DEPARTMENT OF THE INTERIOR
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UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, Director

Water-Supply Paper 458

SURFACE WATER SUPPLY OF THE UNITED STATES

1917

PART VIII. WESTERN GULF OF MEXICO BASINS

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Prepared in cooperation with the STATE OF TEXAS

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SURFACE WATER SUPPLY OF WESTERN GULF OF MEXICO BASINS, 1917.

AUTHORIZATION AND SCOPE OF WORK.

This volume is one of a series of 14 reports presenting records of measurements of flow made on streams in the United States during the year ending September 30, 1917.

The data presented in these reports were collected by the United States Geological Survey under the following authority contained in the organic law (20 State. L., p. 394):

Provided, That this officer [the Director] shall have the direction of the Geological Survey and the classification of public lands and examination of the geological structure, mineral resources, and products of the national domain.

The work was begun in 1888 in connection with special studies relating to irrigation in the arid west. Since the fiscal year ending June 30, 1895, successive sundry-civil bills passed by Congress have carried the following item and appropriations:

For gaging the streams and determining the water supply of the United States, and for the investigation of underground currents and artesian wells, and for the preparation of reports upon the best methods of utilizing the water resources.

Annual appropriations for the fiscal years ending June 30, 1895–1918.

1895	$12,500
1896	20,000
1897 to 1900, inclusive	50,000
1901 to 1902, inclusive	100,000
1903 to 1906, inclusive	200,000
1907	150,000
1908 to 1910, inclusive	100,000
1911 to 1918, inclusive	150,000

In the execution of the work many private and State organizations have cooperated either by furnishing data or by assisting in collecting data. Acknowledgments for cooperation of the first kind are made in connection with the description of each station affected; cooperation of the second kind is acknowledged on page 9.

Measurements of stream flow have been made at about 4,240 points in the United States and also at many points in Alaska and the Hawaiian Islands. In July, 1917, 1,180 gaging stations were being maintained by the Survey and the cooperating organizations. Many miscellaneous discharge measurements are made at other points. In

connection with this work data were also collected in regard to precipitation, evaporation, storage reservoirs, river profiles, and water power in many sections of the country and will be made available in water-supply papers from time to time. Information in regard to publications relating to water resources is presented in the appendix to this report.

DEFINITION OF TERMS.

The volume of water flowing in a stream—the "run-off" or "discharge"—is expressed in various terms, each of which has become associated with a certain class of work. These terms may be divided into two groups—(1) those that represent a rate of flow, as second-feet, gallons per minute, miners' inches, and discharge in second-feet per square mile, and (2) those that represent the actual quantity of water, as run-off in depth in inches, and acre-feet. The principal terms used in this series of reports are second-feet, second-feet per square mile, run-off in inches, acre-feet, and millions of cubic feet. They may be defined as follows:

"Second-feet" is an abbreviation for cubic feet per second." A second-foot is the rate of discharge of water flowing in a channel of rectangular cross section 1 foot wide and 1 foot deep at an average velocity of 1 foot per second. It is generally used as a fundamental unit from which others are computed.

"Second-feet per square mile" is the average number of cubic feet of water flowing per second from each square mile of area drained, on the assumption that the run-off is distributed uniformly both as regards time and area.

"Run-off (depth in inches)" is the depth to which an area would be covered if all the water flowing from it in a given period were uniformly distributed on the surface. It is used for comparing run-off with rainfall, which is usually expressed in depth in inches.

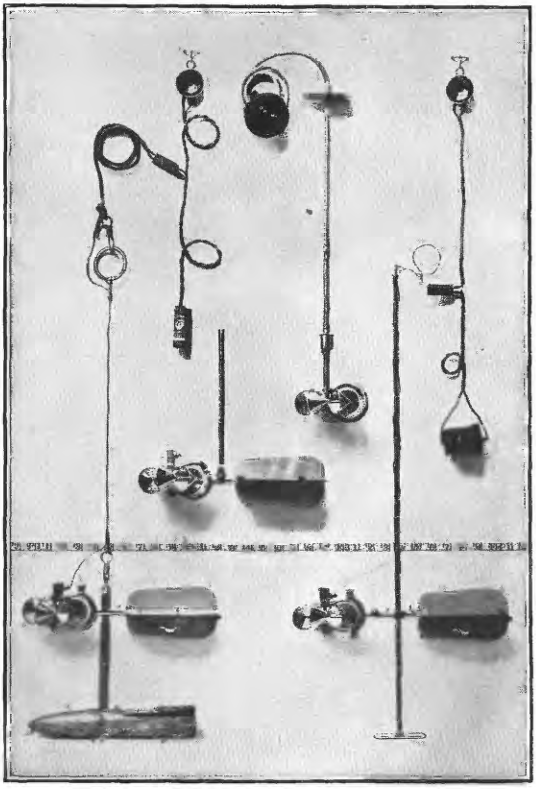
An "acre-foot," equivalent to 43,560 cubic feet, is the quantity required to cover an acre to the depth of 1 foot. The term is commonly used in connection with storage for irrigation.

The following terms not in common use are here defined:

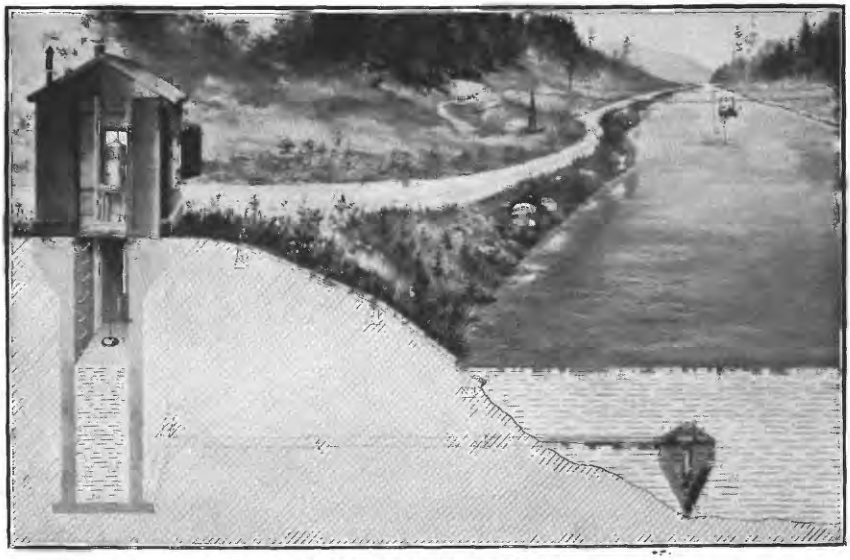
"Stage-discharge relation," an abbreviation for the term "relation of gage height to discharge."

"Control," a term used to designate the section or sections of the stream channel below the gage which determine the stage-discharge relation at the gage. It should be noted that the control may not be the same section or sections at all stages.

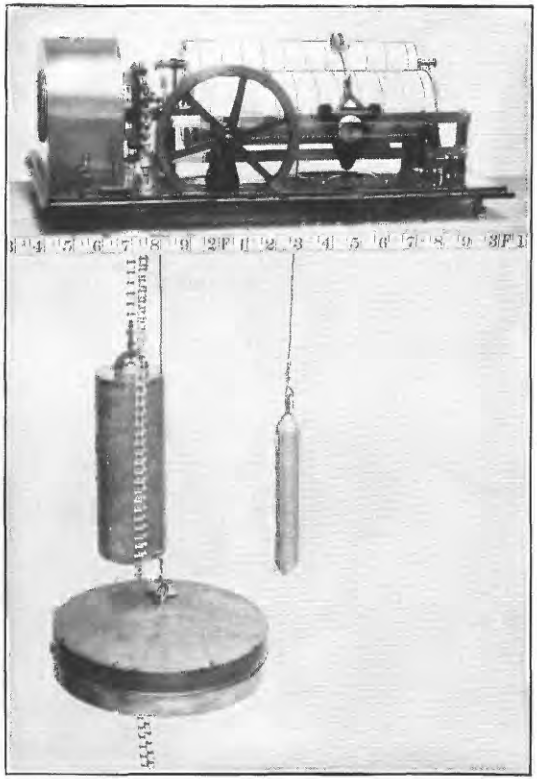
The "point of zero flow" for a given gaging station is that point on the gage—the gage height—to which the surface of the river falls when the discharge is reduced to zero.



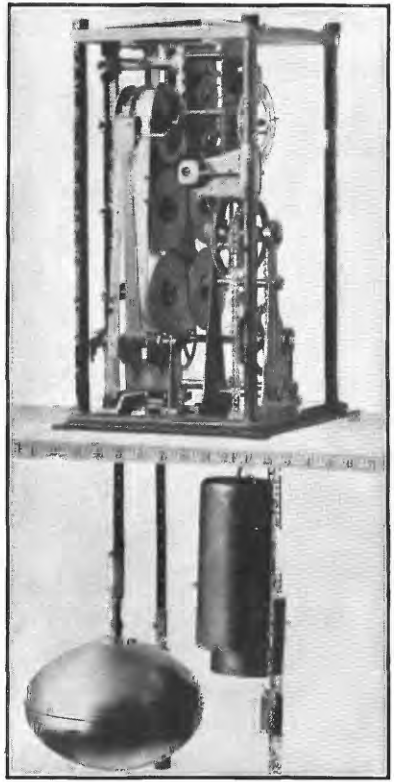
A. PRICE CURRENT METERS.



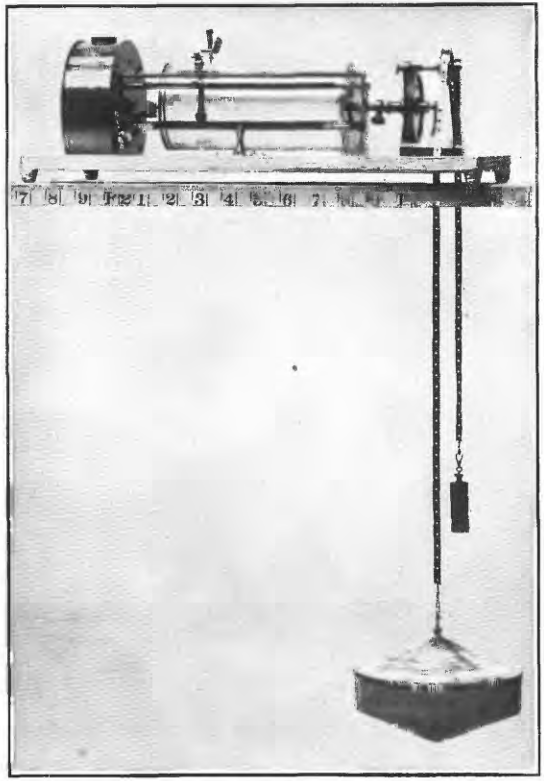
B. TYPICAL GAGING STATION.



A. STEVENS CONTINUOUS.



B. GURLEY PRINTING.



C. FRIEZ.

WATER-STAGE RECORDERS.

EXPLANATION OF DATA.

The data presented in this report cover the year beginning October 1, 1916, and ending September 30, 1917. At the beginning of January in most parts of the United States much of the precipitation in the preceding three months is stored as ground water, in the form of snow or ice, or in ponds, lakes, and swamps, and this stored water passes off in the streams during the spring break-up. At the end of September, on the other hand, the only stored water available for run-off is possibly a small quantity in the ground; therefore the run-off for the year beginning October 1 is practically all derived from precipitation within that year.

The base data collected at gaging stations consist of records of stage, measurements of discharge, and general information used to supplement the gage heights and discharge measurements in determining the daily flow. The records of stage are obtained either from direct readings on a staff gage or from a water-stage recorder that gives a continuous record of the fluctuations. Measurements of discharge are made with a current meter. (See Pls. I, II.) The general methods are outlined in standard textbooks on the measurement of river discharge.

From the discharge measurements rating tables are prepared that give the discharge for any stage, and these rating tables, when applied to the gage heights, give the discharge from which the daily, monthly, and yearly means of discharge are determined.

The data presented for each gaging station in the area covered by this report comprise a description of the station, a table giving records of discharge measurements, a table showing the daily discharge of the stream, and a table of monthly and yearly discharge and run-off.

If the base data are insufficient to determine the daily discharge, tables giving daily gage height and records of discharge measurements are published.

The description of the station gives, in addition to statements regarding location and equipment, information in regard to any conditions that may affect the permanence of the stage-discharge relation, covering such subjects as the occurrence of ice, the use of the stream for log driving, shifting of control, and the cause and effect of backwater; it gives also information as to diversions that decrease the flow at the gage, artificial regulation, maximum and minimum recorded stages, and the accuracy of the records.

The table of daily discharge gives, in general, the discharge in second-feet corresponding to the mean of the gage heights read each day. At stations on streams subject to sudden or rapid diurnal fluctuation the discharge obtained from the rating table and the mean daily gage height may not be the true mean discharge for the day.

If such stations are equipped with water-stage recorders the mean daily discharge may be obtained by averaging discharge at regular intervals during the day, or by using the discharge integrator, an instrument operating on the principle of the planimeter and containing as an essential element the rating curve of the station.

In the table of monthly discharge the column headed "Maximum" gives the mean flow for the day when the mean gage height was highest. As the gage height is the mean for the day, it does not indicate correctly the stage when the water surface was at crest height and the corresponding discharge was consequently larger than given in the maximum column. Likewise, in the column headed "Minimum" the quantity given is the mean flow for the day when the mean gage height was lowest. The column headed "Mean" is the average flow in cubic feet per second during the month. On this average flow computations recorded in the remaining columns, which are defined on pages 6, are based.

The deficiency table presented for some of the gaging stations shows the number of days in each year on which the mean daily discharge was less than the discharge given in the table. By subtraction the table gives the number of days each year that the mean daily discharge was between the discharges given in the table and, also by subtraction, the number of days that the mean daily discharge was equal to or greater than the discharge given. If one discharge rating table was used throughout the period covered by the deficiency table, gage heights that correspond to the discharges are also given.

ACCURACY OF FIELD DATA AND COMPUTED RECORDS.

The accuracy of stream-flow data depends primarily (1) on the permanence of the stage-discharge relation and (2) on the accuracy of observation of stage, measurement of flow, and interpretation of records.

A paragraph in the description of the station gives information regarding the (1) permanence of the stage-discharge relation, (2) precision with which the discharge rating curve is defined, (3) refinement of gage readings, (4) frequency of gage readings, and (5) methods of applying daily gage height to the rating table to obtain the daily discharge.

For the rating tables "well defined" indicates, in general, that the rating is probably accurate within 5 per cent; "fairly well defined," within 10 per cent; "poorly defined," within 15 to 25 per cent. These notes are very general and are based on the plotting of the individual measurements with reference to the mean rating curve.

The monthly means for any station may represent with high accuracy the quantity of water flowing past the gage, but the figures showing discharge per square mile and depth of run-off in inches

may be subject to gross errors caused by the inclusion of large non-contributing districts in the measured drainage area, by lack of information concerning water diverted for irrigation or other use, or by inability to interpret the effect of artificial regulation of the flow of the river above the station. "Second-feet per square mile" and "Run-off (depth in inches)" are therefore not computed if such errors appear probable. The computations are also omitted for stations on streams draining areas in which the annual rainfall is less than 20 inches. All figures representing "second-feet per square mile" and "run-off (depth in inches)" previously published by the Survey should be used with caution because of possible inherent sources of error not known to the Survey.

The table of monthly discharge gives only a general idea of the flow at the station and should not be used for other than preliminary estimates; the tables of daily discharge allow more detailed studies of the variation in flow. It should be borne in mind, however, that the observations in each succeeding year may be expected to throw new light on data previously published.

COOPERATION.

The work of measuring streams in Texas during the year ending September 30, 1917, was carried on in cooperation with the State through the Board of Water Engineers, consisting of James C. Nagle, chairman; John Wilson, and E. B. Gore.

The United States Reclamation Service and the United States Weather Bureau gave assistance to the work in Pecos River valley, Brazos River, and Colorado River basin, and upper Trinity basin by furnishing equipment, records, and giving general assistance. A large part of the equipment for the evaporation station near Austin was furnished by the United States Weather Bureau.

The cities of Corpus Christi, Brownwood, and Austin, the Cuero Commercial Club, the county of Comal, the San Marcos Utilities Co., the Imperial Irrigation Co., the Winter Garden Irrigation Co., the Arlington Land Co., the Kansas City, Mexico & Orient Railroad, the Pecos Valley lines, the Texas & Pacific Railway, the Gulf, Colorado & Sante Fe Railroad, and the International & Great Northern Railway have aided in collecting records by furnishing funds, or giving general assistance.

DIVISION OF WORK.

The data for stations in Texas and southeastern New Mexico, in the Pecos River basin, were collected and prepared for publication under the direction of Glenn A. Gray, district engineer, assisted by William Kessler, Russell J. Hank, Edgar O. Francisco, Edward P. Congdon, junior engineers; and R. C. Thaxton, Victor Lieb, and W. C. Dodd, State hydrographers.

The field data for the Rio Grande drainage basin in New Mexico were collected under the direction of Robert Follansbee, district engineer, by G. S. Cowdrey, jr. Ratings and computations were made by S. B. Soulé and P. V. Hodges.

The manuscript was assembled and reviewed by W. E. Dickinson.

GAGING-STATION RECORDS.

TRINITY RIVER BASIN.

WEST FORK OF TRINITY RIVER AT BRIDGEPORT, TEX.[a]

LOCATION.—At suspension bridge on Balsora-Bridgeport road, half a mile southwest of center of Bridgeport, Wise County, a quarter of a mile above Chicago, Rock Island, & Gulf Railway Co.'s pumping plant and 1 mile below mouth of Gentry Creek.

DRAINAGE AREA.—1,060 square miles (revised).

RECORDS AVAILABLE.—October 1, 1914, to September 30, 1917. Record of stage has been obtained by United States Weather Bureau from August 16, 1908, to October 16, 1915.

GAGE.—Weight and tape gage of the Mott type, fastened to downstream side of bridge, 56 feet from north end of guard rail; read by U. E. Byers.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge or by wading.

CHANNEL AND CONTROL.—Bed composed of clay, gravel, and sand. Banks are high, slightly wooded, and are overflowed at a stage of 25 feet. Channel straight above and below station for 100 feet. Control is a rock outcrop three-quarters of a mile below station.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 14.30 feet at 7 a. m. August 20 (discharge, 3,570 second-feet); no flow June 20–23, June 26 to July 3.

1908–1917: Maximum stage recorded, 28.9 feet June 8, 1915 (discharge, not determined); no flow in stream during several periods.

ICE.—None reported during year.

DIVERSIONS.—None above station for power development; extensive irrigation not required as ordinarily the precipitation in the drainage basin is sufficient to mature crops. The operation of the few small pumping plants along the stream produces little noticeable effect.

REGULATION.—Flow unaffected by water-power plants, dams, or reservoirs above or immediately below the station.

ACCURACY.—Stage-discharge relation changed slightly. Rating curves well defined. Two curves slightly different below 1,500 second-feet used, respectively, October 1–17 and October 18 to September 30. Gage read to hundredths twice daily. Daily discharge ascertained by applying mean-daily gage height to rating table Records good.

Discharge measurements of West Fork of Trinity River at Bridgeport, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 31	R. C. Thaxton	1.31	4.6	Apr. 25	R. J. Hank	1.08	[b]1.0
Jan. 4	R. J. Hank	1.13	1.8	June 17	R. C. Thaxton	.99	.6
Mar. 12	Victor Lieb	1.11	1.0	July 10	Gray and Francisco	1.84	25.9
Apr. 22	R. J. Hank	1.53	11.5	Sept. 6	E. P. Congdon	2.73	126

[a] Published in earlier reports as Trinity River at Bridgeport, Tex. [b] Estimated.

Daily discharge, in second-feet, of West Fork of Trinity River at Bridgeport, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	0.5	3.5	15	2.9	2.3	4.3	19	13	204	0.0	1.2	1.5
2	.5	2.9	11	2.9	2.2	44	4.8	8.8	57	.0	.8	1.3
3	.5	2.2	45	2.9	2.0	24	54	2.5	53	.0	2.4	42
4	.5	2.1	16	3.1	2.0	9.4	880	2.5	17	768	2.1	1,340
5	.5	2.3	9.4	1.2	2.0	5.8	463	2.0	12	475	1.9	373
6	.5	2.4	5.0	1.5	1.9	2.9	200	2.5	5.5	734	1.3	144
7	.5	2.5	2.3	2.1	2.4	2.1	50	7.6	4.3	288	299	67
8	.5	3.1	2.1	1.8	2.9	2.0	38	2.5	3.9	194	142	17
9	.5	3.9	1.9	1.8	3.1	1.7	31	2.0	13	57	58	14
10	.5	2.4	2.0	1.8	3.1	1.6	22	2.2	14	29	14	80
11	.5	2.0	2.2	1.7	3.3	1.5	56	2.2	9.7	16	9.7	79
12	.5	2.0	2.0	1.8	3.3	1.8	43	2.4	5.0	13	7.3	12
13	.5	2.0	2.0	1.8	3.9	1.6	48	2.4	2.5	9.4	4.1	7.3
14	.5	2.0	2.0	2.0	16	1.6	28	2.2	2.1	3.5	2.4	6.8
15	.5	2.0	2.1	2.0	25	1.5	19	2.1	2.0	3.1	2.2	8.2
16	2.0	2.0	2.0	2.1	10	1.4	12	20	2.0	2.4	1.8	7.3
17	26	2.0	2.1	2.3	6.0	1.4	8.2	5.8	1.3	122	1.2	7.0
18	2,080	2.0	2.2	2.4	4.5	1.5	3.7	3.3	1.3	181	530	6.2
19	693	2.0	2.1	2.4	2.7	1.4	366	2.9	1.0	77	1,650	6.0
20	1,790	2.2	2.2	2.4	2.5	1.3	187	3.7	.0	1,490	2,410	5.5
21	796	103	2.2	2.4	2.4	1.2	46	78	.0	1,250	290	4.8
22	223	782	2.2	2.4	2.4	1.3	14	55	.0	806	221	4.1
23	38	221	2.2	2.4	2.4	1.1	5.0	20	.0	447	158	3.7
24	34	160	2.2	2.4	2.4	1.1	2.4	12	1.3	334	120	3.1
25	42	83	2.3	2.4	2.2	1.1	2.0	9.4	.8	55	36	2.5
26	23	64	2.3	2.4	2.0	1.0	2.7	17	.0	32	14	2.2
27	8.8	40	2.4	2.4	1.9	.7	6.2	314	.0	19	9.4	532
28	4.3	33	2.4	2.4	1.8	.7	111	127	.0	7.9	6.2	29
29	4.1	25	2.7	2.4	.....	.6	20	15	.0	3.3	4.3	8.2
30	3.9	21	2.7	2.4	.....	.7	20	390	.0	1.9	2.7	4.1
31	3.9	.....	2.9	2.4	.....	.3	.....	236	.....	1.3	2.2	.....

Monthly discharge of West Fork of Trinity River at Bridgeport, Tex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Total run-off (in acre-feet).
	Maximum.	Minimum.	Mean.	
October	2,080	0.5	186	11,400
November	782	2.0	52.6	3,130
December	45	1.9	5.07	312
January	3.1	1.2	2.24	138
February	25	1.8	4.24	235
March	44	.3	3.95	243
April	880	2.0	92.1	5,480
May	390	2.0	44.1	2,710
June	204	.0	13.8	821
July	1,490	.0	239	14,700
August	2,410	.8	194	11,900
September	1,340	1.3	94.0	5,590
The year	2,410	.0	78.4	56,700

BRAZOS RIVER BASIN.

BRAZOS RIVER NEAR GRAHAM, TEX.

LOCATION.—At two-span steel highway bridge on Murray road, 6 miles above mouth of Clear Fork, 10 miles west of Graham, Young County.

DRAINAGE AREA.—12,900 square miles.

RECORDS AVAILABLE.—November 13, 1915, to September 30, 1917.

GAGE.—Vertical staff on left downstream corner of middle pier; read by Mrs. John Timmons.

DISCHARGE MEASUREMENTS.—Made from upstream side of bridge or by wading.

CHANNEL AND CONTROL.—Channel straight above and below station. Bed is composed of sand and clay; free from vegetation; shifting. Left bank high and not subject to overflow; right bank is of medium height and is overflowed during high stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 9.00 feet at 8 a. m. October 17 (discharge, 3,600 second-feet; determined from extension of rating curve and possibly subject to considerable error); no flow during several periods.

1916–1917: Maximum stage recorded, 9.50 feet at 6 p. m. April 2, 1916 (discharge, 4,100 second-feet, determined from extension of rating curve, and possibly subject to considerable error); no flow during several periods.

ICE.—Slight amount of ice reported in December and January.

DIVERSIONS.—No information available to show that water is diverted above station in any large quantity for irrigation; no diversions between station and mouth of Clear Fork.

REGULATION.—Number of power plants and controlling works above station not known; gage heights do not indicate that flow is regulated.

ACCURACY.—Stage-discharge relation not permanent; not affected by ice during the year. Rating curve poorly defined. Gage read to hundredths twice daily. Daily discharge ascertained by applying mean daily gage height to rating table directly October 17 to July 4; and by shifting-control method October 1–16 and July 5 to September 30. Discharge determinations above 2,000 second-feet obtained from an extension of rating curve; subject to considerable error. Records poor.

Discharge measurements of Brazos River near Graham, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 1	R. C. Thaxton	4.20	47.8	June 16	R. C. Thaxton	.....	0.0
Jan. 3	R. J. Hank	3.56	5.3	July 9	Gray and Francisco	4.32	51.2
Mar. 13	Victor Lieb	3.45	.0	Sept. 7	E. P. Congdon	6.52	1,160
Apr. 23	R. J. Hank	.....	.0				

Daily discharge, in second-feet, of Brazos River near Graham, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	58	49	24	5.0	3.0	3.0	202	6.0	0.0	40	6.0	649
2	39	35	23	4.2	3.0	5.0	82	5.0	.0	24	5.0	444
3	29	26	20	6.0	3.0	6.0	136	.0	82	106	5.0	223
4	22	23	15	5.0	3.0	3.0	106	.0	47	223	5.0	269
5	17	23	15	5.0	3.0	3.0	24	.0	24	1,430	8.5	2,040
6	15	18	12	5.0	3.0	3.0	7.0	.0	17	354	7.0	1,600
7	13	18	11	5.0	4.0	3.0	6.0	5.0	10	223	6.0	1,170
8	13	17	11	4.6	4.0	3.0	5.0	5.0	7.0	142	7.0	884
9	13	15	12	5.0	4.0	.0	5.0	4.0	5.0	121	7.0	354
10	13	15	10	4.6	3.0	.0	4.0	.0	.0	13	7.0	236
11	12	13	10	5.0	3.0	.0	5.0	5.0	.0	10	6.0	215
12	11	12	10	5.0	3.0	.0	6.0	6.0	.0	6.0	5.0	195
13	16	12	10	4.0	3.0	.0	5.0	5.0	.0	5.0	4.6	2,490
14	13	14	9.4	6.0	7.0	.0	5.0	4.0	.0	4.0	4.0	2,560
15	106	20	8.5	8.5	10	.0	.0	.0	.0	4.0	3.0	1,320
16	684	17	7.3	8.5	7.0	.0	.0	.0	.0	5.0	3.0	1,240
17	3,300	16	8.5	8.5	7.0	.0	.0	.0	.0	5.0	4.0	1,000
18	2,490	15	7.3	8.5	7.0	.0	.0	.0	.0	4.0	4.0	804
19	2,000	12	6.2	7.3	7.0	.0	7.0	.0	.0	223	780	649
20	1,360	10	7.0	7.0	5.4	.0	6.0	5.0	.0	614	294	244
21	1,020	12	10	10	6.0	.0	5.0	6.0	.0	106	82	184
22	860	20	8.5	8.2	6.0	.0	4.0	.0	.0	136	29	166
23	509	23	7.0	7.3	4.0	.0	.0	.0	.0	184	12	130
24	390	20	6.6	5.8	4.0	.0	.0	.0	.0	63	7.6	72
25	269	17	6.0	5.4	4.0	.0	.0	.0	106	40	5.0	47
26	191	12	5.4	5.0	4.0	.0	.0	.0	20	17	5.0	29
27	136	47	5.4	5.0	4.0	.0	.0	.0	10	15	6.0	24
28	109	47	5.0	5.0	3.0	.0	.0	.0	8.5	8.5	7.0	24
29	87	42	4.6	3.8	.....	.0	.0	.0	6.0	5.0	8.5	24
30	74	29	4.6	3.0	.....	.0	.0	.0	5.0	1.0	8.5	24
31	50	.....	5.4	3.0	.....	.0	10	.0	.....	2.0	884	.....

Monthly discharge of Brazos River near Graham, Tex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (in acre-feet).
	Maximum.	Minimum.	Mean.	
October	3,300	11	449	27,600
November	49	10	21.6	1,290
December	24	4.6	9.86	606
January	10	3.0	5.78	355
February	10	3.0	4.55	253
March	6.0	.0	.94	58
April	202	.0	21.0	1,250
May	6.0	.0	1.81	111
June	106	.0	11.6	690
July	1,430	1.0	133	8,180
August	884	3.0	71.8	4,410
September	2,560	24	644	38,300
The year	3,300	.0	115	83,100

BRAZOS RIVER AT BRAZOS, TEX.

LOCATION.—At Texas & Pacific Railway bridge half a mile northeast of Brazos, Palo Pinto County, 1½ miles above mouth of Palo Pinto Creek.

DRAINAGE AREA.—20,200 square miles (revised).

RECORDS AVAILABLE.—October 1, 1914, to September 30, 1917. Records of stage have been obtained by the United States Weather Bureau since August 16, 1908.

GAGE.—Vertical staff on northwest side of and one foot from upstream edge of pier nearest the middle of the railway bridge; graduations above 4 feet painted on the pier; read by L. W. Boyett.

DISCHARGE MEASUREMENTS.—Made from three-span highway bridge about 600 feet below railway bridge or by wading.

CHANNEL AND CONTROL.—Bed composed of sand and gravel; shifts slightly. Right bank high, rocky, wooded, and not subject to overflow; left bank composed of sand, gravel, and clay, wooded, and medium in height, and subject to overflow at high water. Channel straight above and below for several thousand feet.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 6.50 feet at 6 p. m. October 18 (discharge, 9,400 second-feet); no flow April 7–14 and August 15–18.

1908–1917: Maximum stage recorded, 22.0 feet May 24, 1908 (discharge not determined); no flow for several periods within period of records.

ICE.—Slight amount of ice reported in December, January, and February.

DIVERSIONS.—A few pumping plants have been installed along the stream for the purpose of irrigating small areas, but water so pumped will not greatly affect the flow of the stream.

REGULATION.—Flow unaffected by power plants, dams, or reservoirs above or immediately below station. Swamps and natural lakes are rare in the drainage basin above the station.

ACCURACY.—Stage-discharge relation not permanent. Two rating curves, fairly well defined below 2.8 feet gage height were used for the year, applicable respectively, October 1–16 and October 17 to September 30; high-water curve fairly well defined below 18,000 second-feet. Gage read to half-tenths twice daily. Daily discharge ascertained by applying daily gage height to rating table. Records fair.

Discharge measurements of Brazos River at Brazos, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 2	R. C. Thaxton	1.40	194	June 18	R. C. Thaxton	0.90	21.5
Jan. 5	R. J. Hank	.80	11.8	July 10	Francisco and Gray	1.85	439
Mar. 14	Victor Lieb	.70	2.4	Sept. 5	E. P. Congdon	3.15	1,710

Daily discharge, in second-feet, of Brazos River at Brazos, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	32	236	22	11	22	11	2.8	246	102	2.8	146	124
2	32	194	22	11	22	11	1.5	246	102	.8	124	82
3	32	146	22	11	16	11	1.5	246	1,090	.8	124	50
4	32	102	22	11	11	11	1.5	246	648	.8	102	568
5	32	82	22	11	11	4.0	1.5	194	499	.8	63	1,700
6	32	63	22	11	11	4.0	1.5	146	379	890	37	1,360
7	32	63	22	11	11	4.0	.0	102	350	102	11	1,760
8	32	63	22	11	11	4.0	.0	63	246	220	16	3,280
9	32	63	22	11	11	4.0	.0	63	740	324	11	1,580
10	32	63	22	11	11	4.0	.0	37	298	379	7.5	840
11	32	63	22	11	11	4.0	.0	37	246	194	4.0	499
12	24	63	22	11	11	4.0	.0	22	194	124	2.8	298
13	24	63	22	11	11	4.0	.0	22	194	82	1.5	648
14	24	63	22	11	11	4.0	.0	22	194	82	.8	740
15	24	63	22	11	11	4.0	1.5	22	194	82	.0	1,960
16	24	63	11	11	11	4.0	1.5	22	146	50	.0	2,960
17	1,890	63	11	11	11	4.0	1.5	11	102	50	.0	2,290
18	5,700	63	11	11	11	4.0	1.5	11	30	50	.0	1,240
19	5,580	63	11	11	11	4.0	82	11	16	170	102	840
20	4,930	63	11	11	11	4.0	30	4.0	16	2,080	890	530
21	3,980	63	11	22	11	4.0	22	4.0	16	840	246	408
22	2,150	63	11	22	11	4.0	11	4.0	16	350	690	324
23	1,640	63	11	22	11	4.0	11	4.0	16	272	1,140	324
24	1,240	37	11	22	11	4.0	11	4.0	16	220	468	324
25	1,040	37	11	22	11	4.0	4.0	4.0	16	220	272	298
26	840	22	11	22	11	4.0	4.0	63	16	220	272	272
27	648	22	11	30	11	4.0	4.0	298	7.5	194	220	272
28	499	22	11	22	11	4.0	438	246	7.5	170	220	272
29	396	22	11	22	.....	4.0	298	194	7.5	170	170	246
30	340	22	11	22	.....	4.0	298	146	2.8	170	170	220
31	288	.....	11	22	.....	4.0	.....	146	.....	170	124	.....

Monthly discharge of Brazos River at Brazos, Tex., for the year ending September 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	5,700	24	1,020	62,700
November	236	22	69.3	4,120
December	22	11	16.3	1,000
January	30	11	15.2	935
February	22	11	12.0	666
March	11	4.0	4.90	301
April	438	.0	41.0	2,440
May	298	4.0	93.1	5,720
June	1,090	2.8	197	11,700
July	2,080	.8	254	15,600
August	1,140	.0	182	11,200
September	3,280	50	877	52,200
The year	5,700	.0	233	169,000

BRAZOS RIVER AT WACO, TEX.

LOCATION.—At suspension bridge on Bridge Street, in Waco, McLennan County, just below Southern Traction Co.'s bridge, 2½ miles below mouth of Bosque River, 4½ miles above mouth of Cottonwood Creek, about 9 miles above lock No. 8, now under construction.

DRAINAGE AREA.—25,500 square miles (revised).

RECORDS AVAILABLE.—September 14, 1898, to December 31, 1911; October 1, 1914, to September 30, 1917. Record of stage has been obtained by United States Weather Bureau since August 9, 1900.

GAGE.—Chain gage attached to downstream guard rail of bridge about 70 feet from southwest pier; read by A. E. Howell. Gage used from September 14, 1898, to February 29, 1908, was an inclined staff gage under left end of bridge. In 1902 a gage agreeing in datum with the inclined gage was marked off on the north pier of a new single-span highway bridge about 300 feet above the suspension bridge, and was used for high-water readings. From August 9, 1900, to May 21, 1902, the United States Weather Bureau used a vertical gage painted on the pier nearest the center of the St. Louis Southwestern Railway bridge. From September 25, 1914, to March 23, 1915, during reconstruction of suspension bridge, chain gage was on the one-span highway bridge. All gages were installed at same datum, but readings probably differ slightly because of differences in position.

DISCHARGES MEASUREMENT.—Made from downstream side of first one-span highway bridge above station.

CHANNEL AND CONTROL.—Bed composed of sand and gravel; shifts. Banks are clay, medium in height, have been improved by the city, and are overflowed at extreme high water. Channel straight above and below for several thousand feet. Position of control not known. Lock No. 8 will eventually form the control; effect at present is very slight.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 14.32 feet at 6.45 a. m. October 19 (discharge, 17,600 second-feet); minimum stage, 4.88 feet 6.50 a. m. April 19 (discharge, 49 second-feet).

1898–1917: Maximum stage recorded, 39.7 feet December 3, 1913 (discharge not determined); minimum stage, 0.80 foot several days during February, June, and July, 1911 (discharge, 4 second-feet).

ICE.—None reported during year.

DIVERSIONS.—So far as is known there are no diversions of any magnitude above station. Small areas of land are irrigated above station, but quantity of water diverted is only a small percentage of the total flow.

REGULATION.—None of importance.

ACCURACY.—Stage-discharge relation not permanent. Rating curve used as basis for ascertaining discharge by shifting-control method is fairly well defined. Gage read to quarter-tenths once daily. Slight error may be introduced by taking one daily gage reading as the mean for the day. Daily discharge ascertained by applying daily gage height to rating table directly, February 23 to April 29; by shifting-control method, October 1 to February 22, and April 30 to September 30. Records fair.

Discharge measurements of Brazos River at Waco, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 30	R. C. Thaxton	7.35	916	June 15	R. C. Thaxton	6.68	511
Jan. 6	R. J. Hank	5.35	107	July 11	Francisco and Gray	6.66	604
Mar. 15	Victor Lieb	5.29	83.7	Sept. 30	E. P. Congdon	7.77	1,620
Apr. 26	R. J. Hank	5.12	70.9				

Daily discharge, in second-feet, of Brazos River at Waco, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	168	646	174	125	93	69	113	2,320	271	820	198	1,160
2	178	522	190	125	81	71	83	1,440	306	745	178	1,100
3	168	456	194	140	79	73	75	973	2,060	652	158	1,080
4	152	400	190	140	81	82	113	588	1,660	474	124	1,080
5	131	364	174	125	79	78	110	368	790	1,920	125	1,230
6	128	334	170	107	79	80	77	274	522	574	95	768
7	116	292	158	114	93	130	77	242	678	212	95	396
8	119	264	154	122	94	92	69	232	1,040	344	95	888
9	116	230	119	119	91	92	57	218	4,590	210	95	1,670
10	104	210	134	119	98	106	56	212	4,380	160	85	2,560
11	104	200	134	110	91	100	55	4,140	1,790	555	225	3,390
12	101	184	125	107	89	92	144	4,000	1,490	414	400	3,280
13	104	168	122	107	91	92	73	1,460	946	260	355	2,380
14	101	164	134	91	98	73	83	919	594	330	110	1,350
15	101	164	125	95	91	78	75	522	478	330	75	1,100
16	152	164	119	95	85	80	73	404	672	330	77	1,000
17	240	160	119	100	89	73	73	352	850	232	73	775
18	1,430	148	119	120	89	73	67	254	991	220	67	672
19	13,900	144	119	118	89	73	49	228	964	232	74	910
20	6,900	144	125	120	85	80	69	316	937	462	78	2,900
21	4,930	144	110	154	79	82	67	919	919	208	74	1,840
22	5,350	700	107	136	89	80	69	1,260	895	186	81	1,240
23	3,800	700	110	120	85	82	63	973	858	146	88	910
24	2,940	271	110	132	77	73	63	1,010	760	1,300	84	715
25	2,270	240	125	114	77	154	69	506	633	1,310	768	568
26	1,890	240	156	112	77	146	69	396	812	715	1,040	500
27	1,490	240	125	114	77	118	67	600	1,220	418	1,340	409
28	1,270	196	119	114	75	174	85	360	1,270	373	1,980	355
29	1,130	176	119	114	.....	136	1,320	288	1,050	264	1,450	1,270
30	910	172	110	112	.....	120	4,550	248	937	248	1,190	1,670
31	775	.....	119	118	.....	102	.....	218	.....	210	1,250	.....

Monthly discharge of Brazos River at Waco, Tex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	13,900	101	1,650	101,000
November	700	144	281	16,700
December	194	107	136	8,360
January	154	91	117	7,190
February	98	75	85.8	4,770
March	174	69	95.3	5,860
April	4,550	49	267	15,900
May	4,140	212	846	52,000
June	4,590	271	1,180	70,200
July	1,920	146	479	29,500
August	1,980	67	391	24,000
September	3,390	355	1,310	78,000
The year	13,900	49	572	413,000

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Days of deficiency in discharge of Brazos River at Waco, Tex., for the years ending Sept. 30, 1901–1910 and 1915–1917.

Discharge in second-feet.	Days of deficient discharge.												
	1900–1	1901–2	1902–3	1903–4	1904–5	1905–6	1906–7	1907–8	1908–9	1909–10	1914–15	1915–16	1916–17
100	34	76	1	14	.....	.....	.....	.....	203	144	.....	.....	91
200	73	124	17	98	15	.....	1	2	260	220	.....	32	202
300	115	141	33	125	63	16	17	20	287	246	4	76	234
400	164	152	42	148	98	79	61	31	300	260	28	132	250
500	199	163	71	181	126	106	102	43	307	282	38	164	260
600	220	177	98	202	136	130	131	56	310	293	42	177	270
700	242	192	130	215	141	145	153	65	314	294	49	189	277
800	256	206	168	239	153	160	179	73	315	305	53	198	288
900	266	222	184	254	161	168	220	97	317	310	67	211	294
1,000	274	235	192	260	164	172	233	109	317	314	83	218	307
1,200	288	250	217	280	184	196	265	153	326	322	124	231	319
1,400	296	265	230	286	195	210	271	183	328	329	152	247	332
1,600	299	279	243	298	214	233	290	218	335	336	176	258	338
1,800	301	292	256	300	227	242	298	232	340	338	199	265	342
2,000	306	302	259	304	233	249	302	250	341	341	204	273	346
2,500	314	314	274	313	245	279	317	274	345	347	223	287	350
3,000	326	323	293	322	252	297	325	291	348	348	245	298	353
4,000	337	327	320	333	274	315	338	307	353	350	277	317	356
5,000	345	337	332	344	291	322	347	318	356	351	294	327	362
6,000	349	342	339	349	308	335	354	325	358	352	306	335	363
7,000	352	346	342	354	314	340	355	329	358	355	314	342	364
8,000	354	350	348	356	320	343	357	333	360	357	316	344	364
9,000	357	351	352	357	329	347	358	335	360	357	321	347	364
10,000	358	352	354	360	331	352	359	337	360	357	326	352	364
15,000	361	357	359	364	343	359	365	343	360	362	339	357	365
20,000	363	359	361	365	354	361	.....	348	362	362	344	359	.....
40,000	365	361	365	366	362	364	.....	356	365	365	354	361	.....
60,000	.....	363	.....	.....	364	365	.....	359	.....	.....	357	365	.....
80,000	.....	365	.....	.....	364	.....	.....	360	.....	.....	361	365	.....
100,000	.....	.....	.....	.....	365	.....	.....	363	.....	.....	365	366	.....
150,000	.....	.....	.....	.....	.....	.....	.....	366	.....	.....	.....	.....	.....

CLEAR FORK OF BRAZOS RIVER NEAR ELIASVILLE, TEX.

LOCATION.—At new suspension highway bridge 2½ miles northeast of Eliasville, Young County, 4½ miles southwest of South Bend, 6 miles above mouth of stream, and below all tributaries.

DRAINAGE AREA.—5,650 square miles.

RECORDS AVAILABLE.—November 12, 1915, to September 30, 1917.

GAGE.—Chain gage attached to downstream side of bridge; read by Alice Vaughn.

DISCHARGE MEASUREMENTS.—Made from bridge or by wading.

CHANNEL AND CONTROL.—Banks high, wooded, composed of clay and gravel, and not subject to overflow. Bed composed of sand and gravel; free from vegetation. Channel straight above and below station. A shoal about 600 feet below station serves as control for low and medium stages; control shifts during changing stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 10.8 feet 5.15 p. m. October 18 (discharge, 2,710 second-feet); no flow during a large part of the year.

1916–17: Maximum stage recorded, 18.2 feet 6 p. m. May 2, 1916 (discharge, 6,630 second-feet); no flow for extended periods.

ICE.—None reported during year.

DIVERSIONS.—Much of the land now irrigated above the station is in Jones and Taylor counties; two diversions are made for irrigation between station and confluence of Clear Fork with Brazos River. Quantity of water diverted unknown. According to the Second Report of the Board of Water Engineers for the State of Texas, the Sweetwater Light & Power Co. has declared a storage of 216 acre-feet, and Abilene Water Co. a continuous use of 1.5 second-feet of water in the headwater region.

REGULATION.—No large reservoirs above or below station. The operation of a water; power grist mill 5 miles upstream produces some effect at the station.

ACCURACY.—Stage-discharge relation not permanent. Rating curve fairly well defined below 9,000 second-feet. Rating curve previously used for 1915–16 has been revised on account of high-water measurements made in 1918. Gage read to hundredths twice daily; observer's work not entirely satisfactory; mean daily gage height may not be true index of daily flow because of regulation for power. Daily discharge ascertained by applying mean daily gage heights to rating table: directly, November 12, 1915 to April 1, 1916, and May 2 to September 30, 1916 by shifting control method, April 2 to May 1, 1916, and October 1, 1916 to September 30, 1917. Records fair.

Records of daily and monthly discharge for 1915–16, based on revised rating curve, are published herewith, and supersede those previously published.

Discharge measurements of Clear Fork of Brazos River near Eliasville, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 1	R. C. Thaxton	4.02	29.9	June 16	R. C. Thaxton	2.97	4.0
Jan. 3	R. J. Hank	2.84	.0	July 9	Gray and Francisco	2.72	*a*.2
Mar. 13	Victor Lieb	.....	.0	Sept. 7	E. P. Congdon	3.34	25.1
Apr. 23	R. J. Hank	.....	.0				

a Estimated.

Daily discharge, in second-feet, of Clear Fork of Brazos River near Eliasville, Tex., for the years ending Sept. 30, 1916 and 1917.

Day.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1915–16.											
1	.....	2.6	3.2	1.2	1.6	585	302	437	453	14	0.0
2	.....	2.6	3.2	1.4	1.6	6,300	200	278	14	.0	
3	.....	2.6	3.0	1.4	1.6	2,920	1,170	122	190	12	.0
4	.....	2.2	3.2	1.4	1.6	1,570	354	79	172	11	.0
5	.....	2.3	3.5	1.4	1.6	1,080	302	63	149	10	.0
6	.....	2.2	3.5	1.4	1.6	385	133	50	109	10	.0
7	.....	2.3	2.9	1.7	1.6	130	120	47	86	10	.0
8	.....	2.3	3.5	1.4	1.6	194	82	38	72	10	.0
9	.....	2.3	4.5	1.4	1.6	144	58	33	52	6.8	.0
10	.....	2.6	4.0	1.4	1.6	63	48	30	52	5.0	.0
11	.....	2.6	3.2	1.4	1.6	53	44	21	52	4.5	.0
12	6.4	3.2	3.2	1.4	1.6	43	44	21	52	3.5	.0
13	7.6	2.6	2.8	1.4	1.6	43	40	21	52	3.5	.0
14	4.0	2.4	3.5	1.6	1.6	43	40	15	43	3.5	.0
15	3.8	2.3	3.5	1.6	1.6	43	28	15	35	3.4	.0
16	4.8	5.0	4.0	1.4	1.6	43	24	222	35	2.6	.0
17	5.0	5.2	3.2	1.4	1.6	43	24	106	35	2.0	.0
18	4.5	5.8	1.2	1.4	1.6	43	24	71	35	.5	.0
19	5.0	5.0	1.2	1.4	3.5	43	17	51	35	.5	.0
20	5.5	5.5	1.4	1.4	2.0	43	17	44	33	.5	.0
21	4.0	5.0	1.4	1.4	2.0	43	17	44	31	.5	.0
22	3.8	5.0	1.4	1.6	2.0	43	17	44	31	.4	.0
23	3.4	5.0	1.4	1.4	2.0	39	17	58	27	.0	.0
24	3.8	5.0	1.6	1.2	2.0	37	16	57	27	.0	.0
25	3.5	5.0	1.4	1.2	2.0	37	26	52	27	.0	.0
26	3.4	5.0	1.4	1.6	2.0	33	38	52	27	.0	.0
27	3.5	4.8	1.4	1.2	2.0	26	38	52	27	.0	.0
28	3.5	4.5	1.4	1.2	2.0	29	38	64	27	.0	.0
29	3.2	4.2	1.4	1.2	2.0	29	1,040	1,500	20	.0	.0
30	2.9	4.5	1.4	.....	2.0	37	4,410	1,000	14	.0	.0
31	.....	4.5	1.4	.....	2.0	.....	2,700	.....	14	.0	.....

Daily discharge, in second-feet, of Clear Fork of Brazos River near Eliasville, Tex., for the years ending Sept. 30, 1916 and 1917—Continued.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1916–17												
1	0.0	2.3	0.8	0.0	0.0	0.0	0.0	0.0	147	0.8	0.8	5.2
2	.0	2.3	.8	.0	.0	.0	.0	.0	82	.6	.5	4.8
3	.0	2.3	.8	.0	.0	.0	.0	.0	236	.5	.4	32
4	.0	2.3	.8	.0	.0	.0	.0	.0	200	.4	.3	97
5	.0	2.3	.8	.0	.0	.0	.0	2.0	166	.4	.2	97
6	.0	2.3	.8	.0	.0	.0	.0	2.0	135	.4	.2	63
7	.0	2.3	.8	.0	.0	.0	.0	2.0	67	.3	.1	21
8	.0	2.3	.8	.0	.0	.0	.0	1.8	39	.2	.1	13
9	.0	1.6	.8	.0	.0	.0	.0	1.8	29	.2	.0	100
10	.0	1.6	.8	.0	.0	.0	.0	1.7	22	.1	.0	79
11	.0	.8	.8	.0	.0	.0	.0	.5	22	.1	.0	63
12	.0	.8	.8	.0	.0	.0	.0	.0	16	.0	.0	53
13	.0	.8	.8	.0	.0	.0	.0	.0	9.6	.0	.0	46
14	.0	.8	.8	.0	.0	.0	.0	.0	5.2	.0	.0	133
15	.0	.8	.8	.0	.0	.0	.0	.0	4.2	.0	.0	100
16	.0	.8	.8	.0	.0	.0	.0	.0	4.0	.0	.0	62
17	.2	.8	.8	.0	.0	.0	.0	.0	3.8	.0	.0	50
18	2,690	.8	.8	.0	.0	.0	.0	.0	3.4	.0	.0	41
19	633	.8	.8	.0	.0	.0	.0	.0	3.0	.0	1.7	33
20	761	.8	.8	.0	.0	.0	.0	.0	2.8	.5	208	26
21	405	.8	.8	.0	.0	.0	.0	.0	2.4	127	35	19
22	138	.8	.8	.0	.0	.0	.0	1,300	2.4	54	20	11
23	78	.8	.8	.0	.0	.0	.0	465	2.0	15	10	7.2
24	52	.8	.8	.0	.0	.0	.0	172	1.8	5.5	5.2	30
25	30	.8	.8	.0	.0	.0	.0	135	1.6	4.5	3.0	3.8
26	18	.8	.5	.0	.0	.0	.0	69	1.6	3.2	2.0	3.4
27	18	.8	.5	.0	.0	.0	.0	46	1.4	2.3	1.4	3.0
28	6.8	.8	.5	.0	.0	.0	.0	33	1.2	1.8	1.1	2.8
29	6.8	.8	.5	.0	.....	.0	.0	22	1.2	1.7	6.0	2.4
30	6.8	.8	.0	.0	.....	.0	.0	17	1.0	1.4	8.4	2.2
31	6.8	.....	.0	.0	.....	.0	.....	725	.....	1.1	7.2	.....

Monthly discharge of Clear Fork of Brazos River near Eliasville, Tex., for the years ending Sept. 30, 1916 and 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1915–16.				
November 12–30	7.6	2.9	4.29	162
December	5.8	2.2	3.75	231
January	4.5	1.2	2.49	153
February	1.7	1.2	1.40	81
March	3.5	1.6	1.82	112
April	6,300	26	472	28,100
May	6,280	16	565	34,700
June	1,500	15	154	9,160
July	453	14	73.9	4,540
August	14	.0	4.14	255
September	.0	.0	.00	0
The period	6,300	.0	121	77,500
1916–17.				
October	2,690	.0	156	9,590
November	2.3	.8	1.25	74
December	.8	.0	.71	44
January	.0	.0	.00	0
February	.0	.0	.00	0
March	.0	.0	.00	0
April	.0	.0	.00	0
May	1,300	.0	96.6	5,940
June	236	1.0	40.5	2,410
July	127	.0	7.16	440
August	208	.0	10.1	621
September	133	2.2	40.1	2,390
The year	2,690	.0	29.7	21,500

LITTLE RIVER AT CAMERON, TEX.

LOCATION.—200 feet below city pumping plant, half a mile south of Cameron, Milam County, 1 mile above Gulf, Colorado & Santa Fe Railway bridge, 6 miles below mouth of San Gabriel River, and 25 miles above confluence with Brazos River.

DRAINAGE AREA.—7,010 square miles (measured on topographic maps, Hill's map of Texas, and Post Route maps).

RECORDS AVAILABLE.—November 1, 1916, to September 30, 1917.

GAGE.—Vertical and inclined staff; three sections, attached to trees on left bank a short distance below home of pump man; read by Bert Petty.

DISCHARGE MEASUREMENTS.—Made from cable at gage or by wading.

CHANNEL AND CONTROL.—Bed composed of rock, gravel, and sand; permanent during normal flow and free from vegetation. Banks clay and gravel; medium height; wooded; subject to overflow only during extreme stages. Rock and gravel shoal 100 feet below gage serves as control for low and medium stages; subject to change during flood stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 16.50 feet at 7 a. m. September 7 (discharge, 5,860 second-feet); minimum stage, 0.93 foot at 7 a. m. September 1 (discharge, 6.5 second-feet).

ICE.—None reported during year.

DIVERSIONS.—Small areas are irrigated in the upper drainage basin, but such diversions have little effect on flow at station. Second Report of the Board of Water Engineers for the State of Texas lists a filing by Cameron Power & Light Co. for continuous use of 5 second-feet with a declared consumption of 3,650 acre-feet per annum for waterworks, light, and power in Cameron. During times of low flow, water pumped by Cameron Power & Light Co. will affect the flow at this station.

REGULATION.—None apparent beyond slight effect of pumping for city of Cameron.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined below 13,000 second-feet by discharge measurements made in 1917 and 1918. Gage read to hundredths twice daily. Daily discharge ascertained by applying mean daily gage height to rating table. Records good.

Discharge measurements of Little River at Cameron, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 2	Gray and Hank	1.88	114	June 5	Hank and Francisco	4.82	976
17	R. J. Hank	1.70	89.0	5	do	4.62	918
Jan. 7	do	1.78	96.3	6	do	3.28	477
Feb. 11	do	1.78	96.5	6	do	2.93	381
Mar. 16	Victor Lieb	1.68	83.9	6	do	2.71	326
May 12	R. J. Hank	1.92	129	July 23	E. O. Francisco	2.20	175
June 5	Hank and Francisco	5.45	1,260	Aug. 25	do	1.00	10.5
5	do	5.29	1,160	Sept. 29	E. P. Congdon	1.18	26.8
5	do	5.15	1,100				

Daily discharge, in second-feet, of Little River at Cameron, Tex., for the year ending Sept. 30, 1917.

Day.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	114	112	94	93	80	87	53	352	78	40	7.0
2	114	109	99	87	81	86	49	245	65	34	99
3	105	102	96	84	80	80	62	216	55	29	180
4	98	104	102	84	81	80	565	1,040	48	25	752
5	93	102	100	82	81	80	481	1,060	93	22	1,980
6	90	102	98	84	82	102	400	424	86	21	4,490
7	87	104	98	87	87	334	262	221	72	20	5,190
8	82	98	99	90	82	176	204	160	55	17	1,480
9	82	96	96	93	81	119	180	169	39	16	514
10	86	93	93	100	84	99	150	130	35	14	361
11	84	93	93	99	84	87	134	112	31	12	475
12	81	90	90	98	82	762	123	204	31	16	736
13	78	88	87	96	81	713	117	165	29	13	234
14	76	90	84	96	81	273	346	130	27	10	228
15	78	92	86	98	82	180	403	102	29	9.0	192
16	76	88	86	99	81	127	373	81	33	8.0	119
17	86	90	88	99	80	102	643	70	27	7.0	94
18	90	88	93	96	78	98	815	65	125	7.5	67
19	90	87	96	90	76	382	622	58	119	9.5	56
20	88	87	98	88	78	2,080	433	50	102	8.0	165
21	93	90	99	88	78	298	329	48	138	9.0	54
22	109	87	105	90	80	105	690	45	162	8.5	46
23	204	90	100	87	78	87	472	41	180	12	41
24	373	90	99	87	78	75	394	36	194	13	37
25	256	90	102	88	75	61	273	33	197	10	33
26	194	92	96	86	84	61	568	31	116	9.0	31
27	190	90	96	84	92	59	1,020	802	76	8.0	31
28	169	93	96	80	90	60	865	323	58	8.0	29
29	138	93	94	.....	105	55	915	130	45	8.0	26
30	123	93	94	.....	102	50	888	102	39	7.0	25
31	.....	96	93	.....	93	.....	577	.....	48	7.0	.....

NOTE.—Discharge Nov. 1 estimated from data furnished by engineer.

Monthly discharge of Little River at Cameron, Tex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
November	373	76	121	7,200
December	112	87	94.2	5,790
January	105	84	95.2	5,850
February	100	80	90.5	5,030
March	105	75	83.1	5,110
April	2,080	50	232	13,800
May	1,020	49	432	26,600
June	1,060	31	222	13,200
July	197	27	78.5	4,830
August	40	7.0	14.1	867
September	5,190	7.0	592	35,200
The period	5,190	7	186	123,000

COLORADO RIVER BASIN.

COLORADO RIVER NEAR BRONTE, TEX.

LOCATION.—At wagon bridge 400 feet below Kansas City, Mexico & Orient Railroad bridge, 1½ miles above mouth of Kickapoo Creek and below mouth of Live Oak Creek, 2½ miles south of Bronte, Coke County

DRAINAGE AREA.—5,550 square miles.

RECORDS AVAILABLE.—September 19, 1915, to September 30, 1917.

GAGE.—Chain gage attached to downstream side of bridge near left bank. Read by R. W. Legg. A vertical staff gage attached to left bent of railroad bridge 400 feet above present site and referred to same datum was used from September 19, 1915, to October 29, 1915.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge or by wading.

CHANNEL AND CONTROL.—Bed composed of a clay hardpan mixed with gravel; shifts; channel straight about 500 feet above and below station. Right bank wooded, sloping, and subject to overflow at extreme stages; left bank high, clean, and not subject to overflow. Control probably at shoal 300 feet below gage.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 15.0 feet at 1.30 p. m. October 15 (discharge not determined); no flow during several periods throughout the year.

1915–1917: Maximum stage recorded, 15.0 feet, 2 a. m. September 25, 1916, and 1.30 p. m. October 15, 1916 (discharge not determined); no flow during periods throughout the record.

ICE.—Slight ice reported in middle of January.

DIVERSIONS.—Some water is diverted for irrigating small areas in Coke and Mitchell counties and for municipal use of the city of Robert Lee. No large irrigation projects developed in drainage basin above station. The Second Report of the Board of Water Engineers for the State of Texas records a filing at Robert Lee on a small quantity of water for storage, but this storage will not influence flow at station.

REGULATION.—Flow not affected by water-power plants or controlling works.

ACCURACY.—Stage-discharge relation not permanent. Standard rating curve well defined below 400 second-feet and extended above 450 second-feet. Gage read to hundredths twice daily. Daily discharge ascertained by shifting-control method throughout the year. Records fair.

Discharge measurements of Colorado River near Bronte, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 9	R. J. Hank	1.53	*a* 1.5	Aug. 12	E. P. Congdon	1.53	*a* 0.2
Dec. 10	....do	1.65	3.9	Sept. 20	....do	1.99	14.2
May 20	Victor Lieb	2.51	114	21	....do	2.67	122
July 3	Francisco and Gray	1.61	*a*. 2				

a Estimated.

Daily discharge, in second-feet, of Colorado River near Bronte, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	12	5.6	5.9	4.5	1.0	0.0	0.0	0.0	0.5	0.0	4.1	201
2	8.5	5.6	5.6	4.5	1.0	.5	.0	.0	.5	.2	20	116
3	6.6	5.6	5.6	4.5	1.0	.5	.0	.0	1,600	.2	14	890
4	5.6	5.6	5.6	3.8	1.0	.5	.0	.0	116	.0	6.6	1,220
5	4.1	5.6	4.8	3.2	1.0	.3	.0	.0	60	.0	47	362
6	3.2	4.1	4.5	2.4	1.0	.3	.0	.5	23	.0	18	191
7	3.0	3.8	4.1	1.8	1.0	.3	.0	.2	11	.0	12	780
8	2.4	3.4	4.1	1.6	1.0	.2	.0	.0	7.5	.0	5.9	264
9	2.0	3.4	4.0	1.4	1.0	.2	.0	.0	5.9	.0	3.2	160
10	1.8	3.0	3.8	1.4	1.0	.2	.0	85	5.6	.0	.1	242
11	.7	2.6	3.4	1.4	1.0	.3	2.0	21	3.4	.0	.1	729
12	.5	2.6	3.4	1.2	1.0	.3	1.2	136	.0	.0	.1	622
13	32	2.6	3.4	1.2	1.0	.5	.3	8.0	.0	.0	.1	264
14	26	2.6	3.2	1.2	1.0	.5	.3	2.8	.0	.0	.1	109
15	2,400	2.6	3.0	1.6	1.0	.5	.3	1.8	.0	.0	.1	41
16	1,800	2.6	2.8	1.6	1.0	.5	73	.2	.0	.0	.1	47
17	1,500	2.6	2.8	1.6	1.0	.5	32	.0	.0	.0	.1	28
18	566	2.6	2.6	1.8	.7	.5	254	.0	.0	.3	30	21
19	322	2.6	2.6	1.8	.5	.5	11	272	.0	360	5.6	17
20	205	2.6	2.6	1.8	.5	.5	10	105	1.4	107	1.8	14
21	127	307	2.6	1.8	.3	.5	7.0	10	.0	77	18	173
22	91	191	2.6	1.8	.3	.5	4.8	3.2	.0	131	2.8	20
23	58	47	2.6	1.6	.2	.5	3.4	1.8	.0	158	43	8.0
24	43	23	2.6	1.6	.0	.5	2.6	1.6	147	79	23	7.0
25	25	17	2.6	1.4	.0	.5	2.6	1.0	75	50	14	3.4
26	19	9.5	2.6	1.4	.0	.5	1.8	.5	30	21	4.8	1.8
27	14	8.0	2.2	1.4	.0	.5	.7	.2	14	6.3	2.8	1.8
28	12	7.0	2.2	1.4	.0	.5	.7	.2	4.8	4.8	56	.1
29	10	7.0	2.0	1.4	.....	.3	.7	.7	3.2	3.4	7.5	.0
30	7.5	7.0	1.8	1.4	.....	.3	.5	.7	1.4	30	553	.0
21	6.6	.....	1.8	1.4	.....	.3	.....	.7	.....	58	330	.....

NOTE.—Discharge on Dec. 9, Apr. 12, June 29, July 25 and 28, Aug. 7, 15, 16, and 25 obtained by interpolation.

Monthly discharge of Colorado River near Bronte, Tex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	2,400	0.5	236	14,500
November	307	2.6	23.2	1,380
December	5.9	1.8	3.34	205
January	4.5	1.2	1.96	121
February	1.0	.0	.70	39
March	.5	.0	.40	25
April	254	.0	13.6	809
May	272	.0	21.1	1,300
June	1,600	.0	70.3	4,180
July	360	.0	35.0	2,150
August	553	.1	39.5	2,430
September	1,220	.0	218	13,000
The year	2,400	.0	55.4	40,100

COLORADO RIVER AT BALLINGER, TEX.

LOCATION.—At Hutchins Avenue highway bridge, 800 feet below Gulf, Colorado & Santa Fe Railway bridge in Ballinger, Runnels County, 1 mile above mouth of Elm Creek.

DRAINAGE AREA.—6,460 square miles (revised).

RECORDS AVAILABLE.—December 11, 1915, to September 30, 1917. Records of stage have been obtained by the United States Weather Bureau since July 1, 1903; current-meter measurements were begun May 29, 1915.

GAGE.—Chain gage attached to downstream handrail of bridge; read by A. J. Voelkel.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge or by wading.

CHANNEL AND CONTROL.—Banks consist of clay and gravel; medium height and wooded; subject to overflow at extremely high stages. Bed composed of hard clay, sand and gravel; somewhat shifting. Control is shoal about 1,000 feet below gage; subject to change.

ICE.—None reported during year.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 11.50 feet at noon October 17 (discharge not determined). No flow during several periods throughout year.

1916–17: Maximum stage recorded, October 17, 1916 (see preceding paragraph); minimum stage, no flow during several periods.

DIVERSIONS.—During low stages a large part of the flow is diverted above the station by gravity or pumping. The Second Report of the Board of Water Engineers for the State of Texas shows 3,307 acres in Runnels County, above the station, to have been declared irrigated by use of 6,614 acre-feet of water. This report also shows filings by cities of Ballinger and Winters for continuous use of 1 and 4 second-feet, respectively, for waterworks. The city of Ballinger started to pump water from river just above station the last of April, 1917, and continued to pump part of its supply therefrom throughout the summer.

REGULATION.—None.

ACCURACY.—Stage-discharge relation not permanent. Rating curve fairly well defined below 600 second-feet and extended above. Gage read to hundredths twice daily. Daily discharge ascertained by applying mean daily gage height to rating table: directly, June 3 to September 4; by shifting-control method, October 1 to June 2, and September 5–29. Discharge interpolated September 30. Records below 1,000 second-feet are fair; above that they may be subject to considerable error.

Discharge measurements of Colorado River at Ballinger, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 11	R. J. Hank	0.65	3.4	May 22	Victor Lieb	1.19	78.2
Dec. 9	do	.66	5.5	July 2	Gray and Francisco	.51	*a*.1
May 18	Victor Lieb	.70	3.0	Sept. 22	E. P. Congdon	1.13	94.5

a Estimated.

Daily discharge, in second-feet, of Colorado River at Ballinger, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	45	29	16	3.4	3.6	5.4	8.9	0.0	1.8	0.7	64	238
2	42	20	16	3.4	3.8	6.1	4.0	.0	1.6	.5	16	147
3	40	15	16	3.4	3.8	6.1	3.6	.0	3,600	.0	5.4	157
4	38	15	16	3.4	3.8	6.1	3.4	.0	259	.0	1.2	2,000
5	20	15	16	3.4	3.8	6.1	3.2	.0	98	.0	.1	820
6	19	15	16	3.4	3.8	6.1	3.2	.0	45	.0	1.8	348
7	18	15	2.8	3.4	3.8	5.4	3.2	.0	23	.0	31	760
8	16	15	2.8	3.4	3.8	4.7	3.2	.0	10	.0	16	662
9	15	15	2.6	3.4	3.8	4.0	3.2	.0	6.8	.0	4.0	315
10	2.4	15	3.8	3.4	3.8	3.8	3.2	.0	4.7	.0	1.2	246
11	2.4	2.8	2.8	3.4	3.8	3.4	5.4	6.8	3.6	.0	.1	628
12	2.4	2.8	2.8	3.4	3.8	3.4	5.4	78	3.2	.0	.0	1,140
13	29	2.8	1.8	3.4	3.8	3.4	4.0	90	2.2	.0	.0	378
14	48	2.8	.9	3.4	4.0	2.6	4.0	24	1.2	.0	.0	175
15	409	2.8	.9	3.6	4.0	3.2	4.0	8.9	.1	.0	.0	92
16	62	2.8	.9	3.8	4.7	568	3.6	4.0	.0	.0	.0	70
17	3,200	2.8	.9	3.8	5.4	12	4.0	3.2	.0	.0	.0	48
18	1,460	2.8	.9	4.7	5.4	5.4	1,560	2.6	.1	.0	.0	28
19	420	2.8	.9	4.7	5.4	4.7	120	2.6	.1	.0	.0	13
20	334	2.8	.9	5.4	5.4	4.7	33	2,300	.1	200	.0	16
21	200	2.8	.9	5.4	5.4	4.0	12	601	.1	73	4.0	144
22	114	2.8	.9	4.7	4.7	4.0	7.5	84	.0	62	42	137
23	76	67	.9	4.7	4.7	4.0	3.8	23	.0	98	5.4	50
24	67	35	1.8	3.8	4.7	3.8	2.2	10	1.8	92	2.2	20
25	64	21	1.8	3.8	5.4	3.8	1.2	4.7	363	35	4.7	11
26	53	16	2.8	3.8	5.4	3.8	.5	3.4	81	11	5.4	8.2
27	53	16	2.8	3.8	5.4	3.4	.3	2.4	20	9.6	3.6	5.4
28	53	16	3.2	3.8	5.4	2.4	.1	2.2	7.5	3.4	2.2	4.7
29	53	16	3.4	3.8	.....	1.4	.1	2.0	4.0	3.0	16	6.1
30	53	16	3.6	3.8	.....	.1	.0	4.0	1.8	3.4	320	5.8
31	53	.....	3.6	3.8	.....	.0	.....	2.4	.....	404	491	.....

Monthly discharge of Colorado River at Ballinger, Tex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	3,200	2.4	228	14,000
November	67	2.8	13.5	803
December	16	.9	4.75	292
January	5.4	3.4	3.83	236
February	5.4	3.6	4.45	247
March	568	.0	22.4	1,380
April	1,560	.0	60.3	3,590
May	2,300	.0	105	6,460
June	3,600	.0	151	8,980
July	404	.0	32.1	1,970
August	491	.0	33.5	2,060
September	2,000	4.7	289	17,200
The year	3,600	.0	79.1	57,200

COLORADO RIVER NEAR CHADWICK, TEX.

LOCATION.—At Gulf, Colorado & Santa Fe Railway bridge half a mile below Chadwick dam, 1 mile above mouth of Elliott Creek, 2 miles west of Chadwick, on line between San Saba and Lampasas counties, 2½ miles below mouth of San Saba River.

DRAINAGE AREA.—26,400 square miles.

RECORDS AVAILABLE.—October 21, 1915, to September 30, 1917.

GAGE.—Inclined staff in three sections, attached to rock ledge on left bank about 75 feet upstream from railway bridge; read by A. G. Walker. A high-water section is painted on left face of left bridge pier. A vertical staff on right bank directly opposite inclined gage is used during low water. Gages refer to same datum.

DISCHARGE MEASUREMENTS.—Made from cable 400 feet below gage, or by wading.

CHANNEL AND CONTROL.—Bed composed of rock and gravel; not likely to shift. Channel straight above and below station for 1,000 feet. Left bank high, rocky, wooded, and not subject to overflow; right bank medium in height, wooded, composed of clay and gravel, and subject to overflow during extreme stages. Position of control not known, but current-meter measurements indicate that it is practically permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 17.0 feet at 3 p. m. September 4 (discharge, 15,300 second-feet; determined from extension of rating curve and possibly subject to slight error); minimum stage, 0.34 foot July 20 and 21 and August 20 (discharge 18 second-feet).

1916–1917: Maximum and minimum stages occurred in 1917.

ICE.—None reported during year.

DIVERSIONS.—No large irrigation works have been completed in drainage basin above station, but tracts ranging in size from 5 to 1,500 acres adjacent to the main river and tributaries are irrigated by diversion. A large part of the irrigated area is in Runnels, Brown, and Mills counties and along Concho and San Saba rivers. Several small dams have been constructed in the drainage basin above station. Chadwick dam, half a mile above, creates a small pond and serves only to divert to a water wheel that has not been operated for some time.

REGULATION.—Flow not regulated by dams or reservoirs.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve well defined between 10 and 13,000 second-feet. Rating curve previously used for 1915–16 has been revised on account of high-water measurements secured in 1918. Gage read to hundredths once daily. Daily discharge ascertained by applying daily gage height to rating table. Records good.

Records of daily and monthly discharge for 1915–16 based on revised rating curve, are published herewith, and supersede those previously published.

Discharge measurements of Colorado River near Chadwick, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Dec. 11	R. J. Hank	1.14	146	May 13	Victor Lieb	6.04	2,820
Feb. 9	Victor Lieb	1.04	121	June 4	do	4.18	1,350
Apr. 19	R. J. Hank	.76	60.6	July 1	E. O. Francisco	1.11	146
20	do	1.50	278				

Daily discharge, in second-feet, of Colorado River near Chadwick, Tex., for the years ending Sept. 30, 1916 and 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1915–16.												
1	.....	320	190	248	378	155	750	750	290	34	48	166
2	.....	308	196	255	262	148	2,560	11,500	160	48	51	160
3	.....	290	199	255	255	140	3,760	8,160	160	47	51	130
4	.....	238	202	248	248	135	2,560	3,320	135	45	53	785
5	.....	283	196	238	244	135	1,100	1,510	130	42	55	1,010
6	.....	318	202	230	244	135	1,020	1,020	122	40	55	660
7	.....	272	3,060	230	238	130	1,250	825	110	38	48	388
8	.....	255	1,330	230	227	128	6,550	668	110	38	45	297
9	.....	262	482	230	220	122	1,650	580	110	42	40	190
10	.....	255	388	230	220	122	1,250	430	105	42	40	172
11	.....	255	342	220	211	122	1,040	395	90	42	40	160
12	.....	244	300	220	211	122	800	367	85	45	40	155
13	.....	255	290	220	211	122	465	325	81	45	40	430
14	.....	262	283	214	205	115	395	325	69	42	42	465
15	.....	248	283	205	205	115	1,870	308	69	42	42	500
16	.....	238	290	205	205	115	520	290	1,200	34	40	430
17	.....	237	290	205	199	115	412	290	850	31	40	325
18	.....	220	283	205	196	115	1,100	2n2	367	31	37	318
19	.....	214	255	205	190	115	423	2,030	220	37	35	248
20	.....	205	255	205	190	115	402	1,020	190	41	34	184
21	2,990	196	255	1,640	184	115	395	2,110	190	45	34	135
22	1,760	205	255	1,580	184	115	360	1,020	145	48	34	120
23	1,080	214	255	800	181	115	342	482	110	45	33	115
24	825	205	262	465	175	115	325	395	81	45	34	110
25	412	205	255	370	175	130	325	395	77	44	34	110
26	520	199	238	336	166	130	318	332	65	45	34	860
27	493	196	227	290	160	122	318	255	56	48	30	4,790
28	402	196	227	272	160	115	255	205	53	51	30	980
29	378	196	227	255	155	115	238	1,020	48	51	32	720
30	360	205	230	248	.....	110	220	500	41	51	32	395
31	332	.....	248	465	.....	110	.....	395	.....	48	33	.....
1916–17.												
1	325	138	174	98	104	111	81	300	860	111	42	1,170
2	202	111	168	98	104	116	74	213	440	102	111	213
3	160	111	168	98	104	116	70	174	5,380	89	89	820
4	135	111	138	100	107	116	168	138	3,510	85	78	15,300
5	120	111	133	102	107	116	138	111	1,900	61	55	6,220
6	85	107	130	104	111	116	93	107	1,820	40	55	5,230
7	81	107	127	107	116	114	85	98	820	33	45	3,210
8	81	104	127	107	116	114	74	89	700	31	42	2,000
9	79	102	127	107	122	114	70	81	405	29	42	1,260
10	69	98	127	107	116	114	67	70	111	27	42	1,280
11	65	89	150	104	116	111	61	61	98	26	35	860
12	55	89	144	104	116	111	58	55	70	24	35	1,140
13	51	89	122	104	116	111	58	2,960	67	22	31	1,400
14	77	83	119	104	119	111	55	1,370	64	21	29	1,890
15	69	83	116	104	119	111	55	708	58	21	29	948
16	220	81	111	104	116	111	58	512	55	21	26	820
17	360	81	111	111	116	111	58	377	55	20	22	526
18	6,110	80	107	116	111	2,830	61	314	47	20	22	377
19	11,700	80	102	122	111	820	64	232	42	20	22	300
20	2,380	80	102	122	111	476	81	440	35	18	18	273
21	1,440	80	100	119	111	300	1,650	1,510	33	18	440	246
22	820	96	100	111	111	200	740	10,000	31	440	660	200
23	732	111	98	111	111	168	440	3,760	31	405	370	138
24	541	363	98	111	111	138	111	1,520	31	384	168	122
25	440	820	98	107	111	111	111	892	700	370	111	107
26	363	548	98	107	111	111	111	660	860	266	107	89
27	280	370	98	107	111	106	107	433	740	89	93	122
28	266	342	98	107	111	101	422	384	620	78	93	111
29	239	232	98	107	.....	96	370	370	489	47	85	102
30	213	181	96	107	.....	89	300	286	370	45	85	89
31	168	.....	96	104	.....	85	.....	252	.....	42	85	.....

NOTE.—1915–16. Discharge Nov. 1, Jan. 5, Feb. 2, Aug. 10, and Sept. 8 and 24 estimated from observer's notes and information collected by engineers.

1916–17. Discharge Nov. 22 and 25, Dec. 24–26, and 31, Feb. 6–8, Mar. 27–29, May 12 and 22, June 5 and 27, Aug. 21 and 28–31, and Sept. 8 and 12 estimated from observer's notes and information collected by engineers. Determination of discharge Sept. 4 obtained from extension of rating curve and possibly subject to slight error.

Monthly discharge of Colorado River near Chadwick, Tex., for the years ending Sept. 30, 1916 and 1917.

Month.	Discharge in second-feet.			Run-off (in total acre-feet).
	Maximum.	Minimum.	Mean.	
1915–16.				
October 21–31	2,990	332	868	18,900
November	320	196	240	14,300
December	3,060	190	387	23,800
January	1,640	205	362	22,300
February	378	155	210	12,100
March	155	110	123	7,560
April	6,550	220	1,100	65,500
May	11,500	205	1,340	82,400
June	1,200	41	184	10,900
July	51	31	42.8	2,630
August	55	30	39.9	2,450
September	4,790	110	517	30,800
The period	11,500	30	427	294,000
1916–17.				
October	11,700	51	901	55,400
November	820	80	169	10,100
December	174	96	119	7,320
January	122	98	107	6,580
February	122	104	112	6,220
March	2,830	85	244	15,000
April	1,650	55	196	11,700
May	10,600	55	919	56,500
June	5,380	31	681	40,500
July	440	18	96.9	5,960
August	660	18	102	6,270
September	15,300	89	1,550	92,200
The year	15,300	18	434	314,000

COLORADO RIVER AT MARBLE FALLS, TEX.

LOCATION.—At steel highway bridge one-fourth mile south of Marble Falls, Burnet County, 10 miles below mouth of Sandy Creek, 16 miles below mouth of Llano River, and 23 miles above mouth of Pedernales River.

DRAINAGE AREA.—32,200 square miles.

RECORDS AVAILABLE.—October 1, 1916, to September 30, 1917. Miscellaneous discharge measurements were made in 1902. Records of stage have been obtained by the United States Weather Bureau since January 1, 1908.

GAGE.—Weight-and-tape gage of the Mott type, fastened to steel post on upstream side of bridge, 60 feet south of middle bridge pier; read by M. M. Berry.

DISCHARGE MEASUREMENTS.—Made from bridge or by wading.

CHANNEL AND CONTROL.—Bed composed of solid rock. Banks, rock, gravel, and clay, wooded, high, and not subject to overflow. Rapids just below gage serve as permanent control for low and medium stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 8.0 feet at 7.30 a. m. October 20 and September 5 (discharge, 17,100 second-feet); minimum stage, zero several times during July and August (discharge, 14 second-feet).

1900–1917: Maximum stage, 23.9 feet April 7, 1900 (discharge, not determined); minimum stage, July and August, 1917.

ICE.—None reported during year.

DIVERSIONS.—Several large projects have been planned in the drainage basin above station, but none have been developed. Small tracts adjacent to the main river and tributaries are irrigated by diversion. A large part of the irrigated land in the basin is along Concho, San Saba, and Llano rivers. The Second Report of the Board of Water Engineers for the State of Texas shows a filing by the Llano Milling & Mining Co. for continuous use of 833 second-feet for hydraulic power and waterworks, and a filing of an unknown amount (believed to be small) by M. H. Reed for waterworks of Marble Falls.

REGULATION.—Flow regulated somewhat by diversions for irrigation and power in the basin immediately above station.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined between 10 and 52,000 second-feet. Gage read to hundredths twice daily, July 1 to September 30; to tenths, once daily, October 1 to June 30. Daily discharge ascertained by applying daily gage height to rating table. Records good.

COOPERATION.—Record of gage height October 1 to June 30 furnished by United States Weather Bureau.

Discharge measurements of Colorado River at Marble Falls, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
July 21	Congdon and Francisco.	0.45	42.2	Sept. 6	R. J. Hank.....	5.06	5,690
Aug. 29	E. P. Congdon.....	1.28	191	7	.....do.....	4.93	5,350
Sept. 6	R. J. Hank.....	5.31	6,930	11	.....do.....	3.55	2,100

Daily discharge, in second-feet, of Colorado River at Marble Falls, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1.....	940	342	202	168	202	202	168	568	508	392	98	117
2.....	568	242	202	202	202	202	168	450	450	508	62	450
3.....	568	242	202	202	202	242	168	450	5,900	450	58	630
4.....	568	202	202	202	168	202	140	450	3,000	292	51	820
5.....	450	202	242	202	168	202	140	450	4,700	168	37	14,900
6.....	450	168	292	202	168	202	168	450	6,900	168	19	8,400
7.....	292	168	292	202	168	202	168	450	3,000	140	19	3,900
8.....	242	168	292	202	242	202	202	392	2,800	95	24	2,980
9.....	202	117	292	202	242	202	242	392	1,420	80	29	2,600
10.....	202	117	242	168	202	202	242	242	940	76	19	2,250
11.....	168	117	242	168	168	202	242	242	630	39	30	2,240
12.....	168	117	202	168	242	202	242	242	630	37	22	2,360
13.....	117	98	202	168	242	202	202	392	392	25	62	1,140
14.....	117	140	202	168	242	202	202	342	342	37	46	1,030
15.....	117	140	202	168	242	202	140	2,150	202	16	46	1,120
16.....	342	117	202	202	242	202	140	1,420	168	25	44	1,420
17.....	342	117	202	202	242	202	140	1,220	168	83	37	1,420
18.....	450	117	202	202	242	202	140	860	117	117	31	1,080
19.....	4,500	117	202	202	242	202	117	568	117	154	25	900
20.....	17,100	117	202	202	242	1,420	117	450	83	62	24	740
21.....	9,000	242	202	202	242	1,220	117	450	83	140	22	700
22.....	3,000	202	202	202	242	1,030	117	568	68	25	16	665
23.....	3,000	242	202	242	242	700	1,420	11,200	56	30	23	568
24.....	1,420	242	202	242	242	568	940	5,600	46	51	16	538
25.....	1,420	242	202	242	202	450	630	3,000	37	39	42	342
26.....	1,320	168	202	242	202	242	568	1,880	37	56	317	234
27.....	1,320	168	202	242	202	242	568	1,320	24	25	302	168
28.....	1,030	168	202	242	202	242	568	1,120	46	16	242	128
29.....	780	168	168	242	.....	242	568	940	508	34	242	117
30.....	630	168	168	202	.....	242	568	630	392	117	222	154
31.....	450	.....	168	202	.....	202	.....	568	.....	108	154	.....

Monthly discharge of Colorado River at Marble Falls, Tex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	17,100	117	1,650	101,000
November	342	98	172	10,200
December	292	168	214	13,200
January	242	168	203	12,500
February	242	168	217	12,100
March	1,420	202	344	21,200
April	1,420	117	318	18,900
May	11,200	242	1,270	78,100
June	6,900	24	1,130	67,200
July	508	16	116	7,130
August	317	16	76.8	4,720
September	14,900	117	1,800	107,000
The year	17,100	16	627	453,000

COLORADO RIVER AT AUSTIN, TEX.

LOCATION.—At Congress Avenue concrete viaduct in Austin, Travis County, half a mile below Shoal Creek and above mouth of Waller Creek, 1 mile below mouth of Barton Creek, 3½ miles below Austin dam.

DRAINAGE AREA.—34,200 square miles (Revised.)

RECORDS AVAILABLE.—February 15, 1898, to December 31, 1911; October 1, 1914, to September 30, 1917; September 1, 1895, to April 7, 1900, at Austin dam. Records of stage have been obtained by United States Weather Bureau since July 1, 1903.

GAGE.—Dexter water-stage recorder, installed June 18, 1915, at end of concrete viaduct. Record of depth of water on crest of dam 3½ miles above Austin was kept from September 1, 1895, to April 7, 1900. Gage used February 15, 1898, to December 31, 1911, was a vertical gage attached to bathhouse on left bank 150 feet above Congress Avenue bridge; during this period high-stage readings were made by means of a staff gage painted on first pier from left end of bridge and a chain gage attached to bridge. All gages at or near the bridge have been referred to the same datum.

DISCHARGE MEASUREMENTS.—Made by wading or from upstream side of Montopolis highway bridge, 4 miles downstream.

CHANNEL AND CONTROL.—Channel straight for 1,000 feet above and 500 feet below station. Right bank of medium height, composed of clay and gravel, clean, improved by city, and not subject to overflow; left bank resembles right bank except that it is high and nearly vertical in places. Bed composed of rock and gravel, clean; shifts. Control is a gravel and rock shoal 500 feet below gage; changes during high water and also during low water because of the removal of sand for municipal use.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 5.20 feet at 6 a. m. October 21 (discharge, 11,100 second-feet); minimum stage, 0.04 foot at 3 p. m. August 28 and 10 a. m. August 29 (discharge, 51 second-feet).

1898–1911; 1914–1917: Maximum stage recorded, 33.5 feet April 7, 1900 (discharge, 122,000 second-feet); minimum stage, 0.50 foot December 13–17, 1914 (discharge, 2 second-feet).

ICE.—None during year.

DIVERSIONS.—The Second Report of the Board of Water Engineers for the State of Texas shows that about 36,000 acres of land were declared irrigated by diversions from Colorado River above station. The report also shows a filing by the city of Austin, for municipal uses, of 4,000 acre-feet per annum, with a storage of 30,000 acre-feet; 160 acre-feet per annum for Winchell waterworks; 2,000 acre-feet for waterworks for city of Brownwood; and an unknown amount for Marble Falls waterworks, all above station. An annual consumption in millions of gallons was reported to Board of Water Engineers, in 1916, by the city of Brownwood of 310, and city of Austin, 946. Much of the area irrigated is in the upper basin of the main stream and adjacent to large tributaries.

REGULATION.—Flow entirely regulated by operations at the Austin dam, about 3½ miles upstream. June 18, gates at Austin dam were opened and water released for rice irrigation in lower Colorado drainage until July 20, when gates were closed to maintain a low stage in reservoir. High water of September 5 and 6 filled the reservoir and water started to flow over crest of dam 4.30 p. m. September 6.

ACCURACY.—Stage-discharge relation not permanent; numerous discharge measurements necessary to determine changes. Standard rating curve well defined below 12,000 second-feet. Error in determinations of mean daily discharge due to regulation of flow eliminated by use of a water-stage recorder. Mean daily gage height, to half tenths, obtained by inspecting the recorder graph, or, for days of considerable fluctuation, by averaging hourly gage heights. Daily discharge ascertained by applying mean daily gage height to rating table directly, October 5–30, November 14–30, December 9 to February 19 and March 22 to September 14; by shifting control method, October 1–4, October 31 to November 13, December 1–8, February 20 to March 21, and September 15–30. Records good.

Discharge measurements of Colorado River at Austin, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 9	Victor Lieb	0.47	140	Apr. 23	Victor Lieb	0.54	143
18	Kessler and Lieb	.50	144	May 11	do	.72	211
21	Lieb and Thaxton	5.00	10,500	May 21	R. C. Thaxton	1.40	758
23	do	2.30	2,840	25	R. J. Hank	3.36	5,850
24	do	1.99	1,950	June 1	Hank and Francisco	1.24	648
26	Lieb and Hank	1.60	1,160	7	Thaxton and Francisco	3.25	5,380
Nov. 6	R. J. Hank	.88	323	9	do	2.08	2,190
17	Victor Lieb	.67	202	14	Victor Lieb	1.19	540
24	do	1.00	351	29	R. J. Hank	1.66	1,320
Dec. 2	do	1.14	440	July 14	Francisco and Congdon	.50	144
13	R. C. Thaxton	.80	263	19	do	.28	90.0
23	do	.72	224	24	E. P. Congdon	.25	91.2
Jan. 3	Victor Lieb	.84	277	28	do	.26	92.6
25	R. J. Hank	.87	292	Aug. 15	do	.18	77.2
Feb. 3	Victor Lieb	.80	262	22	do	.12	59.8
15	R. J. Hank	.94	304	24	do	.10	57.9
28	do	.87	244	28	do	.04	50.6
Mar. 10	Victor Lieb	.82	243	31	do	.11	59.4
27	R. J. Hank	1.04	394	Sept. 8	R. J. Hank	3.40	5,740
Apr. 9	do	.56	174	25	E. P. Congdon	.88	385

Daily discharge, in second-feet, of Colorado River at Austin, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	208	510	450	280	360	216	260	330	540	1,240	88	165
2	208	470	500	280	280	200	240	280	400	1,240	88	88
3	224	432	450	280	280	220	200	300	360	1,240	75	75
4	224	360	500	260	300	224	220	330	1,660	1,340	75	112
5	200	336	460	260	300	204	200	360	3,190	1,440	75	88
6	150	306	424	260	300	228	200	360	4,160	1,050	75	440
7	150	306	392	260	300	208	180	330	5,000	1,050	75	7,840
8	138	300	354	260	300	212	165	300	3,460	360	75	5,700
9	150	296	300	260	300	212	165	260	2,020	360	75	4,020
10	150	272	300	280	300	236	165	240	1,440	360	75	4,160
11	150	248	280	260	300	256	220	220	1,140	260	75	2,670
12	165	244	260	240	300	256	220	280	800	180	75	2,410
13	150	264	260	240	300	256	200	260	660	165	75	2,020
14	150	240	280	220	330	256	200	300	540	150	75	1,240
15	150	220	240	240	330	236	200	730	400	150	75	1,570
16	165	200	240	260	330	236	200	2,280	280	138	75	1,470
17	150	200	240	260	330	236	180	2,020	260	100	68	1,400
18	150	200	260	260	330	236	180	1,340	260	100	68	1,440
19	150	200	260	260	330	256	220	880	280	100	68	1,180
20	1,660	200	260	260	330	256	200	880	260	100	68	864
21	9,750	240	280	260	330	284	165	880	300	88	68	674
22	5,140	280	240	300	330	800	165	960	600	88	68	576
23	3,190	330	220	280	330	880	165	880	660	88	60	470
24	2,150	400	240	300	268	730	220	5,700	660	88	60	440
25	1,550	360	240	300	236	540	730	5,840	730	88	60	400
26	1,340	300	240	300	236	490	800	3,460	1,050	88	60	342
27	1,050	330	260	280	256	400	660	2,150	1,240	88	60	276
28	800	330	260	280	236	360	540	1,550	1,340	88	52	224
29	660	330	260	300	.....	330	440	1,240	1,340	88	52	192
30	600	330	260	330	.....	300	400	960	1,240	88	52	174
31	552	.....	280	360	.....	260	.....	730	.....	88	88	.....

Monthly discharge of Colorado River at Austin, Tex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	9,750	138	1,020	62,700
November	510	200	301	17,900
December	500	220	306	18,800
January	360	220	273	16,800
February	360	236	302	16,800
March	880	200	323	19,900
April	800	165	277	16,500
May	5,840	220	1,180	72,600
June	5,000	260	1,210	72,000
July	1,440	88	390	24,000
August	88	52	70.3	4,320
September	7,840	75	1,420	84,500
The year	9,750	52	590	427,000

Days of deficiency in discharge of Colorado River at Austin, Tex., for the years ending Sept. 30, 1902–1910 and 1915–1917.

Discharge in second-feet.	Days of deficient discharge.											
	1901–2	1902–3	1903–4	1904–5	1905–6	1906–7	1907–8	1908–9	1909–10	1914–15	1915–16	1916–17
100	.....	.....	.....	.....	.....	45	.....	.....	36	26	3	45
200	1	.....	3	20	45	103	1	34	55	44	29	81
300	20	10	22	75	135	204	11	94	102	68	52	203
400	68	30	130	150	185	228	41	156	165	72	97	264
500	167	59	189	177	198	253	78	195	228	83	145	281
600	216	77	223	196	207	261	92	203	241	95	177	290
700	236	90	243	218	221	292	142	226	266	112	222	298
800	251	108	259	234	224	300	166	234	279	120	239	303
900	263	122	266	242	231	305	179	244	281	135	257	313
1,000	271	148	273	247	234	310	190	250	294	142	272	315
1,200	284	197	286	263	241	315	225	273	307	205	289	321
1,400	292	218	292	273	247	323	256	293	319	240	300	333
1,600	301	232	300	282	255	327	261	299	321	255	310	341
1,800	313	247	305	291	263	331	271	310	321	262	315	343
2,000	317	260	309	296	267	334	276	317	322	262	318	343
3,000	330	307	322	315	291	342	299	332	335	289	338	351
4,000	338	321	332	327	301	345	317	342	338	307	346	355
5,000	341	331	337	334	314	347	322	347	341	314	353	358
6,000	343	340	342	339	320	348	329	349	343	324	355	363
7,000	344	344	346	342	323	348	331	352	345	338	358	363
8,000	347	346	348	345	325	348	336	354	350	347	359	364
9,000	349	350	350	347	330	348	340	355	352	348	360	364
10,000	353	351	352	348	335	352	344	356	344	349	362	365
20,000	356	360	359	359	350	363	351	362	364	355	365	.....
30,000	361	362	364	363	359	365	357	365	365	367	366	.....
40,000	365	365	365	364	362	.....	361	.....	.....	362	.....	.....
50,000	.....	.....	366	364	362	.....	362	.....	.....	362	.....	.....
60,000	.....	.....	.....	365	364	.....	364	.....	.....	363	.....	.....
75,000	.....	.....	.....	.....	365	.....	366	.....	.....	364	.....	.....
100,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	365	.....	.....

EVAPORATION NEAR AUSTIN, TEX.

LOCATION.—At reservoir on Hill's ranch, about 1,000 feet from ranch house, 5 miles south of Austin, Travis County. Elevation, 475 feet above sea level.

RECORDS AVAILABLE.—April 1, 1916, to September 30, 1917.

EQUIPMENT.—Two evaporation pans, one floating on surface of reservoir and the other on land about 30 feet from reservoir; auxiliary equipment consists of hook gage, rain gage, anemometer, maximum and minimum thermometers, and psychrometer.

ACCURACY.—Moss and weed growth in reservoir may at times affect results. Record from land pan more accurate than that from floating pan. Observations made daily at 8 a. m. Observer's work good.

Evaporation near Austin, Tex., for the year ending September 30, 1917.

Month.	Temperature (°F).					Mean. relative humidity (per cent).	Wind.		Rainfall (inches)	Evaporation (inches).	
	Air.			Water.			Average velocity (miles per hour).	Prevailing direction.		Floating pan.	Land pan.
	Mean maximum.	Mean minimum.	Mean.	Floating pan (mean).	Land pan (mean).						
October	83.2	54.2	68.7	66.7	60.6	85.1	1.3	South..	1.86	3.75	5.29
November	70.9	41.0	56.0	55.9	50.1	84.5	2.2	South..	1.46	2.49	3.25
December	65.4	36.5	51.0	50.1	45.7	79.3	2.9	South..	.33	2.36	3.42
January	63.5	38.3	50.9	48.9	48.1	80.8	2.8	South..	.70	1.76	2.58
February	68.1	37.4	52.8	52.0	48.5	80.8	3.1	South..	1.43	2.44	4.33
March	73.9	46.9	60.4	57.5	53.7	74.0	3.5	South..	.16	4.44	6.10
April	80.8	53.3	67.0	64.1	58.8	77.5	3.3	South..	1.53	5.68	7.28
May	81.2	56.8	69.0	67.0	63.3	84.3	2.9	South..	3.87	6.07	7.44
June	95.6	68.4	82.0	77.0	74.4	71.8	2.1	South..	2.08	7.50	10.50
July	98.7	70.4	84.6	79.2	76.7	73.4	1.9	South..	.52	7.75	9.96
August	99.4	70.9	85.2	78.2	75.8	67.5	2.0	South..	.36	8.18	11.02
September	90.9	64.6	77.8	75.2	69.9	73.9	1.9	South..	1.03	5.66	7.22
The year..	.....	.....	.....	.....	.....	.....	.....	.....	15.33	58.08	78.39

COLORADO RIVER AT COLUMBUS, TEX.

LOCATION.—At county highway bridge half a block from county jail, 400 feet below the Galveston, Harrisburg & San Antonio Railway bridge, in eastern edge of Columbus, Colorado County.

DRAINAGE AREA.—37,000 square miles (revised).

RECORDS AVAILABLE.—January 1, 1903, to December 31, 1911; May 22, 1916, to September 30, 1917; occasional discharge measurements beginning August 2, 1902. Records of stage have been obtained by the United States Weather Bureau since January 1, 1903.

GAGE.—Chain gage attached to downstream bridge railing; read by A. S. Lowrey. From August 2, 1902, to December 16, 1907, gage heights were obtained by measuring with a tagged chain and lead weight from point on top of bridge pier to water surface. Mott tape and weight gage on downstream handrail of bridge, property of the United States Weather Bureau was read from December 17, 1907, to February 9, 1917, when chain gage was installed. Mott gage and chain gage were referred to same datum.

DISCHARGE MEASUREMENTS.—Made from upstream side of bridge or by wading.

CHANNEL AND CONTROL.—Channel straight above and below station for 400 feet. Right bank composed of firm earth; high and not subject to overflow; left bank of medium height; overflow likely. Bed of stream clean and sandy; shifts during high stages. A sand and gravel section about 350 feet below gage serves as low-water control, but the stage-discharge relation during medium and high stages may be controlled by a bend in river below bridge.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 12.14 feet at 7 a. m. May 7 (discharge, 4,520 second-feet); minimum stage, 5.41 feet from 9 to 10.30 a. m. August 28 (discharge, 101 second-feet).

1902–1911; 1916–1917: Maximum stage recorded, 35.8 feet April 27, 1908 (discharge, 43,100 second-feet); minimum stage, 4.2 feet September 9 and 10, 1910 (discharge, 10 second-feet).

ICE.—None reported during year.

DIVERSIONS.—Considerable water is diverted for irrigation in the drainage basin above Austin, but between Austin and Columbus little water is pumped or diverted by gravity. The station is above the irrigated rice belt, which comprises several thousand acres. Filings have been made with the Board of Water Engineers for the State of Texas for continuous use of water for Smithville, Bastrop, and La Grange waterworks, all above station. Smithville reported to the Board of Water Engineers a consumption of 193,000,000 gallons during 1916.

REGULATION.—Flow at Columbus during ordinary stages controlled by storage at Lake Austin.

ACCURACY.—Stage-discharge relation not permanent. Rating curve well defined below 45,000 second-feet. Gage read to hundredths twice a day. Mean of two readings may not be a true index of daily discharge because of regulation above station. Daily discharge ascertained by applying mean daily gage height to rating table directly, October 23 to December 5, February 4 to March 25, and April 13 to September 30; by shifting-control method October 1–22, December 6 to February 3, and March 26 to April 12. Records good.

COOPERATION.—Morning gage readings furnished by United States Weather Bureau.

Discharge measurements of Colorado River at Columbus, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 1	William Kessler	6.56	353	Apr. 5	Victor Lieb	6.42	436
Nov. 14	Victor Lieb	6.61	441	June 18	Hank and Francisco	7.08	687
Jan. 16	do	6.35	387	Aug. 4	E. P. Congdon	5.75	157
Feb. 9	R. J. Hank	6.52	406	28	E. O. Francisco	5.41	101

Daily discharge, in second-feet, of Colorado River at Columbus, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	348	932	405	332	348	368	520	590	1,390	1,120	168	328
2	336	848	392	328	310	360	525	560	1,210	1,120	164	160
3	340	812	368	328	310	344	445	495	1,030	1,090	162	153
4	356	800	376	328	320	332	435	440	854	1,090	160	217
5	292	710	320	320	340	340	435	430	745	1,060	147	328
6	299	660	450	324	320	320	392	460	630	1,030	141	306
7	292	635	480	388	380	324	376	3,810	670	1,240	138	1,080
8	285	610	470	380	360	316	356	2,230	2,320	1,200	134	1,240
9	285	550	490	380	410	316	324	1,600	3,210	1,110	134	720
10	285	535	470	364	372	313	332	896	3,840	1,050	125	4,060
11	250	540	460	356	376	306	324	1,620	2,850	878	125	3,860
12	241	490	392	368	372	306	340	1,200	2,090	740	122	2,980
13	232	392	410	356	410	299	1,060	932	1,620	500	117	3,880
14	241	405	415	348	425	296	560	872	1,330	440	117	2,620
15	232	410	400	368	400	299	356	860	1,080	400	110	2,040
16	285	410	376	384	410	296	368	635	824	372	108	1,770
17	560	388	384	384	396	292	348	445	780	344	108	1,480
18	620	360	384	360	380	296	313	396	690	316	108	1,410
19	360	400	400	415	380	296	302	760	610	470	106	1,630
20	278	360	368	380	388	299	292	1,450	550	364	106	1,470
21	264	392	368	392	364	288	271	1,450	490	396	107	1,440
22	247	420	376	384	376	299	695	1,260	430	364	107	1,320
23	1,740	392	356	392	372	296	730	1,030	396	475	107	1,110
24	3,900	392	352	368	368	288	470	932	410	368	107	938
25	3,090	376	368	376	384	285	344	795	368	296	106	842
26	2,530	420	364	364	410	420	299	740	460	241	106	725
27	2,130	400	336	356	384	765	296	3,340	824	209	104	655
28	1,700	392	332	352	360	950	271	3,680	1,290	209	104	605
29	1,470	410	348	356	.....	645	299	3,300	884	192	123	795
30	1,320	410	332	348	.....	585	595	1,350	1,010	182	195	675
31	1,150	.....	313	368	.....	595	.....	1,800	.....	180	212	.....

Monthly discharge of Colorado River at Columbus, Tex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	3,900	232	837	51,500
November	932	360	508	30,200
December	490	313	389	23,900
January	415	320	363	22,300
February	425	310	372	20,700
March	950	285	379	23,300
April	1,060	271	422	25,100
May	3,810	396	1,300	79,900
June	3,840	368	1,160	69,000
July	1,240	180	614	37,800
August	212	104	128	7,870
September	4,060	153	1,360	80,900
The year	4,060	104	653	472,000

COLORADO RIVER AT WHARTON, TEX.

LOCATION.—Just below highway bridge in western edge of Wharton, Wharton County, 200 feet below Galveston, Harrisburg & San Antonio Railway bridge.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—July 12 to August 31, 1916, and July 3 to August 18, 1917. Station maintained during distribution of water from Austin Lake for rice irrigation.

GAGE.—Vertical staff, attached to tree on right bank about 75 feet below highway bridge; read by Henry Marsh.

DISCHARGE MEASUREMENTS.—Made from highway bridge.

CHANNEL AND CONTROL.—Channel straight above and below station for a few hundred feet. Bed of stream composed of sand and clay. Both banks medium in height, composed of clay, and subject to overflow during extreme stages. Discharge measurements show control to be fairly permanent but at times subject to shift.

EXTREMES OF DISCHARGE.—1916–1917: Maximum stage recorded during periods of record, 3.27 feet at 3.30 p. m. July 25, 1916 (discharge, 1,680 second-feet); minimum stage, −0.90 foot at 7 a, m. August 1, 1917 (discharge, 62 second-feet).

ICE.—None reported.

DIVERSIONS.—Considerable water is diverted above station for irrigation of rice. Station is in area of rice irrigation. The Second Report of the Board of Water Engineers for the State of Texas shows that 51,126 acres were declared irrigated in Colorado and Wharton counties by means of 102,252 acre-feet of water. A large part of this area is irrigated by means of water pumped from Colorado River above the station.

REGULATION.—Flow is regulated by diversions for rice irrigation and storage in Austin Lake.

ACCURACY.—Stage-discharge relation subject to change. Rating curves fairly well defined. Gage read to hundredths twice daily. Mean of two readings may not be a true index of daily discharge because of regulation above station. Daily discharge ascertained by applying mean daily gage height to rating table directly, July 12–30, 1916, and July 3 to August 18, 1917; by shifting-control method, July 31 to August 10, 1916; and from parallel curve August 11 to 31, 1916. Discharge interpolated August 14, 1916, and July 18, 1917. Records good.

Discharge measurements of Colorado River at Wharton, Tex., during the years ending Sept. 30, 1916 and 1917.

[Made by R. C. Traxton.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1916.	*Feet.*	*Sec.-ft.*	1916.	*Feet.*	*Sec.-ft.*	1917.	*Feet.*	*Sec.-ft.*
June 29	1.44	569	June 28	2.34	1,090	July 6	1.55	852
July 13	.83	360	Aug. 12	1.30	608	13	.74	480
16	1.89	792				17	−.20	177
17	1.82	784	1917.			20	.08	243
25	3.26	1,670	Apr. 7	.63	462			
26	2.79	1,320	July 5	1.55	849			

Daily discharge, in second-feet, of Colorado River at Wharton, Tex., for the period July 12 to Aug. 31, 1916.

Day.	July.	Aug.	Day.	July.	Aug.	Day.	July.	Aug.
1		1,050	11		634	21	584	491
2		932	12	410	602	22	620	467
3		822	13	364	580	23	706	523
4		660	14	410	524	24	893	588
5		593	15	606	467	25	1,600	563
6		535	16	805	455	26	1,320	527
7		559	17	795	656	27	1,130	495
8		800	18	785	724	28	1,070	571
9		760	19	647	539	29	1,160	683
10		665	20	584	452	30	1,340	701
						31	1,360	652

Daily discharge, in second-feet, of Colorado River at Wharton, Tex., for the period July 3 to Aug. 18, 1917.

Day.	July.	Aug.	Day.	July.	Aug.	Day.	July.	Aug.
1	.....	118	11	790	192	21	345	.....
2	.....	192	12	750	190	22	312	.....
3	980	195	13	537	190	23	286	.....
4	880	192	14	312	188	24	265	.....
5	860	197	15	265	190	25	319	.....
6	850	195	16	199	190	26	245	.....
7	810	195	17	239	190	27	181	.....
8	885	192	18	287	190	28	173	.....
9	920	192	19	335	.....	29	110	.....
10	835	192	20	274	.....	30	103	.....
						31	70	.....

NORTH CONCHO RIVER AT SAN ANGELO, TEX.

LOCATION.—At county concrete viaduct in San Angelo, Tom Green County, 1 mile above confluence of North Concho and South Concho rivers.

DRAINAGE AREA.—7,530 square miles.

RECORDS AVAILABLE.—October 27, 1915, to September 30, 1917.

GAGE.—Vertical staff attached to web of third pier of viaduct from left bank; auxiliary staff on left bank 75 feet upstream from bridge referred to same datum; read during stages 0 to 6.8 feet; read by T. R. Lyle and L. E. Gage.

DISCHARGE MEASUREMENTS.—Made by wading 400 feet below viaduct.

CHANNEL AND CONTROL.—Bed composed of solid rock which is to some extent covered in high-water channel with grass and moss; permanent. Channel straight for 500 above and 400 feet below gage. Both banks are sloping, clean, composed of rock and clay, and not subject to overflow except during high floods. About 20 feet below gage and at downstream side of viaduct is a concrete dam about 4½ feet high, which before the viaduct was constructed, served as part of a low-water crossing. This dam forms an artificial control and insures a permanent stage-discharge relation.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 4.90 feet at 8.30 a. m. April 18 (discharge, 1,900 second-feet; determined from extension of rating curve and possibly subject to considerable error). No flow during several periods throughout year.

1916–1917: Maximum and minimum stages recorded in 1917.

ICE.—None reported during year.

DIVERSIONS.—According to Second Report of the Board of Water Engineers for the State of Texas some water is diverted; amount diverted above station not known.

REGULATION.—Flow not regulated by water-power plants or reservoirs.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined below but possibly subject to error above 200 second feet. Gage read to hundredths daily; oftener during high water. Daily discharge ascertained by applying mean daily gage height to rating table. Records good.

Discharge measurements of North Concho River at San Angelo, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 3	R. J. Hank	.....	0.0	May 21	Victor Lieb	1.06	55.0
Dec. 9	.....do	.....	.0	July 3	Gray and Francisco	.....	.0
May 20	Victor Lieb	0.51	1.5	Aug. 11	E. P. Congdon	.....	.0
21	.....do	1.22	118	Sept. 21	.....do	.30	*a* .2

a Estimated.

Daily discharge, in second-feet, of North Concho River at San Angelo, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	0.0	0.0	0.1	0.0	0.1	0.8	1.1	2.1	0.0	0.0	0.0	0.0
2	.0	.0	.0	.0	.4	.8	1.0	1.6	.0	.0	.0	.0
3	.0	.0	.0	.0	.5	.8	.8	1.2	480	.0	.0	.0
4	.0	.0	.0	.0	.6	1.0	.6	.9	.0	.0	.0	70
5	.0	.0	.0	.0	.8	1.2	.6	.5	20	.0	.0	14
6	.0	.0	.0	.0	.8	1.2	.5	.6	9.1	.0	.0	10
7	.0	.0	.0	.0	1.0	1.2	.4	.7	5.6	.0	.0	6.3
8	.0	.0	.0	.0	1.2	1.2	1.9	.7	3.4	.0	.0	1.6
9	.0	.0	.0	.0	1.5	1.1	.3	.8	2.4	.0	.0	142
10	.0	.0	.0	.0	1.8	1.1	.3	.9	1.3	.0	.0	110
11	.0	.0	.0	.0	1.3	1.2	.5	1.2	.8	.0	.0	70
12	.0	.0	.0	.0	1.1	1.2	.9	1.3	.4	.0	.0	126
13	.0	.0	.0	.0	1.1	1.2	1.8	10	.1	.0	.0	20
14	.0	.0	.0	.0	1.0	1.3	1.6	5.6	.0	.0	.0	10
15	.0	.0	.0	.0	.9	1.5	1.9	4.2	.0	.0	.0	5.1
16	186	.0	.0	.0	.9	2.3	2.1	3.1	.0	.0	.0	3.1
17	44	.0	.0	.0	.9	2.4	1.5	1.9	.0	.0	.0	1.2
18	86	.0	.0	.0	1.4	2.9	880	1.2	.0	.0	.0	.8
19	7.1	.0	.0	.0	1.9	3.4	78	.9	.0	.0	.0	.4
20	3.2	.0	.0	.0	2.6	2.6	15	1.3	.0	.0	.0	.2
21	1.2	.0	.0	.0	2.3	2.4	7.5	158	.0	24	.0	.1
22	.8	.0	.0	.0	1.6	1.9	6.3	7.1	.0	3.8	.0	.0
23	.2	6.3	.0	.0	1.5	1.6	5.1	2.6	.0	.7	.0	.0
24	.2	3.6	.0	.0	1.2	1.5	4.9	1.2	.0	.3	.0	5.6
25	.1	1.4	.0	.0	1.0	1.0	4.4	1.1	.5	.1	.0	2.4
26	.0	.9	.0	.0	1.0	.6	4.2	.7	.1	.0	.0	1.6
27	.0	.4	.0	.0	1.1	.5	3.6	.4	.1	.0	.0	.9
28	.0	.3	.0	.0	.8	.5	3.1	.2	.0	2.7	.0	.5
29	.0	.2	.0	.0	.....	.3	2.7	.1	.0	3.4	.0	.3
30	.0	.1	.0	.0	.....	.5	2.4	.0	.0	4.4	.0	.1
31	.0	.....	.0	.1	.....	.5	.....	.0	.....	.0	.0	.....

NOTE.—Discharge interpolated because of missing gage heights, Oct. 22 and Nov. 26; estimated by extension of rating curve and possibly subject to considerable error, Apr. 18 and June 3.

Monthly discharge of North Concho River at San Angelo, Tex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	186	0.0	10.6	652
November	6.3	.0	.44	26
December	.1	.0	.00	0
January	.1	.0	.00	0
February	2.6	.1	1.15	64
March	3.4	.3	1.35	83
April	880	.3	34.5	2,050
May	158	.0	6.84	421
June	480	.0	17.5	1,040
July	24	.0	1.27	78
August	.0	.0	.00	0
September	142	.0	20.1	1,200
The year	880	.0	7.75	5,610

CONCHO RIVER NEAR SAN ANGELO, TEX.

LOCATION.—Half a mile below confluence of North Concho and South Concho rivers, 1¾ miles southeast of San Angelo, Tom Green County.

DRAINAGE AREA.—10,800 square miles.

RECORDS AVAILABLE.—September 17, 1915, to September 30, 1917.

GAGE.—Stevens water-stage recorder installed August 9, 1917, on right bank, 1,500 feet below an old ford. B. H. Cummins, observer. Prior to August 9, 1917, a vertical staff gage in several sections attached to trees on left bank opposite water-stage recorder was read by Mrs. B. H. Cummins. Water-stage recorder and vertical staff gage referred to same datum.

DISCHARGE MEASUREMENTS.—Made by wading or from cable near gage.

CHANNEL AND CONTROL.—Bed composed of solid rock and gravel. Channel straight for 1,000 feet above and below station. Right bank high, rocky, wooded, and not subject to overflow; left bank of medium height, composed of clay and gravel, covered with scattering trees, and subject to overflow at high stages. Rapids just below gage serve as control for medium and low stages; do not shift. Position of control for high stages not known. Stage-discharge relation affected by moss at low stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 13.7 feet at 9 a. m. April 18 (discharge not determined); minimum stage, 0.44 foot from 1 to 3 p. m. August 11 (discharge, 1.0 second-foot).

1915–1917: Maximum and minimum stages recorded in 1917

ICE.—None reported during year.

DIVERSIONS—Considerable water is diverted above station, and pumping plants are immediately below. Second Report of the Board of Water Engineers for the State of Texas shows that a total of 22,000 acre-feet per annum is taken from the stream for beneficial use. About a mile above mouth of South Concho River a storage dam has been constructed by the San Angelo Light & Power Co. for waterworks, but as the capacity of the reservoir is small and the height of the dam constant, a large part of the natural flow of the stream that enters the reservoir will join the water of the North Concho at confluence of the two streams.

REGULATION.—Storage at the dam of the San Angelo Light & Power Co. has slight effect on flow at station; no regulation by storage on North Concho River.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve well defined below 400 second-feet. Gage read to hundredths once daily prior to August 9, 1917; after that date water-stage recorder in operation; one reading daily may not be a true index of the mean daily discharge because of regulation and rapid fluctuation during floods. Daily discharge ascertained by applying daily gage height to rating table. Mean daily gage height determined from recorder chart by use of planimeter. Records good for medium and low stages, and poor for high stages; determination of discharge above 500 second-feet may be considerably in error.

Discharge measurements of Concho River near San Angelo, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 10	R. J. Hank	1.00	15.0	May 21	Victor Lieb	1.84	116
Dec. 9	do	1.37	39.5	21	do	1.78	108
May 20	Victor Lieb	1.11	19.3	July 6	Gray and Francisco	.58	2.5
21	do	2.31	286	Aug. 11	E. P. Congdon	.46	1.0
21	do	2.22	257	Sept. 21	do	.57	2.4

Daily discharge, in second-feet, of Concho River near San Angelo, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	27	26	38	40	43	43	15	3.8	4.6	2.5	1.8	2.6
2	30	26	39	45	43	43	20	4.8	3.0	2.5	2.0	2.6
3	29	27	42	40	48	43	32	3.4	660	2.6	1.6	5.0
4	24	26	39	40	48	54	25	3.4	70	2.5	1.6	15
5	20	32	38	39	47	66	24	3.0	26	3.0	1.6	34
6	19	32	43	41	41	49	14	5.0	15	2.8	1.6	442
7	19	26	33	45	33	45	11	3.0	4.6	3.0	1.6	60
8	20	18	32	39	33	49	18	3.0	3.0	2.5	1.4	56
9	20	16	38	43	41	49	15	3.0	3.0	3.0	1.4	278
10	15	20	37	43	41	49	15	3.8	3.8	3.0	1.3	196
11	24	22	39	35	41	41	17	4.2	3.8	3.0	1.3	115
12	31	25	42	39	39	43	17	10	3.0	3.4	1.6	310
13	38	26	39	38	39	38	29	45	3.0	3.4	1.6	46
14	41	25	41	39	33	35	30	33	2.0	3.4	2.0	20
15	51	29	39	47	34	30	26	24	1.8	3.0	2.3	12
16	203	28	36	47	39	38	21	18	1.8	2.5	2.2	7.0
17	85	26	36	51	38	41	15	16	2.0	2.8	1.9	5.2
18	196	32	39	51	47	41	1,340	7.5	1.8	3.0	2.3	3.8
19	81	29	33	51	41	36	174	5.0	1.8	4.2	2.6	3.8
20	45	22	30	51	43	26	30	22	2.0	4.2	4.0	3.6
21	51	32	29	51	43	25	15	137	2.0	17	2.8	2.8
22	39	43	30	50	39	29	10	33	2.3	6.0	2.9	2.6
23	33	43	33	50	35	25	7.5	20	2.5	4.2	2.6	2.6
24	36	41	36	48	30	28	13	17	5.0	3.8	2.8	10
25	26	36	38	49	30	26	10	11	5.0	3.4	2.6	6.8
26	25	43	36	49	36	20	7.5	5.0	4.6	3.4	2.3	4.6
27	25	36	33	48	35	18	5.0	3.0	3.0	3.4	2.4	4.2
28	26	32	29	49	35	22	5.0	11	2.5	3.4	2.4	3.6
29	29	32	27	49	.....	25	5.0	5.0	2.5	3.0	2.5	3.4
30	27	32	33	41	.....	18	4.2	5.0	2.5	3.0	2.6	2.9
31	26	.....	38	48	.....	15	.....	5.0	.....	1.8	2.3	.....

NOTE.—Discharge, Aug. 7–10, estimated from information furnished by engineer; Apr. 18 and June 3 determined from an extension of rating curve and subject to considerable error.

Monthly discharge of Concho River near San Angelo, Tex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	203	15	43.9	2,700
November	43	16	29.4	1,750
December	43	27	36.0	2,210
January	51	38	45.0	2,770
February	48	30	39.1	2,170
March	66	15	35.8	2,200
April	1,340	4.2	65.7	3,910
May	137	3.0	15.3	941
June	660	1.8	28.3	1,680
July	17	1.8	3.64	224
August	4.0	1.3	2.13	131
September	442	2.6	55.4	3,300
The year	1,340	1.3	33.1	24,000

CONCHO RIVER NEAR PAINT ROCK, TEX.

LOCATION.—At Concho, San Saba & Llano Valley Railroad bridge a quarter of a mile below mouth of Kickapoo Creek, 2 miles northwest of Paint Rock, Concho County.

DRAINAGE AREA.—11,800 square miles.

RECORDS AVAILABLE.—September 20, 1915, to September 30, 1917.

GAGE.—Vertical staff attached to downstream end of middle railroad bridge pier; read by Bob Word.

DISCHARGE MEASUREMENTS.—Made by wading or from downstream side of bridge.

CHANNEL AND CONTROL.—Bed composed of solid rock, smooth, clean, free from vegetation, and permanent. Channel straight for 500 feet above and below gage. Right bank 30 feet high, solid rock, clean, and not subject to overflow; left bank of medium height, sloping, wooded, and subject to overflow during high water. Permanent control during low and medium stages at a shoal in solid rock 400 feet below gage.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 8.5 feet at 5.20 p. m. April 18 (discharge, 7,150 second-feet); no flow June 21–24, and July 6 to August 18.

1915–1917: Maximum stage recorded, 8.6 feet 11.30 a. m. September 24, 1915 (discharge, 7,300 second-feet); no flow July 4 to September 1, 1916, June 21–24, 1917, and July 6 to August 18, 1917.

ICE.—None reported during year.

DIVERSIONS.—Station is above a large part of the irrigable area in the vicinity of Paint Rock, but considerable water is diverted from the stream in that part of the basin above San Angelo; quantity of water diverted between San Angelo and this station not known, but during low stages the flow is affected thereby.

REGULATION.—Ten storage dams of small capacity are located between this station and San Angelo. An abandoned dam, 12 feet high, known as "Four-Mile dam" is 4 miles below San Angelo, and a small dam, 8 feet in height, has been constructed for storage on Sims ranch just above the station. An 11-foot concrete dam was constructed during the summer for storage at a point 12 miles above gage, but the high water of September destroyed it. None of the dams appreciably affect the flow by storing water except during extremely low stages.

ACCURACY.—Stage-discharge relation permanent. Rating curve fairly well defined below 6,500 second-feet; determination above 6,500 second-feet possibly subject to slight error. Rating curve previously used for 1915–16 has been revised on account of high water measurements secured in 1918. Gage read to hundredths once daily; oftener during high water. Daily discharge 1915–1917 ascertained by applying mean daily gage height to rating table. Records good.

Records of daily and monthly discharge for 1915–16, based on revised rating curve, are published herewith, and supersede those previously published.

Discharge measurements of Concho River near Paint Rock, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 11	R. J. Hank	1.26	13.6	May 22	Victor Lieb	2.02	171
Dec. 8	do	1.47	37.9	July 2	Gray and Francisco	.78	[a] 5
May 19	Victor Lieb	1.20	11.5	Sept. 23	E. P. Congdon	1.15	[b] 12.4

[a] Estimated. [b] Discharge somewhat uncertain; result believed to be too large.

Daily discharge, in second-feet, of Concho River near Paint Rock, Tex., for the period Sept. 20, 1915, to Sept. 30, 1916.

Day.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	.....	122	103	79	83	83	39	270	61	14	0.6	0.0	0.0
2	.....	122	103	79	88	83	39	270	65	12	.3	.0	2,820
3	.....	122	96	83	88	83	39	195	61	11	.2	.0	550
4	.....	122	96	83	88	79	34	137	61	10	.0	.0	166
5	.....	122	96	83	96	79	34	137	52	9.0	.0	.0	108
6	.....	114	96	137	93	79	34	137	46	7.0	.0	.0	61
7	.....	108	96	160	83	79	34	131	42	6.5	.0	.0	42
8	.....	103	88	160	83	79	30	131	42	5.2	.0	.0	27
9	.....	103	83	152	83	79	30	122	39	5.2	.0	.0	22
10	.....	103	83	152	83	79	27	108	39	4.2	.0	.0	19
11	.....	103	83	143	83	79	27	96	34	3.5	.0	.0	52
12	.....	96	83	93	83	65	27	88	27	2.9	.0	.0	108
13	.....	96	83	96	83	72	25	83	25	2.5	.0	.0	166
14	.....	96	83	96	83	72	25	83	22	2.1	.0	.0	315
15	.....	96	79	88	83	73	25	382	22	1.5	.0	.0	131
16	.....	96	79	88	83	65	25	166	22	1.0	.0	.0	83
17	.....	96	72	88	83	65	22	137	25	.6	.0	.0	61
18	.....	108	72	83	83	65	22	108	34	.3	.0	.0	52
19	.....	450	72	83	79	65	22	96	30	17	.0	.0	46
20	122	195	72	83	79	65	22	88	27	11	.0	.0	46
21	96	152	72	83	79	61	19	79	27	7.0	.0	.0	42
22	96	108	72	83	79	57	17	72	25	5.8	.0	.0	42
23	96	103	72	83	79	52	19	65	25	4.7	.0	.0	39
24	4,340	103	72	79	72	46	22	61	25	3.5	.0	.0	34
25	1,400	103	72	79	79	44	25	52	25	2.5	.0	.0	108
26	338	103	79	79	83	42	27	46	25	2.1	.0	.0	52
27	195	103	79	79	79	42	27	46	22	1.5	.0	.0	39
28	180	103	79	79	79	39	27	42	22	1.2	.0	.0	30
29	160	103	79	79	79	34	30	42	19	1.0	.0	.0	25
30	137	103	79	79	96	.....	36	42	17	.8	.0	.0	19
31	.....	103	.....	83	88	.....	42	.....	16	.....	.0	.0	.....

Daily discharge, in second-feet, of Concho River near Paint Rock, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	17	17	27	24	34	24	27	4.7	7.0	1.0	0.0	0.3
2	17	17	27	24	27	24	14	4.7	7.0	.6	.0	840
3	22	17	27	27	27	27	9.0	4.7	4.7	.3	.0	61
4	27	17	27	27	27	27	7.0	4.0	166	.3	.0	108
5	22	17	27	27	27	27	5.8	4.0	61	.1	.0	166
6	27	17	27	27	27	27	3.5	4.7	42	.0	.0	840
7	27	17	27	27	27	27	2.5	4.7	27	.0	.0	315
8	17	17	27	27	27	24	1.5	4.0	17	.0	.0	61
9	17	17	27	27	27	24	1.0	3.5	11	.0	.0	405
10	17	17	27	27	27	22	.6	2.5	7.0	.0	.0	230
11	16	17	27	27	27	22	.6	1.9	4.7	.0	.0	166
12	16	17	34	27	27	22	.6	11	4.0	.0	.0	83
13	17	17	34	27	27	22	.6	5.8	3.5	.0	.0	61
14	17	17	34	42	27	22	.6	4.7	2.5	.0	.0	27
15	17	17	34	42	27	22	.6	4.0	2.5	.0	.0	17
16	27	17	34	42	27	19	.8	2.5	1.9	.0	.0	17
17	315	17	34	42	24	19	.3	1.9	1.0	.0	.0	17
18	270	17	34	42	24	17	7,150	11	.0	.0	.0	11
19	500	22	34	42	27	27	382	11	.3	.0	600	11
20	108	22	27	42	27	24	83	17	.3	.0	4.7	9.0
21	83	22	27	42	27	17	61	1,060	.0	.0	42	9.0
22	42	22	22	42	27	11	17	166	.0	.0	27	9.0
23	34	25	22	42	24	7.0	17	34	.0	.0	11	9.0
24	27	25	22	42	24	4.7	17	27	.0	.0	4.7	9.0
25	27	42	23	42	24	4.7	16	22	600	.0	1.0	9.0
26	27	42	27	42	24	2.5	14	17	360	.0	1.0	7.0
27	27	34	27	42	24	1.5	11	15	166	.0	1.0	7.0
28	27	34	27	42	24	1.5	5.8	14	61	.0	1.0	5.8
29	27	34	27	39	.....	1.5	4.7	12	7.0	.0	.6	5.8
30	22	34	27	39	.....	1.3	4.7	15	2.5	.0	.6	3.5
31	22	.....	27	34	.....	1.0	.....	7.0	.....	.0	.3	.....

NOTE.—Discharge Sept. 21 and 22 estimated from information furnished by observer. Observer reports that flood of June 25 was caused by water from Kickapoo Creek.

Monthly discharge of Concho River near Paint Rock, Tex., for the years ending Sept. 30, 1915, 1916, and 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1915.				
September 20–30	4,340	96	651	14,200
1915–16.				
October	450	96	121	7,440
November	103	72	82.4	4,900
December	160	79	96.6	5,940
January	96	72	83.3	5,120
February	83	34	65.7	3,780
March	42	17	28.2	1,730
April	382	42	117	6,960
May	65	16	33.0	2,030
June	17	.3	5.22	311
July	.6	.0	.035	2
August	.0	.0	.0	0
September	2,820	.0	177	10,500
The year	2,820	.0	67.2	48,700
1916–17.				
October	500	16	60.6	3,730
November	42	17	22.1	1,320
December	34	22	28.2	1,730
January	42	24	35.1	2,160
February	34	24	26.4	1,470
March	27	1.0	16.9	1,040
April	7,150	.3	262	15,600
May	1,060	1.9	48.4	2,980
June	600	.0	52.2	3,110
July	1.0	.0	.07	4
August	600	.0	22.4	1,380
September	840	.3	117	6,960
The year	7,150	.0	57.3	41,500

PECAN BAYOU AT BROWNWOOD, TEX.

LOCATION.—Near city pumping plant of Brownwood, 600 feet above lower city dam, at City Park, 1 mile north of Brownwood, Brown County, 2 miles above mouth of Adams Branch, 30 miles above confluence with Colorado River.

DRAINAGE AREA.—1,560 square miles.

RECORDS AVAILABLE.—May 24, to September 30, 1917.

GAGE.—Vertical staff attached to two trees on right bank about 200 feet below pumping plant; read by C. N. Davis. From May 24 to June 3 readings were taken from an inclined and vertical staff gage located at right end of lower dam. This gage was destroyed June 4 and present gage installed June 8. Present gage referred to datum 1.04 feet lower than original one to avoid negative readings.

DISCHARGE MEASUREMENTS.—Conditions will not allow measurements at low stages, but high and medium stage measurements can be made from upstream side of highway bridge located 800 feet below lower city dam.

CHANNEL AND CONTROL.—Bed composed of mud and clay, free from vegetation. Channel straight above and below station. Banks wooded; subject to overflow during extreme high stages. When stream is nearly bank full, water is likely to flow through a slough that leaves the river a short distance above the gage and connects with Adams Branch. One channel at all stages when flow is confined by banks of main stream. City dam, 600 feet below gage, serves as a control when flow is confined within banks; dam has opening of 140 feet; crest regular. Position of control when banks are submerged not known.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 4.40 feet at 6 p. m. September 3 (discharge, 3,340 second-feet: determined by formula using the dam as a weir; possibly subject to considerable error); no flow June 13 to August 19, August 26 to September 2, and September 16-30.

ICE.—None reported.

DIVERSIONS.—The Second Report of the Board of Water Engineers for the State of Texas shows that 590 acres were declared irrigated by a beneficial use of 1,179 acre-feet of water diverted from Pecan Bayou above the station. This report also lists a filing by the city of Brownwood for a storage of 2,000 acre-feet for waterworks. The city of Brownwood reported a consumption of 310 million gallons during 1916, pumped from stream just above station. Two pumping plants are operated below the control dam near Brownwood, but the amounts pumped are not known.

REGULATION.—Flow at station regulated during normal flow by storage reservoir and pumping plants above. Two miles above the station the city of Brownwood has constructed a dam to impound water for municipal use. Water is released from this reservoir when the supply is short in pond at the gage from which the city supply is pumped. Backwater from the lower dam extends to the upper dam.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve based on discharge computed by formula, using the dam as a weir, and one low-water discharge measurement; possibly subject to error. Length of dam makes station sensitive. Gage read to hundredths twice daily; oftener during high stages. Daily discharge ascertained by applying mean daily gage heights to rating table. Records poor.

Discharge measurements of Pecan Bayou at Brownwood, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
June 9	Victor Lieb	0.99	[a] 7.0
July 1	Gray and Hank	.....	.0
Sept, 23	E. P. Congdon	.....	.0

[a] Estimated.

Daily discharge, in second-feet, of Pecan Bayou at Brownwood, Tex., for the year ending Sept. 30, 1917.

Day.	May.	June.	July.	Aug.	Sept.	Day.	May.	June.	July.	Aug.	Sept.
1	.....	85	0.0	0.0	0.0	16	.....	0.0	0.0	0.0	0.0
2	.....	64	.0	.0	.0	17	.....	.0	.0	.0	.0
3	.....	94	.0	.0	888	18	.....	.0	.0	.0	.0
4	.....	82	.0	.0	1,470	19	.....	.0	.0	.0	.0
5	.....	70	.0	.0	112	20	.....	.0	.0	.5	.0
6	.....	58	.0	.0	410	21	.....	.0	.0	158	.0
7	.....	45	.0	.0	550	22	.....	.0	.0	39	.0
8	.....	31	.0	.0	240	23	.....	.0	.0	25	.0
9	.....	13	.0	.0	121	24	94	.0	.0	8.6	.0
10	.....	9.2	.0	.0	36	25	42	.0	.0	.5	.0
11	.....	5.0	.0	.0	8.6	26	25	.0	.0	.0	.0
12	.....	1.0	.0	.0	3.8	27	15	.0	.0	.0	.0
13	.....	.0	.0	.0	2.0	28	10	.0	.0	.0	.0
14	.....	.0	.0	.0	1.0	29	5.0	.0	.0	.0	.0
15	.....	.0	.0	.0	.5	30	55	.0	.0	.0	.0
						31	42	.....	.0	.0	.....

NOTE.—Discharge estimated from data furnished by observer May 27-29 and June 4-7.

Monthly discharge of Pecan Bayou at Brownwood, Tex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
May 24-31	94	5.0	36.0	571
June	94	.0	18.6	1,110
July	.0	.0	.0	0
August	158	.0	7.47	459
September	1,470	.0	128	7,620
The period				9,760

SAN SABA RIVER AT MENARD, TEX.

LOCATION.—At steel highway bridge in Menard, Menard County, about 80 miles above mouth of stream.

DRAINAGE AREA.—1,140 square miles.

RECORDS AVAILABLE.—September 14, 1915, to September 30, 1917.

GAGE.—Chain gage attached to floor on downstream side of highway bridge; read by Henry Patton.

DISCHARGE MEASUREMENTS.—Made by wading or from downstream side of bridge.

CHANNEL AND CONTROL.—Channel straight 800 feet above and 100 feet below station; water flows through a series of shoals and ponds, channel above gage somewhat obstructed by reeds and grass, but below the gage the flow is only slightly obstructed at times. Right bank composed of gravel and clay, wooded, sloping, high, and not subject to overflow; left bank similar in material, wooded, low, and subject to overflow during high stages. A sand and gravel ford just below gage forms a practically permanent control during low and medium stages but shifts during high stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.90 feet at 8.20 a. m. June 3 (discharge, 425 second-feet; determined from extension of rating curve and possibly subject to considerable error); minimum stage recorded, 1. 61 feet at 6 p. m. July 30 (discharge, 0.6 second-foot, determined from extension of rating curve; possibly subject to considerable error).

1915–1917: Maximum stage recorded, 13.6 feet at 2.30 a. m. September 16, 1915 (discharge not determined); minimum stage July 30, 1917.

ICE.—None reported during year.

DIVERSIONS.—Considerable land is irrigated with water diverted or pumped above station. Noyes canal, on right side of river, which serves a considerable area of land carries water that is diverted a short distance above gage. Several pumping plants are above and below gage. The Second Report of the Board of Water Engineers for the State of Texas shows that 5,807 acres are declared irrigated with 11,614 acre-feet of water per annum in Schleicher and Menard counties. More than half of this area is above the station.

REGULATION.—Flow unregulated by storage or water-power plants but is largely controlled by diversion to Noyes canal.

ACCURACY.—Stage-discharge relation practically permanent during low and medium stages, but changes during high water; changed somewhat during period October 6–12. Rating curve well defined between 1 and 90 second-feet. Determinations of discharge above 100 second-feet may be subject to considerable error. Gage read to hundredths twice daily; oftener during high water. Daily discharge ascertained by applying mean daily gage heights to rating tables directly October 1–5, October 13 to April 20, and June 3 to September 30; by shifting-control method October 6 to 12 and April 21 to June 2. Records good except for extreme stages for which they may be considerably in error.

Discharge measurements of San Saba River at Menard, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Dec. 14	R. J. Hank	2.11	25.0	May 17	Victor Lieb	2.34	33.8
Feb. 10	Victor Lieb	2.11	21.9	June 30	E. O. Francisco	1.86	2.4

Discharge measurements of Noyes Canal at Menard, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Dec. 14	R. J. Hank	.....	22.0	May 17	Victor Lieb	.....	0.0
Feb. 10	Victor Lieb	.....	15.4	June 30	E. O. Francisco	.....	[b] 4.0

[a] See description of San Saba River at Menard, Tex. [b] Estimated.

Daily discharge, in second-feet, of San Saba River at Menard, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	32	5.0	20	28	23	50	23	41	15	7.8	0.8	3.2
2	32	5.0	19	26	24	50	22	30	13	7.1	7.1	5.7
3	32	5.0	19	26	23	50	21	20	345	4.7	4.4	12
4	32	5.7	19	24	26	48	19	7.8	96	4.1	1.8	18
5	32	5.7	19	21	26	48	16	4.1	67	2.9	2.6	135
6	32	5.0	19	21	26	52	15	3.8	47	1.8	2.9	67
7	31	6.4	21	22	26	53	14	9.2	56	1.4	1.8	26
8	34	7.8	23	23	26	53	18	12	50	1.8	1.8	23
9	32	5.0	23	21	26	53	16	9.2	53	1.4	2.9	21
10	31	4.4	23	21	24	53	14	4.4	60	1.0	1.8	21
11	32	3.8	24	20	24	55	46	4.4	56	1.0	1.8	29
12	30	3.8	26	19	26	55	35	67	46	1.9	2.0	29
13	7.8	4.1	26	19	29	18	30	19	36	3.5	2.3	32
14	8.5	4.4	26	20	29	18	26	9.2	18	3.8	1.6	35
15	5.7	13	26	21	29	16	26	9.2	14	3.5	11	32
16	5.0	13	26	21	29	16	26	8.5	12	3.2	4.4	26
17	5.7	12	26	24	28	16	23	28	20	7.8	1.6	23
18	6.4	12	26	26	29	16	62	32	19	15	1.6	21
19	5.7	13	26	26	32	16	53	22	11	3.5	1.6	19
20	5.0	15	26	24	32	16	53	82	9.2	1.6	1.8	6.4
21	5.7	16	28	24	29	16	46	280	4.4	1.5	6.4	2.6
22	5.0	21	28	24	30	16	38	67	2.9	1.8	3.2	2.6
23	5.0	21	28	26	47	16	36	36	1.9	1.6	2.9	3.2
24	5.0	20	29	26	50	16	42	34	1.9	1.2	1.9	2.9
25	6.4	16	28	26	48	15	47	34	5.7	1.8	1.7	2.0
26	5.0	18	26	24	47	15	47	34	9.2	1.0	1.7	1.4
27	4.7	18	23	26	47	16	46	35	9.2	.8	1.5	1.1
28	5.0	18	23	26	48	21	41	34	11	.8	1.4	1.0
29	5.0	16	26	26	.....	18	40	32	7.8	.8	1.4	1.0
30	5.0	18	26	26	.....	14	50	34	4.7	.7	1.7	.8
31	5.0	.....	29	26	.....	13	.....	15	.....	.7	2.3	.....

Monthly discharge of San Saba River at Menard, Tex., for the year ending September 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	34	4.7	15.8	972
November	21	3.8	11.0	655
December	29	19	24.4	1,500
January	28	19	23.6	1,450
February	50	23	31.5	1,750
March	55	13	29.9	1,840
April	62	14	33.0	1,960
May	280	3.8	34.1	2,100
June	345	1.9	36.7	2,180
July	15	.7	2.95	181
August	11	.8	2.70	166
September	135	.8	20.1	1,200
The year	345	.7	22.1	16,000

SAN SABA RIVER NEAR SAN SABA, TEX.

LOCATION.—200 feet above Beveridge highway bridge, 1 mile below mouth of China Creek, 2 miles northwest of San Saba, San Saba County, 3 miles below mouth of Richland Creek, 4 miles above mouth of Simpson Creek.

DRAINAGE AREA.—3,000 square miles.

RECORDS AVAILABLE.—December 30, 1904, to December 31, 1906; September 11, 1915, to September 30, 1917. Miscellaneous discharge measurements previous to 1904.

GAGE.—Vertical and inclined staff, on right bank; read by G. M. Pool. From December 30, 1904, to December 31, 1906, gage heights were obtained by measuring with a tape from a reference point on the bridge to the water surface. Relation between datum used 1904–1906 and that of present gage is not known.

DISCHARGE MEASUREMENTS.—Made by wading or from downstream side of bridge.

CHANNEL AND CONTROL.—Channel straight above and below station for 100 feet. Bed composed of rock and gravel; shifts. Left bank composed of gravel and clay, wooded, high, and not subject to overflow; right bank consists of clay and gravel, wooded, sloping, medium in height, and subject to overflow during high water. A shoal at a ford about 75 feet below gage serves as control during medium and low stages; control is free from vegetation and is fairly permanent during low and medium stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 21.5 feet 1.30 p. m. June 3 (discharge not determined); minimum stage, 0.84 foot during July 13 (discharge, 6.8 second-feet).

1904–1906; 1915–1917: Maximum stage recorded, 31.7 feet August 7, 1906 (discharge not determined); minimum flow July 13, 1917.

ICE.—None reported during year.

DIVERSIONS.—Considerable water is diverted or pumped from the stream and tributaries above station. There are also diversions below the station, but none in the vicinity of the station. The Second Report of the Board of Water Engineers for the State of Texas shows that about 11,000 acres of land were declared irrigated, and that about 23,000 acre-feet of water is used each year from San Saba River. A large part of this amount is diverted above the station. Flood water from Brady Creek at Brady is stored for municipal uses; capacity of reservoir not known but probably small. City of Menard uses small amount for waterworks.

REGULATION.—Flow not regulated by dams or reservoirs.

ACCURACY.—Stage-discharge relation fairly permanent during low and medium stages. Rating curve fairly well defined between 15 and 1,200 second-feet; determinations above 1,200 second-feet possibly subject to considerable error. Rating curve previously used for 1915 and 1916 has been revised in accordance with measurements at higher stages subsequently made. Gage read to hundredths twice daily; oftener during high water. Daily discharge ascertained by applying mean daily gage height to rating table as indicated in footnote to table of daily discharge. Records excellent except for periods of high water.

Records of daily and monthly discharge for 1915 and 1916, based on revised rating curve, are published herewith and supersede those previously published.

Discharge measurements of San Saba River near San Saba, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Dec. 12	R. J. Hank	1.50	54.7	June 5	Victor Lieb	2.90	374
Feb. 9	Victor Lieb	1.66	68.6	5	do	2.70	296
May 13	do	1.70	72.0	6	do	2.32	197
June 4	do	5.07	1,030	6	do	2.28	209
5	do	2.96	408	July 1	E. O. Francisco	1.18	22.9

Daily discharge, in second-feet, of San Saba River near San Saba, Tex., for the period Sept. 11, 1915, to Sept. 30, 1916.

Day.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	.....	210	128	111	120	235	94	401	1,500	70	30	46	32
2	.....	200	120	111	118	128	88	543	2,400	70	35	46	33
3	.....	187	128	109	116	120	87	337	699	69	30	49	35
4	.....	182	120	106	111	120	85	194	311	63	25	55	34
5	.....	171	122	111	111	120	85	150	218	67	23	55	30
6	.....	171	120	681	111	118	85	140	187	56	26	46	31
7	.....	171	122	768	109	116	82	158	162	56	27	44	33
8	.....	160	130	225	102	111	78	150	156	54	29	40	38
9	.....	160	128	156	104	111	84	136	140	49	43	35	39
10	.....	160	130	144	109	111	94	128	132	39	29	38	38
11	111	160	130	136	111	109	88	120	130	50	29	37	39
12	88	160	130	128	111	109	84	118	122	44	24	36	41
13	82	160	130	120	109	102	82	111	118	36	22	37	126
14	82	160	136	120	106	102	78	116	111	31	24	40	57
15	210	160	130	124	102	102	82	144	111	162	22	42	43
16	.....	160	120	124	106	102	84	132	113	73	32	41	41
17	.....	160	122	130	109	102	84	120	152	57	28	43	41
18	2,750	483	122	122	102	102	79	116	178	52	24	43	39
19	950	279	122	120	113	102	78	113	150	48	23	35	45
20	525	200	116	120	120	102	70	104	128	42	26	42	50
21	401	178	102	116	171	100	70	102	124	36	116	40	52
22	314	150	102	116	140	99	82	102	116	37	35	40	49
23	285	136	102	111	124	102	87	99	111	38	55	42	48
24	257	124	102	120	111	95	94	94	104	37	50	38	48
25	257	124	106	111	111	94	92	94	104	40	45	37	235
26	230	120	102	111	111	85	85	95	106	31	50	38	132
27	218	124	104	111	116	85	73	94	88	30	52	40	88
28	205	124	102	111	116	85	72	92	79	26	60	38	82
29	205	120	104	113	116	85	70	92	78	23	57	35	60
30	230	120	106	113	118	.....	64	87	72	26	51	35	56
31	.....	128	.....	118	200	.....	67	.....	70	.....	51	36	.....

NOTE.—Discharge determined as follows: Sept. 11 to Oct. 20, 1915, and Oct. 23, 1915, to Sept. 30, 1916, directly from rating table; Oct. 21 and 22, 1915, by shifting-control method. Discharge, Sept. 18, 1915, and May 1 and 2, 1916, determined from extension of rating curve, and possibly subject to considerable error. Dec. 26, 1915, by interpolation.

Daily discharge, in second-feet, of San Saba River near San Saba, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	56	41	78	64	63	66	35	42	64	22	14	48
2	55	41	78	67	62	67	30	41	62	16	13	41
3	52	42	70	70	59	66	29	41	4,100	11	13	45
4	49	43	64	73	54	67	28	44	901	15	14	1,180
5	45	44	62	70	56	74	26	37	352	20	19	501
6	44	42	56	70	55	76	24	40	191	30	21	244
7	44	42	62	64	59	73	24	44	128	21	16	320
8	46	38	62	67	64	72	26	43	97	19	11	134
9	52	35	56	59	67	69	23	40	76	19	9.6	82
10	46	35	60	59	64	66	22	39	73	7.6	7.8	87
11	46	35	56	64	66	67	26	39	59	7.2	10	80
12	44	38	56	62	63	72	24	160	46	9.2	19	215
13	56	41	60	63	63	67	29	72	42	6.8	14	130
14	56	44	57	60	64	64	30	90	37	8.8	8.8	99
15	56	43	67	62	66	62	35	97	32	12	7.4	69
16	54	42	63	62	62	59	34	74	25	9.6	7.6	52
17	54	44	57	69	56	64	30	67	36	8.0	9.2	46
18	52	52	59	80	56	44	29	55	29	7.6	13	44
19	50	56	59	74	54	39	128	50	24	10	28	39
20	50	55	63	78	51	38	178	228	21	14	39	39
21	49	55	64	84	48	35	82	474	15	26	180	36
22	48	70	63	80	51	36	60	1,240	10	27	210	38
23	48	69	69	74	54	36	42	471	9.6	16	102	41
24	45	67	73	76	49	34	38	169	20	16	57	40
25	45	56	70	74	48	36	29	122	59	10	38	33
26	41	76	70	72	51	35	30	95	22	8.0	32	29
27	42	76	72	67	55	35	41	87	16	8.8	22	44
28	43	74	79	69	55	30	97	84	15	9.2	22	28
29	41	72	72	67	.....	27	48	80	13	18	27	25
30	42	73	72	63	.....	30	41	78	12	13	30	25
31	41	.....	70	63	.....	29	.....	69	.....	16	76	.....

NOTE.—Discharge determined as follows: Oct. 1 to Jan. 16, and May 20 to Sept. 30, directly from rating table; Jan. 17 to May 19 by shifting-control method. Discharge June 3 determined from extension of rating curve; subject to considerable error. Oct. 14–19 by interpolation.

Monthly discharge of San Saba River near San Saba, Tex., for the years ending Sept. 30, 1916 and 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1915–16.				
October	483	120	171	10,500
November	136	102	118	7,020
December	768	106	162	9,960
January	200	102	117	7,190
February	235	85	109	6,270
March	94	64	81.5	5,010
April	543	87	149	8,870
May	2,400	70	267	16,400
June	162	23	50.4	3,000
July	116	22	37.8	2,320
August	55	35	40.9	2,510
September	235	30	57.2	3,400
The year	2,400	22	114	82,400
1916–17.				
October	56	41	48.1	2,960
November	76	35	51.4	3,060
December	79	56	65.1	4,000
January	84	59	68.6	4,220
February	67	48	57.7	3,200
March	76	27	52.7	3,240
April	178	22	43.9	2,610
May	1,240	37	139	8,550
June	4,100	9.6	250	14,900
July	30	6.8	14.3	879
August	210	7.4	35.2	2,160
September	1,180	25	128	7,620
The year	4,100	6.8	79.2	57,400

NORTH LLANO RIVER NEAR JUNCTION, TEX.

LOCATION.—About 500 feet above remains of old Wilson dam, 1 mile below mouth of Bear Creek, 2½ miles above North Llano highway bridge, 3 miles northwest of Junction, Kimble County, 4 miles above confluence of North Llano and South Llano rivers.

DRAINAGE AREA.—803 square miles.

RECORDS AVAILABLE.—September 14, 1915, to September 30, 1917.

GAGE.—Overhanging chain gage on left bank; read by W. T. Hardesty.

DISCHARGE MEASUREMENTS.—Made by wading or from highway bridge 2½ miles below station.

CHANNEL AND CONTROL.—Bed composed of solid rock; clean and permanent. Channel straight above and below for 400 feet, with a series of pools and rapids. Left bank high, clean, and not subject to overflow; right bank low, wooded, and subject to overflow during high stages. One channel at all stages; current sluggish at gage during low and medium stages. A solid rock ledge of approximately 2 feet vertical fall at site of old dam serves as a permanent control for medium and low stages; control clean and free from vegetation.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 2.96 feet at 7.30 a. m. May 21 (discharge, 700 second-feet, determined from extension of rating curve and possibly subject to some error); minimum stage, no flow July 16 to September 2 and September 30.

1915–1917: Maximum stage recorded, 18.0 feet during night of September 15, 1915 (discharge not determined); minimum stage, no flow July 16 to September 2 and September 30, 1917.

ICE.—None reported during year.

DIVERSIONS.—Data do not show that large areas are irrigated in drainage area above station; some land is irrigated below station with water taken from North Llano River.

REGULATION.—No indication that flow at station is regulated.

ACCURACY.—Stage-discharge relation permanent during low and medium stages. Rating curve well defined below 100 second-feet. Gage read to hundredths twice daily; oftener during high water. Daily discharge ascertained by applying mean daily gage height to rating table. Records good for medium and low stages; determinations of discharge above 100 second-feet subject to error.

Discharge measurements of North Llano River near Junction, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Dec. 13	R. J. Hank	1.30	16.2	May 16	Victor Lieb	1.24	9.8
Feb. 10	Victor Lieb	1.28	12.0	June 29	E. O. Francisco	1.02	.5

Daily discharge, in second-feet, of North Llano River near Junction, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	1.7	5.1	11	14	14	16	14	9.0	13	1.6	0.0	0.0
2	1.7	5.1	11	14	16	21	14	9.0	13	1.5	.0	.0
3	1.7	5.1	11	16	16	19	14	7.8	13	1.4	.0	5.1
4	1.7	5.1	12	16	16	16	14	7.8	13	1.4	.0	3.1
5	1.7	5.1	12	16	14	16	14	7.8	11	1.2	.0	1.5
6	1.7	5.1	12	14	14	16	14	7.8	11	1.2	.0	1.3
7	1.7	5.1	12	14	14	16	14	7.8	10	1.0	.0	1.3
8	1.7	5.7	11	14	14	14	14	7.8	9.0	.9	.0	1.2
9	1.7	5.7	11	14	14	14	13	7.8	7.8	.8	.0	1.0
10	1.7	5.7	11	14	14	14	13	7.8	7.8	.7	.0	.9
11	1.7	5.7	11	14	14	14	13	7.8	6.6	.6	.0	.9
12	3.4	5.7	11	14	14	14	13	157	6.0	.4	.0	.8
13	4.5	5.7	11	14	14	14	13	37	5.7	.3	.0	.7
14	4.5	6.6	13	14	14	14	13	19	5.1	.2	.0	.6
15	4.5	7.8	13	14	14	14	13	15	4.5	.1	.0	.6
16	3.9	6.6	13	14	14	14	13	14	3.9	.0	.0	.4
17	5.1	5.7	13	14	14	14	13	13	3.9	.0	.0	.4
18	5.1	6.6	13	14	14	14	13	13	3.4	.0	.0	.3
19	5.1	7.8	13	14	14	14	13	11	2.8	.0	.0	.5
20	5.7	9.0	13	14	14	14	11	47	2.0	.0	.0	.7
21	5.7	9.0	13	14	14	14	11	392	1.6	.0	.0	.8
22	5.7	10	13	14	14	14	11	131	1.5	.0	.0	.9
23	5.7	11	13	14	14	14	11	44	1.5	.0	.0	.7
24	5.7	11	13	14	14	13	11	26	1.5	.0	.0	.6
25	5.7	11	13	14	14	13	11	22	1.5	.0	.0	.5
26	5.7	11	13	14	14	13	11	18	5.5	.0	.0	.4
27	5.7	11	14	14	16	13	10	21	4.0	.0	.0	.3
28	5.1	11	14	14	16	13	10	18	3.0	.0	.0	.2
29	5.7	11	14	14	.....	13	10	16	2.3	.0	.0	.1
30	5.7	11	14	14	.....	13	10	14	2.3	.0	.0	.0
31	5.7	.....	14	14	.....	13	.....	14	.....	.0	.0	.....

NOTE.—Discharge June 24–29 determined from record for Llano River near Junction.

Monthly discharge of North Llano River near Junction, Tex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	5.7	1.7	3.95	243
November	11	5.1	7.57	450
December	14	11	12.5	769
January	16	14	14.2	873
February	16	14	14.4	800
March	21	13	14.5	892
April	14	10	12.4	738
May	392	7.8	36.5	2,240
June	13	1.5	5.91	352
July	1.6	.0	.43	26
August	.0	.0	.00	0
September	5.1	.0	.86	51
The year	392	.0	10.3	7,430

LLANO RIVER NEAR JUNCTION, TEX.

LOCATION.—100 feet north of Kerrville-Junction road, a quarter of a mile northeast of Oliver's ranch house, 3 miles below confluence of North Llano and South Llano rivers, 3½ miles east of Junction, Kimble County, 4 miles above creek entering river from south.

DRAINAGE AREA.—1,700 square miles.

RECORDS AVAILABLE.—September 13, 1915, to September 30, 1917.

GAGE.—Vertical staff, reading from 0 to 7.5 feet, attached to tree on right bank, and inclined staff, reading from 7.6 to 19.5 feet, a few feet upstream from vertical staff; read by Sadie Oliver.

DISCHARGE MEASUREMENTS.—Made by wading at Mason road crossing a quarter of a mile above gage, or from cable 400 feet above gage.

CHANNEL AND CONTROL.—Bed composed of solid rock, clean, and permanent. Channel straight for 700 feet above and 350 feet below the gage. Left bank of medium height, slightly wooded, and subject to overflow during high water; right bank clean, high, and not subject to overflow. One channel at all stages except during extreme floods, when a small part of the flow may follow a slough that leaves the river a short distance above the gage, passes to the south of Oliver's ranch house, and enters the main stream below the gage. Such conditions do not occur, however, at intervals more frequent than 10 to 15 years and will not greatly affect records. Rock ledge about 75 feet below gage, forming a fall of about 3 feet, serves as permanent control for low and medium stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 1.88 feet during night of May 11 (discharge, 192 second-feet); minimum stage 1.34 feet during August 24 and 25 (discharge, 17 second-feet).

1915–1917: Maximum stage recorded, 26.3 feet at 3 a. m. September 16, 1915 (discharge not determined); minimum stage August 24 and 25, 1917.

ICE.—None reported during year.

DIVERSIONS.—The Second Report of the Board of Water Engineers for the State of Texas shows that 4,741 acres of land have been declared irrigated requiring 9,482 acre-feet of water annually from Llano River and tributaries above the station on the assumption that the duty of water is 2 acre-feet per acre. Available data show that a large part of this land is in the vicinity of Junction, near the confluence of North Llano and South Llano rivers. A filing of 500 second-feet for continuous use in connection with hydraulic power for the Junction Gin & Water Co. is also listed in the same report.

REGULATION.—No apparent regulation of the flow at this point.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve well defined between 20 and 300 second-feet. Gage read to hundredths once daily; during high water oftener. Daily discharge ascertained by applying mean daily gage heights to rating table. Records excellent for medium and low stages; determination of discharge above 400 second-feet may be subject to error.

Discharge measurements of Llano River near Junction, Tex., during the year ending Sept 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Dec. 14	R. J. Hank	1.54	63.6	May 16	Victor Lieb	1.48	48.5
Feb. 11	Victor Lieb	1.55	62.3	June 29	E. O. Francisco	1.43	31.2
May 16	do	1.48	52.0				

Daily discharge, in second-feet, of Llano River near Junction, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	60	63	63	69	66	56	56	48	48	27	27	25
2	60	63	63	69	66	56	56	48	48	24	24	25
3	60	63	63	69	66	56	56	43	56	27	24	34
4	60	63	63	69	66	56	50	43	48	24	24	79
5	60	63	63	69	66	56	50	43	48	24	24	132
6	53	56	63	69	66	56	50	43	48	20	27	79
7	53	56	63	69	60	56	50	43	45	20	27	48
8	82	56	63	69	60	56	50	66	45	20	27	48
9	76	50	63	69	60	56	56	38	45	20	24	48
10	76	56	63	69	60	56	63	38	43	20	24	48
11	69	56	63	69	72	56	63	101	43	20	24	90
12	69	56	63	69	72	63	69	60	38	20	24	43
13	69	63	63	69	72	63	69	60	25	20	24	43
14	69	63	63	69	66	63	69	60	25	20	24	38
15	69	63	63	69	66	63	69	53	25	20	20	38
16	76	63	69	69	66	63	69	45	25	20	20	43
17	76	63	69	69	66	63	63	45	25	32	20	43
18	76	63	69	69	66	63	63	45	25	32	20	43
19	82	63	69	69	66	63	63	45	25	32	20	43
20	82	63	69	69	66	63	56	86	22	32	82	43
21	82	63	69	76	66	63	56	86	22	32	32	43
22	82	63	69	76	72	63	56	66	22	32	20	43
23	82	63	69	69	72	63	56	48	22	32	20	38
24	82	63	69	69	72	63	50	48	22	32	17	38
25	82	63	69	69	66	63	45	48	25	32	17	38
26	82	63	69	69	66	63	45	48	29	32	20	38
27	82	63	69	69	66	56	45	48	29	32	20	38
28	82	63	69	69	66	56	45	48	29	32	36	38
29	69	63	69	69	.....	56	45	48	34	27	27	38
30	69	63	69	69	.....	56	50	48	34	27	27	43
31	63	.....	69	69	.....	56	.....	48	.....	27	27	.....

Monthly discharge of Llano River near Junction, Tex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	82	53	72.1	4,430
November	63	50	61.2	3,640
December	69	63	66.1	4,060
January	76	69	69.5	4,270
February	72	60	66.4	3,690
March	63	56	59.4	3,650
April	69	45	56.1	3,340
May	101	38	52.8	3,250
June	56	22	34.0	2,020
July	32	20	26.2	1,610
August	82	17	25.6	1,570
September	132	25	47.6	2,830
The year	132	17	53.0	38,400

BARTON CREEK AT AUSTIN, TEX.

LOCATION.—500 feet below Barton Springs, 1,100 feet above Bee Cave highway bridge, half a mile above confluence with Colorado River, half a mile southwest of Austin, Travis County.

DRAINAGE AREA.—Indeterminate. Normal flow at station comes from Barton Springs; drainage area of stream not applicable.

RECORDS AVAILABLE.—April 25, to September 30, 1917. Miscellaneous discharge measurements have been made from 1894 to 1906, and during 1916 and 1917.

GAGE.—Vertical staff, two sections, reading from 0 to 10.1 feet and 10. 2 to 20.3 feet, attached to large tree on left bank; read by M. L. Farquhar. April 25 to May 23, gage readings from a vertical staff gage 300 feet downstream. Relation between datums not known.

DISCHARGE MEASUREMENTS.—Made by wading about 800 feet below gage.

CHANNEL AND CONTROL.—Bed composed of rock, gravel, and sand. Banks high. wooded, and not subject to overflow. One channel at all stages. Shoal just below gage serves as a control during ordinary flow, but weed growth in channel affects stage-discharge relation. Flood stages in Colorado River cause backwater at the station.

EXTREMES OF DISCHARGE.—Maximum flow during period of record, June 1 to 4 (discharge, 19 second-feet, or 11,300,000 gallons per day); minimum flow, May 20 and 21, and August 2–20 (discharge, 13 second-feet, or 8,400,000 gallons per day).

1894–1906; 1916–1917: Maximum flow recorded August 31, 1900, and June, 1903 (discharge, 69 second-feet, or 44,600,000 gallons per day); minimum flow, May 20 and 21, 1917, and August 2–20, 1917.

ICE.—None reported.

DIVERSIONS.—So far as known no diversions above or below station.

REGULATION.—Flow not affected by water power plants or controlling works. Discharge of Barton Springs regulates flow during ordinary conditions. Flow is perennial at station, but from a point 3 miles northeast of Oak Hill to Barton Springs, is erratic, occurring only during heavy precipitation.

ACCURACY.—Stage-discharge relation affected by growth of weeds in channel. Rating curve poorly defined; discharge determined by interpolation between discharge measurements. Gage read to hundredths twice daily. Constant flow does not require additional readings. Frequent discharge measurements increase accuracy of records. Records good.

Discharge measurements of Barton Creek at Austin, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Feb. 23	Gray and Hank	.....	17.2	Aug. 15	E. P. Congdon	1.49	14.9
Apr. 26	Victor Lieb	1.26	15.3	22	Hank and Francisco	1.48	15.0
May 11	Gray and Lieb	1.22	14.5	24	R. J. Hank	[a]1.57	15.4
June 1	Hank and Francisco	1.28	19.9	29	.....do	1.52	14.3
12	Lieb and Gray	1.30	18.0	31	.....do	1.53	15.0
26	Hank and Francisco	1.35	18.0	Sept. 12	Hank and Walsh	1.56	18.2
26	.....do	1.35	17.8				
July 14	Congdon and Francisco.	1.40	15.8				
28	Hank and Congdon	1.45	14.9				

[a] Referred to datum of new gage.

Daily discharge, in second-feet, of Barton Creek at Austin, Tex., for the year ending Sept. 30, 1917.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Day.	Apr.	May.	June.	July.	Aug.	Sept.
1	.....	15	19	17	14	15	16	.....	14	18	16	13	18
2	.....	15	19	17	13	14	17	.....	14	18	16	13	18
3	.....	15	19	17	13	14	18	.....	14	18	16	13	18
4	.....	15	19	16	13	14	19	.....	14	18	16	13	18
5	.....	15	18	16	13	15	20	.....	13	18	15	13	17
6	.....	15	18	16	13	16	21	.....	13	18	15	14	17
7	.....	15	18	16	13	16	22	.....	14	18	15	14	17
8	.....	15	18	16	13	16	23	.....	16	18	14	14	17
9	.....	15	18	16	13	16	24	.....	18	18	14	15	17
10	.....	15	18	16	13	17	25	15	18	18	14	15	17
11	.....	14	18	16	13	18	26	15	18	18	14	15	17
12	.....	14	18	16	13	18	27	15	17	18	14	15	17
13	.....	14	18	16	13	18	28	15	17	17	14	15	17
14	.....	14	18	16	13	18	29	15	18	17	14	15	17
15	.....	14	18	16	13	18	30	15	18	17	14	15	17
							31	.....	18	.....	14	15	.....

Monthly discharge of Barton Creek at Austin, Tex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
April 25-30	15	15	15.0	179
May	18	13	15.3	941
June	19	17	18.0	1,070
July	17	14	15.4	947
August	15	13	13.6	836
September	18	14	16.7	994
The period	.....	.....	.....	4,970

GUADALUPE RIVER BASIN.

GUADALUPE RIVER AT NEW BRAUNFELS, TEX.

LOCATION.—At highway bridge on San Antonio-Austin post road 700 feet below International & Great Northern Railway bridge, 1 mile below mouth of Comal River, 1 mile northeast of center of New Braunfels, Comal County.

DRAINAGE AREA.—1,760 square miles.

RECORDS AVAILABLE.—March 13, 1898, to December 30, 1899; January 27, 1915, to September 30, 1917.

GAGE.—Stevens water-stage recorder referred to staff gage in well, attached to downstream side of middle pier of highway bridge. A vertical staff gage in three sections attached to trees on left bank 200 feet below highway bridge and one section on east side of left pier of highway bridge was read from January 27, 1915, to September 28, 1917, when recorder was installed. Gage used from March 13, 1898, to December 30, 1899, was an inclined staff gage near present highway bridge; relation between datum of earlier gage and that of present gage not known. During normal flow levels show 0.08 foot fall between intake of recorder and vertical staff gage location. Vertical staff gage in well of recorder set to read same as vertical staff downstream.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge.

CHANNEL AND CONTROL.—Bed composed of solid rock with pockets of coarse gravel; banks gravel, clay, and rock, slightly wooded, high, and not subject to overflow. Rock and gravel shoal just below gage serves as control; permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 4.60 feet at 6 a. m. September 7 (discharge, 2,370 second-feet); minimum stage, 1.50 feet August 26 to September 2 (discharge, 305 second-feet).

1898–1899 and 1915–1917: Maximum stage recorded, 27.2 feet at 9.30 p. m. September 17, 1915, determined by leveling from flood marks (discharge not determined); minimum stage recorded, August 26 to September 2, 1917.

ICE.—None reported during year.

DIVERSIONS.—Some water diverted for irrigation above station in Kerr and Comal counties, and for water power, waterworks, and other municipal uses in Kerr, Kendall, and Comal counties; amount not known.

REGULATION.—Flow at this point slightly regulated by operation of power plants.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve well defined below 7,000 second-feet. Gage read to hundredths twice daily prior to September 28. Mean daily gage height obtained from two readings may not be a true index of mean daily flow because of fluctuation caused by operations of power plant. Gage heights from recorder chart determined by planimeter. Daily discharge ascertained by applying mean daily gage height to rating table. Records good.

Discharge measurements of Guadalupe River at New Braunfels, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 4	Gray and Lieb	1.72	395	June 21	Francisco and Hank	1.51	310
Jan. 10	Gray and Kessler	1.71	384	Aug. 24	Congdon and Francisco.	1.60	334
Mar. 1	Gray and Hank	1.70	377	Sept. 13	Gray and Walsh	1.75	403

Daily discharge, in second-feet, of Guadalupe River at New Braunfels, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	400	405	405	405	390	380	380	344	380	329	335	305
2	400	405	405	405	380	380	380	344	380	335	335	305
3	405	400	405	405	380	380	380	362	390	335	335	311
4	395	400	405	405	380	380	380	371	380	380	335	329
5	410	390	405	405	380	380	380	358	371	376	335	344
6	390	390	405	405	380	380	380	858	358	371	335	335
7	380	490	405	405	380	380	380	755	358	358	335	1,560
8	380	400	405	405	380	380	380	634	358	358	335	645
9	376	405	405	400	380	380	380	546	358	358	335	640
10	376	405	405	390	380	380	380	491	353	358	335	568
11	380	400	405	390	390	380	380	455	344	371	335	470
12	380	380	405	380	405	380	380	535	344	358	335	420
13	371	371	400	380	405	380	380	530	340	358	335	390
14	380	371	390	380	405	380	380	579	335	358	335	362
15	376	371	390	405	390	380	371	579	335	358	335	358
16	430	385	390	410	390	380	358	502	335	358	335	340
17	420	380	390	400	390	380	358	480	335	358	335	335
18	618	380	390	385	390	380	358	455	335	358	335	335
19	711	390	400	380	390	380	358	405	335	358	320	335
20	562	390	390	380	385	380	358	430	335	390	320	335
21	524	380	390	380	390	380	358	508	323	371	320	329
22	470	470	390	420	390	380	358	470	332	358	320	329
23	430	450	390	455	390	380	358	524	329	358	320	329
24	430	430	390	440	390	380	358	470	329	358	326	320
25	425	405	400	430	390	380	358	420	323	358	317	320
26	405	430	405	430	390	380	358	385	320	358	305	320
27	405	430	400	430	390	380	358	440	320	358	305	317
28	405	420	390	420	390	380	358	420	320	358	305	311
29	405	420	390	405	.....	380	358	380	320	358	305	317
30	390	420	390	405	.....	380	358	380	320	340	305	317
31	405	.....	405	400	.....	380	.....	405	.....	335	305	.....

Monthly discharge of Guadalupe River at New Braunfels, Tex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	711	371	427	26,300
November	470	371	402	23,900
December	405	390	398	24,500
January	455	380	404	24,800
February	405	380	388	21,500
March	380	380	380	23,400
April	380	358	369	22,000
May	858	344	478	29,400
June	390	320	343	20,400
July	390	329	358	22,000
August	335	305	326	20,000
September	1,560	305	408	24,300
The year	1,560	305	390	282,000

GUADALUPE RIVER NEAR GONZALES, TEX.

LOCATION.—Just below Guadalupe highway bridge, 1¼ miles south of Gonzales, Gonzales County, 1 mile below power house of Gonzales Water Power Co., 2½ miles below mouth of San Marcos River.

DRAINAGE AREA.—3,620 square miles (revised).

RECORDS AVAILABLE.—July 1, 1915, to September 30, 1917. The United States Weather Bureau has obtained records from a gage at power house of Gonzales Water Power Co. since September 1, 1904.

GAGE.—Vertical staff in three sections on right bank just below bridge; read by Albert Garcia. Relation between this gage and that of United States Weather Bureau not known.

DISCHARGE MEASUREMENTS.—Made from cable one-fourth mile below gage, or by wading below cable.

CHANNEL AND CONTROL.—Bed composed of gravel and sand; channel below station is straight for 500 feet, but above is broken by an island and is straight for not more than 50 feet. Banks composed of gravel and clay; medium height; wooded along water's edge on the right and for some distance back on the left; subject to overflow only during extremely high stages. Position of control not known.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 15.14 feet from 8 to 9.30 a. m. May 8 (discharge, 7,800 second-feet); minimum stage, 0.62 foot at 6.30 p. m. August 25 (discharge, 350 second-feet).

1915–1917: Maximum stage recorded, 23.25 feet at 7 a. m. May 25, 1916 (discharge, 22,800 second-feet; determined from extension of rating curve and possibly subject to error); minimum stage, August 25, 1917.

ICE.—None reported during year.

DIVERSIONS.—Some water diverted for irrigation above this point by gravity or pumping, but the amount is small in comparison with the total run-off. As rainfall is nearly sufficient for general farming, irrigation is intermittent and it is extremely difficult to estimate the amount of water used.

REGULATION.—Flow at this point regulated somewhat by operation of water-power plants in the drainage above. Power house of Gonzales Water Power Co. is located one mile above station.

ACCURACY.—Stage-discharge relation practically permanent during the year. Rating curve fairly well defined below 9,000 second-feet. Gage read to hundredths twice daily. Mean daily gage height based on two readings may not be true index of mean daily discharge because of fluctuation caused by power operations. Daily discharge ascertained by applying mean daily gage height to rating table. Records fair.

Discharge measurements of Guadalupe River near Gonzales, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 15	Victor Lieb	1.03	a 397	June 20	Hank and Francisco	0.80	410
Jan. 7	Gray and Kessler	1.28	558	July 18	Congdon and Francisco	.72	384
Apr. 6	Victor Lieb	.96	439	Aug. 29	E. O. Francisco	1.38	610
May 8	Hank and Gray	15.07	7,710				

a Discharge uncertain.

Daily discharge, in second-feet, of Guadalupe River near Gonzales, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	488	488	548	474	523	488	502	388	448	394	370	424
2	478	488	530	481	523	488	502	391	439	391	365	424
3	467	495	530	481	537	488	502	412	433	391	360	409
4	460	502	540	502	537	484	502	430	430	388	360	388
5	448	488	551	502	537	484	454	460	424	388	365	516
6	430	488	548	509	537	484	448	478	421	388	365	467
7	418	488	548	516	537	484	451	3,450	415	388	365	385
8	406	481	554	516	537	484	454	6,170	415	388	360	370
9	400	481	558	516	537	484	454	1,400	403	394	360	379
10	406	481	548	516	537	484	454	805	403	394	360	388
11	454	474	537	516	523	488	478	717	403	394	360	394
12	460	474	520	523	516	488	1,120	1,540	403	394	360	424
13	474	474	516	523	512	488	969	2,950	403	391	360	436
14	484	478	520	523	506	495	498	2,020	397	388	360	433
15	488	481	523	523	502	495	467	1,360	397	382	360	424
16	495	481	523	523	488	495	454	1,350	397	379	365	424
17	502	481	523	523	488	502	436	1,250	397	379	362	424
18	509	481	523	523	488	502	470	1,200	397	379	376	424
19	509	481	520	537	488	502	454	1,140	397	412	370	415
20	512	488	516	537	484	502	2,220	1,490	397	1,880	376	421
21	516	488	512	537	484	502	2,210	2,950	397	1,460	370	418
22	516	502	509	537	484	502	562	1,280	379	1,000	365	424
23	520	512	509	537	484	506	445	1,150	385	637	365	415
24	516	520	509	523	484	506	430	837	391	467	365	382
25	516	530	502	523	488	506	415	689	400	403	358	376
26	509	540	502	523	484	509	409	593	418	388	365	379
27	502	554	502	523	481	506	406	551	427	388	365	365
28	502	565	502	523	481	509	397	548	394	388	382	365
29	502	573	484	523	.....	506	388	530	388	388	448	365
20	495	554	478	523	.....	506	388	512	388	382	439	365
31	488	.....	474	523	.....	502	.....	488	.....	382	424	.....

Monthly discharge of Guadalupe River near Gonzales, Tex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	520	400	480	29,500
November	573	474	500	29,800
December	558	474	521	32,000
January	537	474	518	31,900
February	537	481	507	28,200
March	509	484	496	30,500
April	2,220	388	611	36,400
May	6,170	388	1,280	78,700
June	448	379	406	24,200
July	1,880	379	502	30,900
August	448	358	372	22,900
September	516	365	407	24,200
The year	6,170	358	551	399,000

GUADALUPE RIVER BELOW CUERO, TEX.

LOCATION.—Three-fourths mile upstream from Heard's bridge on Arneckville road, 1 mile south of Dietze farmhouse, 2 miles below Clinton bridge, 2½ miles southeast of Cuero, Dewitt County, 4 miles below Schleicher bridge, 8 miles below dam used for power development.

DRAINAGE AREA.—5,020 square miles.

RECORDS AVAILABLE.—August 6, 1916, to September 30, 1917. From December 26, 1902, to December 31, 1906, and August 19, 1915, to August 6, 1916, a station was maintained at Schleicher bridge, 4 miles above this point. Discharge at two sites practically the same.

GAGE.—Stevens water-stage recorder on left bank.

DISCHARGE MEASUREMENTS.—Made from cable 40 feet upstream from gage or by wading below low-stage control.

CHANNEL AND CONTROL.—Channel straight above and below station for 1,000 feet. Bed composed of gravel and small rock; clean and not subject to shift. Left bank composed of sand and dirt, covered with brush and open timber and is 20 feet high, but at stage above a gage height of 20 feet is overflowed, the water submerging an area extending one-fourth mile back from the river; right bank composed of sand and dirt, covered with brush and trees on sloping sides and cultivated land on top; high and not subject to overflow. Rock and gravel rapids 250 feet below gage serves as a permanent control during low and medium stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, from water-stage recorder, 9.58 feet at 3 p. m. May 9 (discharge, 6,930 second-feet); minimum stage, from water-stage recorder, about 0.60 foot at 9 a. m. September 27 (discharge, 80 second-feet); exact stage not determined because of sand in float well; discharge determined from extension of rating curve and possibly slightly in error.

1916–1917 Maximum and minimum stages recorded in 1917.

ICE.—None reported during year.

DIVERSIONS.—Diversion of small quantities of water for irrigation in upper part of Guadalupe River basin does not greatly influence flow at station. The second report of the Board of Water Engineers for the State of Texas shows filings for 730 acre-feet per annum for the city of Cuero, 4,277 second-feet for continuous use for municipal and manufacturing plants, 2,145 acre-feet per annum for New Braunfels, Seguin, and Gonzales, and 2,900 acre-feet storage per annum in the drainage basin above station.

REGULATION.—Flow regulated by operation of water-power plants upstream, chiefly by a plant about 8 miles above.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve well defined between 200 and 7,500 second-feet. Operation of the water-stage recorder unsatisfactory, resulting in breaks in the gage-height record. Daily discharge ascertained by applying to rating table mean daily gage height determined by use of planimeter. Records good.

Discharge measurements of Guadalupe River below Cuero, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 9	Victor Lieb	1.50	587	May 10	R. J. Hank	4 33	2,540
10	.....do	1.54	601	10	.....do	3 84	2,110
Jan. 8	Kessler and Hall	1.82	703	10	.....do	3 32	1,820
Feb. 10	R. J. Hank	1.38	509	11	.....do	2.54	1,230
Apr. 7	Victor Lieb	1.26	491	June 19	Francisco and Hank	1.15	394
May 8	R. J. Hank	6.85	4,630	July 16	Congdon and Francisco	1.08	368
9	.....do	9.23	6,600				
9	.....do	9.35	6,740	17	.....do	1.06	325
9	.....do	9.56	6,890	29	E. O. Francisco	1.18	386
9	.....do	9.52	6,870	Aug. 29	.....do	.92	248
10	.....do	4.66	2,840				

Daily discharge, in second-feet, of Guadalupe River below Cuero, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	438	564	702	636	476	680	410	355	526	465	410	492
2	492	564	718	690	426	641	614	614	514	457	454	394
3	514	570	729	758	597	570	438	410	514	449	399	443
4	509	602	818	624	470	448	460	426	504	441	410	465
5	526	487	854	476	542	592	399	421	470	432	404	570
6	564	586	619	636	608	558	454	410	460	424	388	690
7	509	652	586	514	548	724	416	410	460	416	366	690
8	448	614	652	712	498	388	448	2,680	443	408	344	646
9	592	548	758	674	514	548	575	6,460	443	400	333	366
10	548	586	504	712	696	558	448	2,770	438	391	311	782
11	564	564	718	564	520	553	432	1,210	426	382	300	794
12	504	553	548	558	608	602	438	1,130	410	373	284	746
13	482	575	614	492	641	586	658	1,660	410	364	284	860
14	465	619	663	476	630	520	1,430	3,530	399	355	306	866
15	482	553	602	658	624	454	663	2,690	382	346	262	460
16	377	542	690	652	608	553	800	1,140	382	338	272	460
17	558	619	465	399	597	592	465	848	377	432	289	542
18	542	520	658	624	514	492	509	764	372	1,110	284	438
19	432	531	788	608	608	630	426	752	372	426	272	465
20	586	586	597	602	586	564	509	624	360	372	262	432
21	597	630	608	487	646	564	1,230	674	360	399	278	366
22	646	641	641	602	707	438	2,450	3,620	360	652	256	536
23	782	624	641	636	696	402	1,200	1,720	360	1,680	294	443
24	734	702	641	636	602	465	646	899	370	892	416	536
25	658	794	640	608	575	382	498	812	370	558	262	509
26	592	712	640	580	696	570	465	746	400	476	212	366
27	608	752	638	592	702	531	410	674	400	432	218	306
28	382	729	638	498	592	531	602	531	420	410	306	289
29	421	712	638	619	.....	509	542	514	380	399	355	300
30	548	696	636	712	.....	432	394	580	370	399	448	399
31	536	.....	636	658	.....	531	.....	558	.....	410	707	.....

NOTE.—Discharge Dec. 23-31 and June 21 to July 15 estimated from record on Guadalupe River near Gonzales, Tex., and data furnished by engineers.

Monthly discharge of Guadalupe River below Cuero, Tex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	782	377	537	33,000
November	794	487	614	36,500
December	854	465	654	40,200
January	758	399	603	37,100
February	707	426	590	32,800
March	724	382	536	33,000
April	2,450	394	648	38,600
May	6,460	355	1,310	80,600
June	526	360	415	24,700
July	1,680	338	500	30,700
August	707	212	335	20,600
September	866	289	522	31,100
The year	6,460	212	606	439,000

SAN MARCOS RIVER AT SAN MARCOS, TEX.

LOCATION.—Just below Cape Ginning Co.'s mill, 300 feet southwest of main San Marcos-Luling highway, 1 mile southeast of San Marcos, Hayes County, 1¼ miles above mouth of Blanco River, 1½ miles below dam of San Marcos Utilities Co., and the large springs that furnish a constant supply for the stream.

DRAINAGE.—Indeterminate.

RECORDS AVAILABLE.—June 10, 1915, to January 19, 1916; March 13, 1916, to September 30, 1917. Miscellaneous measurements made from 1894 to 1903.

GAGE.—Stevens water-stage recorder on left bank, 300 feet below Cape Ginning Co.'s mill. Gage used June 10, 1915, to January 19, 1916, was a vertical staff gage attached to the sewer trestle of San Marcos Utilities Co., 1,000 feet below Austin-San Antonio highway bridge, 1¼ miles above present site. No known relation between datum of staff gage and that of water-stage recorder.

DISCHARGE MEASUREMENTS.—Made by wading.

CHANNEL AND CONTROL.—Bed composed of gravel and sand; some vegetation in the flowing water. Channel straight for 200 feet above and below the station. Water very clear, deep, and with scarcely any sediment except during floods caused by local rains. Channel was cleaned and dredged above and below gage June 21–29 to increase head for Cape Ginning Co.'s mill. Left bank wooded, high, and not subject to overflow; right bank wooded, low, and subject to overflow, the water spreading back a short distance to a second bank. Position of control not known; current-meter measurements indicate that it changes slightly.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, from water-stage recorder, 8.05 feet (no backwater from Blanco River) at 1 p. m. May 6 (discharge not determined); minimum stage recorded, 0.38 foot at 4.30 p. m. August 22 (discharge, 20 second-feet; determined from extension of rating curve and possibly in error).

1915–1917: Maximum and minimum stages recorded in 1917.

ICE.—None reported during year.

DIVERSIONS.—A concrete dam just above the San Marcos-Luling road bridge makes a pond for Roger's resort and serves as a diversion dam for an irrigation plant on left bank; diversion intermittent, but when used takes about 95 second-feet from river. A water wheel is used to pump the water for irrigation and the water that passes through it is returned to the river above Cape Ginning Co.'s dam. About 1,000 feet above the station is a dam constructed for the purpose of creating a pond from which water was pumped to the south-bank lands. Only pumping plant or diversion between station and mouth of Blanco River is about 250 feet below gage. Beckman dam, just below mouth of Blanco River, is used to impound water for irrigation. During ordinary stages in San Marcos and Blanco rivers this dam backs water up San Marcos River a distance of three-quarters of a mile, but flood stages in Blanco River produce backwater at the station. The Second Report of the Board of Water Engineers of Texas shows a declared acreage of 989 acres in Hayes County being irrigated from San Marcos River by means of 1,978 acre-feet of water per annum. A large part of this area is above the station. The Report of the Board of Water Engineers also shows a filing of 1,120 acre-feet per annum for waterworks by San Marcos Utilities Co.

REGULATION.—Flow at station entirely regulated by dams above, the greatest effect being that produced by the power dam of the San Marcos Utilities Co. in the upper part of the city of San Marcos, near the springs. This dam backs water over the springs that form the source of supply of the river during ordinary stages. Water is stored at this point throughout the afternoon and evening and released during the morning. Large fluctuations are also caused by operation of water wheel at Cape Ginning Co.'s mill.

ACCURACY.—Stage-discharge relation changes slightly; rating curve fairly well defined from 35 to 200 second-feet. The periods of back-water from Blanco River are of short duration only and the constant flow of San Marcos River allows estimates of the discharge to be made without material reduction in accuracy. Mean daily gage height determined by use of planimeter. Discharge determined by shifting-control method. Records good.

Discharge measurements of San Marcos River at San Marcos, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 4	Gray and Lieb	1.56	105	Jan. 13	R. J. Hank	1.44	88.6
28	Gray and Hank	1.71	110	Feb. 20	Hank and Gray	1.56	91.4
Nov. 25	do	1.39	87.0	Mar. 2	do	1.65	91.2
Dec. 19	do	1.25	72.7	May 19	do	1.38	81.5
19	do	1.27	78.5	23	do	1.20	66.6
19	do	1.10	62.3	June 8	Francisco and Gray	1.64	103
19	do	.80	37.8	July 18	Congdon and Franciso	[a].88	61.3
19	do	.71	38.3	Aug. 24	R. J. Hank	.76	46.3
Jan. 7	Hoyt and Kessler	1.73	121				

[a] Stage-discharge relation changed by cleaning of channel.

Daily discharge, in second-feet, of San Marcos River at San Marcos, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	119	124	121	122	118	112	117	104	114	88	83	83
2	139	128	124	123	118	105	114	99	108	87	80	84
3	133	120	121	126	118	80	117	102	114	90	76	85
4	123	121	113	125	116	114	105	111	105	96	108	81
5	117	117	114	122	116	104	108	108	104	92	88	87
6	118	122	99	122	116	110	111	314	109	91	85	87
7	118	120	114	119	114	113	112	122	103	85	86	81
8	113	120	116	114	114	105	114	114	105	88	87	84
9	127	126	112	114	114	107	112	108	106	92	84	89
10	126	123	123	113	114	108	114	108	113	88	88	81
11	111	123	105	112	112	115	106	115	110	88	87	94
12	112	114	114	112	112	98	114	131	100	90	92	82
13	115	122	117	108	112	111	113	125	110	90	89	87
14	110	124	123	112	112	103	113	108	102	87	91	87
15	126	121	118	112	112	115	114	105	104	90	92	88
16	125	124	117	116	112	111	113	122	104	85	88	85
17	125	103	121	114	110	105	113	116	108	84	87	82
18	125	125	116	112	110	119	115	114	107	78	85	79
19	136	112	102	113	110	110	115	105	115	86	96	85
20	130	114	121	113	110	114	117	107	104	89	90	88
21	132	114	113	114	111	112	108	109	104	92	92	88
22	126	132	119	113	106	110	110	115	105	84	89	92
23	121	124	122	112	104	118	107	108	106	97	89	88
24	125	114	110	109	105	107	112	114	106	83	86	88
25	128	124	116	110	117	108	105	120	107	79	92	87
26	124	124	119	110	108	111	109	109	108	79	94	80
27	126	126	118	115	104	94	107	113	108	87	88	83
28	128	128	104	115	106	105	102	114	100	81	85	83
29	107	128	112	109	.....	109	109	114	88	84	100	85
30	122	125	110	114	.....	109	104	114	91	93	75	85
31	124	.....	123	115	.....	112	.....	111	.....	83	88	.....

NOTE.—Recorder not in operation Feb. 2–19 and Sept. 17, 29, and 30; channel cleaned June 21–29; discharge during these periods determined by interpolation.

Monthly discharge of San Marcos River at San Marcos, Tex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	139	107	123	7,560
November	132	103	121	7,200
December	124	99	115	7,070
January	126	108	115	7,070
February	118	104	112	6,220
March	119	80	108	6,640
April	117	102	110	6,550
May	314	99	119	7,320
June	115	88	106	6,310
July	97	78	87.3	5,370
August	108	75	88.4	5,440
September	94	79	85.3	5,080
The year	314	75	108	77,800

SAN MARCOS RIVER AT OTTINE, TEX.

LOCATION.—Above highway bridge one-fourth mile southwest of Ottine, Gonzales County, 4 miles below mouth of Plum Creek, 10 miles above confluence of San Marcos and Guadalupe rivers.

DRAINAGE AREA.—Indeterminate.

RECORDS AVAILABLE.—June 22, 1915, to September 30, 1917.

GAGE.—Vertical staff in four sections attached to trees on left bank about 200 feet above bridge; read by J. H. Kaine. Gage used from June 22 to October 12, 1915, was a vertical staff under the highway bridge, but gage heights have been reduced to datum of present gage by means of a curve of relation.

DISCHARGE MEASUREMENTS.—Made by wading at shoal 100 feet below gage or from downstream side of highway bridge.

CHANNEL AND CONTROL.—Bed composed of sand, rock, and gravel; not subject to great shifting. Both banks high and wooded; not overflowed except by extremely high water. Channel straight above and below the station for 150 feet. Low-stage control formed by shoal 100 feet below gage; during high stages in Guadalupe River backwater changes stage-discharge relation; backwater did not exist from this cause during 1917.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 26.5 feet at 1 p. m., May 7 (discharge, 7,480 second-feet). Minimum stage, 1.06 feet at 7 p. m., August 26 and 27 (discharge, 26 second-feet).

1915–1917: Maximum and minimum stage recorded in 1917.

ICE.—None reported during year.

DIVERSIONS.—Small amounts of water are diverted by gravity or pumping for irrigation in drainage basin above station, but only a small part of the total run-off is so used.

REGULATION.—Flow regulated by the operation of a small cotton gin a short distance above station. The operation of several small water-power plants in the upper drainage basin near San Marcos and Martindale does not materially affect the flow at this station.

ACCURACY.—Stage-discharge relation practically permanent. Gage read once daily to hundredths, October 1 to June 30, and twice daily, July 1 to September 30. Owing to regulation of the flow the assumption that one gage reading or the mean of two daily readings gives the mean for the day causes errors in the determination. Daily discharge ascertained by applying daily gage height to rating table. Records good.

Discharge measurements of San Marcos River at Ottine, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 15	Victor Lieb	1.64	113	May 7	Gray and Hank	25.22	6,730
15	do	1.60	105	8	G. A. Gray	5.22	629
25	Hank and Dean	1.79	139	June 20	Francisco and Hank	1.52	95.1
Jan. 7	Gray and Kessler	1.64	116	July 18	Congdon and Francisco	1.38	71.4
Apr. 6	Victor Lieb	1.62	107	Aug. 30	E. O. Francisco	1.65	110
May 7	Gray and Hank	25.74	7,450				

Daily discharge, in second-feet, of San Marcos River at Ottine, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	106	119	126	112	119	119	137	109	133	88	45	100
2	96	112	122	116	116	106	106	112	112	80	87	106
3	96	109	126	116	116	122	109	109	103	88	95	106
4	106	109	122	112	112	109	112	122	103	247	66	103
5	119	112	133	109	116	106	109	106	100	166	88	119
6	106	112	130	106	112	109	112	1,300	103	101	73	106
7	96	112	126	119	122	112	116	6,030	112	96	96	90
8	96	106	122	106	130	122	112	1,910	103	90	84	74
9	100	109	122	109	133	119	109	274	112	85	111	61
10	145	112	126	119	137	112	112	209	112	80	70	76
11	149	119	119	116	137	109	122	149	112	96	64	175
12	90	112	122	112	133	112	854	141	109	92	61	149
13	93	116	106	109	126	119	208	2,680	93	85	68	88
14	100	112	109	90	130	119	333	523	93	63	76	104
15	96	109	112	103	133	122	333	284	96	61	77	61
16	106	109	119	112	137	126	106	183	106	66	84	40
17	109	112	122	116	112	122	109	168	104	61	61	54
18	179	112	126	106	122	122	106	152	96	71	67	96
19	183	109	130	109	130	126	109	152	112	64	77	87
20	109	126	133	112	126	130	2,930	2,510	104	68	59	93
21	106	130	122	122	133	133	854	365	116	585	76	111
22	149	126	126	130	109	126	179	333	112	173	79	106
23	145	119	122	141	112	133	156	179	106	150	76	166
24	126	141	126	130	109	133	122	168	87	101	66	88
25	122	132	119	119	109	119	112	160	106	95	79	66
26	109	119	116	106	112	116	109	156	112	93	43	76
27	112	122	109	112	130	112	119	116	116	100	43	73
28	109	126	106	119	112	109	112	160	117	74	98	71
29	112	122	116	116	.....	112	116	156	116	88	208	74
30	126	122	112	112	.....	137	112	152	101	90	208	76
31	119	.....	109	112	.....	126	.....	156	.....	126	137	.....

Monthly discharge of San Marcos River at Ottine, Tex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	183	90	117	7,190
November	141	106	117	6,960
December	133	106	121	7,440
January	141	90	114	7,010
February	137	109	122	6,780
March	137	106	119	7,320
April	2,930	106	278	16,500
May	6,030	106	623	38,300
June	133	87	107	6,370
July	585	61	114	7,010
August	208	43	84.6	5,200
September	175	40	93.2	5,550
The year	6,030	40	168	122,000

93838°—19—WSP 458——5

SAN ANTONIO RIVER BASIN.

SAN ANTONIO RIVER AT SAN ANTONIO, TEX.

LOCATION.—At Presa Street Bridge, just below office of San Antonio Water Supply Co., in San Antonio, Bexar County, 3 miles below San Antonio Springs, the source of the river.

DRAINAGE AREA.—Indeterminate.

RECORDS AVAILABLE.—October 23, 1914, to September 30, 1917. Miscellaneous discharge measurements were made from 1895 to 1906.

GAGE.—Vertical staff in two sections attached to upstream side of second bent of bridge from right bank and right abutment of bridge; read by E. L. Wilson and E. H. Elder. Gage used from October 23, 1914, to February 28, 1916, was a vertical staff gage attached to downstream side of middle pier, Commerce Street bridge; relation of the datums of these gages not known.

DISCHARGE MEASUREMENTS.—Made from downstream side of Market Street bridge, (first bridge above station) or by wading just below gage.

CHANNEL AND CONTROL.—Channel straight for a short distance above and below station, but the general course is very crooked. Bed composed of gravel, sand, and silt. Banks high and clean; not subject to overflow except during extremely high stages, at which time the river spreads over a wide area. A rock and gravel shoal, and remains of old concrete dam just below the station serve as a control. Vegetation collects in channel and on control at times, but stage-discharge relation was not affected thereby during 1917.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 1.80 feet March 24 and 25, and early morning of May 20 (discharge, 147 second-feet); minimum stage recorded 0.76 foot several days during June, July and September (discharge, 23 second-feet).

1914-1917: Maximum stage recorded, 14.0 feet at 5.30 p. m. October 23, 1914 (discharge, 4,700 second-feet; determined from extension of rating curve and possibly subject to considerable error); minimum stage, during June, July and September, 1917.

ICE.—None reported during year.

DIVERSIONS.—Considerable land is irrigated in San Antonio and vicinity south of the city; quantity of water diverted not definitely known.

REGULATION.—Flow not regulated by permanent dams or controlling works, but at times temporary works constructed in improving the channel have regulated the flow. Flow at station is dependent on discharge of San Antonio Springs.

ACCURACY.—Stage discharge relation practically permanent. Rating curve well defined below 350 second-feet. Gage read to hundredths twice daily. Gage readings prior to April 8 are doubtful. Daily discharge ascertained by applying mean daily gage height to rating table. Records fair October 1 to April 10, and good April 11 to September 30.

The normal flow of San Antonio River comes from springs within the city limits, but two tributaries from the north furnish considerable run-off at times of heavy precipitation. Changes in stage during low flow are believed to be due to pumping from deep wells for the city water supply and the use of artesian water for irrigation in areas adjacent to the river for it is thought that the wells draw from the underground reservoir that feeds the river by springs.

Discharge measurements of San Antonio River at San Antonio, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 20	Gray and Hank	1.37	79.0	Apr. 12	Victor Lieb	1.00	36.3
Jan. 9	William Kessler	1.25	59.8	May 24	R. C. Thaxton	1.10	43.6
Mar. 1	Hank and Gray	1.12	48.1	June 21	Hank and Francisco	.79	25.4
Apr. 8	Victor Lieb	.95	31.2	Aug. 30	E. P. Congdon	.75	22.1
12	....do	1.00	32.5				

Daily discharge, in second-feet, of San Antonio River at San Antonio, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	84	81	81	81	78	78	38	26	35	24	26	24
2	84	81	81	81	78	78	38	26	32	24	26	24
3	84	81	81	81	78	78	38	28	28	24	26	24
4	84	81	81	81	78	78	38	27	35	24	26	23
5	84	81	81	81	78	77	38	26	29	47	26	23
6	84	81	81	81	78	77	34	64	28	25	25	23
7	84	81	81	81	78	77	32	55	27	24	24	23
8	84	81	81	81	78	77	32	31	26	24	24	23
9	84	81	81	81	78	77	32	34	26	24	24	23
10	84	81	81	78	78	77	32	35	26	24	24	23
11	84	81	81	78	78	74	32	31	26	24	24	23
12	84	81	81	78	78	74	35	73	26	24	24	23
13	84	81	81	78	78	74	33	45	26	24	24	23
14	81	81	81	78	78	71	35	43	25	24	24	24
15	81	81	81	78	78	70	34	40	24	24	24	24
16	90	81	81	78	78	62	35	41	24	24	24	24
17	84	81	81	78	78	57	32	39	24	24	24	24
18	84	81	81	78	78	55	34	39	24	23	24	24
19	84	81	81	78	78	52	37	39	24	24	24	24
20	81	81	81	78	78	51	35	81	23	24	24	27
21	81	81	81	78	78	51	33	43	23	24	24	24
22	81	81	81	78	78	50	35	43	23	70	24	24
23	81	81	81	78	78	91	34	43	24	26	24	24
24	81	81	81	78	78	147	34	44	24	26	24	24
25	81	81	81	78	78	147	32	42	24	26	24	24
26	81	81	81	78	78	41	29	41	24	26	24	23
27	81	81	81	78	78	43	28	41	27	26	24	23
28	81	81	81	78	78	38	28	40	24	26	24	23
29	81	81	81	78	.....	38	35	39	24	26	24	23
30	81	81	81	78	.....	38	41	37	23	27	24	23
31	81	.....	81	78	.....	38	.....	37	.....	26	24	...

NOTE.—Observer reports considerable construction work being done on stream from Oct. 1 to Apr. 4. Records for that period may be slightly in error. Discharge, Apr. 5-7 and 9 and 10, and July 21 determined by interpolation.

Monthly discharge of San Antonio River at San Antonio, Tex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	90	81	82.8	5,090
November	81	81	81.0	4,820
December	81	81	81.0	4,980
January	81	78	78.9	4,850
February	78	78	78.0	4,330
March	147	38	68.9	4,240
April	41	28	34.1	2,030
May	81	26	41.1	2,530
June	35	23	25.9	1,540
July	70	23	26.8	1,650
August	26	24	24.4	1,500
September	27	23	23.6	1,400
The year	147	23	53.8	39,000

SAN PEDRO CREEK AT SAN ANTONIO, TEX.

LOCATION.—At Commerce Street Bridge, 1½ blocks west of court house, in San Antonio, Bexar County, 1½ miles above mouth of Salsamora and Martinez creeks, 1½ miles below San Pedro Springs, source of creek, 3 miles above confluence with San Antonio River.

DRAINAGE AREA.—Indeterminate.

RECORDS AVAILABLE.—July 20, 1916, to September 30, 1917.

GAGE.—Vertical staff, attached to wall of building No. 713 Commerce Street, on upstream side of bridge on left bank, read by E. L. Wilson and E. H. Elder.

DISCHARGE MEASUREMENTS.—Made by wading below gage.

CHANNEL AND CONTROL.—Bed composed of rock, gravel and mud; shifting. Channel straight above and below station. Both banks formed by walls of buildings. City improvements have confined the stream to a small channel during low and medium stages, but during floods the streets are covered with water for several blocks. A shoal subject to shift, about 100 feet below gage, serves as control.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.00 feet at 5.10 p. m. December 30, and during December 31 (discharge 24 second-feet; determined by extension of rating curve and subject to considerable error); minimum stage recorded, 1.36 feet during September 11, 12, and 13 (discharge 2.2 second-feet).

1916–1917: Maximum stage recorded, 6.25 feet at 7.40 a. m. September 25, 1916 (discharge not determined); minimum stage recorded during September 11, 12, and 13, 1917.

ICE.—None reported during year.

DIVERSIONS.—None.

REGULATION.—No dams, reservoirs, or controlling works that permanently regulate the flow. Fluctuations were caused during year by improvement work along the channel above and below the gage.

ACCURACY.—Stage-discharge relation not permanent. Rating curve poorly defined. Gage read to hundredths twice daily. Daily discharge for 1916 and 1917 determined by indirect method for shifting control. Records poor.

Entire flow of San Pedro Creek, except during times of heavy precipitation, is furnished by San Pedro Springs, and the flow at this station is believed to be that which reaches San Antonio River. Martinez and Salsamora creeks carry no water except during heavy local rains, and have been known to be dry for several years at a time.

Discharge measurements of San Pedro Creek at San Antonio, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 20	Gray and Hank	1.94	7.2	May 24	R. C. Thaxton	1.70	4.5
Jan. 9	William Kessler	1.55	7.7	June 21	Francisco and Hank	2.21	4.5
Mar. 1	Gray and Hank	1.50	5.8	Aug. 30	E. P. Congdon	1.34	2.0
Apr. 8	Victor Lieb	1.50	4.5				

Daily discharge, in second-feet, of San Pedro Creek at San Antonio, Tex., for the years ending Sept. 30, 1916, and 1917.

Day.	July.	Aug.	Sept.	Day.	July.	Aug.	Sept.	Day.	July.	Aug.	Sept.
1916.											
1	.....	5.0	6.4	11	.....	4.8	5.7	21	18	4.8	5.9
2	.....	5.0	6.4	12	.....	4.8	6.1	22	9.6	4.8	5.9
3	.....	5.0	5.9	13	.....	4.8	5.9	23	9.9	4.8	5.9
4	.....	5.0	5.9	14	.....	4.8	5.9	24	8.8	4.8	5.9
5	.....	6.2	5.9	15	.....	4.8	5.9	25	9.5	4.8	15
6	.....	8.8	5.9	16	.....	4.8	5.9	26	7.5	4.8	8.8
7	.....	5.7	5.8	17	.....	4.8	5.9	27	6.8	4.8	8.8
8	.....	5.0	5.7	18	.....	5.7	5.9	28	6.3	5.4	8.8
9	.....	5.0	5.7	19	.....	5.0	5.9	29	5.0	18	8.8
10	.....	4.8	5.7	20	11	4.8	5.9	30	14	9.0	8.8
								31	6.6	6.4	.....

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1916–17.												
1	8.8	7.4	8.0	18	12	8.1	5.0	4.8	4.7	4.9	2.6	2.8
2	8.8	7.4	8.0	16	12	8.1	5.0	4.8	4.7	4.9	2.6	2.8
3	8.8	7.4	8.0	15	12	8.1	5.0	5.0	4.9	4.9	2.6	2.6
4	8.8	7.4	8.0	14	12	5.9	4.9	5.0	4.7	4.8	2.6	2.6
5	8.8	7.4	8.0	14	12	5.9	4.8	4.8	5.0	4.2	2.6	2.6
6	8.8	7.4	8.0	14	12	5.9	4.7	7.1	4.7	4.2	2.6	2.6
7	8.8	7.4	8.0	14	12	5.9	4.6	4.5	4.7	3.7	2.6	2.4
8	8.8	8.0	8.0	14	12	5.9	4.5	4.7	4.9	3.7	2.6	2.4
9	9.2	8.6	8.0	13	12	5.9	4.9	4.8	4.9	3.2	2.6	2.4
10	8.8	8.0	8.0	13	12	5.9	5.4	4.6	5.1	2.6	2.6	2.4
11	8.8	8.0	8.0	13	12	5.7	5.8	4.4	4.7	2.6	2.6	2.2
12	8.8	8.0	8.0	13	12	5.7	5.8	6.4	4.9	2.6	2.8	2.2
13	8.8	8.0	8.0	13	12	5.7	5.1	4.5	4.7	2.6	2.8	2.2
14	8.8	8.0	8.0	13	12	5.1	5.1	4.4	4.9	2.6	2.8	2.4
15	8.8	8.0	8.0	13	12	5.1	5.6	4.1	4.9	2.6	2.8	2.6
16	16	8.0	8.0	13	12	4.9	5.1	4.4	4.7	2.6	3.0	2.6
17	8.6	8.0	8.0	13	12	4.9	4.0	4.6	4.7	2.6	3.0	2.6
18	8.0	8.0	8.0	13	12	4.9	4.2	4.6	4.7	2.6	3.0	2.6
19	8.0	8.0	8.0	13	12	4.9	4.1	4.8	4.7	2.6	3.0	2.6
20	8.0	8.0	8.0	13	12	4.9	4.0	8.0	4.6	2.6	3.0	3.3
21	8.0	8.2	8.0	13	12	4.7	4.1	4.1	4.6	2.6	3.0	2.4
22	7.7	8.0	8.0	13	12	4.7	4.0	4.1	4.8	8.2	3.0	2.4
23	7.4	8.0	8.0	13	12	4.7	4.1	4.1	4.8	2.6	3.0	2.4
24	7.4	8.0	8.0	13	12	4.7	4.4	4.6	5.0	2.6	3.0	2.4
25	7.4	8.0	8.0	13	12	4.7	4.1	4.6	5.5	2.6	3.0	2.6
26	7.4	8.0	8.0	12	10	4.5	4.1	5.0	5.2	2.8	3.0	2.6
27	7.4	8.0	8.0	12	10	4.5	3.3	5.4	5.5	2.8	3.0	2.6
28	7.4	8.0	8.0	12	9.3	4.5	3.7	5.1	5.5	2.8	3.0	2.4
29	7.4	8.0	8.0	12	.....	4.5	3.7	4.9	4.4	2.8	3.0	2.4
30	7.4	8.0	21	12	.....	4.5	3.7	4.7	4.6	3.0	2.8	2.4
31	7.4	.....	24	12	.....	4.5	.....	4.7	.....	2.8	2.8	.....

NOTE.—Discharge Apr. 4–7, 9–10, and July 21 determined by interpolation.

Monthly discharge of San Pedro Creek at San Antonio, Tex., for the period July 20, 1916, to Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1916.				
July 20-31	18	5.0	9.42	224
August	18	4.8	5.71	351
September	15	5.7	6.70	399
The period				974
1916-17.				
October	16	7.4	8.49	522
November	8.6	7.4	7.89	469
December	24	8.0	8.94	550
January	18	12	13.3	818
February	12	9.3	11.8	655
March	8.1	4.5	5.42	333
April	5.8	3.3	4.56	271
May	8.0	4.1	4.89	301
June	5.5	4.4	4.86	289
July	8.2	2.6	3.32	204
August	3.0	2.6	2.82	173
September	3.3	2.2	2.52	150
The year	24	2.2	6.54	4,740

NUECES RIVER BASIN.

NUECES RIVER NEAR CINONIA, TEX.

LOCATION.—Just below suspension highway bridge near Oswald's ranch, 2 miles east of Cinonia, Zavalla County, 8 miles northeast of Crystal City, 20 miles above Winter Garden ranch dam.

DRAINAGE AREA.—2,060 square miles.

RECORDS AVAILABLE.—July 5, 1915, to September 30, 1917.

GAGE.—Dexter water-stage recorder, on right bank, 250 feet below highway bridge. Gage readings were taken by C. C. Oswald from vertical staff gage in several sections, on both banks, just below bridge from July 5, 1915, to September 22, 1917, when recorder was installed.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge by wading 100 feet below bridge or by wading on crest of concrete control.

CHANNEL AND CONTROL.—Bed composed of clay and gravel; free from vegetation. Banks high and wooded and not subject to overflow. Channel straight above and below station. September 23, 1917, a concrete artificial control was completed at the site of water-stage recorder installation; point of zero flow, 0.85 foot. The stage-discharge relation has been seriously affected at times prior to installation of artificial control by collection of logs, leaves, and brush below gage.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 4.30 feet at 11 a. m. May 20 (discharge, 90 second-feet); minimum stage, no flow August 4–18 and 25–28.

1915–1917: Maximum stage recorded, 20 feet at 6.30 a. m. September 19, 1915 (discharge not determined); minimum stage, no flow August 4–18 and 25–28, 1917.

ICE.—None reported during year.

DIVERSIONS.—Considerable water diverted above station for irrigation; amount not known.

REGULATION.—Available data indicate no regulation above station.

ACCURACY.—Stage-discharge relation not permanent previous to September 23; permanent after that date. Rating curve well defined below 150 second-feet. Gage read to half-tenths twice daily October 1 to September 22; gage heights subject to error because of careless observations. Mean daily gage height for period of recorder record determined by averaging hourly readings from recorder charts. Daily discharge ascertained by applying mean daily gage height to rating table as indicated in footnote to table of daily discharge. Records fair.

Backwater from a dam 40 feet high, about 20 miles below station, extends within 2 miles of station when reservoir is full. A large part of the flow of the river is known to seep into the bed just below Uvalde and return to the surface just above the station. The condition of the underground waters may have an effect on this return water and thus help to equalize the flow.

Discharge measurements of Nueces River near Cinonia, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 1	Victor Lieb	2.30	12.4	June 13	Hank and Francisco	1.60	3.9
1	do	2.30	13.4	July 27	E. O. Francisco	1.35	1.3
Jan. 12	do	2.33	11.2	Sept. 16	R. J. Hank	1.45	[a].8
12	do	2.33	14.8	21	do	1.55	[a]1.0
Apr. 13	R. J. Hank	2.10	9.6	23	do	[b]1.09	1.2

[a] Estimated. [b] Referred to new datum.

Daily discharge, in second-feet, of Nueces River near Cinonia, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	14	13	16	16	13	14	11	4.8	6.2	11	0.8	0.4
2	14	13	16	16	13	14	11	4.8	6.2	8.1	.8	.4
3	14	13	16	16	13	14	10	4.1	5.4	7.2	.7	.7
4	14	13	16	16	13	14	9.5	4.1	5.4	4.3	.0	.9
5	14	12	16	16	13	14	9.5	4.1	5.4	3.1	.0	1.0
6	13	12	16	16	13	14	9.5	4.1	5.1	1.6	.0	1.0
7	13	12	16	14	13	14	9.5	4.1	4.6	1.6	.0	1.0
8	13	12	16	14	13	14	9.5	4.1	4.0	1.6	.0	1.0
9	13	12	16	14	13	14	9.5	4.1	4.0	1.6	.0	.8
10	13	12	16	14	13	14	9.5	4.1	4.0	1.5	.0	.7
11	13	12	16	14	14	14	9.5	4.1	4.0	1.3	.0	.6
12	13	13	16	14	14	14	9.5	4.1	4.0	1.3	.0	.6
13	13	14	16	14	14	14	9.5	12	3.6	1.3	.0	.6
14	13	14	16	14	14	14	9.5	8.3	3.3	1.3	.0	.6
15	13	14	16	14	14	14	9.5	5.9	3.3	1.3	.0	.6
16	13	13	16	14	14	14	9.5	5.6	3.3	1.3	.0	.6
17	13	13	16	14	14	14	9.5	5.6	3.3	1.1	.0	.6
18	13	13	16	14	14	13	9.5	5.6	3.3	1.0	.0	.7
19	13	13	16	14	14	13	9.5	4.8	3.3	1.0	1.6	.8
20	12	13	16	14	13	12	9.5	64	3.3	.8	1.3	1.0
21	12	13	16	14	13	12	9.5	36	3.3	.8	.8	1.3
22	12	13	16	14	13	12	7.7	29	2.8	1.0	.6	1.3
23	12	13	16	14	13	12	6.4	18	2.8	1.3	.4	1.0
24	18	13	16	16	13	12	5.2	10	2.8	1.6	.3	1.0
25	12	13	16	17	13	12	4.1	6.8	2.8	1.6	.0	1.1
26	12	14	16	17	13	12	4.1	6.2	2.8	1.6	.0	1.1
27	12	14	16	16	13	12	4.1	6.2	18	1.0	.0	1.1
28	12	16	16	14	13	12	4.1	6.2	16	1.0	.0	1.0
29	12	16	16	13	.....	12	4.8	6.2	12	1.0	.2	1.0
30	13	16	16	13	.....	12	4.8	6.2	4.6	.9	.2	.9
31	13	.....	16	13	.....	12	.....	6.2	.....	.8	.4	.....

NOTE.—Discharge determined as follows: Oct. 1 to Feb. 28, May 20 and 21, and Aug. 21 to Sept. 22 directly from rating table; Mar. 1 to May 19 and May 22 to Aug. 20 by indirect method ofr shifting control; Sept. 2-3 30 interpolated from discharge measurements.

Monthly discharge of Nueces River near Cinonia, Tex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	18	12	13.0	799
November	16	12	13.2	786
December	16	16	16.0	984
January	17	13	14.6	898
February	14	13	13.3	739
March	14	12	13.2	812
April	11	4.1	8.28	493
May	64	4.1	9.66	594
June	18	2.8	5.10	303
July	11	.8	2.13	131
August	1.6	.0	.26	16
September	1.3	.4	.85	51
The year	64	.0	9.13	6,610

NUECES RIVER NEAR COTULLA, TEX.

LOCATION.—At Hargus dam, 4 miles west of Cotulla, LaSalle County.

DRAINAGE AREA.—5,030 square miles.

RECORDS AVAILABLE.—July 1, 1915, to September 30, 1917.

GAGE.—Vertical staff attached to trees on right bank just above dam; read by Irvin Peoples and William Peoples.

DISCHARGE MEASUREMENTS.—Made by wading below dam. No facilities for measurements at medium and high stages except at highway bridge 4 miles below gage.

CHANNEL AND CONTROL.—Bed composed of gravel, rock, and sand; channel straight above and below station. Banks wooded, medium in height, and not subject to overflow. Long concrete dam just below gage serves as a control; crest of dam irregular.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 1.10 feet at 10 a. m. September 4 (discharge, 1,180 second-feet, determined from extension of rating curve and possibly subject to considerable error); no flow during a large part of the year.

1915–1917: Maximum stage recorded, 6.50 feet August 22, 1916 (discharge, 23,000 second-feet, determined from extension of rating curve and possibly subject to error). No flow during large part of each year.

ICE.—None reported during year.

DIVERSIONS.—Large part of ordinary flow above station pumped or diverted for irrigation. The station is in upper end of an irrigated section near Cotulla. Two large filings are listed in the Second Report of the Board of Water Engineers for the State of Texas, in the name of Winter Garden Irrigation Co. and Nueces Valley Irrigation Co., in Zavalla and Dimmit counties; irrigable area under each system, 10,000 acres; capacities of diversion works 95 and 66 second-feet, respectively.

REGULATION.—Flow at station regulated by storage reservoirs and pumping plants above.

ACCURACY.—Stage-discharge relation permanent. Rating curve based on low-water discharge measurements and discharge computed by formula using the dam as a weir; possibly subject to considerable error. Because of the length of the dam (600 feet) the station is non-sensitive. Gage read to hundredths once daily. Daily discharge ascertained by applying daily gage height to rating table. Records poor.

Discharge measurements of Nueces River near Cotulla, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 31	Victor Lieb	0.20	8.0	June 14	Francisco and Hank	.....	0.0
31	....do	.20	7.2	July 26	E. O. Francisco	.....	.0
Jan. 11	....do	.....	.0	Sept. 28	R. J. Hank	.....	.0

Daily discharge, in second-feet, of Nueces River near Cotulla, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	May.	June.	July.	Aug.	Sept.
1	14	14	1.0	.....	22	.....	22	0.0
2	14	14	1.0	.....	14	.....	22	.0
3	14	7.0	1.0	.....	7.0	.....	22	337
4	14	7.0	1.0	.....	4.5	.....	14	1,180
5	7.0	4.5	1.0	.....	4.5	.....	7.0	854
6	7.0	2.0	1.0	.....	2.0	.....	7.0	407
7	7.0	2.0	1.0	.....	2.0	.....	4.5	337
8	7.0	2.0	.....	.....	1.0	.....	2.0	207
9	7.0	1.0	.....	.....	1.0	.....	2.0	107
10	7.0	1.0	.....	.....	1.0	.....	1.0	57
11	7.0	1.0	.....	.....	.....	.....	1.0	44
12	4.5	.0	.....	.....	.....	.....	.....	22
13	4.5	.0	.....	.....	.....	.....	.....	22
14	4.5	2.0	.....	.....	.....	.....	.....	14
15	2.0	2.0	.....	.....	.....	.....	.....	7.0
16	7.0	2.0	.....	.....	.....	.....	.....	7.0
17	67	2.0	.....	.....	.....	.....	.....	4.5
18	267	2.0	.....	.....	.....	.....	.....	4.5
19	660	2.0	.....	.....	.....	.....	.....	4.5
20	660	2.0	.....	.....	.....	.....	.....	4.5
21	267	1.0	.....	.....	.....	.....	.....	7.0
22	22	1.5	.....	.....	.....	.....	.....	7.0
23	22	2.0	.....	.....	.....	.....	.....	4.5
24	14	2.0	.....	.....	.....	.....	.....	2.0
25	7.0	1.0	.....	107	.....	.....	.....	.0
26	4.5	1.0	.....	107	.....	.....	.....	.0
27	4.5	1.0	.....	207	.....	207	.....	.0
28	2.0	1.0	.....	147	.....	207	.....	.0
29	7.0	1.0	.....	67	.....	147	.....	.0
30	22	1.0	.....	44	.....	67	.....	.0
31	14	.....	.....	22	.....	44	.....	.....

NOTE.—No water flowing on days for which discharge is not given. Discharge interpolated Nov. 22.

Monthly discharge of Nueces River near Cotulla, Tex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	660	2.0	69.9	4,300
November	14	.0	2.73	162
December	1.0	.0	.23	14
January	.0	.0	.0	0
February	.0	.0	.0	0
March	.0	.0	.0	0
April	.0	.0	.0	0
May	207	.0	22.6	1,390
June	22	.0	1.97	117
July	207	.0	21.7	1,330
August	22	.0	3.37	207
September	1,180	.0	122.	7,260
The year	1,180	.0	20.4	14,800

NUECES RIVER NEAR THREE RIVERS, TEX.

LOCATION.—At San Antonio, Uvalde & Gulf Railroad bridge 1 mile west of Kittie, 2 miles southeast of Three Rivers, Live Oak County, half a mile below mouth of Frio River.

DRAINAGE AREA.—15,600 square miles.

RECORDS AVAILABLE.—July 1, 1915, to September 30, 1917.

GAGE.—Vertical staff, attached to center pier of railroad bridge; read by P. H. Jank and A. J. Sharpley.

DISCHARGE MEASUREMENTS.—Made by wading or from highway bridge half a mile below gage.

CHANNEL AND CONTROL.—Bed composed of adobe shale; does not change greatly. Channel straight above and below station. Banks wooded, high, and not subject to overflow. Position of high-water control not known; shoal just below gage probably forms low-water control.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 13.05 feet at 6 p. m. November 10 (discharge, 2,960 second-feet); no flow April 2–21, May 30 to July 21 and July 31 to August 29.

1915–1917: Maximum stage recorded, 30 feet August 25, 1916 (discharge, 15,500 second-feet); no flow during large part of each summer.

ICE.—None reported during year.

DIVERSIONS.—Considerable land irrigated above station but there appears to be no irrigable land immediately above.

REGULATION.—Flow regulated somewhat by storage reservoirs and pumping in the drainage basin above, but the effect is not so pronounced as at the stations in the upper part of the drainage basin. Such water-power plants as exist in the area above the station are probably small.

ACCURACY.—Stage-discharge relation changes slightly. Rating curve well defined below 7,000 second-feet. Gage read to hundredths twice daily; oftener when fluctuations of stage are rapid or extreme. Daily discharge ascertained by applying mean daily gage height to rating table directly October 1–16, and November 9 to September 30; by shifting-control method October 17 to November 8. Records good.

Discharge measurements of Nueces River near Three Rivers, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 5	Victor Lieb	0.92	29.3	June 15	Hank and Francisco	.....	0.0
5	do	.92	29.8	July 28	E. O. Francisco	0.31	1.3
Jan. 14	do	.28	.90	Sept. 30	R. J. Hank	.11	*a*.1
May 25	R. C. Thaxton	.16	.50				

a Estimated.

Daily discharge, in second-feet, of Nueces River near Three Rivers, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	81	85	7.7	3.2	9.8	1.0	0.5	211	0.0	0.0	0.0	24
2	52	72	6.4	3.6	8.8	.8	.0	73	.0	.0	.0	74
3	40	54	6.0	4.0	7.7	.8	.0	19	.0	.0	.0	42
4	37	34	5.6	4.2	6.2	.8	.0	8.1	.0	.0	.0	28
5	32	30	5.2	4.4	5.2	.8	.0	4.0	.0	.0	.0	25
6	28	25	4.8	4.6	4.2	.6	.0	2.4	.0	.0	.0	386
7	25	21	4.4	4.8	3.6	.5	.0	2.0	.0	.0	.0	38
8	22	17	4.0	2.4	3.2	.4	.0	1.7	.0	.0	.0	18
9	18	1,900	3.6	2.4	2.6	.3	.0	1.5	.0	.0	.0	14
10	427	2,760	3.2	2.0	3.2	.2	.0	1.3	.0	.0	.0	26
11	114	713	2.9	1.7	2.8	.2	.0	1.0	.0	.0	.0	23
12	779	386	2.6	1.7	2.8	.2	.0	.8	.0	.0	.0	237
13	466	173	2.3	1.7	2.2	.2	.0	9.0	.0	.0	.0	292
14	312	78	2.0	1.5	2.3	.2	.0	43	.0	.0	.0	378
15	213	57	1.7	1.2	1.8	.5	.0	73	.0	.0	.0	355
16	16	38	1.5	1.2	1.4	.4	.0	42	.0	.0	.0	114
17	1,640	29	5.2	2.4	1.2	.3	.0	20	.0	.0	.0	62
18	1,900	20	4.8	3.6	.9	.2	.0	17	.0	.0	.0	30
19	1,640	18	4.4	4.2	.9	.2	.0	14	.0	.0	.0	24
20	872	16	4.0	3.6	2.2	.2	.0	7.7	.0	.0	.0	19
21	556	15	3.6	3.2	3.0	.4	.0	5.8	.0	.0	.0	14
22	418	14	3.2	3.2	2.8	.4	154	4.0	.0	382	.0	10
23	753	20	2.9	409	2.4	.4	486	2.6	.0	446	.0	8.6
24	658	100	2.6	165	2.2	.4	250	1.7	.0	312	.0	6.8
25	418	150	2.3	57	1.8	.4	91	1.0	.0	47	.0	4.4
26	706	74	2.0	18	1.6	.4	125	.6	.0	12	.0	2.6
27	486	25	1.7	10	1.4	.4	111	.4	.0	4.0	.0	1.5
28	283	16	1.5	7.7	1.2	.4	147	.2	.0	1.7	.0	.5
29	221	13	1.3	6.2	.....	.4	91	.1	.0	1.0	.0	.1
30	184	10	1.0	5.4	.....	.4	55	.0	.0	.1	261	.1
31	124	.....	5.2	4.6	.....	.4	.....	.0	.....	.0	74	.....

Monthly discharge of Nueces River near Three Rivers, Tex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	1,900	16	436	26,800
November	2,760	10	232	13,800
December	7.7	1.0	3.54	218
January	409	1.2	24.1	1,480
February	9.8	.9	3.19	177
March	1.0	.2	.43	26
April	486	.0	50.4	3,000
May	211	.0	18.3	1,130
June	.0	.0	.0	0
July	446	.0	38.9	2,390
August	261	.0	10.8	664
September	386	.1	75.3	4,480
The year	2,760	.0	74.9	54,200

NUECES RIVER AT CALALLEN, TEX.

LOCATION.—At old pump house for city of Corpus Christi, half a mile northwest of Calallen, Nueces County, 18 miles west of Corpus Christi, 8 miles above Nueces Bay, half a mile above edge of tidewater and breakwater dam.

DRAINAGE AREA.—16,700 square miles.

RECORDS AVAILABLE.—August 12, 1915, to September 30, 1917.

GAGE.—Vertical staff attached to pipe-line support of old pump house; read by Henry Wagner.

DISCHARGE MEASUREMENTS.—Made by wading at the breakwater or from cable 125 feet below gage.

CHANNEL AND CONTROL.—Bed composed of clay and gravel. Channel straight above and below station. Left bank wooded, low, and bordered by levee constructed to prevent overflow; right bank wooded, medium in height, and not subject to overflow. The breakwater, which is a loose rock fill half a mile below, serves as control. May 11 and 12 loose rocks were placed below the breakwater, causing change in control.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.00 feet at 4 p. m. October 20 (discharge, 1,930 second-feet); minimum stage, —0.40 foot at 4 p. m. July 25 (discharge, 0.6 second-foot).

1915–1917: Maximum stage recorded, 8.38 feet September 5, 1916 (discharge, 6,190 second-feet); minimum stage July 25, 1917.

ICE.—None reported during year.

DIVERSIONS.—Considerable water taken from river for irrigation immediately above station; water also used for irrigation throughout the drainage basin above. The city of Corpus Christi pumps water just below the gage for municipal supply and has made a filing with the Board of Water Engineers for the State of Texas for a continuous use of 0.93 second-foot and a storage of 675 acre-feet per annum; they reported a consumption of 218 million gallons during 1916. A second small pump for private use installed between city intake and breakwater is seldom operated. The quantities pumped are small and do not greatly affect the natural flow during ordinary stages.

REGULATION.—No water power plants of consequence above station.

ACCURACY.—Stage-discharge relation not permanent because of leakage through and repair to the breakwater dam. Low-water discharge measurements made at breakwater are poor because of leakage through dam. Rating curve fairly well defined. Gage read to hundredths twice daily. Daily discharge ascertained by applying mean daily gage height to rating table as indicated in footnote to table of daily discharge. Allowance made for rising and falling stages in computing discharge. Records poor.

Discharge measurements of Nueces River at Calallen, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 8	Victor Lieb	1.00	69.7	June 16	Francisco and Hank		0.0
Jan. 15	do	.78	6.1	July 28	E. O. Francisco	1.82	85.8
May 26	R. C. Thaxton	1.10	*a* 8.0	Sept. 30	R. J. Hank	1.30	*a* 12.0

a Estimated.

NOTE.—Measurements made at breakwater.

Daily discharge, in second-feet, of Nueces River at Calallen, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	324	338	31	15	29	8.2	5.8	39	6.4	2.0	41	390
2	198	274	27	15	27	7.4	5.8	38	6.0	2.0	38	268
3	172	183	27	15	27	7.4	5.8	41	5.8	2.0	23	123
4	155	138	26	15	27	6.6	5.0	43	5.8	2.0	20	90
5	138	105	26	15	27	6.6	4.5	46	5.4	2.0	15	123
6	120	85	24	16	27	6.6	4.0	46	5.0	2.0	15	153
7	114	75	23	15	24	6.6	4.0	48	5.4	2.0	13	175
8	96	72	22	13	24	6.6	3.0	48	4.0	1.8	12	213
9	78	320	22	11	23	6.6	3.0	144	3.6	1.8	9.6	245
10	78	804	22	9.8	21	6.6	2.5	281	3.4	1.6	8.0	205
11	65	1,360	21	8.2	20	6.6	2.0	200	3.3	1.4	8.0	213
12	65	1,810	21	8.2	20	6.6	2.0	138	3.2	1.4	7.0	237
13	189	1,180	20	8.2	17	6.6	1.5	123	3.0	1.2	7.0	245
14	384	811	18	8.2	16	6.6	1.0	80	3.0	1.2	5.8	245
15	579	478	18	8.2	16	5.8	1.0	44	2.8	1.1	5.0	245
16	360	155	18	8.2	15	5.8	1.0	41	2.7	1.1	4.2	245
17	315	105	18	8.2	14	5.8	2.0	40	2.7	1.1	4.0	268
18	556	85	17	8.2	11	5.8	2.5	39	2.7	1.0	3.5	268
19	1,090	70	17	8.2	11	5.8	3.0	40	2.7	1.0	2.9	213
20	1,650	46	17	8.2	9.0	5.8	3.0	36	2.5	1.0	2.8	153
21	1,140	41	17	8.2	9.0	5.8	4.0	34	2.4	1.0	2.5	114
22	868	41	17	8.2	9.0	5.8	4.5	15	2.3	.9	2.3	80
23	811	41	17	8.2	8.2	5.8	6.6	9.6	2.2	.9	2.0	62
24	797	41	16	8.2	8.2	5.8	21	8.0	2.2	.8	1.8	48
25	783	38	16	11	8.2	5.8	46	8.0	2.1	.6	1.6	38
26	762	38	16	24	8.2	5.8	48	7.8	2.1	144	2.5	26
27	608	38	16	38	8.2	5.8	46	7.6	2.1	144	1.4	20
28	562	38	16	36	8.2	5.8	43	7.6	2.1	96	1.3	15
29	532	38	16	34	.....	5.8	41	7.6	2.1	67	1.2	15
30	472	38	16	31	.....	5.8	41	7.4	2.1	58	1.2	15
31	410	.....	16	31	.....	5.8	.....	6.8	.....	53	646	.....

NOTE.—Discharge determined as follows: Oct. 1–21, Dec. 1 to May 10, and May 13, to Sept. 30, directly from rating tables; Oct. 22 to Nov. 30, by indirect method for shifting control; May 11 and 12, by interpolation.

Monthly discharge of Nueces River at Calallen, Tex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	1,650	65	467	28,700
November	1,810	38	296	17,600
December	31	16	19.8	1,220
January	38	8.2	14.8	910
February	29	8.2	16.9	939
March	8.2	5.8	6.26	385
April	48	1.0	12.1	720
May	281	6.8	54.0	3,320
June	6.4	2.1	3.37	201
July	144	.6	19.3	1,190
August	646	1.2	29.3	1,800
September	390	15	158	9,400
The year	1,810	.6	91.8	66,400

FRIO RIVER NEAR DERBY, TEX.

LOCATION.—At International & Great Northern Railway bridge 900 feet below mouth of Leoña River, 4 miles south of Derby, Frio County.

DRAINAGE AREA.—3,500 square miles.

RECORDS AVAILABLE.—August 1, 1915, to September 30, 1917.

GAGE.—Vertical staff attached to railway bridge pier; read by John Speed.

DISCHARGE MEASUREMENTS.—Made from railway bridge or by wading.

CHANNEL AND CONTROL.—Bed composed of rock, sand, and gravel; channel curved above and below station but straight at gage for 150 feet. Banks wooded, high, and not subject to overflow. A concrete dam 50 feet below gage serves as control during low and medium stages; position of high-water control not known. Point of zero flow, gage height 0.06 foot.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 8.0 feet at 8 a. m. October 18 (discharge, 3,080 second-feet); no flow in stream during several long periods.

1915–1917: Maximum stage recorded, 13.0 feet at 10.30 a. m. April 3, 1916 (discharge, not determined); no flow during parts of each year.

ICE.—None reported during year.

DIVERSIONS.—Small areas are irrigated by diversions and pumping at the headwaters, but available information does not show that water is taken from the stream immediately above the station.

ACCURACY.—Stage discharge relation practically permanent. Rating curve well defined below 2,200 second-feet. Gage read to hundredths once daily; oftener during extreme fluctuations. Daily discharge ascertained by applying daily gage height to rating table. Records fair.

Discharge measurements of Frio River near Derby, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 31	Victor Lieb	.....	0.0	July 26	E. O. Francisco	.....	0.0
Jan. 11	....do	.....	.0	Sept. 28	R. J. Hank	0.08	a.1
June 12	Hank and Francisco	.....	.0				

a Estimated.

Daily discharge, in second-feet, of Frio River near Derby, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	June.	July.	Sept.	Day.	Oct.	June.	July.	Sept.
1	.....	.....	18	.....	16	0.0	.....	.....	.....
2	.....	.....	6.3	.....	17	371	.....	.....	.....
3	.....	.....	2.7	0.0	18	1,300	.....	.....	.....
4	.....	.....	.5	443	19	.334	.....	.....	.....
5	.....	.....	.0	605	20	98	.....	.....	.....
6	.....	.....	.....	55	21	44	.....	.....	.....
7	.....	.....	.....	14	22	19	.....	.....	0.0
8	.....	.....	.....	3.8	23	8.1	.....	.....	209
9	.....	.....	.....	1.0	24	4.6	.....	.....	46
10	.....	.....	.....	.0	25	2.4	.....	.....	12
11	.....	.....	.....	.....	26	1.0	.....	.....	3.8
12	.....	.....	.....	.....	27	.7	0.0	.....	1.0
13	.....	.....	.....	.....	28	.2	54	.....	.2
14	.....	.....	.....	.....	29	1.0	25	.....	.0
15	.....	.....	.....	.....	30	.0	38	.....	.0
					31	.....	.....	.....	.....

NOTE.—No flow on days for which discharge is not given.

Monthly discharge of Frio River near Derby, Tex., for the year ending September 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	1,300	0.0	70.4	4,330
November	.0	.0	.0	0
December	.0	.0	.0	0
January	.0	.0	.0	0
February	.0	.0	.0	0
March	.0	.0	.0	0
April	.0	.0	.0	0
May	.0	.0	.0	0
June	54	.0	3.90	232
July	18	.0	.89	55
August	.0	.0	.0	0
September	605	.0	46.5	2,770
The year	1,300	.0	10.2	7,390

FRIO RIVER AT FOWLERTON, TEX.

LOCATION.—At Frio River dam, about half a mile northeast of Fowlerton, LaSalle County, 1½ miles below diversion for Frio Lake storage reservoir, 8 miles below mouth of Jahuey Creek.

DRAINAGE AREA.—4,350 square miles.

RECORDS AVAILABLE.—July 1, 1915, to September 30, 1917.

GAGE.—Vertical staff attached to tree on right bank about 30 feet above dam; read by Joe McMains.

DISCHARGE MEASUREMENTS.—Made by wading below dam or from railroad bridge about a mile above.

CHANNEL AND CONTROL.—Channel straight for some distance above the station, but slightly curved below; banks about 5 feet high and not subject to overflow; right bank cultivated; left bank wooded. Concrete dam about 20 feet below gage serves as permanent control at all stages. Point of zero flow, gage height −0.05 foot.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 1.3 feet at 5 p. m. September 6 (discharge, 470 second-feet); no flow for extended periods.

1915–1917: Maximum stage recorded, 3.9 feet at 6 a. m. April 19, 1916 (discharge, 4,120 second-feet); no flow during parts of each year.

ICE.—None reported during year.

DIVERSIONS.—Some water diverted for irrigation above station. A diversion for the Frio Lake reservoir is made 1½ miles above; other diversions are scattered; amount diverted and areas irrigated not known. A large part of the irrigated land in the drainage basin above the station is watered by wells.

REGULATION.—Flow regulated by the diversion into Frio Lake a short distance above gage; extent of regulation above Frio Lake diversion not known but probably small.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve well defined below 4,500 second-feet. Gage read once daily to hundredths; slight error may be introduced by the assumption that one reading gives the mean stage for the day. Daily discharge ascertained by applying daily gage height to rating table. Records fair.

Discharge measurements of Frio River at Fowlerton, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 2	Victor Lieb	.....	0.0	July 27	E. O. Francisco	.....	0.0
June 14	Hank and Francisco	.....	.0	Sept. 29	R. J. Hank	.....	.0

Daily discharge, in second-feet, of Frio River at Fowlerton, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Sept.	Day.	Oct.	Sept.	Day.	Oct.	Sept.
1	2.0	.....	11	0.0	.....	21	115	.....
2	2.0	.....	12	.....	.....	22	38	.....
3	1.6	.....	13	.....	.....	23	21	.....
4	1.6	.....	14	.....	.....	24	12	.....
5	1.4	0.0	15	.....	.....	25	5	0.0
6	1.2	470	16	.....	.....	26	3.5	18
7	1.0	88	17	.....	.....	27	2.0	7.7
8	1.0	89.0	18	.0	.....	28	2.0	6.4
9	.5	2.0	19	355	.....	29	2.0	.0
10	.5	.0	20	407	.....	30	2.0	.0
						31	.0	.....

NOTE.—No flow in stream on days for which discharge is not given. The small channel which was cut around left end of dam in the early part of April, 1916, was repaired Oct. 31, 1916; no flow over dam Oct. 1–18, and 25–30; amount in by-channel estimated from data furnished by the observer and engineers.

Monthly discharge of Frio River at Fowlerton, Tex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	407	0.0	31.5	1,940
November	.0	.0	.0	0
December	.0	.0	.0	0
January	.0	.0	.0	0
February	.0	.0	.0	0
March	.0	.0	.0	0
April	.0	.0	.0	0
May	.0	.0	.0	0
June	.0	.0	.0	0
July	.0	.0	.0	0
August	.0	.0	.0	0
September	470	.0	20.0	1,190
The year	470	.0	4.32	3,130

FRIO LAKE OUTLET NEAR FOWLERTON, TEX.

LOCATION.—At Frio Lake dam, 2 miles northeast of Fowlerton, La Salle County, 1½ miles northeast of gaging station on Frio River.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—July 1, 1915, to September 30, 1917.

GAGE.—Vertical staff attached to post on right bank about 100 feet above dam; read by Joe McMains.

DISCHARGE MEASUREMENTS.—Made by wading below dam or from railroad bridge about a mile above gage.

CHANNEL AND CONTROL.—Channel straight above and below station for some distance. Right bank clean, cultivated, about 8 feet high; left bank is wooded and is from 5 to 8 feet high; neither bank subject to overflow. Concrete dam about 100 feet below gage serves as control at all stages. Point of zero flow, gage height —0.05 foot.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 0.78 foot at 4.30 p. m. October 20 (discharge, 353 second-feet); no flow for extended periods.

1915–1917: Maximum stage recorded, 3.16 feet from 8.30 a. m. to 10 a. m. April 19, 1916 (discharge, 4,070 second-feet); no flow for extended periods each year.

ICE.—None reported during year.

DIVERSIONS.—Lake is used for storage; capacity not known.

REGULATION.—Flow controlled at intake on Frio River, some distance above; flow of Frio River above this diversion probably not regulated.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve fairly well defined below 5,000 second-feet. Gage read to hundredths once daily; one daily gage reading may not be a true index of the mean daily discharge. Daily discharge ascertained by applying daily gage height to the rating table. Records good.

Frio Lake is a storage reservoir fed by a diversion from Frio River. The diversion is made 1½ miles above the Frio River dam and the gaging station on the river. The water released from the lake is used for irrigation. This station is maintained in conjunction with that on Frio River at Fowlerton to show the total run-off at that point.

Discharge measurements of Frio Lake outlet near Fowlerton, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 2	Victor Lieb	.....	0.0	July 27	E. O. Francisco	.....	0.0
June 14	Francisco and Hank	.....	.0	Sept. 29	R. J. Hank	0.13	3.7

Daily discharge, in second-feet, of Frio Lake outlet near Fowlerton, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Sept.	Day.	Oct.	Sept.	Day.	Oct.	Sept.
1	.....	.....	11	.....	2.7	21	70	.....
2	.....	.....	12	.....	1.4	22	15	.....
3	.....	.....	13	.....	.0	23	6.2	.....
4	.....	.....	14	.....	.....	24	2.0	.....
5	.....	.....	15	.....	.....	25	1.2	0.0
6	.....	.....	16	.....	.....	26	.0	2.7
7	.....	.....	17	.....	.....	27	.....	8.3
8	.....	0.0	18	.....	.....	28	.....	5.5
9	.....	1.0	19	0.0	.....	29	.....	4.1
10	.....	8.3	20	353	.....	30	.....	1.8
						31	.....	.....

NOTE.—No flow on days for which discharge is not given.

Monthly discharge of Frio Lake outlet near Fowlerton, Tex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	353	0.0	14.4	885
November	.0	.0	.0	0
December	.0	.0	.0	0
January	.0	.0	.0	0
February	.0	.0	.0	0
March	.0	.0	.0	0
April	.0	.0	.0	0
May	.0	.0	.0	0
June	.0	.0	.0	0
July	.0	.0	.0	0
August	.0	.0	.0	0
September	8.3	.0	1.19	71
The year	353	.0	1.32	956

RIO GRANDE BASIN.

RIO GRANDE NEAR SAN MARCIAL, N. MEX.

LOCATION.—In sec. 19 T., 7 S., R. 1 W., at Atchison, Topeka & Santa Fe Railway bridge 1 mile south of San Marcial in Socorro County. No large tributaries enter near station.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—January 29, 1895, to September 30, 1917.

GAGE.—Inclined staff established January 29, 1895, and destroyed by flood in 1896. Wire gage established in its place, at same datum, was soon abandoned and gage heights have since been obtained by measuring with a graduated rod from bridge deck to water surface. Gage datum unchanged.

DISCHARGE MEASUREMENTS.—Made from three-span bridge.

CHANNEL AND CONTROL.—Bed sandy and very shifting; broken by two bridge piers. No well-defined control.

EXREMES OF DISCHARGE.—Maximum mean daily discharge during year, 11,000 second-feet on October 15; no flow August 16 to 18, August 22 to September 15, September 24 to 30.

DIVERSIONS.—Considerable water diverted for irrigation above station.

ACCURACY.—Stage-discharge relation not permanent; not affected by ice. Owing to shifting control determinations of daily discharge are based almost entirely on frequent current-meter measurements.

COOPERATION.—Records furnished by United States Reclamation Service and reduced to three significant figures by United States Geological Survey.

Daily discharge, in second-feet, of Rio Grande near San Marcial, N. Mex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	160	2,240	1,020	649	609	625	665	3,960	3,380	5,780	454	0
2	145	2,030	1,040	817	609	662	1,540	3,240	3,610	5,870	301	0
3	135	1,950	1,060	985	646	883	1,800	2,330	3,840	5,440	301	0
4	135	1,860	1,050	985	665	837	1,440	1,600	3,760	5,440	149	0
5	155	1,770	1,030	780	665	836	1,260	1,600	3,520	4,810	338	0
6	155	1,680	1,020	780	665	790	1,140	978	3,740	4,490	509	0
7	195	1,600	1,020	780	665	745	1,080	1,760	3,740	4,610	283	0
8	195	1,510	1,020	788	725	565	719	1,690	3,210	4,410	247	0
9	230	1,730	1,020	789	710	520	719	1,930	5,250	4,100	101	0
10	554	1,570	1,020	809	725	484	719	1,850	4,980	3,740	92	0
11	880	1,570	707	808	769	538	1,450	1,850	5,030	3,480	55	0
12	1,080	1,410	707	817	750	503	1,200	1,850	3,990	3,210	30	0
13	2,970	1,570	602	693	701	543	1,390	1,830	6,880	3,240	3	0
14	9,490	1,490	497	693	681	584	1,320	1,520	7,000	3,140	34	0
15	11,400	1,490	497	694	655	674	1,160	1,520	7,230	2,970	22	0
16	6,810	1,640	518	694	659	618	1,160	1,900	8,090	2,570	0	78
17	5,640	1,100	539	701	723	618	1,710	3,160	7,760	3,440	0	866
18	4,720	1,250	561	678	728	618	1,870	5,680	7,410	2,270	0	1,930
19	3,630	1,250	629	609	733	581	1,940	6,660	7,630	2,120	92	746
20	3,840	1,100	697	609	737	544	1,870	8,200	8,430	1,730	34	174
21	3,660	1,100	766	747	725	507	1,760	8,830	8,000	2,000	6	48
22	3,480	1,260	761	885	743	473	1,500	9,080	7,920	1,090	0	36
23	3,130	1,260	756	885	791	456	1,230	7,430	8,630	1,090	0	24
24	2,780	1,360	751	860	680	439	1,060	6,760	8,040	1,090	0	0
25	2,430	1,440	821	694	569	596	915	5,110	7,690	1,060	0	0
26	2,380	1,440	856	694	568	991	915	6,430	7,690	960	0	0
27	2,340	1,350	892	526	611	754	1,350	5,670	8,220	832	0	0
28	2,340	1,260	805	609	625	666	2,940	3,760	6,810	832	0	0
29	2,280	1,070	717	694	.....	666	5,240	5,440	7,160	832	0	0
30	2,260	1,000	649	609	.....	666	4,670	3,310	6,300	720	0	0
31	2,240	.....	649	609	.....	578	.....	3,310	.....	608	0	0

NOTE.—Figures have been changed slightly to comply with the rules of computations followed by the U. S. Geological Survey.

Monthly discharge of Rio Grande near San Marcial, N. Mex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	11,400	135	2,640	162,000
November	2,240	1,000	1,480	88,100
December	1,060	497	796	48,900
January	985	526	741	45,600
February	791	568	683	37,900
March	991	439	631	38,800
April	5,240	665	1,590	94,600
May	9,080	978	3,880	239,000
June	8,630	3,210	6,160	367,000
July	5,870	608	2,840	175,000
August	509	.....	98.4	6,050
September	1,930	.....	130	7,740
The year	11,400	.....	1,810	1,310,000

RIO GRANDE BELOW ELEPHANT BUTTE DAM, N. MEX.

LOCATION.—In T. 13 S., R. 4 W., 1 mile below Elephant Butte dam, in Sierra County. Nearest tributary, Mescal Canyon, enters half a mile downstream.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—October 1, 1916, to September 30, 1917.

GAGE.—Stevens water-stage recorder on left bank 1 mile below dam.

DISCHARGE MEASUREMENTS.—Made from cable at gage.

CHANNEL AND CONTROL.—Channel composed of compact gravel; probably permanent. Control located at gravel bar at mouth of Mescal Canyon; shifts.

ICE.—Stage-discharge relation not affected by ice.

REGULATION.—Flow controlled by Elephant Butte dam, which forms reservoir having capacity of 2,638,000 acre-feet.

EXTREMES OF DISCHARGE.—No information.

COOPERATION.—Complete records furnished by United States Reclamation Service.

Discharge measurements of Rio Grande below Elephant Butte dam, N. Mex., during the year ending Sept. 30, 1917.

[Made by H. L. Lewis.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Dec. 1	4.95	1,770	Feb. 19	4.70	1,920	Aug. 6	4.95	2,080
6	5.65	2,960	May 4	4.95	2,080	16	4.95	2,040
28	5.57	2,750	15	4.87	2,030	Sept. 1	4.80	2,020
Jan. 11	4.78	1,870	June 1	4.97	2,140	4	4.70	1.820
27	3.95	1,030	26	5.62	3,130			
29	4.80	1,920	Aug. 1	5.75	2.960			

Daily discharge, in second-feet, of Rio Grande below Elephant Butte dam, N. Mex., for the ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	1,800	1,800	0	2,980	1,920	1,920	1,740	1,680	2,150	3,020	3,200	1,920
2	1,800	0	0	2,980	1,920	1,400	1,740	1,680	2,150	3,020	3,200	1,920
3	1,800	0	0	2,980	1,920	1,180	1,740	1,920	2,150	3,020	3,200	1,920
4	1,800	0	3,170	2,420	1,920	1,180	1,740	2,030	2,150	3,020	2,680	1,860
5	1,800	0	3,170	1,920	1,920	1,400	1,740	2,030	2,150	3,020	2,100	1,860
6	1,800	0	3,170	1,920	1,920	1,920	1,740	2,030	2,150	3,030	2,100	1,860
7	1,800	0	1,920	1,920	1,920	1,920	1,740	2,030	2,150	3,030	2,100	1,860
8	1,800	0	1,180	1,920	1,920	1,920	1,740	2,030	2,150	3,040	2,100	1,860
9	1,800	0	1,180	1,920	1,920	1,920	1,740	2,100	2,150	3,040	2,100	1,860
10	.....	0	1,180	1,120	1,920	1,920	1,740	2,030	2,150	3,060	2,100	1,860
11	1,800	0	1,580	1,920	1,920	1,920	1,740	2,010	2,150	3,080	2,100	1,860
12	1,800	0	1,970	1,920	1,920	1,920	1,740	2,000	2,160	3,090	2,100	1,860
13	1,800	0	1,970	1,920	1,920	1,920	1,740	2,000	2,160	3,090	2,100	1,860
14	1,800	0	1,970	1,920	1,920	1,920	1,740	2,000	2,160	3,120	2,100	1,860
15	1,800	632	1,970	1,920	1,920	1,800	1,740	2,000	2,160	3,120	2,100	1,860
16	1,800	1,090	1,970	1,920	1,920	1,800	1,740	2,000	2,170	3,120	2,100	1,860
17	1,800	1,680	1,970	1,920	1,920	1,800	1,680	2,000	2,170	3,120	2,100	1,860
18	1,800	1,840	1,970	1,920	1,920	1,800	1,680	2,000	2,190	3,120	2,100	1,860
19	1,800	1,840	1,970	1,920	1,920	1,800	1,680	2,010	2,190	3,120	2,100	1,820
20	1,800	1,800	2,030	0	1,920	1,800	1,680	2,030	2,200	3,120	0	1,820
21	1,780	1,800	1,980	0	1,920	1,860	1,680	2,030	2,200	3,120	0	1,820
22	1,780	1,800	1,980	0	1,920	1,860	1,680	2,040	2,200	3,120	0	1,820
23	1,780	1,740	1,980	0	1,920	1,800	1,680	2,100	2,200	3,120	0	1,820
24	1,780	1,720	1,980	300	1,920	1,800	1,680	2,110	2,200	3,160	0	1,800
25	1,780	1,720	1,980	300	1,920	1,800	1,680	2,130	2,590	3,160	2,030	1,800
26	1,740	1,720	1,980	300	1,920	1,800	1,680	2,120	3,010	3,180	2,030	1,800
27	1,740	1,720	.....	695	1,920	1,800	1,680	2,120	3,010	3,180	2,030	1,800
28	1,740	1,720	2,930	1,060	1,920	1,800	1,680	2,120	3,010	3,180	1,970	1,800
29	1,740	1,720	2,930	1,490	0	1,800	1,680	2,120	3,010	3,200	1,970	1,800
30	1,740	1,720	2,980	1,920	.....	1,800	1,680	2,120	3,010	3,200	1,970	1,800
31	1,740	.....	2,980	1,920	.....	1,800	.....	2,120	.....	3,200	1,950	.....

Monthly discharge of Rio Grande below Elephant Butte dam, N. Mex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	1,800	1,740	1,790	110,000
November	1,840	0	935	55,600
December	3,170	0	1,870	115,000
January	2,980	0	1,550	95,300
February	1,920	1,920	1,920	107,000
March	1,920	1,180	1,780	109,000
April	1,740	1,680	1,710	102,000
May	2,130	1,680	2,020	124,000
June	3,010	2,150	2,320	138,000
July	3,200	3,020	3,100	191,000
August	3,200	0	1,860	114,000
September	1,920	1,800	1,850	110,000
The year	3,200	0	1,890	1,370,000

CHAMA RIVER NEAR CHAMA, N. MEX.

LOCATION.—In sec. 25, T. 31 N., R. 3 E., at highway bridge on main road from Chama to Tierra Amarilla, 2½ miles southeast of Chama, 200 feet above mouth of Little Chama River, in northern part of Rio Arriba County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 27, 1914, to September 12, 1917, when station was discontinued. From September 23, 1912, to May 26, 1914, a station was maintained on Chama River at Chama, 2 miles upstream. No intervening tributaries of consequence.

GAGE.—Stevens water-stage recorder installed on downstream side of bridge pier.

DISCHARGE MEASUREMENTS.—Made by wading or from highway bridge.

CHANNEL AND CONTROL.—Banks are medium in height but are not overflowed except during extremely high stage. Bed of stream composed of sand, gravel, and rock. Control at rapids 100 feet downstream; shifting.

EXTREMES OF DISCHARGE.—Maximum stage during year, from water-stage recorder, 4.25 feet at 9 p. m. June 9 (discharge, 1,740 second-feet); minimum stage 1.42 feet at 1 a. m. August 31 (discharge, 29 second-feet).

ICE.—Stage-discharge relation seriously affected by ice; observations discontinued during winter.

DIVERSIONS.—City ditch diverts about 2 second-feet from June to September.

REGULATION.—None.

ACCURACY.—Stage-discharge relation changes from year to year. Rating curve well defined between 40 and 600 second-feet but not well defined above 600 second-feet. Operation of the water-stage recorder intermittent for lack of permanent observer. Daily discharge ascertained by applying to rating table the mean daily gage height obtained by inspecting recorder graph. Records good below 600 second-feet and fair above.

Discharge measurements of Chama River near Chama, N. Mex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Apr. 26	G. S. Cowdrey, jr	3.50	953
Sept. 12	Robert Follansbee	1.49	33.6

Daily discharge, in second-feet, of Chama River near Chama, N. Mex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Apr.	May.	June.	Aug.	Sept.
1	52	85	.....	264	.....	.....	32
2	56	83	.....	317	.....	.....	32
3	43	80	.....	341	.....	.....	32
4	41	81	.....	356	.....	.....	33
5	41	74	.....	317	870	.....	33
6	89	70	.....	268	853	.....	35
7	80	72	112	247	980	.....	37
8	128	74	136	224	1,080	.....	38
9	235	74	198	209	1,180	.....	41
10	224	76	174	213	1,180	.....	41
11	602	76	158	235	1,100	.....	38
12	325	70	191	290	1,040	.....	34
13	220	56	277	377	1,020	.....	.....
14	317	50	299	588	998	.....	.....
15	224	50	264	980	980	.....	.....
16	184	48	188	1,110	912	.....	.....
17	184	48	154	1,200	794	.....	.....
18	177	48	126	1,140	721	.....	.....
19	158	48	117	955	675	.....	.....
20	139	48	105	690	581	.....	.....
21	134	47	126	595	515	.....	.....
22	131	48	209	660	509	.....	.....
23	134	46	356	785	534	.....	.....
24	139	44	515	721	.....	.....	.....
25	120	46	690	.....	.....	.....	.....
26	120	43	794	.....	.....	.....	.....
27	126	42	567	.....	.....	31	.....
28	115	.....	351	.....	.....	30	.....
29	112	.....	285	.....	.....	31	.....
30	100	.....	239	.....	.....	30	.....
31	94	.....	.....	.....	.....	31	.....

Monthly discharge of Chama River near Chama, N. Mex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	602	41	156	9,590
November 1–27	85	42	60.3	3,230
April 7–30	794	105	276	13,100
May 1–24	1,200	209	542	25,800
June 5–23	1,180	509	870	32,800

CHAMA RIVER NEAR EL VADO, N. MEX.

LOCATION.—In T. 28 N., R. 2 E., at entrance to box canyon 1 mile below El Vado, 15 miles southwest of Tierra Amarilla, near center of Rio Arriba County. Nutrias Creek, which forms south line of Tierra Amarilla land grant, joins Chama River from the north 4 miles below the station.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—September 28, 1913, to June 18, 1917, when station was discontinued.

GAGE.—Stevens water-stage recorder installed on rock wall on right bank.

DISCHARGE MEASUREMENTS.—Made by wading or from cable located just above the gage.

CHANNEL AND CONTROL.—Bed composed of solid rock overlain with gravel; changes slightly. Banks high and not subject to overflow. Rock reef just below gage serves as control.

EXTREMES OF DISCHARGE.—Not determined.

ICE.—Stage-discharge relation seriously affected by ice; observations discontinued during winter.

DIVERSIONS.—Between Park View and the El Vado station, approximately 3 second-feet diverted from Chama River and 2 second-feet from intervening tributaries during irrigation season.

REGULATION.—None.

ACCURACY.—Stage-discharge relation changes slightly. Rating curve well defined below 1,400 second-feet, but not well defined above. Operation of water-stage recorder satisfactory. Daily discharge ascertained by applying to rating table the mean daily gage height obtained by inspecting recorder graph. Records good.

Discharge measurements of Chama River near El Vado, N. Mex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 30	G. S. Cowdrey, jr	0.57	95	June 14	G. S. Cowdrey, jr	5.62	2,150
Mar. 29	do	1.73	378	Sept. 13	Robert Follansbee	.20	60
June 5	do	5.82	2,580				

Daily discharge, in second-feet, of Chama River near El Vado, N. Mex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	June.	Day.	Oct.	Nov.	June.	Day.	Oct.	Nov.	June.
1	72	214		11	1,280	136		21	312		
2	119	212		12	1,270	132		22	296		
3	96	201		13	655	116		23	282		
4	72	190		14	935	87		24	318		
5	65	178		15	850		2,350	25	300		
6	76	164		16	546		2,140	26	280		
7	152	148		17	496		2,010	27	274		
8	201	139		18	453		1,890	28	289		
9	718	126		19	400			29	265		
10	747	132		20	338			30	245		
								31	232		

NOTE.—Oct. 8-12, 14-15, daily discharge was obtained by averaging the hourly discharge.

Monthly discharge of Chama River near El Vado, N. Mex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (in acre-feet).
	Maximum.	Minimum.	Mean.	
October	1,280	65	408	25,100
November 1-14	214	87	155	4,300

BRAZOS RIVER NEAR BRAZOS, N. MEX.

LOCATION.—At the mouth of box canyon 3 miles east of Brazos, 15 miles southeast of Chama, in northern part of Rio Arriba County, about 1½ miles above mouth of Little Brazos River.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—September 18, 1913, to September 6, 1917, when station was discontinued.

GAGE.—Friez water-stage recorder on left bank.

DISCHARGE MEASUREMENTS.—Made by wading or from cable near the gage.

CHANNEL AND CONTROL.—Bed of stream composed of rock, gravel, and sand; slightly shifting. Banks are of medium height and not subject to overflow except during extremely high stages. Control at small rapids 150 feet downstream; practically permanent.

EXTREMES OF DISCHARGE.—Maximum stage during the year, from water-stage recorder, 3.85 feet at 10 p. m., June 4, 8, 9 (discharge, 2,680 second-feet); minimum discharge probably occurs during winter.

ICE.—Stage-discharge relation seriously affected by ice; observations discontinued during winter.

DIVERSIONS.—No diversions above station, but approximately 8 second-feet diverted below during irrigation season.

REGULATION.—None.

ACCURACY.—Stage-discharge relation not permanent. Rating curve well defined below 1,400 second-feet, but not well defined above. Operation of water-stage recorder satisfactory. Daily discharge ascertained by applying to rating table the mean daily gage height obtained by inspecting recorder graph. Records excellent below 1,400 second-feet; fair above.

Discharge measurements of Brazos River near Brazos, N. Mex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Dec. 6	G. S. Cowdrey, jr	0.61	34.2	June 6	G. S. Cowdrey, jr	2.67	972
Apr. 26	do	2.63	1,020	Sept. 13	Robert Follansbee	.23	24.9

Daily discharge, in second-feet, of Brazos River near Brazos, N. Mex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Apr.	May.	June.	July.	Aug.	Sept.
1	50	102	.....	224	745	285	38	24
2	67	100	.....	246	896	268	34	24
3	41	90	.....	289	1,210	246	32	24
4	34	85	.....	340	1,560	218	30	24
5	32	80	.....	307	1,520	191	30	23
6	61	70	.....	222	1,340	173	29	23
7	52	70	.....	191	1,510	162	29	.....
8	111	63	.....	145	1,610	145	29	.....
9	356	70	.....	123	1,730	138	28	.....
10	196	76	.....	114	1,600	162	28	.....
11	508	76	.....	114	1,310	132	27	.....
12	383	.....	.....	111	1,120	108	28	.....
13	258	.....	.....	187	1,010	88	32	.....
14	388	.....	.....	549	908	74	32	.....
15	310	.....	.....	1,140	832	64	30	.....
16	258	.....	.....	1,660	738	58	29	.....
17	263	.....	.....	2,140	678	57	30	.....
18	245	.....	.....	1,780	650	58	29	.....
19	203	.....	.....	1,350	622	68	28	.....
20	155	.....	.....	738	582	56	28	.....
21	155	.....	.....	556	538	48	26	.....
22	145	.....	.....	624	497	46	26	.....
23	149	.....	.....	866	469	48	25	.....
24	162	.....	.....	954	436	41	25	.....
25	138	.....	.....	816	420	38	25	.....
26	138	.....	1,390	515	400	43	25	.....
27	159	.....	1,030	410	379	42	25	.....
28	152	.....	570	570	350	37	24	.....
29	135	.....	352	816	326	34	24	.....
30	123	.....	195	1,030	307	34	24	.....
31	111	.....	.....	1,040	.....	44	24	.....

NOTE.—May 2 to June 28, discharge computed by the indirect method for shifting control. Apr. 29, May 1, 13–14, 22, and 28, daily discharge obtained by averaging the bihourly discharge.

Monthly discharge of Brazos River near Brazos, N. Mex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	508	32	179	11,000
November 1–11	102	63	80.2	1,750
April 26–30	1,390	195	707	7,010
May	2,140	111	651	40,000
June	1,730	307	876	52,100
July	285	34	103	6,330
August	38	24	28.2	1,730
September 1–6	24	23	23.7	282

PECOS RIVER NEAR DAYTON, N. MEX.

LOCATION.—In sec. 13, T. 18 S., R. 26 E., 3 miles east of Dayton, Eddy County, half a mile above mouth of Penasco River.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—March 24, 1905, to September 30, 1917.

GAGE.—Stevens water-stage recorder on right bank; installed August 27, 1914, at same site and datum as staff gage installed September 7, 1905. Original gage, which was 100 feet below the mouth of Penasco River and half a mile below present gage, was washed out September 6, 1905.

DISCHARGE MEASUREMENTS.—Made from cable.

CHANNEL AND CONTROL.—Bed composed of sand and gravel. Shifts, especially during high stages. Right bank consists of clay, left bank of sand; both banks subject to overflow during extremely high stages. No well defined control.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 10.50 feet at 10 a. m. August 20 (discharge, 4,110 second-feet); minimum stage, 2.50 feet, at 11 a. m. July 21 (discharge, 27 second-feet).

1905–1917: Maximum discharge, (gage height not recorded,) 50,300 second-feet, July 25, 1905, (derived from discharge at Lake McMillan and includes flow of Penasco River); minimum stage, 2.45 feet from 11 p. m. July 26 to 1 a. m. July 27, 1916 (discharge, 23 second-feet).

ICE.—None reported during year.

DIVERSIONS.—Considerable water is diverted above station for the use of irrigable valley lands; quantity not known but not in conflict with rights of Carlsbad project of the United States Reclamation Service, which serves about 20,000 acres in the vicinity of Carlsbad and stores part of the water used near Carlsbad in Lake McMillan, 10 miles below gage.

REGULATION.—None.

ACCURACY.—Stage-discharge relation not permanent; periods of change are covered by discharge measurements. Daily stage determined by inspecting recorder-graph, or, for days of considerable fluctuation, by averaging hourly gage heights. Discharge determined by shifting-control method, or by applying mean gage height directly to rating table.

COOPERATION.—Complete records furnished by the United States Reclamation Service, from October 1 to December 31; base data, January 1 to September 30.

Discharge measurements of Pecos River near Dayton, N. Mex., during the year ending Sept. 30, 1917.

[Made by engineers of United States Reclamation Service.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Oct. 1	3.49	106	Mar. 18	3.59	133	Aug. 6	3.15	60
15	5.60	732	Apr. 1	3.40	116	9	2.68	26
29	4.40	311	15	3.22	83	15	7.00	1,605
Nov. 12	4.00	222	29	3.10	80	20	9.00	2,975
26	4.52	348	May 20	3.50	118	25	4.52	250
Dec. 17	4.68	415	June 2	3.60	146	Sept. 1	5.70	821
31	4.64	352	17	2.72	39	15	3.85	177
Jan. 21	4.45	270	30	2.80	45	30	3.80	158
Feb. 4	4.42	268	July 14	2.60	31			
18	4.40	263	23	2.56	31			

Daily discharge, in second-feet, of Pecos River, near Dayton, N. Mex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	109	256	262	366	275	164	116	82	127	36	32	880
2	110	256	262	382	270	163	122	74	143	37	66	552
3	108	252	262	448	275	167	118	67	139	47	488	685
4	104	240	262	474	280	175	109	65	128	45	243	506
5	101	222	262	434	270	174	106	66	127	44	135	470
6	98	198	262	382	263	177	106	71	118	47	66	430
7	95	210	262	350	263	187	106	79	104	52	41	386
8	92	230	268	331	296	175	98	89	111	41	35	347
9	95	226	270	324	314	175	94	88	118	38	28	314
10	101	230	272	317	308	165	88	94	110	38	31	288
11	104	222	262	305	290	172	88	102	99	35	32	263
12	128	222	260	296	272	172	89	108	89	36	32	245
13	204	218	258	290	272	157	88	128	71	32	36	225
14	352	214	242	285	270	146	84	175	62	33	39	213
15	588	230	254	288	268	140	82	182	53	30	655	185
16	584	240	266	288	270	135	80	218	45	45	1,040	174
17	528	238	340	280	268	135	85	207	41	59	795	488
18	511	240	436	275	268	135	82	161	45	44	670	479
19	445	236	415	278	263	132	78	128	47	36	630	585
20	412	238	338	282	257	130	76	116	42	32	2,910	547
21	457	316	328	282	243	130	74	114	42	30	2,050	362
22	442	334	320	299	236	119	73	105	47	30	880	324
23	433	331	310	575	236	116	78	91	45	32	488	243
24	394	334	310	552	224	128	79	172	45	32	370	217
25	349	331	300	390	205	128	76	251	56	32	278	192
26	305	337	298	382	188	131	74	218	66	32	251	241
27	285	322	298	350	172	128	73	187	60	32	205	261
28	280	310	302	378	164	128	77	171	55	30	178	205
29	302	290	349	354	.....	128	78	143	50	30	157	184
30	282	278	338	314	.....	124	78	126	45	32	147	157
31	268	.....	346	302	.....	115	.....	122	.....	33	140	.....

NOTE.—Discharge determined as follows: Jan. 23 to Mar. 20 and June 12 to Aug. 3 directly from rating table; Jan. 1–22, Mar. 21 to June 11, Aug. 4 to Sept. 30 by indirect method for shifting control. Oct. 1 to Dec. 31 records furnished by engineers of United States Reclamation Service; discharge from Jan. 1 to Sept. 30 computed by engineers of United States Geological Survey and approved by engineers of Reclamation Service.

Monthly discharge of Pecos River near Dayton, N. Mex., for the year ending September 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	588	92	280	17,200
November	337	198	260	15,500
December	436	242	297	18,300
January	575	275	350	21,500
February	314	164	256	14,200
March	187	115	147	9,040
April	122	73	88.5	5,270
May	251	65	129	7,930
June	143	41	77.7	4,620
July	59	30	37.2	2,290
August	2,910	28	424	26,100
September	880	157	355	21,100
The year	2,910	28	225	163,000

Days of deficiency in discharge of Pecos River near Dayton, N. Mex., for the years ending Sept. 30, 1906–1917.

Discharge in second-feet.	Days of deficient discharge.											
	1905–6	1906–7	1907–8	[a] 1908–9	1909–10	1910–11	1911–12	1912–13	1913–14	1914–15	1915–16	1916–17
50	.....	.....	7	80	19	.....	1	3	.....	.....	28	49
75	.....	.....	54	119	61	9	18	26	.....	4	34	69
100	13	12	94	154	106	37	34	83	3	22	37	100
125	20	40	136	171	179	91	62	151	37	34	47	129
150	49	75	162	200	216	120	82	184	68	37	76	156
175	64	84	173	225	237	165	109	218	105	42	88	178
200	84	120	180	230	248	193	126	234	118	56	106	186
250	115	148	189	263	272	248	185	262	172	85	155	221
300	158	175	210	285	320	282	241	295	236	116	222	282
350	188	208	244	318	324	303	280	320	258	157	264	317
400	225	243	279	339	331	311	303	333	271	226	284	329
450	242	262	299	342	339	317	309	340	276	263	294	338
500	254	282	306	346	344	325	315	344	278	275	301	345
550	267	307	314	347	347	329	327	346	288	283	310	349
600	287	318	314	347	349	336	332	347	294	292	317	355
650	304	328	314	347	349	337	332	349	297	299	323	356
700	320	339	319	347	353	339	338	349	305	306	331	359
800	337	347	322	350	354	341	342	350	312	317	341	360
900	347	351	326	352	355	347	346	352	317	327	346	362
1,000	351	358	334	352	355	350	357	353	326	333	347	362
1,200	358	359	341	354	356	357	362	356	336	243	356	363
1,400	358	361	343	356	357	359	365	356	344	349	360	393
1,700	361	363	353	356	358	360	365	358	354	354	363	363
2,000	362	364	358	356	358	361	365	358	357	356	363	363
2,500	363	364	361	356	360	362	365	362	359	361	365	364
3,000	364	364	363	356	360	362	365	362	362	361	365	365
4,000	365	365	365	366	361	362	366	362	363	362	365	.....
6,000	.....	.....	365	357	362	362	.....	364	363	362	365	.....
8,000	.....	.....	366	.....	363	363	.....	364	364	362	366	.....
10,000	.....	.....	.....	.....	365	364	.....	364	364	362	.....	.....
15,000	.....	.....	.....	.....	.....	365	.....	365	364	363	.....	.....
50,000	.....	.....	.....	.....	.....	.....	.....	.....	365	365	.....	.....

[a] Daily discharge for July 26 to Aug. 2, 1908, not included. Figures given for discharge above 90 second-feet are therefore subject to error.

PECOS RIVER AT CARLSBAD, N. MEX.

LOCATION.—In SE. ¼ sec. 6, T. 22 S., R. 27 E., at Green Street Bridge in Carlsbad, Eddy County, 300 feet downstream from Atchison, Topeka & Santa Fe Railway station, 1,500 feet above mouth of Dark Canyon, 2,000 feet below Hagerman dam.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 28, 1903, to March 31, 1908; May 13, 1914, to September 30, 1917.

GAGE.—Vertical staff attached to upstream side of middle bridge pier, installed May 18, 1914; gage used from May 28, 1903, to October, 1904, was an inclined staff gage at the present site. From October, 1904, to March 31, 1908, vertical staff gage at the same site was used.

DISCHARGE MEASUREMENTS.—Made by wading or from bridge.

CHANNEL AND CONTROL.—Bed composed of gravel and rock; nearly permanent, but changes may occur after high stages and slight changes have taken place during the lower stages. Banks of medium height; not subject to overflow. Position of control not known.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 6.0 feet October 14 (discharge, 5,910 second-feet); minimum stage, 0.50 foot July 24 (discharge, 26 second-feet).

1903–1908, 1914–1917: Maximum stage recorded, about 21.0 feet August 7, 1916 (discharge, 85,700 [1] second-feet); minimum stage, July 24, 1917.

[1] Discharge at Avalon dam; reported by engineers of United States Reclamation Service.

ICE.—None reported during year.

DIVERSIONS.—Large quantities of water are stored a few miles above station in Lakes McMillan and Avalon by the United States Reclamation Service for irrigating lands near Carlsbad. Water is also diverted for irrigation in valleys adjacent to river above Lake McMillan. Capacity of storage reservoirs in connection with the Carlsbad project, 58,500 acre-feet. Considerable water seeps into the river between the storage reservoirs and the gaging station, the quantity depending on the quantity being used for irrigation between the two points.

REGULATION.—Flow at this point completely controlled by storage reservoirs of the Carlsbad project.

ACCURACY.—Stage-discharge relation not permanent. Standard rating curve fairly well defined below 8,000 second-feet. Gage read to half-tenths once daily. One daily reading may not be a true index of the mean daily discharge because of fluctuation due to operation of storage reservoirs. Daily discharge ascertained by indirect method for shifting control. Records fair.

COOPERATION.—Gage-height record furnished by United States Reclamation Service.

Discharge measurements of Pecos River at Carlsbad, N. Mex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Jan. 16	R. C. Thaxton	2.00	480	May 6	R. C. Thaxton	1.05	91.4
Mar. 14	R. J. Hank	1.17	102	June 23	do	.86	58.3

Daily discharge, in second-feet, of Pecos River at Carlsbad, N. Mex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	113	152	167	270	413	174	103	91	69	152	87	101
2	113	152	483	1,770	476	109	103	91	62	123	87	91
3	113	152	419	1,600	413	99	103	91	62	182	82	91
4	113	256	483	1,140	444	99	103	91	62	167	77	91
5	113	359	483	483	476	99	103	91	57	152	77	91
6	113	182	359	421	476	109	103	91	57	152	77	91
7	113	167	359	359	476	109	103	91	57	167	87	91
8	113	152	299	483	413	109	103	91	57	167	87	91
9	113	152	299	483	293	109	103	91	57	152	87	91
10	113	152	299	483	240	109	103	91	57	152	87	91
11	137	152	299	483	202	119	103	91	213	167	87	93
12	137	152	299	483	164	119	103	91	119	182	87	95
13	137	152	299	599	111	119	107	101	79	182	87	97
14	5,910	152	299	715	111	119	107	101	79	182	87	99
15	400	152	299	832	111	119	107	91	79	182	87	101
16	155	152	299	419	121	131	107	91	62	182	87	103
17	155	152	299	389	111	109	107	91	57	36	89	105
18	155	152	299	389	138	119	107	43	119	36	91	107
19	185	152	299	389	164	109	107	43	119	41	101	109
20	185	152	483	389	476	99	97	43	79	41	101	111
21	155	152	483	389	413	109	97	53	52	41	101	113
22	155	152	299	389	413	109	97	71	57	41	91	113
23	155	152	299	436	413	109	97	81	57	87	91	113
24	155	152	329	483	323	99	97	81	57	26	91	113
25	4,970	152	359	419	260	99	107	111	57	36	91	113
26	483	152	299	419	197	103	111	101	57	36	106	113
27	483	152	359	389	217	103	101	81	57	117	121	113
28	483	415	359	389	240	103	101	71	79	128	121	93
29	318	789	359	389	.....	103	91	71	79	107	116	93
30	152	478	344	389	.....	103	91	71	80	97	111	83
31	152	.....	329	400	.....	103	.....	71	.....	87	111	.....

NOTE.—Gage heights missing on Oct. 1, 7, 8, 12, 15, 16, 22, and 29; Nov. 4, 7, 12, 20, 25, 28, and 30; Dec. 8–17, 24, and 30; Jan. 6, 13, 14, 19, 23, and 28; Feb. 4, 11, 18, 22, and 25; Mar. 1; Apr. 16; June 10, 30; July, 4, 16, 26, and 30; Aug. 3, 8, 17, 20, 26, and 29; Sept. 1, 3, 7, 9, 11–20; discharge determined by interpolation and information furnished by observer and engineers.

Monthly discharge of Pecos River at Carlsbad, N. Mex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	5,910	113	527	32,400
November	789	152	205	12,200
December	483	167	343	21,100
January	1,770	270	551	33,900
February	476	111	297	16,500
March	174	99	111	6,820
April	107	91	102	6,070
May	111	43	82.5	5,070
June	213	52	74.5	4,430
July	182	26	116	7,130
August	121	77	93.2	5,730
September	113	83	100	5,950
The year	5,910	26	217	157,000

PECOS RIVER NEAR ANGELES, TEX.

LOCATION.—In T. 26 S., R. 29 E., just below Pecos Valley Railroad bridge crossing Delaware Creek at its mouth, 2 miles north of New Mexico-Texas State line, 2¼ miles southeast of Red Bluff, Eddy County, N. Mex., 8½ miles northwest of Angeles, Reeves County, Tex.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 27, 1914, to September 30, 1917.

GAGE.—Stevens continuous water-stage recorder, at first outcropping of rock on the right bank about 600 feet below railroad bridge and mouth of Delaware Creek.

DISCHARGE MEASUREMENTS.—Made by wading or from cable half a mile downstream. Cable washed down in August, 1916; new cable installed in March, 1917.

CHANNEL AND CONTROL.—Bed and banks composed of sand, gravel, and rock; banks not subject to overflow. Control formed by a series of rapids about 200 feet below the gage; shifts.

EXTREMES OF DISCHARGE.—Maximum stage during year, from water-stage recorder, 3.65 feet 3 p. m. October 14 (discharge, 3,860 second-feet); minimum discharge, June 20, 104 second-feet (gage height from water-stage recorder, 0.38 foot).

1914–1917: Maximum stage recorded, 21.5 feet 10 a. m. August 8, 1916, measured by leveling from flood marks (discharge not determined); minimum discharge June 20, 1917.

ICE.—Stage-discharge relation not seriously affected by ice; open channel rating assumed applicable.

DIVERSIONS.—The Carlsbad project of the United States Reclamation Service, with reservoirs of a capacity of 58,500 acre-feet, diverts a large part of the natural run-off above Carlsbad, N. Mex. During the season of irrigation considerable water is returned to the stream by seepage from the lands in the vicinity of Carlsbad. In addition to the water used by the Carlsbad project, some diversions are made for irrigation in the basin above the storage reservoirs of the Carlsbad project.

REGULATION.—The operation of a water-power plant of 300 horsepower capacity above station, just below Carlsbad, N. Mex., does not materially regulate flow at gage. The flow is, however, regulated to a large extent by waters stored in the reservoirs of the Carlsbad project. In the season of irrigation the effect of the regulation is decreased by return seepage waters, but during the winter the flow depends on water released at the reservoirs.

ACCURACY.—Stage-discharge relation not permanent. Standard rating curve, used for computing daily discharge by shifting-control method, fairly well defined between 140 and 4,500 second-feet. Gage-height record not continuous due to imperfect operation of recorder. Mean daily gage height obtained by inspecting recorder graph, or, for days of considerable fluctuation, by averaging the hourly gage heights. Records fair October 1, to February 28, and August 26 to September 14; good, March 1 to August 25, and September 15–30.

Discharge for September, 1916, has been revised by means of measurements made in 1917. The determinations published herewith supersede those published in Water-Supply Paper 438.

Discharge measurements of Pecos River near Angeles, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Mar. 16	R. J. Hank	0.53	170	July 6	Gray and Hank	0.52	169
May 5	R. C. Thaxton	.47	139	Sept. 11	E. P. Congdon	.88	476
June 24	do	.43	119	15	do	.45	143

Daily discharge, in second-feet, of Pecos River near Angeles, Tex., for the period Sept. 1, 1916, to Sept. 30, 1917.

Day.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	535	208	305	200	402	260	156	160	216	131	128	131	180
2	435	200	280	188	402	350	164	176	200	140	137	232	170
3	335	208	260	228	776	340	160	184	188	137	125	176	170
4	330	208	256	300	990	335	160	164	168	134	128	144	170
5	325	208	390	300	840	355	172	152	152	116	137	131	170
6	320	204	280	265	632	366	172	144	172	119	160	248	170
7	315	200	252	260	496	305	164	152	184	125	152	144	170
8	310	200	236	256	474	310	160	160	180	128	137	128	170
9	305	228	244	252	444	335	164	160	172	122	125	128	170
10	300	248	257	252	414	320	184	164	180	116	122	128	1,000
11	295	270	270	315	378	270	188	160	184	110	125	122	980
12	290	305	260	345	378	216	192	168	176	128	119	131	780
13	290	680	252	350	444	188	184	180	176	164	119	168	580
14	270	2,300	232	345	752	295	192	188	168	134	119	160	380
15	340	704	220	350	664	300	176	180	164	122	122	140	184
16	372	680	208	300	536	236	196	176	152	113	128	134	488
17	420	680	212	280	438	172	180	184	148	119	131	140	280
18	1,060	648	216	290	372	168	172	192	144	113	137	208	236
19	1,070	664	220	290	350	125	164	192	148	107	134	184	192
20	544	496	228	408	355	113	180	200	148	104	134	134	208
21	265	440	232	450	345	113	184	204	152	116	131	131	188
22	244	385	236	462	345	156	172	220	134	119	134	128	256
23	228	330	224	396	335	140	172	228	148	116	125	137	176
24	216	270	228	384	340	224	172	232	152	122	128	131	456
25	212	220	224	315	350	208	172	244	152	172	122	160	172
26	212	1,500	212	372	340	164	180	244	144	122	116	160	168
27	204	500	196	420	340	184	188	240	140	125	125	170	172
28	192	430	512	432	310	192	172	236	144	140	128	190	172
29	196	360	340	426	330	.....	164	236	134	144	125	190	168
30	204	355	244	420	320	.....	156	220	131	134	125	185	168
31	.....	330	.....	408	300	.....	168	.....	131	.....	128	180	.....

NOTE.—No gage-height record Sept. 1, 2, and 4–12, 1916, Oct. 21–28, Oct. 31 to Nov. 3, Nov. 10, and Aug. 26 to Sept. 14; discharge estimated from record at Carlsbad and notes furnished by observer and engineers.

Monthly discharge of Pecos River near Angeles, Tex., for the period Sept. 1, 1916, to Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1916.				
September	1,070	192	354	21,100
1916–17.				
October	2,300	200	473	29,100
November	512	196	258	15,400
December	462	188	331	20,400
January	990	300	458	28,200
February	366	113	241	13,400
March	196	156	174	10,700
April	244	144	191	11,400
May	216	131	161	9,900
June	172	104	126	7,500
July	160	116	129	7,930
August	248	122	157	9,650
September	1,000	168	298	17,700
The year	2,300	104	250	181,000

PECOS RIVER ABOVE BARSTOW, TEX.

LOCATION.—Three-quarters of a mile below head gate of Biggs irrigation project, 1 mile east of Patrole siding on Pecos Valley Railway, 1¼ miles above head gate of Barstow Irrigation Co., 14 miles northwest of Barstow, Reeves County, 10 miles northwest of Pecos.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—February 1, 1916, to September 30, 1917.

GAGE.—Stevens water-stage recorder on right bank.

DISCHARGE MEASUREMENTS.—Made by wading or from cable 150 feet below gage.

CHANNEL AND CONTROL.—Channel straight 100 feet above and 300 feet below station. Bed composed of gravel, clay, and sand; not permanent. Right bank is clay, clean, and fairly permanent; left bank loose and covered with salt cedar; both banks are overflowed at gage height about 10 feet. Shoal 250 feet below gage serves as control; shifts during high water.

EXTREMES OF DISCHARGE.—Maximum stage during year, from water-stage recorder, 9.7 feet October 15 (discharge, 2,820 second-feet); minimum discharge June 24, 22 second-feet (gage height from water-stage recorder, 0.88 foot).

1916–1917: Maximum stage, from water-stage recorder, 12.1 feet at 6 a. m. August 10, 1916 (discharge not determined); minimum discharge, June 24, 1917.

ICE.—None reported during year.

DIVERSIONS.—In addition to water stored and lands irrigated in New Mexico by the Carlsbad project of the United States Reclamation Service, some lands in Texas are irrigated just above the station. Considerable water is returned to the river by seepage below the reservoirs. The Second Report of the Board of Water Engineers for the State of Texas shows that 28,800 acres were declared irrigated above the station, the quantity of water necessary under an assumed duty of 3 acre-feet per acre being 86,400 acre-feet.

REGULATION.—Storage in connection with the Carlsbad project controls the run-off during parts of the year. The operation of a water-power plant of 300-horsepower capacity, below Carlsbad, does not affect the flow at this point.

ACCURACY.—Stage-discharge relation not permanent. Standard rating curve well defined below 700 second-feet and poorly defined above. Mean daily gage height determined by inspecting recorder graph or, for days of considerable fluctuation, by averaging the hourly gage height. Breaks in gage-height records caused by collections of silt in float box. Daily discharge ascertained by shifting-control method. Determinations of discharge during extremely high stages is subject to error caused by water flowing over both banks. Records good for periods during which water-stage recorder operated satisfactorily.

Discharge measurements of Pecos River above Barstow, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 8	R. C. Thaxton	2.96	251	June 20	R. C. Thaxton	0.95	28
10	do	2.70	202	July 6	Gray and Hank	1.14	56.7
Jan. 10	do	4.12	511	Aug. 12	E. O. Francisco	.98	35.4
26	do	4.15	473	Sept. 9	E. P. Congdon	1.09	45.3
Mar. 17	R. J. Hank	2.05	110	13	do	1.97	136
May 4	R. C. Thaxton	1.50	81.3				

Daily discharge, in second-feet, of Pecos River above Barstow, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	173	368	337	348	368	280	94	87	59	83	76	100
2	173	282	289	346	361	278	96	86	60	83	60	58
3	170	249	210	342	353	274	84	84	63	78	55	54
4	167	241	177	545	423	262	86	81	73	68	48	53
5	162	240	171	1,090	401	234	94	83	71	63	92	50
6	160	420	220	977	391	231	95	83	65	58	83	48
7	158	330	288	864	401	184	96	83	62	70	53	47
8	158	248	291	751	380	166	96	89	58	87	48	46
9	145	224	251	638	304	142	95	98	56	90	43	46
10	135	204	272	525	330	217	97	101	50	68	43	46
11	125	214	296	525	323	225	104	99	50	62	38	46
12	115	241	321	525	288	224	101	102	49	61	37	292
13	105	246	348	515	276	224	99	103	49	58	35	292
14	95	238	355	591	274	197	99	103	50	56	78	126
15	2,000	227	346	667	272	170	99	104	86	54	66	121
16	401	214	289	743	264	143	118	97	74	48	66	348
17	502	203	265	820	259	116	104	84	54	44	65	689
18	410	192	265	773	258	107	99	79	43	40	63	252
19	376	190	260	725	258	100	95	77	35	36	98	208
20	450	196	260	677	256	99	94	75	28	35	104	184
21	378	195	420	629	255	96	90	77	27	36	70	162
22	372	183	470	581	255	92	88	74	24	26	55	147
23	360	184	485	533	291	92	88	75	24	28	52	144
24	340	198	456	485	290	93	92	72	22	31	50	141
25	320	191	428	480	288	90	92	66	110	35	49	227
26	300	182	400	474	286	89	88	64	232	43	49	146
27	635	183	372	463	284	86	91	61	159	45	52	128
28	401	178	344	430	282	88	90	62	141	40	54	110
29	419	174	361	406	.....	90	88	64	108	38	53	98
30	417	266	363	393	.....	89	84	64	98	56	57	94
31	401	.....	357	389	.....	89	.....	60	.....	100	60	.....

NOTE.—No gage-height record Oct. 9–15, 23–26, Nov. 5–7, Dec. 18–27, Jan. 6–9, 14–16, 18–23, and 25, Feb. 24 to Mar. 2, Mar. 14–16, Apr. 6 and 7, June 19, Aug. 31, and Sept. 1; discharge determined by interpolation, by means of record on Pecos River at Angeles and data furnished by engineers and observer.

Monthly discharge of Pecos River above Barstow, Tex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	2,000	95	339	20,800
November	420	174	230	13,700
December	485	171	322	19,800
January	1,090	342	589	36,200
February	423	255	310	17,200
March	280	86	157	9,650
April	118	84	94.5	5,620
May	104	60	81.8	5,030
June	232	22	69.3	4,120
July	100	26	55.5	3,410
August	104	35	59.7	3,670
September	689	46	150	8,930
The year	2,000	22	205	148,000

PECOS RIVER NEAR GRANDFALLS, TEX.

LOCATION.—At site of old highway bridge where Grandfalls-Fort Stockton road formerly crossed Pecos River 1½ miles upstream from present Grandfalls-Fort Stockton road crossing at Iron Bridge, 2 miles below diversion dam for silt-line canal of Imperial Irrigation Co., about 3 miles south of Grandfalls, Ward County, 4½ miles above diversion dam of Zimmerman project, 21 miles south of Monahans.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—November 6, 1915, to September 30, 1917. Records were taken at Iron Bridge, 1½ miles downstream, from November 6, 1915, to August 3, 1917. Discharge at both points believed to be the same.

GAGE.—Stevens water-stage recorder, installed August 9, 1917, on downstream side of old bridge pier near left water's edge. Prior to August 3 a Stevens water-stage recorder at Iron Bridge. Backwater from Zimmerman dam compelled the relocation of the station.

DISCHARGE MEASUREMENTS.—Made by wading 500 feet above station, from cable 50 feet above gage, or during extremely high stages, at Iron Bridge.

CHANNEL AND CONTROL.—Bed of stream solid rock, clean, smooth, and permanent. Channel straight for 100 feet above and below station. One channel below gage height of 8 feet; above this stage both banks which are dirt and wooded are subject to overflow. Rock ledge extending diagonally across stream just below gage serves as low-water control.

EXTREMES OF DISCHARGE.—Maximum stage recorded during the year, from water-stage recorder, 8.10 feet, 6 p. m. October 16 (discharge, 1,640 second-feet); minimum discharge, 3.9 second-feet, May 31 (gage height from water-stage recorder, 2.49 feet).

1915–1917: Maximum stage, from water-stage recorder, 12.8 feet at 8 a. m. August 29, 1916 (discharge, 4,370 second-feet; determined from extension of rating curve and possibly subject to considerable error); minimum stage, 0.38 foot at 1 a. m. April 17, 1916 (discharge not determined, but less than 0.7 second-foot).

ICE.—None reported during year.

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DIVERSIONS.—Station is 2 miles below diversion of silt-line canal of the Imperial Irrigation Co., 18½ miles below diversion for the Imperial reservoir (17,000 acre-feet capacity), 15½ miles below diversion for Grandfalls project and 4½ miles above diversion for Zimmerman project. Available data show that tracts aggregating approximately 143,000 acres are irrigable between station and lower limits of Carlsbad project of United States Reclamation Service. Second Report of Board of Water Engineers for the State of Texas shows total number of acres declared irrigated in Texas above the station to be about 58,000, the amount of water required under an assumed duty of 3 acre-feet per acre being 174,000 acre-feet. The effect of diversions is somewhat counterbalanced by water returned to stream by seepage.

REGULATION.—None.

ACCURACY.—Stage discharge relation permanent at present site, but subject to changes in control and effect of backwater at former site. Rating curve well defined below 3,200 second-feet for Iron Bridge station and below 75 second-feet feet at present site. Gage-height record somewhat fragmentary, owing to stopping of water-stage recorder. Gage read once daily to hundredths; November 9 to January 9, recorder not in working order. Mean daily gage height obtained by inspecting recorder graph or, for days of considerable fluctuations, by use of planimeter. Daily discharge ascertained by applying mean daily gage height to rating table as indicated in footnote to table of daily discharge. Records fair, October 1 to May 11, and August 9 to September 30; poor May 12 to August 8.

Discharge measurements of Pecos River near Grandfalls, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 9	R. C. Thaxton	3.10	109	May 3	R. C. Thaxton	1.47	18.5
18	do	2.96	105	June 19	do.[a]	[b] 3.35	21.0
Jan. 9	do	4.16	382	July 5	Gray and Hank	[b] 2.66	11.6
25	do	3.79	268	Aug. 9	E. O. Francisco [c]	.56	9.2
Mar. 18	R. J. Hank	1.90	41.7	Sept. 19	E. P. Congdon	.83	43.5

[a] Measurement made in gap in flash boards of Zimmerman dam located below station.
[b] Stage-discharge relation affected by backwater from Zimmerman dam.
[c] August 8 station was moved 1.5 miles upstream. Gage referred to new datum.

Daily discharge, in second-feet, of Pecos River near Grandfalls, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	59	242	338	202	180	20	42	22	4.4	24	28	16
2	55	192	275	202	109	20	50	21	5.0	18	29	20
3	46	127	200	202	76	20	47	20	6.0	14	28	24
4	38	124	142	178	71	21	43	22	6.2	13	28	27
5	38	121	335	182	87	37	39	23	6.2	11	24	29
6	37	118	332	705	96	54	35	24	8.0	11	20	31
7	35	115	188	621	83	58	35	24	9.7	12	16	34
8	31	112	192	549	81	71	31	26	9.2	12	13	37
9	29	109	164	325	79	74	29	27	8.5	13	10	34
10	27	85	127	154	75	63	29	28	8.2	14	9.5	32
11	27	80	126	140	69	60	28	28	8.2	16	8.0	27
12	29	78	138	132	73	60	27	27	8.2	17	8.0	24
13	144	83	164	134	85	56	26	30	8.2	18	8.5	20
14	201	89	192	150	78	58	26	33	9.7	20	8.5	29
15	253	102	235	146	69	52	26	31	12	20	12	26
16	1,420	100	242	405	61	49	25	28	14	21	20	15
17	954	108	248	639	56	43	24	25	16	22	21	11
18	468	108	265	561	54	41	23	22	19	24	10	151
19	429	100	195	468	54	37	22	19	21	25	10	45
20	250	102	182	402	50	34	21	17	25	26	9.5	16
21	72	95	170	355	56	33	21	14	29	27	9.5	12
22	72	90	164	342	70	31	20	12	28	28	9.5	10
23	72	86	252	325	62	31	20	12	24	29	9.5	10
24	450	108	295	295	47	31	21	11	24	29	10	9.0
25	400	112	305	265	29	33	22	9.4	22	28	10	9.0
26	330	101	218	260	21	33	23	9.2	22	25	10	9.5
27	245	110	205	278	21	34	24	9.4	23	23	9.5	9.5
28	170	110	157	265	21	35	27	8.8	29	22	10	10
29	250	108	148	230	.....	36	25	6.2	30	21	11	9.5
30	320	108	205	240	.....	37	22	4.2	29	22	11	10
31	295	.....	215	212	.....	38	.....	3.9	.....	26	14	.....

NOTE.—No gage-height record Oct. 20, 22–26, and 29; Nov. 4–8; Mar. 26–30; Apr. 10–13, 15–20, 22,24, and 26; May 2; Aug. 4–8. Discharge determined as follows: Oct. 1–26, Jan. 6 to Mar. 4, Apr. 10 to May 11, and Aug. 9 to Sept. 30 directly from rating tables; Oct. 27 to Jan. 5, Mar. 5 to Apr. 9, and May 12 to Aug. 8 by indirect method for shifting control. For days of no gage-height record, discharge estimated from observer's notes, engineer's record, and discharge of Pecos River above Barstow. Record from May 12 to Aug. 3 greatly affected by backwater from Zimmerman dam.

Monthly discharge of Pecos River near Grandfalls, Tex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	1,420	27	234	14,400
November	242	78	111	6,600
December	338	126	213	13,100
January	705	132	309	19,000
February	180	21	68.3	3,790
March	74	20	41.9	2,580
April	50	20	28.4	1,690
May	33	3.9	19.3	1,190
June	30	4.4	15.8	940
July	29	11	20.4	1,250
August	29	8.0	14.0	861
September	151	9.0	24.9	1,480
The year	1,420	3.9	92.3	66,900

PECOS RIVER NEAR COMSTOCK, TEX.

LOCATION.—At Pecos high bridge of Galveston, Harrisburg & San Antonio Railway Co., 11 miles west of Comstock, Val Verde County, 18 miles east of Langtry, 14 miles by stream above confluence with Rio Grande, and below all tributaries.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 1, 1900, to September 30, 1917. (Also gage heights for 1898.)

GAGE.—Vertical staff attached to the downstream side of bridge pier on left bank, read by W. A. Clare.

DISCHARGE MEASUREMENTS.—Made from cable 1,000 feet above bridge.

CHANNEL AND CONTROL.—Banks and stream bed composed of rock and gravel; water flows through a series of rapids and pools in a canyon approximately 300 feet deep; banks not subject to overflow. Stage-discharge relation at the lower stages changes slightly.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 2.65 feet at 8 a. m. May 12 (discharge, 1,590 second-feet); minimum stage, 0.01 foot several days in August (discharge, 145 second-feet).

1900–1917: Maximum stage recorded, 35.75 feet April 6, 1900 (discharge not determined); minimum discharge recorded, 110 second-feet May 13, 14, 1904 (gage height 0.5 foot).

ICE.—None reported during year.

DIVERSIONS.—Considerable water is diverted and stored above the station for irrigation. Lake McMillan and Lake Avalon of the Carlsbad project of the United States Reclamation Service, with a combined capacity of 58,500 acre-feet, are on Pecos River a few miles above Carlsbad, N. Mex. In addition to the water stored in New Mexico, water from Pecos River is used to irrigate large areas of land in the vicinity of Barstow and Grandfalls, Tex. There are no diversions below the station. Return waters tend to equalize effects of diversions in lower part of drainage basin.

REGULATION.—Yearly run-off at this point controlled by storage and diversions for irrigation above station. No water-power plants of any consequence operated in the drainage basin, except a public utility plant of about 300 horsepower, near Carlsbad, N. Mex.

ACCURACY.—Stage-discharge relation subject to changes. Rating curve well defined between 100 and 4,000 second-feet. Gage read to hundredths twice daily; mean of two readings may not be a true index of mean daily discharge. Daily discharge ascertained by applying mean daily gage height to rating table as indicated in footnote to table of daily discharge. Records good.

Discharge measurements of Pecos River near Comstock, Tex., during the year ending Sept. 30, 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 18	W. C. Dodd	0.70	364	May 22	W. C. Dodd	0.26	188
Nov. 18	do	.68	371	July 5	do	.14	184
Dec. 20	do	.90	455	20	do	.08	162
Jan. 10	do	.96	437	Sept. 25	Hank and Dodd	.45	194
Mar. 20	do	.48	269				

Daily discharge, in second-feet, of Pecos River near Comstock, Tex., for the year ending Sept. 30, 1917.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	510	495	397	460	460	320	235	202	190	200	168	150
2	485	490	374	415	438	312	235	202	185	200	162	150
3	460	661	374	460	460	316	229	205	185	200	162	150
4	415	661	366	415	460	280	229	200	180	192	162	150
5	402	739	366	460	451	271	235	200	180	188	162	148
6	433	752	374	460	451	265	229	200	180	185	168	152
7	410	510	456	460	415	265	220	192	182	180	168	150
8	420	480	460	451	370	250	220	198	185	172	168	150
9	362	460	460	451	350	250	211	192	185	172	165	148
10	323	424	438	446	354	241	205	195	182	172	168	148
11	342	415	415	485	330	250	262	195	180	172	162	148
12	309	402	392	480	334	253	217	1,100	180	170	162	150
13	320	424	392	475	312	250	229	259	175	168	158	148
14	326	424	415	470	312	250	220	309	170	168	152	148
15	346	415	410	460	312	265	220	235	175	168	145	148
16	374	402	388	460	312	265	220	232	172	160	145	148
17	366	379	388	438	295	250	220	220	170	155	145	148
18	366	362	388	424	295	250	226	217	162	155	145	148
19	410	370	420	415	298	235	253	205	160	155	145	148
20	1,030	379	446	424	295	247	235	205	158	158	148	148
21	978	388	456	480	289	259	220	202	155	162	145	150
22	778	446	505	480	283	250	205	200	155	170	145	150
23	679	424	500	480	280	250	205	200	155	198	145	268
24	625	402	495	505	265	253	220	200	155	190	148	195
25	595	424	490	521	250	241	220	205	302	182	145	195
26	521	415	460	521	253	241	220	200	182	168	145	195
27	510	424	442	470	250	235	223	200	180	162	145	292
28	490	402	428	510	250	238	220	192	217	162	145	182
29	490	402	470	460	.....	235	205	180	208	162	152	170
30	465	379	470	456	.....	229	205	192	195	162	148	158
31	505	.....	465	510	.....	235	.....	185	.....	168	148	.....

NOTE.—Discharge determined as follows: Oct. 1–3, Jan. 1 to June 24 directly from rating table; Oct. 4 to Dec. 31, June 25 to Sept. 30 by indirect method for shifting control.

Monthly discharge of Pecos River near Comstock, Tex., for the year ending Sept. 30, 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	1,030	309	485	29,800
November	752	362	458	27,300
December	505	366	429	26,400
January	521	415	465	28,600
February	460	250	337	18,700
March	320	229	256	15,700
April	262	205	223	13,300
May	1,100	180	236	14,500
June	302	155	181	10,800
July	200	155	173	10,600
August	168	145	154	9,470
September	292	148	164	9,760
The year	1,100	145	297	215,000

Days of deficiency in discharge of Pecos River near Comstock, Tex., for the years ending Sept. 30, 1901–1917.

Discharge in second-feet.	Days of deficient discharge.								
	1900–1901	1901–2	1902–3	1903–4	1904–5	1905–6	1906–7	1907–8	1908–9
100	.....	.....	.....	.....	.....	.....	.....	.....	.....
150	.....	.....	.....	45	.....	.....	.....	.....	.....
200	19	.....	5	130	.....	.....	3	.....	19
250	29	20	59	256	.....	.....	33	12	82
300	73	57	109	291	.....	.....	81	17	157
350	88	81	125	305	.....	.....	83	63	212
400	114	108	150	306	.....	.....	115	101	293
450	143	127	232	306	.....	16	175	128	334
500	185	165	269	309	.....	39	200	158	338
600	251	208	333	317	18	98	316	186	344
700	280	256	339	326	47	188	329	222	348
800	299	273	345	334	107	255	361	258	350
900	306	290	348	344	162	320	365	293	352
1,000	313	307	350	344	176	325	.....	313	354
1,200	330	326	350	346	211	336	.....	330	358
1,500	345	338	352	352	247	354	.....	350	362
1,800	352	345	352	354	290	356	.....	355	365
2,200	360	353	365	357	315	359	.....	355	.....
2,600	363	360	.....	357	328	359	.....	359	.....
3,000	363	364	.....	358	338	359	.....	364	.....
3,500	363	364	.....	361	342	359	.....	364	.....
4,000	363	364	.....	361	345	359	.....	364	.....
5,000	364	364	.....	362	355	361	.....	364	.....
7,000	364	364	.....	362	362	361	.....	364	.....
10,000	365	364	.....	362	364	362	.....	365	.....
15,000	.....	364	.....	365	365	362	.....	366	.....
20,000	.....	364	.....	366	.....	363	.....	.....	.....
25,000	.....	365	.....	.....	.....	363	.....	.....	.....
30,000	.....	.....	.....	.....	.....	364	.....	.....	.....
35,000	.....	.....	.....	.....	.....	364	.....	.....	.....
37,000	.....	.....	.....	.....	.....	365	.....	.....	.....

Discharge in second-feet.	Days of deficient discharge.							
	1909–10	1910–11	1011–12	1912–13	1913–14	1914–15	1915–16	1916–17
100	.....	.....	.....	.....	.....	.....	.....	.....
150	.....	.....	54	10	.....	.....	.....	28
200	78	21	129	63	.....	.....	.....	123
250	123	128	187	150	18	.....	65	185
300	238	217	325	214	91	.....	121	220
350	309	264	363	255	130	.....	181	237
400	345	295	365	283	151	28	211	261
450	350	310	365	299	193	57	243	299
500	352	321	265	305	216	76	273	342
600	353	331	365	316	239	141	287	355
700	354	336	365	325	272	193	300	359
800	357	340	365	331	285	240	320	362
900	358	343	365	335	297	281	337	362
1,000	358	345	365	339	310	290	342	363
1,200	359	347	366	346	322	303	344	365
1,500	363	353	.....	352	331	321	353	.....
1,800	364	356	.....	353	339	331	359	.....
2,200	364	358	.....	357	347	333	362	.....
2,600	364	363	.....	359	352	337	364	.....
3,000	364	363	.....	359	353	344	364	.....
3,500	364	363	.....	359	355	346	364	.....
4,000	364	364	.....	360	356	350	364	.....
5,000	364	364	.....	361	360	354	364	.....
7,000	364	364	.....	362	361	361	364	.....
10,000	364	364	.....	362	365	362	365	.....
15,000	364	365	.....	362	.....	363	365	.....
20,000	364	.....	.....	365	.....	363	.....	.....
25,000	364	.....	.....	.....	.....	363	.....	.....
30,000	365	.....	.....	.....	.....	364	.....	.....
35,000	.....	.....	.....	.....	.....	364	.....	.....
37,000	.....	.....	.....	.....	.....	365	.....	.....

MISCELLANEOUS MEASUREMENTS.

Miscellaneous discharge measurements in Texas during the year ending September 30, 1917.

Date.	Stream.	Tributary to—	Location.	Discharge.
				Sec.-ft.
Feb. 21	Colorado River	Gulf of Mexico	200 feet below Austin dam, Tex.	236
Aug. 22	do	do	do	53.4
24	do	do	do	45.3
28	do	do	do	39.2
31	do	do	do	54.1
May 25	Pecan Bayou	Colorado River	1¾ miles northeast of Brownwood, Tex.	51.3
July 4	Howard Creek	Pecos River	Ozona, Tex.	.0
4	Live Oak Creek	do	Sheffield-Ozona road crossing, Tex.	[a] 5.0
4	McKenzie Creek	do	Sheffield-Fort Stockton road crossing, Tex.	[a] 4.0

[a] Estimated.

INDEX.

STREAM-GAGING STATIONS

AND

PUBLICATIONS RELATING TO WATER RESOURCES

PART VIII. WESTERN GULF OF MEXICO DRAINAGE BASINS

STREAM-GAGING STATIONS AND PUBLICATIONS RELATING TO WATER RESOURCES.

INTRODUCTION.

Investigation of water resources by the United States Geological Survey has consisted in large part of measurements of the volume of flow of streams and studies of the conditions affecting that flow, but it has comprised also investigation of such closely allied subjects as irrigation, water storage, water powers, underground waters, and quality of waters. Most of the results of these investigations have been published in the series of water-supply papers, but some have appeared in the bulletins, professional papers, annual reports, and monographs.

The results of stream-flow measurements are now published annually in 12 parts, each part covering an area whose boundaries coincide with natural-drainage features as indicated below:

Part I. North Atlantic basins.
II. South Atlantic and esatern Gulf of Mexico basins.
III. Ohio River basin.
IV. St. Lawrence River basin.
V. Upper Mississippi River and Hudson Bay basins.
VI. Missouri River basin.
VII. Lower Mississippi River basin.
VIII. Western Gulf of Mexico basins.
IX. Colorado River basin.
X. Great basin.
XI. Pacific basins in California.
XII. North Pacific slope basins, in three volumes:
A. Pacific slope basins in Washington and Upper Columbia River basin.
B. Snake River basin.
C. Lower Columbia River basin and Pacific slope basins in Oregon.

HOW GOVERNMENT REPORTS MAY BE OBTAINED OR CONSULTED.

Water-supply papers and other publications of the United States Geological Survey containing data in regard to the water resources of the United States may be obtained or consulted as indicated below.

1. Copies may be obtained free of charge by applying to the Director of the Geological Survey, Washington, D. C. The edition printed for free distribution is, however, small and is soon exhausted.

2. Copies may be purchased at nominal cost from the Superintendent of Documents, Government Printing Office, Washington, D. C., who will furnish lists giving prices.

3. Sets of the reports may be consulted in the libraries of the principal cities in the United States.

4. Complete sets are available for consultation in the local offices of the water-resources branch of the Geological Survey, as follows:

Boston, Mass., 2500, Customhouse.
Albany, N. Y., 704 Journal Building.
Atlanta, Ga., Post Office Building.
Madison, Wis., °/₀ Railroad Commission of Wisconsin.
Topeka, Kans., 25 Federal Building.
Austin, Tex., Capitol Building.
Helena, Mont., Montana National Bank Building.
Denver, Colo., 403 New Post Office Building.
Salt Lake City, Utah, 421 Federal Building.
Boise, Idaho, 615 Idaho Building.
Tucson, Ariz., University of Arizona.
Portland, Oreg., 606 Post Office Building.
Tacoma, Wash., 406 Federal Building.
San Francisco, Cal., 328 Customhouse.
Los Angeles, Cal., 619 Federal Building.
Honolulu, Hawaii, 14 Capitol Building.

A list of the Geological Survey's publications may be obtained by applying to the Director of the United States Geological Survey, Washington, D. C.

STREAM-FLOW REPORTS.

Stream-flow records have been obtained at more than 4,240 points in the United States, and the data obtained have been published in the reports tabulated below:

Stream-flow data in reports of the United States Geological Survey.

[A=Annual Report; B=Bulletin; W=Water-Supply Paper.]

Report.	Character of data.	Year.
10th A, pt. 2	Descriptive information only	
11th A, pt. 2	Monthly discharge and descriptive information	1884 to Sept., 1890.
12th A, pt. 2	....do	1884 to June 30, 1891.
13th A, pt. 3	Mean discharge in second-feet	1884 to Dec. 31, 1892.
14th A, pt. 2	Monthly discharge (long-time records, 1871 to 1893)	1888 to Dec. 31, 1893.
B 131	Description, measurements, gage heights, and ratings	1893 and 1894.
16th A, pt. 2	Descriptive information only	
B 140	Descriptions, measurements, gage heights, ratings, and monthly discharge (also many data covering earlier years).	1895.
W 11	Gage heights (also gage heights for earlier years)	1896.
18th A, pt. 4	Descriptions, measurements, ratings, and monthly discharge (also similar data for some earlier years).	1895 and 1896.
W 15	Descriptions, measurements, and gage heights, eastern United States, eastern Mississippi River, and Missouri River above junction with Kansas.	1897.
W 16	Descriptions, measurements, and gage heights, western Mississippi River below junction of Missouri and Platte, and western United States.	1897.
19th A, pt. 4	Descriptions, measurements, ratings, and monthly discharge (also some long-time records).	1897.
W 27	Measurements, ratings, and gage heights, eastern United States, eastern Mississippi River, and Missouri River.	1898.
W 28	Measurements, ratings, and gage heights, Arkansas River and western United States.	1898.
20th A, pt. 4	Monthly discharge (also for many earlier years)	1898.
W 35 to 39	Descriptions, measurements, gage heights, and ratings	1899.

Stream-flow data in reports of the United States Geological Survey—Continued.

Report.	Character of data.	Year.
21st A, pt. 4	Monthly discharge	1899.
W 47 to 52	Descriptions, measurements, gage heights, and ratings	1900.
22d A, pt. 4	Monthly discharge	1900.
W 65, 66	Descriptions, measurements, gage heights, and ratings	1901.
W 75	Monthly discharge	1901.
W 82 to 85	Complete data	1902.
W 97 to 100	do	1903.
W 124 to 135	do	1904.
W 165 to 178	do	1905.
W 201 to 214	do	1906.
W 241 to 252	do	1907-8.
W 261 to 272	do	1909.
W 281 to 292	do	1910.
W 301 to 312	do	1911.
W 321 to 332	do	1912.
W 351 to 362	do	1913.
W 381 to 394	do	1914.
W 401 to 414	do	1915.
W 431 to 444	do	1916.
W 451 to 464	do	1917.

NOTE.—No data regarding stream flow are given in the 15th and 17th annual reports.

The records at most of the stations discussed in these reports extend over a series of years, and miscellaneous measurements at many points other than regular gaging stations have been made each year. An index of the reports containing records obtained prior to 1904 has been published in Water-Supply Paper 119.

The table below gives, by years and drainage basins, the numbers of the papers on surface-water supply published from 1899 to 1917. The data for any particular station will in general be found in the reports covering the years during which the station was maintained. For example, data for Machias River at Whitneyville, Me., 1903 to 1917, are published in Water-Supply Papers 97, 124, 165, 201, 241, 261, 281, 301, 321, 351, 381, 401, 431, and 451, which contain records for the New England streams from 1903 to 1917. Results of miscellaneous measurements are published by drainage basins.

In these papers and in the following lists the stations are arranged in downstream order. The main stem of any river is determined by measuring or estimating its drainage area—that is, the headwater stream having the largest drainage area is considered the continuation of the main stream, and local changes in name and lake surface are disregarded. All stations from the source to the mouth of the main stem of the river are presented first, and the tributaries in regular order from source to mouth follow, the streams in each tributary basin being listed before those of the next basin below.

In exception to this rule the records for Mississippi River are given in four parts, as indicated on page iii, and the records for large lakes are taken up in order of streams around the rim of the lake.

Numbers of water-supply papers containing results of stream measurements, 1899–1917.

Year.	North Atlantic coast (St. John River to York River).	South Atlantic coast and eastern Gulf of Mexico (James River to the Mississippi).	Ohio River.	St. Lawrence River and Great Lakes.	Hudson Bay and upper Mississippi River.	Missouri River.	Lower Mississippi River.	Western Gulf of Mexico.	Colorado River.	Great Basin.	Pacific coast in California.	North Pacific drainage basins.		
												Pacific basins in Washington and upper Columbia River.	Snake River basin.	Lower Columbia River and Pacific basins in Oregon.
1899 [a]	35	[b] 35, 36	36	36	36	[c] 36, 37	37	37	[d] 37, 38	38, [e] 39	38, [f] 39	38	38	38
1900 [g]	47, [h] 48	48	48, [i] 49	49	49	49, [j] 50	50	50	50	51	51	51	51	51
1901	65, 75	65, 75	65, 75	65, 75	[k] 65, 66, 75	66, 75	[k] 65, 66, 75	66, 75	66, 75	66, 75	66, 75	66, 75	66, 75	66, 75
1902	82	[b] 82, 83	84	[l] 82, 83	[k] 83, 85	84	[k] 83, 84	84	85	85	85	85	85	85
1903	97	[b] 97, 98	98	97	[k] 98, 99, [m] 100	99	[k] 98, 99	99	100	100	100	100	100	100
1904	[n] 124, [o] 125, [p] 126	[p] 126, 127	128	129	[k] 128, 130	130, [q] 131	[k] 128, 131	132	133	133, [r] 134	134	135	135	135
1905	[n] 165, [o] 166, [p] 167	[p] 167, 168	169	170	171	172	[k] 169, 173	174	175, [s] 177	176, [r] 177	177	178	178	[t] 177, 178
1906	[n] 201, [o] 202, [p] 203	[p] 203, 204	205	206	207	208	[k] 205, 209	210	211	212, [r] 213	213	214	214	214
1907–8	241	242	243	244	245	246	247	248	249	250, [r] 251	251	252	252	252
1909	261	262	263	264	265	266	267	268	269	270, [r] 271	271	272	272	272
1910	281	282	283	284	285	286	287	288	289	290	291	292	292	292
1911	301	302	303	304	305	306	307	308	309	310	311	312	312	312
1912	321	322	323	324	325	326	327	328	329	330	331	332A	332B	332C
1913	351	352	353	354	355	356	357	358	359	360	361	362A	362B	362C
1914	381	382	383	384	385	386	387	388	389	390	391	392	393	394
1915	401	402	403	404	405	406	407	408	409	410	411	412	413	414
1916	431	432	433	434	435	436	437	438	439	440	441	442	443	444
1917	451	452	453	454	455	456	457	458	459	460	461	462	463	464

[a] Rating tables and index to Water-Supply Papers 35-39 contained in Water-Supply Paper 39. Tables for monthly discharge for 1899 in Twenty-first Annual Report, Part IV.
[b] James River only.
[c] Gallatin River.
[d] Green and Gunnison rivers and Grand River above junction with Gunnison.
[e] Mohave River only.
[f] Kings and Kern rivers and south Pacific coast basins.
[g] Rating tables and index to Water-Supply Papers 47–52 and data on precipitation, wells, and irrigation in California and Utah contained in Water-Supply Paper 52. Tables for monthly discharge for 1900 in Twenty-second Annual Report, Part IV.
[h] Wissahickon and Schuylkill rivers to James River.
[i] Scioto River.
[j] Loup and Platte rivers near Columbus, Nebr., and all tributaries below junction with Platte.
[k] Tributaries of Mississippi from east.
[l] Lake Ontario and tributaries to St. Lawrence River proper.
[m] Hudson Bay only.
[n] New England rivers only.
[o] Hudson River to Delaware River, inclusive.
[p] Susquehanna River to Yadkin River, inclusive.
[q] Platte and Kansas rivers.
[r] Great Basin in California, except Truckee and Carson river basins.
[s] Below junction with Gila.
[t] Rogue, Umpqua, and Siletz rivers only.

PART VIII. WESTERN GULF OF MEXICO DRAINAGE BASINS.

PRINCIPAL STREAMS.

The western Gulf of Mexico drainage basins include all streams draining into the Gulf of Mexico west of the mouth of the Mississippi and into the Rio Grande. The largest streams flowing into the Gulf of Mexico north of the mouth of the Rio Grande are Sabine, Trinity, and Brazos rivers, Colorado River of Texas, and Guadalupe River. The principal tributaries of the Rio Grande are Chama River, Rio Puerco, and Pecos River in the United States and Rio Salado and Rio San Juan in Mexico. The streams drain wholly or in part the States of Colorado, Louisiana, New Mexico, Texas, and northern States of Mexico.

In addition to the list of gaging stations and annotated list of publications relating specifically to the section, these pages contain a similar list of reports that are of general interest in many sections and cover a wide range of hydrologic subjects, and also brief references to reports published by State and other organizations. (See p. xviii.)

GAGING STATIONS.

NOTE.—Dash after a date indicates that station was being maintained September 30, 1917; period after a date indicates discontinuance. Tributaries are indicated by indention.

SABINE RIVER BASIN.

Sabine River near Longview, Tex., 1904–1906.
Sabine River at Loganport, La., 1903–1906.
  Neches River at Evadale, Tex., 1904–1906.

TRINITY RIVER BASIN.

West fork of Trinity River at Bridgeport, Tex., 1915–
Trinity River at Dallas, Tex., 1898–99; 1903–1906.
Trinity River at Riverside, Tex., 1903–1906.

BRAZOS RIVER BASIN.

Brazos River near Graham, Tex., 1915–
Brazos River at Brazos, Tex., 1914–
Brazos River at Waco, Tex., 1898–1911; 1914–
Brazos River near Lewis (Hearne), Tex., 1898–99.
Brazos River at Richmond, Tex., 1903–1906.
  Clear Fork of Brazos River near Eliasville, Tex., 1915–
  Little River at Cameron, Tex., 1917–

COLORADO RIVER (OF TEXAS) BASIN.

Colorado River near Bronte, Tex., 1915–
Colorado River at Ballinger, Tex., 1915–
Colorado River near Chadwick, Tex., 1915–

Colorado River at Marble Falls, Tex., 1916–
Colorado River at Austin, Tex., 1895–1911; 1914–
Evaporation near Austin, Tex., 1916–
Colorado River at Columbus, Tex., 1903–1911; 1916–
Colorado River at Wharton, Tex., 1916–
North Concho River at San Angelo, Tex., 1915–
Concho River near San Angelo, Tex., 1915–
Concho River near Paint Rock, Tex., 1915–
Pecan Bayou at Brownwood, Tex., 1917–
San Saba River at Menard, Tex., 1915–
San Saba River near San Saba, Tex., 1905–6; 1915–
North Llano River near Junction, Tex., 1915–
Llano River near Junction, Tex., 1915–
Barton Creek at Austin, Tex., 1917–

GUADALUPE RIVER BASIN.

Guadalupe River near New Braunfels, Tex., 1898–99; 1915–
Guadalupe River near Gonzales, Tex., 1915–
Guadalupe River near Cuero, Tex., 1903–1906; 1915–16.
Guadalupe River below Cuero, Tex., 1916–
San Marcos River at San Marcos, Tex., 1915–
San Marcos River at Ottine, Tex., 1915–

SAN ANTONIO RIVER BASIN.

San Antonio River at San Antonio, Tex., 1915–
San Pedro Creek at San Antonio, Tex., 1916–

NUECES RIVER BASIN.

Nueces River near Cinonia, Tex., 1915–
Nueces River near Cotulla, Tex., 1915–
Nueces River near Three Rivers, Tex., 1915–
Nueces River at Calallen, Tex., 1915–
Frio River near Derby, Tex., 1915–
Frio River at Fowlerton, Tex., 1915–
Frio River at Three Rivers, Tex., 1915.
Frio Lake outlet near Fowlerton, Tex., 1915–

RIO GRANDE BASIN.

Rio Grande at Thirtymile Bridge near Creede, Colo., 1909–1913.
Rio Grande near Creede (Wason), Colo., 1907–1913.
Rio Grande near Del Norte, Colo., 1889–1906; 1908–1913.
Rio Grande near Alamosa, Colo., 1894–95; 1903; 1912–13.
Rio Grande near Lobatos (Cenicero), Colo., 1899–1913.
Rio Grande at Embudo, N. Mex., 1899–1903; 1912–16.
Rio Grande near Buckman, N. Mex. (Rio Grande near Ildefonso), 1895–1905; 1909–1914.
Rio Grande near San Marcial, N. Mex., 1895–
Rio Grande below Elephant Butte dam N. Mex., 1916–
Rio Grande near El Paso, Tex., 1889–1893; 1895–1915.
Rio Grande near Fort Hancock, Tex., 1900–1903.
Rio Grande above Presidio, Tex., 1900–1914.
Rio Grande below Presido, Tex., 1900–1915.
Rio Grande near Langtry, Tex., 1900–1914.
Rio Grande near Devils River, Tex., 1900–1915.

REPORTS ON WATER RESOURCES OF THE WESTERN GULF STATES.

PUBLICATIONS OF UNITED STATES GEOLOGICAL SURVEY.

WATER-SUPPLY PAPERS.

Water-supply papers are distributed free by the Geological Survey as long as its stock lasts. An asterisk (*) indicates that this stock has been exhausted. Many of the papers marked in this way may, however, be purchased (at price noted) from the SUPERINTENDENT OF DOCUMENTS, WASHINGTON, D. C. Omission of the price indicates that the report is not obtainable from Government sources. Water-supply papers are of octavo size.

*10. Irrigation in Mesilla Valley, N. Mex., by F. C. Barker. 1898. 51 pp., 11 pls. 10c.

Describes primitive methods of irrigation and agriculture employed in an area lying along both sides of the Rio Grande, extending from Fort Seldon, N. Mex., on the north, to within 3 miles of El Paso on the south. Chiefly of historic interest.

*13. Irrigation systems in Texas, by W. F. Hutson. 1898. 68 pp., 10 pls.

Discusses climate, rainfall, irrigation works and projects in Texas; considers use of both surface and underground waters.

*40. The Austin dam, by T. U. Taylor. 1900. 52 pp., 16 pls. 15c.

Describes preliminary projects, constructiou, economic aspect, and failure of the dam across Colorado River.

*57. Preliminary list of deep borings in the United States, Part I (Alabama-Montana), by N. H. Darton. 1902. 60 pp. (See No. 149.) 5c.

*61. Preliminary list of deep borings in the United States, Part II (Nebraska-Wyoming), by N. H. Darton. 1902. 67 pp. 5c.

Nos. 57 and 61 contain information as to depth, diameter, yield, and head of water in borings more than 400 feet deep; under head "Remarks" gives information concerning temperature, quality of water, purposes of boring, etc. The lists are arranged by States, and the States are arranged alphabetically. A second, revised, editiou was published in 1905 as Water-Supply Paper 149 (q. v.). 5c.

71. Irrigation systems of Texas, by T. U. Taylor. 1902. 137 pp., 9 pls. 10c.

Discusses principal irrigation systems in geographic order and gives statistics as to the location, cost, and benefits of the devices for obtaining water; describes rice irrigation systems, and appends a brief statement of laws governing irrigation in the State.

74. Water resources of the State of Colorado, by A. L. Fellows. 1902. 151 pp., 14 pls. 25c.

Discusses drainage and irrigation and gives records of stream flow.

93. Proceedings of first conference of engineers of the Reclamation Service, with accompanying papers, compiled by F. H. Newell, chief engineer. 1904, 361 pp. 25c. [Inquiries concerning this report should be addressed to the Reclamation Service.]

Contains "Investigations in Pecos Valley," by W. M. Reed.

101. Underground waters of southern Louisiana, by G. D. Harris, with discussions of their uses for water supplies and for rice irrigation, by M. L. Fuller. 1904. 98 pp., 11 pls. 20c.

Discusses the topography and stratigraphic geology of the area and the origin of the well waters, gives statistics of artesian wells, describes methods of well drilling and pumping, and treats briefly of rice cultivation.

*103. A review of the laws forbidding pollution of inland waters in the United States, by E. B. Goodell. 1904. 120 pp. [Superseded by No. 152, q. v.]

Cites statutory restrictions of water pollution.

105. The water powers of Texas, by T. U. Taylor. 1904. 116 pp., 17 pls. 15c.

Gives a résumé of the available data regarding water powers and briefly describes the principal streams.

114. Underground waters of eastern United States, by M. L. Fuller, geologist in charge. 1905. 285 pp., 18 pls. 25c.

Contains brief report on Louisiana and southern Arkansas; discusses the geologic formation as related to water supply; gives a list of the principal publications.

*122. Relation of the law to underground waters, by D. W. Johnson. 1905. 55 pp. 5c.

Cites legislative acts relating to ground waters in Colorado and New Mexico.

140. Field measurements of the rate of movement of underground waters, by C. S. Slichter. 1905. 122 pp., 15 pls. 15c.

Contains a chapter giving results of tests of typical pumping plants in the Rio Grande valley in Texas and New Mexico.

141. Observation on the ground waters of the Rio Grande valley, by C. S. Slichter. 1905. 83 pp., 5 pls. 5c.

Describes investigation of the underflow in the valley of the Rio Grande in Texas and New Mexico, gives details of tests of pumping plants near El Paso, Tex., in Mesilla Valley, N. Mex. and near Berino, N. Mex., and analyses of well waters and data concerning wells at and near El Paso.

147. Destructive floods in the United States in 1904, by E. C. Murphy and others. 1905. 206 pp., 18 pls. 15c. Contains:

Pecos River basin flood, New Mexico, from report of Frank S. Dobson.
Failures of Lake Avalon dam near Carlsbad, N. Mex., by E. C. Murphy.
Rio Grande floods, New Mexico, by E. C. Murphy.

149. Preliminary list of deep borings in the United States, second edition, with additions, by N. H. Darton. 1905. 175 pp. 10c.

Gives, by States (and within the States by counties), location, depth, diameter, yield, height of water, and other available information, concerning wells 400 feet or more in depth; includes all wells listed in Water-Supply Papers 57 to 61; mentions also principal publications relating to deep borings.

152. A review of the laws forbidding pollution of inland waters in the United States (second edition), by E. B. Goodell. 1905. 149 pp. 10c.

Cites statutory restrictions of water pollution in Colorado, Louisiana, New Mexico, and Texas.

158. Preliminary report on the geology and underground waters of the Roswell artesian area, New Mexico, by C. A. Fisher. 1906. 29 pp., 9 pls. 15c.

Discusses topography and geology of belt lying along Pecos River from Roswell to Lake McMillan; discusses area and extent of artesian basins, source, amount, pressure, quality (with analyses), and waste of artesian waters, and irrigation; lists typical wells and gives well records.

*162. Destructive floods in the United States in 1905, with a discussion of flood discharge and frequency and an index to flood literature, by E. C. Murphy and others. 1906. 105 pp., 4 pls. 15c.

Gives accounts of flood on Pecos and Hondo rivers and the Rio Grande, and estimates flood frequency and discharge for Rio Grande at San Marcial, N. Mex., and Colorado River (of Texas) at Austin; contains also index to literature on floods in American streams.

*188. Water resources of the Rio Grande valley in New Mexico, and their development, by W. T. Lee. 1907. 59 pp., 10 pls. 20c.

Describes the physical features of the valley, rock formation and structure, the Engle, San Acaci, San Felipe, and Espanola reservoir sites, surface and underground waters by districts, the origin, course, and quantity of the underflow, the chemical character of the water in the Mesilla and other districts, and the utilization of the underflow by wells and seepage ditches.

*190. Underground waters of Coastal Plain of Texas, by Thomas U. Taylor. 1907. 73 pp., 3 pls. 15c.

Describes topography, drainage, and geology, and discusses the underground waters by counties; gives many well records and analyses.

236. The quality of surface waters in the United States: Part I.—Analyses of waters east of the one hundredth meridian, by R. B. Dole. 1909. 123 pp. 10c.

Describes collection of samples, methods of examination, preparation of solutions, accuracy of estimates, and expression of analytical results; gives results of analyses of waters of Brazos and Colorado (of Texas) rivers and the Rio Grande.

*240. Geology and water resources of the San Luis Valley, Colorado, by C. E. Siebenthal. 1910. 128 pp., 13 pls. 25c.

Describes the topography, drainage, climate, geologic features, flowing and nonflowing wells, springs, the grouping of wells, and variations in flow and temperature, and the quality (with analyses) and uses of the water; discusses briefly well-drilling methods and costs, and approximate measurements of flows.

*260. Preliminary report on the ground waters of Estancia Valley, New Mexico, by O. E. Meinzer. 1910. 33 pp. 5c. (See Water-Supply Paper 275.)

Discusses briefly the geographic relation and industrial development, geology, and soils discusses the source, disposal, recovery, quality, and utilization of the ground waters, cost of pumping, windmills, value of crops, and the alkali problem.

274. Some stream waters of the western United States, with chapters on sediment carried by the Rio Grande and the industrial application of water analyses, by Herman Stabler. 1911. 188 pp. 15c.

Describes collection of samples, plan of analytical work, and methods of analysis; discusses soap-consuming power of waters, water softening, boiling waters, and water for irrigation; gives results of analyses of water of the Rio Grande and of Pecos, Gallinas, and Hondo rivers.

275. Geology and water resources of Estancia Valley, New Mexico, with notes on ground-water conditions in adjacent parts of central New Mexico, by O. E. Meinzer. 1911. 89 pp., 14 pls. 20c.

Describes physiographic features and geologic formations, soils and climate; discusses the source and disposal of the water supply, the head of the water supply, artesian conditions, yield of wells and quantity of water available, the quality of the water (dissolved solids, chlorine, sulphates, carbonates, and bicarbonates), the storage of storm water, the present and future use of ground water for irrigation, proper types of wells, windmills, cost of pumping, value of crops; and the alkali problem; tables give depths to water and field assays. Contains also briefs reports on physiography, geology, soil, ground water, and irrigation in Encino and Pinos Wells basins.

*317. Geology and underground waters of the Wichita region, north-central Texas, by C. H. Gordon. 1913. 88 pp., 2 pls. 10c.

Describes the physiography, climate, surface, and deep waters of an area in Montague, Clay Wichita, Wilbarger, Hardeman, Foard, Knox, Baylor, Archer, Jack, Young, Throckmorton, and Haskell counties; gives details by counties.

*335. Geology and underground waters of the southeastern part of the Texas Coastal Plain, by Alexander Deussen. 1914. 365 pp., 9 pls. 55c.

Describes an area lying east of Brazos River and south of a line extending east and west through Jefferson, in Marion County; discusses the underground-water horizons of the region and the artesian conditions and prospects in the several counties; gives well sections and tabulated details of the wells.

343. Geology and water resources of Tularosa Basin, New Mexico, by O. E. Meinzer and R. F. Hare. 1915. 317 pp., 19 pls. 40c.

Describes a closed basin lying between the Pecos and the Rio Grande; gives an account of the climate, history of previous investigations and literature, and industrial development; discusses the physiography and drainage, rocks, sources of the underground water, yield of wells, and quality of the waters in the various formations; suggests methods of drilling, boring, digging, casing, and finishing wells; discusses also soil and native vegetation in relation to water supply, irrigation from streams, springs, flood waters, and wells, and railroad and public water supplies; gives detailed information in regard to watering places on routes of travel.

*345. Contributions to the hydrology of the United States. 1914. N. C. Grover, chief hydraulic engineer. 1915. 225 pp., 17 pls. 30c. Contains:

(c) Underground water of Luna County, N. Mex., by N. H. Darton, with results of pumping tests, by A. T. Schwennesen, pp. 25–40.

Describes briefly the extent and thickness of the water-bearing beds underlying the wide bolsons of Luna County, the source and quality of the underground waters, the wells in the region about Deming, Iola, Waterloo, Columbus, and Myndus in the Carne region, lower Mimbres Valley, the region west of Red Mountain, and other parts of the county; discusses the depletion of supply by the pumping plants. The pumping tests were made at plants representing average types.

358. Water resources of the Rio Grande basin, 1888–1913, by Robert Follansbee and H. J. Dean, including surface water supply of the western Gulf of Mexico basins, 1913, by Robert Follansbee, W. W. Follett, and G. A. Gray. 1915. 725 pp., 3 pls. 50c.

Describes the general features of the Rio Grande basin and the closed basins lying between the Rio Grande and the Pecos, west of the Rio Grande, and in Mexico; discusses the distribution of precipitation, forestation, and population. Contains "not only all data concerning stream flow in the Rio Grande basin collected by the Survey and cooperating parties, but also records furnished by individuals connected with private interests." Most of the records have been taken from publications of the Geological Survey, but original estimates have been revised where later data have indicated errors.

364. Water analyses from the laboratory of the United States Geological Survey, tabulated by F. W. Clarke, chief chemist. 1914. 40 pp. 5c.

Contains analyses of brines from Texas, spring waters from Colorado and New Mexico, water from the Gulf of Mexico, and mine waters from Creede, Colo.

421. Profile surveys in 1915 along the Rio Grande, Pecos River, and Mora River, New Mexico, prepared under the direction of W. H. Herron, acting chief geographer. 1916. 11 pp., 11 pls. 15c.

Gives results of surveys made to determine the location of undeveloped water power on some of the rivers of the United States that are adapted to the development of power by low or medium heads at 20 to 100 feet.

422. Ground water in Animas, Playas, Hachita, and San Luis basins, N. Mex., by A. T. Schwennesen (in press).

Covers the southern part of Grant County. Describes the physiography and geology and the ground-water conditions in each basin with respect to the occurrence, depth, quantity, quality, artesian conditions, and irrigation prospects. Gives well data, analyses of water, and analyses of the water soluble contents of the soil. Contains a map of the area showing depths to the water table and other features.

425. Contributions to the hydrology of the United States, 1917; N. C. Grover, chief hydraulic engineer. 1918.

Issued also in separate chapters. The following papers relate to ground water:

(a) Ground water in San Simon Valley, Ariz., by A. T. Schwennesen, with a chapter on agriculture by R. H. Forbes (pp. 1–35, Pls. I–III). Describes the physiography and geology of the valley, the upper water horizen, and the deeper artesian horizon of the San Simon and Bowie areas, the ground water in the Rodeo and Artesia valleys, and the irrigation supplies from flowing and nonflowing wells; contains 39 analyses of well and spring waters, numerous records of deep wells and maps showing areas of artesian flow, depth to water table, and lands irrigated with well water; also includes a chapter by R. H. Forbes on soil, vegetation, and agricultural prospects.

ANNUAL REPORTS.

Each of the papers contained in the annual reports was also issued in separate form.

Annual reports are distributed free by the Geological Survey as long as its stock lasts. An asterisk (*) indicates that this stock has been exhausted. Many of the papers so marked, however, may be purchased from the SUPERINTENDENT OF DOCUMENTS, WASHINGTON, D. C.

*Tenth Annual Report of the United States Geological Survey, 188–89, J. W. Powell, Director. 1890. 2 parts. *Pt. II, Irrigation, viii, 123 pp. 35c.

Makes a preliminary report on the organization and prosecution of the survey of the arid lands for purpose of irrigation; includes an account of the methods of topographic and hydraulic work, the segregation work on reservoir sites and irrigable lands, field and office methods, and brief descriptions of the topography of some of the river basins.

Eleventh Annual Report of the United States Geological Survey, 1889–90, J. W. Powell, Director. 1891. 2 parts. Pt. II, Irrigation, xiv, 395 pp., 30 pls. and maps. $1.25. Contains:

*Hydrography, pp. 1–110. Discusses scope of work, methods of stream measurement, rainfall and evaporation, and describes the more important streams; sediment in the Rio Grande, pp. 55–57.

*Engineering, pp. 111–200. Defines the scope of the work and gives an account of the surveys in the Sun River basin and in the Arkansas, Rio Grande, California, Lahontan, Utah, and Snake River divisions.

*The arid lands, pp. 201–289. Includes statement of the Director to the House Committee on Irrigation, extracts from the constitutions of States relating to irrigation, and a report on artesian irrigation on the Great Plains, including a discussion of the general considerations affecting artesian water supply, the economic limit to the utilization of artesian water for irrigation, irrigation by artesian wells in various countries, and the geologic conditions and statistics of artesian wells on the Great Plains.

*Topography, pp. 291–343. Comprises reports of the topographic surveys in California, Nevada, Colorado, Idaho, Montana, and New Mexico, and a brief report on reservoir sites.

*Irrigation literature, pp. 345–388. Gives a list of books and pamphlets on irrigation and allied subjects, mainly contained in the library of the United States Geological Survey.

Twelfth Annual Report of the United States Geological Survey, 1890–91, J. W. Powell, Director. 1891. 2 parts. Pt. II, Irrigation, xviii, 576 pp., 93 pls. $2. Contains:

*Report upon the location and survey of reservoir sites during the fiscal year ending June 30, 30, 1891, by A. H. Thompson, pp. 1–212, pls. 54–57. Describes reservoir sites in Rio Arriba, Taos, Santa Fe, Bernalillo, Mora, San Miguel, Valencia, Socorro, and Sierra counties, New Mexico, and on tributaries of the Rio Grande; for each reservoir site gives the location, height of dam, areas inclosed by contour, approximate contents of reservoir, position of irrigable lands, and areas of segregated lands.

*Hydrography of the arid regions, by F. H. Newell, pp. 213–361, pls. 58–106. Discusses the available water supply of the arid regions, the duty of water, flood waters, relation of rainfall to the river flow; classifies the drainage basins; and describes the rivers of the Missouri, Arkansas, Rio Grande, Colorado, Sacramento, and San Joaquin basins, and the principal streams of the Great Basin in Nevada and Utah and the Snake River drainage.

Thirteenth Annual Report of the United States Geological Survey, 1891–92, J. W. Powell, Director. 1892. (Pts. II and III, 1893.) 3 parts. *Pt. III, Irrigation, xi, 486 pp., 77 pls. $1.85. Contains:

*Engineering results of irrigation survey, by H. N. Wilson, pp. 351–437, pls. 147–182. Discusses surveys, flood-water storage, dam site, estimated cost of El Paso reservoir, Texas.

Sixteenth Annual Report of the United States Geological Survey, 1894–95, Charles D. Walcott, Director. 1896. (Pts. II, III, and IV, 1895.) 4 parts. *Pt. II. Papers of an economic character, xix, 598 pp., 43 pls. $1.25. Contains:

The public lands and their water supply, by F. H. Newell, pp. 457–533, pls. 35–39. Describes general character of the public lands, the lands disposed of (railroad, grant and swamp lands, and private miscellaneous entries), lands reserved (Indian, forest, and military reservations), the vacant lands, and the rate of disposal of vacant lands; discusses the streams, wells, and reservoirs as sources of water supply; gives details for each State.

Eighteenth Annual Report of the United States Geological Survey, 1896–97, Charles D. Walcott, Director. 1897. (Pts. II and III, 1898.) 5 parts in 6 vols. Pt. II. *Papers chiefly of a theoretic nature, v, 653 pp., 105 pls. $1.65. Contains:

*Geology of portions of the Edwards Plateau and Rio Grande Plain adjacent to Austin and San Antonio, Tex., with especial reference to the occurence of artesian and other underground waters, by R. T. Hill and T. W. Vaughan, pp. 193–322, pls. 21–64. Discusses the general principles of artesian waters, the capacity of the various rock sheets for water, the nonflowing wells, the gravity springs, and artesian wells of the Edwards Plateau and Rio Grande Plain; the probable identity of source of artesian and fissure spring waters, and the availability and limitations of underground waters; treats of the chemical quality of the artesian-well waters, and gives analyses of waters from the various beds and of spring waters from Austin and vicinity.

Twenty-first Annual Report of the United States Geological Survey, 1899–1900, Charles D. Walcott, Director. 1900. (Parts III, IV, VI, VI continued, and VII, 1901.) 7 parts in 8 vols., and separate case for maps with Pt. V. *Pt. IV, Hydrography, 768 pp., 156 pls. $2.35. Contains:

*The High Plains and their utilization, by W. D. Johnson, pp. 601–741, pls. 113–146. Describes the area lying in an irregular belt about midway across the long eastward slope of the Great Plains and including parts of Wyoming, Colorado, and Nebraska (North and South Platte) Platte, Republican, and Smoky Hill River basins), Colorado, Kansas, New Mexico, Oklahoma and Texas (Arkansas River basin), and Colorado, New Mexico, and Texas (Rio Grande basin); discusses the origin and structure of the High Plains, the precipitation, temperature, and other factors of climate, experiments with irrigation, and the use of mountain streams, local storm, water storage, and artesian waters. Concluded in the Twenty-second Annual Report.

*Part VII. Geography and geology of the Black and Grand prairies, Tex., with detailes descriptions of the Cretaceous formations and special reference to artesian waters, by R. T. Hill. 1901. 666 pp., 71 pls. $1.90.

Gives a general description of the geography of a region including Texas, Oklahoma, and New Mexico east of the Rio Grande, and describes in more detail the geography and geology of the Black and Grand prairies. Discusses the principles governing artesian and other ground waters, the artesian systems of Texas, and the quality of the waters of these systems. Describes the artesian conditions by counties and gives analyses. Includes maps showing the geology, the locations of artesian wells, and the outcrop of, depths to, and areas of artesian flow from the Trinity, Paluxy, and Woodbine formations.

Twenty-second Annual Report of the United States Geological Survey, 1900–1901, Charles D. Walcott, Director. 1901. (Pts. III and IV, 1902.) 4 parts. *Pt. IV, Hydrography, 631–669 pp., pls. 51–65. $2.20. Contains:

*Conclusion of The High Plains and their utilization.

BULLETINS.

An asterisk (*) indicates that the Geological Survey's stock of the paper is exhausted. Many of the papers so marked may be purchased from the SUPERINTENDENT OF DOCUMENTS, WASHINGTON, D. C. Bulletins are of octavo size.

*264. Records of deep-well drilling for 1904, by M. L. Fuller, E. F. Lines, and A. C. Veatch. 1905. 106 pp. 10c.

Discusses the importance of accurate well records to the driller, to owners of oil, gas, and water wells, and to geologists; describes the general methods of work; gives tabulated records of wells in Colorado, Louisiana, New Mexico, and Texas, and detailed record of well near Houston, Harris County, Tex. This well was selected because it affords definite stratigraphic information.

*298. Record of deep-well drilling for 1905, by M. L. Fuller and Samuel Sanford. 1906. 209 pp. 25c.

Gives an account of progress in the collection of well records and samples; contains tabulated records of wells in Colorado, Louisiana, New Mexico, and Texas; and detailed records of wells in Eddy and Torrance counties, New Mexico; and Bexar, Cameron, Coleman, Dallas, Dimmit, Duval, Fayette, Fort Bend, Guadalupe, Hardin, Harris, Hays, Jasper, Johnson, Kendall, Lampasas, Liberty, Medina, Navarro, Nueces, Parker, Williamson, and Zavalla counties, Tex. The wells of which detailed sections are given were selected because they afford valuable stratigraphic information.

618. Geology and underground water of Luna County, N. Mex., by N. H. Darton. 1916. 188 pp., 13 pls.

Describes the geography and geology, the mineral resources, the water supplies from streams, springs, and wells, and the irrigation development from surface and ground waters. Discusses the source, quantity, and quality of the ground waters and the extent of the water-bearing strata and gives well data by townships. Includes maps showing the geology, the contours of the water table, and the depths to ground water.

GEOLOGIC FOLIOS.

Under the plan adopted for the preparation of a geologic map of the United States the entire area is divided into small quadrangles, bounded by certain meridians and parallels, and these quadrangles, which number several thousand, are separately surveyed and mapped.[1] The unit of survey is also the unit of publication, and the maps and descriptions of each quadrangle are issued in the form of a folio. When all the folios are completed they will constitute the Geologic Atlas of the United States.

A folio is designated by the name of the principal town or of a prominent natural feature within the quadrangle. Each folio includes maps showing the topography, geology, underground structure, and mineral deposits of the area mapped and several pages of descriptive text. The text explains the maps and describes the topographic and geological features of the country and its mineral products. The topographic map shows roads, railroads, waterways, and, by contour lines, the shapes of the hills and valleys and the height above sea levels of all points in the quadrangle. The areal-geology map shows the distribution of the various rocks at the surface. The structural-geology map shows the relations of the rocks to one another underground. The economic-geology map indicates the location of mineral deposits that are commercially valuable. The artesian-water map shows the depth to underground-water horizons. Economic-geology and artesian-water maps are included in folios if the conditions in the area mapped warrant their publication. The folios are of special interest to students of geography and geology and are valuable as guides in the development and utilization of mineral resources.

The folios numbered from 1 to 163, inclusive, are published in only one form (18 by 22 inches), called the library edition. Some of the folios that bear numbers higher than 163 are published also in an octavo edition (6 by 9 inches). Owing to a fire in the Geological Survey building May 18, 1913, the stock of geological folios was more or less damaged by fire and water, but 80 or 90 per cent of the folios are usable. They will be sold at the uniform price of 5 cents each, with no reduction for wholesale orders. This rate applies to folios in stock from 1 to 184, inclusive, also to the library edition of folio 186. The library edition of folios 185, 187, and higher numbers sells for 25 cents a copy, except that some folios which contain an unusually large amount of matter sell for 50 cents a copy. The octavo edition of folio 185 and higher numbers sells for 50 cents a copy. If 34 folios selling at 25 cents each (or their equivalent in higher-priced folios) are ordered at one time a discount of 40 per cent is allowed; $5.10 is the minimum amount accepted at this rate.

All the folios contain descriptions of the drainage of the quadrangles. The folios in the following list contain also brief discussions of the underground waters in connection with the economic resources of the areas and more or less information concerning the utilization of the water resources.

An asterisk (*) indicates that the stock of the folio is exhausted.

[1] Index maps showing areas in the western Gulf of Mexico basins covered by topographic maps and by geologic folios will be mailed on receipt of request addressed to the Director, U. S. Geological Survey, Washington, D. C.

42. Nueces, Texas. 5c.
Describes geography and geology and relations of geological formations to underground waters.

*64. Uvalde, Texas.
Describes the topography and geology of the area, the streams, springs, and wells, and discusses the possibility of obtaining artesian flows.

*76. Austin, Texas.
Describes the topography and geology of the area, the drainage, and discusses the possibility of obtaining artesian water.

*120. Silverton, Colorado.

*166. El Paso,[1] Texas.
Gives analyses of underground waters.

183. Llano-Burnet,[1] Texas. 5c.
Under "Mineral Resources" discusses rainfall, streams, springs, wells, tanks, and cisterns.

194. Van Horn, Texas. 25c.
Gives analyses of water from railroad wells at Van Horn and well at Figure 2 ranch headquarters.

199. Silver City, New Mexico. 25c.

207. Deming, New Mexico. 25c.

MISCELLANEOUS REPORTS.

Other Federal bureaus, State, and other organizations, have from time to time published reports relating to the water resources of various sections of the country. Notable among those pertaining to the western Gulf of Mexico drainage basins are the reports of the State geological surveys of Louisiana and Texas, the reports of the State engineers of Colorado and New Mexico, and the annual reports of the United States Reclamation Service. The following deserve special mention.

Report of commission appointed to revise the laws of the State of Colorado regulating the appropriation, distribution, and use of water. 1890.

Preliminary examination of reservoir sites in Wyoming and Colorado; letter from the Secretary of War transmitting a letter from the Chief of Engineers, together with a report of Capt. Chittenden: 55th Cong., 2d sess., House Doc. 141.

Report on the underground waters of Louisiana, by G. D. Harris, A. C. Veatch, and others, made under the direction of the State experiment stations. Louisiana Geol. Survey Bull. 1, 1905.

Preliminary report on the soils and waters of the upper Rio Grande and Pecos valleys in Texas, by H. H. Harrington: Texas Geol. Survey Bull. 2, 1890.

Water supply of southwest Texas, compiled by H. M. Madison. 1912.

Artesian water on the Llano Estacado, by G. G. Shumard: Texas Geol. Survey Bull. 1, 1892.

Preliminary reports on the artesian wells of the Gulf coastal slope, by J. A. Singley, and on the organic remains from the deep well at Galveston, by Gilbert D. Harris: Texas Geol. Survey Fourth Ann. Rept., 1892.

A study of the use of water for irrigation on the Rio Grande del Norte, by W. W. Follett: International (Water) Boundary Comm. Proc., pp. 284–323, 1903.

Silt in the Rio Grande, by W. W. Follett: International Boundary Comm. Proc., 1913.

Silt survey on Pecos River: U. S. Recl. Service Third Ann. Rept., 1905.

[1] Issued in two editions. Specify edition desired.

GEOLOGICAL SURVEY HYDROLOGIC REPORTS OF GENERAL INTEREST.

The following list comprises reports not readily classifiable by drainage basins and covering a wide range of hydrologic investigations:

WATER-SUPPLY PAPERS.

*1. Pumping water for irrigation, by H. M. Wilson. 1896. 57 pp., 9 pls.

Described pumps and motive powers, windmills, water wheels, and various kinds of engines; also storage reservoirs to retain pumped water until needed for irrigation.

*3. Sewage irrigation, by G. W. Rafter. 1897. 100 pp., 4 pls. (See Water-Supply Paper 22.) 10c.

Discusses methods of sewage disposal by intermittent filtration and by irrigation; describes utilization of sewage in Germany, England, and France, and sewage purification in the United States.

*8. Windmills for irrigation, by E. C. Murphy. 1897. 49 pp., 8 pls. 10c.

Gives results of experimental tests of windmills during the summer of 1896 in the vicinity of Garden, Kans.; describes instruments and methods and draws conclusions.

*14. New tests of certain pumps and water lifts used in irrigation, by O. P. Hood. 1898. 91 pp., 1 pl.

Discusses efficiency of pumps and water lifts of various types.

*20. Experiments with windmills, by T. O. Perry. 1899. 97 pp., 12 pls. 15c.

Includes tables and descriptions of wind wheels, compares wheels of several types, and discusses results.

*22. Sewage irrigation, Part II, by G. W. Rafter. 1899. 100 pp., 7 pls. 15c.

Gives résumé of Water-Supply Paper 3; discusses pollution of certain streams, experiments on purification of factory wastes in Massachusetts, value of commercial fertilizers, and describes American sewage-disposal plants by States; contains bibliography of publications relating to sewage utilization and disposal.

*41. The windmill; its efficiency and economic use, Part I, by E. C. Murphy. 1901 72 pp., 14 pls. 5c.

*42. The windmill; its efficiency and economic use, Part II, by E. C. Murphy. 1901. 75 pp. (73–147), 2 pls. (15–16). 10c.

Nos. 41 and 42 give details of results of experimental tests with windmills of various types.

*43. Conveyance of water in irrigation canals, flumes, and pipes, by Samuel Fortier. 1901. 86 pp., 15 pls. 15c.

*56. Methods of stream measurement. 1901. 51 pp., 12 pls. 15c.

Describes the methods used by the Survey in 1901–2. (See also Nos. 64, 94, and 95.)

*64. Accuracy of stream measurements, by E. C. Murphy. 1902. 99 pp., 4 pls. (See No. 95.) 10c.

Describes methods of measuring velocity of water and of measuring and computing stream flow, and compares results obtained with the different instruments and methods; describes also experiments and results at the Cornell University hydraulic laboratory. A second, enlarged, edition published as Water-Supply Paper 95.

*67. The motions of underground waters, by C. S. Slichter. 1902. 106 pp., 8 pls. 15c.

Discuss origin, depth, and amount of ground waters; permeability of rocks and porosity of soils; causes, rates, and laws of motions of ground water; surface and deep zones of flow, and recovery of waters by open wells and artesian and deep wells; treats of the shape and position of the water table; gives simple methods of measuring yield of flowing wells; describes artesian wells at Savannah, Ga.

72. Sewage pollution in the metropolitan area near New York City and its effect on inland water resources, by M. O. Leighton. 1902. 75 pp., 8 pls. 10c.

Defines "normal" and "polluted" waters and discusses the damage resulting from pollution.

*80. The relation of rainfall to run-off, by G. W. Rafter. 1903. 104 pp. 10c.

Treats of measurements of rainfall and laws and measurements of stream flow; gives formulas for rainfall, run-off, and evaporation; discusses effects of forests on rainfall and run-off.

87. Irrigation in India (second edition), by H. M. Wilson. 1903. 238 pp., 27 pls. 25c.

First edition was published in Part II of the Twelfth Annual Report.

93. Proceedings of first conference of engineers of the Reclamation Service, with accompanying papers, compiled by F. H. Newell, Chief Engineer. 1904. 361 pp. 25c. [Requests for this report should be addressed to the U. S. Reclamation Service.]

Contains the following papers of more or less general interest:
Limits of an irrigation project, by D. W. Ross.
Relation of Federal and State laws to irrigation, by Morris Bien.
Electrical transmission of power for pumping, by H. A. Storrs.
Correct design and stability of high masonry dams, by Geo. Y. Wisner.
Irrigation surveys and the use of the plane table, by J. B. Lippincott.
The use of alkaline waters for irrigation, by Thomas H. Means.

*94. Hydrographic manual of the United States Geological Survey, prepared by E. C. Murphy, J. C. Hoyt, and G. B. Hollister. 1904. 76 pp., 3 pls. 10c.

Gives instruction for field and office work relating to measurements of stream flow by current meters. (See also No. 95.)

*95. Accuracy of stream measurements (second, enlarged edition), by E. C. Murphy. 1904. 169 pp., 6 pls.

Describes methods of measuring and computing stream flow and compares results derived from different instruments and methods. (See also No. 94.)

*103. A review of the laws forbidding pollution of inland waters in the United States by E. B. Goodell. 1904. 120 pp. (See No. 152.)

Explains the legal principles under which antipollution statutes become operative, quotes court decisions to show authority for various deductions, and classifies according to scope the statutes enacted in the different States.

110. Contributions to the hydrology of eastern United States, 1904; M. L. Fuller, geologist in charge. 1905. 211 pp., 5 pls. 10c.

Contains the following reports of general interest. The scope of each paper is indicated by its title.

Description of underflow meter used in measuring the velocity and direction of underground water, by Charles S. Slichter.

The California or "stovepipe" method of well construction, by Charles S. Slichter.

Approximate methods of measuring the yield of flowing wells, by Charles S. Slichter.

Corrections necessary in accurate determinations of flow from vertical well casings, from notes furnished by A. N. Talbot.

113. The disposal of strawboard and oil-well wastes, by R. L. Sackett and Isaiah Bowman. 1905. 52 pp., 4 pls. 5c.

The first paper discusses the pollution of streams by sewage and by trade wastes, describes the manufacture of strawboard, and gives results of various experiments in disposing of the waste. The second paper describes briefly the topography, drainage, and geology of the region about Marion, Ind., and the contamination of rock wells and of streams by waste oil and brine.

*114. Underground waters of eastern United States; M. L. Fuller, geologist in charge. 1905. 285 pp., 18 pls. 25c.

Contains reports on "Occurrence of underground waters," by M. L. Fuller, discussing sources, amount, and temperature of waters, permeability and storage capacity of rocks, water-bearing formations, recovery of water by springs, wells, and pumps, essential conditions of artesian flows, and general conditions affecting ground waters in eastern United States.

119. Index to the hydrographic progress reports of the United States Geological Survey, 1888 to 1903, by J. C. Hoyt and B. D. Wood. 1905. 253 pp. 15c.

120. Bibliographic review and index of papers relating to underground waters published by the United States Geological Survey, 1879–1904, by M. L. Fuller. 1905. 128 pp. 10c.

*122. Relation of the law to underground waters, by D. W. Johnson. 1905. 55 pp. 5c.

Defines and classifies underground waters, gives common-law rules relating to their use, and cites State legislative acts affecting them.

140. Field measurements of the rate of movement of underground waters, by C. S. Slichter. 1905. 122 pp., 15 pls. 15c.

Discusses the capacity of sand to transmit water, describes measurements of underflow in Rio Hondo, San Gabriel, and Mohave River valleys, Cal., and on Long Island, N. Y., gives results of tests of wells and pumping plants, and describes stovepipe method of well construction.

143. Experiments on steel-concrete pipes on a working scale, by J. H. Quinton. 1905. 61 pp., 4 pls. 5c.

Scope indicated by title.

145. Contributions to the hydrology of eastern United States, 1905; M. L. Fuller, geologist in charge. 1905. 220 pp., 6 pls. 10c.

Contains brief reports of general interest as follows:

Drainage of ponds into drilled wells, by Robert E. Horton. Discusses efficiency, cost, and capacity of drainage wells, and gives statistics of such wells in southern Michigan.

Construction of so-called fountain and geyser springs, by Myron L. Fuller.

A convenient gage for determining low artesian heads, by Myron L. Fuller.

146. Proceedings of second conference of engineers of the Reclamation Service, with accompanying papers, compiled by F. H. Newell, chief engineer. 1905. 267 pp. 15c. [Inquiries concerning this report should be addressed to the U. S. Reclamation Service.]

Contains brief account of the organization of the hydrographic [water resources] branch and the Reclamation Service, reports of conferences and committees, circulars of instruction, and many brief reports on subjects closely related to reclamation, and a bibliography of technical papers by members of the service. Of the papers read at the conference those listed below (scope indicated by title) are of more or less general interest:

Proposed State code of water laws, by Morris Bien.
Power engineering applied to irrigation problems, by O. H. Ensign.
Estimates on tunneling in irrigation projects, by A. L. Fellows.
Collection of stream-gaging data, by N. C. Grover.
Diamond-drill methods, by G. A. Hammond.
Mean-velocity and area curves, by F. W. Hanna.
Importance of general hydrographic data concerning basins of streams gaged by R. E. Horton.
Effect of aquatic vegetation on stream flow, by R. E. Horton.
Sanitary regulations governing construction camps, by M. O. Leighton.
Necessity of draining irrigated lands, by Thos. H. Means.
Alkali soils, by Thos. H. Means.
Cost of stream-gaging work, by E. C. Murphy.
Equipment of a cable gaging station, by E. C. Murphy.
Silting of reservoirs, by W. M. Reed.
Farm-unit classification, by D. W. Ross.
Cost of power for pumping irrigating water, by H. A. Storrs.
Records of flow at current-meter gaging stations during the frozen season, by F. H. Tillinghast.

147. Destructive floods in the United States in 1904, by E. C. Murphy and others. 1905. 206 pp., 18 pls. 15c.

Contains a brief account of "A method of computing cross-section area of waterways," including formulas for maximum discharge and area of cross-section.

*150. Weir experiments, coefficients, and formulas, by R. E. Horton. 1906. 189 pp., 38 pls. (See Water-Supply Paper 200.) 15c.

Scope indicated by title.

151. Field assay of water, by M. O. Leighton. 1905. 77 pp., 4 pls.

Discusses methods, instruments, and reagents used in determining turbidity, color, iron, chlorides, and hardness in connection with the studies of the quality of water in various parts of the United States.

*152. A review of the laws forbidding pollution of inland waters in the United States, second edition, by E. B. Goodell. 1905. 149 pp. 10c.

Scope indicated by title.

*155. Fluctuations of the water level in wells, with special reference to Long Island, N. Y., by A. C. Veatch. 1906. 83 pp., 9 pls. 25c.

Includes general discussion of fluctuations due to rainfall and evaporation, barometric changes, temperature changes, changes in rivers, changes in lake level, tidal changes, effects of settlement, irrigation, dams, underground-water developments, and to indeterminate causes.

*160. Underground water papers. 1906; M. L. Fuller, geologist in charge. 1906. 104 pp., 1 pl.

Gives account of work in 1905; lists publications relating to underground waters, and contains the following brief reports of general interest:

Significance of the term "artesian," by Myron L. Fuller.
Representation of wells and springs on maps, by Myron L. Fuller.
Total amount of free water in the earth's crust, by Myron L. Fuller.
Use of fluorescein in the study of underground waters, by R. B. Dole.
Problems of water contamination, by Isaiah Bowman.
Instances of improvement of water in wells, by Myron L. Fuller.

*162. Destructive floods in the United States in 1905, with a discussion of flood discharge and frequency and an index to flood literature, by E. C. Murphy and others. 1906. 105 pp., 4 pls. 15c.

*163. Bibliographic review and index of underground-water literature published in the United States in 1905, by M. L. Fuller, F. G. Clapp, and B. L. Johnson. 1906. 130 pp. 15c.

Scope indicated by title.

*179. Prevention of stream pollution by distillery refuse, based on investigations at Lynchburg, Ohio, by Herman Stabler. 1906. 34 pp., 1 pl. 10c.

Describes grain distillation, treatment of slop, sources, character, and effects of effluents on streams; discusses filtration, precipitation, fermentation, and evaporation methods of disposal of wastes without pollution.

*180. Turbine water-wheel tests and power tables, by R. E. Horton. 1906. 134 pp., 2 pls. 20c.

Scope indicated by title.

*185. Investigations on the purification of Boston sewage, * * * with a history of the sewage-disposal problem, by C. E. A. Winslow and E. B. Phelps. 1906. 163 pp. 25c.

Discusses composition, disposal, purification, and treatment of sewages and tendencies in sewage-disposal practice in England, Germany, and the United States; describes character of crude sewage at Boston, removal of suspended matter, treatment in septic tanks, and purification by intermittent sand filtration and in beds of coarse material; gives bibliography.

*186. Stream pollution by acid-iron wastes, a report based on investigations made at Shelby, Ohio, by Herman Stabler. 1906. 36 pp., 1 pl.

Gives history of pollution by acid-iron wastes at Shelby, Ohio, and of resulting litigation; discusses effect of acid-iron liquors of sewage-purification processes, recovery of copperas from acid-iron wastes, and other processes for removal of pickling liquor.

*187. Determination of stream flow during the frozen season, by H. K. Barrows and R. E. Horton. 1907. 93 pp., 1 pl. 15c.

Scope indicated by title.

*189. The prevention of stream pollution by strawboard waste, by E. B. Phelps. 1906. 29 pp., 2 pls.

Describes manufacture of strawboard, present and proposed methods of disposal of waste liquors, laboratory investigations of precipitation and sedimentation, and field studies of amount and character of water used, raw material and finished product, and mechanical filtration.

*194. Pollution of Illinois and Mississippi rivers by Chicago sewage (a digest of the testimony taken in the case of the State of Missouri *v.* the State of Illinois and the Sanitary District of Chicago), by M. O. Leighton. 1907. 369 pp., 2 pls.

Scope indicated by amplification of title.

*200. Wier experiments, coefficients, and formulas (revision of paper No. 150), by R. E. Horton. 1907. 195 pp., 38 pls. 35c.

Scope indicated by title.

*226. The pollution of streams by sulphite-pulp waste, a study of possible remedies, by E. B. Phelps. 1909. 37 pp., 1 pl. 10c.

Describes manufacture of sulphite pulp, the waste liquors, and the experimental work leading to suggestions as to methods of preventing stream pollution.

*229. The disinfection of sewage and sewage filter effluents, with a chapter on the putrescibility and stability of sewage effluents, by E. B. Phelps. 1909. 91 pp., 1 pl. 15c.

Scope indicated by title.

*234. Papers on the conservation of water resources. 1909. 96 pp., 2 pls. 15c.

Contains the following papers, whose scope is indicated by their titles: Distribution of rainfall by Henry Gannett; Floods, by M. O. Leighton; Developed water powers, compiled under the direction of W. M. Steuart, with discussion by M. O. Leighton; Undeveloped water powers, by M. O. Leighton; Irrigation, by F. H. Newell; Underground waters, by W. C. Mendenhall; Denudation, by R. B. Dole and Herman Stabler; Control of catchment areas, by H. N. Parker.

*235. The purification of some textile and other factory wastes, by Herman Stabler and G. H. Pratt. 1909. 76 pp. 10c.

Discusses waste waters from wool scouring, bleaching and dyeing cotton yarn, bleaching cotton piece goods, and manufacture of oleomargarine, fertilizer, and glue.

236. The quality of surface waters in the United States, Part I, Analyses of waters east of the one hundredth meridian, by R. B. Dole. 1909. 123 pp. 10c.

Describes collection of samples, methods of examination, preparation of solutions, accuracy of estimates, and expression of analytical results.

238. The public utility of water powers and their governmental regulation, by René Tavernier and M. O. Leighton. 1910. 161 pp. 15c.

Discusses hydraulic power and irrigation, French, Italian, and Swiss legislation relative to the development of water powers, and laws proposed in the French Parliament; reviews work of bureaus of hydraulics and agricultural improvements of the French department of agriculture, and gives résumé of Federal and State water-power legislation in the United States.

*255. Underground waters for farm use, by M. L. Fuller. 1910. 58 pp., 17 pls. 15c.

Discusses rocks as sources of water supply and the relative safety of supplies from different materials; springs and their protection; open or dug and deep wells, their location, yield, relative cost, protection, and safety; advantages and disadvantages of cisterns and combination wells and cisterns.

*257. Well-drilling methods, by Isaiah Bowman. 1911. 139 pp., 4 pls. 15c.

Discusses amount, distribution, and disposal of rainfall, water-bearing rocks, amount of ground water, artesian conditions, and oil and gas bearing formations; gives history of well drilling in Asia, Europe, and the United States; describes in detail the various methods and the machinery used; discusses loss of tools and geologic difficulties; contamination of well waters and methods of prevention; tests of capacity and measurement of depth; and costs of sinking wells.

*258. Underground-water papers, 1910, by M. L. Fuller, F. G. Clapp, G. C. Matson, Samuel Sanford, and H. C. Wolff. 1911. 123 pp., 2 pls. 15c.

Contains the following papers (scope indicated by titles) of general interest:
Drainage by wells, by M. L. Fuller.
Freezing of wells and related phenomena, by M. L. Fuller.
Pollution of underground waters in limestone, by G. C. Matson.
Protection of shallow wells in sandy deposits, by M. L. Fuller.
Magnetic wells, by M. L. Fuller.

274. Some stream waters of the western United States, with chapters on sediment carried by the Rio Grande and the industrial application of water analyses, by Herman Stabler. 1911. 188 pp. 15c.

Describes collection of samples, plan of analytical work, and methods of analyses; discusses soap-consuming power of waters, water softening, boiler waters, and water for irrigation.

*315. The purification of public water supplies, by G. A. Johnson. 1913. 84 pp., 8 pls. 10c.

Discusses ground, lake, and river waters as public supplies, development of waterworks systems in the United States, water consumption, and typhoid fever; describes methods of filtration and sterilization of water, and municipal water softening.

334. The Ohio Valley flood of March-April, 1913 (including comparisons with some earlier floods), by A. H. Horton and H. J. Jackson. 1913. 96 pp., 22 pls. 20c.

Although relating specifically to floods in the Ohio Valley, this report discusses also the causes of floods and the prevention of damage by floods.

337. The effects of ice on stream flow, by William Glenn Hoyt. 1913. 77 pp., 7 pls. 15c.

Discusses methods of measuring the winter flow of streams.

*345. Contributions to the hydrology of the United States, 1914. N. C. Grover, chief hydraulic engineer. 1915. 225 pp., 17 pls. 30c. Contains:

(e) A method of determining the daily discharge of rivers of variable slope, by M. R. Hall, W. E. Hall, and C. H. Pierce, pp. 53–65.

364. Water analyses from the laboratory of the United States Geological Survey, tabulated by F. W. Clarke, chief chemist. 1914. 40 pp. 5c.

Contains analyses of waters from rivers, lakes, wells, and springs in various parts of the United States, including analyses of the geyser water of Yellowstone National Park, hot springs in Montana, brines from Death Valley, water from the Gulf of Mexico, and mine waters from Tennessee, Michigan, Missouri and Oklahoma, Montana, Colorado and Utah, Nevada and Arizona, and California.

371. Equipment for current-meter gaging stations, by G. J. Lyon. 1915. 64 pp., 37 pls. 20c.

Describes methods of installing automatic and other gages and of constructing gage wells, shelters, and structures for making discharge measurements and artificial controls.

*375. Contributions to the hydrology of the United States, 1915; N. C. Grover, chief hydraulic engineer. 1916. 181 pp., 9 pls. 15c.

Contains three papers presented at the conference of engineers of the water-resources branch in December, 1914.
*(c) The relation of stream gaging to the science of hydraulics, by C. H. Pierce and R. W. Davenport, pp. 77–84.
(e) A method for correcting river discharge for changing stage, by B. E. Jones, pp. 117–130.
(f) Conditions requiring the use of automatic gages in obtaining records of stream flow, by C. H. Pierce, pp. 131–139.

*400. Contributions to the hydrology of the United States, 1916; N. C. Grover, chief hydraulic engineer. 1917. 108 pp., 7 pls. Contains:

(a) The people's interest in water-power resources, by G. O. Smith, pp. 1–8.
*(c) The measurement of silt-laden streams, by R. C. Pierce, pp. 39–51.
(d) Accuracy of stream-flow data, by N. C. Grover and J. C. Hoyt, pp. 53–59.

416. The divining rod, a history of water witching, with a bibliography, by Arthur J. Ellis. 1917. 59 pp. 10c.

A brief paper published "merely to furnish a reply to the numerous inquiries that are continually being received from all parts of the country" as to the efficacy of the divining rod for locating underground water.

425. Contributions to the hydrology of the United States, 1917; N. C. Grover, chief hydraulic engineer. 1918. Contains:

*(c) Hydraulic conversion tables and convenient equivalents, pp. 71–94. 1917.

427. Bibliography and index of the publications of the United States Geological Survey relating to ground water, by O. E. Meinzer. 1918. 169 pp., 1 pl.

Includes publications prepared, in whole or part, by the Geological Survey that treat any phase of the subject of ground water or any subject directly applicable to ground water. Illustrated by map showing reports that cover specific areas more or less thoroughly.

ANNUAL REPORTS.

*Fifth Annual Report of the United States Geological Survey, 1883–84, J. W. Powell, Director. 1885. xxxvi, 469 pp., 58 pls. $2.25. Contains:

*The requisite and qualifying conditions of artesian wells, by T. C. Chamberlin, pp. 125 to 173, pl. 21. Scope indicated by title.

Twelfth Annual Report of the United States Geological Survey, 1890–91, J. W. Powell, Director. 1891. 2 parts. Pt. II, Irrigation, xvii, 576 pp., 93 pls. $2. Contains:

*Irrigation in India, H. M. Wilson, pp. 363–561, pls. 107 to 146. See Water-Supply Paper 87.

Thirteenth Annual Report of the United States Geological Survey, 1891–92, J. W. Powell, Director. 1892. (Pts. II and III, 1893.) 3 parts. *Pt. III, Irrigation, xi, 486 pp., 77 pls. $1.85. Contains:

*American irrigation engineering, by H. M. Wilson, pp. 101–349, pls. 111–145. Discusses the economic aspects of irrigation, alkaline drainage, silt and sedimentation; gives brief history of legislation; describes perennial canals in Idaho-California, Wyoming, and Arizona; discusses water storage at reservoirs of the California and other projects, subsurface sources of supply, pumping, and subirrigation.

Fourteenth Annual Report of the United States Geological Survey, 1892–93, J. W. Powell, Director. 1893. (Pt. II, 1894.) 2 parts. *Pt. II, Accompanying papers, xx, 597 pp., 73 pls. $2.10. Contains:

*The potable waters of eastern United States, by W. J. McGee, pp. 1–47. Discusses cistern water, stream waters, and ground waters, including mineral springs and artesian wells.

*Natural mineral waters of the United States, by A. C. Peale, pp. 49–88, pls. 3 and 4. Discusses the origin and flow of mineral springs, the source of mineralization, thermal springs, the chemical composition and analysis of spring waters, geographic distribution, and the utilization of mineral waters; gives a list of American mineral-spring resorts; contains also some analyses.

Nineteenth Annual Report of the United States Geological Survey, 1897–98, Charles D. Walcott, Director. 1898. (Parts II, III, and V, 1899.) 6 parts in 7 vols. and separate case for maps with Pt. V. *Pt. II, Papers chiefly of a theoretic nature, v, 958 pp., 172 pls. $2.65. Contains:

*Principles and conditions of the movements of ground water, by F. H. King, pp. 59–294, pls. 6 to 16. Discusses the amount of waters stored in sandstone, in soil, and in other rocks, and the depth to which ground water penetrates; gravitational, thermal, and capillary movements of ground waters, and the configuration of the ground-water surface; gives the results of experimental investigations on the flow of air and water through a rigid, porous medium, and through sand, sandstones, and silts; discusses results obtained by other investigators, and summarizes results of observations; discusses also rate of flow of water through sand and rock, the growth of rivers, rate of filtration through soil, interference of wells, etc.

*Theoretical investigation of the motion of ground waters, by C. S. Slichter, pp. 295–384, pl. 17. Scope indicated by title.

PROFESSIONAL PAPERS.

*72. Denudation and erosion in the southern Appalachian region and the Monongahela basin, by L. C. Glenn. 1911. 137 pp., 21 pls. 35c.

Describes the topography, geology, drainage, forests, climate and population, and transportation facilities of the region, the relation of agriculture, lumbering, mining, and power development to erosion and denudation, and the nature, effects, and remedies of erosion; gives details of conditions in Holston, Nolichucky, French Broad, Little Tennessee, and Hiwassee River basins, along Tennessee River proper, and in the basins of the Coosa-Alabama system, Chattahooche, Savannah, Saluda, Broad, Catawba, Yadkin, New, and Monongahela rivers.

86. The transportation of dèbris by running water, by G. K. Gilbert, based on experiments made with the assistance of E. C. Murphy. 1914. 263 pp., 3 pls. 70c.

The results of an investigation which was carried on in a specially equipped laboratory at Berkeley, Cal., and was undertaken for the purpose of learning "the laws which control the movement of bed load and especially to determine how the quantity of load is related to the stream slope and discharge and to the degree of comminution of the débris."

A highly technical report.

105. Hydraulic-mining débris in the Sierra Nevada, by G. K. Gilbert. 154 pp., 34 pls. 1917. 50c.

Presents the results of an investigation undertaken by the United States Geological Survey in response to a memorial from the California Miners' Association asking that a particular study be made of portions of the Sacramento and San Joaquin valleys affected by detritus from torrential streams. The report deals largely with geologic and physiographic aspects of the subject, traces the physical effects, past and future, of the hydraulic mining of earlier decades, the similar effects which certain other industries induce through stimulation of the erosion of the soil, and the influence of the restriction of the area of inundation by the construction of levees. Suggests cooperation by several interests for the control of the streams now carrying heavy loads of débris.

BULLETINS.

*32. Lists and analyses of the mineral springs of the United States (a preliminary study), by A. C. Peale. 1886. 235 pp.

Defines mineral waters, lists the springs by States, and gives tables of analyses.

*319. Summary of the controlling factors of artesian flows, by M. L. Fuller. 1908. 44 pp., 7 pls. 10c.

Describes underground reservoirs, the sources of ground waters, the confining agents, the primary and modifying factors of artesian circulation, the essential and modifying factors of artesian flow, and typical artesian systems.

*479. The geochemical interpretation of water analyses, by Chase Palmer. 1911. 31 pp. 5c.

Discusses the expression of chemical analyses, the chemical character of water and the properties of natural waters; gives a classification of waters based on property values and reacting values, and discusses the character of the waters of certain rivers as interpreted directly from the results of analyses; discusses also the relation of water properties to geologic formations, silica in river water, and the character of the water of the Mississippi and the Great Lakes and St. Lawrence River as indicated by chemical analyses.

616. The data of geochemistry (third edition), by F. W. Clarke. 1916. 821 pp. 45c.

Earlier editions were published as Bulletins 330 and 491. Contains a discussion of the statement and interpretation of water analyses, and a chapter on "Mineral wells and springs" (pp. 179–216). Discusses the definition and classification of mineral waters, changes in the composition of water, deposits of calcareous, ocherous, and siliceous materials made by water, vadose and juvenile waters, and thermal springs in relation to volcanism. Describes the different kinds of ground water and gives typical analyses. Includes a brief bibliography of papers containing water analyses.

INDEX BY AREAS AND SUBJECTS.

A=Annual Reports; M=Monograph; B=Bulletin; P=Professional Paper; W=Water-Supply Paper; G F=Geologic folio.]

[1] Many of the reports contain brief subject bibliographies. See abstracts.

[2] Many analyses of river, spring, and well waters are scattered through publications, as noted in abstracts.

INDEX OF STREAMS.