, 2 miles southwest	31 02	98 36	• 15

See footnotes at end of table.

TABLE 6.—*Total rainfall at miscellaneous points in central Texas, July 16–25, 1938*—Continued

Station	Latitude	Longitude	Rainfall (inches)
Colorado River Basin—Continued			
Miscellaneous basins—Continued.	° ′	° ′	
Cherokee	30 59	98 43	14
Colorado River, 1 mile north of, on Highway 81	31 21	98 39	15
Colorado River, on Highway 16	31 26	99 21	12
Colorado River, 10 miles north of, on Highway 16	31 35	99 20	11
Cow Creek, near head of, on Highway 16	31 14	99 24	17
Harper	30 17	99 15	2.75
Mercury	31 25	99 09	17.5
Mills-Lampasas County line, 2 miles south of, on Highway 84	31 16	98 27	15
Pecan Bayou, on old Goldthwaite-Regency road	31 25	98 44	18
Regency, 1 mile north	31 25	98 52	[a] 20
Regency, 4 miles north	31 28	98 52	20
Regency, 5 miles south	31 21	98 51	[a] 23
Rockwood	31 29	99 21	15
San Saba, 7 miles north on Highway 81	31 17	98 43	[a] 20
San Saba, 10 miles northeast on Highway 81	31 19	98 41	20
San Saba, 10 miles southeast	31 08	98 36	18
San Saba, east part of county	31 09	98 38	[a] 24
Santa Anna	31 44	99 18	14.5
Tow, 5 miles north	30 56	98 29	[a] 12
Winchell, 2 miles north	31 30	99 08	15
Zephyr, 3½ miles from, 2 miles north of Highway 84	31 42	98 50	15.5
Miscellaneous			
Rock Springs, near	30 01	100 07	[m] 9.52
Rock Springs, 16 miles northwest of	30 06	100 29	[a] 26
Sonora, 4 miles south on Highway 277	30 30	100 40	14
Sonora, 9 miles north on Highway 277	30 41	100 39	13.5
Sonora, 17 miles south-southeast on Highway 55	30 16	100 40	15

[a] 13 inches fell July 23.
[b] 1 inch fell July 17 and 13 inches July 23.
[c] Record furnished by Corps of Engineers, U. S. Army.
[d] 8 inches fell July 23.
[e] Doubtful.
[f] 4.5 inches fell July 22.
[g] 6 inches fell July 20, 21, and 22.
[h] 5.5 inches fell July 22.
[i] 9 inches fell July 21.
[j] 3.5 inches fell July 19.
[k] 5.0 inches fell July 24.
[m] 0.75 inch fell July 20 and 1.75 inches July 21.

As no recording rain gage was located in the storm area, data on intensities are meager. The following information was obtained from local observers of nonrecording gages:

Eden

[Observed by Mrs. Spizer]

Date	Rainfall (inches)	Time	Date	Rainfall (inches)	Time
July 17	0.48	Afternoon.	July 22	1.39	1 a. m. to 12 m.
18	.45	Do.	23	6.89	12 p. m. to 3:30 p. m.
19	2.10	1–3 p. m.	24	2.86	2–4 a. m.
20	1.60	12:30 a. m. to 12 m.	25	.02	3 or 4 a. m.
21	1.58	1–10 a. m.	17–25	17.37	

Brady

Rain of 2.63 inches on July 21, 4.39 inches on July 22, and 3.54 inches on July 23 fell between the hours of midnight and 7 a. m. each day.

North of Menard on Dry Creek

[Reported by Chas. Wilkerson, observer, U. S. Entomology Station, Menard]

Date	Rainfall (inches)	Time	Date	Rainfall (inches)	Time
July 19	2.84	Morning.	July 23	4.50	Morning.
20	2.73	Do.		2.63	Afternoon.
	.75	Afternoon.	24	.63	
21	4.40	Morning.	19–24	23.33	
22	4.85	Do.			

Menard

[Luckenbach Motor Co.]

Date	Rainfall (inches)	Time	Date	Rainfall (inches)	Time
July 19	0.85	7–8 a. m.	July 23	2.55	
20	1.30	Do.	24–25	.35	
21	5.50	Do.	19–25	16.60	
22	6.05				

Sloan

[U. S. Weather Bureau gage]

Date	Rainfall (inches)	Time	Date	Rainfall (inches)	Time
July 18	0.25	4:30–5 p. m.	July 23	8.47	All day.
19	1.37	Intermittently.	24	.22	Day and night.
20	.70	At night.	25	2.86	Do.
21	3.70	Intermittently.	18–25	21.49	
22	3.92	All day.			

These rainfall records are shown graphically in figure 5, except that the rainfall for July 17 at Eden is not included.

Distribution of the rain with respect to time and area is shown by the isohyetal lines in figures 6–9, which give for part of the Colorado River Basin the precipitation for 2- and 4-day periods from July 16 to 25. The ischyetal map of part of the Colorado River Basin showing total precipitation July 16–25 is given in figure 10.

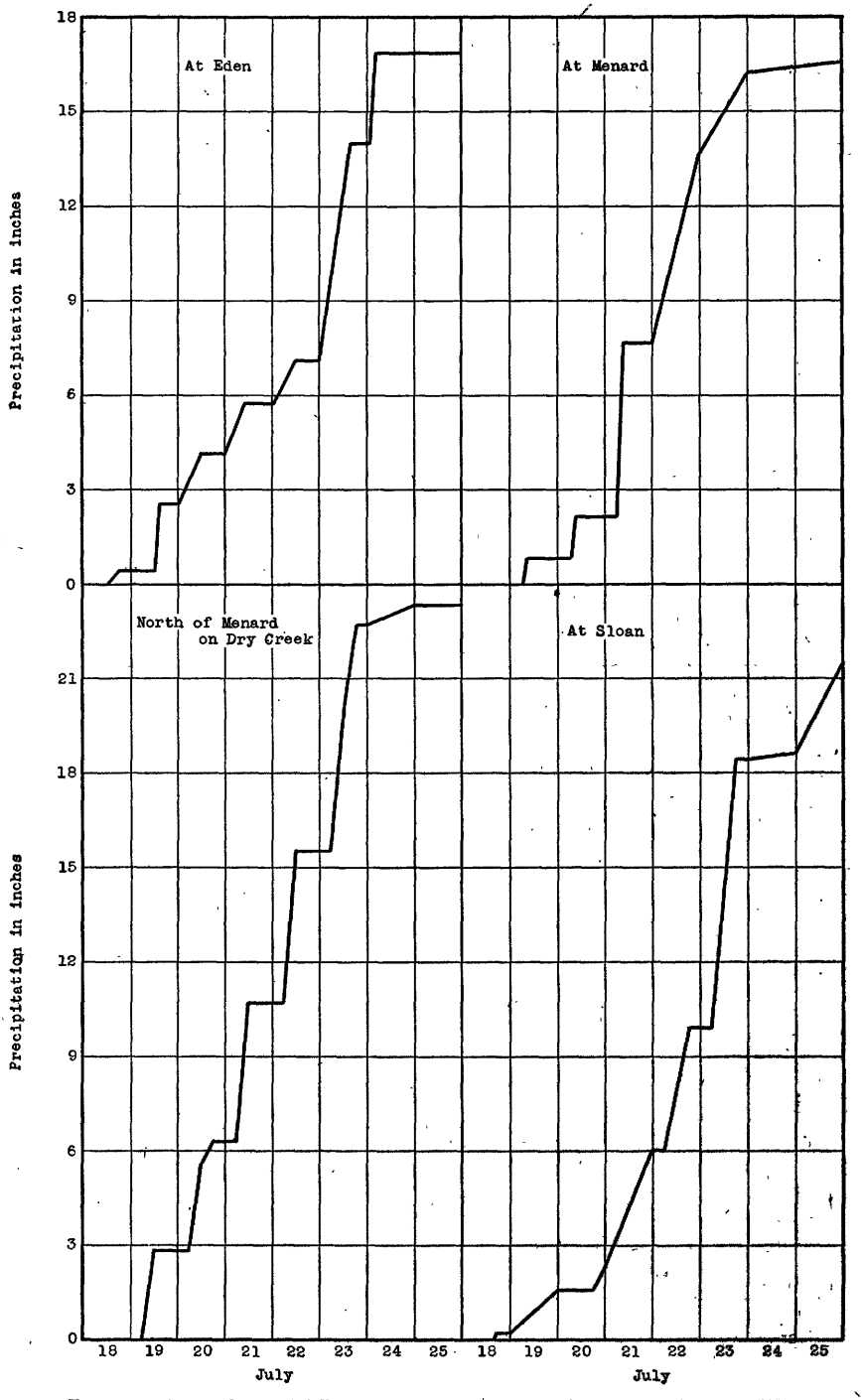


FIGURE 5.—Accumulated rainfall at stations in the San Saba River Basin, July 18–25, 1938.

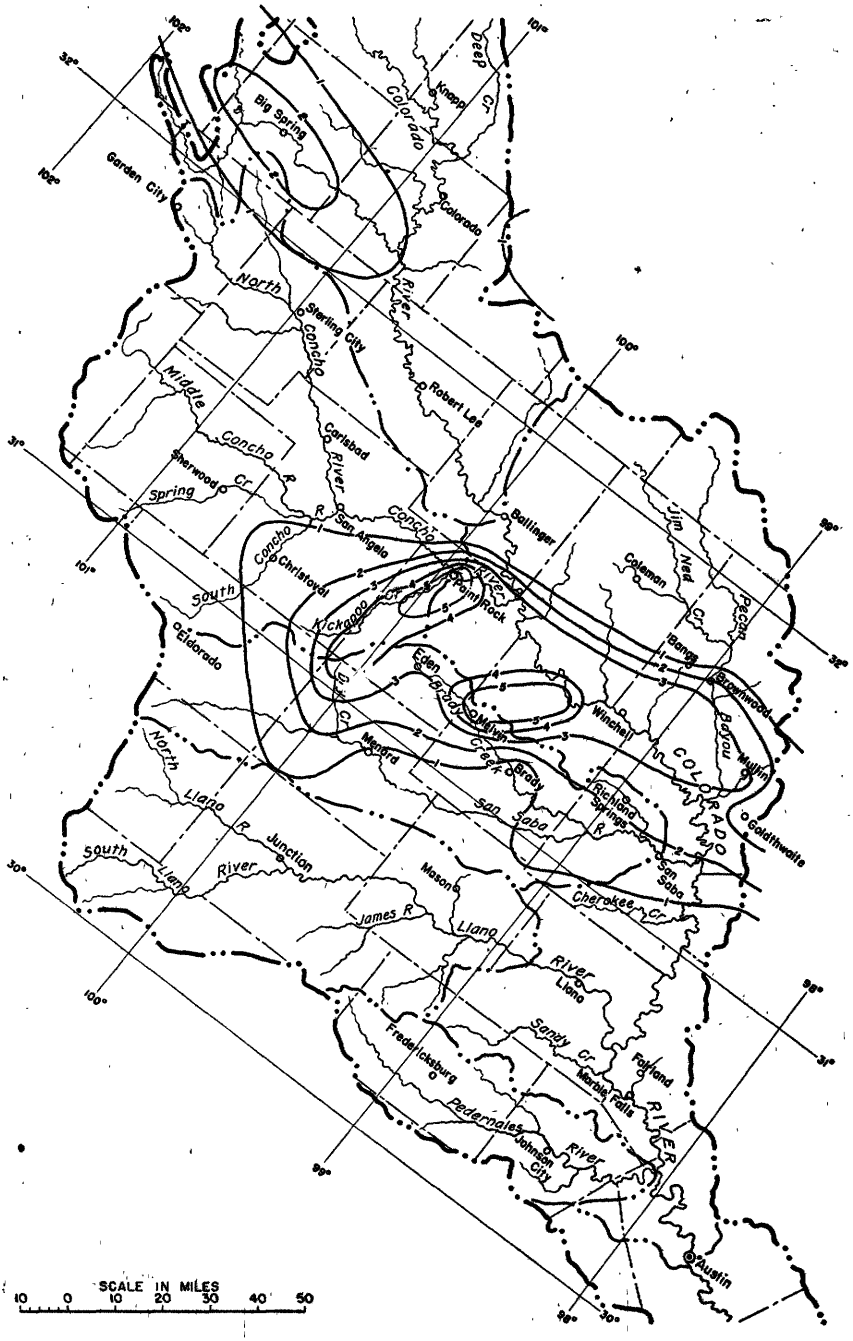


FIGURE 6.—Isohyetal map of part of Colorado River Basin, showing total rainfall, July 16–19, 1938.

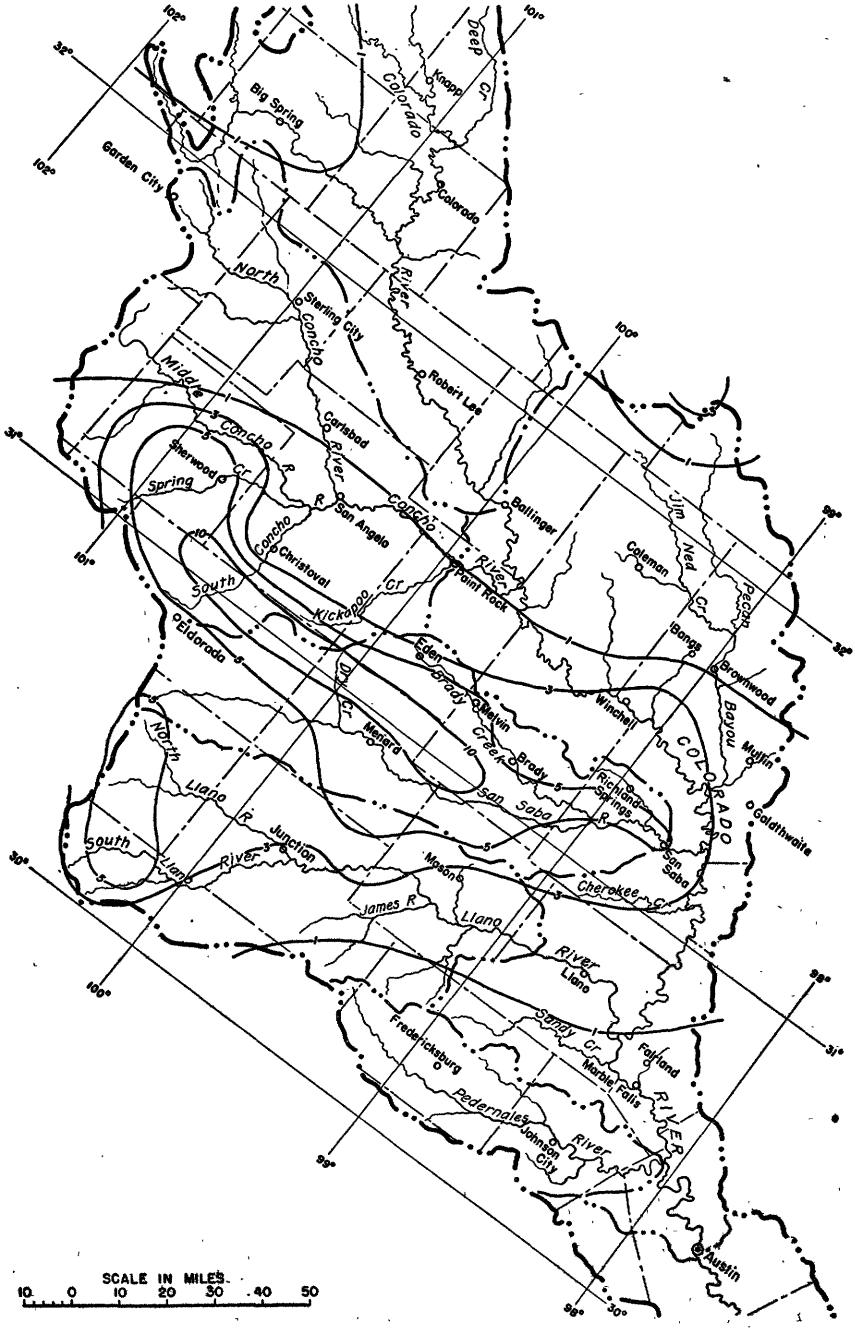


FIGURE 7.—Isohyetal map of part of Colorado River Basin, showing total rainfall, July 20–21, 1938.

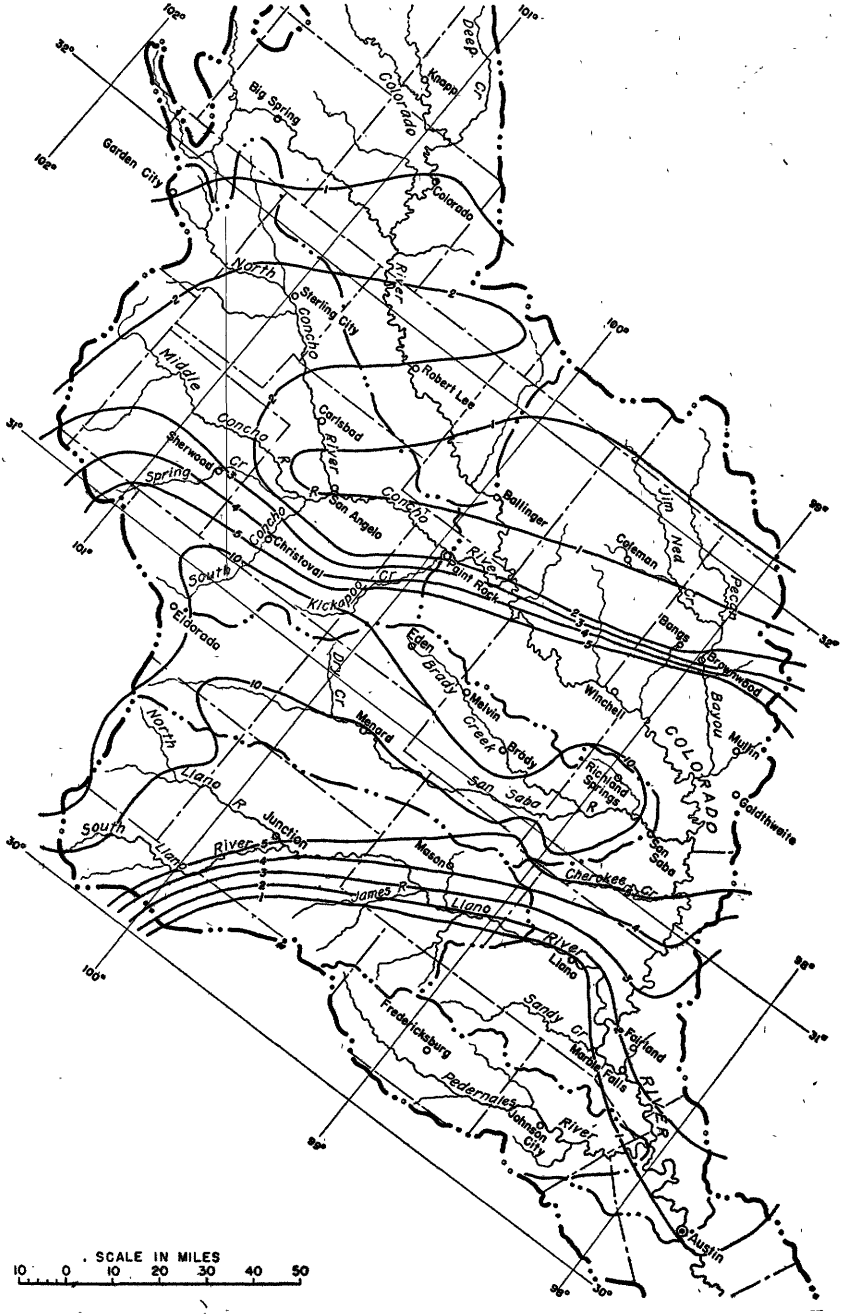


FIGURE 8.—Isohyetal map of part of Colorado River Basin, showing total rainfall, July 22–23, 1938.

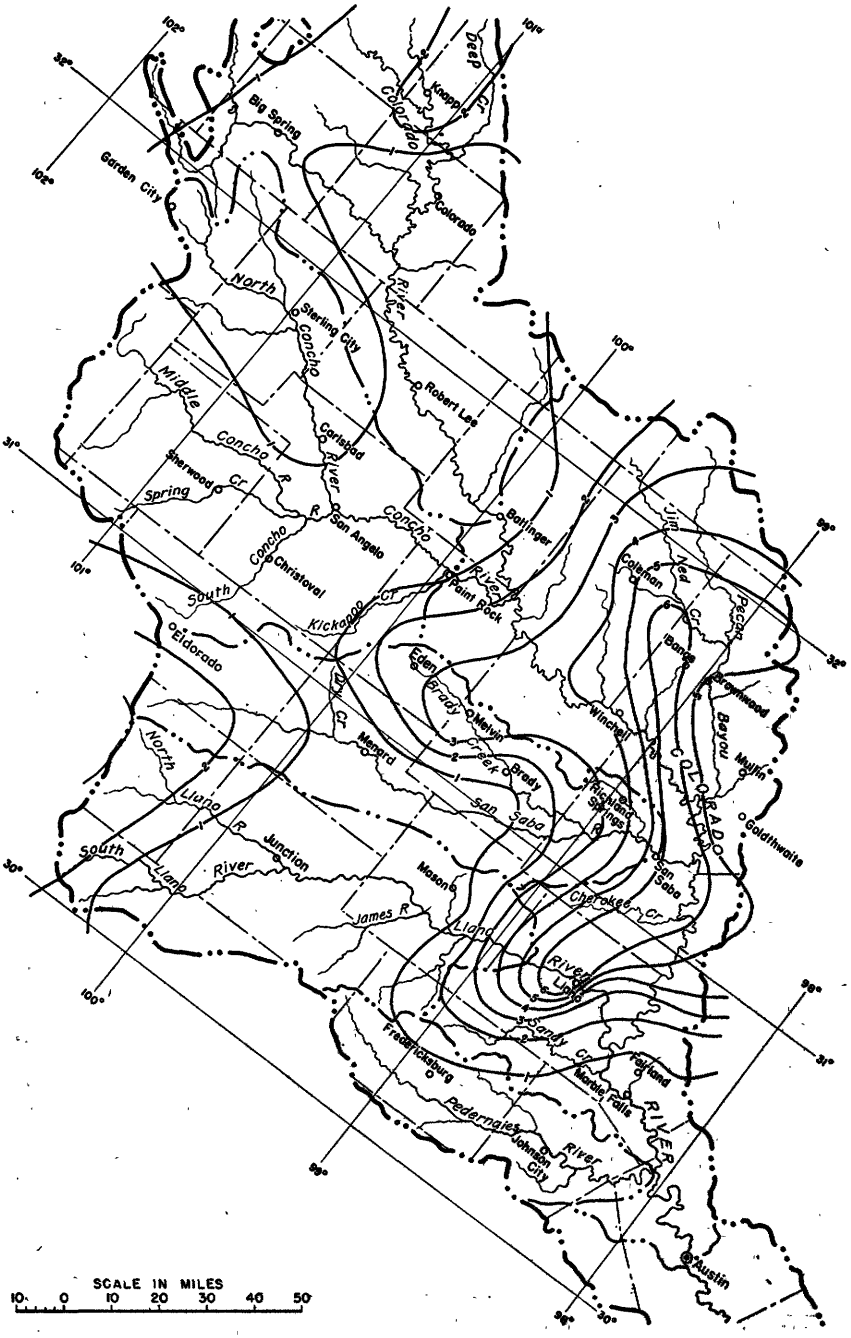


FIGURE 9.—Isohyetal map of part of Colorado River Basin, showing total rainfall, July 24–25, 1938.

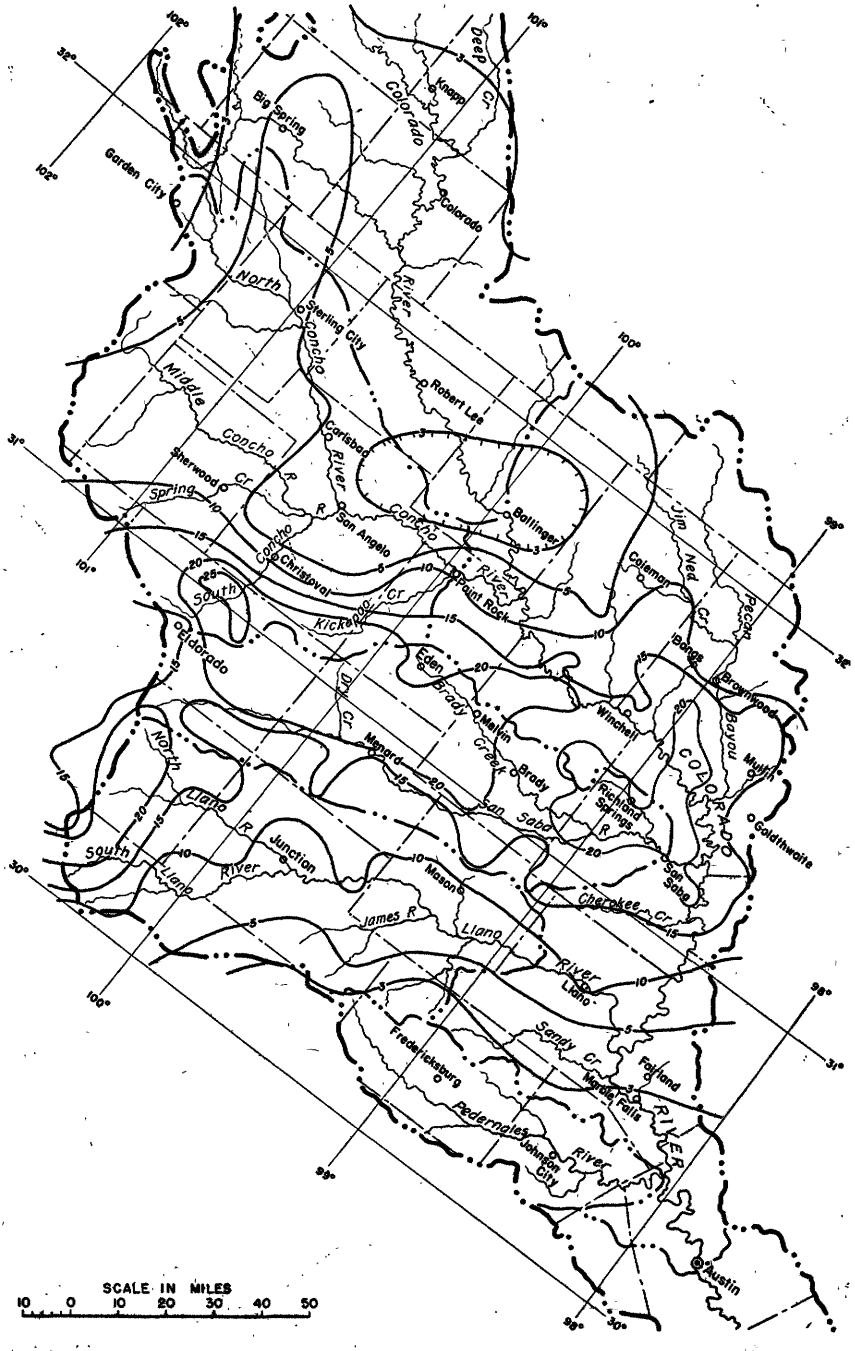


FIGURE 10.—Isohyetal map of part of Colorado River Basin, showing total rainfall, July 16–25, 1938.

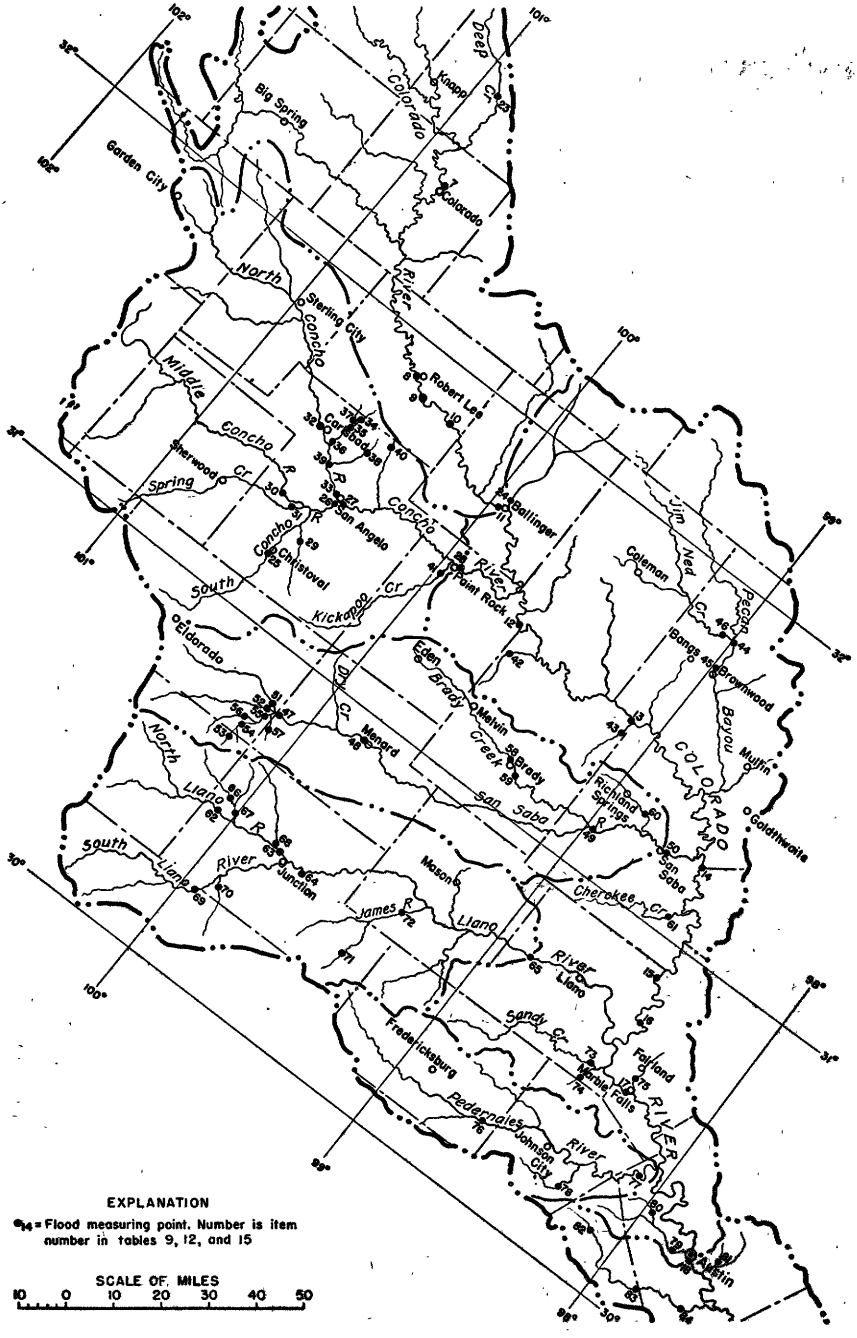


FIGURE 11.—Map of part of Colorado River Basin, showing places at which discharge records were obtained for flood of July 1938 and for previous floods.

COLORADO RIVER FLOOD

The flood in the Colorado River came principally from the San Saba River. The floodwaters from the Concho River reached the mouth of the San Saba River about 30 hours after the peak in that stream had passed and, while contributing little to the flood peak, caused a longer sustained high discharge in the Colorado River. A fairly large flood from the Llano River, with a peak discharge of 133,000 second-feet at the river-measurement station near Castell, entered the Colorado River below Roy Inks Dam and helped to maintain the high flow in the lower reaches of the stream. Other tributaries contributed little to the maximum discharge of the Colorado River.

Buchanan Dam, which forms Buchanan Reservoir, had some regulatory effect on the flood. A succeeding section of this report discusses the flood at this place. Other dams on the Colorado River between Buchanan Dam and Austin (Roy Inks, Marshall Ford, and Tom Miller Dams), have little storage capacity and probably had small effect on the flood. Marshall Ford Dam, which was under construction at the time of the flood, will have a storage capacity of about 2,000,000 acre-feet when completed. This dam is located below the mouth of the Llano and Pedernales Rivers and in the future will offer a means of preventing floods that originate in the upper part of the basin from seriously damaging the property along the river at Austin and below.

Views of the flood at Roy Inks Dam, at Austin, and at Wharton are shown in plates 1, *B*, 2, and 3. Views of Buchanan Dam during the flood are shown in plates 7 and 8.

Hydrographs of discharge at river-measurement stations on the Colorado River (fig. 15) and hydrographs showing computed inflow and outflow at Buchanan Dam (fig. 16) are given in the section of this report on stages and discharges at river-measurement stations.

A more detailed discussion of the floods in the Concho and San Saba River Basins is given on the following pages. The flood peak in the Llano River was 133,000 second-feet at Castell, but this was much less than the peak of 388,000 second-feet in 1935 and did little damage. The flood peak of the Llano River entered the Colorado River before the peak of the San Saba River arrived and probably conditioned the channel so that the latter peak below the mouth of the Llano River traveled faster, produced higher stages, and had a more sustained flow than it would otherwise have had.

CONCHO RIVER FLOOD

The flood in South Concho River was caused by the same storm center that produced the flood in Brady Creek and San Saba River. The flood in Concho River came mostly from South Concho River,

with considerable water added in the lower reaches by streams that drain the area to the south. The town of Christoval, on South Concho River about 17 miles by road south of San Angelo, felt the full force of the flood. With less precipitation downstream there was a considerable reduction in the peak discharge and little property damage at San Angelo. Lake Nasworthy, on the South Concho River below the Middle Concho River and above San Angelo, tended to reduce further the peak discharge at the latter place. Records of flood flow through the lake, as well as records of flow at Christoval, San Angelo, and other places in the basin, are given in a succeeding section of this report.

The following description of the flood at Christoval is quoted from the San Angelo Standard-Times for July 24, 1938:

CHRISTOVAL, July 23.—The South Concho River, usually an attraction responsible for doubling this resort-town's population during the summer from 500 to 1,000 persons, went on its greatest rampage in history today. Tonight it was still out of its banks but slowly receding.

Reaching a record stage of 23 feet, it caused damage estimated at approximately $30,000 as it swept away dozens of camp houses, a filling station, hundreds of acres of crops along an irrigation belt, inundated hundreds more, and swept some livestock down the valley.

The rainfall was estimated at from 3½ to 10 inches on the watershed above Christoval during the 24 hours preceding the higher flood stage at noon today. Ten inches had fallen at Christoval during the week and the (South) Concho had swung out across the highway this morning for the fourth successive day. * * *

Warning came from Eldorado at 6 o'clock this morning, advising campers and residents to vacate the lowlands. Water reached flood stage here by 9 o'clock. By 11 o'clock tourist cabins were pounding themselves to splinters against the highway and railroad bridges. By 12, residents a quarter mile from the river had vacated homes into which the water had risen to a depth of 3 and 4 feet.

Turbulent waters 3 miles in width were rolling through the valley here by 12:30 when the flood reached its peak and then began to recede rapidly. * * *

A stob placed on the J. W. Warnock farm as a marker of the peak of the 1936 flood went out of sight here shortly after noon. The Warnock farm is 3 miles north of Christoval.

Figure 12 is a map of the Concho River Basin showing isohyetal lines for the total rainfall for the period July 16–25 and also showing location of discharge measuring places.

Hydrographs of discharge at river-measurement stations on the South Concho and Concho Rivers are shown on figure 17. Data from which these hydrographs were drawn, and similar data for other river-measurement stations in the Concho River Basin, are given in the section of this report on stages and discharges at river-measurement stations.

SAN SABA RIVER FLOOD

The San Saba River rises in Sutton and Schleicher Counties at an elevation of about 2,400 feet and flows in a generally eastward direction about 130 miles across Menard, Mason, McCulloch, and San Saba Counties, and then flows into the Colorado River at an ele-

vation of about 1,130 feet. Its largest tributary, Brady Creek, rises in Concho and Menard Counties and flows eastward about 80 miles and enters the San Saba River about 15 miles above the town of San Saba. The area of 3,100 square miles that is drained by the San Saba River is about 130 miles long and has a maximum width of about 40 miles. The entire basin lies on the Edwards Plateau and consists mostly of low hills, which are fairly well wooded with oak, cedar, and mesquite trees. The basin is largely devoted to the raising

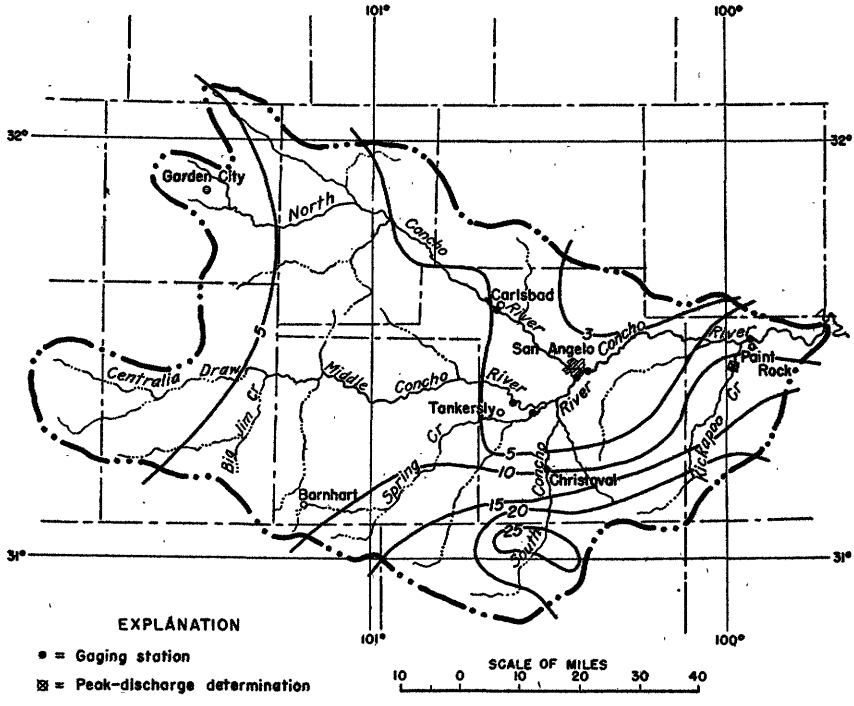


FIGURE 12.—Map of Concho River Basin showing isohyetals for total rainfall July 16–25, 1938, and places at which discharge records were obtained.

of live stock—cattle, sheep, and goats—but along the streams and in the lower part of the basin, principally north of the river, extensive areas are under cultivation. A map of the San Saba River Basin is shown in figure 13.

During the latter part of July, heavy rains fell over the entire San Saba River Basin and produced record-breaking stages on most streams of the area. The most damage was done in the towns of Menard, San Saba, and Brady, the first two situated on the San Saba River and the latter on Brady Creek.

The Menard News of July 21, 1938, states:

> The heavy rains during the past 3 days came as a needed relief for the crops and grazing land of this section. Having received no rains of any consequence in the past 2 months this section was fast approaching a drouth-stricken condition.

The issue of July 28 reports:

After a week of heavy rains and several visitations of flood water the San Saba went to the highest flood stage Saturday in 40 years. The river began a rapid rise about 4 o'clock Saturday afternoon and in a short time was running down the main street. Merchants worked desperately to strengthen the barricades built earlier in the week when it became evident that the water was going much higher. San Saba Street became flooded, in many places waist deep, and water was about a foot deep in the lobby of the Bevans Hotel.

The water gradually crept farther into the town until a peak was reached about 10 o'clock. From then on it receded rapidly, and by midnight the danger was over. * * *

At the highest peak the water was going over the bridge, and the floating span of the structure was expected to go out; but it held against the worst flood since the bridge was constructed.

The flood at San Saba has been described by the San Saba News for July 28 as follows:

The greatest flood ever to visit the San Saba Valley is now history * * * leaving in its wake a scene of desolation and destruction that almost beggars description. * * *

Many hundreds of our rural and city citizens were made homeless through the loss or serious damage to their homes, many thousands of acres of crops washed out throughout the valley, quite a little livestock lost, and many narrow escapes from loss of lives were recorded in this the greatest San Saba flood of all time, being some 5 to 8 feet higher than the previous high marks. * * *

Starting Tuesday of last week, with occasional slight intermissions, the rain fell steadily, at times almost in torrents, day after day and night after night until Monday morning of this week, when a total fall for the week of eighteen and a fraction inches of rainfall was recorded in San Saba. * * * Fed by torrential rains up Brady Creek above Brady in the Menard area and all along the line, including Richland Creek, and all tributaries, the San Saba began rising here rapidly Thursday and gradually spread over the valley, catching many of the valley farmers unprepared. By Friday morning the city pump station was submerged at Mill Creek and the water supply shut off, scores of homes in the lower parts of the city were inundated and many homes completely covered. Dozens of the smaller homes were washed from their foundations and dislodged, some collapsed and were carried downstream, breaking up as they collided with trees and fences. * * *

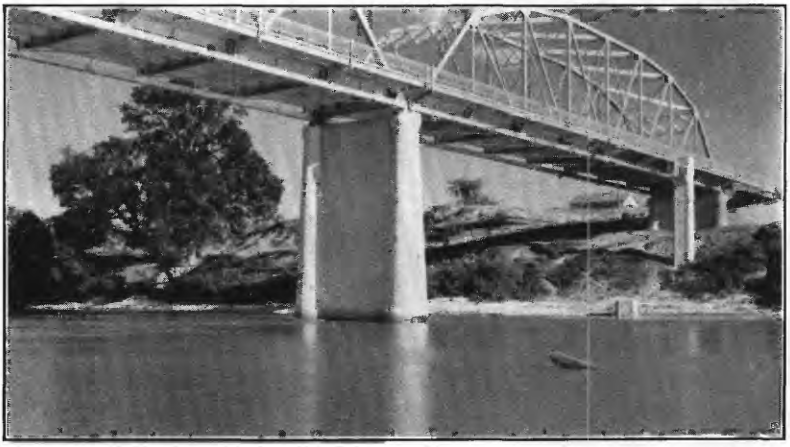
Harkeyville, Algerita, Richland Springs were all heavy sufferers, and hardly a section of the county in which there was a stream was spared from damage and loss. * * *

Brady, Menard, Eden, and Voca were inundated. * * *

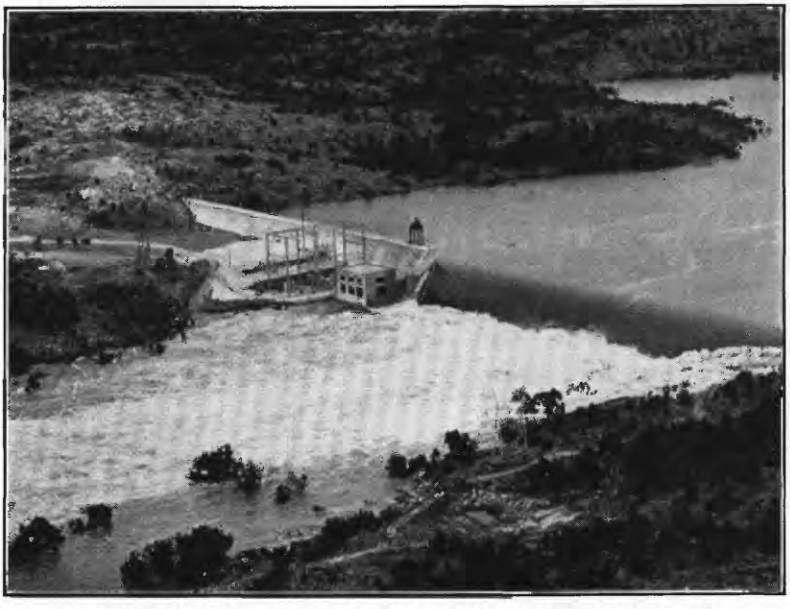
At the height of the flood the width of the river here at San Saba was estimated at 1¾ miles wide, and at Harkeyville it was placed at between 3 and 4 miles at its greatest width. * * *

The rain ceased Monday morning of this week at 10 o'clock, and for the first time in 7 days the sun came out from behind the clouds at 3:40 that afternoon and has shone daily since. The wild San Saba is again back in its banks for the most part after rising to its greatest height in history, leaving in its wake a desolation to the valley farming community and valley villages unprecedented. * * *

The one consoling thing about the heavy rains that brought on the flood is that the higher ranch lands received enough rains to take care of their grazing needs through the winter, some ranchers say. Since a large part of San Saba County,



A. RIVER-MEASUREMENT STATION ON COLORADO RIVER AT AUSTIN.
Recording gage with silt trap at water's edge. Discharge measurements are made from bridge.
Photo by Boone.



B. FLOOD OF JULY 1938 AT ROY INKS DAM ON COLORADO RIVER.
Photo by Neal Douglas. Courtesy of Lower Colorado River Authority.

FLOOD OF JULY 1938 ON COLORADO RIVER AT AUSTIN.

Congress Avenue Bridge, July 26, after stage had fallen about 4 feet from peak. Photo by Bill Nottingham. Courtesy of city of Austin.

A. NEAR WHARTON.

B. AT WHARTON.

COLORADO RIVER FLOOD, JULY 30, 1938.

Photos by Bill Nottingham.

A. MAIN STREET, MENARD, FLOODED BY SAN SABA RIVER, JULY 22, 1938.
Photo from Western Photo Studio.

B. COURTHOUSE SQUARE, BRADY, FLOODED BY BRADY CREEK, JULY 23, 1938.

SAN SABA RIVER AT SAN SABA.

Overflow on July 24, 1938, about 6 feet below peak. Photo by 111th Photo Sec. A. C., Texas National Guard, Houston, Tex.

A. RAILROAD DAMAGED BY FLOOD.

Picture made July 24, 1938, when river was about 6 feet below peak. Photo by 111th Photo Sec. A. C., Texas National Guard, Houston, Tex.

B. PART OF TOWN DAMAGED BY FLOOD.

Picture made July 22, 1938, before peak of flood.

SAN SABA RIVER AT SAN SABA.

BUCHANAN DAM AND RESERVOIR ON COLORADO RIVER.

Picture made July 24, 1938, when dam was discharging 191,000 second-feet. Photo by 111th Photo Sec. A. C., Texas National Guard, Houston, Tex.

BUCHANAN DAM SPILLWAY, JULY 24, 1938.

Lake about 2 feet below peak stage. Photo by 111th Photo Sec. A. C., Texas National Guard, Houston, Tex.

probably more than 75 percent, is in stock ranches, good fall and winter grazing will be an important item in recovery.

The Brady Standard in issues for July 26 and 29 describes the flood at Brady as follows:

Swirling derelict waters that had menaced the town twice the past week, made Brady Creek a veritable mad river Saturday afternoon, as the muddy waters inundated three-fourths of the business section of the town, washed away any number of homes and businesses, damaged merchandise, and otherwise left Bradyites suffering from a loss estimated at $500,000. The worst flood in the town's history broke over the flood wall—which had held waters back on two occasions last week—Saturday afternoon about 3 o'clock, took out the bridge on North Bridge Street a half hour later, and within a few minutes covered the entire plaza. The water was about 14 inches higher than the flood of October 6, 1930, when damage estimated at $300,000 was done to Brady property. The town was fortunate in one instance, at least, since no lives were lost, though there were at least three narrow escapes. * * *

After the flood, which washed away some 25 or 30 dwellings in the lowlands, rendering about 100 homeless and driving another 200 from their homes, relief headquarters were set up * * * where Saturday night coffee and sandwiches were served the stricken persons. They were fed and clothed by the local chapter of the American Red Cross. * * *

During the early stages of the flood, when a person would hardly think about venturing into the rampaging waters * * * a Mexican calmly gathered up exactly a half dozen floating roosters, and scuttled to safety, carrying them under his arms.

An interesting observation was made in the column "Sauce" of the Brady Standard:

Why do folks go right back and reestablish themselves upon the very spot where disaster has overtaken them? That was answered many years ago in the saying "Home is where the heart is." The sturdy oak tree roots deep. Wind and storm may tear at its branches, and twist and gnarl and break them, but the tree lives on. So with men of will, of strength and purpose. They continue to make their home where their heart is—in the "Dust Bowl;" in the frozen wastes of the Arctic; upon the storm-bound seacoast; and upon the banks of turgid Brady Creek.

Old-timers recall that the late W. B. White, pioneer settler and ranchman * * * away back in the Seventies when the town of Brady City was first being established, pleaded with his pioneer fellowmen to locate the business section on top of the south hill, even offering to give the land for the business district. His pleadings were overruled, and Brady's business district was laid out upon its present site.

Views of the flood at Menard, Brady, and San Saba are shown in plates 4–6.

There are only two river-measurement stations in the San Saba River Basin—at Menard and San Saba. In addition to records at these places, slope-area determinations of peak discharge were made on San Saba River below the mouth of Brady Creek near Richland Springs, on Brady Creek near Brady, and on Richland Creek near Richland Springs. The locations of all measuring places are shown in figure 13, as well as isohyetal lines for the total rainfall in the basin July 19–25.

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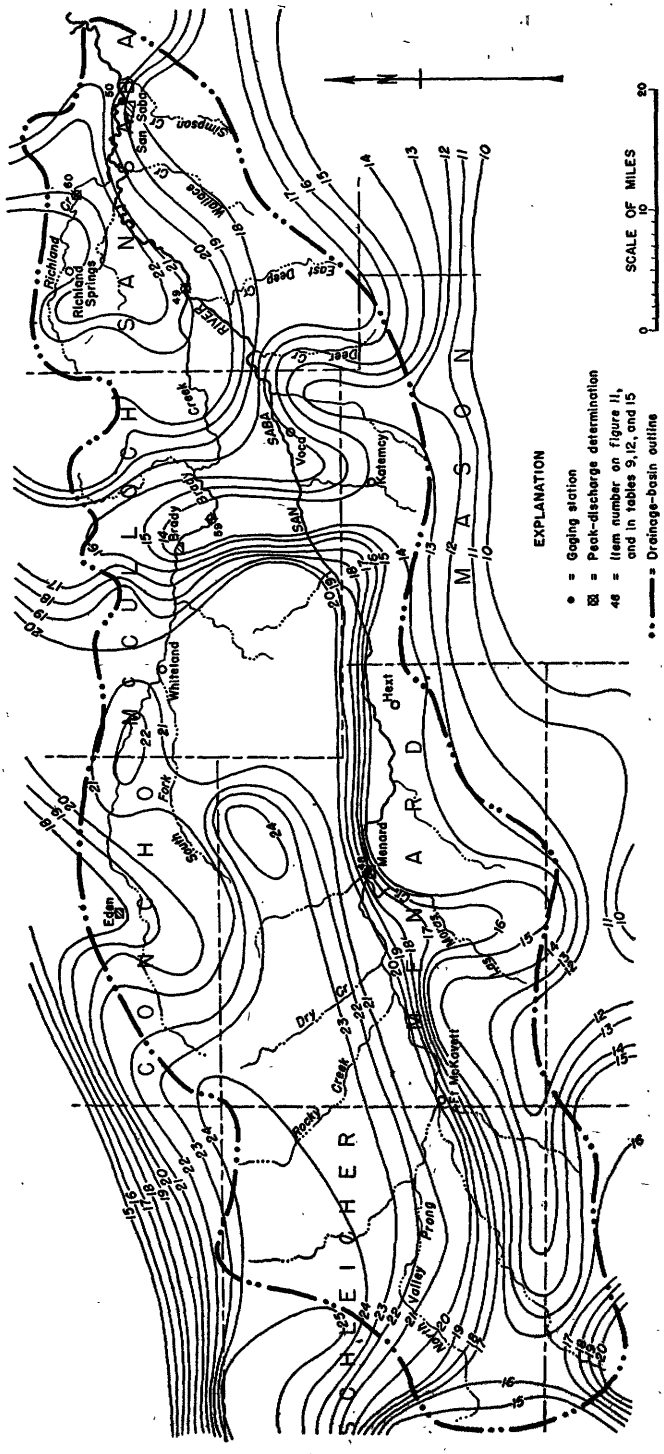

FIGURE 13.—Map of San Saba River Basin showing isohyetals for total rainfall, July 16–25, 1938, and places at which discharge records were obtained.

Hydrographs of discharge at the river-measurement stations in the San Saba River Basin are given in figure 18.

FLOOD AT BUCHANAN DAM

The recently completed Buchanan Dam, on the Colorado River at the Llano-Burnet County line about 13 miles upstream from the Llano River, was started by private interests as a power project and, after failure of the private company, was completed by the State-created Lower Colorado River Authority with the aid of Federal funds. This dam forms a reservoir with a storage capacity of 992,000 acre-feet at the spillway level of 1,020 feet, which is about the average annual runoff of the river at this place. People living along the Colorado River below Austin had come to believe that after completion of Buchanan Dam they would be protected from flood overflows that periodically visit them and that cause loss of life and property almost every year.

The disastrous flood of July-August 1938 destroyed the feeling of security from floods held by the people of the lower part of the basin, brought public accusation of improper operation of Buchanan Dam, and resulted in an investigation by the Senate Investigating Committee of the Forty-fifth Texas Legislature. At the direction of this committee, the State Board of Water Engineers made an extensive study of the flood, the operation of the dam, and the probable effects on the flood if the dam had been operated differently.

In the report of the Board [6] a number of conclusions are given, among which are:

1. That this is the largest flood of record occurring above the Buchanan Dam, both as to peak flow and duration of flood.

2. That the storm causing this flood covered practically the entire contributing drainage area of the Colorado River above the Pedernales River.

3. That the maximum total rainfall for the period of the storm, July 16–26, was on the watershed of the South Concho River above the town of Christoval, and amounted to 25 inches; that a total of 20 inches for the period occurred on the drainage basin of the San Saba River and covered practically the entire basin.

4. That the intense rains and resulting flood were so close to the Buchanan reservoir that sufficient time was not had in which to materially lower the lake level.

5. That Buchanan reservoir is not sufficient to control floods of such volume and peak discharge as the flood of July–August 1938, originating in so close proximity to the reservoir. * * *

10. That the flood on the Colorado River below the Buchanan Dam was not a man-made flood. * * *

13. That the Buchanan and Marshall Ford Dams afford no flood protection to the tributaries. * * *

26. [That] adequate information should be available and a careful study of the information should be made before releasing water from the reservoir in advance of a flood, in order not to produce a man-made flood below the dam.

[6] Colorado River flood, July–August 1938, Report of the State Board of Water Engineers to the Senate Investigating Committee of the 45th Legislature (mimeographed), Sept. 19, 1938.

27. [That] any reservoir of a capacity comparable to Buchanan reservoir would be a flood-control structure and would reduce and delay the crest of a flood if the gates remained fixed in the positions they occupied at the start of the flood.

Records of lake levels, capacity tables, and operation of gates were furnished by the Lower Colorado River Authority. Inflow and outflow records were computed by the Board of Water Engineers. These data are included in the section of this report on stages and discharges at river-measurement stations. Graphs of storage, inflow, and outflow for the period July 21 to August 3 are shown in figure 16. Views of Buchanan Dam during the flood are shown in plates 7 and 8.

FLOOD STAGES AND DISCHARGES

CREST STAGES

Records of crest stages were obtained at a number of places on the Colorado River from Ballinger to Wharton and are given in table 7. The observation points along the river channel are at such intervals that they do not define a continuous profile of the water surface. Stages at Chadwick and places below probably are of the same flood peak, but above that point they are for different peaks.

For the crest stages along the San Saba River and Brady Creek, which were determined at frequent intervals, accurate flood profiles were prepared by the Corps of Engineers, United States Army. The crest stages for the San Saba River and Brady Creek given in table 8 were taken from these profiles. The altitudes that have been selected for publication have been limited to those that are essential for adequate definition of the flood profile. These data are shown graphically in figure 14.

In addition to obtaining flood-crest stages, the office of the Corps of Engineers, United States Army, at Galveston made about 240 cross sections along the San Saba River and Brady Creek and obtained sufficient data to define the profiles of the stream bed, low water, right bank, and left bank. These data are not incorporated in this report.

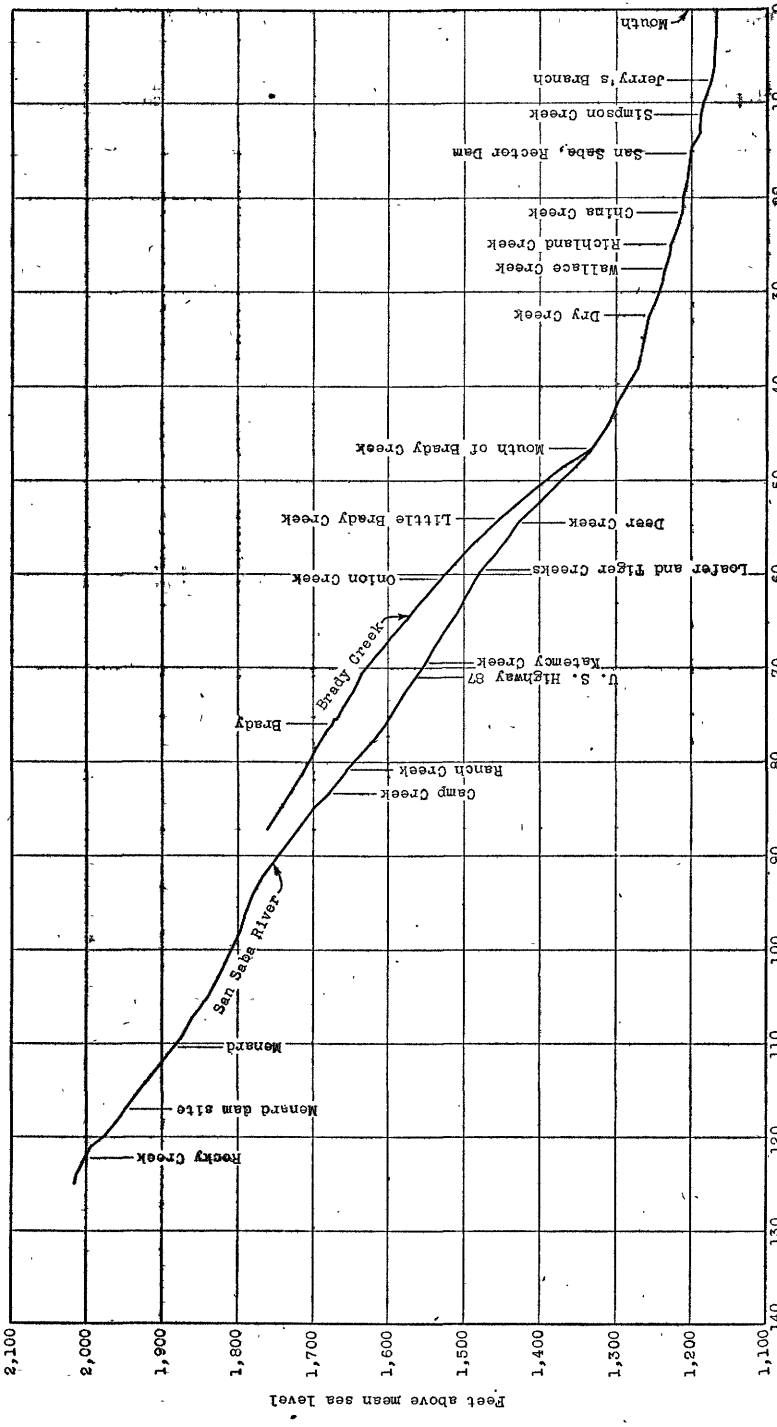

FIGURE 14.—Profile of flood-crest stages on the San Saba River and Brady Creek, July 1938.

TABLE 7.—*Flood-crest stages on Colorado River, July 1938*

Place of determination	Latitude	Longitude	River distance above mouth [a] (miles)	Time of crest	Altitude above mean sea level (feet)
	° ′	° ′			
Ballinger, Geological Survey gage	31 44	99 56	643.8	July 26, 12 m.	1,611.7
Leaday, 1½ miles south	31 33	99 40	608.6	July 24, 9 p. m.	1,494.7
Stacy, 2 miles northeast	31 30	99 34	590.7	July 24	1,425.6
Waldrip, 1½ miles north	31 28	99 25	572.2	July 23	1,380.3
Mitchell crossing	31 25	99 20	562.5	do	1,349.7
Winchell	31 28	99 10	546.4	July 24, 11:15 p. m.	1,311.0
Milburn, 2 miles north	31 28	99 06	541.9	July 24, 6 p. m.	1,299.8
Whittet crossing, ⅝ mile below	31 27	98 57	523.3	July 23	1,263.8
Regency	31 25	98 51	515.3	July 25, 5 a. m.	1,249.7
Ratler crossing	31 23	98 46	505.3	July 26	1,230.6
San Saba-Goldthwaite bridge, 1 mile below	31 21	98 40	486.6	July 24	1,190.7
Chadwick, railroad bridge near	31 14	98 34	461.5	July 23	1,162.1
San Saba, Geological Survey gage	31 13	98 34	459.9	July 23, 6 p. m.	1,158.5
Bend, 1¼ miles upstream	31 05	98 32	445.0	July 23	1,107.5
Marble Falls, U. S. Weather Bureau gage	30 34	98 16	369.2	do	740.1
Austin, Geological Survey gage	30 16	97 45	280.9	July 25, 6 p. m.	454.0
Smithville, Geological Survey gage	31 01	97 10	198.7	July 27, 5:25 a. m.	306.1
La Grange, Geological Survey gage	29 54	96 52	163.3	July 27, 7 p. m.	254.2
Eagle Lake, Geological Survey gage	29 35	96 25	99.5	July 29, 10:30 p. m.	167.7
Wharton, U. S. Weather Bureau gage	29 18	96 06	55.3	July 30, 12:10 p. m.	103.1

[a] Revised since publication in Water-Supply Paper 816.

TABLE 8.—*Flood-crest stages on San Saba River and Brady Creek, July 1938*

San Saba River

River distance above mouth (miles)	Altitude above mean sea level (feet)	Location	River distance above mouth (miles)	Altitude above mean sea level (feet)	Location
125.0	2,017	Near Fort McKavett.	58.0	1,461	
124.0	2,013		56.0	1,441	
122.4	1,997	Rocky Creek.	54.5	1,428	Deer Creek.
121.0	1,989		52.0	1,396	
119.9	1,975	Clear Creek.	50.0	1,372	
119.6	1,973	Dry Creek.	48.1	1,349	Deep Creek.
118.5	1,963		46.7	1,332	Brady Creek.
117.0	1,947	Menard dam site.	46.2	1,324	San Saba dam site.
115.0	1,930		44.0	1,307	
113.0	1,910		42.0	1,297	
111.1	1,892	Las Moras Creek.	40.0	1,283	
110.4	1,886	Menard, U. S. Highway No. 83.	38.0	1,270	
109.0	1,872		36.0	1,262	
107.0	1,858		34.0	1,257	
105.0	1,840		32.5	1,254	Dry Creek.
102.5	1,820		31.0	1,246	
100.0	1,809		29.0	1,237	
98.0	1,798		27.6	1,234	Wallace Creek.
96.0	1,790		26.3	1,229	Bridge, G. C. & S. F. R. R.
94.0	1,783		25.7	1,227	Bridge, U. S. Highway No. 190.
92.0	1,767		25.0	1,226	Richland Creek.
90.0	1,747		23.3	1,218	
88.0	1,730		21.6	1,211	China Creek.
86.0	1,711		20.0	1,210	
84.5	1,697		18.3	1,205	
83.2	1,681	Camp Creek.	16.6	1,202	Bridge, State Highway No. 81.
80.7	1,653	Ranch Creek.	15.4	1,200	San Saba, Rector Dam.
78.5	1,630		14.7	1,198	Rector Bridge.
76.0	1,605		13.0	1,188	
74.0	1,591		11.2	1,186	Simpson Creek.
72.5	1,580		10.0	1,184	
70.9	1,563	Bridge, U. S. Highway No. 87.	9.0	1,178	
70.6	1,560	Hudson Branch.	7.7	1,176	Jerrys Branch.
69.3	1,548	Katemcy Creek.	7.3	1,175	Rabbit Branch.
67.5	1,535		6.0	1,172	
65.6	1,521	Bridge.	4.0	1,171	
64.0	1,510		2.5	1,170	Bridge.
62.0	1,497		1.2	1,167	
59.7	1,478	Loafer and Tiger Creeks.	0	1,164	Mouth.

TABLE 8.—*Flood-crest stages on San Saba River and Brady Creek, July 1938*—Continued

Brady Creek

River distance above mouth (miles)	Altitude above mean sea level (feet)	Location	River distance above mouth (miles)	Altitude above mean sea level (feet)	Location
40.6	1,761		22.0	1,614	
38.0	1,742		20.0	1,594	
36.0	1,727		18.0	1,572	
34.0	1,711		16.0	1,553	
32.0	1,696		14.0	1,534	Onion Creek.
30.1	1,680	Bridge, U. S. Highway No. 87.	12.0	1,509	
30.1	1,679	Do.	10.0	1,485	
30.0	1,678	Live Oak Creek.	8.8	1,470	
29.5	1,675	Brady.	7.6	1,452	Little Brady Creek.
28.8	1,670	Bridge, G. C. & S. F. R. R.	6.0	1,428	
28.8	1,667	Do.	4.0	1,399	
27.5	1,661		2.0	1,363	
26.0	1,648		.5	1,335	
24.0	1,634		0	1,332	Mouth.

NOTE.—Records obtained by Corps of Engineers U. S. Army.

SUMMARY OF FLOOD STAGES AND DISCHARGES

Table 9 is a summary of flood stages and discharges in the Colorado River Basin during the July flood for all river-measurement stations and other places at which the peak discharge was determined. For purposes of comparison the previous maximum stage and discharge are given where known. The heading "Period of known floods" is a summary of the periods listed under the heading "Maxima" for the individual stations. Also shown in table 9 is the maximum 24-hour discharge at all river-measurement stations. The locations of most of the points in table 9 are shown in figure 11, which is a map of the part of the Colorado River above Austin that experienced the storm and flood of July 1938.

STAGES AND DISCHARGES AT RIVER-MEASUREMENT STATIONS IN TEXAS

On the following pages are presented stage and discharge records at all river-measurement stations in the Colorado River Basin. These records consist essentially of a station description, a table of daily mean discharges and daily and total runoff for the flood period, and a table of discharges at indicated times during the flood in sufficient detail for a reasonably reliable delineation of the hydrograph.

Under the heading "Drainage area" in the station description for some stations the probable noncontributing area is noted. This is the area that lies above the Cap Rock[7] and is believed never to contribute any surface runoff to the lower reaches of the streams. The drainage areas were measured from topographic maps that were available and from soil maps and county road-maps.

[7] Dalrymple, Tate, and others, Major Texas floods of 1936: U. S. Geol. Survey Water-Supply Paper 816, p. 7, fig. 2, 1937.

TABLE 9.—*Summary of flood stages and discharges in Colorado River Basin, July 1938*

Item No.	Stream and place of determination	Latitude	Longitude	Drainage area (square miles)[a]	Period of known floods	Maximum stage and discharge prior to July 1938			Maximum stage and discharge, July 1938				Maximum 24-hour discharge (second-feet)
						Date	Stage (feet)	Discharge (second-feet)	Time	Stage (feet)	Discharge		
											Second-feet	Second-feet per square mile	
		° ′	° ′										
10	Colorado River at Ballinger	31 44	99 56	5,340	1882–1938	Sept. 18, 1936	[b] 28.6	75,400	July 26, 12 m	17.75	21,100	4.0	18,000
14	Colorado River near San Saba	31 13	98 34	18,800	1878–1938	Sept. 25, 1900	57.5	184,000	July 23, 6 p. m	62.25	224,000	11.9	202,000
16	Colorado River at Buchanan Dam.—Inflow	30 45	98 25	19,450	1938				July 25, 1 p. m		202,000	10.4	192,000
	Colorado River at Buchanan Dam.—Outflow								July 25, 12 m.–3:30 p. m.		192,000	9.9	190,000
18	Colorado River at Austin	36 16	97 45	26,350	1843–1938	July 7, 1869	43	(c)	July 25, 6:30 p. m	32.1	276,000	10.5	256,000
						June 15, 1935	42.0	481,000					
19	Colorado River at Smithville	30 01	97 10	27,850	1913–38	December 1913	47.4	(c)	July 27, 4:25 a. m	36.02	209,000	7.5	206,000
						June 16, 1935	42.5	305,000					
21	Colorado River near Eagle Lake	29 35	96 25	29,140	1913–38	December 1913	32	(c)	July 29, 10 p. m	28.1	165,000	5.7	163,000
						June 19, 1935	29.45	177,000					
24	Elm Creek at Ballinger	31 45	99 57	458	1906–38	Sept. 3, 1935	10.3	26,100	July 26, 7 a. m	5.26	2,070	4.5	1,480
25	South Concho River at Christoval	31 13	100 30	434	1882–1938	Aug. 6, 1906	23.1	(c)	July 23, 12 m	21.95	100,000	230	30,300
						Sept. 17, 1936	20.5	80,100					
26	South Concho River at San Angelo	31 27	100 26	2,535	1854–1938	Aug. 6, 1906	29.7	(c)	July 23. 8 p. m	17.15	80.100	31.6	39,500
						Sept. 17, 1936	[d] 23.4	111,000					
27	Concho River near San Angelo	31 27	100 25	4,217	1854–1938	Aug. 6, 1906	47.5	[e] 246,000	July 23, 8:30 p. m	35.9	85,100	20.2	39,700
28	Concho River near Paint Rock	31 31	99 55	5,263	1882–1938	Sept. 17, 1936	43.4	301,000	July 24, 10:15 a. m	31.95	86,000	16.4	54,200
29	Middle Concho River near Tankersly	31 23	100 37	1,128	1922–38	April 1922	27.2	(c)	July 20, 8:30 p. m	6.70	1,280	1.1	323
						Sept. 26, 1936	24.2	[e] 35,000					
30	Spring Creek near Tankersly	31 22	100 32	734	1930–38	Sept. 17, 1936	[f] 20.3	23,900	July 23, 8 p. m	15.15	12,000	16.3	3,070
32	North Concho River near Carlsbad	31 36	100 40	1,406	1922–38	Sept. 26, 1936	16.0	94,600	July 25, 11:30 a. m	8.98	4,870	3.5	1,740
41	Kickapoo Creek near Paint Rock	31 28	99 59	289	1938				July 23, about 12 m		48,100	166	
42	Salt Creek near Doole	31 24	99 25	88.2	1938				July 23, about 10 a. m.		20,400	231	
43	Deep Creek near Milburn	31 23	99 06	59.2	1938				July 23, about 6 a. m.		33,600	568	
44	Pecan Bayou at Brownwood Reservoir.	31 50	99 00	1,535	1932	July 3, 1932		235,000					
45	Pecan Bayou at Brownwood	31 44	98 58	1,614	1917–18, 1923–38	Oct. 14, 1930	16.9	52,700	July 26, 4:30 a. m	5.72	5,290	3.3	4,470
48	San Saba River at Menard	30 55	99 48	1,151	1899–1938	June 5 or 6, 1899	23.7	(c)	July 23, 9 p. m	22.7	117,000	102	59,100
						Sept. 16, 1936	21.2	68,600					
49	San Saba River near Richland Springs.[g]	31 08	98 57	2,757	1938				July 22		181,000	65.7	

50	San Saba River at San Saba	31	12	98	42	3,046	1899–1938	June 6, 1899 Apr. 26, 1922	[h] 42.6 [i] 42.1	[c] 57,000	July 23, 11 a. m.	45.18	208,000	66.6	134,000
59	Brady Creek near Brady	31	06	99	18	595	1930–38				July 23, about 2:30 p. m.		86,000	145	
60	Richland Creek near Richland Spring.	31	16	98	50	72.4	1938				July 23, 7 a. m.		61,000	843	
61	Cherokee Creek near Chappel	31	03	98	34	149	1882, 1938	1882	[j]		July 25, 6 a. m.		20,900	140	
63	North Llano River near Junction	30	30	99	47	914	1875–1938	Sept. 16, 1936	[k] 24.9	94,800	July 22, 4:30 p. m.	24.4	68,600	75.1	36,100
64	Llano River near Junction	30	30	99	44	1,762	1889–1938	June 14, 1935	43.3	319,000	July 22, about 11 p. m.	30.3	137,000	77.8	65,900
65	Llano River near Castell	30	43	98	53	3,514	1889–1938	do	37.0	388,000	July 23, about 8 a. m.	21.43	133,000	37.8	70,100
77	Pedernales River near Spicewood	30	25	98	05	1,294	1869–1938	May 28, 1929	[m] 40.4	155,000	July 25, 8 a. m.	9.3	6,650	5.1	5,150

[a] Noncontributing area above Cap Rock not included
[b] A stage of about 36 feet occurred in 1884.
[c] Not determined.
[d] Includes about 2.4 feet of backwater from North Concho River.
[e] About.
[f] A stage of about 25 feet has been reported (date and discharge unknown).
[g] 2 miles below mouth of Brady Creek.
[h] May have been affected by backwater.
[i] Affected by backwater.
[j] Stage about 10 feet higher than in 1938.
[k] At former site 440 feet below present gage.
[m] About same stage occurred in 1869.

Under the heading "Maxima" in the station description are two or three paragraphs. The first paragraph, headed "1938", gives the maximum discharge and gage height during the flood of July 1938; the second, headed by the inclusive dates of continuous records, gives the maximum discharge and the corresponding gage height during the period of continuous records prior to July 1938; the third, when included, is headed by inclusive dates, and gives the maximum stage and discharge during the period prior to the beginning of continuous records, is based mostly on information from local residents, and varies in the degree of its accuracy and reliability.

The tables showing stage and discharge at indicated times are designed to present the rise and recession of the flood in detail, as the rate of rise and fall is usually so rapid that daily mean values do not define the hydrographs adequately. Hydrographs of discharge, showing characteristics of the flood peaks and conditions of flow during the flood period, are shown in figures 15–19.

The discharge at an indicated time is related to the corresponding gage height in accordance with a stable stage-discharge relation, except for those stations where there are changing conditions of channel and where certain adjustments have been made. In determining the discharge from the stage, the stage has been used to the nearest hundredth, half tenth, or tenth of a foot in accordance with certain established limits of refinements, which are indicated in the station description.

Several storage reservoirs in the basin affect flood flows, but no attempt has been made to adjust discharges to show the natural flow. Reservoir records, where available, are incorporated in this report.

The records are presented in accordance with the regular arrangement used by the Geological Survey in its water-supply papers: the stations on the main stem of the stream are treated first, in downstream order, and then stations on the tributaries in similar order beginning with the uppermost, and the streams in each tributary basin are listed before those of the next basin below.

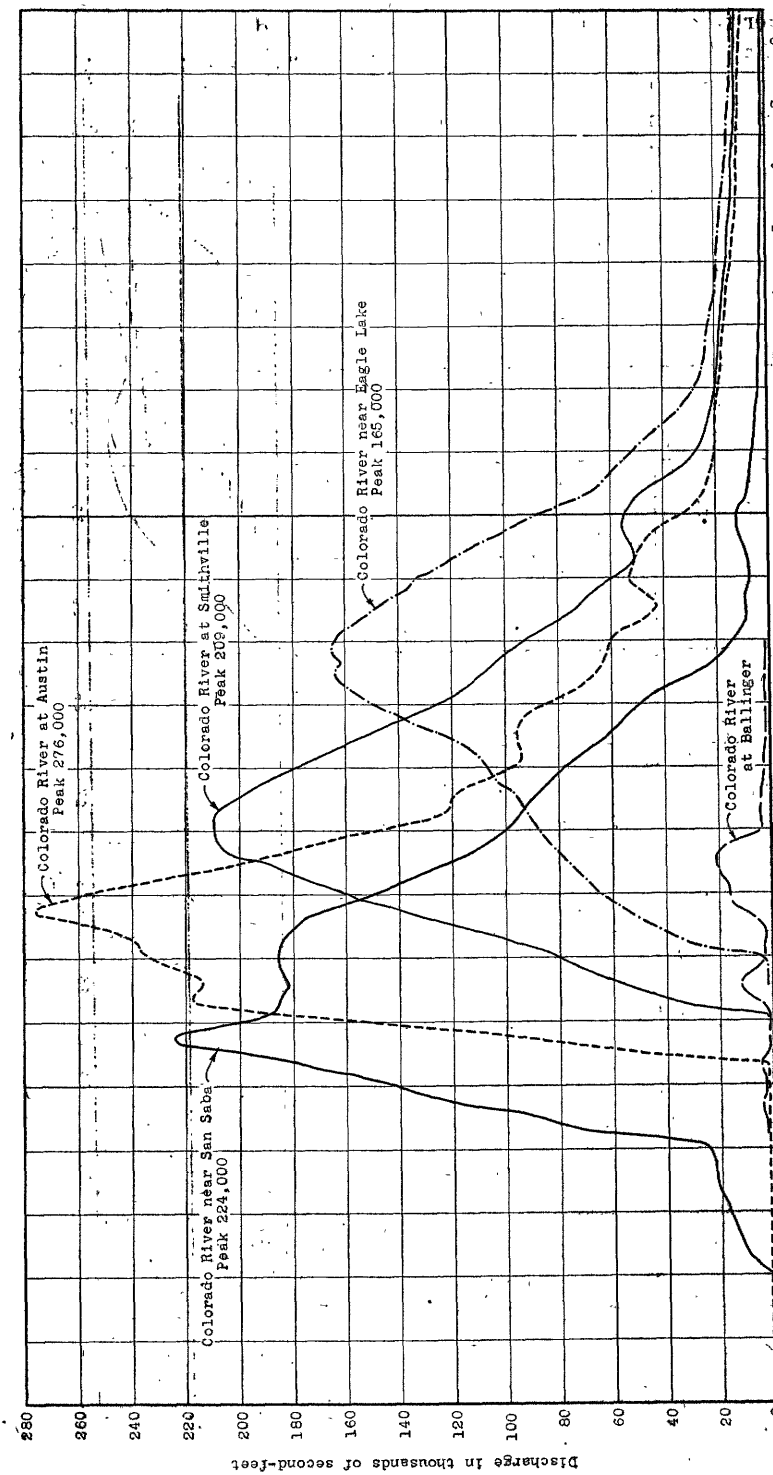

FIGURE 15.—Hydrographs of discharge at river-measurement stations on Colorado River, July 18 to August 8, 1938.

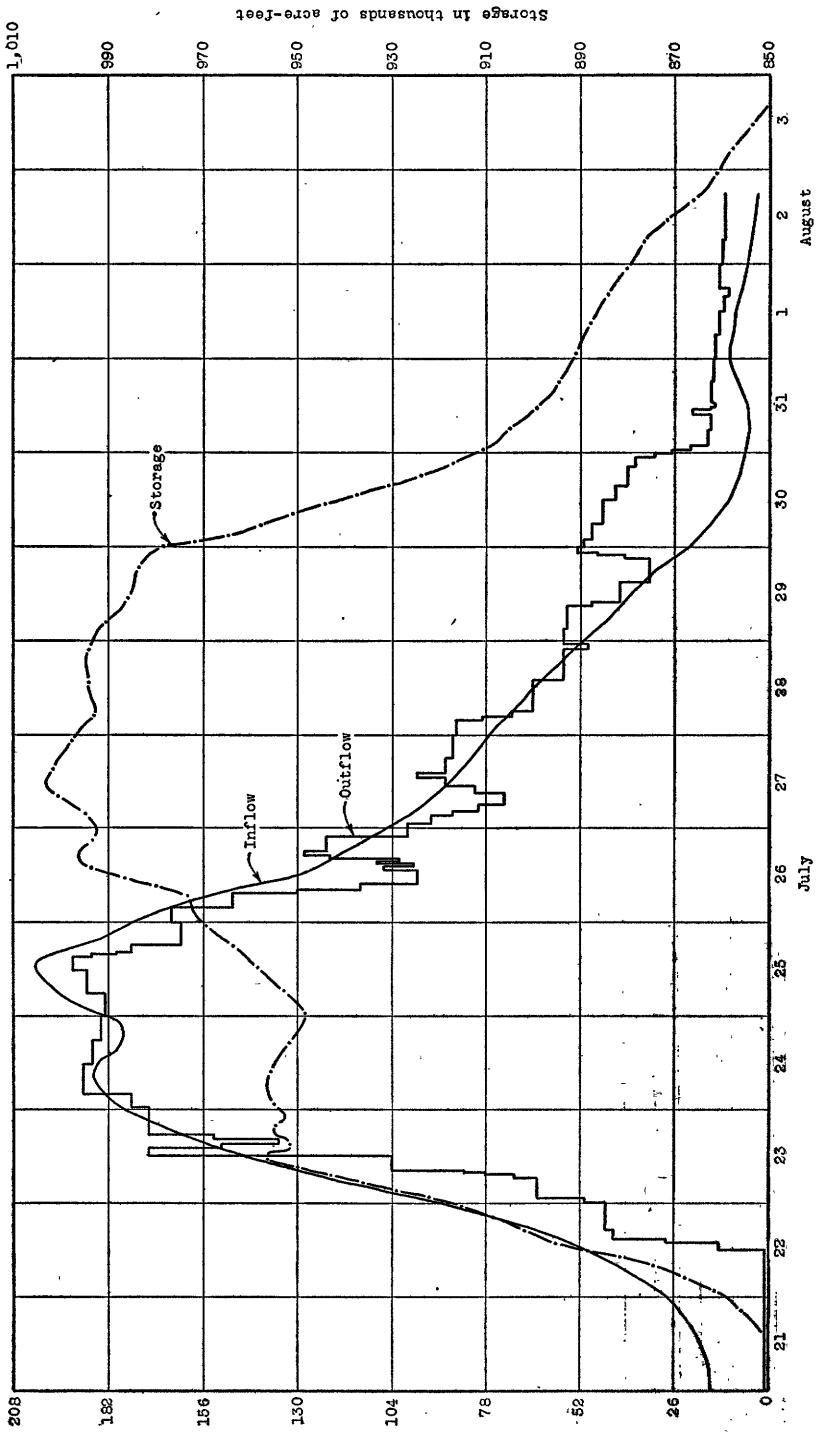

FIGURE 16.—Hydrographs of inflow, outflow, and storage at Buchanan Reservoir, on Colorado River, July 21 to August 3, 1938.

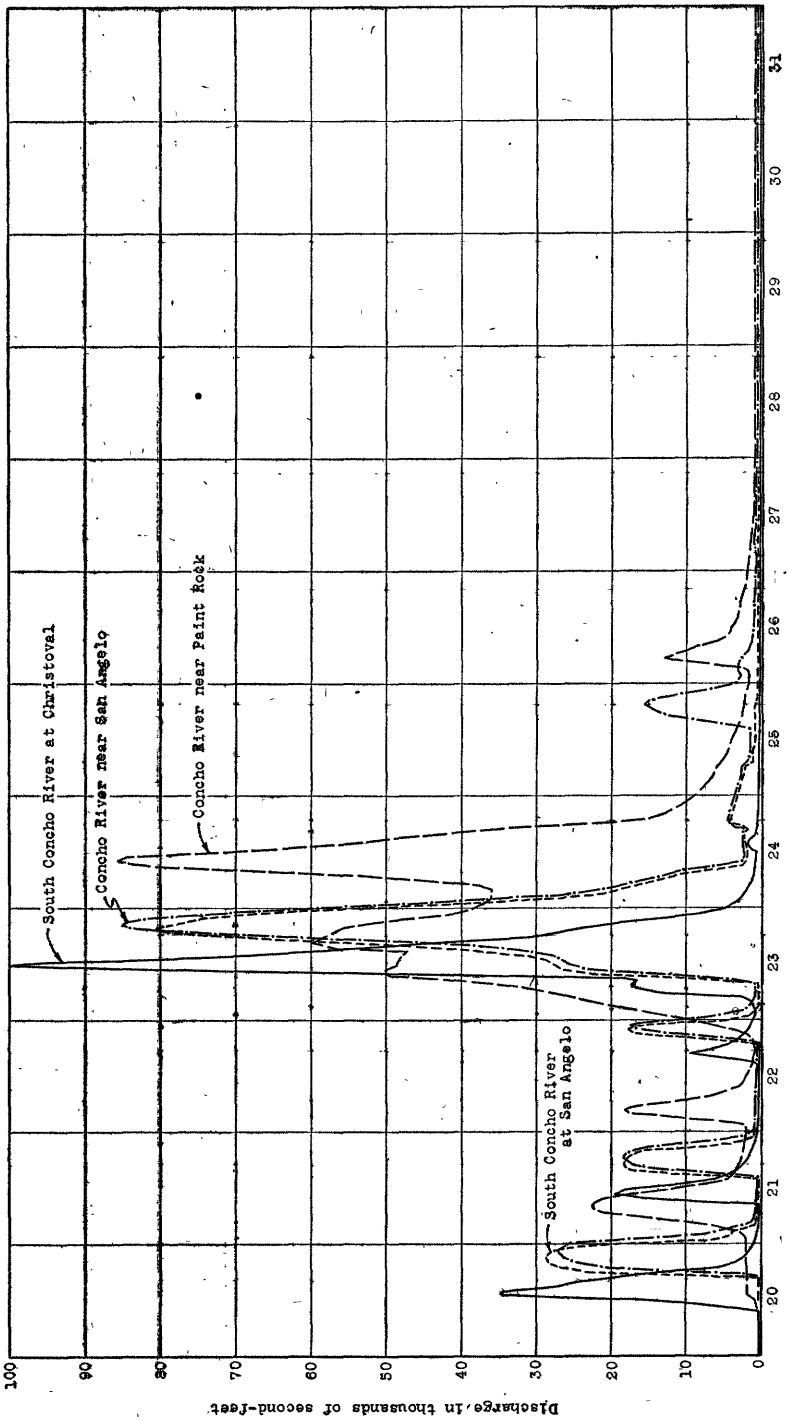

FIGURE 17.—Hydrographs of discharge at river-measurement stations on South Concho and Concho Rivers, July 20-31, 1938.

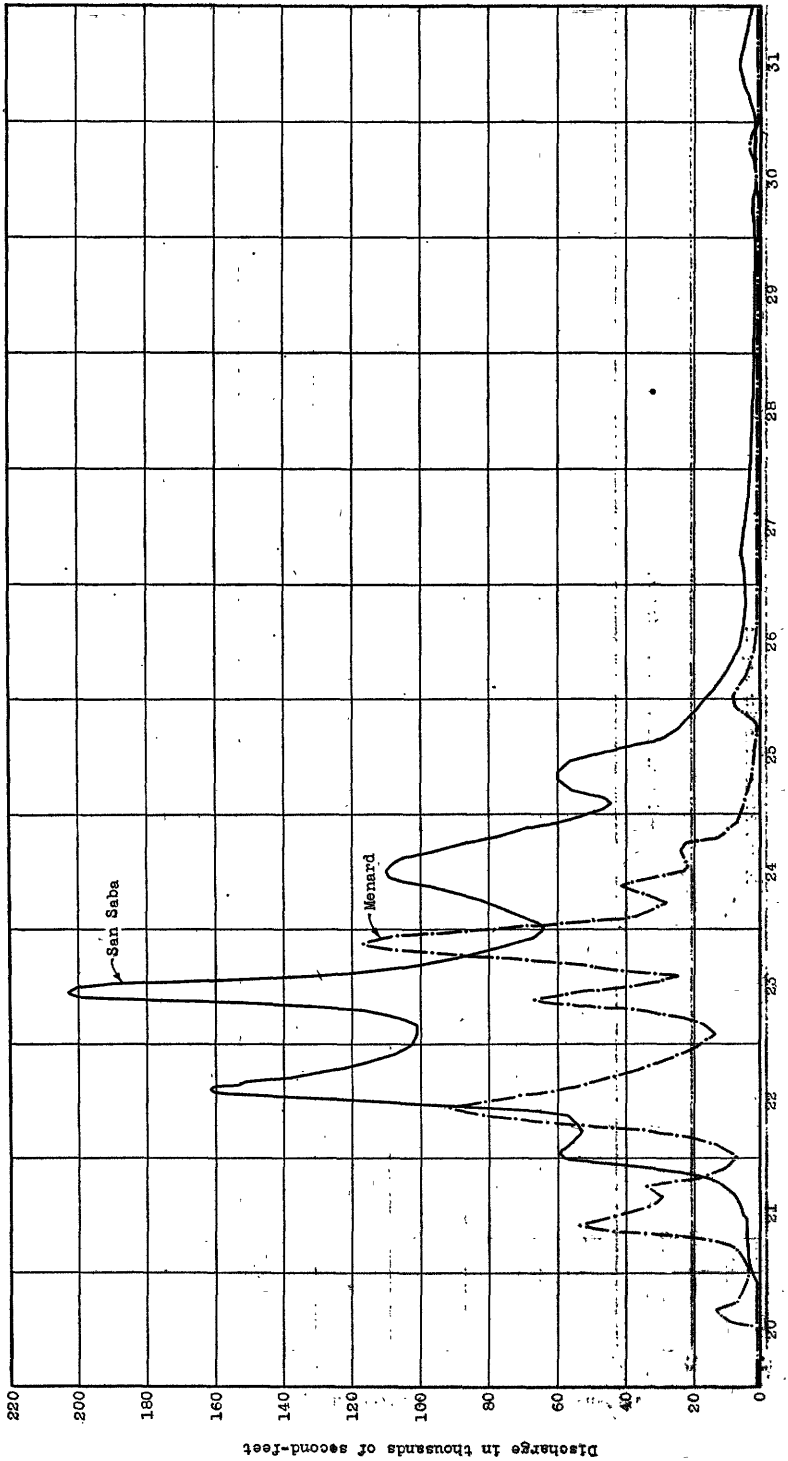

FIGURE 18.—Hydrographs of discharge at river-measurement stations on San Saba River at Menard and at San Saba, July 20–31, 1938.

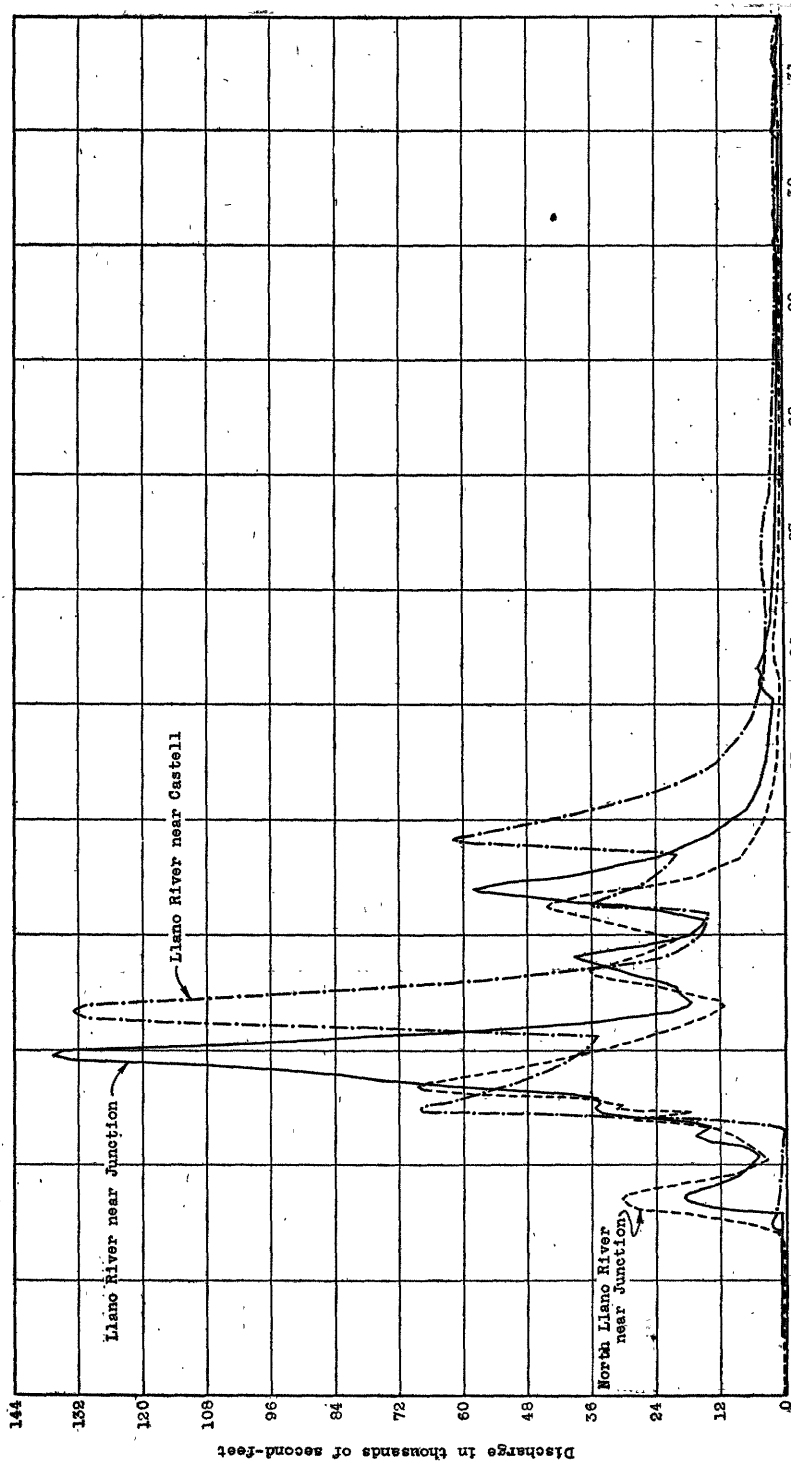

FIGURE 19.—Hydrographs of discharge at river-measurement stations on North Llano and Llano Rivers, July 20-31, 1938.

COLORADO RIVER AT BALLINGER, TEX.

LOCATION.—Lat. 31°43'50", long. 99°56'25", at bridge on U. S. Highway 83 at Ballinger, Runnels County, 2,000 feet upstream from Elm Creek. Zero of gage is 1,593.7 feet above mean sea level (general adjustment of 1929).

DRAINAGE AREA.—16,840 square miles, of which about 11,500 square miles is probably noncontributing.

GAGE-HEIGHT RECORD.—Water-stage recorder graph except 1 p. m. July 23 to 5 a. m. July 24 and 8 p. m. July 27 to 10 a. m. Aug. 14, when it was determined from graph based on records at other stations, local information, and weather records. Gage heights used to half tenths between 3.7 and 5.1 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements below 55,200 second-feet; extended to 75,400 second-feet on basis of one float measurement of 65,500 second-feet.

MAXIMA.—1938: Discharge, 21,100 second-feet 12 m. July 26 (gage height, 17.75 feet).

1907–37: Discharge, 75,400 second-feet Sept. 18, 1936 (gage height, 28.6 feet).

1882–1906: Stage, about 36 feet, present site and datum, in 1884. A stage of about 32 feet occurred Aug. 6, 1906, present site and datum (discharge not determined, but probably less than in 1936); affected by backwater from Elm Creek.

REMARKS.—Small diversions for irrigation above station affect low flow only.

Mean discharge, in second-feet, and runoff, in acre-feet, 1938

Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet
July 19	36	71	July 28	1,400	2,780	Aug. 6	143	284
20	789	1,560	29	705	1,400	7	136	270
21	933	1,850	30	476	944	8	130	258
22	3,550	7,040	31	348	690	9	120	238
23	2,920	5,790	Aug. 1	256	508	10	110	218
24	6,520	12,930	2	216	428	11	100	198
25	7,380	14,640	3	186	369	12	91	180
26	16,900	33,520	4	167	331	13	79	157
27	3,610	7,160	5	153	303	14	62	123

Runoff in acre-feet, for period July 19 to Aug. 14 94,240

Gage-height, in feet, and discharge, in second-feet, at indicated time, 1938

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
July 19			*July 23*			*July 26*		
1 a. m.	1.40	23	3:00 a. m.	6.11	4,480	4 a. m.	15.72	17,600
7 p. m.	1.39	22	5:45	6.68	5,230	6	16.50	18,900
9	1.82	140	8:00	6.11	4,480	8	17.08	19,900
11	1.85	150	12:00 m.	4.48	2,500	10	17.53	20,600
12	1.84	147	6:00 p. m.	3.72	1,550	12 m.	17.75	21,100
July 20			12:00	3.55	1,380	2 p. m.	17.58	20,800
			July 24			4	16.85	19,400
6 a. m.	1.70	100				6	15.15	16,900
9	1.66	88	4 a. m.	4.00	1,990	8	11.70	11,900
10	1.85	150	6	5.25	3,350	10	8.65	7,760
11	2.88	673	8	7.30	6,010	12	7.20	5,880
12 m.	3.37	1,180	10	9.65	9,110	*July 27*		
3 p. m.	3.63	1,470	12 m.	11.60	11,800			
8	3.55	1,380	2 p. m.	12.30	12,800	6 a. m.	6.33	4,720
12	3.48	1,300	4	11.54	11,700	12 m.	5.14	3,220
July 21			6	9.65	9,110	6 p. m.	4.53	2,560
			8	6.83	5,360	12	4.15	2,080
3:00 a. m.	3.38	1,190	10	5.08	3,220	*July 28*		
6:00	3.35	1,150	11	4.98	3,100			
12:00 m.	2.85	689	12	5.08	3,220	12 m.	3.53	1,350
10:00 p. m.	2.49	438	*July 25*			12 p. m.	3.12	917
11:00	4.60	2,620				*July 29*		
11:50	5.18	33,30	2 a. m.	5.32	3,480			
12:00	5.00	,1500	4	5.23	3,350	12 m.	2.87	705
July 22			6	5.33	3,480	12 p. m.	2.68	562
			9	5.15	3,290	*July 30*		
1:50 a. m.	5.26	3,480	12 m.	6.00	4,350			
4:00	5.00	3,100	2 p. m.	7.63	6,410	12 m.	2.55	476
8:00	4.46	2,440	3	8.60	7,760	12 p. m.	2.43	403
10:00	4.76	2,800	4	9.87	9,520	*July 31*		
12:00 m.	5.40	3,600	5	10.90	10,900			
2:00 p. m.	5.82	4,100	6	11.90	12,200	12 m.	2.33	348
5:00	6.20	4,600	7	12.85	13,500	12 p. m.	2.24	304
8:00	5.92	4,220	8	13.34	14,200			
12:00	5.20	3,350	12	14.64	16,000			

COLORADO RIVER NEAR SAN SABA, TEX.

LOCATION.—Lat. 31°12'45", long. 98°34'00", at Red Bluff crossing, 5.7 miles downstream from San Saba River and 9.2 miles east of San Saba, San Saba County. Zero of gage is 1,096.22 feet above mean sea level (general adjustment of 1929).

DRAINAGE AREA.—30,600 square miles, of which about 11,800 square miles is probably noncontributing.

GAGE-HEIGHT RECORD.—Water-stage recorder graph except 7 p. m. July 22 to 10 a. m. July 30, when it was determined from graph based on numerous staff-gage readings daily, and Aug. 3–14, when it was partly estimated on basis of one staff-gage reading daily. Gage heights used to half tenths between 3.9 and 7.5 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements.

MAXIMA.—1938: Discharge, 224,000 second-feet 6 p. m. July 23 (gage height, 62.24 feet, from floodmarks); this is the greatest flood known to local residents, whose knowledge goes back to 1878.

1930–37: Discharge, 179,000 second-feet Sept. 21, 1936 (gage height, 56.7 feet, from floodmarks).

1900–1929: Discharge, 184,000 second-feet Sept. 25, 1900 (gage height, about 57.5 feet, present site and datum, according to information from local residents).

REMARKS.—Small diversions above station for irrigation and municipal use affect low flow only. Flood flow subject to some regulation by reservoirs upstream (see records for Lake Nasworthy near San Angelo and Brownwood Reservoir near Brownwood).

Mean discharge, in second-feet, and runoff, in acre-feet, 1938

Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet
July 19	178	353	July 29	28,700	56,930	Aug. 7	1,740	3,450
20	10,600	21,020	30	8,580	17,020	8	1,680	3,330
21	20,700	41,060	31	9,190	18,230	9	1,570	3,110
22	87,000	172,600	Aug. 1	7,500	14,880	10	1,510	3,000
23	191,000	378,800	2	4,100	8,130	11	1,450	2,880
24	186,000	368,900	3	2,960	5,870	12	1,510	3,000
25	175,000	347,100	4	2,380	4,720	13	1,540	3,050
26	122,000	242,000	5	2,060	4,090	14	1,450	2,880
27	88,800	176,100	6	1,900	3,770			
28	61,600	122,200						

Runoff, in acre-feet, for period July 19 to Aug. 14 2,028,000

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
July 19			*July 21—Con.*			*July 23—Con.*		
1 a. m.	2.61	172	5 p. m.	17.0	22,100	12 m	59.0	196,000
12 m.	2.60	169	6	17.05	22,100	1 p. m.	59.8	202,000
9 p. m.	2.68	194	7	17.15	22,500	2	60.8	211,000
12	3.00	328	8	17.25	22,500	3	61.5	218,000
July 20			9	17.35	22,900	4	62.05	222,000
			10	17.5	23,000	5	62.2	223,000
1 a. m.	4.00	880	11	17.75	23,600	6	62.24	224,000
2	6.50	2,960	12	18.0	24,000	7	62.15	224,000
3	7.70	4,640				8	61.85	220,000
4	8.50	6,080	*July 22*			9	61.4	217,000
5	9.20	7,370				10	60.8	211,000
6	9.80	8,480	1 a. m.	18.6	25,200	11	60.2	206,000
7	10.1	9,040	2	20.0	28,200	12	59.6	201,000
8	10.4	9,590	3	22.8	35,100			
9	10.65	10,000	4	25.6	43,100	*July 24*		
10	10.9	10,500	5	28.2	51,800			
11	11.1	10,900	6	30.2	59,200	1 a. m.	59.0	196,000
12 m.	11.4	11,500	7	32.2	67,200	2	58.5	192,000
1 p. m.	11.6	11,800	8	34.0	74,400	3	58.05	188,000
2	11.85	12,300	9	35.1	79,000	4	57.9	187,000
3	12.05	12,600	10	36.0	82,800	5	57.75	187,000
4	12.3	13,200	11	36.7	85,700	6	57.65	185,000
5	12.5	13,600	12 m.	37.3	88,300	7	57.6	185,000
6	12.7	13,900	1 p. m.	38.0	91,200	8	57.55	185,000
7	12.9	14,300	2	38.8	94,600	9	57.5	184,000
8	13.1	14,700	3	40.1	100,000	10	57.4	184,000
9	13.35	15,300	4	42.0	108,000	11	57.35	184,000
10	13.55	15,600	5	43.7	115,000	12 m.	57.2	182,000
11	13.75	16,000	6	44.9	120,000	1 p. m.	57.1	182,000
12	14.0	16,400	7	45.9	125,000	2	57.05	181,000
July 21			8	46.6	128,000	3	57.05	181,000
			9	47.4	131,000	4	57.15	182,000
1 a. m.	14.15	16,800	10	48.2	135,000	5	57.2	182,000
2	14.35	17,200	11	48.9	138,000	6	57.3	183,000
3	14.6	17,500	12	49.6	141,000	7	57.4	184,000
4	14.85	17,900	*July 23*			8	57.5	184,000
5	15.1	18,500				9	57.55	185,000
6	15.45	19,100	1 a. m.	50.2	144,000	10	57.6	185,000
7	15.8	19,800	2	50.95	148,000	11	57.65	185,000
8	16.05	20,200	3	51.8	152,000	12	57.7	186,000
9	16.25	20,600	4	52.7	156,000			
10	16.45	21,000	5	53.9	162,000	*July 25*		
11	16.55	21,300	6	54.8	168,000	1 a. m.	57.7	186,000
12 m.	16.7	21,500	7	55.5	172,000	2	57.7	186,000
1 p. m.	16.75	21,700	8	56.1	176,000	3	57.65	185,000
2	16.85	21,700	9	56.6	179,000	4	57.6	185,000
3	16.9	21,900	10	57.1	182,000	5	57.55	185,000
4	16.95	22,100	11	57.9	187,000	6	57.45	184,000

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938—Continued

Time	Feet	Second-feet
July 25—Con.		
7 a. m.	57.35	184,000
8	57.25	182,000
9	57.15	182,000
10	57.0	181,000
11	56.8	180,000
12 m.	56.6	179,000
1 p. m.	56.4	177,000
2	56.15	176,000
3	55.9	174,000
4	55.6	173,000
5	55.3	171,000
6	54.8	168,000
7	54.3	165,000
8	53.8	162,000
9	53.3	159,000
10	52.75	156,000
11	52.3	154,000
12	51.7	151,000
July 26		
1 a. m.	51.15	148,000
2	50.65	146,000
3	50.1	143,000
4	49.5	141,000
5	49.0	138,000
6	48.5	136,000
7	48.0	134,000
8	47.5	132,000
9	46.9	129,000
10	46.3	126,000
11	45.6	123,000
12 m.	44.9	120,000
1 p. m.	44.35	118,000
2	43.9	116,000
3	43.4	114,000
4	42.95	112,000
5	42.5	110,000
6	42.1	108,000
7	41.75	107,000
8	41.4	105,000
9	41.05	104,000
10	40.75	103,000
11	4 .45	101,000
12	40.15	100,000
July 27		
1 a. m.	39.9	99,200
2	39.65	97,900
3	39.4	97,100
4	39.15	96,200
5	38.9	95,000
6	38.7	94,100
7	38.5	93,300
8	38.3	92,500
9	38.1	91,600
10	37.95	91,200
11	37.75	90,400
12 m.	37.5	89,100
1 p. m.	37.3	88,300
2	37.1	87,400
3	36.9	86,600
4	36.7	85,700
5	36.45	84,500
6	36.2	83,600
7	35.95	82,800
8	35.7	81,500
9	35.4	80,300
10	35.0	78,600
11	34.75	77,800
12	34.5	76,500
July 28		
1 a. m.	34.2	75,200
2	33.9	74,000
3	33.55	72,800
4	33.25	71,200
5 a. m.	32.95	70,400
6	32.6	68,800
7	32.3	67,600
8	31.95	66,400
9	31.65	64,800
10	31.3	63,600
11	31.0	62,400
12m	30.65	60,800
1 p. m.	30.3	59,600
2	30.0	58,400
3	29.7	57,300
4	29.5	56,500
5	29.2	55,400
6	29.0	54,600
7	28.8	53,900
8	28.5	52,800
9	28.3	52,200
10	28.0	51,100
11	27.7	50,000
12	27.3	48,600
July 29		
1 a. m.	26.9	47,300
2	26.5	46,000
3	26.0	44,300
4	25.5	42,800
5	24.9	40,900
6	24.3	39,200
7	23.6	37,300
8	22.8	35,100
9	22.0	33,000
10	21.2	31,100
11	20.3	29,900
12 m.	19.5	27,100
1 p. m.	18.6	25,200
2	17.8	23,600
3	16.9	21,900
4	16.2	20,600
5	15.5	19,200
6	15.0	18,300
7	14.4	17,200
8	14.0	16,400
9	13.5	15,400
10	13.0	14,500
11	12.6	13,700
12	12.1	12,800
July 30		
1 a. m.	11.7	12,000
2	11.4	11,500
3	11.05	10,700
4	10.8	10,300
5	10.5	9,780
6	10.2	9,220
7	10.0	8,850
8	9.50	7,920
9	9.50	7,920
12 m.	9.70	8,300
2 p. m.	9.80	8,480
3	9.75	8,480
6	9.40	7,740
9	9.18	7,370
12	9.07	7,180
July 31		
2 a. m.	9.03	7,000
3	9.03	7,000
5	9.07	7,180
6	9.15	7,370
9	9.50	7,920
12 m.	10.0	8,850
2 p. m.	10.6	9,960
4	11.1	10,900
6	11.4	11,500
7	11.5	11,600
8	11.6	11,800
9 p. m.	11.6	11,800
10	11.5	11,600
12	11.3	11,300
Aug. 1		
2 a. m.	11.1	10,900
4	10.4	9,590
6	9.90	8,660
8	9.50	7,920
12 m.	9.05	7,000
6 p. m.	8.57	6,260
12	8.12	5,340
Aug. 2		
6 a. m.	7.68	4,640
12 m.	7.46	4,310
12 p. m.	7.00	3,600
Aug. 3		
12 m.	6.62	3,080
12 p. m.	6.34	2,780
Aug. 4		
12 m.	6.07	2,460
12 p. m.	5.87	2,280
Aug. 5		
12 m.	5.74	2,180
12 p. m.	5.63	2,100
Aug. 6		
12 m.	5.55	1,900
6 p. m.	5.55	1,900
12	5.45	1,820
Aug. 7		
12 m.	5.32	1,740
12 p. m.	5.27	1,710
Aug. 8		
12 m.	5.21	1,680
12 p. m.	5.13	1,600
Aug. 9		
12 m.	5.07	1,570
12 p. m.	5.02	1,540
Aug. 10		
12 m.	4.95	1,510
12 p. m.	4.90	1,480
Aug. 11		
12 m.	4.87	1,450
12 p. m.	4.90	1,480
Aug. 12		
12 m.	4.97	1,510
12 p. m.	5.02	1,540
Aug. 13		
12 m.	5.05	1,570
12 p. m.	4.97	1,510
Aug. 14		
12 m.	4.85	1,450
12 p. m.	4.78	1,420

BUCHANAN RESERVOIR NEAR BURNET, TEX.

LOCATION.—Lat. 30°45′, long. 98°25′, at Buchanan Dam on Colorado River on Llano-Burnet County line, 4 miles upstream from Roy Inks Dam, 10 miles west of Burnet, Burnet County, and 13 miles upstream from Llano River. Gage heights are elevations above mean sea level.

DRAINAGE AREA.—31,250 square miles, of which 11,800 square miles is probably noncontributing.

GAGE-HEIGHT RECORD.—Float and cloth-tape gage located in well of gate tower of dam; gage read at 30-minute intervals July 24 to 4:20 p. m. July 31, and at about 1-hour intervals at other times.

STORAGE RECORD.—Capacity table based on survey of reservoir site made before storage began.

DISCHARGE RECORD.—Based on change in elevation of lake level, capacity table, gate and weir ratings, and record of operation of gates and weirs.

MAXIMA.—1938: Inflow, 202,000 second-feet 1 p. m. July 25; outflow, 192,000 second-feet 12 m. to 3:30 p. m. July 25; storage, 1,003,700 acre-feet 11:50 a. m. July 27 (elevation, 1,020.48 feet).

REMARKS.—Records of stage and capacity furnished by Lower Colorado River Authority. Inflow and outflow records computed by Texas Board of Water Engineers. In the table, for those periods where the outflow is shown to be constant, the mean elevation of the reservoir was used in computing the discharge.

Elevation, in feet, and contents, in acre-feet, at indicated time, 1938

Time	Feet	Acre-feet	Time	Feet	Acre-feet	Time	Feet	Acre-feet
July 20			*July 24—Con.*			*July 27—Con.*		
7 a. m.	1,012.02	816,800						
3 p. m.	1,012.10	818,500	2:50 p. m.	1,018.29	953,300	9:50 p. m.	1,020.24	998,100
11	1,012.42	825,200	5:50	1,018.21	951,400	11:50	1,020.20	997,100
12	1,012.45	825,800	8:50	1,018.14	949,800	12:00	1,020.19	996,900
July 21			11:50	1,018.07	948,300	*July 28*		
			12:00	1,018.08	948,500			
3 p. m.	1,013.42	846,300	*July 25*			1:20 a. m.	1,020.16	996,200
8	1,013.73	852,900				2:50	1,020.10	994,800
12	1,014.02	859,000	2:20 a. m.	1,018.12	949,400	4:20	1,020.05	993,600
July 22			4:50	1,018.20	951,200	7:50	1,020.03	993,200
			8:50	1,018.37	955,100	12:20 p. m.	1,020.08	994,300
4:00 a. m.	1,014.32	865,500	1:50 p. m.	1,018.56	959,400	3:20	1,020.08	994,300
6:00	1,014.51	869,600	4:50	1,018.68	962,100	5:50	1,020.10	994,800
8:00	1,014.72	874,100	7:50	1,018.83	965,600	8:50	1,020.08	994,300
10:00	1,015.02	880,600	11:20	1,019.00	969,400	11:50	1,020.06	993,900
12:00 m.	1,015.38	888,500	12:00	1,019.03	970,100	12:00	1,020.06	993,900
2:20 p. m.	1,015.77	897,000				*July 29*		
5:20	1,016.00	902,000	*July 26*					
8:20	1,016.28	908,200				2:50 a. m.	1,020.00	992,500
10:20	1,016.54	914,000	1:50 a. m.	1,019.10	971,700	5:20	1,019.90	990,200
12:00	1,016.74	918,400	4:20	1,019.14	972,600	8:20	1,019.78	987,400
July 23			8:20	1,019.28	975,900	11:20	1,019.72	986,000
			10:50	1,019.64	984,200	2:20 p. m.	1,019.67	984,000
12:20 a. m.	1,016.78	919,300	1:20 p. m.	1,019.94	991,100	5:20	1,019.64	984,200
2:20	1,017.03	924,900	4:50	1,020.16	996,200	8:20	1,019.59	983,000
4:20	1,017.32	931,400	7:50	1,020.09	994,600	10:50	1,019.51	981,200
6:20	1,017.68	939,500	10:50	1,020.01	992,700	12:00	1,019.35	977,500
8:20	1,018.04	947,600	12:00	1,020.01	992,700	*July 30*		
11:20	1,018.44	956,700	*July 27*					
2:20 p. m.	1,018.22	951,700				12:20 a. m.	1,019.32	976,800
5:20	1,018.36	954,900	1:50 a. m.	1,020.03	993,200	2:20	1,018.97	968,700
9:20	1,018.28	953,000	4:50	1,020.14	995,700	4:20	1,018.72	963,000
12:00	1,018.32	953,900	6:50	1,020.26	998,500	6:50	1,018.40	955,800
July 24			8:20	1,020.35	1,000,600	9:20	1,018.08	948,500
			9:50	1,020.44	1,002,700	11:50	1,017.79	941,900
12:20 a. m.	1,018.33	954,200	11:50	1,020.48	1,003,700	2:20 p. m.	1,017.48	935,000
5:50	1,018.43	956,400	1:50 p. m.	1,020.44	1,002,700	4:50	1,017.19	928,500
8:50	1,018.41	956,000	3:50	1,020.39	1,001,600	7:20	1,016.89	921,800
11:50	1,018.36	954,900	6:20	1,020.34	1,000,400	9:50	1,016.59	915,100
			8:20	1,020.30	999,500	12:00	1,016.39	910,700

Elevation, in feet, and contents, in acre-feet, at indicated time, 1938—Continued

Time	Feet	Acre-feet	Time	Feet	Acre-feet	Time	Feet	Acre-feet
July 31			*Aug. 2*			*Aug. 4*		
1:50 a. m.	1,016.30	908,700	12:20 a. m.	1,014.95	879,100	4:20 a. m.	1,013.23	842,200
5:20	1,016.18	906,000	4:20	1,014.80	875,900	11:20	1,013.01	837,600
8:50	1,016.00	902,000	12:20 p. m.	1,014.55	870,500	6:20 p. m.	1,012.81	833,400
12:50 p. m.	1,015.82	898,100	8:20	1,014.28	864,600	12:00	1,012.67	830,400
4:20	1,015.71	895,700	12:00	1,014.13	861,400			
11:20	1,015.53	891,800				*Aug. 5*		
12:00	1,015.53	891,800	*Aug. 3*			12:20 a. m.	1,012.66	820,200
Aug. 1						7:20	1,012.47	826,200
6:20 a. m.	1,015.42	889,400	4:20 a. m.	1,014.00	858,600	1:20 p. m.	1,012.30	822,700
12:20 p. m.	1,015.28	886,300	1:20 p. m.	1,013.71	852,400	6:20	1,012.13	819,100
6:20	1,015.14	883,200	10:20	1,013.42	846,300	11:20	1,011.96	815,500
12:00	1,014.96	879,300	12:00	1,013.37	845,200	12:00	1,011.94	815,100

Mean inflow, in second-feet, and runoff, in acre-feet, 1938

Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet
July 22	53,500	106,100	July 26	137,000	271,700	July 30	12,400	24,600
23	140,000	277,700	27	89,100	176,700	31	7,380	14,640
24	182,000	361,000	28	64,500	127,900	Aug. 1	8,810	17,470
25	192,000	380,800	29	37,400	74,180			

Runoff, in acre-feet, for period July 22 to Aug. 1 1,833,000

Inflow, in second-feet, at indicated time, 1938

Time	Second-feet	Time	Second-feet	Time	Second-feet	Time	Second-feet
July 21		*July 24*		*July 26*—Con.		*July 29*—Con.	
1 a. m.	16,000	3 a. m.	182,000	11 a. m.	134,000	6 p. m.	31,000
12 p. m.	28,000	5	184,000	1 p. m.	128,000	12	22,000
July 22		9	186,000	4	121,000	*July 30*	
4 a. m.	35,000	1 p. m.	184,000	7	116,000	6 a. m.	16,000
8	42,000	3	180,000	12	106,000	12 m.	11,000
12 m.	50,000	7	178,000	*July 27*		6 p. m.	8,200
3 p. m.	58,000	10	179,000	3 a. m.	100,000	12	6,600
6	67,000	12	182,000	6	95,000	*July 31*	
9	78,000	*July 25*		12 m.	88,000	6 a. m.	6,500
12	90,000	2 a. m.	188,000	6 p. m.	82,000	12 m.	6,200
July 23		4	193,000	12	77,000	6 p. m.	9,000
3 a. m.	104,000	8	198,000	*July 28*		12	11,000
6	119,000	1 p. m.	202,000	6 a. m.	71,000	*Aug. 1*	
9	132,000	3	200,000	12 m.	65,000	6 a. m.	10,000
12 m.	144,000	5	193,000	6 p. m.	58,000	12 m.	9,200
3 p. m.	154,000	8	184,000	12	51,000	6 p. m.	7,500
6	162,000	12	176,000	*July 29*		12	6,100
9	170,000	*July 26*		6 a. m.	44,000		
12	177,000	3 a. m.	168,000	12 m.	38,000		
		6	158,000				
		9	145,000				

Mean outflow, in second-feet, and runoff, in acre-feet, 1938

Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet
July 22	19,600	38,880	July 26	126,000	249,900	July 30	43,400	86,080
23	120,000	238,000	27	86,100	170,800	31	16,800	33,320
24	184,000	365,000	28	66,300	131,500	Aug. 1	13,800	27,370
25	182,000	361,000	29	45,700	90,640			

Runoff, in acre-feet, for period July 22 to Aug. 1 1,792,000

Outflow, in second-feet, at indicated time, 1938

Time	Second-feet	Time	Second-feet	Time	Second-feet	Time	Second-feet
July 21		*July 25*		*July 27—Con.*		*July 30*	
1 a. m.	500	6:00 a. m.	183,000			2:00 a. m.	51,000
12 p. m.	500		188,000	6:00 a. m.	80,000		49,000
		12:00 m.	188,000		73,000	6:00	49,000
July 22			192,000	9:45	73,000		46,000
12:00 m.	500	3:30 p. m.	192,000		81,000	12:00 m.	46,000
	14,000		187,000	10:45	81,000		42,000
2:00 p. m.	14,000	4:00	187,000		89,000	4:00 p. m.	42,000
	28,500		180,000	1:20 p. m.	89,000		39,000
2:30	28,500	4:20	180,000		97,000	8:00	39,000
	43,000		176,000	1:50	97,000		37,000
5:00	43,000	9:30	176,000		89,000	11:20	37,000
	45,000		162,000	6:00	89,000		31,500
12:00	45,000	12:00	162,000		86,500	11:45	31,500
			165,000	12:00	86,500		27,000
July 23		*July 26*				12:00	27,000
12:20 a. m.	45,000			*July 28*			
	51,000	4:00 a. m.	165,000			*July 31*	
1:20	51,000		148,000	4:00 a. m.	86,000		
	64,000	7:45	148,000		79,000	12:30 a. m.	27,000
6:40	64,000		130,000	4:40	79,000		22,000
	71,000	8:15	130,000		71,000	1:30	22,000
7:15	71,000		113,000	8:30	71,000		17,000
	78,300	10:00	113,000		65,000	6:00	17,000
7:40	78,300		97,000	2:20 p. m.	65,000		16,500
	84,000	1:30 p. m.	97,000		57,000		16,500
8:00	84,000		106,000	10:20	57,000	10:00	21,000
	104,000	2:20	106,000		50,000		21,000
12:20 p. m.	104,000		98,000	11:40	50,000	11:00	16,500
	171,000	3:00	98,000		57,000		16,500
2:40	171,000		108,000	12:00	57,000	11:20	15,000
	151,000	3:45	108,000				15,000
3:20	151,000		102,000			12:45 p. m.	16,000
	135,000	4:30	102,000			1:00	16,000
4:40	135,000		121,000	*July 29*		6:20	15,500
	153,000	5:00	121,000				15,500
5:40	153,000		128,000	3:00 a. m.	57,000	12:00	15,000
	171,000	6:15	128,000		56,000		
12:00	171,000		122,000	9:00	56,000		
July 24		10:45	122,000		49,000	*Aug. 1*	
12:40 a. m.	171,000		100,000	9:40	49,000		
	176,000	12:00	100,000		41,000	6:00 a. m.	15,000
4:20	176,000			3:00 p. m.	41,000		14,000
	182,000	*July 27*			33,000	12:00 m.	14,000
4:30	184,000			9:30	33,000		12,500
	189,000	1:45 a. m.	100,000		40,000	4:00 p. m.	12,500
12:00 m.	189,000		93,000	10:00	40,000		11,000
	186,500	3:30	93,000		47,000	5:30	11,000
6:00 p. m.	186,500		87,000	10:20	47,000		14,000
	184,000	4:15	87,000		53,000	12:00	14,000
12:00	184,000		80,000	12:00	53,000		13,000
	183,000				51,000		

NOTE.—Two values of outflow for a given time represent the flow before and after change in setting of outlet gates at that time.

COLORADO RIVER AT AUSTIN, TEX.

LOCATION.—Lat. 30°16′, long. 97°45′, at Congress Avenue viaduct in Austin, Travis County, 1 mile downstream from Barton Creek. Zero of gage is 421.86 feet above mean sea level (general adjustment of 1929).

DRAINAGE AREA.—38,150 square miles, of which about 11,800 square miles is probably noncontributing.

GAGE-HEIGHT RECORD.—Water-stage recorder graph except July 25 and Aug. 11, 12, for which a graph was drawn on basis of floodmark and reading on U. S. Weather Bureau gage. For rating used July 22 and 23, gage heights used to half tenths between 0.8 foot and 2.5 feet and for rating used July 24 to Aug. 25, gage heights used to half tenths between 0.6 foot and 2.1 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements. Discharge Aug. 1, to 9 a. m., Aug. 3 determined by shifting-control method.

MAXIMA.—1938: Discharge, 276,000 second-feet about 6:30 p. m. July 25 (gage height, 32.1 feet, from floodmark on gage structure at downstream side of bridge pier).

1898–1937: Discharge, 481,000 second-feet June 15, 1935 (gage height, 42.0 feet, from U. S. Weather Bureau wire-weight gage on downstream side of bridge at center of first span from left bank; 41.2 feet from floodmarks on gage structure at downstream side of bridge pier. Both gages to same datum).

1843–97: Stage, about 43 feet July 7, 1869 (discharge not determined).

REMARKS.—Flow partly regulated by reservoirs upstream.

Mean discharge, in second-feet, and runoff, in acre-feet, 1938

Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet
July 22	1,390	2,760	Aug. 2	20,100	39,870	Aug. 14	2,440	4,840
23	53,500	106,100	3	17,500	34,710	15	2,210	4,380
24	209,000	414,500	4	15,500	30,740	16	2,050	4,070
25	254,000	503,800	5	13,200	26,180	17	2,020	4,010
26	202,000	400,700	6	11,800	23,400	18	2,070	4,110
27	119,000	236,000	7	11,800	23,400	19	2,280	4,520
28	93,400	185,300	8	10,000	19,830	20	2,320	4,600
29	67,300	133,500	9	8,400	16,660	21	2,070	4,110
30	48,900	96,990	10	4,400	8,730	22	2,050	4,070
31	45,700	90,640	11	2,870	5,690	23	1,980	3,930
Aug. 1	24,400	48,400	12	2,560	5,080	24	1,980	3,930
			13	2,480	4,920	25	1,950	3,870

Runoff, in acre-feet, for period July 22 to Aug. 25 2,508,000

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Time	Feet	Second-feet
July 22		
1 a. m.	−0.12	1,390
9 p. m.	−.12	1,390
12	−.09	1,460
July 23		
1 a. m.	−.06	1,460
7	.00	1,500
8	.20	1,880
9	3.60	11,800
10	6.80	25,700
11	9.20	38,100
12 m.	11.2	49,400
1 p. m.	12.7	58,100
2	14.0	65,800
3	15.1	72,300
11	24.3	140,000
12	25.4	153,000
July 24		
1 a. m.	26.3	164,000
4	28.3	193,000
6	29.1	210,000
8	29.4	217,000
10	29.4	217,000
12 m.	29.3	215,000
3 p. m.	29.2	212,000
6	29.4	217,000
10	29.9	228,000
12	30.1	232,000
July 25		
2 a. m.	30.2	234,000
7	30.4	239,000
10	30.7	245,000
12 m.	31.0	252,000
2 p. m.	31.4	261,000
4	31.9	272,000
6:30	32.1	276,000
9	31.8	270,000
12	31.3	259,000
July 26		
7 a. m.	29.7	223,000
10	29.1	210,000
12 m.	28.6	199,000
2 p. m.	28.1	190,000
6	27.2	176,000
10	26.0	160,000
12	25.1	149,000
July 27		
2 a. m.	24.1	138,000
5	23.0	127,000
8	22.4	122,000
12 m.	22.2	120,000
2 p. m.	22.0	118,000
5	21.3	113,000
9	19.9	103,000
12	18.9	96,400
July 28		
1 a. m.	18.6	94,400
3	18.4	93,100
9	18.7	95,000
1 p. m.	18.8	95,700
5	18.6	94,400
July 28—Con.		
8 p. m.	18.2	91,800
10	17.7	88,600
12	17.0	84,000
July 29		
3 a. m.	15.9	77,100
5	15.3	73,500
8	14.6	69,300
10	14.2	67,000
12 m.	13.8	64,600
3 p. m.	13.5	62,800
6	13.25	62,000
9	13.1	60,500
12	13.0	59,900
July 30		
2 a. m.	12.6	57,500
4	12.2	55,200
6	11.5	51,100
8	10.9	47,600
10	10.4	44,800
12 m.	10.0	42,500
2 p. m.	9.95	42,200
3	10.1	43,100
4	10.3	44,200
6	10.7	46,500
8	11.2	49,400
10	11.5	51,100
12	11.7	52,300
July 31		
2 a. m.	11.6	51,700
4	11.55	51,400
6	11.4	50,500
8	11.25	49,600
12 m.	10.9	47,600
2 p. m.	10.6	45,900
4	10.3	44,200
6	9.9	42,000
8	9.4	39,200
10	8.7	35,400
12	8.1	32,200
Aug. 1		
2 a. m.	7.70	30,200
4	7.20	27,700
6	6.90	26,200
8	6.70	25,300
10	6.46	24,300
12 m.	6.30	23,300
2 p. m.	6.20	22,900
4	6.10	22,400
12	5.87	21,400
Aug. 2		
6 a. m.	5.68	20,500
12 m.	5.58	20,100
6 p. m.	5.40	19,200
12	5.28	18,800
Aug. 3		
3 a. m.	5.25	18,300
9	5.10	17,900
12 m.	5.05	17,500
12 p. m.	4.77	16,700
Aug. 4		
12 m.	4.46	15,500
12 p. m.	4.19	14,300
Aug. 5		
12 m.	3.94	13,200
12 p. m.	3.70	12,500
Aug. 6		
12 m.	3.45	11,400
6 p. m.	3.40	11,400
10	3.50	11,800
12	3.57	12,200
Aug. 7		
6 a. m.	3.60	12,200
12 m.	3.50	11,800
12 p. m.	3.25	10,900
Aug. 8		
12 m.	3.00	10,000
12 p. m.	2.80	9,330
Aug. 9		
12 m.	2.62	8,730
6 p. m.	2.33	7,780
12	1.82	6,440
Aug. 10		
6 a. m.	1.30	5,190
12 m.	.93	4,320
6 p. m.	.68	3,690
12	.53	3,260
Aug. 11		
12 m.	.35	2,820
12 p. m.	.28	2,650
Aug. 12		
12 m.	.24	2,560
12 p. m.	.24	2,560
Aug. 13		
12 m.	.21	2,480
12 p. m.	.22	2,510
Aug. 14		
12 m.	.19	2,440
12 p. m.	.14	2,320
Aug. 15		
12 m.	.09	2,210
12 p. m.	.06	2,140
Aug. 16		
12 m.	.02	2,050
12 p. m.	.01	2,020

COLORADO RIVER AT SMITHVILLE, TEX.

LOCATION.—Lat. 30°01′, long. 97°10′, 1,200 feet upstream from highway bridge on State Highway 71 at Smithville, Bastrop County. Zero of gage is 270.14 feet above mean sea level (general adjustment of 1929).

DRAINAGE AREA.—39,650 square miles, of which about 11,800 square miles is probably noncontributing.

GAGE-HEIGHT RECORD.—Water-stage recorder graph except 4 a. m. July 26 to 4 a. m. July 28, when it was determined from graph based on staff-gage readings by engineer. Gage heights used to half tenths between 3.4 and 5.5 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATIONS.—Defined by current-meter measurements. Discharge Aug. 17–31 determined by shifting-control method.

MAXIMA.—1938: Discharge, 209,000 second-feet 4:25 a. m. July 27 (gage height, 36.02 feet).

1930–37: Discharge, 305,000 second-feet June 16, 1935 (gage height, 42.5 feet, from floodmarks).

1913–29: Stage, about 47.4 feet December 1913 (discharge not determined).

REMARKS.—Flow partly regulated by reservoirs upstream.

Mean discharge, in second-feet, and runoff, in acre-feet, 1938

Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet
July 23	1,570	3,110	Aug. 6	12,800	25,390	Aug. 20	2,640	5,240
24	46,000	91,240	7	11,500	22,810	21	2,780	5,510
25	118,000	234,000	8	11,300	22,410	22	2,640	5,240
26	189,000	374,900	9	10,100	20,030	23	2,520	5,000
27	199,000	394,700	10	8,800	17,450	24	2,400	4,760
28	152,000	301,500	11	5,890	11,680	25	2,400	4,760
29	108,000	214,200	12	4,320	8,570	26	2,340	4,640
30	74,000	146,800	13	3,680	7,300	27	2,280	4,520
31	52,900	104,900	14	3,440	6,820	28	2,280	4,520
Aug. 1	40,800	80,930	15	3,200	6,350	29	2,280	4,520
2	22,100	43,830	16	2,990	5,930	30	2,220	4,400
3	18,100	35,900	17	2,780	5,510	31	2,220	4,400
4	16,200	32,130	18	2,640	5,240			
5	14,100	27,970	19	2,640	5,240			

Runoff, in acre-feet, for period July 23 to Aug. 31 2,314,000

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Time	Feet	Second-feet
July 24		
1:00 a. m.	3.65	1,570
2:00	4.0	1,920
2:30	5.5	4,000
3:00	7.7	8,000
3:30	9.6	12,300
4:00	11.3	17,200
5:00	13.3	24,000
6:00	14.7	29,800
7:00	15.75	35,000
8:00	16.45	38,400
9:00	17.0	42,000
10:00	17.5	45,000
11:00	17.9	47,400
12:00 m.	18.35	50,400
1:00 p. m.	18.7	52,900
2:00	19.15	56,000
3:00	19.5	58,500
4:00	19.85	61,000
5:00	20.2	63,400
6:00	20.6	66,200
7:00	20.95	68,600
8:00	21.3	71,100
9:00	21.6	73,200
10:00	21.95	75,600
11:00	22.25	77,800
12:00	22.6	80,200
July 25		
1 a. m.	22.85	82,000
2	23.15	84,200
3	23.5	87,000
4	23.75	89,000
5	24.1	91,900
6	24.5	95,500
7	24.9	99,100
8	25.3	103,000
9	25.75	107,000
10	26.2	111,000
11	26.6	114,000
12 m.	27.0	118,000
1 p. m.	27.35	121,000
2	27.75	125,000
3	28.15	128,000
4	28.45	132,000
5	28.8	135,000
6	29.15	139,000
7	29.5	142,000
8	29.9	146,000
9	30.2	149,000
10	30.55	153,000
11	30.9	156,000
12	31.15	159,000
July 26		
1 a. m.	31.4	161,000
2	31.7	164,000
3	31.95	167,000
4	32.2	169,000
5	32.5	172,000
6	32.75	175,000
7	33.05	177,000
8	33.35	181,000
9	33.55	183,000
10	33.8	185,000
11	34.0	187,000
12 m.	34.3	190,000
1 p. m.	34.6	194,000
2	34.95	198,000
3	35.35	202,000
4	35.55	205,000
6	35.75	206,000
8	35.85	207,000
10	35.95	208,000
12	35.98	208,000
July 27		
4:25 a. m.	36.02	209,000
8:00	35.9	208,000
9:00	35.8	207,000
10:00	35.65	205,000
11:00	35.4	202,000
12:00 m.	35.3	201,000
2:00 p. m.	35.0	198,000
4:00	34.7	195,000
6:00	34.45	191,000
8:00	34.05	187,000
10:00	33.65	184,000
12:00	33.2	179,000
July 28		
2 a. m.	32.75	175,000
4	32.3	170,000
6	31.85	166,000
8	31.4	161,000
10	30.95	157,000
12 m.	30.5	152,000
2 p. m.	30.1	148,000
4	29.6	143,000
6	29.15	139,000
8	28.7	134,000
10	28.2	129,000
12	27.75	125,000
July 29		
2 a. m.	27.4	122,000
4	27.0	118,000
6	26.65	115,000
8	26.35	112,000
10	26.1	110,000
12 m.	25.85	108,000
2 p. m.	25.65	106,000
4	25.35	103,000
6	25.1	101,000
8	24.8	98,200
10	24.5	95,500
12	24.15	92,000
July 30		
2 a. m.	23.75	89,000
4	23.3	85,400
6	22.85	82,000
8	22.4	78,800
10	22.0	76,000
12 m.	21.6	73,200
2 p. m.	21.25	70,800
4	21.05	69,400
5	20.9	68,300
6	20.7	66,900
7	20.5	65,500
8	20.25	63,800
10	19.85	61,000
12	19.4	57,800
July 31		
2 a. m.	18.9	55,000
4	18.6	52,200
6	18.4	50,800
8	18.3	50,100
10	18.4	50,800
12 m.	18.55	52,200
1 p. m.	18.65	52,200
2	18.7	52,900
3	18.8	53,600
6	18.9	54,300
8	18.9	54,300
10	18.9	54,300
12	18.8	53,600
Aug. 1		
2 a. m.	18.65	52,200
4	18.45	50,800
6	18.15	49,400
8	17.85	49,800
10	17.45	44,400
12 m.	16.9	41,400
2 p. m.	16.4	38,400
4	15.85	35,000
6	15.3	32,600
8	14.8	30,300
10	14.3	28,000
12	13.9	26,400
Aug. 2		
2 a. m.	13.6	25,200
4	13.35	24,400
6	13.15	23,600
8	13.0	22,900
10	12.8	22,200
12 m.	12.7	21,800
3 p. m.	12.6	21,500
5	12.2	20,100
8	12.1	19,800
11	12.0	19,400
12	11.97	19,400
Aug. 3		
2 a. m.	11.9	19,100
5	11.8	18,800
8	11.7	18,400
12 m.	11.6	18,100
4 p. m.	11.5	17,800
8	11.4	17,500
12	11.3	17,200
Aug. 4		
3 a. m.	11.25	16,800
10	11.1	16,500
1 p. m.	11.0	16,200
4	10.9	15,900
8	10.8	15,600
11	10.7	15,300
12	10.7	15,300
Aug. 5		
3 a. m.	10.6	15,000
6	10.5	14,700
12 m.	10.3	14,100
6 p. m.	10.15	13,900
12	10.0	13,300
Aug. 6		
6 a. m.	9.85	12,800
12 m.	9.75	12,800
6 p. m.	9.6	12,300
12	9.5	12,000
Aug. 7		
6 a. m.	9.35	11,800
12 m.	9.25	11,300
6 p. m.	9.25	11,300
12	9.35	11,800
Aug. 8		
6 a. m.	9.35	11,800
12 m.	9.25	11,300
6 p. m.	9.15	11,300
12	9.0	10,800

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938—Continued

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
Aug. 9			*Aug. 11*—Con.			*Aug. 13*		
6 a. m.	8.85	10,300				12 m.	5.31	3,680
12 m.	8.75	10,300	9 a. m.	6.8	6,240	12 p. m.	5.21	3,520
6 p. m.	8.6	9,840	12 m.	6.6	5,880			
12	8.5	9,600	3 p. m.	6.4	5,520	*Aug. 14*		
			6	6.25	5,160			
Aug. 10			9	6.1	4,980	12 m.	5.13	3,440
			12	6.0	4,800	12 p. m.	5.08	3,360
6 a. m.	8.35	9,400						
12 m.	8.2	9,000	*Aug. 12*			*Aug. 15*		
6 p. m.	7.9	8,400						
9	7.7	8,000	2 a. m.	5.9	4,640	12 m.	5.03	3,280
12	7.45	7,400	6	5.8	4,480	12 p. m.	4.98	3,200
			12 m.	5.65	4,160			
Aug. 11			4 p. m.	5.6	4,160	*Aug. 16*		
3 a. m.	7.2	7,000	8	5.55	4,160	12 m.	4.86	2,990
6	7.0	6,600	12	5.4	3,840	12 p. m.	4.77	2,850

COLORADO RIVER NEAR EAGLE LAKE, TEX.

LOCATION.—Lat. 29°35′, long. 96°25′, at Lakeside Irrigation Co.'s pumping plant, 1.2 miles downstream from bridge of Texas and New Orleans R. R. Co. and 5 miles southwest of Eagle Lake, Colorado County. Zero of gage is 139.56 feet above mean sea level (general adjustment of 1929).

DRAINAGE AREA.—40,940 square miles, of which about 11,800 square miles is probably noncontributing.

GAGE-HEIGHT RECORD.—Water-stage recorder graph except 2 p. m. July 25 to 3 p. m. July 26, when it was determined from graph based on staff-gage readings. For rating used July 24–29 gage heights used to half tenths between 3.2 and 4.8 feet and for rating used July 30 to Aug. 31 gage heights used to half tenths between 3.9 and 5.8 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements. Discharge for July 24, 29, 30 determined by shifting-control method.

MAXIMA.—1938: Discharge, 165,000 second-feet 10 p. m. July 29 (gage height, 28.1 feet).

1930–37: Discharge, 177,000 second-feet June 19, 1935 (gage height, 29.45 feet).

1913–29: Stage, about 32 feet December 1913, present site and datum (discharge not determined).

REMARKS.—Flow partly regulated by reservoirs upstream.

Mean discharge, in second-feet, and runoff, in acre-feet, 1938

Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet
July 24	2,020	4,010	Aug. 6	15,900	31,540	Aug. 19	3,160	6,270
25	42,500	84,300	7	14,100	27,970	20	3,100	6,150
26	76,300	151,300	8	13,000	25,790	21	3,070	6,090
27	96,500	191,400	9	12,600	24,990	22	3,070	6,090
28	126,000	249,900	10	11,400	22,616	23	3,050	6,050
29	161,000	319,300	11	9,930	19,700	24	2,940	5,830
30	148,000	293,600	12	7,490	14,860	25	2,790	5,530
31	110,000	218,200	13	5,490	10,890	26	2,720	5,400
Aug. 1	64,900	128,700	14	4,540	9,000	27	2,660	5,280
2	38,100	75,570	15	4,110	8,150	28	2,620	5,200
3	23,700	47,010	16	3,860	7,660	29	2,620	5,200
4	19,900	39,470	17	3,520	6,980	30	2,640	5,240
5	17,900	35,500	18	3,390	6,720	31	2,730	5,410

Runoff, in acre-feet, for period July 24 to Aug. 31 2,129,000

Gage-height, in feet, and discharge, in second-feet, at indicated time, 1938

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
July 24			*July 27*			*July 30*		
12 m	3.0	1,510	2 a. m	22.25	89,000	3 a. m	28.0	162,000
6 p. m	3.14	1,680	4	22,35	90,200	5	27.9	160,000
10	3.14	1,680	6	22.4	90,800	7	27.7	155,000
11	3.7	2,330	8	22.55	92.600	9	27.6	153,000
12	6.1	5,370	10	22.6	93,200	10	27.5	152,000
July 25			12 m	22,75	95,000	12 m	27.4	150,000
1 a. m	8.7	10,900	2 p. m	22.9	96,800	1 p. m	27.3	147,000
2	10.5	16,500	4	23.1	99,300	2	27.25	146,000
3	11.8	21,300	6	23.3	102,000	4	27.1	143,000
4	12.9	25,600	8	23.4	103,000	5	27.0	141,000
5	13.8	29,400	10	23.6	106,000	6	26.95	139,000
6	14.45	32,100	12	23.7	107,000	8	26.8	136,000
7	15.1	35,000				10	26.7	135,000
8	15.6	37,200	*July 28*			12	26.6	133,000
9	16.05	39,200				*July 31*		
10	16.5	41,500	1 a. m	23.75	108,000			
11	16.9	43,700	2	23.8	108,000	1 a. m	26.5	130,000
12 m	17.25	45,700	4	23.95	110,000	2	26.4	128,000
1 p. m	17.6	47,900	6	24.1	112,000	3	26.3	126,000
2	17.8	49,100	8	24.3	115,000	4	26.2	124,000
3	18.0	50,400	10	24.55	119,000	5	26.1	123,000
4	18.25	52,000	11	24.7	121,000	6	26.0	121,000
5	18.45	53,400	12 m	24.8	122,000	7	25.9	119,000
6	18.65	54,700	1 p. m	24.9	124,000	8	25.8	118,000
7	18.85	56,100	2	25.25	128,000	10	25.6	115,000
8	19.1	57,900	3	25.4	131,000	11	25.5	113,000
9	19.3	59,400	5	25.7	135,000	12 m	25.35	111,000
10	19.5	61,000	6	25.85	137,000	1 p. m	25.25	109,000
11	19.7	62,700	7	26.0	139,000	2	25.1	107,000
12	19.9	64,600	8	26.15	141,000	3	25.0	106,000
July 26			9	26.3	143,000	4	24.75	102,000
1 a. m	20.0	65,500	10	26.5	146,000	5	24.6	100,000
2	20.1	66,500	12	26.8	150,000	6	24.5	99,000
3	20.2	67,400				7	24.35	97,200
4	20.3	68,400	*July 29*			8	24.2	95,400
5	20.4	69,300				9	24.0	93,600
6	20.5	70,300				10	23.8	90,600
7	20.6	71,200	1 a. m	26.9	150,000	11	23.6	88,200
8	20.7	72,200	2	27.05	152,000	12	23.4	85,800
9	20.8	73,200	3	27.15	154,000	*Aug. 1*		
10	20.9	74.200	4	27.25	155,000			
11	21.0	75,200	5	27.4	158,000	1 a. m	23.2	83,400
12 m	21.1	76,200	6	27.5	159,000	2	23.0	81,000
1 p. m	21.2	77,200	7	27.6	159,000	3	22.75	78,500
2	21.3	78,300	8	27.7	160,000	4	22.55	76,500
3	21.4	79,400	9	27.75	161,000	5	22.3	74,000
4	21.5	80,500	10	27.8	162,000	6	22.1	72,000
5	21.6	81.600	12 m	27.95	164,000	7	21.9	70,100
6	21.65	82,200	2 p. m	28.0	164,000	8	21.7	68,300
7	21.75	83,200	4	27.90	162,000	9	21.45	66,000
8	21.8	83,800	5	27.95	163,000	10	21.3	64,700
9	21.9	84,900	6	28.0	164,000	11	21.15	63,400
10	22.0	86.000	10	28.1	165,000	12 m	21.0	62,200
12	22.1	87,200	12	28.05	164,000	1 p. m	20.9	61,400

Gage-height, in feet, and discharge, in second-feet, at indicated time, 1938—Con.

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
Aug. 1—Con.			*Aug. 3*—Con.			*Aug. 9*		
						12 m	9.2	12,300
2 p. m	20.8	60,600	6 a. m	13.65	24,900	6 p. m	9.1	12,000
3	20.65	59,600	8	13.5	24,400	12	8.95	11,700
4	20.5	58,500	10	13.35	23,900			
5	20.4	57,800	12 m	13.22	23,400	*Aug. 10*		
6	20.25	56,800	2 p. m	13.1	23,000			
7	20.1	55,700	4	13.0	22,700	6 a. m	8.8	11,300
8	20.0	55,000	7	12.9	22,400	12 m	8.7	11,100
9	19.85	54,100	10	12.8	22,100	6 p. m	8.6	10,800
10	19.7	53,200	12	12.65	21,700	12	8.45	10,500
11	19.5	52,000	*Aug. 4*			*Aug. 11*		
12	19.3	50,800						
			3 a. m	12.5	21,100	6 a. m	8.3	10,100
Aug. 2			6	12.35	20,800	12 m	8.15	9,760
			9	12.2	20,200	6 p. m	6.95	9,290
1 a. m	19.15	49,900	10	12.15	20,000	12	7.7	8,740
2	19.0	49,000	12 m	12.1	19,900			
3	18.8	47,800	3 p. m	12.0	19,600	*Aug. 12*		
4	18.6	46,700	6	11.95	19,500			
5	18.4	45,600	9	11.85	19,200	6 a. m	7.4	8,080
6	18.15	44,200	12	11.75	18,900	12 m	7.0	7,200
7	17.95	43,100	*Aug. 5*			6 p. m	6.7	6,600
8	17.7	41,800				12	6.45	6,100
9	17.5	40,700	6 a. m	11.55	18,300			
10	17.3	39,600	12 m	11.4	17,900	*Aug. 13*		
11	17.05	38,400	6 p. m	11.2	17,400			
12 m	16.8	37,200	12	11.0	16,900	6 a. m	6.2	5,600
1 p. m	16.6	36,300				12 m	6.0	5,200
2	16.35	35,200	*Aug. 6*			6 p. m	5.85	5,110
3	16.1	34,100				12	5.70	4,830
4	15.85	33,100	6 a. m	10.8	16,400			
5	15.7	32,500	12 m	10.6	15,900	*Aug. 14*		
6	15.5	31,700	6 p. m	10.45	15,500			
7	15.3	30,900	12	10.3	15,100	12 m	5.55	4,540
8	15.1	30,200	*Aug. 7*			12 p. m	5.40	4,290
9	14.9	29,400						
10	14.7	28,700	6 a. m	10.1	14,600	*Aug. 15*		
11	14.55	28,200	12 m	9.9	14,000			
12	14.4	27,600	6 p. m	9.75	13,700	12 m	5.30	4,110
			12	9.6	13,300	12 p. m	5.20	3,950
Aug. 3			*Aug. 8*					
						Aug. 16		
1 a. m	14.25	27,100	6 a. m	9.45	12,900			
2	14.1	26,600	12 m	9.35	12,700	12 m	5.15	3,950
3	14.0	26,200	6 p. m	9.3	12,600	12 p. m	5.10	3,770
4	13.9	25,800	12	9.25	12,400			
5	13.75	25,300						

ELM CREEK AT BALLINGER, TEX.

LOCATION.—Lat. 31°45′00″ long. 99°56′50″, 1,000 feet above city water-supply storage dam in Ballinger, Runnels County, and 1¼ miles upstream from mouth. Zero of gage is 1,617.72 feet above mean sea level (general adjustment of 1929).

DRAINAGE AREA.—458 square miles.

GAGE-HEIGHT RECORD.—Water-stage recorder graph. Gage heights used to half tenths between 5.7 and 8.5 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements below 13,800 second-feet; extended above to peak stage.

MAXIMA.—July 1938: Discharge, 2,070 second-feet 7 a. m. July 26 (gage height 5.26 feet).

1932–June 1938: Discharge, about 26,100 second-feet Sept. 3, 1935 (gage height, 10.3 feet from floodmarks, probably slightly affected by backwater from Colorado River).

1906–31: Maximum discharge probably less than in 1935.

REMARKS.—Flood flow probably not affected by diversions and regulation.

Mean discharge, in second-feet, and runoff, in acre-feet, 1938

Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet
July 17	0	0	July 23	4.5	8.9	July 29	2.5	5.0
18	60	119	24	45	89	30	1.0	2.0
19	20	40	25	629	1,250	31	.6	1.2
20	25	50	26	1,060	2,100	Aug. 1	.4	.8
21	6.4	13	27	56	111	2–14	0	0
22	28	56	28	11	22			

Runoff, in acre-feet, for period July 17 to Aug. 14 3,870

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
July 18			*July 23*			*July 26—Con.*		
6 a. m.		0	12 m.	3.87	2.5	10 a. m.	5.04	1,630
7	3.50	0	12 p. m.	3.87	2.5	11	4.88	1,330
8	3.80	0	*July 24*			12 m.	4.74	1,080
9	4.04	108				1 p. m.	4.60	843
10	4.09	158				2	4.48	663
11	4:10	169	4 a. m.	3.87	2.5	3	4.37	502
12 m.	4.08	147	6	3.88	4.5	4	4.28	384
2 p. m.	4.05	117	4 p. m.	3.88	4.5	5	4.22	308
4	4.02	90	5	3.93	27	6	4.18	260
6	3.99	66	6	4.05	117	7	4.15	224
8	3.97	52	7	4.11	180	8	4.13	202
12	3.95	39	8	4.12	191	10	4.10	169
July 19			9	4.12	191	12	4.07	137
6 a. m.	3.92	21	10	4.10	169	*July 27*		
12 m.	3.90	11	11	4.08	147			
6 p. m.	3.88	4.5	12	4.06	127	3 a. m.	4.03	99
9	3.88	4.5				6	4.00	74
10	3.93	27	*July 25*			9	3.98	59
11	3.97	52				12 m.	3.97	52
12	3.98	59	2 a. m.	4.05	117	6 p. m.	3.94	33
July 20			4	4.10	169	12	3 92	21
			7	4.13	202			
4 a. m.	3.97	52	12 m.	4.09	158			
8	3.94	33	1 p. m.	4.11	180	*July 28*		
12 m.	3.92	21	2	4.23	320			
4 p. m.	3.90	11	3	4.37	502	12 m.	3.89	7.0
8	3.89	7.0	4	4.54	753	12 p. m.	3.88	4.5
12	3.89	7.0	5	4.70	1,000			
July 21			6	4.88	1,330			
			7	5.01	1,570			
12 m.	3.87	2.5	8	5.06	1,660	*July 29*		
9 p. m.	3.86	1.5	9	5.05	1,640			
10	3.90	11	10	5.04	1,630	12 m.	3.87	2.5
11	3.94	33	12	5.04	1,630	12 p. m.	3.86	1.5
12	3.97	52						
July 22			*July 26*			*July 30*		
2 a. m.	3.98	59						
4	3.97	52	2 a. m.	5.05	1,640	12 m.	3.85	1.0
6	3.96	45	3	5.09	1,720	12 p. m.	3.84	.6
8	3.95	39	4	5.14	1,820			
10	3.93	27	5	5.20	1,940	*July 31*		
12 m.	3.92	21	6	5.25	2,040			
4 p. m.	3.91	16	7	5.26	2,070	12 m.	3.84	.6
8	3.90	11	8	5.22	1,980	12 p. m.	3.83	.4
12	3.90	11	9	5.14	1,820			

SOUTH CONCHO RIVER AT CHRISTOVAL, TEX.

LOCATION.—Lat. 31°13′, long. 100°30′, at Panhandle & Santa Fe Ry. bridge in Christoval, Tom Green County. Zero of gage is 2,010.22 feet above mean sea level (general adjustment of 1929).

DRAINAGE AREA.—434 square miles.

GAGE-HEIGHT RECORD.—Water-stage recorder graph except for a few hours on July 23, when float was against instrument table; for this period a graph was drawn on basis of peak stage determined from floodmarks and shape of recorder graph before and after peak. Gage heights used to half tenths between 3.7 and 5.2 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements below 8,300 second-feet; extended to peak discharge on basis of a slope-area measurement of 80,100 second-feet. Discharge July 19 to 9:30 a. m. July 20, July 25 to 6 p. m. July 26, and July 31 to Aug. 14 determined by shifting-control method.

MAXIMA.—1938: Discharge, 100,000 second-feet 12 m. July 23 (gage height, 21.95 feet, from floodmarks).

1930–37: Discharge, 80,100 second-feet Sept. 17, 1936 (gage height, 20.5 feet).

1882–1929: Stage, about 23.1 feet Aug. 6, 1906 (discharge not determined).

REMARKS.—Flood flows not affected by diversions or regulations.

Mean discharge, in second-feet, and runoff, in acre-feet, 1938

Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet
July 19	8.8	17	July 28	63	125	Aug. 6	60	119
20	7,890	15,650	29	63	125	7	57	113
21	3,990	7,910	30	64	127	8	56	111
22	1,500	2,980	31	63	125	9	56	111
23	29,500	58,510	Aug. 1	63	125	10	56	111
24	1,210	2,400	2	63	125	11	56	111
25	143	284	3	63	125	12	55	109
26	94	186	4	62	123	13	54	107
27	63	125	5	62	123	14	54	107

Runoff, in acre-feet, for period July 19 to Aug. 14 90,180

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
July 19			*July 22*			*July 24*		
1 a. m.	8.87	11	1:00 a. m.	2.72	422	1:00 a. m.	6.60	3,520
12 m.	.83	8.1	3:00	2.44	305	2:00	5.85	2,690
11 p. m.	.83	8.1	5:00	2.18	228	3:00	5.27	2,250
12	.99	8.1	8:00	1.95	167	5:00	4.33	1,480
July 20			11:00	1.80	136	7:00	3.72	990
			1:30 p. m.	1.72	122	9:00	3.30	715
4:00 a. m.	.84	8.8	2:00	2.00	178	12:00 m.	3.20	655
9:35	.97	20	3:00	3.30	715	12:30 p. m.	4.10	1,280
10:00	5.50	2,420	3:30	5.75	2,690	1:00	4.55	1,640
10:30	8.00	5,620	4:00	7.30	4,460	1:30	4.73	1,800
11:00	9.40	8,520	4:30	9.10	7,840	2:30	4.40	1,520
11:30	10.60	11,700	5:00	9.30	8,300	3:30	3.90	1,130
12:00 m.	12.00	16,600	5:30	9.05	7,620	5:00	3.42	794
12:30 p. m.	13.20	25,300	6:00	8.50	6,570	7:00	2.95	525
1:00	13.90	32,900	7:00	7.30	4,460	10:00	2.46	322
1:30	14.40	34,900	8:00	6.25	3,080	12:00	2.24	248
2:00	15.15	32,900	9:00	5.40	2,340			
2:30	14.55	29,300	10:00	4.70	1,760	*July 25*		
3:00	14.15	27,900	11:00	4.20	1,360	2:00 a. m.	2.07	196
4:00	13.68	24,300	12:00	3.80	1,060	8:00	1.75	127
5:00	12.65	19,000				5:00 p. m.	1.50	85
6:00	10.80	12,300				8:30	1.48	82
6:30	9.40	8,520	*July 23*			10:30	1.98	174
7:00	8.20	6,000				12:00	1.91	158
8:00	6.50	3,400				*July 26*		
9:00	5.50	2,420	1:00 a. m.	3.40	730	2 a. m.	1.75	127
10:00	4.75	1,800	2:15	3.10	602	7	1.52	88
11:00	4.17	1,320	3:00	3.30	715	2 p. m.	1.40	70
12:00	3.70	990	4:00	4.05	1,240	6	1.36	70
July 21			5:00	5.80	2,690	12	1.33	66
			5:30	10.10	10,200	*July 27*		
2:00 a. m.	3.11	607	6:00	11.10	13,300			
4:00	2.67	402	7:00	12.00	16,600	12 m.	1.31	63
6:00	2.40	302	7:45	12.25	17,300	12 p. m.	1.30	62
8:20	2.15	219	8:30	11.95	16,600	*July 28*		
8:30	4.00	1,200	9:00	12.45	18,100			
8:40	5.30	2,420	9:30	13.90	25,300	12 m.	1.31	63
8:50	7.50	4,740	10:00	17.00	45,600	12 p. m.	1.31	63
9:00	9.40	8,520	10:30	18.60	59,400	*July 29*		
9:30	10.80	12,300	11:00	20.50	80,100			
10:00	11.85	15,800	11:30	21.50	93,100	12 m.	1.31	63
10:55	12.74	19,400	12:00 m.	21.95	100,000	12 p. m.	1.31	63
11:30	12.45	18,100	12:30 p. m.	21.55	94,500	*July 30*		
12:00 m.	11.80	15,800	1:00	20.90	85,000			
1:00 p. m.	10.10	10,200	1:30	20.10	75,200	9 a. m.	1.30	62
2:00	8.30	6,190	2:00	19.50	68,600	10	1.28	59
3:00	7.15	4,310	2:30	19.10	64,300	11	1.28	59
4:00	6.30	3,180	3:00	18.50	58,500	1 p. m.	1.32	64
5:00	5.55	2,510	4:00	17.45	48,900	2	1.39	74
6:00	4.95	1,960	5:00	16.20	39,700	4	1.30	62
7:00	4.40	1,520	6:00	14.85	30,400	6	1.32	64
8:00	4.00	1,200	7:00	14.20	27,000	12	1.31	63
9:00	3.60	920	8:00	13.40	22,800	*July 31*		
10:00	3.32	728	9:00	12.40	18,100			
11:00	3.08	591	10:00	10.90	12,700	12 m.	1.31	63
12:00	2.89	496	11:00	9.20	8,070	12 p. m.	1.30	62
			12:00	7.60	4,920			

LAKE NASWORTHY NEAR SAN ANGELO, TEX.

LOCATION.—Lat. 31°23′15″, long. 100°28′40″, on South Concho River 250 feet upstream from spillway of Nasworthy Dam, half a mile downstream from mouth of Middle Concho River and 7 miles southwest of San Angelo, Tom Green County. Elevations are feet above mean sea level.

DRAINAGE AREA.—2,659 square miles, of which about 152 square miles is probably noncontributing.

GAGE-HEIGHT RECORD.—Water-stage recorder graph.

STORAGE RECORD.—Capacity curve, obtained from Floyd and Lochridge, designers of dam, dated July 28, 1928.

REMARKS.—Capacity of reservoir at spillway level, 10,500 acre-feet (elevation, 1,870.0 feet above mean sea level).

Elevation, in feet, and contents, in acre-feet, at indicated time, 1938

Time	Feet	Acre-feet
July 19		
6 a. m.	1,867.63	7,790
10	1,867.63	7,790
11	1,867.66	7,830
1 p. m.	1,867.69	7,860
6	1,867.70	7,870
11	1,867.69	7,860
12	1,867.69	7,860
July 20		
1:00 a. m.	1,867.69	7,860
10:00	1,867.72	7,890
12:00 m.	1,867.76	7,940
2:15 p. m.	1,867.78	7,960
3:00	1,868.13	8,340
3:30	1,868.43	8,670
4:00	1,868.75	9,480
4:30	1,869.32	9,680
4:45	1,869.37	9,740
5:00	1,869.27	9,620
6:00	1,869.23	9,580
7:30	1,869.23	9,580
8:00	1,869.18	9,520
9:00	1,868.97	9,270
10:00	1,868.37	8,610
11:00	1,867.45	7,600
11:30	1,867.24	7,360
12:00	1,867.35	7,480
July 21		
1:00 a. m.	1,867.46	7,610
2:00	1,867.49	7,650
3:00	1,867.73	7,900
4:00	1,867.92	8,110
5:00	1,868.07	8,280
6:00	1,868.19	8,410
7:00	1,868.30	8,530
8:00	1,868.39	8,630
9:00	1,868.46	8,710
10:00	1,868.53	8,780
11:00	1,868.58	8,840
12:00 m.	1,868.65	8,920
1:00 p. m.	1,869.05	9,360
2:00	1,869.47	9,860
2:45	1,869.56	9,970
3:00	1,869.53	9,940
4:00	1,869.44	9,830
5:00	1,869.12	9,440
6:00	1,868.55	8,800
7:00	1,867.70	7,870
8:00	1,867.10	7,210
8:30	1,867.07	7,180
9:00	1,867.08	7,190
10:00	1,867.30	7,430
11:00	1,867.49	7,640
12:00	1,867.63	7,790

Time	Feet	Acre-feet
July 22		
1 a. m.	1,867.75	7,920
2	1,867.85	8,040
3	1,867.93	8,120
4	1,868.00	8,200
6	1,868.10	8,310
8	1,868.20	8,420
10	1,868.27	8,500
12 m.	1,868.33	8,560
2 p. m.	1,868.37	8,610
3	1,868.38	8,620
4	1,868.42	8,660
5	1,868.50	8,750
6	1,868.57	8,830
7	1,868.44	8,680
8	1,868.10	8,310
9	1,867.25	7,380
10	1,866.45	6,500
11	1,865.80	5,820
12	1,866.10	6,110
July 23		
1:00 a. m.	1,866.47	6,520
2:00	1,866.77	6,850
3:00	1,867.03	7,130
4:00	1,867.30	7,430
5:00	1,867.60	7,760
6:00	1,867.90	8,090
7:00	1,868.50	8,750
8:00	1,869.20	9,540
8:40	1,869.38	9,760
9:00	1,869.35	9,720
9:50	1,869.12	9,440
11:30	1,869.14	9,470
12:00 m.	1,869.11	9,430
1:00 p. m.	1,868.98	9,280
2:00	1,868.70	8,970
2:15	1,868.68	8,950
3:00	1,868.90	9,190
4:00	1,869.50	9,900
5:15	1,869.87	10,340
6:00	1,869.82	10,280
7:00	1,869.50	9,900
8:00	1,869.00	9,300
9:00	1,868.00	8,200
10:00	1,867.00	7,100
11:00	1,866.65	6,720
11:30	1,866.58	6,640
12:00	1,866.60	6,660
July 24		
1:00 a. m.	1,866.68	6,750
1:30	1,866.66	6,730

Time	Feet	Acre-feet
July 24—Con.		
2:00	1,866.55	6,600
3:00	1,865.89	5,820
4:00	1,864.90	5,020
5:00	1,863.95	4,270
6:00	1,862.90	3,650
7:00	1,861.95	3,180
7:30	1,861.77	3,080
8:00	1,861.90	3,150
9:00	1,862.25	3,320
10:00	1,862.45	3,420
11:00	1,862.58	3,490
12:00 m.	1,862.80	3,600
1:00 p. m.	1,863.05	3,730
2:00	1,863.22	3,830
3:00	1,863.31	3,890
4:00	1,863.48	3,990
5:00	1,863.25	3,850
6:00	1,863.07	3,740
7:00	1,862.85	3,620
8:00	1,862.60	3,500
9:00	1,862.30	3,350
10:00	1,862.00	3,200
11:00	1,861.67	3,040
12:00	1,861.36	2,880
July 25		
1:00 a. m.	1,861.02	2,710
3:00	1,860.54	2,520
5:00	1,860.10	2,340
5:30	1,860.00	2,300
6:00	1,860.10	2,340
6:30	1,860.11	2,340
8:00	1,860.07	2,330
10:00	1,859.95	2,290
12:00 m.	1,859.85	2,260
2:00 p. m.	1,859.70	2,210
4:00	1,859.55	2,160
6:00	1,859.38	2,110
7:00	1,859.32	2,100
8:00	1,859.42	2,130
9:00	1,859.50	2,150
10:00	1,859.68	2,200
11:00	1,859.95	2,280
12:00	1,860.35	2,440
July 26		
1 a. m.	1,860.65	2,560
2	1,860.93	2,670
4	1,861.35	2,880
6	1,861.70	3,050
8	1,861.95	3,180
10	1,862.16	3,280
12 m.	1,862.32	3,360
6 p. m.	1,862.71	3,560
12	1,863.12	3,770

SOUTH CONCHO RIVER AT SAN ANGELO, TEX.

LOCATION.—Lat. 31°26'45", long. 100°25'30", at bridge on U. S. Highways 87 and 277 and half a mile south of San Angelo, Tom Green County, and 1 mile upstream from confluence with North Concho River. Zero of gage is 1,802.94 feet above mean sea level (general adjustment of 1929).

DRAINAGE AREA.—2,687 square miles, of which about 152 square miles is probably noncontributing.

GAGE-HEIGHT RECORD.—Water-stage recorder graph. Gage heights used to half tenths between 4.4 and 6.2 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements below 11,800 second-feet; extended to peak discharge on basis of study of flow over Nasworthy Dam, 6½ miles upstream. Discharge July 19 determined by shifting-control method.

MAXIMA.—1938: Discharge, 80,100 second-feet 8 p. m. July 23 (gage height, 17.15 feet).

1931–37: Discharge, 111,000 second-feet Sept. 17, 1936 (gage height, 23.4 feet, of which about 2.4 feet was caused by backwater from North Concho River) by slope-area method.

1854–1930: Stage, 29.7 feet Aug. 6, 1906, not affected by backwater (discharge not determined).

REMARKS.—Flow partly regulated by storage in Lake Nasworthy (capacity at spillway level, 10,500 acre-feet) 6½ miles upstream, and by about 500 acre-feet of storage in small reservoirs below Lake Nasworthy.

Mean discharge, in second-feet, and runoff, in acre-feet, 1938

Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet
July 19	8.7	17	July 28	28	56	Aug. 6	11	22
20	7,550	14,980	29	22	44	7	14	28
21	5,470	10,850	30	18	36	8	14	28
22	2,630	5,220	31	17	34	9	14	28
23	32,100	63,670	Aug. 1	15	30	10	17	34
24	9,370	18,590	2	39	77	11	20	40
25	1,330	2,640	3	21	42	12	30	60
26	219	434	4	9.2	18	13	22	44
27	60	119	5	8.0	16			

Runoff, in acre-feet, for period July 19 to Aug. 13 117,200

Gage-height, in feet, and discharge, in second-feet, at indicated time, 1938

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
July 19			*July 21—Con.*			*July 23—Con.*		
6 a. m.	1.98	5				8:30 a. m.	4.00	3,500
9	1.94	4	2:00 p. m.	3.10	1,120	9:00	5.60	9,920
10	2.03	8	2:30	4.70	5,940	9:30	7.00	17,200
12 m.	2.06	11	3:00	5.80	10,900	10:00	8.00	22,400
2 p. m.	2.09	15	4:00	7.00	17,200	11:00	8.85	26,600
12	2.05	10	5:00	7.22	18,300	12:00 m.	9.05	27,700
July 20			6:00	7.20	18,200	1:00 p. m.	9.20	28,800
			7:00	7.00	17,200	2:00	9.90	32,500
6:00 a. m.	2.06	7	8:00	6.70	15,600	3:00	11.00	38,300
12:00 m.	2.08	9	9:00	4.90	6,740	4:00	12.50	46,500
4:30 p. m.	2.09	11	10:00	3.70	2,580	5:00	14.50	59,700
5:00	5.60	9,920	11:00	3.00	920	6:00	16.00	70,700
5:00	7.20	18,200	12:00	2.75	505	7:00	16.90	77,700
6:00	8.10	22,900	*July 22*			8:00	17.15	80,100
7:00	8.80	26,600				8:30	16.95	78,200
8:00	9.08	28,800	1:00 a. m.	2.64	352	9:00	16.85	76,900
9:00	9.14	28,400	2:00	2.60	300	10:00	16.40	73,700
10:00	9.08	28,000	4:00	2.58	276	11:00	15.40	66,200
11:00	8.80	26,600	6:30 p. m.	2.58	276	12:00	13.80	54,800
12:00	7.30	18,700	7:00	3.00	920	*July 24*		
July 21			8:00	5.00	7,170			
			9:00	6.60	15,100	1:00 a. m.	11.5	41,000
12:30 a. m.	5.40	8,970	10:00	7.10	17,700	1:30	10.0	33,000
1:00	4.65	5,750	11:00	6.60	15,100	2:00	9.0	27,700
2:00	4.14	3,940	12:00	4.60	5,560	3:00	7.8	21,300
2:30	4.10	3,810	*July 23*			4:00	7.3	18,700
3:00	3.60	2,300				5:00	6.8	16,100
4:00 a. m.	2.95	830	1 a. m.	3.40	1,790	6:00	6.30	13,500
5:00	2.72	460	2	2.90	740	7:00	5.85	11,200
6:00	2.63	339	3	2.70	430	8:00	5.00	7,170
7:00	2.60	300	4	2.63	339	9:00	3.70	2,580
1:30 p. m.	2.58	276	8	2.58	276	10:00	3.45	1,920

Gage height, in feet, and discharge, in second-feet, at indicated times, 1938—Con.

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
July 24—Con.			*July 25*—Con.			*July 28*		
						12 m	2.19	28
12:00 m	3.45	1,920	12 m	3.08	1,080	12 p. m	2.17	24
2:00 p. m	3.51	2,070	7 p. m	3.02	960			
4:00	3.54	2,140	8	2.90	740	*July 29*		
4:30	3.46	1,940	9	2.72	460			
5:00	4.00	3,500	10	2.63	339	12 m	2.16	22
6:00	4.18	4,070	12	2.57	265	12 p. m	2.15	20
7:00	4.16	4,000						
10:00	4.00	3,500	*July 26*			*July 30*		
12:00	3.88	3,130						
			1 a. m	2.56	253	12 m	2.14	18
July 25			8 p. m	2.54	230	12 p. m	2.13	17
			12	2.45	140			
5 a. m	3.57	2,220	*July 27*			*July 31*		
6	3.50	2,040						
7	3.05	1,020	12 m	2.28	50	12 m	2.13	17
9	3.10	1,120	12 p. m	2.22	35	12 p. m	2.12	15

CONCHO RIVER NEAR SAN ANGELO, TEX.

LOCATION.—Lat. 31°27'10", long. 100°24'40", half a mile downstream from confluence of North Concho and South Concho Rivers and 1¾ miles southeast of San Angelo, Tom Green County. Zero of gage is 1,776.8 feet above mean sea level (general adjustment of 1929).

DRAINAGE AREA.—4,492 square miles, of which about 275 square miles is probably noncontributing.

GAGE-HEIGHT RECORD.—Water-stage recorder graph. Gage heights used to half tenths between 3.4 and 5.2 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements below 26,400 second-feet; extended to peak discharge on basis of slope-area measurements of 167,000 and 230,000 second-feet.

MAXIMA.—1938: Discharge, 85,100 second-feet 8:30 p. m. July 23 (gage height, 35.9 feet).

1915–37: Discharge, 230,000 second-feet Sept. 17, 1936 (gage height, 46.6 feet, from floodmarks).

1854–1914: Discharge, about 246,000 second-feet Aug. 6, 1906 (gage height, 47.5 feet), by extension of 1936 rating curve.

REMARKS.—Flow partly regulated by storage in Lake Nasworthy and several small reservoirs upstream.

Mean discharge, in second-feet, and runoff, in acre-feet, 1938

Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet
July 19	27	54	July 28	118	234	Aug. 5	25	50
20	6,230	12,360	29	71	141	6	24	48
21	6,750	13,390	30	56	111	7	25	50
22	2,570	5,100	31	46	91	8	23	46
23	31,300	62,080	Aug. 1	39	77	9	23	46
24	11,200	22,210	2	54	107	10	24	48
25	5,420	10,750	3	40	79	11	26	52
26	1,780	3,530	4	28	56	12	35	60
27	462	916				13	30	69

Runoff, in acre-feet, for period July 19 to Aug. 13 131,800

Gage-height, in feet, and discharge, in second-feet, at indicated time, 1938

Time	Feet	Second-feet
July 19		
1:00 a. m.	1.05	15
8:00	1.02	13
9:00	1.10	18
10:00	1.55	56
12:00 m.	1.44	44
4:30 p. m.	1.25	28
7:00	1.50	50
8:00	1.57	58
12:00	1.35	36
July 20		
6:00 a. m.	1.18	23
10:00	1.14	20
12:00 m.	1.25	28
1:00 p. m.	1.30	31
5:00	1.25	28
5:30	5.0	2,130
6:00	14.0	12,200
6:00	18.0	17,800
7:00	20.0	20,600
8:00	22.6	24,900
9:00	23.5	26,500
10:00	23.7	26,900
11:00	23.6	26,700
12:00	22.9	25,400
July 21		
1 a. m.	18.0	17,800
2	10.5	7,760
3	7.6	4,530
4	5.2	2,310
5	3.8	1,170
6	3.2	765
7	2.95	610
8	2.80	520
9	2.73	487
12 m.	2.59	405
2 p. m.	2.55	385
3	8.0	4,930
4	15.0	13,600
5	17.5	17,100
6	18.3	18,200
7	18.3	18,200
8	17.5	17,100
9	15.0	13,600
10	10.0	7,160
11	5.5	2,580
12	3.5	960
July 22		
1 a. m.	2.90	580
2	2.62	421
4	2.45	335
9	2.43	325
11	2.49	355
12 m.	2.46	340
July 22—Con.		
7 p. m.	2.37	295
8	6.5	3,480
9	12.5	10,300
10	16.8	16,100
11	17.5	17,100
12	14.0	12,200
July 23		
1:00 a. m.	9.0	6,000
2:00	5.5	2,580
3:00	4.20	1,470
4:00	3.77	1,140
5:00	3.65	1,060
6:00	3.40	895
7:00	3.15	732
8:00	3.00	640
9:00	7.0	3,960
10:00	16.5	15,700
11:00	21.5	23,000
12:00 m.	23.0	25,600
1:00 p. m.	23.5	26,500
2:00	24.3	28,000
3:00	25.7	31,200
4:00	27.5	36,800
5:00	30.0	47,000
6:00	33.0	63,000
7:00	35.0	77,000
8:00	35.8	84,200
8:30	35.9	85,100
10:00	35.5	81,500
11:00	34.4	72,800
12:00	32.7	61,200
July 24		
1 a. m.	30.5	49,500
2	27.5	36,800
3	23.0	25,600
4	20.5	21,400
5	18.4	18,400
6	16.5	15,700
7	14.5	12,900
8	12.8	10,700
9	8.5	5,450
10	5.4	2,490
11	5.06	2,180
4 p. m.	5.34	2,400
5	5.25	2,310
6	7.00	3,960
7	7.34	4,280
8	7.25	4,150
10	6.85	3,770
12	6.42	3,390
July 25		
5:00 a. m.	5.50	2,580
6:00	5.50	2,580
7:00	4.70	1,880
8:00	4.10	1,400
2:00 p. m.	4.22	1,470
3:00	7.00	3,960
4:00	11.0	8,360
5:00	14.0	12,200
6:00	15.2	13,900
7:00	16.1	15,100
7:30	16.3	15,400
9:00	15.0	13,600
10:00	12.0	9,640
11:00	8.9	5,890
12:00	6.60	3,580
July 26		
1:30 a. m.	5.90	2,940
3:30	6.10	3,120
5:00	5.80	2,850
7:00	4.70	1,880
9:00	3.94	1,280
12:00 m.	3.67	1,060
2:00 p. m.	3.67	1,060
6:00	3.28	882
12:00	2.75	492
July 27		
3 a. m.	2.55	385
5	3.10	700
6	3.28	817
7	3.31	836
8	3.27	810
9	3.17	746
12 m.	2.93	538
2 p. m.	2.65	438
4	2.50	360
8	2.26	242
12	2.13	187
July 28		
6 a. m.	1.98	138
12 m.	1.90	116
6 p. m.	1.82	98
12	1.75	86
July 29		
12 m.	1.68	74
12 p. m.	1.59	61
July 30		
12 m.	1.55	56
12 p. m.	1.50	50
July 31		
12 m.	1.47	47
12 p. m.	1.42	42

CONCHO RIVER NEAR PAINT ROCK, TEX.

LOCATION.—Lat. 31°31′, long. 99°55′, upstream from spillway of masonry dam at bridge on U. S. Highway 83, a quarter of a mile north of Paint Rock, Concho County. Zero of gage is 1,574.43 feet above mean sea level (general adjustment of 1929).

DRAINAGE AREA.—5,538 square miles, of which about 275 square miles is probably noncontributing.

GAGE-HEIGHT RECORD.—Graph drawn on basis of several wire-weight gage readings daily. Gage heights used to half tenths between 11.1 and 13.8 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements below 85,000 second-feet; extended on basis of slope-area measurements of 144,000 and 301,000 second-feet.

MAXIMA.—1938: Discharge, 86,000 second-feet 10:15 a. m. July 24 (gage height, 31.95 feet).

1915–37: Discharge, 301,000 second-feet Sept. 17, 1936 (gage height, 43.4 feet, from floodmarks; 41.3 feet, from floodmarks at former recording gage site, about 1.5 miles upstream).

1882–1914: Discharge, 201,000 second-feet August 1882 (gage height, 38.4 feet, former recorder site and datum), from 1936 rating curve.

REMARKS.—Flow affected by diversions and storage upstream.

Mean discharge, in second-feet, and runoff, in acre-feet, 1938

Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet
July 18	27	54	July 28	575	1,140	Aug. 6	84	167
19	598	1,190	29	318	631	7	76	151
20	1,140	2,260	30	200	397	8	71	141
21	8,120	16,110	31	145	288	9	71	141
22	4,980	9,880	Aug. 1	130	258	10	67	133
23	40,400	80,130	2	118	234	11	67	133
24	42,600	84,500	3	112	222	12	76	151
25	4,270	8,470	4	120	238	13	67	133
26	4,230	8,390	5	94	186	14	76	151
27	1,040	2,060						

Runoff, in acre-feet, for period July 18 to Aug. 14 217,900

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Time	Feet	Second-feet
July 19		
1 a. m.	10.6	22
9	10.4	12
10	13.1	880
11	14.6	2,820
12 m.	14.1	2,090
3 p. m.	13.1	880
4	12.8	575
12	12.7	485
July 20		
10 a. m.	12.4	290
12 m.	13.0	775
1 p. m.	13.9	1,820
12	14.0	1,950
July 21		
1:00 a. m.	14.0	1,950
2:00	14.3	2,370
3:00	15.2	3,810
4:00	16.8	6,930
5:00	18.6	11,500
6:00	20.3	17,000
7:00	22.0	21,700
7:30	22.2	22,200
8:00	22.3	22,400
9:00	22.3	22,400
9:30	21.85	21,200
10:00	21.3	19,800
11:00	19.9	15,700
12:00 m.	18.45	10,900
1:00 p. m.	16.9	7,130
2:00	15.6	4,530
3:00	15.2	3,810
4:00	15.0	3,450
6:00	14.6	2,820
8:00	14.3	2,370
10:00	14.1	2,090
12:00	14.0	1,950
July 22		
1:00 a. m.	14.0	1,950
1:30	14.2	2,230
2:00	15.4	4,170
2:30	16.6	6,530
3:00	17.8	9,260
3:30	19.0	12,800
4:00	20.3	17,000
5:00	20.7	18,200
5:30	20.4	17,300
6:00	19.6	14,700
6:30	18.7	11,800
7:00	18.0	9,800
8:00	16.7	6,730
9:00	15.6	4,530
10:00	14.7	2,970
11:00	14.3	2,370
12:00 m.	14.0	1,950
1:00 p. m.	13.8	1,690
July 22—Con.		
2:00 p. m.	13.6	1,440
4:00	13.35	1,100
6:00	13.1	880
7:00	13.1	880
8:00	13.3	1,100
9:00	13.9	1,820
10:00	15.1	3,630
11:00	16.4	6,130
12:00	17.6	8,760
July 23		
1:00 a. m.	18.8	12,200
2:00	20.0	16,000
3:00	21.1	19,300
4:00	22.3	22,400
5:00	23.4	25,000
6:00	24.5	27,700
7:00	25.7	31,500
8:00	26.8	36,000
9:00	27.9	42,300
10:00	29.0	50,000
11:00	29.0	50,000
12:00 m.	28.8	48,600
1:00 p. m.	28.75	48,300
3:00	28.6	47,200
3:30	29.7	56,400
5:00	30.0	60,000
6:00	29.8	57,600
7:00	29.7	56,400
8:00	29.55	55,400
9:00	29.15	51,600
10:00	28.4	45,800
11:00	27.6	40,300
12:00	27.15	38,000
July 24		
2:00 a. m.	26.8	36,000
4:00	26.8	36,000
5:00	27.2	38,000
6:00	28.3	45,100
7:00	29.4	53,400
8:00	30.5	66,600
9:00	31.6	80,800
10:00	31.9	84,700
10:15	31.95	86,000
11:00	31.8	83,400
12:00 m.	31.0	73,000
1:00 p. m.	30.3	63,900
2:00	29.5	54,400
3:00	28.8	48,600
4:00	28.0	43,000
5:00	26.8	36,000
5:30	25.2	29,600
6:00	23.2	24,500
6:30	21.4	20,100
7:00	20.0	16,000
8:00	19.2	13,400
9:00	18.7	11,800
10:00	18.3	10,600
11:00	18.0	9,800
12:00	17.6	8,760
July 25		
1 a. m.	17.4	8,260
2	17.1	7,570
4	16.6	6,530
6	16.2	5,730
8	15.8	4,930
10	15.5	4,350
12 m.	15.2	3,810
2 p. m.	14.9	3,290
4	14.6	2,820
6	14.4	2,520
8	14.2	2,220
10	14.0	1,950
12	13.8	1,690
July 26		
2:00 a. m.	13.8	1,690
3:00	13.9	1,820
3:30	15.1	3,630
4:00	16.4	6,130
4:30	17.6	8,760
5:00	18.6	11,500
5:30	19.0	12,800
6:00	18.7	11,800
7:00	18.0	9,800
8:00	17.4	8,260
9:00	16.3	5,930
10:00	15.6	4,530
11:00	15.4	4,170
12:00 m.	15.2	3,810
2:00 p. m.	14.9	3,290
5:00	14.6	2,820
8:00	14.2	2,230
12:00	13.85	1,690
July 27		
4 a. m.	13.6	1,440
12 m.	13.2	990
6 p. m.	13.0	775
12	12.9	675
July 28		
12 m.	12.8	575
12 p. m.	12.6	405
July 29		
12 m.	12.45	318
12 p. m.	12.3	240
July 30		
12 m.	12.2	200
12 p. m.	12.12	165
July 31		
12 m.	11.96	138
12 p. m.	11.93	138

MIDDLE CONCHO RIVER NEAR TANKERSLY, TEX.

LOCATION.—Lat. 31°22'35", long. 100°36'50", at Twelvemile Bridge, 3 miles northeast of Tankersly, Tom Green County, and 9½ miles upstream from Spring Creek. Zero of gage is 1,919.5 feet above mean seal level (general adjustment of 1929).

DRAINAGE AREA.—1,280 square miles, of which about 152 square miles is probably noncontributing.

GAGE-HEIGHT RECORD.—Water-stage recorder graph. Gage heights used to half tenths between 4.7 and 5.5 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements below 11,000 second-feet; extended on basis of study of flow over Lake Nasworthy Dam.

MAXIMA.—July 1938: Discharge, 1,280 second-feet 8:30 p. m. July 20 (gage height, 6.70 feet).

1930–June 1938: Discharge about 35,000 second-feet Sept. 26, 1936, (gage height, 24.2 feet), computed on basis of record of flow over Nasworthy Dam, 12 miles downstream, corrected for inflow and storage.

1922–29: Stage, 27.2 feet in April 1922 (discharge not determined).

REMARKS.—Small diversions above station affect low flow only.

Mean discharge, in second-feet, and runoff, in acre-feet, 1938

Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet
July 19	0	0	July 28	19	38	Aug. 6	0.5	1.0
20	170	337	29	11	22	7	.3	.6
21	165	327	30	6.7	13	8	.1	.2
22	107	212	31	4.5	8.9	9	0	0
23	90	179	Aug. 1	3.2	6.3	10	0	0
24	166	329	2	2.8	5.6	11	0	0
25	187	371	3	1.5	3.0	12	0	0
26	94	186	4	1.0	2.0	13	0	0
27	38	75	5	.6	1.2	14	0	0

Runoff, in acre-feet, for period July 19 to Aug. 14 2,120

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
July 20			*July 23*			*July 25—Con.*		
12:00 m	1.46	0	6 a. m	3.50	114	9 p. m	3.85	215
7:00 p. m	1.40	0	12 m	3.25	60	10	3.92	237
7:30	4.00	265	4 p. m	3.15	46	12	3.82	206
8:00	6.50	1,220	9	3.08	38	*July 26*		
8:30	6.70	1,280	10	3.35	78	4 a. m	3.55	128
9:00	6.35	1,190	11	3.60	141	8	3.38	85
10:00	5.50	875	12	3.58	136	4 p. m	3.34	76
11:00	4.90	645	*July 24*			12	3.23	57
12:00	4.60	525	6 a. m	3.55	128	*July 27*		
July 21			7	3.60	141	1 a. m	3.22	55
4 a. m	4.12	308	8	3.79	197	12 m	3.06	36
8	3.68	164	9	3.88	224	12 p. m	2.94	27
12 m	3.44	99	10	3.85	215	*July 28*		
5 p. m	3.25	60	12 m	3.72	176	12 m	2.79	19
6	3.27	63	5 p. m	3.50	114	12 p. m	2.68	14
7	3.35	78	9	3.37	83	*July 29*		
8	3.38	85	10	4.00	265	12 m	2.58	11
9	3.38	85	11	4.60	525	12 p. m	2.50	8.4
12	3.30	68	12	4.50	480	*July 30*		
July 22			*July 25*			12 m	2.42	6.7
7:00 p. m	2.96	28	2 a. m	4.18	332	12 p. m	2.34	5.3
7:30	4.20	340	4	3.90	230	*July 31*		
8:00	4.85	625	7	3.68	164	12 m	2.29	4.5
9:00	4.50	480	9	3.74	182	12 p. m	2.23	3.6
10:00	4.20	340	12 m	3.65	156			
11:00	4.00	265	4 p. m	3.48	109			
12:00	3.90	230	7	3.39	87			
			8	3.50	114			

SPRING CREEK NEAR TANKERSLY, TEX.

LOCATION.—Lat. 31°21'30", long. 100°32'05", 2¾ miles upstream from mouth and 6½ miles east of Tankersly, Tom Green County. Zero of gage is 1,874.6 feet above mean sea level (general adjustment of 1929).

DRAINAGE AREA.—734 square miles.

GAGE-HEIGHT RECORD.—Water-stage recorder graph. Gage heights used to half tenths between 3.6 and 6.0 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements below 17,000 second-feet; extended logarithmically to peak stage. Discharge 1 a. m. to 3 p. m. July 20 and July 29 to Aug. 14 determined by shifting-control method.

MAXIMA.—1938: Discharge, 12,000 second-feet 8 p. m. July 23 (gage height, 15.15 feet).

1930–37: Discharge, 23,900 second-feet Sept. 17, 1936 (gage height, 20.3 feet).

A stage of about 25 feet has been reported (date and discharge unknown).

REMARKS.—Small diversions upstream affect low flow only.

Mean discharge, in second-feet, and runoff, in acre-feet, 1938

Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet
July 19	1	2	July 28	66	131	Aug. 6	34	67
20	1,460	2,900	29	60	119	7	33	65
21	350	694	30	57	113	8	30	60
22	280	555	31	51	101	9	25	50
23	2,610	5,180	Aug. 1	54	107	10	20	40
24	926	1,840	2	48	95	11	18	36
25	222	440	3	47	93	12	20	40
26	414	821	4	46	91	13	20	40
27	106	210	5	41	81	14	16	32

Runoff, in acre-feet, for period July 19 to Aug. 14 14,000

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
July 20			*July 21*—Con.			*July 22*—Con.		
1:00 a. m.	1.21	0.9						
3:00 p. m.	1.24	1.1	10 a. m.	3.21	327	7 a. m.	2.37	78
4:00	1.60	5.8	11	3.12	298	8	2.36	76
4:30	9.00	3,760	12 m.	3.02	266	9	2.35	74
5:00	13.40	9,100	1 p. m.	2.95	244	3 p. m.	2.35	74
5:10	13.50	9,250	2	2.90	228	4	2.50	107
6:00	12.95	8,500	3	2.83	206	5	4.75	868
7:00	11.00	5,870	4	2.77	187	6	5.19	1,080
8:00	9.10	3,850	5	2.72	171	7	4.83	912
9:00	7.90	2,800	6	2.68	159	8	4.35	708
10:00	6.85	2,040	7	2.63	144	9	3.98	585
11:00	6.00	1,540	8	2.60	135	10	3.68	486
12:00	5.45	1,210	9	2.56	124	11	3.47	410
July 21			10	2.53	115	12	3.30	356
1 a. m.	4.90	935	11	2.51	110	*July 23*		
2	4.50	765	12	2.49	105			
3	4.20	654	*July 22*			1:00 a. m.	3.30	366
4	3.98	585				2:00	3.75	502
5	3.78	519	1 a. m.	2.47	100	3:00	3.87	536
6	3.64	470	2	2.45	95	4:50	3.82	519
7	3.53	430	3	2.44	93	5:50	4.00	585
8	3.42	394	4	2.42	88	6:00	4.20	654
9	3.32	362	5	2.40	83	7:00	3.96	568
			6	2.39	81	8:00	3.95	568

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938—Con.

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
July 23—Con.			*July 25*			*July 26*—Con.		
			1 a. m.	2.78	190	9 p. m.	2.83	206
9:00 a. m.	6.00	1,540	2	2.74	177	10	2.80	196
9:50	7.58	2,580	3	2.71	168	11	2.76	184
10:00	7.45	2,440	4	2.68	159	12	2.73	174
11:00	6.20	1,660	5	2.66	153	*July 27*		
12:00 m.	5.25	1,110	6	2.63	144	1 a. m.	2.70	165
1:00 p. m.	4.47	746	7	2.62	141	2	2.67	156
2:00	4.08	619	8	2.60	135	3	2.65	150
3:00	3.80	519	9	2.58	129	4	2.62	141
4:00	3.58	446	10	2.56	124	5	2.60	135
5:00	3.40	388	11	2.55	121	6	2.58	129
6:00	4.50	765	12 m.	2.55	121	7	2.57	127
7:00	13.70	9,550	1 p. m.	2.55	121	8	2.55	121
7:50	15.10	11,800	2	2.54	118	9	2.53	115
8:00	15.15	12,000	3	2.53	115	10	2.51	110
9:00	14.20	10,300	4	2.52	113	11	2.50	107
10:00	12.00	7,100	5	2.51	110	12 m.	2.49	105
11:00	10.50	5,300	6	2.49	105	1 p. m.	2.47	100
12:00	9.70	4,440	7	2.48	102	2	2.46	97
			8	2.47	100	3	2.44	93
July 24			9	3.10	292	4	2.43	90
			10	4.24	672	5	2.42	88
1 a. m.	8.75	3,570	11	5.10	1,030	6	2.40	83
2	7.85	2,730	12	5.70	1,360	7	2.39	81
3	7.00	2,170	*July 26*			8	2.39	81
4	6.35	1,780				9	2.38	80
5	5.80	1,420	1 a. m.	5.40	1,180	10	2.37	78
6	5.40	1,180	2	5.00	983	11	2.36	76
7	5.00	983	3	4.56	785	12	2.35	74
8	4.60	805	4	4.28	690	*July 28*		
9	4.38	708	5	4.03	602			
10	4.08	619	6	3.83	536	12 m.	2.30	66
11	3.89	552	7	3.65	470	12 p. m.	2.26	60
12m.	3.73	502	8	3.50	420	*July 29*		
1 p. m.	3.58	446	9	3.38	382			
2	3.46	407	10	3.26	343	12 m.	2.25	60
3	3.35	372	11	3.16	311	12 p. m.	2.23	57
4	3.26	343	12 m.	3.08	286	*July 30*		
5	3.19	321	1 p. m.	3.00	260			
6	3.12	298	2	2.94	241	12 m.	2.22	57
7	3.07	282	3	2.88	222	12 p. m.	2.20	54
8	3.05	276	4	2.84	209	*July 31*		
9	2.99	257	5	2.82	202			
10	2.92	234	6	2.83	206	12 m.	2.17	49
11	2.87	218	7	2.85	212	12 p. m.	2.20	54
12	2.82	202	8	2.85	212			

NORTH CONCHO RIVER NEAR CARLSBAD, TEX.

LOCATION.—Lat. 31°36′, long. 100°40′, just upstream from spillway of State Sanatorium Dam, 2 miles upstream from Carlsbad, Tom Green County. Zero of gage is 2,000.8 feet above mean sea level (general adjustment of 1929).

DRAINAGE AREA.—1,529 square miles, of which about 123 square miles is probably noncontributing.

GAGE-HEIGHT RECORD.—Water-stage recorder graph. Gage heights used to half tenths between 7.5 and 10.8 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements below 4,600 second-feet; extended on basis of slope-area measurements of 15,000, 55,200, and 94,600 second-feet. Discharge for part or all of July 20, 22, 25–27, determined by shifting-control method.

MAXIMA.—July 1938: Discharge, 4,870 second-feet 11:30 a. m. July 25 (gage height, 8.98 feet).

1924–June 1938: Discharge, 94,600 second-feet Sept. 26, 1936 (gage height, 16.0 feet, from highest floodmarks ever known).

1922–23; Stage, 14.0 feet Apr. 1, 1922.

REMARKS.—Small reservoir above gage affects low flow only.

Mean discharge, in second-feet, and runoff, in acre-feet, 1938

Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet
July 19	2.4	5	July 29	28	56	Aug. 7	6.3	12
20	207	411	30	20	40	8	5.7	11
21	24	48	31	16	32	9	6.3	12
22	253	502				10	6.3	12
23	60	119	Aug. 1	16	32	11	6.3	12
24	88	175	2	14	28	12	5.7	11
25	1,470	2,920	3	12	24	13	7.0	14
26	554	1,100	4	10	20	14	5.7	11
27	197	391	5	8.6	17			
28	46	91	6	7.8	15			

Runoff, in acre-feet, for period July 19 to Aug. 14 6,120

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
July 19			*July 23*—Con.			*July 26*—Con.		
12 m	4.19	2.4	12 m	4.55	46	4 a. m	6.05	565
12 p. m	4.19	2.4	6 p. m	4.44	28	8	6.15	620
July 20			8	4.66	65	10	6.00	535
			12	4.55	46	12 m	5.70	399
12 m	4.20	2.8				3 p. m	5.35	265
2 p. m	4.20	2.8	*July 24*			6	5.10	186
3	5.50	310				7	5.20	216
4	7.44	1,760	12 m	4.38	19	8	5.50	318
5	7.00	1,360	4 p. m	4.38	19	10	6.06	565
6	6.00	540	5	4.50	37	12	6.20	644
7	5.50	321	6	5.10	180			
8	5.20	216	7	5.50	310	*July 27*		
9	5.00	150	8	5.65	367			
10	4.86	112	9	5.45	293	1 a. m	6.10	586
11	4.77	89	10	5.20	210	2	5.95	506
12	4.70	73	12	5.10	180	3	5.78	424
						4	5.60	348
July 21			*July 25*			5	5.47	300
						6	5.35	258
4 a. m	4.50	37	1:00 a. m	5.05	165	7	5.23	220
12 m	4.40	22	2:00	5.15	201	8	5.14	192
12 p. m	4.30	9.2	3:00	5.38	275	10	5.02	156
			5:00	5.25	232	12 m	4.93	132
July 22			9:00	4.95	136	6 p. m	4.75	84
			10:00	5.60	359	12	4.65	64
8 a. m	4.27	6.7	11:00	7.00	1,300			
9	4.50	37	11:30	8.98	4,870	*July 28*		
10	4.85	112	12:00 m	8.95	4,760			
12 m	4.78	94	1:00 p. m	7.95	2,600	12 m	4.55	46
3 p. m	4.63	60	2:00	8.45	3,570	12 p. m	4.47	32
4	5.38	275	3:00	8.35	3,360			
5	5.04	168	4:00	7.80	2,340	*July 29*		
6	7.00	1,230	5:00	7.40	1,720			
7	7.30	1,570	6:00	7.15	1,400	12 m	4.44	28
8	6.70	1,050	7:00	7.10	1,340	12 p. m	4.41	23
9	5.90	491	8:00	7.30	1,580			
10	5.50	318	9:00	7.70	2,170	*July 30*		
12	5.00	156	10:00	7.90	2,510			
			11:00	7.95	2,600	12 m	4.39	20
July 23			12:00	7.80	2,340	12 p. m	4.36	16
			July 26			*July 31*		
3 a. m	4.75	84	1 a. m	7.30	1,580			
6	4.70	73	2	6.70	1,060	12 m	4.36	16
9	4.65	64	3	6.25	684	12 p. m	4.35	15

BROWNWOOD RESERVOIR NEAR BROWNWOOD, TEX.

LOCATION.—Lat. 31°50′, long. 99°00′, on Pecan Bayou at gate tower just upstream from dam, a quarter of a mile downstream from mouth of Jim Ned Creek and 7 miles north of Brownwood, Brown County. Elevations are feet above mean sea level.

DRAINAGE AREA.—1,535 square miles.

GAGE-HEIGHT RECORD.—Staff gage read once daily. Reading made between 7 and 8 a. m. on days shown.

STORAGE RECORD.—Capacity table, obtained from Brown County Water Improvement District No. 1, dated Nov. 9, 1932.

MAXIMUM.—Flood of July 3, 1932, probably the greatest known, reached a discharge of about 235,000 second-feet as it entered Brownwood Reservoir (computed from rate of storage in reservoir).

REMARKS.—Records furnished by Herman Bettis, manager, Brown County Water Improvement District No. 1.

Elevation, in feet, and contents, in acre-feet, 1938

Date	Feet	Acre-feet	Date	Feet	Acre-feet	Date	Feet	Acre-feet
July 17	1,418.9	107,200	July 27	1,426.9	163,900	Aug. 6	1,424.9	147,800
18	1,418.8	106,600	28	1,426.3	158,900	7	1,424.8	147,000
19	1,419.1	108,400	29	1,426.1	157,200	8	1,424.7	146,200
20	1,419.2	109,000	30	1,425.7	154,000	9	1,424.6	145,500
21	1,419.3	109,600	31	1,425.1	149,300	10	1,424.5	144,800
22	1,419.4	110,200	Aug. 1	1,425.1	149,300	11	1,424.4	144,000
23	1,419.5	110,800	2	1,425.1	149,300	12	1,424.3	143,200
24	1,421.0	120,100	3	1,425.1	149,300	13	1,424.2	142,500
25	1,427.5	169,000	4	1,425.0	148,500	14	1,424.1	141,800
26	1,427.5	169,000	5	1,424.9	147,800	15	1,424.0	141,000

PECAN BAYOU AT BROWNWOOD, TEX.

LOCATION.—Lat. 31°44′10″, long. 98°58′30″, at Fort Worth & Rio Grande Ry. bridge, 1 mile north of Brownwood, Brown County, and 10 miles downstream from Brownwood Reservoir. Zero of gage is 1,318.58 feet above mean sea level (general adjustment of 1929).

DRAINAGE AREA.—1,614 square miles.

GAGE-HEIGHT RECORD.—Water-stage recorder graph. Gage heights used to half tenths between 3.1 and 4.6 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements below 38,000 second feet; extended above to peak discharge reached in 1930.

MAXIMA.—1938: Discharge, 5,290 second-feet 4:30 a. m. July 26 (gage height, 5.72 feet).

1917–18, 1923–37: Discharge, 52,700 second-feet Oct. 14, 1930 (gage height, 16.9 feet).

REMARKS.—Flow regulated by storage in Brownwood Reservoir.

Mean discharge, in second-feet, and runoff, in acre-feet, 1938

Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet
July 20	0	0	July 29	1,020	2,020	Aug. 7	324	643
21	0	0	30	830	1,650	8	317	629
22	0	0	31	820	1,630	9	317	629
23	128	254	Aug. 1	647	1,280	10	317	629
24	1,100	2,180	2	481	954	11	317	629
25	2,310	4,580	3	383	760	12	317	629
26	4,410	8,750	4	330	655	13	317	629
27	2,540	5,040	5	317	629	14	317	629
28	1,620	3,210	6	317	629			

Runoff, in acre-feet, for period July 20 to Aug. 14 39,270

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
July 23			*July 25—Con.*			*July 27*		
6 a. m.	0.86	0	3 a. m.	1.47	190	2 a. m.	4.24	3,140
8	1.00	11	4	1.40	152	4	4.14	3,000
10	1.19	64	5	1.50	207	6	4.04	2,880
12 m.	1.35	129	6	2.12	638	8	3.93	2,750
1 p. m.	1.47	190	7	3.00	1,590	10	3.83	2,620
2	1.80	396	8	3.65	2,370	12 m.	3.76	2,500
3	1.90	466	9	4.10	2,940	2 p. m.	3.68	2,440
4	1.80	396	10	4.27	3,140	4	3.60	2,310
6	1.58	255	11	4.15	3,000	6	3.52	2,190
8	1.42	163	12 m.	3.96	2,750	8	3.46	2,130
10	1.31	111	1 p. m.	3.90	2,680	10	3.40	2,070
12	1.22	75	3	3.90	2,680	12	3.34	2,010
July 24			4	3.92	2,680	*July 28*		
4 a. m.	1.12	41	5	4.02	2,810	4 a. m.	3.20	1,830
5	1.25	87	6	4.17	3,000	8	3.08	1,690
6	1.41	158	7	4.33	3,270	12 m.	3.00	1,590
7	1.65	298	8	4.50	3,480	4 p. m.	2.90	1,470
8	2.28	790	9	4.70	3,760	8	2.80	1,350
9	3.50	2,190	10	4.85	3,910	12	2.73	1,270
10	4.20	3,070	11	5.05	4,210	*July 29*		
11	4.40	3,340	12	5.20	4,520	12 m.	2.50	1,020
12 m.	4.25	3,140	*July 26*			12 p. m.	2.32	880
1 p. m.	3.90	2,680	1 a. m.	5.35	4,840	*July 30*		
2	3.50	2,190	2	5.50	4,990	6 a. m.	2.29	800
3	3.20	1,830	3	5.66	5,200	10	2.28	790
4	2.95	1,580	4	5.72	5,290	3 p. m.	2.43	942
5	2.60	1,120	6	5.68	5,240	10	2.28	790
6	2.30	810	7	5.60	5,140	12	2.35	860
7	2.12	638	8	5.52	4,990	*July 31*		
8	1.98	525	10	5.33	4,680	3 a. m.	2.34	850
9	2.00	540	12 m.	5.15	4,520	11	2.25	760
10	1.98	525	2 p. m.	4.98	4,210	3 p. m.	2.35	860
11	1.85	431	4	4.82	3,910	12	2.25	760
12	1.75	363	6	4.70	3,760			
July 25			8	4.57	3,550			
1 a. m.	1.60	267	10	4.46	3,410			
2	1.55	237	12	4.35	3,270			

SAN SABA RIVER AT MENARD, TEX.

LOCATION.—Lat. 30°55′, long. 99°48′, 1,000 feet upstream from bridge on U. S. Highway 83 at Menard, Menard County, and half a mile downstream from Las Moras Creek. Zero of gage is 1,865.05 feet above mean sea level (general adjustment of 1929).

DRAINAGE AREA.—1,151 square miles.

GAGE-HEIGHT RECORD.—Graph drawn from two or more staff-gage readings daily and peak stage determined from floodmarks. Gage heights used to half

tenths between 4.8 and 5.4 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements below 55,400 second-feet; extended to peak stage by weighting results of two slope-area measurements. Discharge July 28 to 4 a. m. July 30 and July 31 to Aug. 14 determined by shifting-control method.

MAXIMA.—1938: Discharge, 117,000 second-feet 9 p. m., July 23 (gage height, 22.7 feet).

1915–37: Discharge, 68,600 second-feet Sept. 16, 1936 (gage height, 21.2 feet, from floodmarks) based on slope-area measurement.

1899–1914: Stage, 23.7 feet, present site and datum, June 5 or 6, 1899 (discharge not determined).

REMARKS.—Small diversions above affect low flow only.

Mean discharge, in second-feet, and runoff, in acre-feet, 1938

Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet
July 19	17	34	July 28	220	436	Aug. 6	96	190
20	3,640	7,220	29	156	309	7	88	175
21	23,200	46,020	30	1,290	2,560	8	84	167
22	44,400	88,070	31	220	436	9	82	163
23	53,300	105,700	Aug. 1	147	292	10	86	171
24	26,000	51,750	2	147	292	11	116	230
25	3,290	6,530	3	116	230	12	116	230
26	2,740	5,430	4	107	212	13	114	226
27	730	1,450	5	100	198	14	109	216

Runoff, in acre-feet, for period July 19 to Aug. 14 318,800

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
July 20			*July 22—Con.*			*July 24—Con.*		
12:00 m	2.6	43						
12:20 p.m.	4.0	450	6:00 a. m.	16.0	36,600			
12:40	6.0	2,300	7:10	18.0	55,000	7:30 a. m.	16.0	36,600
1:00	8.0	4,800	8:40	20.0	79,000	9:10	16.65	41,800
1:20	10.0	7,400	10:30	20.9	91,600	12:00 m	14.0	22,700
2:20	12.0	10,800	12:00 m	20.0	79,000	1:00 p. m.	13.9	22,100
3:50	12.9	13,400	2:40 p. m.	18.0	55,000	2:40	14.0	22,700
4:40	12.0	10,800	6:20	16.0	36,600	4:30	14.25	23,900
5:50	10.0	7,400	10:20	14.0	22,700	5:50	14.0	22,700
10:30	8.0	4,800	12:00	13.05	17,400	7:00	12.0	13,000
12:00	7.8	4,550				10:00	10.0	7,400
			July 23			12:00	9.0	6,100
July 21								
			1:50 a. m.	12.3	14,200	*July 25*		
1:00 a. m.	7.75	4,550	4:00	13.0	17,400			
2:40	8.0	4,800	5:20	14.0	22,700	2:30 a. m.	8.0	4,800
5:10	10.0	7,400	7:00	16.0	36,600	10:20	6.0	2,300
6:10	12.0	10,800	8:00	18.0	55,000	4:30 p. m.	4.7	730
7:10	14.0	17,600	9:00	19.0	66,500	7:30	6.0	2,300
8:00	16.0	28,000	10:30	18.0	55,000	8:40	8.0	4,800
8:30	18.0	43,500	11:50	16.0	36,600	10:10	10.0	7,400
10:10	19.08	54,000	1:50 p. m.	14.35	25,100	12:00	10.45	8,100
11:50	18.0	43,500	2:30	16.0	36,600			
2:00 p. m.	16.6	32,200	4:30	18.0	55,000	*July 26*		
3:40	16.25	29,400	6:10	20.0	79,000			
6:00	16.75	33,600	7:30	22.0	107,000	1:00 a. m.	10.0	7,400
6:50	16.0	28,000	9:00	22.7	117,000	4:30	8.0	4,800
8:00	14.0	17,600	10:30	22.0	107,000	9:40	6.0	2,300
10:00	12.0	10,800	12:00	20.0	79,000	3:00 p. m.	5.0	1,080
12:00	10.05	7,400				6:00	5.2	1,320
			July 24			12:00	5.2	1,320
July 22								
			1:00 a. m.	18.0	55,000	*July 27*		
2:40 a. m.	12.0	13,000	2:20	16.0	36,600			
4:30	14.0	22,700	5:20	14.9	28,300	12:00 p. m.	4.3	370

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938—Con.

Time	Feet	Second-feeet	Time	Feet	Second-feeet	Time	Feet	Second-feet
July 28			*July 30*			*July 30*—Con.		
7:00 a. m.	4.2	265						
5:30 p. m.	4.0	180	2 a. m.	4.0	171	10 p. m.	5.9	2,180
12:00	3.97	171	4	4.1	242	12	4.8	840
			6	4.4	440			
July 29			8	4.8	840	*July 31*		
			10	5.2	1,320			
8:15 a. m.	3.99	168	12 m.	5.0	1,080	2 a. m.	4.6	570
6:00 p. m.	3.90	142	2 p. m.	5.2	1,320	4	4.5	440
12:00	3.90	142	4	5.6	1,800	6	4.3	315
			6	6.3	2,680	10	4.2	265
			8	6.4	2,800	12 p. m.	3.94	162

SAN SABA RIVER AT SAN SABA, TEX.

LOCATION.—Lat. 31°12'10", long. 98°42'15", at bridge on San Saba-Chadwick Mill highway, three-quarters of a mile northeast of San Saba, San Saba County, and 15 miles upstream from mouth.

Zero of gage is 1,153.3 feet above mean sea level (general adjustment of 1929).

DRAINAGE AREA.—3,046 square miles.

GAGE-HEIGHT RECORD.—Water-stage recorder graph except for 10 a. m. July 22 to 11 p. m. July 23 and 2 a. m. to 9 p. m. July 24, when recorder was submerged and gage-height record obtained from graph based on numerous water-surface elevations observed by engineers, and peak stage determined from floodmarks. Gage heights used to half tenths between 4.8 and 6.5 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements below 30,000 second-feet; extended to peak discharge as determined by slope-area method. Discharge July 19 and July 26 to Aug. 14 determined by shifting-control method.

MAXIMA.—1938: Discharge, 203,000 second-feet 11 a. m. July 23 (gage height, 45.18 feet, from floodmarks).

1904–6, 1915–37: Discharge, 57,000 second-feet Apr. 26, 1922 (gage height, 42.1 feet, present site and datum, from floodmarks, affected by backwater).

1899–1903, 1907–14: Stage, 42.6 feet June 6, 1899 (discharge not determined); may have been affected by backwater.

REMARKS.—Diversions above station affect low flow only.

Mean discharge, in second-feet, and runoff, in acre-feet, 1938

Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet
July 19	115	228	July 29	1,620	3,210	Aug. 8	705	1,400
20	574	1,140	30	1,900	3,770	9	665	1,320
21	11,500	22,810	31	4,180	8,290	10	625	1,240
22	95,900	190,200	Aug. 1	2,200	4,360	11	605	1,200
23	117,000	232,100	2	1,310	2,600	12	692	1,370
24	84,700	168,000	3	1,070	2,120	13	830	1,650
25	40,200	79,740	4	935	1,850	14	605	1,200
26	7,980	15,830	5	845	1,680			
27	4,640	9,200	6	785	1,560			
28	2,330	4,620	7	745	1,480			

Runoff, in acre-feet, for period July 19 to Aug. 14 764,200

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Time	Feet	Second-feet
July 19		
10 a. m.	3.55	52
11	3.75	74
12 m	4.00	104
1 p. m.	4.12	120
2	4.12	120
3	4.03	108
5	3.90	92
6	3.90	92
7	4.05	110
8	4.55	177
9	5.30	285
10	5.75	352
11	6.00	391
12	6.00	391
July 20		
1:00 a. m.	5.90	360
2:00	5.75	338
3:00	5.55	308
4:00	5.35	278
5:00	5.15	248
6:00	5.00	226
8:00	4.70	184
9:00	4.63	174
10:00	4.70	184
11:00	5.30	270
12:00 m	5.95	368
1:00 p. m.	6.55	473
2:00	6.80	509
3:00	6.95	545
4:00	6.95	545
5:00	6.85	509
6:00	6.70	491
7:00	6.65	473
8:00	7.20	585
8:30	7.90	725
9:00	8.70	885
9:30	9.90	1,180
10:00	11.60	1,650
10:30	12.80	2,010
11:00	13.90	2,340
11:30	14.60	2,550
12:00	16.10	3,030
July 21		
12:30 a. m.	16.90	3,300
1:00	17.70	3,560
1:30	18.35	3,800
2:00	18.85	3,940
3:00	19.60	4,250
4:00	19.97	4,430
5:00	20.05	4,430
6:00	20.00	4,430
7:00	19.94	4,380
8:00	20.00	4,430
9:00	20.32	4,570
10:00	20.85	4,820
11:00	21.60	5,240
12:00 m	22.30	5,630
1:00 p. m.	23.25	6,170
2:00	24.25	6,810
3:00	25.20	7,510
4:00	26.10	8,300
5:00	27.10	9,560
6:00	28.10	11,180
7:00	29.45	13,700
7:30	30.20	15,700
8:00	31.10	18,400
8:30	32.00	22,000
9:00	32.70	24,800
9:30	33.50	29,000
10:00	34.15	33,600
10:30	34.85	39,600
11:00	35.30	46,200
11:30	35.60	50,400
12:00	36.10	57,600
July 22		
1:00 a. m.	36.25	59,200
2:00	36.12	57,600
3:00	36.00	56,000
4:00	35.87	54,200
5:00	35.78	53,000
6:00	35.80	53,200
7:00	35.85	54,000
8:00	35.95	55,200
9:00	36.05	56,800
10:00	36.65	65,600
10:30	37.50	80,000
11:00 a. m.	38.10	89,600
11:30	38.90	102,000
12:00 m	39.60	114,000
12:30 p. m.	40.40	126,000
1:00	41.20	139,000
1:30	42.40	158,000
2:00	42.65	162,000
2:30	42.70	163,000
3:00	42.65	162,000
3:30	42.25	155,000
4:00	41.90	151,000
5:00	41.10	138,000
6:00	40.60	130,000
7:00	40.10	122,000
8:00	39.75	117,000
10:00	39.25	107,000
12:00	38.94	102,000
July 23		
2:00 a. m.	38.85	101,000
4:00	38.85	101,000
5:00	39.00	104,000
6:00	39.35	110,000
7:00	39.85	117,000
8:00	41.00	136,000
8:30	42.00	152,000
9:00	43.00	168,000
9:30	44.40	190,000
10:00	45.00	200,000
11:00	45.18	203,000
12:00 m	45.00	200,000
12:30 p. m.	44.40	190,000
1:00	43.40	172,000
1:30	42.30	157,000
2:00	41.10	138,000
2:30	40.40	126,000
3:00	39.85	117,000
4:00	39.00	104,000
5:00	38.55	97,600
6:00	38.10	89,600
7:00	37.70	83,200
8:00	37.35	78,400
9:00	37.10	73,600
10:00	36.85	68,800
11:00	36.60	65,600
12:00	36.50	64,000
July 24		
1 a. m.	36.55	65,600
2	36.75	68,800
3	37.00	72,000
4	37.20	75,200
6	37.60	81,600
7	37.95	88,000
9	38.60	97,600
10	39.10	106,000
11	39.30	109,000
12 m	39.32	110,000
1 p. m.	39.30	109,000
2	39.23	107,000
3	38.95	104,000
4	38.60	97,600
5	38.25	91,200
6	37.90	86,400
7	37.50	80,000
July 24—Con.		
8 p. m.	37.10	73,600
9	36.75	68,800
10	36.25	59,200
11	36.00	56,000
12	35.60	50,400
July 25		
1 a. m.	35.30	46,200
2	35.15	44,100
3	35.25	45,500
4	35.65	50,400
5	36.00	56,000
7	36.15	59,200
9	36.15	59,200
11	36.00	56,000
12 m	35.65	50,400
1 p. m.	35.15	44,100
2	34.60	37,400
3	33.90	31,400
4	33.35	28,400
5	32.90	25,600
6	32.50	24,000
7	32.20	22,800
8	31.90	21,600
10	31.20	18,800
12	30.55	16,800
July 26		
2 a. m.	29.70	14,000
4	28.80	12,100
6	27.90	10,500
8	27.00	9,120
10	25.60	7,670
12 m	24.40	6,810
1 p. m.	23.80	6,420
2	23.30	6,110
3	22.90	5,870
4	22.40	5,570
5	22.05	5,350
6	21.70	5,180
8	21.00	4,620
10	20.75	4,520
11	21.00	4,620
12	21.43	4,820
July 27		
1 a. m.	21.90	5,080
2	22.40	5,350
3	22.75	5,570
4	23.10	5,750
5	23.25	5,810
6	23.30	5,870
7	23.20	5,810
8	23.05	5,690
9	22.80	5,570
10	22.40	5,350
11	22.00	5,130
12 m	21.50	4,870
1 p. m.	20.90	4,570
2	20.55	4,430
3	20.15	4,250
4	19.85	4,090
5	19.40	3,870
6	19.00	3,730
7	18.50	3,560
8	18.15	3,460
10	17.50	3,230
12	16.90	3,030
July 28		
2 a. m.	16.40	2,840
4	16.00	2,700
6	15.65	2,610

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938—Continued

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
July 28—Con.			*July 30*			*July 31*—Con.		
			1 a. m.	11.80	1,590			
8 a. m.	15.30	2,490	2	12.10	1,680	6 a. m.	19.00	3,870
10	14.90	2,370	4	12.95	1,950	7	20.25	4,380
12 m.	14.55	2,280	6	13.65	2,160	8	21.20	4,820
2 p. m.	14.30	2,190	7	13.73	2,190	9	21.75	5,130
4	14.00	2,100	8	13.70	2,160	10	22.50	5,520
6	13.80	2,040	9	13.57	2,130	11	22.85	5,750
8	13.57	1,980	10	13.38	2,070	12 m.	22.90	5,750
10	13.35	1,920	12 m.	13.07	1,980	1 p. m.	22.83	5,690
12	13.17	1,860	4 p. m.	12.70	1,860	2	22.60	5,570
			8	12.50	1,800	3	22.20	5,350
July 29			10	12.45	1,800	4	21.70	5,080
			11	12.48	1,800	5	21.10	4,770
	12.88	1,770	12	12.75	1,890	6	20.40	4,430
4 a. m.	12.60	1,680	*July 31*			7	19.75	4,170
8	12.30	1,590				8	19.15	3,940
12 m.	12.03	1,530	1 a. m.	13.60	2,130	9	18.40	3,660
4 p. m.	11.80	1,440	2	14.00	2,250	10	17.80	3,460
8	11.70	1,410	3	15.10	2,580	11	17.05	3,230
12			4	16.20	2,930	12	16.40	3,000
			5	17.50	3,360			

NORTH LLANO RIVER NEAR JUNCTION, TEX.

LOCATION.—Lat. 30° 30′, long. 99° 47′, about 1,000 feet upstream from remains of old Wilson Dam and 3 miles northwest of Junction, Kimble County. Prior to July 22 at site 440 feet downstream. Zero of gages is 1,699.9 feet above mean sea level (general adjustment of 1929).

DRAINAGE AREA.—914 square miles.

GAGE-HEIGHT RECORD.—Graph drawn from one or more staff-gage readings daily; gage read at frequent intervals during period of flood. For rating used July 16–21, gage heights used to half tenths between 3.5 and 6.5 feet; for rating used July 22 to August 10, gage heights used to half tenths between 2.9 and 4.3 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements below 68,000 second-feet; extended on basis of slope-area measurement of 94,800 second-feet.

MAXIMA.—1938: Discharge, 68,600 second-feet 4:30 p. m. July 22 (gage height, 24.4 feet).

1915–37: Discharge, 94,800 second-feet 12:01 a. m. Sept. 16, 1936 (gage height, 24.9 feet, from floodmarks at gage 440 feet downstream).

1875–1914: Stage, about 22.9 feet in 1889 (at gage downstream).

REMARKS.—Diversions above station for irrigation affect low flow only.

Mean discharge, in second-feet, and runoff, in acre-feet, 1938

Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet
July 20	4	8	July 28	340	674	Aug. 4	200	397
21	10,100	20,030	29	295	585	5	187	371
22	31,000	61,490	30	945	1,870	6	171	339
23	23,400	46,410	31	769	1,530	7	162	321
24	20,400	40,460	Aug. 1	325	645	8	144	286
25	1,540	3,050	2	267	530	9	138	274
26	1,150	2,280	3	239	474	10	138	274
27	575	1,140						

Runoff, in acre-feet, for period July 20 to Aug. 10 183,400

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
July 20			*July 23*			*July 26—Con.*		
12 m	0.90	4	4:00 a. m.	12.4	22,200			
12 p. m.	.90	4	7:00	10.1	14,700	1 p. m.	4.04	1,690
July 21			9:20	8.70	10,900	6	3.72	1,240
			10:00	9.00	11,700	12	3.40	920
6 a. m.	.92	4	12:00 m.	11.3	18,400	*July 27*		
8	1.12	16	2:00 p. m.	14.0	27,800			
10	3.00	1,300	3:00	15.5	33,400	8 a. m.	3.06	615
12 m.	6.20	7,300	4:30	16.3	36,400	4 p. m.	2.82	449
2 p. m.	9.00	18,500	5:00	16.0	35,200	12	2.73	393
3	11.0	27,500	7:00	14.4	29,300			
5	11.7	30,600	9:00	12.9	24,000	*July 28*		
6	11.4	29,300	11:00	11.7	19,800			
8	9.40	20,300	12:00	12.7	23,200	12 m.	2.63	340
10	6.80	9,300	*July 24*			12 p. m.	2.55	300
12	5.55	5,320				*July 29*		
July 22			3 a. m.	15.8	34,500			
			5	17.8	42,200	12 m.	2.48	267
1:00 a. m.	5.00	3,200	6	18.4	44,600	6 p. m.	2.45	255
3:00	6.20	5,400	7	17.8	42,200	9	2.60	325
6:00	8.10	9,500	9	15.8	34,500	12	2.90	505
8:00	9.90	14,100	10	13.5	26,000			
9:00	11.8	20,100	12 m.	10.7	16,500	*July 30*		
9:20	14.0	27,800	4 p. m.	7.50	8,100			
10:00	12.9	24,000	8	6.15	5,400	4:00 a. m.	3.62	1,120
11:00	11.0	17,400	12	5.20	3,560	6:30	4.07	1,690
11:30	13.8	27,100	*July 25*			8:00	4.00	1,620
12:00 m.	15.0	31,500				12:00 m.	3.60	1,120
12:30 p. m.	14.8	30,800	6 a. m.	4.25	1,980	6:00 p. m.	3.10	655
1:00	15.2	32,200	12 m.	3.73	1,300	12:00	2.84	463
2:00	16.5	37,200	12 p. m.	3.05	615			
3:00	21.8	58,200				*July 31*		
4:00	24.0	67,000	*July 26*					
4:30	24.4	68,600				2:00 a. m.	2.83	456
5:00	24.1	67,400	1 a. m.	3.03	615	8:00	2.94	540
6:00	22.7	61,800	3	3.07	615	2:00 p. m.	3.35	872
7:00	21.5	57,000	6	3.36	872	6:30	3.83	1,420
8:00	20.0	51,000	9	3.87	1,420	9:00	3.54	1,070
10:00	17.9	42,600	11	4.10	1,760	12:00	3.11	655
12:00 p. m.	15.9	34,800						

LLANO RIVER NEAR JUNCTION, TEX.

LOCATION.—Lat. 30°30′, long. 99°44′, 100 feet north of Kerrville-Junction road, 3 miles downstream from confluence of North Llano and South Llano Rivers, and 3½ miles east of Junction, Kimble County. Zero of gage is 1,630.32 feet above mean sea level (general adjustment of 1929).

DRAINAGE AREA.—1,762 square miles.

GAGE-HEIGHT RECORD.—Water-stage recorder graph except for 5½ hours July 22, 23, when recorder was submerged and gage heights were obtained from graph based on peak stage determined from flood marks and on shape of recorder graph before and after peak. Gage heights used to half tenths between 3.5 and 7.1 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements below 32,000 second-feet; extended on basis of slope-area measurements of 76,900, 85,500, 154,000, and 319,000 second-feet. Discharge July 20, 28–29, and Aug. 1–10 determined by shifting-control method.

MAXIMA.—1938: Discharge, 137,000 second-feet about 11 p. m. July 22 (gage height, 30.3 feet, from floodmarks).

1915–37: Discharge, 319,000 second-feet June 14, 1935 (gage height, 43.3 feet, from floodmarks).

1889–1914: No flood as great as that of June 14, 1935.

REMARKS.—Small diversions and storage above station affect low flow only.

Mean discharge, in second-feet, and runoff, in acre-feet, 1938

Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet
July 20	66	131	July 28	840	1,670	Aug. 4	426	845
21	5,450	10,810	29	678	1,340	5	394	781
22	46,800	92,830	30	759	1,510	6	375	744
23	38,800	76,960	31	1,010	2,000	7	350	694
24	27,400	54,350	Aug. 1	635	1,260	8	331	657
25	3,830	7,600	2	512	1,020	9	306	607
26	3,080	6,110	3	446	885	10	288	571
27	1,340	2,660						

Runoff, in acre-feet, for period July 20 to Aug. 10 266,000

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
July 20			*July 23—Con.*			*July 26*		
12 m	1.49	66	10:00 a. m.	9.8	17,400	1 a. m.	3.80	1,920
12 p. m.	1.49	66	11:00	10.2	18,900	2	4.50	2,750
July 21			12:00 m	10.4	19,700	3	5.30	3,850
			1:00 p. m.	10.5	20,100	4	5.56	4,280
6:00 a. m.	1.50	70	2:00	11.1	22,400	5	5.56	4,280
7:00	1.55	84	3:00	11.8	25,600	6	5.50	4,190
8:00	1.65	116	4:00	12.6	29,200	7	5.60	4,380
9:00	1.87	208	5:00	13.2	31,900	8	5.66	4,480
1:50 p. m.	1.85	198	6:00	13.9	35,000	9	5.55	4,280
2:30	7.5	9,650	7:00	14.5	37,800	10	5.40	4,010
3:00	8.7	13,600	7:30	14.8	39,100	12 m	5.00	3,410
4:00	9.7	17,000	8:00	14.5	37,800	2 p. m.	4.70	3,010
5:00	10.2	18,900	9:00	13.5	33,200	4	4.40	2,630
6:00	10.0	18,200	10:00	11.8	25,600	6	4.20	2,390
7:00	9.3	15,600	11:00	10.6	20,400	8	4.00	2,150
8:00	8.4	12,600	12:00	9.8	17,400	10	3.85	1,980
9:00	7.7	10,300	*July 24*			12	3.72	1,810
10:00	7.2	8,600				*July 27*		
11:00	6.8	7,370				4 a. m.	3.53	1,640
12:00	6.4	6,200	1:00 a. m.	9.4	16,000	8	3.37	1,450
July 22			2:00	9.2	15,300	12 m.	3.25	1,320
			3:00	9.0	14,600	4 p. m.	3.14	1,190
1:00 a. m.	5.95	5,120	4:00	10.0	18,200	8	3.05	1,100
2:00	5.7	4,590	5:00	11.2	22,900	12	2.96	1,000
3:00	6.2	5,680	6:00	13.0	31,000			
4:00	7.0	8,000	7:00	15.0	40,000	*July 28*		
5:00	8.8	13,900	8:00	16.6	48,000	12 m	2.78	831
6:00	9.5	16,400	9:00	18.3	56,500	12 p. m.	2.67	734
7:00	9.05	15,000	9:30	18.6	58,000			
8:00	8.75	13,900	10:00	18.3	56,500	*July 29*		
9:00	10.0	18,200	11:00	17.3	51,500	12 m	2.58	663
10:00	12.5	28,800	12:00 m	15.5	42,500	10 p. m.	2.52	621
11:00	13.7	34,200	1:00 p. m.	14.3	36,800	11	2.75	804
12:00 m	14.0	35,500	2:00	13.4	32,800	12	3.00	1,050
1:00 p. m.	13.8	34,600	3:00	12.5	28,800			
2:00	13.9	35,000	4:00	11.5	24,200	*July 30*		
3:00	15.0	40,000	5:00	10.9	21,600	2 a. m.	2.91	950
4:00	18.2	56,000	6:00	10.4	19,700	4	2.85	890
5:00	20.5	67,500	7:00	9.8	17,400	6	2.76	804
5:30	21.4	72,200	8:00	9.2	15,300	8	2.70	750
6:00	22.2	76,600	9:00	8.6	13,300	10	2.65	710
7:00	23.3	82,800	10:00	8.3	12,300	12 m	2.61	678
8:00	25.0	93,000	11:00	7.8	10,600	10 p. m.	2.49	593
9:00	27.3	109,000	12:00	7.5	9,650	11	3.30	1,370
10:00	30.0	134,000	*July 25*			12	3.60	1,700
11:00	30.3	137,000				*July 31*		
12:00	30.0	134,000	1 a. m.	7.0	8,000	1 a. m.	3.50	1,590
July 23			2	6.7	7,070	3	3.28	1,350
			4	6.2	5,680	5	3.12	1,170
1:00 a. m.	27.0	107,000	5	6.0	5,220	7	3.00	1,040
2:00	24.5	90,000	7	5.7	4,590	12 m	2.77	813
3:00	22.0	75,500	9	5.3	3,850	1 p. m.	2.90	940
4:00	19.0	60,000	12 m	4.8	3,140	2	2.98	1,020
5:00	16.3	46,500	2 p. m.	4.6	2,880	3	2.98	1,020
6:00	14.0	35,500	4	4.4	2,630	4	2.95	990
7:00	12.6	29,200	6	4.23	2,450	6	2.87	910
8:00	10.7	20,800	8	4.10	2,270	8	2.80	840
9:00	10.0	18,200	10	3.98	2,150	10	2.74	786
			12	3.85	1,980	12	2.68	734

LLANO RIVER NEAR CASTELL, TEX.

LOCATION.—Lat. 30°43′, long. 98°53′, 4 miles upstream from Hickory Creek and 4.5 miles east of Castell, Llano County. Zero of gage is 1,121.8 feet above mean sea level (general adjustment of 1929).

DRAINAGE AREA.—3,514 square miles.

GAGE-HEIGHT RECORD.—Graph drawn from two staff-gage readings daily. Gage heights used to half tenths between 1.5 and 4.4 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements below 10,000 second-feet; extended on basis of a float measurement of 33,600 second-feet and slope-area measurements of 135,000 and 388,000 second-feet. Discharge July 28 to Aug. 10 determined by shifting-control method.

MAXIMA.—1938: Discharge, 133,000 second-feet about 8 a. m. July 23 (gage height, 21.43 feet, from floodmarks).

1923–37: Discharge, 388,000 second-feet July 14, 1935 (gage height, 37.0 feet, from floodmarks), by slope-area method.

1889–1922: Stage, 28.4 feet in 1889 (discharge not determined).

REMARKS.—Small diversions above station affect low flow only.

Mean discharge, in second-feet, and runoff, in acre-feet, 1938

Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet
July 20	70	139	July 28	1,840	3,650	Aug. 4	590	1,170
21	751	1,490	29	1,280	2,540	5	510	1,010
22	30,100	59,700	30	1,340	2,660	6	460	912
23	63,100	125,200	31	1,160	2,300	7	440	873
24	30,700	60,890	Aug. 1	1,160	2,300	8	420	833
25	16,600	32,930	2	820	1,630	9	380	754
26	3,720	7,380	3	705	1,400	10	363	720
27	3,300	6,550						

Runoff, in acre-feet, for period July 20 to Aug. 10 317,000

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
July 21			*July 22—Con.*			*July 23—Con.*		
1:00 a. m.	1.1	80						
8:00	1.1	80	2:00 p. m.	15.2	60,500	5:00 p. m.	12.5	36,500
9:00	1.2	94	5:00	14.2	51,000	6:00	11.6	29,700
10:00	2.7	460	8:00	13.4	44,000	7:00	10.7	23,800
11:00	4.4	2,230	12:00	12.6	37,300	8:00	10.2	21,100
11:40	4.6	2,580				10:00	9.6	18,000
12:00 m.	4.5	2,400	*July 23*			12:00	9.2	16,000
1:00 p. m.	4.3	2,070						
3:00	3.9	1,470	3:00 a. m.	12.3	34,900	*July 24*		
6:00	3.5	990	3:30	13.7	46,500			
9:00	3.2	740	4:00	15.0	58,500	2:00 a. m.	9.0	15,000
12:00	2.8	510	4:30	16.2	70,600	4:40	8.8	14,200
			5:00	17.5	84,600	5:00	9.6	18,000
July 22			5:30	18.9	101,000	5:30	11.0	25,500
			6:00	20.1	116,000	6:00	12.4	35,700
3:00 a. m.	2.6	420	6:30	21.1	129,000	6:30	12.4	35,700
7:30	2.4	346	7:00	21.3	131,000	7:00	12.3	34,900
8:00	3.9	1,470	8:00	21.43	133,000	8:00	12.0	32,500
8:30	5.6	4,590	9:00	21.3	131,000	10:00	11.3	27,600
9:00	7.2	8,800	9:30	21.1	129,000	11:00	11.0	25,500
9:30	9.0	15,000	10:00	20.5	121,000	12:00 m.	10.8	24,400
10:00	10.9	25,000	10:30	19.9	113,000	2:00 p. m.	10.4	22,800
10:30	12.6	37,300	11:00	19.2	105,000	4:40	10.0	20,000
11:00	14.5	53,800	12:00 m.	18.0	90,200	5:00	10.6	23,300
11:30	15.9	67,500	1:00 p. m.	16.8	76,900	5:30	11.7	30,400
12:00 m.	16.0	68,500	2:00	15.6	64,500	6:00	12.7	38,100
12:30 p. m.	15.9	67,500	3:00	14.5	53,800	6:30	13.9	48,200
1:00	15.7	65,500	4:00	13.5	44,800	7:00	14.9	57,600

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938—Continued

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
July 24—Con.			*July 25*—Con.			*July 28*		
						12 m	4.15	1,760
7:30 p. m.	15.2	60,500	9 p. m.	6.2	6,050	12 p. m.	3.90	1,400
8:00	15.3	61,500	12	5.9	5,310	*July 29*		
8:30	15.2	60,500						
9:00	14.9	57,600	*July 26*			12 m	3.80	1,280
9:30	14.6	54,700				12 p. m.	3.70	1,160
10:00	14.4	52,900	6 a. m.	5.3	3,930	*July 30*		
11:00	13.9	48,200	12 m.	5.0	3,300			
12:00	13.4	43,900	6 p. m.	4.8	2,940	12 m	3.90	1,340
			12	4.9	3,120	6 p. m.	4.00	1,470
July 25						12	4.05	1,540
			July 27					
3 a. m.	12.0	32,500				*July 31*		
6	10.6	23,300	6 a. m.	5.2	3,720			
9	9.4	17,000	12 m.	5.2	3,720	7:30 a. m.	3.96	1,340
12 m.	8.4	12,600	3 p. m.	5.0	3,300	6:20 p. m.	3.66	990
3 p. m.	7.6	10,000	8	4.5	2,400	12:00	3.55	900
6	6.7	7,360	12	4.4	2,230			

PEDERNALES RIVER NEAR SPICEWOOD, TEX.

LOCATION.—Lat. 30°25′15″, long. 98°04′50″, in Travis County, 5.4 miles upstream from mouth and 8 miles southeast of Spicewood, Burnet County. Zero of gage is 624.88 feet above mean sea level (general adjustment of 1929).

DRAINAGE AREA.—1,294 square miles.

GAGE-HEIGHT RECORD.—Graph drawn from two staff-gage readings daily; flood peak determined by levels to high-water marks. Gage heights used to half-tenths between 1.8 and 3.0 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements below 7,070 second-feet; extended above on basis of one slope-area measurement and velocity-area studies.

MAXIMA.—July 1938: Discharge, 6,650 second-feet 8 a. m. July 25 (gage height, 9.3 feet, from floodmarks).

1923–June 1938: Discharge, 155,000 second-feet May 28, 1929 (gage height, 40.4 feet, from floodmarks).

1869–1922: Stage, about the same as in 1929, reached in 1869.

REMARKS.—No regulations or diversions.

Mean discharge, in second-feet, and runoff, in acre-feet, 1938

Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet
July 22	29	58	July 31	70	139	Aug. 8	23	46
23	731	1,450	Aug. 1	56	111	9	22	44
24	1,900	3,770	2	49	97	10	21	42
25	4,810	9,540	3	39	77	11	20	40
26	251	498	4	34	67	12	19	38
27	122	242	5	32	63	13	19	38
28	70	139	6	29	58	14	19	38
29	51	101	7	25	50	15	19	38
30	66	131						

Runoff, in acre-feet, for period July 22 to Aug. 15 16,920

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
July 22			*July 24—Con.*			*July 26—Con.*		
1 a. m.	0.90	27						
12 m.	.90	27	7 p. m.	7.10	3,820	8 p. m.	1.50	134
12 p. m.	.92	29	8	7.45	4,240	12	1.50	134
			9	7.65	4,480			
July 23			11	7.40	4,180	*July 27*		
			12	7.12	3,820			
7 a. m.	1.00	38				3 a. m.	1.50	134
10	1.20	70	*July 25*			9	1.60	160
1 p. m.	1.60	160				1 p. m.	1.50	134
3	2.00	280	1 a. m.	6.90	3,590	7	1.30	89
5	2.70	515	2	6.90	3,590	12	1.22	74
6	3.40	810	3	7.10	3,820			
8	5.60	2,300	5	8.50	5,570	*July 28*		
9	6.20	2,860	6	9.00	6,230			
11	6.70	3,370	8	9.31	6,650	2 a. m.	1.20	70
12	6.63	3,260	10	9.20	6,510	8 p. m.	1.20	70
			12 m.	9.00	6,230	2	1.18	66
July 24			3 p. m.	8.50	5,570	*July 29*		
			5	8.00	4,920			
1 a. m.	6.40	3,060	7	7.50	4,300	4 a. m.	1.10	52
2	6.00	2,660	11	4.90	1,740	12 m.	1.10	52
3	5.30	2,050	12	4.00	1,130	12 p. m.	1.08	49
4	4.30	1,320				*July 30*		
5	3.60	910	*July 26*					
7	3.00	635				12 m.	1.12	56
9	2.60	480	1 a. m.	3.20	720	12 p. m.	1.30	89
11	2.45	428	3	2.40	411			
1 p. m.	2.60	480	6	2.00	280	*July 31*		
3	3.30	765	12 m.	1.70	188	8 a. m.	1.18	66
6	6.00	2,660	3 p. m.	1.60	160	12 m.	1.14	59
						12 p. m.	1.16	63

SILT

Measurements of the silt content have been made at several places on the Colorado River for a number of years by the Bureau of Agricultural Engineering, United States Department of Agriculture, in cooperation with the State Board of Water Engineers. A report on the silt load of the Colorado River during the flood of July–August 1938 was prepared by Harry G. Nichols, assistant engineer, Bureau of Agricultural Engineering, and is included in the report on the Colorado River flood, July–August 1938, made to the State Senate Investigating Committee by the Board of Water Engineers. The following records were taken from that report or were furnished by the Austin office of the Bureau of Agricultural Engineering.

Silt-measurement stations are maintained on the Colorado River at the regular river-measurement stations near San Saba, at Austin, and near Eagle Lake. Table 10 shows the silt load carried by the Colorado River for various periods of maximum silt movement during the flood of July–August 1938, as measured at the above-named places. The percentage of silt, by weight, and the silt load, in tons per second, have been computed for the flood period in sufficient detail to define the continuous values of these factors. These data, which are given in table 11, are shown graphically in figure 20, together with the hydrographs of discharge.

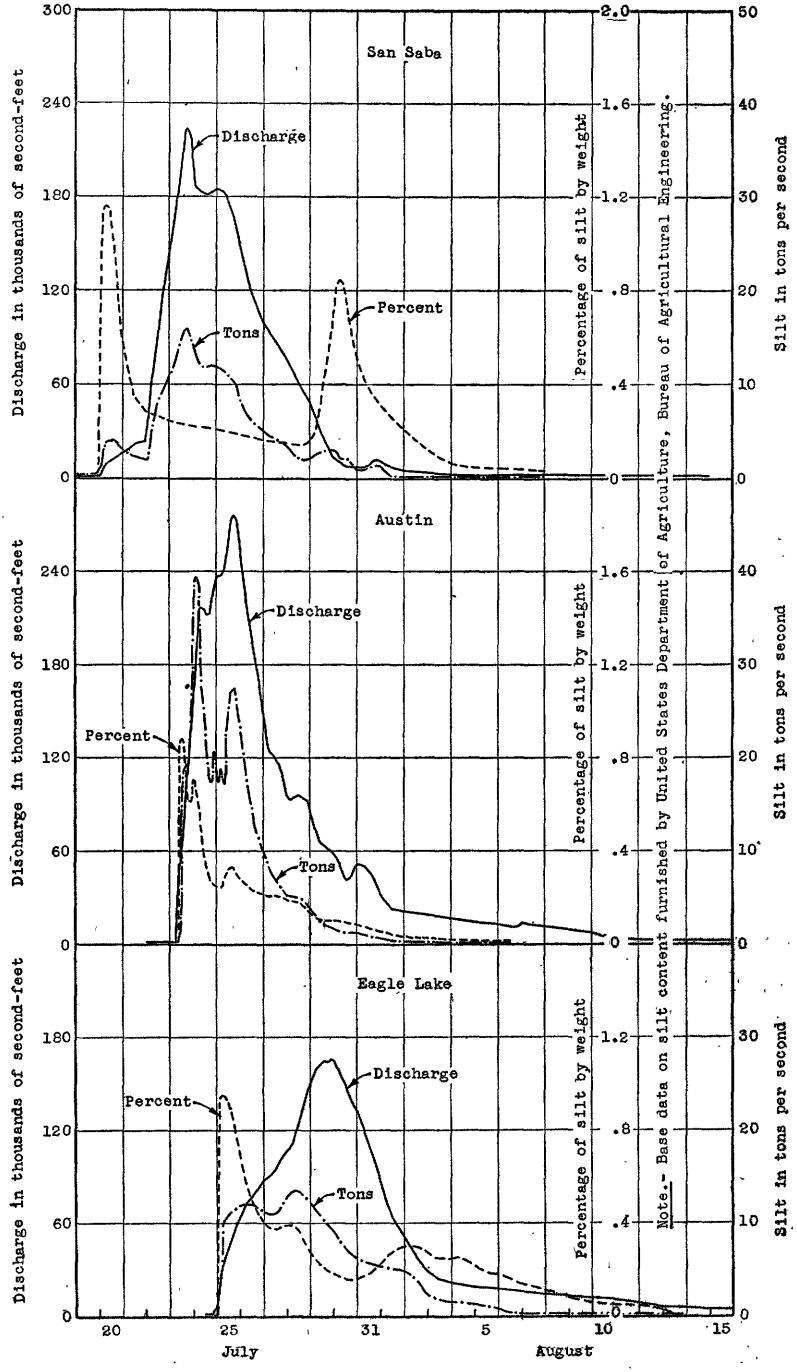

FIGURE 20.—Discharge, and silt content in percent and tons per second, at stations on the Colorado River July–August 1938.

TABLE 10.—*Silt load of Colorado River during indicated periods of maximum silt movement, July–August 1938*

Silt	Silt-measurement station		
	San Saba (July 20 to Aug. 5)	Austin (July 23 to Aug. 5)	Eagle Lake (July 25 to Aug. 12)
Maximum concentration.....percent by weight	1.163	0.880	0.953
Maximum load.....tons per second	16.2	39.6	13.8
Maximum average:			
24 hours.....tons per day	1,256,000	2,383,000	1,130,000
3 consecutive days.....do	1,081,000	1,846,700	1,053,300
5 consecutive days.....do	886,200	1,418,400	979,800
10 consecutive days.....do	575,400	799,000	695,100
14 consecutive days.....do	436,100	573,600	521,000
Total for period.....tons	6,121,800	8,030,600	7,393,700

NOTE.—Base data furnished by U. S. Department of Agriculture, Bureau of Agricultural Engineering.

TABLE 11.—*Silt content of Colorado River at stations near San Saba, at Austin, and near Eagle Lake, July–August 1938*

Time		Percent by weight	Tons per second
Day	Hour		
Near San Saba			
July 19	7 a. m.	0.009	0.0005
	12 p. m.	.033	.005
20	2 a. m.	.300	.24
	4	.940	1.76
	6:15	1.163	3.09
	2 p. m.	1.010	3.88
	12	.613	3.16
21	7 a. m.	.429	2.78
	4 p. m.	.330	2.25
	12	.288	2.18
22	8:15 a. m.	.264	6.29
	12 p. m.	.247	10.88
23	10 a. m.	.238	13.54
	6 p. m.	.231	16.17
24	3 a. m.	.225	13.22
	2 p. m.	.215	12.16
	12	.208	12.06
25	2	.195	10.76
	12	.188	8.81
26	8	.171	5.63
27	12	.149	3.59
28	8 a. m.	.141	2.93
	12 p. m.	.153	2.33
29	8:15 a. m.	.224	2.44
	4 p. m.	.430	2.75
	12	.660	2.74
30	8:45 a. m.	.850	2.12
	2 p. m.	.750	2.06
	12	.523	1.13
31	8 a. m.	.432	1.05
	10 p. m.	.338	1.25
Aug. 1	7:30 a. m.	.284	.71
2	7:30	.182	.27
3	8	.108	.10
4	6	.069	.056
5	7	.048	.033
	12 p. m.	.044	.029

Time		Percent by weight	Tons per second
Day	Hour		
At Austin			
July 22	10:48 a. m.	0.004	0.002
23	8	.017	.012
	9	.060	.30
	10:28	.137	1.37
	12 m.	.880	13.48
	2 p. m.	.806	16.37
	4	.770	18.89
	6	.660	19.08
	8	.586	19.78
	10	.623	25.11
	12	.660	31.35
24	2 a. m.	.715	38.54
	4	.660	39.60
	6	.550	35.92
	8	.440	29.81
	10	.421	28.52
	12 m.	.366	24.57
	2 p. m.	.312	20.82
	4	.275	18.36
	6	.256	17.36
	8	.256	17.78
	10	.293	20.83
	12	.256	18.56
25	2 a. m.	.238	17.44
	4	.256	18.94
	6	.220	16.35
	8	.249	18.74
	9:32	.278	21.20
	2:35 p. m.	.328	27.01
	6	.319	27.51
	12	.292	23.45
26	9:18 a. m.	.246	16.34
	4:25 p. m.	.222	12.56
	12	.214	10.03
27	9:02 a. m.	.208	7.86
	12 p. m.	.191	5.19
28	1:45	.170	5.07

TABLE 11.—*Silt content of Colorado River at stations near San Saba, at Austin, and near Eagle Lake, July–August 1938*—Continued

Time		Percent by weight	Tons per second	Time		Percent by weight	Tons per second
Day	Hour			Day	Hour		
At Austin—Con.				*Near Eagle Lake*—Con.			
July 29	11:10 a.m.	0.106	2.19				
30	10:40	.096	1.30	July 28	6:50 a. m.	0.390	13.77
	12 p. m.	.082	1.33	29	6:15	.234	11.59
31	2	.067	.97	30	6:30	.163	7.95
Aug. 1	11:08 a. m.	.046	.34	31	6:15	.164	6.19
2	10:28	.030	.19	Aug. 1	6:15	.264	5.91
3	4 p. m.	.021	.11	2	6:15	.300	4.12
4	2:35	.018	.083	3	6:15	.253	1.96
6	11:15 a. m.	.010	.032	4	6:15	.253	1.64
				5	6:35	.201	1.16
Near Eagle Lake				6	6:35	.173	.88
				7	6:35	.132	.60
July 24	6:50 a. m.	.001	.0005	8	6:30	.104	.42
	12 p. m.	.075	.10	9	6:30	.075	.29
25	2 a. m.	.550	2.84	10	6:20	.062	.22
	4	.930	7.56	11	6:35	.054	.17
	6:10	.953	9.98	12	6:45	.048	.13
26	6:40	.559	12.46	13	6:25	.025	.044
27	6:15	.386	11.01				

NOTE.—Base data furnished by U. S. Department of Agriculture, Bureau of Agricultural Engineering.

The volume a certain weight of silt will occupy depends on the degree of consolidation of the material. It is generally assumed that for average conditions of deposition in reservoirs in Texas 70 pounds of dry material will occupy a volume of 1 cubic foot of silt in place.[8] If the deposited silt is never dewatered and no opportunity is thus allowed for the silt to dry and consolidate, the average will not be attained. On the other hand, if the reservoir is dewatered frequently so that conditions are very favorable for maximum consolidation (drying, cracking, and subsequent refilling of these cracks with more silt when again submerged), then a higher figure than 70 pounds will be attained.

Assuming that 70 pounds of dry material will occupy a volume of 1 cubic foot, during the flood of July–August 1938 the total volume of silt measured at stations on the Colorado River was 4,015 acre-feet near San Saba, 5,267 acre-feet at Austin, and 4,850 acre-feet near Eagle Lake.

RAINFALL AND RUNOFF

Analyses of the rainfall and runoff records have been made for the purpose of showing the relation between storm rainfall and the resulting direct runoff. The differences between rainfall and runoff give an indication of the volume of water retained in the drainage basins; this retention is a valuable factor in flood-control and other problems.

For the purpose of making a study of the rainfall-runoff relations, the storm has been separated into four periods—July 16–19, 20–21, 22–23, and 24–25. Although the rain did not fall uniformly over the

[8] Faris, O. A., The silt load of Texas streams: U. S. Dept. Agr. Tech. Bull. 382, pp. 49, 55, September 1933.

entire area, either with respect to amount or time, in general the divisions were defined by separate peaks of both rainfall and runoff. A small portion of the total rain fell before July 19, but practically no increase in stream flow was noted until July 20.

The rainfall for each drainage area was determined by planimeter from the isohyetal maps (figs. 6–10, 12, 13), and its accuracy depends on that of the isohyetals. As the South Concho, San Saba, and Llano River Basins were well covered by rainfall measurements, the figures derived for these basins can be used with greater confidence than those for the other areas.

The figures of rainfall and runoff are given in inches of depth over the entire drainage basin, although for some basins most of the rain fell over only a small part of the area. Ordinarily the depth of runoff in inches for streams in Texas is not regarded as significant and so is not computed, but for this study the depth is computed as it furnishes a practical basis of comparison with rainfall. The small depth of runoff measured for some areas in which heavy rains fell is due to the fact that only a small part of the basin received the heavy rain, whereas the remainder of the basin received a light rain. The number of square miles of each basin that received different depths of rain, computed mostly for 5-inch intervals, is shown in table 12.

The determinations of direct runoff during the storm periods have been based on the records of daily mean discharge at stream-measurement stations. A discharge hydrograph covering the flood period was constructed for each station. The base flow, attributed to ground water, was subtracted from the total flow, shown by the station records, to estimate the direct runoff caused by flow over the ground surface or through the ground with a responsiveness approaching that of surface runoff. The base flow was estimated by a consideration of the flow before and after the storm period.

As the separation of the hydrograph into peaks corresponding to the different storm periods is subject to considerable error when two or more flood peaks combine, records at stations on the Colorado River were difficult to determine for this reason.

The method of analysis used for computing the direct runoff for storm periods has been described in previous reports of the Geological Survey.[9] A comprehensive study of the relations of rainfall, runoff, and related factors has been made by Hoyt.[10]

[9] See Grover, N. C., and others, The floods of March 1936, Part 1, New England rivers: U. S. Geol. Survey Water-Supply Paper 798, pp. 341–345, 1937; and Grover, N. C., and others, Floods of Ohio and Mississippi Rivers, January–February 1937: U. S. Geol. Survey Water-Supply Paper 838, pp. 486–494, 1938.

[10] Hoyt, W. G., and others, Studies of relations of rainfall and runoff in the United States: U. S. Geol. Survey Water-Supply Paper 772, 1936.

TABLE 12.—*Rainfall and runoff of flood of July 1938 in Colorado River Basin*

Item No.	Stream and point of measurement	Drainage area [1] (square miles)	Rainfall, in inches, for indicated storm period					Direct runoff, in inches, associated with indicated storm period					Rainfall minus runoff, July 16–25 (inches)	Mean annual runoff (inches)	Drainage area, in square miles, receiving rainfall between limits shown, during period July 16–25					
			July 16–19	July 20–21	July 22–23	July 24–25	Total, July 16–25	July 16–19	July 20–21	July 22–23	July 24–25	Total, July 16–25			2–5 inches	5–10 inches	10–15 inches	15–20 inches	20–25 inches	25 inches or more
14	Colorado River near San Saba	13,460	1.3	3.1	4.8	2.1	11.3	------	0.15	1.25	1.15	2.55	8.75	1.5	2,912	4,009	1,736	2,537	2,209	57
16	Colorado River at Buchanan Dam	14,110	1.3	3.0	4.8	2.3	11.4	------	.1	1.15	.9	2.15	9.25	------	2,912	4,155	1,966	2,794	2,226	57
18	Colorado River at Austin	21,010	------	2.9	4.4	2.1	9.4	------	------	1.0	.85	[2] 1.85	7.55	1.45	6,295	5,838	3,182	3,104	2,534	57
25	South Concho River at Christoval	434	.8	8.4	9.4	1.1	19.7	------	1.05	2.65	.05	3.75	15.95	2.3	------	------	46	135	196	57
26	South Concho River at San Angelo	2,535	.4	4.4	4.3	.7	9.8	------	.2	.65	.01	.86	8.94	1.1	347	1,316	321	298	196	57
27	Concho River near San Angelo	4,217	.4	2.8	3.5	.8	7.5	------	.1	.4	.05	.55	6.95	.65	1,276	2,069	321	298	196	57
28	Concho River near Paint Rock	5,263	1.0	2.7	3.5	.8	8.0	------	.1	.6	.05	.75	7.25	.7	1,788	2,217	468	390	343	57
29	Middle Concho River near Tankersly	1,128	------	2.3	2.8	.7	5.8	------	.01	.01	.01	.03	5.77	.65	146	982	------	------	------	------
30	Spring Creek near Tankersly	734	------	6.1	4.5	.4	11.0	------	.1	.2	.05	.35	10.65	2.3	61	283	250	140	------	------
32	North Concho River near Carlsbad	1,406	.4	.6	2.0	1.2	4.2	------	.01	.01	.05	.07	4.13	.65	653	753	------	------	------	------
48	San Saba River at Menard	1,151	1.4	6.6	9.7	1.6	19.3	------	.85	3.55	.65	5.05	14.25	.95	------	------	278	292	581	------
49	San Saba River near Richland Springs	2,757	1.6	6.4	9.2	1.5	18.7	------	------	------	------	------	------	------	------	------	597	880	1,280	------
50	San Saba River at San Saba	3,046	1.4	6.3	9.4	1.7	18.8	------	.4	2.55	1.4	4.35	14.45	1.35	------	------	597	1,018	1,431	------
59	Brady Creek near Brady	595	2.7	6.4	9.0	2.2	20.3	------	------	------	------	------	------	------	------	------	15	145	435	------
60	Richland Creek near Richland Springs	72.4	2.3	4.8	10.4	3.6	21.1	------	------	------	------	------	------	------	------	------	------	72	------	------
61	Cherokee Creek near Chappel	149	.8	3.4	5.1	5.7	15.0	------	------	------	------	------	------	------	------	------	64	85	------	------
63	North Llano River near Junction	914	------	4.4	8.8	1.7	14.9	------	.4	2.2	.85	3.45	11.45	1.25	------	95	405	202	212	------
64	Llano River near Junction	1,762	------	3.9	7.2	1.5	12.6	------	.1	1.8	.55	2.45	10.15	1.9	78	536	530	310	308	------
65	Llano River near Castell	3,514	------	3.3	5.1	1.3	9.7	------	.02	1.15	.3	1.47	8.23	1.7	547	1,421	928	310	308	------

[1] Does not include areas above the Cap Rock and above Ballinger on the Colorado River.
[2] Adjusted for storage in Buchanan Reservoir.

DISCUSSION OF RESULTS

The results of the studies of rainfall and runoff are summarized in table 12. This table includes data for the gaging stations in the Colorado River Basin for which detailed discharge records are included in a previous section of this report. The drainage area given does not include the areas above the Cap Rock and above Ballinger on the Colorado River, as they contributed very little runoff to the flood, and records of rainfall thereon are not plentiful. The average rainfall on the basins for the separate storm periods and the total period is that obtained from the isohyetal maps (fig. 6–10, 12, and 13). The difference between total rainfall and the associated direct runoff for the storm period is given in the column "Rainfall minus runoff." The mean annual runoff is based on gaging-station records that are continuous for periods of from 7 to 40 years, as shown in the descriptions for individual stations presented in a previous section of this report.

The difference between rainfall and direct runoff represents the basin retention and includes net infiltration, evaporation, and transpiration. The evaporation from free-water surfaces for July may average 10 inches or more in this part of the State but as the temperatures during the storm period were lower and the relative humidity was higher than average, the average evaporation over the area was probably much less than that indicated by free water-surface measurements. The transpiration loss is not known, but as the flood area is not heavily covered with vegetation it is believed the transpiration was small during the short period of time considered. Probably a small percentage of the total retention represents evaporation and transpiration that took place during the storm period.

COLORADO RIVER BASIN

The storm of July 16–25 was confined almost entirely to three of the upper tributaries of the Colorado River—the Concho, San Saba, and Llano Rivers. Relatively little rain fell in the basin above Ballinger and practically none in the basin below Austin. At no place in the drainage area of the South Concho River above Christoval or the San Saba River above San Saba was there a rainfall of less than 10 inches, and more than 10 inches fell in 90 percent of the drainage area of the North Llano River. Fifteen inches or more of rain fell in about 90 percent of the drainage area of the South Concho River above Christoval, and 20 inches or more fell in 58 percent of the area. The heaviest rain probably fell in Brady Creek, where 75 percent of the basin received 20 or more inches of rain.

The mean annual precipitation in the Concho River Basin is about 20 inches and in the San Saba and Llano River Basins is about 25 inches. The mean in the area of the Colorado River covered by this

report is probably about 23 inches, and it varies from 18.60 inches [11] at Garden City, in Glasscock County, in the upper part of the North Concho River Basin, to 34.08 inches [11] at Austin. The mean annual runoff of 1.45 inches at Austin is 6.5 percent of the precipitation.

The direct runoff resulting from the rains of July 16–25, as measured at 15 stream-gaging stations in the basin, did not exceed 30 percent of the rain or 5.05 inches of depth over any basin.

Peak discharges were determined for San Saba River near Richland Springs, Brady Creek near Brady, Richland Creek near Richland Springs, and Cherokee Creek near Chappel, but as they were not at regular gaging stations data from which the runoff could be computed were not obtained. An indication of the runoff from these areas may be had by comparing it with the runoff from adjacent basins. The total rainfall in each of these four basins is shown in table 12.

A basin retention of 7.55 inches at Austin is equivalent to 8,460,000 acre-feet of water and is exclusive of that stored in Buchanan Reservoir.

CONCHO RIVER BASIN

The main Concho River begins at the town of San Angelo and is formed by the confluence of the North and South Concho Rivers, which drain areas north and south of the town. Middle Concho River, which drains areas west of the town, is tributary to South Concho River a few miles above San Angelo. The North and Middle Concho River Basins received rainfall in the areas above the gaging stations averaging 4.2 and 5.8 inches, respectively, which produced less than 0.1 inch of direct runoff.

Heavy rains fell in the upper part of the South Concho River Basin and part of Spring Creek, which is tributary to the Middle Concho River. The average in the basin above Christoval (434 square miles) was 19.7 inches, and no part of the basin received less than 10 inches. The direct runoff produced by this rain was 3.75 inches, which is about 19 percent of the rainfall and is 1.6 times the mean annual runoff of 2.3 inches.

The gaging station on the Concho River near San Angelo is immediately below the confluence of the North Concho and South Concho Rivers and gives the combined runoff from an area that received heavy rainfall and one that received relatively light rainfall. The average precipitation of 7.5 inches over the 4,217 square miles produced a direct runoff of only 0.55 inch, or about 7 percent; but the mean annual runoff at this station, based on a 23-year record, is 0.65 inch. The runoff at this station, as well as at Paint Rock, was but slightly affected by storage in Lake Nasworthy, records for which are included in this report.

The river measurement station farthest downstream on the Concho River is near Paint Rock. The area above this station received an

[11] U. S. Weather Bur., Climatological data, Texas section, 1939–40.

average rain of 8.0 inches, which produced a direct runoff of 0.75 inch, or 9 percent of the precipitation and about the same as the mean annual runoff.

The basin retention of 7.25 inches for the 5,263 square miles above Paint Rock is equivalent to about 2,035,000 acre-feet.

SAN SABA RIVER BASIN

As shown in table 12, the San Saba River Basin received an average rain of about 19 inches during the 10-day period July 16–25. The section of this report on "Meteorologic conditions" gives four measurements of rainfall, which are well distributed over the area and which partly indicate the intensities. The most intense rains were the 5.50 inches reported as falling at Menard from 7 to 8 a. m. on July 21 and the 6.89 inches reported as falling at Eden in the 3½ hours after midnight on July 22.

The direct runoff for the period July 16–25 at Menard was 5.05 inches and at San Saba 4.35 inches, and the basin retention was 14.25 and 14.45 inches, respectively, or about 75 percent of the rainfall. A considerable area along the lower reaches of the river was overflowed, a condition which likely increased the percentage of evaporation over that of the other basins. However, the direct runoff of the San Saba River at Menard was 26 percent and at San Saba was 23 percent of the total rainfall, which are the highest percentages of runoff of all the basins in the flood area.

River-measurement stations have been maintained on the San Saba River at Menard and at San Saba for 23 years, and the records from these stations show the mean annual runoff to be 0.95 and 1.35 inches, respectively. The corresponding direct runoff during the flood of July was 5.3 and 3.2 times the mean annual runoff.

Brady Creek, a tributary of the San Saba River, drains an area of 785 square miles. During the period July 16–25 the rain in this area varied from about 14 to 24 inches, with 20 inches or more falling in 70 percent of the area. The average precipitation in the entire basin was 19.9 inches. No stream-measurement station, from which the runoff could be accurately determined, is maintained on Brady Creek. By comparison with the San Saba River at Menard and at San Saba, it may be assumed that the retention was 14.35 inches, or that the direct runoff from Brady Creek was 5.5 inches. The runoff in acre-feet, less a small flow sustained by ground-water, would be 224,400.

The retention of 14.45 inches for the 3,046 square miles above the gaging station at San Saba indicates 2,348,000 acre-feet of water was held in the basin.

LLANO RIVER BASIN

At the gaging station on the North Llano River near Junction a direct runoff of 3.45 inches was produced from the drainage area of

914 square miles by an average rainfall of 14.9 inches. The runoff of 3.45 inches is 23 percent of the total rainfall and is 2.8 times the mean annual runoff as determined from a 23-year record.

The drainage area of 1,762 square miles upstream from the gaging station on the Llano River near Junction received an average of 12.6 inches of rain during the period July 16–25. This area includes about 800 square miles of the South Llano River Basin, which received an average rainfall of about 10 inches. The resulting direct runoff of 2.45 inches is about 19 percent of the total rainfall and is 1.3 times the mean annual runoff of 1.9 inches, as determined from a record of 23 years.

An average rainfall of 9.7 inches fell on the drainage area of 3,514 square miles upstream from the gaging station on the Llano River near Castell. This station is the farthest downstream and is about 35 miles upstream from the mouth of the river. The direct runoff of 1.47 inches is 15 percent of the rainfall and is 87 percent of the mean annual runoff as determined from a 14-year record.

The retention of 8.23 inches, as determined from the records at the Castell gaging station, represents 1,542,000 acre-feet of water.

FLOOD OF JUNE 1939 IN UPPER COLORADO RIVER BASIN

On June 19–20, 1939, a rain of from 4 to 19 inches that lasted from 4 to 10 hours fell in an area of about 1,000 square miles near Snyder, in Scurry County, and in adjoining counties. The resulting flood of the Colorado River and its tributaries caused the loss of one life and property damage of about $350,000, including a wrecked highway bridge.[12]

There were no Weather Bureau rain gages in the area of heaviest rainfall. This area was visited soon after the flood and all information available from local residents was obtained. This information is given in table 13. Figure 21 is a map of the upper Colorado River Basin showing isohyetals for total rainfall June 19–20 and locations of the rainfall stations listed in table 13 except numbers 1, 6, and 10.

[12] U. S. Weather Bur., Climatological data, Texas section, June 1939.

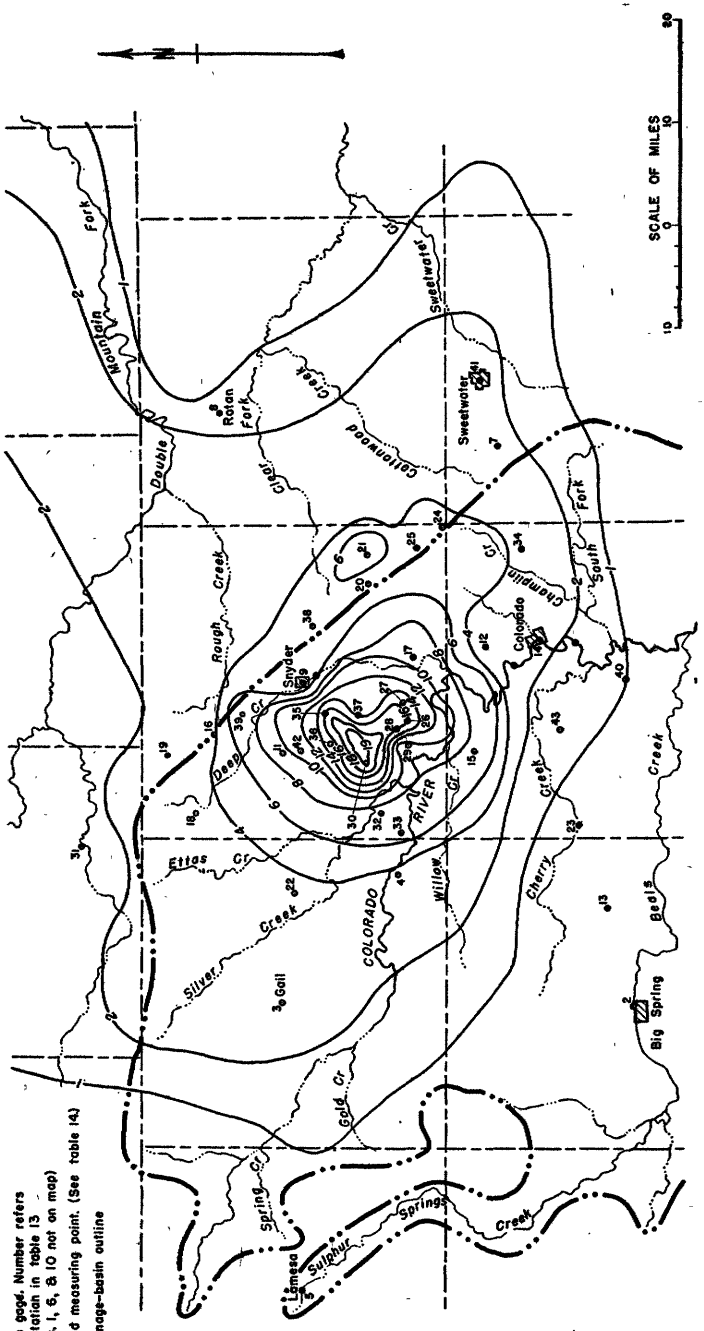

FIGURE 21.—Map of upper Colorado River Basin, showing rainfall stations, isohyetal lines of total rainfall June 19–20, 1939, and flood measuring points.

TABLE 13.—*Rainfall in upper Colorado River Basin, June 19–20, 1939*

[T=less than 0.01 inch]

Station No.	Location	Rainfall (inches)	Observer	Type of gage and remarks
1	Aspermont	2.31	U. S. Weather Bureau	Standard nonrecording.
2	Big Spring	.01	do	Do.
3	Gail	2.40	do	Do.
4	Knapp, near	3.43	do	Do.
5	Lamesa	.06	do	Do.
6	Post	1.89	do	Do.
7	Roscoe	2.31	do	Do.
8	Rotan	1.07	do	Do.
9	Snyder	5.05	do	Do.
10	Tahoka	T	do	Do.
11	Bethel School, 2 miles north and 7 miles west of Snyder.	10	Hollie Schulter	Type of gage not known. Rained 5–6 p. m. and 8:30–11 p. m., June 19.
12	Buford	2.50		Estimated. Light rain 6 p. m., June 19; heavy rain 10 p. m., June 19, to 2 a. m., June 20.
13	Coahoma	0		No rain.
14	Colorado	2.74	Lower Colorado River Authority.	Standard nonrecording.
15	Cuthbert, 1 mile southeast	7.50		Type of gage not known.
16	Dermott	4		No measurement, but general opinion set rain at 4 inches.
17	Dunn	8–10		No gage. Estimated by several people.
18	Fluvanna	3.50	W. P. Simms	Straight-sided jar. Rained 8–10 p. m., June 19.
19	Fullers ranch, 1 mile east Fullersville	2.75		Type of gage not known. Rained 5:30 p. m., June 19, to 1:15 p. m., June 20.
20	Hermleigh	5		Type of gage not known. Rained 5:30–12 p. m., June 19.
21	Hermleigh, 3 miles east	7	A. L. Brown	7-inch gage ran over.
22	Highway 15, 3 miles south and 5 miles west of Borden-Scurry County line.	3.75	Joe Evans	Measured in coffee can.
23	Iatan	.75	Mr. McKenny	Type of gage not known. Rained 11 p. m., June 19, to 1 a. m., June 20.
24	Inadale	3½–4½		Several cans in vicinity measured 3½–4½ inches; 1 inch fell 7–7:30 p. m., June 19, and the rest fell from 11 p. m., June 19, to 1:30 a. m., June 20.
25	Inadale, 4 miles northwest	4.50		No information.
26	Ira	16	L. L. Eubanks	8-inch bucket. Rained 8 inches 5–7 p. m. and 8 inches 8–11 p. m., June 19.
27	Ira, 2¼ miles east	15–16	Bob Blacker	12-inch can ran over; estimated 3–4 inches after can filled.
28	Ira, 2½ miles north	15–20	T. J. Frambro	Estimated. Washpot ran over.
29	Ira, 2½ miles west	9.50	J. W. Meiner	Straight-sided bucket. Rained 4 p. m., June 19, to 1 a. m., June 20.
30	Ira, 3½ miles west and 4 miles north	19.25	Lewis Smith	Straight-sided can. Rained 9⅝ inches 4–7 p. m. and 9⅝ inches 7:30–10:30 p. m., June 19.
31	Justiceburg	1.50		Straight-sided can. Rained 5–11 p. m., June 19.
32	Knapp	7–8		Wind too strong for accurate measurement. Rained 4:30–6 p. m. and 8–11:30 p. m., June 19.
33	Knapp, 2 miles south and 2 miles west	6.50	Jim Sorrells	Rained in bucket. Catch weighed to determine amount.
34	Loraine	3.91	C. W. Palmer	Type of gage not known. Rained 11 p. m., June 19, to 12:45 a. m., June 20.
35	Snyder, 3 miles south and 3 miles west	16	J. F. Cox	Type of gage not known. Started raining about 3 p. m., June 19.
36	Snyder, 3 miles south and 7 miles west	15	John Lain	Concrete tank. Rained 4–12 p. m., June 19.

37	Snyder, 4 miles west and 5½ miles south	14	E. E. Carlile	Measured in tank with straight sides. Rain started 3:30 p. m., June 19, and lasted 7–8 hours
38	Snyder, 5½ miles east and 1 mile south of Plainview School.	4.80	Edgar Vonroder	Measured in washpot and weighed to determine amount. Rained 4:30–11:30 p. m., June 19.
39	Snyder, 7 miles northwest	7	Tom C. Davis	Measured in buckets. Rained 1 inch 5–6 p. m. and 6 inches 9–11:30 p. m., June 19.
40	Spade	1		Estimated.
41	Sweetwater	2.61	Mr. Monroe	Standard nonrecording.
42	Union Church, 7 miles west of Snyder	10		Estimated by several people. Rained 4:30–6 p. m. and 8–11:30 p. m., June 19.
43	Westbrook	1.50	Mr. Oglesby	Type of gage not known. Rained 11 p. m., June 19, to 1 a. m., June 20.

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Peak discharges were computed by slope-area methods at reaches on the Colorado River 2.5 miles above and 4.9 miles below the town of Colorado and on Deep Creek 0.5 mile below Snyder. The first river-measurement station downstream at which a record of total discharge was obtained is at Robert Lee, on the Colorado River. The runoff at this station is indicated by the records that follow. As Robert Lee is about 70 miles downstream from the town of Colorado, considerable water was probably lost between the two places. Peak discharges as measured at miscellaneous places and for all river-measurement stations above Lake Buchanan are given in table 14.

The flood resulting from this rainfall was the largest known on the Colorado River at Colorado, according to Mr. C. C. Thompson of Colorado. Long-time residents state that a flood in 1908 or 1909 reached nearly the same stage as in 1939. Local residents state that the peak on Deep Creek, near Snyder, was 7 or 8 feet lower than in 1892.

DISCHARGE RECORDS

COLORADO RIVER AT ROBERT LEE, TEX.

LOCATION.—Lat. 31°54′, long. 100°29′, at highway bridge at Robert Lee. Zero of gage is 1,771.7 feet above mean sea level.

DRAINAGE AREA.—15,770 square miles, of which about 11,500 is probably noncontributing.

GAGE-HEIGHT RECORD.—Graph drawn from numerous gage readings daily.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements below 11,200 second-feet; extended to peak discharge on basis of surface-velocity readings at peak stage.

MAXIMA.—1939: Discharge, 31,700 second-feet 2:30 a. m. June 22 (gage height, 21.7 feet).

REMARKS.—Records furnished by the Bureau of Reclamation.

Mean discharge, in second-feet, and runoff, in acre-feet, June 1939

Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet	Day	Second-feet	Acre-feet
			20	5,200	10,310	24	965	1,910
17	1	2	21	22,600	44,830	25	402	797
18	1,080	2,140	22	19,200	38,080	26	307	609
19	909	1,800	23	2,390	4,740	27	235	466

Runoff, in acre-feet, for period June 17 to 27 105,700

TABLE 14.—*Peak discharges in upper Colorado River Basin, June 1939*

Stream and place of determination	Latitude	Longitude	Drainage area (square miles)	Peak discharge		
				Time	Second-feet	Second-feet per square mile
	° ′	° ′				
Colorado River, 2.5 miles above Colorado.	32 25	100 53	[a] 1,759	June 20, 10 a. m.	66,500	37.8
Colorado River, 4.9 miles below Colorado.	32 20	100 51	[a] 1,848	June 20, 10:30 a. m.	72,800	39.4
Colorado River at Robert Lee	31 54	100 29	[b] 4,270	June 22, 2:30 a. m.	[c] 31,700	7.42
Colorado River at Ballinger	31 44	99 56	[b] 5,340	June 23, 4 a. m.	29,200	5.47
Colorado River at Winchell	31 28	99 10	[d] 12,780	June 24, 6 a. m.	24,300	1.90
Colorado River near San Saba	31 13	98 34	[d] 18,800	June 25, 3 p. m.	20,400	1.09
Deep Creek, 0.5 mile below Snyder.	32 43	100 56	120	June 19, 11:30 p. m.	36,400	303

[a] Does not include 2,440 square miles of noncontributing area.
[b] Does not include 11,500 square miles of noncontributing area.
[c] Record furnished by Bureau of Reclamation.
[d] Does not include 11,800 square miles of noncontributing area.

PREVIOUS FLOODS

Data pertaining to previous floods in Texas have been presented in the following publications of the Geological Survey:

Water-Supply Paper 488. The floods in central Texas in September 1921, by C. E. Ellsworth. Contains precipitation and discharge records for the floods of September 1921 and previous floods in the Brazos, Colorado, Guadalupe, and San Antonio River Basins.

Water-Supply Paper 771. Floods in the United States, magnitude and frequency, by C. S. Jarvis and others. Gives the gage height, peak discharge, daily mean discharge, and other pertinent information relative to all floods of record above a certain selected base flow for river-measurement stations on the Brazos River at Waco, Colorado River at Austin, Rio Grande near El Paso, and Pecos River near Comstock.

Water-Supply Paper 796–G. Major Texas floods of 1935, by Tate Dalrymple and others. Contains precipitation and discharge records for the flood in May on Seco Creek in the Nueces River Basin, the floods of June in the Colorado, Nueces, and Rio Grande Basins, and the flood of December on Buffalo Bayou at Houston. Short discussions of previous floods in these basins are also given.

Water-Supply Paper 816. Major Texas floods of 1936, by Tate Dalrymple and others. Presents detailed information on rainfall and flood discharges of the floods of June–July in the Guadalupe, San Antonio, and Neches River Basins and of the floods of September in the Trinity, Brazos, and Colorado River Basins; detailed data on previous floods in Texas; special data about precipitation and discharge during the floods of May 1929 in the Colorado and Guadalupe River Basins and during the floods of July 1932 in the Llano, Guadalupe, and Nueces River Basins; also, in tabular form, records of maximum floods on streams over the entire State.

Water-Supply Paper 847. Maximum discharges at stream-measurement stations, through December 31, 1937, by G. R. Williams and L. C. Crawford, with a supplement including additions and changes through September 30, 1938, by W. S. Eisenlohr, Jr. Contains, in tabular form, records of maximum discharges at practically all stream-measurement stations that have been operated in the State and also peak discharges computed at miscellaneous places in the State.

Water-Supply Paper 850. Summary of records of surface waters of Texas, 1898–1937, by C. E. Ellsworth. Contains, in tabular form, records of maximum

discharges at practically all stream-measurement stations that have been operated in the State and also peak discharges computed at miscellaneous places in the State.

RECORDS OF MAXIMUM STAGE AND DISCHARGE

Table 15 shows the peak stages and discharges at places in the Red and Sabine River Basins that have been discussed in this report and at gaging stations and all other places where records have been obtained in the Colorado River Basin. The locations of most of these points are shown in figure 11. The latitude and longitude, drainage area, period of record, and date, stage, and discharge of the maximum flood of record are given for each station.

Discharge figures were taken from published reports of the Geological Survey or were computed from unpublished data in the files of the Geological Survey or the Texas Board of Water Engineers at Austin. Many of the records of stage were obtained from reports of the Weather Bureau.

The drainage areas represent the best measurements that could be made from available sources, which include topographic maps of the Geological Survey and Texas Reclamation Department, maps of the United States Army, maps of soil surveys of the United States Department of Agriculture, county road maps, and airplane pictures. All noncontributing areas above the Cap Rock are excluded from the areas given.

The heading "Period of known floods" in table 15 shows the year or period for which information regarding floods is available but does not always indicate the period for which continuous and systematic records of flow have been kept. Some of the earlier records are based on information obtained from local residents and are believed to be reliable.

At certain places no data are available concerning floods other than the flood given. Although many records of flood stages are available, no discharge can be determined for them because of lack of discharge measurements for earlier dates. Changing channels and uncertain conditions of flow preclude the application of these earlier discharge measurements to stage-discharge ratings based on later measurements.

TABLE 15.—*Maximum stages and discharges on streams in Red, Sabine, and Colorado River Basins, Tex.*

Item No.	Stream and place of determination	Latitude	Longitude	Drainage area (square miles)	Period of known floods	Peak stage and discharge				Method of determination
						Date	Stage (feet)	Discharge		
								Second-feet	Second-feet per square mile	
	Red River Basin	° ′	° ′							
1	Lake Creek near Lelia Lake	34 53	100 43	48.6	1938–39	June 15–16, 1938 [a]		40,800	840	Slope-area.
2	Lake Creek near Hedley	34 56	100 42	68.5	1938–39	do		64,700	945	Do.
3	Sulphur River near Darden	33 15	94 37	2,754	1909–39	Jan. 25, 1938	34.9	92,900	33.7	Rating curve extended above 70,000 second-feet.
4	Cypress Creek near Jefferson	32 45	94 29	848	1924–39	May 20, 1930 [a]	25.37	26,100	30.8	Rating curve extended above 16,000 second-feet.
	Sabine River Basin									
5	Sabine River near Gladewater	32 32	94 57	2,846	1932–39	Jan. 1932	39.4	48,500	17.0	Rating curve extended above 40,000 second-feet.
6	Sabine River at Logansport, La	31 58	94 00	4,858	1884 1903–39	May 1884 May 5, 1915	39.4 36.9	47,000	9.7	Rating curve extended above 35,000 second-feet.
	Colorado River Basin									
7	Colorado River at Colorado	32 23	100 51	[b] 1,835	1910–39	June 20, 1939 [a]		[c] 72,800	39.4	Slope-area.
8	Colorado River at Robert Lee	31 54	100 29	[b] 4,270	1939	June 22, 1939	21.7	31,700	7.42	Surface-velocity measurement. Record furnished by Bureau of Reclamation.
9	Colorado River near Robert Lee	31 52	100 23	[b] 4,360	1883–1939 1923–27	Unknown Sept. 6, 1926	28.5 20.2	32,500	7.5	Rating curve extended above 14,800 second-feet.
10	Colorado River near Bronte	31 50	100 17	[b] 4,440	1896–1939	In 1896 and 1908	29.3			
11	Colorado River at Ballinger	31 44	99 56	[b] 5,340	1882–1939 1907–39	1884 [a] Sept. 18, 1936	36 28.6	75,400	14.1	Well-defined rating curve.
12	Colorado River near Stacy	31 31	99 40	[b] 11,660	1936–39	Sept. 18, 1936 [a]		356,000	30.5	Slope-area.
13	Colorado River near Milburn	31 28	99 06	[b] 12,800	1882–1938 1923–34	Sept. 19, 1936 Oct. 15, 1930	60.3 48.7	76,100	5.9	Rating curve extended above 57,000 second-feet.
14	Colorado River near San Saba	31 13	98 34	[b] 18,800	1878–1939	July 23, 1938 [a]	62.24	224,000	11.9	Well-defined rating curve.
15	Colorado River near Tow	30 52	98 27	[b] 19,320	1900–1936	April 1900 Sept. 21, 1936	28.4 27.9	202,000	10.5	Float measurement.
16	Colorado River at Buchanan Dam	30 45	98 25	[b] 19,450	1938	July 25, 1938		[d] 192,000	9.9	Weir and gate rating.
17	Colorado River at Marble Falls	30 34	98 16	[b] 24,320	1907–39	June 15, 1935	48.2			

See footnotes at end of table.

TABLE 15.—*Maximum stages and discharges on streams in Red, Sabine, and Colorado River Basins, Tex.*—Continued

Item No.	Stream and place of determination	Latitude	Longitude	Drainage area (square miles)	Period of known floods	Peak stage and discharge				Method of determination
						Date	Stage (feet)	Discharge		
								Second-feet	Second-feet per square mile	
	Colorado River Basin—Continued									
18	Colorado River at Austin	30 16	97 45	[b] 26,350	1843–1938	July 7, 1869	43			
						June 15, 1935	42.0	481,000	18.3	Well-defined rating curve.
19	Colorado River at Smithville	30 01	97 10	[b] 27,850	1913–39	December 1913	47.4			
						June 16, 1935	42.5	305,000	11.0	Slope-area.
20	Colorado River at Columbus	29 43	96 32	[b] 29,040	1869–1939	July 1869	[c] 41.6			
						Dec. 6, 1913	[c] 41.6			Based on rating curve for station at Eagle Lake.
						June 18, 1935	[c] 38.5	190,000	6.5	
21	Colorado River near Eagle Lake	29 35	96 25	[b] 29,140	1913–39	December 1913	32			
						June 19, 1935	29.45	177,000	6.1	Do.
22	Colorado River at Wharton	29 18	96 06	[b] 29,350	1913–39	December 1913	44.0			
23	Deep Creek near Snyder	32 43	100 55	120	1892–1939	1892	29.0			
						June 19, 1939	21.5	36,400	303	Slope-area.
24	Elm Creek at Ballinger	31 45	99 57	458	1906–39	Sept. 3, 1935	10.3	[f] 26,100	57.0	Rating curve extended above 15,000 second-feet.
25	South Concho River at Christoval	31 13	100 30	434	1882–1939	Aug. 6, 1906	23.1			
						July 23, 1938	21.95	100,000	230	Slope-area.
26	South Concho River at San Angelo	31 27	100 26	[b] 2,535	1854–1939	Aug. 6, 1906	[g] 29.7			
						Sept. 17, 1936	[h] 23.4	111,000	43.8	Do.
27	Concho River near San Angelo	31 27	100 25	[b] 4,217	1854–1939	Aug. 6, 1906	47.5	[f] 246,000	58.3	Do.
28	Concho River near Paint Rock	31 31	99 57	[b] 5,263	1882–1939	Sept. 17, 1936	41.3	301,000	57.3	Do.
29	Pecan Creek near San Angelo	31 19	100 27	81	1936–39	Sept. 15, 1936 [a]		30,500	377	Do.
30	Middle Concho River near Tankersley	31 23	100 37	[b] 1,128	1922–39	April 1922 [a]	27.2			
						Sept. 26, 1936	24.2	[f] 35,000	31.0	Rating of spillway of dam.
31	Spring Creek near Tankersly	31 22	100 32	734	1930–39	Sept. 17, 1936	20.3	23,900	32.6	Well-defined rating curve.
32	North Concho River near Carlsbad	31 36	100 40	[b] 1,406	1922–39	Sept. 26, 1936 [a]	16.0	94,600	67.3	Slope-area.
33	North Concho River at San Angelo	31 27	100 26	[b] 1,675	1854–1939	Sept. 17, 1936	39.9	184,000	110	Do.
34	East Fork of Grape Creek near Carlsbad.	31 39	100 34	32	1936–39	do. [a]		23,500	734	Do.
35	Grape Creek near Carlsbad	31 38	100 34	53	1936–39	do. [a]		31,800	600	Do.
36	Grape Creek at railroad bridge near Carlsbad.	31 34	100 34	79	1936–39	do. [a]		45,600	577	Contracted-opening.
37	West Fork of Grape Creek near Carlsbad.	31 40	100 35	17	1936–39	do. [a]		14,200	836	Slope-area.

38	Dry Creek near San Angelo	31	40	100	29	14	1936–39	do.[a]		24,600	1,760	Do.
39	Dry Creek at railroad bridge near San Angelo.	31	33	100	32	48	1936–39	do.[a]		19,200	400	Contracted-opening.
40	Red Bank Creek near San Angelo	31	41	100	26	.76	1936–39	do.[a]		2,490	3,280	Slope-area.
41	Kickapoo Creek near Paint Rock	31	28	99	59	289	1938–39	July 23, 1938		48,100	166	Do.
42	Salt Creek near Doole	31	24	99	25	88.2	1938–39	do		20,400	231	Do.
43	Deep Creek near Milburn	31	23	99	06	59.2	1938–39	do		33,600	568	Do.
44	Pecan Bayou at Brownwood Reservoir[j]	31	50	99	00	1,535	1932	July 3, 1932[a]		235,000	153	Rate of storage in reservoir.
45	Pecan Bayou at Brownwood	31	44	98	58	1,614	1917–18 1923–39	Oct. 14, 1930	16.9	52,700	32.7	Rating curve extended above 38,000 second-feet.
46	Jim Ned Creek near Brownwood	31	48	99	02	668	1932	July 3, 1932[a]		187,000	280	Slope-area.
47	San Saba River near Fort McKavett	30	52	100	01	688	1899–1936	Sept. 16, 1936		50,700	73.7	Do.
48	San Saba River at Menard	30	55	99	48	1,151	1899–1939	June 5 or 6, 1899 July 23, 1938	23.7 22.7	117,000	102	Do.
49	San Saba River near Richland Springs	31	08	98	57	2,757	1938–39	July 22, 1938		181,000	65.7	Do.
50	San Saba River at San Saba	31	12	98	42	3,046	1899–1939	July 23, 1938	45.18	203,000	66.6	Do.
51	North Valley Prong of San Saba River near Fort McKavett.	30	51	100	08	328	1936	Sept. 16, 1936		38,800	118	Do.
52	Middle Valley Prong of San Saba River near Fort McKavett.	30	50	100	08	188	1920–36	do		20,900	111	Do.
53	East Fork of Terrett Draw above Coal Kiln Draw near Fort McKavett.	30	41	100	11	19	1936	do.[a]		12,100	637	Do.
54	East Fork of Terrett Draw below Coal Kiln Draw near Fort McKavett.	30	43	100	10	33	1936	do.[a]		18,700	567	Do.
55	Terrett Draw near Fort McKavett	30	50	100	07	103	1899–1936	do		35,800	348	Do.
56	West Fork of Terrett Draw near Fort McKavett.	30	45	100	10	21	1936	Sept. 15 or 16, 1936[j]		5,880	280	Do.
57	Colston Draw near Fort McKavett	30	47	100	07	24	1936	Sept. 16, 1936[j]		10,000	417	Do.
58	Brady Creek at Brady	31	09	99	20	554	1930	Oct. 6, 1930		48,400	87.4	Do.
59	Brady Creek near Brady	31	06	99	18	595	1930–39	July 23, 1938[a]		86,000	145	Do.
60	Richland Creek near Richland Springs	31	16	98	50	72.4	1938–39	do		61,000	843	Do.
61	Cherokee Creek near Chappel	31	03	98	34	149	1882, 1938	Sept. 25, 1938	(k)	20,900	140	Do
62	North Llano River near Roosevelt	30	30	100	03	443	1936	Sept. 16, 1936[j]		22,600	51.0	Do.
63	North Llano River near Junction	30	30	99	47	914	1875–1939	do	24.9	94,800	104	Do.
64	Llano River near Junction	30	30	99	44	1,762	1889–1939	June 14, 1935	43.3	319,000	181	Do.
65	Llano River near Castell	30	43	98	53	3,514	1889–1939	do	37.0	388,000	110	Do.
66	West Fork of Copperas Creek near Roosevelt.	30	33	100	03	81	1879–1939	Sept. 16, 1936		50,400	622	Do.
67	Copperas Creek near Roosevelt	30	31	100	00	118	1936–39	Sept. 15 or 16, 1936[a]		98,900	838	Do.
68	Bear Creek near Junction	30	32	99	50	155	1936–39	Sept. 16, 1936[j]		31,300	202	Do.
69	South Llano River near Telegraph	30	15	99	57	540	1935–39	June 14, 1935[a]		160,000	296	Do.
70	Paint Creek near Telegraph	30	18	99	53	218	1923–39	June 14, 1935		69,300	318	Do.
71	East Fork of James River at Old Noxville.	30	22	99	24	60.8	1915–39	July 1, 1932		105,000	1,730	Do.
72	James River near Mason	30	35	99	19	336	1932	July 2, 1932		85,900	256	Do.
73	Sandy Creek near Marble Falls	30	34	98	28	344	1886–1939	Sept. 15, 1936		41,500	121	Do.
74	Walnut Creek near Marble Falls	30	32	98	27	24	1936	do		13,600	567	Do.
75	Hamilton Creek near Marble Falls	30	38	98	14	67	1885–1939	Sept. 26, 1936		29,100	435	Do.

See footnotes at end of table.

TABLE 15.—*Maximum stages and discharges on streams in Red, Sabine, and Colorado River Basins, Tex.*—Continued

Item No.	Stream and place of determination	Latitude	Longitude	Drainage area (square miles)	Period of known floods	Peak stage and discharge				Method of determination
						Date	Stage (feet)	Discharge		
								Second-feet	Second-feet per square mile	
	Colorado River Basin—Continued									
76	Pedernales River at Stonewall	30 14	98 40	647	{1900 1924–34	April 1900 May 28, 1929	24 14.2	28,300	43.7	Slope-area. Do.
77	Pedernales River near Spicewood	30 25	98 05	1,294	1869–1939	do	40.4	155,000	120	Do.
78	Miller Creek near Johnson City	30 12	98 18	56.3	1929	do		22,900	407	Do.
79	Barton Creek near Riley	30 15	97 49	114	1929	do		39,400	346	Do.
80	Little Barton Creek near Bee Cave	30 18	97 58	6.3	1880–1939	do		2,450	389	Do.
81	Little Walnut Creek near Austin	30 18	97 40	12	1921–26	September 1921	21			
82	Onion Creek near Dripping Springs	30 10	98 06	54.8	1881–1939	May 28, 1929		21,900	400	Do.
83	Onion Creek near Buda	30 05	97 51	151	1929	do		53,200	352	Do.
84	Onion Creek near Delvalle	30 11	97 42	337	1870–1939	Sept. 10, 1921	33.6	138,000	409	Rating curve extended above 57,000 second-feet.

[a] Greatest flood known to local residents.
[b] Excluding noncontributing area.
[c] Measured 4.9 miles below Colorado; effective drainage area, 1,848 square miles.
[d] Outflow from reservoir.
[e] To datum of gage used after Aug. 21, 1934, which is 3 feet higher datum than gage used prior to that time.
[f] About.
[g] Not affected by backwater.
[h] 2.4 feet caused by backwater.
[i] Record furnished by Brown County Water Improvement District 1.
[j] Higher stages known to have occurred.
[k] Flood of 1882 reached a stage about 10 feet higher than in 1938.

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