DEPARTMENT OF THE INTERIOR
FRANKLIN K. LANE, Secretary

UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, Director

Water-Supply Paper 407

SURFACE WATER SUPPLY OF THE UNITED STATES

1915

PART VII. LOWER MISSISSIPPI RIVER BASIN

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Prepared in cooperation with
THE STATES OF COLORADO AND NEW MEXICO

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SURFACE WATER SUPPLY OF THE LOWER MISSISSIPPI RIVER BASIN, 1915.

AUTHORIZATION AND SCOPE OF WORK.

This volume is one of a series of 14 reports presenting results of measurements of flow made on streams in the United States during the year ending September 30, 1915.

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

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 of water supply for irrigation. 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, 1895–1916.

1895	$12,000
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 1916, 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 11.

Measurements of stream flow have been made at about 3,800 points in the United States and also at many points in Alaska and the Hawaiian Islands. In July, 1915, 1,350 gaging stations were being maintained by the Survey and the cooperating organizations. Many miscellaneous discharge measurements were 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 the regular 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, miner's 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, acre-feet, and millions of cubic 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 by the use of the factors given in the tables of convenient equivalents (pp. 7–9).

"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 of 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.

"Millions of cubic feet" is applied to quantities of water stored in reservoirs, most frequently in connection with studies of flood control.

The following terms not in common use are here defined:

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

"Control," "controlling section," and "point of control," terms used to designate the section or sections of the stream below the gage which determine the 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 would fall if there were no flow.

CONVENIENT EQUIVALENTS.

The following is a list of convenient equivalents for use in hydraulic computations:

Table for converting discharge in second-feet per square mile into run-off in depth in inches over the area.

Discharge (second-feet per square mile).	Run-off (depth in inches).				
	1 day.	28 days.	29 days.	30 days.	31 days.
1.....	0.03719	1.041	1.079	1.116	1.153
2.....	.07438	2.083	2.157	2.231	2.306
3.....	.11157	3.124	3.236	3.347	3.459
4.....	.14876	4.165	4.314	4.463	4.612
5.....	.18595	5.207	5.393	5.578	5.764
6.....	.22314	6.248	6.471	6.694	6.917
7.....	.26033	7.289	7.550	7.810	8.070
8.....	.29752	8.331	8.628	8.926	9.223
9.....	.33471	9.372	9.707	10.041	10.376

NOTE.—For part of month multiply run-off for 1 day by the number of days.

Table for converting discharge in second-feet into run-off in acre-feet.

Discharge (second-feet).	Run-off (acre-feet).				
	1 day.	28 days.	29 days.	30 days.	31 days.
1.....	1.983	55.54	57.52	59.50	61.49
2.....	3.967	111.1	115.0	119.0	123.0
3.....	5.950	166.6	172.6	178.5	184.5
4.....	7.934	222.1	230.1	238.0	246.0
5.....	9.917	277.7	287.6	297.5	307.4
6.....	11.90	333.2	345.1	357.0	368.9
7.....	13.88	388.8	402.6	416.5	430.4
8.....	15.87	444.3	460.2	476.0	491.9
9.....	17.85	499.8	517.7	535.5	553.4

NOTE.—For part of a month multiply the run-off for 1 day by the number of days.

Table for converting discharge in second-feet into run-off in millions of cubic feet.

Discharge (second-feet).	Run-off (millions of cubic feet).				
	1 day.	28 days.	29 days.	30 days.	31 days.
1.....	0.0864	2.419	2.506	2.592	2.678
2.....	.1728	4.838	5.012	5.184	5.356
3.....	.2592	7.257	7.518	7.776	8.034
4.....	.3456	9.676	10.02	10.37	10.71
5.....	.4320	12.10	12.53	12.96	13.39
6.....	.5184	14.51	15.04	15.55	16.07
7.....	.6048	16.93	17.54	18.14	18.75
8.....	.6912	19.35	20.05	20.74	21.42
9.....	.7776	21.77	22.55	23.33	24.10

NOTE.—For part of a month multiply the run-off for 1 day by the number of days.

Table for converting discharge in second-feet into run-off in millions of gallons.

Discharge (second-feet).	Run-off (millions of gallons).				
	1 day.	28 days.	29 days.	30 days.	31 days.
1.....	0.6463	18.10	18.74	19.39	20.04
2.....	1.293	36.20	37.48	38.78	40.08
3.....	1.939	54.30	56.22	58.17	60.12
4.....	2.585	72.40	74.96	77.56	80.16
5.....	3.232	90.50	93.70	96.95	100.2
6.....	3.878	108.6	112.4	116.3	120.2
7.....	4.524	126.7	131.2	135.7	140.3
8.....	5.171	144.8	149.9	155.1	160.3
9.....	5.817	162.9	168.7	174.5	180.4

NOTE.—For part of a month multiply the run-off for 1 day by the number of days.

Table for converting velocity in feet per second into velocity in miles per hour.

[1 foot per second=0.681818 mile per hour, or two-thirds mile per hour, very nearly; 1 mile per hour=1.4666 feet per second. In computing the table the values 0.68182 and 1.4667 were used.]

Feet per second (units).	Miles per hour for tenths of foot per second.									
	0	1	2	3	4	5	6	7	8	9
0.....	0.000	0.068	0.136	0.205	0.273	0.341	0.409	0.477	0.545	0.614
1.....	.682	.750	.818	.886	.995	1.02	1.09	1.16	1.23	1.30
2.....	1.36	1.43	1.50	1.57	1.64	1.70	1.77	1.84	1.91	1.98
3.....	2.05	2.11	2.18	2.25	2.32	2.39	2.45	2.52	2.59	2.66
4.....	2.73	2.80	2.86	2.93	3.00	3.07	3.14	3.20	3.27	3.34
5.....	3.41	3.48	3.55	3.61	3.68	3.75	3.82	3.89	3.95	4.02
6.....	4.09	4.16	4.23	4.30	4.36	4.43	4.50	4.57	4.64	4.70
7.....	4.77	4.84	4.91	4.98	5.05	5.11	5.18	5.25	5.32	5.39
8.....	5.45	5.52	5.59	5.66	5.73	5.80	5.86	5.93	6.00	6.07
9.....	6.14	6.20	6.27	6.34	6.41	6.48	6.55	6.61	6.68	6.75

1 second-foot equals 40 California miner's inches (law of Mar. 23, 1901).

1 second-foot equals 38.4 Colorado miner's inches.

1 second-foot equals 40 Arizona miner's inches.

1 second-foot equals 7.48 United States gallons per second; equals 448.8 gallons per minute; equals 646,317 gallons for one day.

1 second-foot for one year (365 days) covers 1 square mile 1.131 feet, or 13.572 inches deep.

1 second-foot for one year (365 days) equals 31,536,000 cubic feet.

1 second-foot equals about 1 acre-inch per hour.

1 second-foot for one year (365 days) equals 724 acre-feet.

1 second-foot for one day equals 86,400 cubic feet.

1,000,000,000 (1 United States billion) cubic feet equals 11,570 second-feet for one day.

1,000,000,000 cubic feet equals 414 second-feet for one 28-day month.

1,000,000,000 cubic feet equals 399 second-feet for one 29-day month.

1,000,000,000 cubic feet equals 386 second-feet for one 30-day month.

1,000,000,000 cubic feet equals 373 second-feet for one 31-day month.

100 California miner's inches equals 18.7 United States gallons per second.

100 California miner's inches for one day equals 4.96 acre-feet.

100 Colorado miner's inches equals 2.60 second-feet.

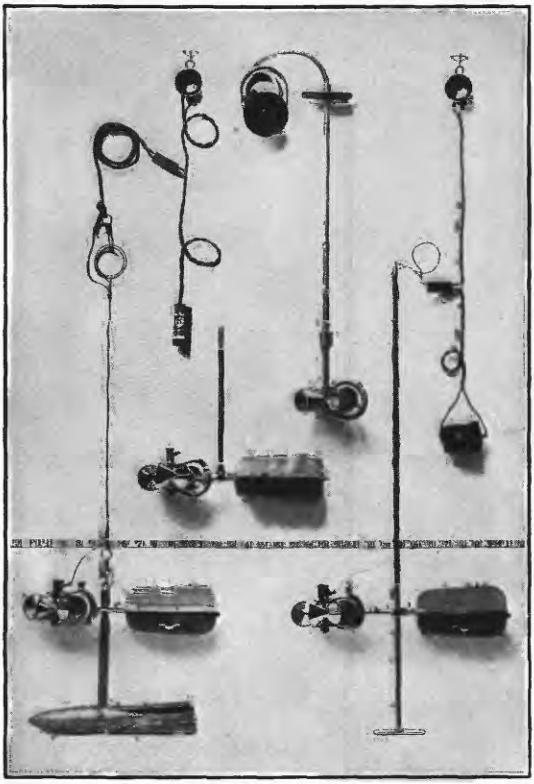
100 Colorado miner's inches equals 19.5 United States gallons per second.

100 Colorado miner's inches for one day equals 5.17 acre-feet.

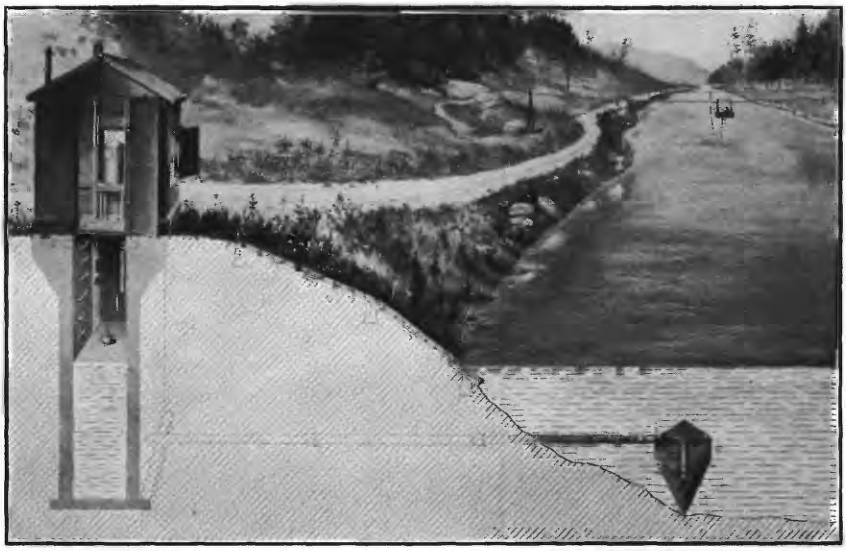
100 United States gallons per minute equals 0.223 second-foot.

100 United States gallons per minute for one day equals 0.442 acre-foot.

1,000,000 United States gallons per day equals 1.55 second-feet.



A. PRICE CURRENT METERS.



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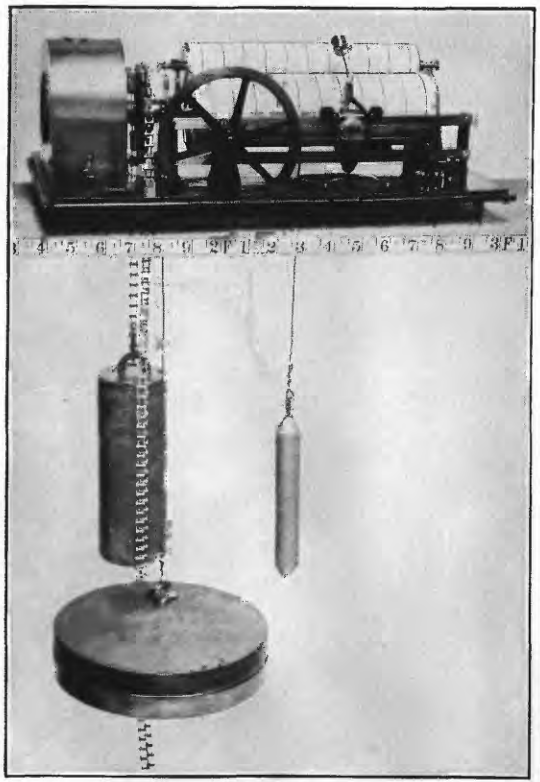

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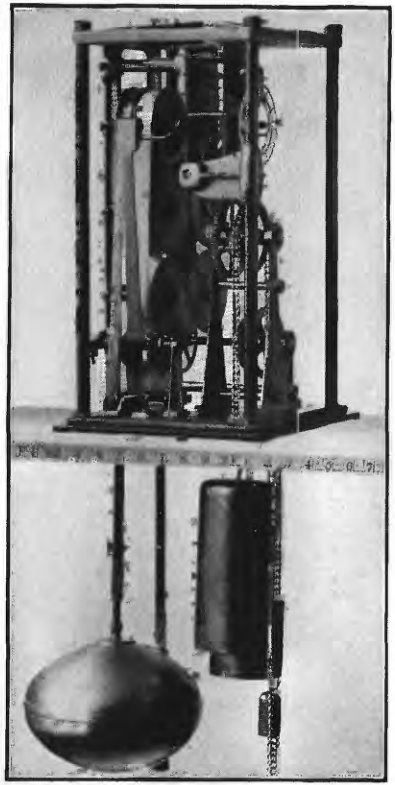
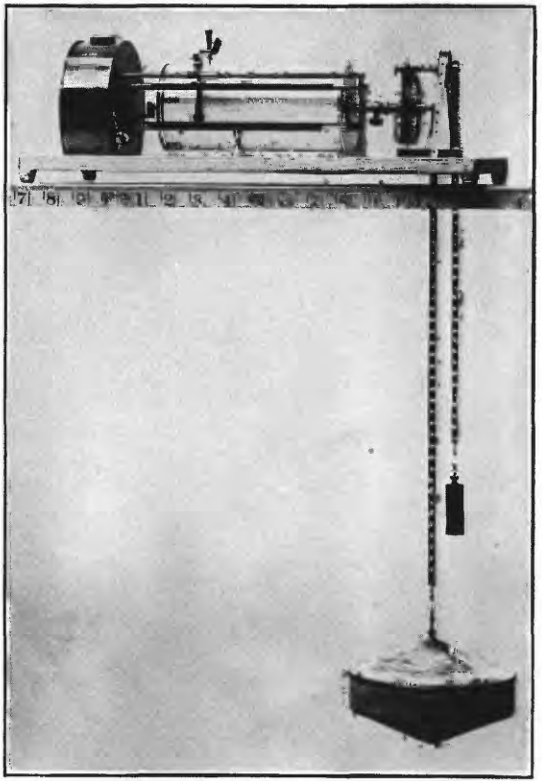


B. GURLEY PRINTING.



C. FRIEZ.

WATER-STAGE RECORDERS.

1,000,000 United States gallons equals 3.07 acre-feet.
1,000,000 cubic feet equals 22.95 acre-feet.
1 acre-foot equals 325,850 gallons.
1 inch deep on 1 square mile equals 2,323,200 cubic feet.
1 inch deep on 1 square mile equals 0.0737 second-foot per year.
1 foot equals 0.3048 meter.
1 mile equals 1.60935 kilometers.
1 mile equals 5,280 feet.
1 acre equals 0.4047 hectare.
1 acre equals 43,560 square feet.
1 acre equals 209 feet square, nearly.
1 square mile equals 2.59 square kilometers.
1 cubic foot equals 0.0283 cubic meter.
1 cubic foot of water weighs 62.5 pounds.
1 cubic meter per minute equals 0.5886 second-foot.
1 horsepower equals 550 foot-pounds per second.
1 horsepower equals 76.0 kilogram-meters per second.
1 horsepower equals 746 watts.
1 horsepower equals 1 second-foot falling 8.80 feet.
1½ horsepower equals about 1 kilowatt.

To calculate water power quickly: $\frac{\text{Second-feet} \times \text{fall in feet}}{11}$ = net horsepower on water wheel realizing 80 per cent of theoretical power.

EXPLANATION OF DATA.

The data presented in this report cover the year beginning October 1, 1914, and ending September 30, 1915. At the 1st 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 by the general methods outlined in standard textbooks on the measurement of river discharge. (See Pls. I and II.)

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 daily discharge from which the monthly and yearly mean discharge is determined.

The data presented for each gaging station in the area covered by this report comprise a description of the station, a table giving results

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 heights and results 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 constancy of the discharge relation, covering such subjects as the occurrence of ice, the use of the stream for log driving, shifting of channel, 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 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 weighting discharge for parts of the day.

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 for each second during the month. On this average flow computations recorded in the remaining columns, which are defined on page 6, are based.

ACCURACY OF FIELD DATA AND COMPUTED RESULTS.

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

Footnotes added to the daily discharge tables give information regarding the probable accuracy of the rating tables used, and an accuracy column is inserted in the monthly discharge table. 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" or "approximate," 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 letter in the column headed "Accuracy," in the monthly discharge table, rates the accuracy of the monthly mean and not that of the estimate of maximum or minumum discharge or the discharge for any one day. The rating is determined by considering the accuracy of the rating curve, the probable reliability of the observer, the number of gage readings per day, the range of the fluctuation in stage, and local conditions. In this column A indicates that the mean monthly flow is probably accurate within 5 per cent; B, within 10 per cent; C, within 15 per cent; D, within 25 per cent. Special conditions are covered by footnotes.

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 noncontributing 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 in New Mexico was carried on in cooperation with the State through James A. French, State engineer.

The stations on the Arkansas at Granite and Salida, Colo., were maintained in cooperation with the State of Colorado, through John E. Field, State engineer. The United States Forest Service furnished gage readings on South Fork of Arkansas River and Poncha Creek at Poncha, Colo., and winter readings on East Fork of Arkansas River and Tennessee River near Leadville, Colo.; the United States Reclamation Service paid the expenses for maintaining the stations in Oklahoma.

The Red River Valley Co. assisted in maintaining the station on Canadian River near Sanchez, N. Mex., and George H. Webster, jr., furnished the services of gage reader and gave assistance in construction work on Urraca Creek near Cimarron, N. Mex.

DIVISION OF WORK.

Data for stations in Colorado and Oklahoma were collected and prepared for publication under the direction of Robert Follansbee, district engineer, who was assisted by R. H. Fletcher, F. B. King, W. R. King, and T. J. Watkins.

For stations in New Mexico the data were collected and prepared for publication under the direction of G. A. Gray, district engineer, who was assisted by W. R. King and C. J. Emerson and J. E. Powers and R. J. Hank.

The records were reviewed and assembled by B. J. Peterson.

GAGING-STATION RECORDS.

ARKANSAS RIVER BASIN.

EAST FORK OF ARKANSAS RIVER NEAR LEADVILLE, COLO.

LOCATION.—In sec. 16, T. 9 S., R. 80 W., at highway bridge about 200 yards above mouth of Tennessee Fork, 3 miles northwest of Leadville, in Lake County.

DRAINAGE AREA.—52 square miles (measured on topographic map).

RECORDS AVAILABLE.—April 25 to August 31, 1890; June 18 to September 29, 1903; June 5, 1911, to September 30, 1915.

GAGE.—Vertical staff on left bridge abutment, near upstream end; read morning and evening by Fred Coquoz. No known relation between present gage and gages used prior to 1911.

DISCHARGE MEASUREMENTS.—Made from bridge at high water; by wading at ordinary stages.

CHANNEL AND CONTROL.—Bed composed of coarse gravel and small bowlders. Control 30 feet downstream from gage; shifts at intervals. Banks low; may overflow at extreme high water.

WINTER FLOW.—Discharge relation seriously affected by ice; observations discontinued during winter months.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 1.2 feet at 7.40 p. m., June 11 (discharge, 235 second feet); minimum discharge recorded, 8 second-feet November 28, but actual minimum may have occurred during winter months.

DIVERSIONS.—The Leadville Water Co. makes a continuous diversion of 2 second-feet from the East Fork above the station; during the winter months this diversion may be 3 second-feet.

REGULATION.—None.

ACCURACY.—Results considered only fair; rating curve well defined and control permanent in 1915, but the mean based on morning and evening readings of the gage is subject to some error due to diurnal fluctuations of stage during the spring; gage-height record not altogether reliable.

Discharge measurements of East Fork of Arkansas River near Leadville, Colo., during the year ending Sept. 30, 1915.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 6	R. H. Fletcher	0.22	14	Aug. 19	W. R. King	.31	23
July 9	Robert Follansbee	.60	70				

Daily discharge, in second-feet, East Fork of Arkansas River near Leadville, Colo., for the year ending Sept. 30, 1915.

Day.	Oct.	Nov.	Apr.	May.	June.	July.	Aug.	Sept.
1	20	14	.....	.....	113	94	35	15
2	20	14	.....	.....	118	106	30	14
3	20	14	.....	.....	55	94	34	12
4	17	9	.....	.....	99	94	35	19
5	27	9	.....	.....	118	71	30	19
6	27	9	.....	.....	123	94	29	19
7	27	9	.....	.....	132	76	28	18
8	27	9	.....	.....	118	67	69	23
9	27	9	.....	9	99	61	99	23
10	27	9	.....	9	167	71	61	22
11	27	9	.....	12	203	61	33	17
12	27	9	.....	23	197	67	30	21
13	27	9	.....	89	167	63	28	15
14	27	9	.....	167	145	69	28	15
15	27	9	.....	55	145	67	30	15
16	27	9	.....	76	145	61	28	15
17	27	9	.....	76	118	49	28	14
18	27	9	.....	197	167	43	23	14
19	27	9	.....	151	197	35	23	15
20	27	9	.....	140	173	41	22	12
21	27	9	.....	48	167	34	20	12
22	27	9	9	48	145	41	23	12
23	27	9	12	76	159	45	21	10
24	27	9	12	82	145	35	21	10
25	27	9	12	76	209	55	21	29
26	27	9	12	89	167	55	21	29
27	20	9	12	71	173	45	21	29
28	20	8	9	51	151	48	19	25
29	20	8	35	51	113	48	19	23
30	20	8	35	106	106	37	15	23
31	14	.....	.....	140	.....	35	15	.....

NOTE.—Discharge determined from well-defined rating curves. New curve used beginning Apr. 22. Discharge estimated Nov. 29, 30, Apr. 24, 25, and 30, as gage was not read.

Monthly discharge of East Fork of Arkansas River near Leadville, Colo., for the year ending Sept. 30, 1915.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
October	27	14	24.7	1,520	D.
November	14	8	9.4	559	D.
April 22–30	35	9	16.4	293	C.
May 9–31	197	9	80.1	3,650	C.
June	209	55	144	8,570	C.
July	106	34	60.1	3,700	B.
August	99	15	30.3	1,860	B.
September	29	10	18.0	1,070	C.

ARKANSAS RIVER AT GRANITE, COLO.

LOCATION.—In sec. 31, T. 11 S., R. 79 W., at Granite, in Lake County, below mouth of Lake Creek and above Lost Canyon and Clear creeks.

DRAINAGE AREA.—425 square miles.

RECORDS AVAILABLE.—May 1, 1897, to September 10, 1899; April 6, 1910, to September 30, 1915.

GAGE.—Bristol water-stage recorder on left bank, one-half mile above Denver & Rio Grande Railroad station at Granite; established in 1910 by the State engineer. No known relation between present gage and that used from 1897 to 1899.

DISCHARGE MEASUREMENTS.—Made from cable one-fourth mile above gage.

CHANNEL AND CONTROL.—Bed composed of coarse gravel and small bowlders; control shifts at intervals; banks will not overflow.

WINTER FLOW.—Discharge relation seriously affected by ice; observations discontinued during winter months.

EXTREMES OF DISCHARGE.—Maximum stage during year, from water-stage recorder, 3.68 feet at 10 a. m. June 12, 10.30 a. m. June 21, and 8.30 a. m. June 23 (discharge, 1,630 second-feet); minimum discharge occurs in winter.

DIVERSIONS.—There are court decrees for the diversion of 77 second-feet between this station and the junction of Tennessee and East forks.

REGULATION.—Discharge regulated by operation of Twin Lakes reservoir, which has a storage decree for 20,645 acre-feet, and by flume used to carry water from Lake Creek to a point below the station.

ACCURACY.—Results considered good, as shifts in control during year are fairly well defined and the gage-height record is reliable.

Discharge measurements of Arkansas River at Granite, Colo., during the year ending Sept. 30, 1915.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 7	R. H. Fletcher	1.79	201	July 18	W. R. King	2.23	340
May 19	H. E. Turner	2.40	487	June 28	H. E. Turner	3.30	1,090

Daily discharge, in second-feet, of Arkansas River at Granite, Colo., for the year ending Sept. 30, 1915.

Day.	Oct.	Nov.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	174	174	.....	85	167	1,040	770	290	139
2	189	146	.....	104	139	1,190	770	269	153
3	189	146	.....	115	127	1,140	730	232	167
4	204	133	.....	104	115	1,040	690	232	182
5	204	133	.....	104	127	900	690	215	182
6	204	133	.....	104	153	770	730	250	182
7	160	133	.....	104	153	730	690	269	167
8	174	133	.....	104	139	650	690	428	182
9	174	133	.....	115	115	730	650	400	198
10	189	133	.....	115	104	900	580	378	182
11	189	133	.....	115	167	1,190	548	250	167
12	174	133	.....	115	290	1,410	548	250	153
13	160	133	.....	115	455	1,140	615	250	139
14	146	120	.....	127	428	945	580	215	139
15	160	120	.....	139	455	900	580	215	127
16	160	95	.....	127	455	900	548	232	115
17	160	95	.....	139	485	990	485	232	115
18	146	82	.....	139	548	1,090	378	232	269
19	160	108	.....	139	515	1,090	355	198	232
20	160	146	76	167	485	1,190	455	153	215
21	160	120	68	167	455	1,240	485	167	232
22	189	95	76	167	378	1,140	485	167	182
23	174	95	85	153	332	1,240	485	153	115
24	189	95	85	139	355	1,240	515	198	127
25	204	95	85	127	428	1,300	615	167	139
26	189	95	94	127	428	1,140	515	167	198
27	174	95	104	139	378	1,040	548	167	115
28	174	95	85	139	310	900	378	167	115
29	174	95	85	167	400	810	310	153	104
30	189	95	85	215	428	770	332	139	115
31	189	.....	76	.....	690	.....	310	127	.....

NOTE.—Discharge determined as follows: Oct. 1 to Nov. 30 from rating curve fairly well defined; Mar. 20 to May 10, May 26 to June 10, from rating curve not well defined; May 11–25, June 11 to Sept. 30, by indirect method for shifting control.

Monthly discharge of Arkansas River at Granite, Colo., for the year ending Sept. 30, 1915.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
October	204	146	177	10,900	B.
November	174	82	118	7,090	B.
March 20-31	104	68	83.7	1,990	B.
April	215	85	131	7,800	B.
May	690	104	329	20,200	B.
June	1,410	650	1,030	61,300	B.
July	770	310	550	33,800	B.
August	428	127	225	13,800	B.
September	269	104	162	9,640	B.

ARKANSAS RIVER AT SALIDA, COLO.

LOCATION.—At Salida, in Chaffee County, some distance above mouth of South Fork of Arkansas River, the nearest important tributary.

DRAINAGE AREA.—1,160 square miles.

RECORDS AVAILABLE.—April 11, 1895, to October 31, 1903; November 3, 1909, to September 30, 1915.

GAGE.—Bristol water-stage recorder on right bank 400 feet below highway bridge in city part; installed by State engineer.

DISCHARGE MEASUREMENTS.—Made from highway bridge.

CHANNEL AND CONTROL.—Bed composed of coarse gravel which shifts at intervals; no well-defined control; banks high and not likely to overflow.

EXTREMES OF DISCHARGE.—Maximum stage during year, from water-stage recorder, 4.53 feet at 10 a. m. June 23 (discharge, 2,750 second-feet); minimum stage recorded, 0.10 foot January 28 (discharge, 155 second-feet).

WINTER FLOW.—Discharge relation not affected by ice, as river is kept open by springs.

DIVERSIONS.—There are court decrees for diversions of 199 second-feet between this station and Granite.

REGULATION.—Flow at station regulated to some extent by Twin Lakes and Clear Creek reservoirs, which have storage decrees for 20,645 and 11,489 acre-feet, respectively.

ACCURACY.—Results considered good except for high water, for which they are only fair, owing to shifting of control. Gage-height record reliable.

Discharge measurements of Arkansas River at Salida, Colo., during the year ending Sept. 30, 1915.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 8	R. H. Fletcher	1.09	473	May 19	H. E. Turner	1.75	733
Jan. 17	T. J. Watkins	.41	147	June 28	H. E. Turner	3.50	1,440
Mar. 1	R. H. Fletcher	.45	223	July 21	W. R. King	1.90	812

NOTE.—Measurement made Jan. 17 of doubtful accuracy and not used in determining daily discharge.

Daily discharge, in second-feet, of Arkansas River at Salida, Colo., for the year ending Sept. 30, 1915.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	476	455	255	230	196	218	230	385	1,060	1,480	540	385
2	476	455	368	230	198	230	230	315	1,520	1,420	520	368
3	497	435	460	230	200	205	255	300	1,420	1,420	500	385
4	497	435	540	242	202	205	270	285	1,420	1,310	460	402
5	518	435	440	242	204	218	255	285	1,240	1,240	420	402
6	518	435	315	218	205	205	285	300	1,120	1,280	420	420
7	518	415	300	230	206	205	270	285	1,090	1,160	500	402
8	497	395	300	230	208	218	255	285	970	1,090	680	368
9	497	395	270	218	210	205	285	285	970	1,090	885	368
10	497	395	270	230	212	205	285	270	1,150	1,060	755	385
11	476	376	285	230	214	218	270	270	1,790	1,000	655	368
12	497	376	285	230	216	205	285	300	2,400	970	608	402
13	476	395	270	230	218	205	300	402	2,120	1,000	655	402
14	415	395	255	230	205	218	285	585	1,710	1,060	608	402
15	395	356	230	230	205	218	300	608	1,560	1,090	540	385
16	435	337	230	205	205	218	315	655	1,590	1,060	562	368
17	415	337	230	205	230	218	300	755	1,790	940	540	332
18	395	337	255	218	230	230	285	780	1,870	858	630	402
19	395	318	270	218	230	230	270	705	1,990	730	562	440
20	395	376	242	218	242	218	300	630	2,260	780	460	420
21	395	376	242	218	230	218	300	608	2,440	805	420	420
22	455	318	242	218	218	218	315	520	2,440	830	420	420
23	476	300	255	205	218	218	300	500	2,580	830	420	332
24	497	300	270	170	218	230	285	500	2,530	830	420	300
25	497	300	270	180	205	242	300	585	2,480	912	480	350
26	497	318	270	180	218	255	315	630	2,350	912	460	460
27	476	318	255	170	230	242	368	562	2,260	1,030	460	385
28	476	318	242	155	218	270	385	500	2,080	940	440	350
29	455	318	242	192	.....	242	402	540	1,670	705	420	368
30	455	281	230	192	.....	218	460	540	1,480	630	420	385
31	476	.....	230	194	.....	230	.....	705	.....	562	402	.....

NOTE.—Discharge determined as follows: Oct. 1 to Jan. 31 by indirect method for shifting control; Feb. 1 to Sept. 30, from rating curve fairly well defined between 200 and 2,800 second-feet; Feb. 1–5, 7–12, discharge interpolated, as water-stage recorder was not recording correctly.

Monthly discharge of Arkansas River at Salida, Colo., for the year ending Sept. 30, 1915.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
October	518	395	466	28,700	B.
November	455	281	367	21,800	B.
December	540	230	284	17,500	B.
January	242	155	213	13,100	C.
February	242	196	214	11,900	D.
March	270	205	222	13,600	B.
April	460	230	299	17,800	A.
May	780	270	480	29,500	B.
June	2,580	970	1,780	106,000	C.
July	1,480	562	1,000	61,500	B.
August	885	402	528	32,500	A.
September	460	300	386	23,000	A.
The year	2,580	155	522	377,000	

TENNESSEE FORK NEAR LEADVILLE, COLO.

LOCATION.—In sec. 16, T. 9 S., R. 80 W., at highway bridge a few hundred yards above mouth of stream and about 3 miles northwest of Leadville, in Lake County.

DRAINAGE AREA.—45 square miles (measured on topographic map).

RECORDS AVAILABLE.—May 10 to October 31, 1890; June 18 to October 16, 1903; February 8, 1911, to September 30, 1915.

GAGE.—Vertical staff on left bridge abutment, downstream side; datum was lowered 0.40 foot October 6, 1914. No known relation between present gage and gages used in 1890 and 1903.

DISCHARGE MEASUREMENTS.—Made from bridge at high stages; by wading near bridge at low stages.

CHANNEL AND CONTROL.—Bed composed of small bowlders; rough. Control a short distance below gage at rapids which are practically permanent. Banks not subject to overflow.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 1.2 feet at 4 p. m. June 1, 9 a. m. and 5 p. m. June 2, and 4.50 p. m. June 22 (discharge, 177 second-feet); minimum stage, −0.10 foot February 13, 24, and March 3 (discharge, 1 second-foot).

WINTER FLOW.—Discharge relation seriously affected by ice; data too meager to warrant preparation of winter estimates.

DIVERSIONS.—There are court decrees for diversions of 24 second-feet above the station. There is also a decree for the diversion of 18.5 second-feet from the basin of Eagle River to that of Tennessee Fork above the station. No water was diverted from Eagle River basin in 1915.

ACCURACY.—Results considered good, as rating curve is well defined, control permanent, and gage-height record fairly reliable.

Discharge measurements of Tennessee Fork near Leadville, Colo., during the year ending Sept. 30, 1915.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 6	R. H. Fletcher	[a] 0.40	11	July 9	Robert Follansbee	0.60	33
Jan. 14	[b] T. J. Watkins	.30	1.3	Aug. 19	W. R. King	.40	12

[a] New gage datum; old gage read 0.00. [b] Ice measurement.

Daily discharge, in second-feet, of Tennessee Fork near Leadville, Colo., for the year ending Sept. 30, 1915.

Day.	Oct.	Nov.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	12	10	.....	.....	.....	.....	.....	161	90	12	10
2	12	10	.....	2	.....	.....	.....	177	78	9	8
3	12	10	.....	.....	1	.....	.....	95	58	12	7
4	12	10	.....	.....	.....	.....	.....	90	33	10	7
5	11	10	.....	.....	.....	.....	.....	36	27	12	7
6	11	10	.....	3	2	.....	.....	78	40	10	7
7	11	10	.....	.....	.....	.....	.....	67	36	9	7
8	11	10	.....	.....	.....	.....	.....	58	33	65	11
9	11	10	.....	.....	.....	.....	27	45	33	58	12
10	11	10	.....	.....	3	.....	36	85	27	20	12
11	11	10	.....	2	.....	.....	36	130	31	14	14
12	11	10	.....	.....	3	.....	90	130	34	10	14
13	11	10	.....	1	.....	.....	122	95	34	10	13
14	11	10	1.3	.....	.....	.....	52	78	31	10	12
15	11	10	.....	2	.....	.....	23	78	31	11	12
16	11	10	.....	.....	.....	.....	111	72	26	10	12
17	11	10	.....	.....	2	.....	139	90	16	10	11
18	11	10	.....	.....	3	.....	45	111	19	8	11
19	11	10	.....	.....	.....	48	23	151	16	12	10
20	11	10	.....	.....	.....	48	19	103	12	12	10
21	11	10	.....	.....	.....	53	58	116	14	10	10
22	11	10	.....	.....	.....	58	45	171	9	12	10
23	11	10	.....	.....	3	40	52	122	7	12	8
24	11	10	.....	1	.....	46	72	116	7	12	7
25	11	10	.....	.....	4	52	63	90	26	12	11
26	11	10	.....	.....	.....	58	111	103	16	11	10
27	11	10	.....	2	5	48	111	95	21	10	10
28	11	10	.....	.....	.....	58	52	90	19	10	9
29	11	10	.....	.....	.....	72	52	95	16	10	9
30	11	10	3	.....	.....	72	78	72	12	8	8
31	11	.....	.....	.....	5	.....	95	.....	11	10	.....

NOTE.—Discharge determined as follows: Oct. 1 to Nov. 30 from well-defined rating curve Jan. 30 to Sept. 30 from fairly well-defined rating curve. Discharge interpolated Apr. 21, 24, 25, 30, as gage was not read.

Monthly discharge of Tennessee Fork near Leadville, Colo., for the year ending Sept. 30, 1915.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
October	12	11	11.1	682	B.
November	10	10	10.0	595	B.
January	.....	.....	1.5	92	D.
February	.....	.....	1.5	83	D.
March	.....	.....	3.0	184	C.
April 19–30	72	40	54.4	1,290	B.
May 9–31	139	23	65.7	3,000	C.
June	177	36	100	5,950	C.
July	90	7	27.8	1,710	B.
August	65	8	14.2	873	B.
September	14	7	10.0	595	B.

COTTONWOOD CREEK BELOW HOT SPRINGS, NEAR BUENA VISTA, COLO.

LOCATION.—In sec. 22, T. 14 S., R. 79 W., half a mile below the old Hot Springs Hotel and 6 miles west of Buena Vista, in Chaffee County. Nearest tributary, South Fork, enters 2 miles above.

DRAINAGE AREA.—72 square miles (measured on Forest atlas).

RECORDS AVAILABLE.—April 7, 1911, to September 30, 1915. From September 23, 1910, to September 13, 1911, a station was maintained in sec. 21, 1 mile above present site.

GAGE.—Vertical staff moved February 19, 1915, from side of left abutment to downstream end and reset to same datum; read morning and evening by E. D. Masters. In present position water does not pile up on gage, especially during high water, and therefore for same discharge gage height will be less.

DISCHARGE MEASUREMENTS.—Made from bridge during high water and by wading at ordinary stages.

CHANNEL AND CONTROL.—Channel composed of boulders; very rough. Control, which is practically permanent, is a short distance below gage. Banks high and not likely to overflow.

EXTREMES OF STAGE.—Maximum stage recorded during year, 2.0 feet at 6 a. m. June 23; minimum stage, 0.52 foot at 7 a. m. March 21.

WINTER FLOW.—Discharge relation not affected by ice; hot springs keep creek open.

DIVERSIONS.—These are court decrees for diversions of 148 second-feet from Cottonwood Creek, those for 28 second-feet being above the gaging station.

REGULATION.—None.

ACCURACY.—Base data considered reliable, but as the gage has not been completely rated in its present position estimates of daily discharge have not been made for periods subsequent to February 19.

Discharge measurements of Cottonwood Creek below Hot Springs, near Buena Vista, Colo., during the period Feb. to 19 Sept. 30, 1915.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 7	R. H. Fletcher	0.90	54	June 18	R. G. Hosea	1.60	228
Jan. 17	T. J. Watkins	.59	22	July 19	W. R. King	.98	63
Feb. 19	R. H. Fletcher	*a*.57	22				

a New site of gage; reading at old site, 0.63 foot.

Daily gage height, in feet, of Cottonwood Creek below Hot Springs, near Buena Vista, Colo., for the period Feb. 19 to Sept. 30, 1915.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1		0.58	0.58	0.83	1.50	1.58	0.85	0.81
2		.57	.58	.70	1.55	1.55	.82	.80
3		.57	.58	.68	1.35	1.52	.80	.84
4		.56	.59	.69	1.22	1.48	.79	.85
5		.57	.58	.69	1.25	1.50	.78	.84
6		.56	.58	.68	1.20	1.52	.78	.81
7		.56	.58	.66	1.12	1.36	.86	.80
8		.56	.58	.70	1.20	1.38	1.20	.80
9		.56	.57	.74	1.38	1.30	1.08	.79
10		.56	.57	.74	1.45	1.28	.99	.78
11		.57	.57	.82	1.72	1.22	.95	.78
12		.56	.58	.98	1.80	1.18	.99	.80
13		.56	.59	1.10	1.50	1.18	.94	.78
14		.57	.62	1.15	1.40	1.18	.90	.80
15		.57	.66	1.10	1.45	1.15	.94	.80
16		.58	.60	1.18	1.55	1.12	.91	.80
17		.56	.62	1.20	1.65	1.08	.88	.80
18		.56	.60	1.30	1.62	1.05	.85	.79
19	0.57	.56	.60	1.18	1.75	1.02	.86	.78
20	.58	.55	.68	1.00	1.82	1.00	.88	.76
21	.58	.54	.69	.92	1.78	1.00	.86	.75
22	.56	.55	.68	.92	1.85	1.00	.84	.74
23	.56	.54	.66	.98	1.88	.98	.98	.73
24	.55	.56	.62	1.08	1.85	.95	.96	.73
25	.56	.56	.60	1.22	1.78	.95	.94	.85
26	.57	.56	.61	1.18	1.75	.90	.90	.92
27	.57	.58	.68	1.08	1.75	.08	.89	.91
28	.57	.58	.79	1.05	1.65	.92	.86	.84
29		.57	.86	1.18	1.62	.90	.85	.84
30		.58	.91	1.20	1.6	.88	.86	.88
31		.58		1.32		.85	.85	

NOTE.—Gage heights refer to gage at its new site. See station description.

Daily discharge, in second-feet, of Cottonwood Creek below Hot Springs, near Buena Vista, Colo., for the period Oct. 1, 1914 to Feb. 18, 1915.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Day.	Oct.	Nov.	Dec.	Jan.	Feb.
1	52	43	27	21	21	16	46	27	18	19	18
2	48	43	24	21	19	17	43	29	18	19	18
3	45	38	28	19	19	18	43	27	18	19	18
4	55	38	27	19	18	19	43	27	18	19	.....
5	52	38	27	19	18	20	43	25	18	18	.....
6	52	38	25	19	18	21	43	27	21	21	.....
7	55	37	25	19	18	22	50	25	21	21	.....
8	52	37	25	19	19	23	50	27	21	21	.....
9	52	37	23	19	19	24	62	27	21	21	.....
10	52	34	23	19	21	25	54	27	21	21	.....
11	50	34	23	19	21	26	50	25	22	21	.....
12	48	33	22	18	19	27	50	27	22	21	.....
13	48	37	19	18	19	28	46	27	22	18	.....
14	46	33	18	18	18	29	50	27	22	19	.....
15	46	24	19	19	18	30	46	27	22	19	.....
						31	46	.....	21	21	.....

NOTE.—Discharge Oct. 1–Feb. 18 determined from well-defined rating curve. On Feb. 19 gage moved to slightly different position, and rating at new site has not been completed.

Monthly discharge of Cottonwood Creek below Hot Springs, near Buena Vista, Colo., for the period Oct. 1, 1914, to Jan. 31, 1915.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	62	43	49.0	3,010
November	43	24	31.5	1,870
December	27	18	22.0	1,350
January	21	18	19.5	1,200

CHALK CREEK (UPPER STATION) NEAR ST. ELMO, COLO.

LOCATION.—In sec. 27, T. 15 S., R. 80 W., a quarter of a mile below the power plant of the Tin Cup Gold Dredging Co. and 1¼ miles below St. Elmo, in Chaffee County. Nearest tributary, Coal Creek, enters a quarter of a mile below.

DRAINAGE AREA.—48 square miles (measured on Forest atlas).

RECORDS AVAILABLE.—November 15, 1913, to September 30, 1915.

GAGE.—Friez water-stage recorder on left bank a quarter of a mile below power house.

DISCHARGE MEASUREMENTS.—Made from footbridge, near gage.

CHANNEL AND CONTROL.—Channel composed of coarse gravel. Control a short distance below gage at small rapids which are practically permanent. Banks not likely to overflow.

EXTREMES OF DISCHARGE.—Maximum stage during year, from water-stage recorder, 2.8 feet at 9 p. m. June 19 (discharge, 325 second-feet); minimum stage recorded, 0.90 foot February 18 to 20 (discharge, 7 second-feet).

WINTER FLOW.—Discharge relation not seriously affected by ice.

DIVERSIONS.—No court decrees for diversion of water that is not returned to the stream above the station.

REGULATION.—Low-water flow regulated to a certain extent by a small reservoir at St. Elmo, formed by the diversion dam for the Tin Cup Gold Dredging Co.'s power house.

ACCURACY.—Results considered excellent, as rating curve is well defined below 180 second-feet, control is permanent, and gage-height record reliable.

Discharge measurements of Chalk Creek (upper station) near St. Elmo, Colo., during the year ending Sept. 30, 1915.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Jan. 16	T. J. Watkins	0.98	8.2	July 20	W. R. King	1.57	48
Feb. 18	R. H. Fletcher	.90	6.8				

Daily discharge, in second-feet, of Chalk Creek (upper station) near St. Elmo, Colo., for the year ending Sept. 30, 1915.

Day.	Oct.	Nov.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	16	17	.....	.....	.....	9	32	159	152	34	19
2	17	17	.....	.....	.....	10	21	148	148	32	18
3	22	16	.....	.....	.....	9	20	123	136	29	20
4	32	14	.....	.....	.....	12	18	99	134	28	20
5	20	14	.....	.....	.....	10	18	93	143	27	20
6	20	14	.....	.....	.....	9	18	86	148	33	20
7	20	14	.....	.....	.....	8	18	84	123	52	18
8	20	11	.....	.....	.....	9	18	105	113	60	18
9	20	12	.....	.....	.....	8	21	150	107	50	18
10	21	11	.....	.....	.....	9	27	176	105	41	16
11	20	11	.....	.....	.....	9	53	220	103	42	15
12	17	11	.....	.....	.....	10	68	210	97	45	15
13	18	11	.....	8	.....	13	92	171	95	40	14
14	16	8	.....	.....	.....	13	115	161	92	41	15
15	17	7	.....	7	8	13	88	190	88	52	16
16	16	7	8	7	7	11	119	195	79	45	16
17	17	8	.....	7	8	11	134	195	67	35	16
18	16	9	.....	7	8	14	105	222	59	30	16
19	16	8	.....	7	8	17	77	235	52	28	16
20	13	8	.....	7	.....	20	60	225	49	25	16
21	16	8	.....	8	8	22	53	228	46	24	15
22	19	9	.....	.....	8	19	54	235	19	24	14
23	16	8	.....	.....	8	18	74	232	20	40	14
24	19	8	.....	.....	8	16	97	222	47	41	14
25	19	9	.....	8	7	18	105	228	46	40	23
26	19	9	.....	.....	7	17	79	220	47	28	27
27	20	8	.....	.....	8	23	70	190	65	25	22
28	18	8	.....	.....	8	34	86	176	53	22	21
29	19	8	.....	.....	8	47	99	164	46	21	22
30	18	8	.....	.....	8	52	99	161	41	22	24
31	19	.....	.....	.....	8	.....	130	.....	38	21	.....

NOTE.—Discharge determined as follows: Oct. 1 to Nov. 30 from well-defined rating curve; Feb. 13 to Sept. 30 from rating curve well defined below 180 second-feet; Nov. 29 and 30, interpolated, as gage was not read.

Monthly discharge of Chalk Creek (upper station) near St. Elmo, Colo., for the year ending Sept. 30, 1915.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
October	32	13	18.6	1,140	A.
November	17	7	10.4	619	B.
February	.....	.....	7.0	389	C.
March	.....	.....	8.0	492	C.
April	52	8	16.3	970	B.
May	134	18	66.7	4,100	A.
June	235	84	177	10,500	A.
July	152	19	82.5	5,070	A.
August	60	21	34.7	2,130	A.
September	27	14	17.9	1,070	A.

NOTE.—Discharge February and March, estimated as discharge relation was affected by ice for short periods.

CHALK CREEK NEAR ST. ELMO, COLO.

LOCATION.—In sec. 28, T. 15 S., R. 79 W., at highway bridge just below the cascades of Chalk Creek and 6 miles east of St. Elmo in Chaffee County. Nearest tributary, a small intermittent stream entering from the north just above the station.

DRAINAGE AREA.—75 square miles (measured on Forest atlas).

RECORDS AVAILABLE.—March 10, 1911, to September 30, 1915. From September 6, to December 28, 1910, a station was maintained in sec. 24, T. 15 S., R. 79 W.

GAGE.—Vertical staff, on downstream side of pile bent; read twice daily by L. D. Patano.

DISCHARGE MEASUREMENTS.—Made from bridge during high water and by wading at ordinary stages.

CHANNEL AND CONTROL.—Channel composed of small bowlders, rough. Control, which is somewhat shifting, is just below gage. Banks not likely to overflow.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 2.0 feet at 3.15 p. m., June 25 (discharge, 415 second-feet); minimum stage, 0.79 foot February 15 (discharge, 15 second-feet).

WINTER FLOW.—Discharge relation not seriously affected by ice; open channel rating curve assumed applicable.

DIVERSION.—No court decrees for diversions from Chalk Creek between the upper station and this one; decrees for 117 second-feet below.

REGULATION.—None.

ACCURACY.—Results considered only fair, as control shifted during year and mean stage derived from two daily readings is somewhat in error for the high-water period owing to diurnal fluctuations due to alternate melting and freezing of snow on headwaters.

Discharge measurements of Chalk Creek near St. Elmo, Colo., during the year ending Sept. 30, 1915.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 7	R. H. Fletcher	1.16	43	June 18	R. G. Hosea	1.80	294
Jan. 16	T. J. Watkins	.83	21	July 20	W. R. King	1.42	84
Feb. 18	R. H. Fletcher	.79	15				

Daily discharge, in second-feet, of Chalk Creek near St. Elmo, Colo., for the year ending Sept. 30, 1915.

Day.	Oct.	Nov.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	41	41				20	58	198	230	65	43
2	41	37				23	50	198	178	56	37
3	41	41				20	42	173	178	56	37
4	45	29				22	42	152	178	56	37
5	41	29				23	36	152	178	56	37
6	48	33				20	42	133	178	60	37
7	45	41				20	42	114	169	56	37
8	45	26				20	36	114	169	74	37
9	48	29				20	36	198	148	93	37
10	41	29				23	36	254	148	56	37
11	41	29				22	42	318	148	56	37
12	37					22	68	382	148	56	37
13	41					24	114	290	148	56	37
14	26					25	198	198	128	60	37
15	35			15		36	132	254	121	58	37
16	35		21			28	142	285	140	56	37
17	35					28	152	382	103	56	37
18	35					28	173	350	96	56	33
19	35					28	173	350	88	56	33
20	35					28	96	360	88	47	33
21	35					32	82	370	74	41	29
22	41					32	82	304	74	44	29
23	41					32	99	337	74	47	26
24	41					28	114	337	74	56	26
25	35					28	152	370	74	47	34
26	35					28	132	370	74	41	38
27	35					32	114	337	79	41	43
28	35					42	114	304	68	41	43
29	35				16	48	114	261	74	41	43
30	35				18	48	123	261	74	41	43
31	35				16		132		74	41	

NOTE.—Discharge determined as follows: Apr. 13 to June 20, from rating curve not well defined; Oct. 1 to Nov. 11 and June 21 to Sept. 30 by indirect method for shifting control. Apr. 4, 11, 18, 25, May 2, 9, 16, 23, 30, June 6, 13, 20, 27, July 4, 11, 18, 25, Aug. 1, 8, 15, 22, 29, Sept. 5, 12, 19, 26, discharge interpolated, as gage was not read.

Monthly discharge of Chalk Creek near St. Elmo, Colo., for the year ending Sept. 30, 1915.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
October	48	26	38.5	2,370	B.
November 1–11	41	29	33.1	722	B.
April	48	20	27.7	1,650	B.
May	198	36	95.7	5,880	C.
June	382	114	270	16,100	C.
July	230	68	122	7,500	C.
August	93	41	53.7	3,300	C.
September	43	26	36.3	2,160	C.

SOUTH FORK OF ARKANSAS RIVER AT PONCHA, COLO.

LOCATION.—In sec. 10, T. 49 N., R. 8 E., at single-span highway bridge about half a mile from Poncha, in Chaffee County. Nearest tributary Poncha Creek, enters one-fourth mile below.

DRAINAGE AREA.—140 square miles (measured on Forest atlas).

RECORDS AVAILABLE.—January 14, 1911, to September 30, 1915.

GAGE.—Vertical staff on left bridge abutment; read twice daily by J. F. Cuenin. Datum lowered 1.00 foot August 19, 1914.

DISCHARGE MEASUREMENTS.—Made from bridge at high water and by wading nearby at low stages.

CHANNEL AND CONTROL.—Channel composed of coarse gravel and small bowlders; rough. Control 20 feet below gage at small rapids which may shift slightly. Banks not subject to overflow.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.6 feet during night of June 11, determined from high-water mark on gage (discharge 485 second-feet); minimum stage recorded, 0.60 foot at 7 p. m., July 21 (discharge, 5 second-feet).

WINTER FLOW.—Discharge relation only slightly affected by ice as the river is kept open by springs.

DIVERSIONS.—There are court decrees for diversion of 114 second-feet from the South Fork above station, and 77 second-feet below; also for 85 second-feet from the North Fork, which enters above.

REGULATION.—None.

ACCURACY.—Results considered good except for winter months, for which they are approximate owing to slight backwater. Rating curve well defined below 250 second-feet, control permanent during year, and gage-height record reliable, except that at high stages mean daily stage derived from readings morning and evening and the maximum stage for the 24-hour period, may be somewhat in error.

Discharge measurements of South Fork of Arkansas River at Poncha, Colo., during the year ending Sept. 30, 1915.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 8	R. H. Fletcher	0.74	9.8	Mar. 1	R. H. Fletcher	1.34	42
Jan. 18	T. J. Watkins	1.08	25	July 21	W. R. King	.70	8.0

Daily discharge, in second-feet, of South Fork of Arkansas River at Poncha, Colo., for the year ending Sept. 30, 1915.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	8	44	26	33	32	30	27	128	89	151	41	33
2	8	41	26	33	33	30	26	120	205	130	32	24
3	8	37	26	35	33	32	26	120	205	117	26	22
4	10	33	26	33	33	33	30	100	113	103	28	22
5	9	35	26	33	33	33	37	87	109	116	20	25
6	9	35	26	33	33	33	41	76	93	135	14	22
7	10	35	26	33	35	33	41	60	81	76	13	20
8	8	32	26	33	37	33	41	37	85	68	30	20
9	10	30	26	33	37	33	41	30	113	87	35	22
10	9	30	26	33	37	33	41	30	177	55	26	19
11	9	32	26	33	41	33	37	30	265	63	19	20
12	10	32	26	33	35	33	33	65	335	57	20	16
13	10	32	26	26	32	30	26	76	215	50	16	18
14	13	37	26	33	33	32	26	151	160	47	14	14
15	18	46	26	32	32	37	26	135	168	50	15	16
16	14	37	26	31	32	35	27	177	151	32	14	12
17	14	37	26	30	32	33	26	215	135	13	10	12
18	14	37	26	30	32	33	25	215	205	12	9	9
19	13	37	35	30	32	33	26	168	285	8	9	9
20	16	37	37	26	33	33	26	116	335	8	13	7
21	33	41	33	26	33	33	26	102	265	6	15	7
22	35	50	33	33	33	33	33	81	285	7	33	7
23	52	41	33	33	33	33	33	72	310	10	32	7
24	37	50	33	33	33	33	41	78	335	17	28	7
25	39	50	33	33	33	30	46	78	285	25	26	21
26	43	46	33	33	33	32	55	65	310	22	26	32
27	39	46	33	33	32	30	55	65	245	135	30	18
28	39	41	33	35	32	27	65	55	196	93	28	12
29	44	37	32	33	.....	26	87	58	160	67	37	21
30	43	33	33	33	.....	25	168	62	151	41	55	41
31	43	.....	33	35	.....	30	.....	62	.....	46	33	.....

NOTE.—Discharge determined as follows: Oct. 1 to Dec. 18, and Mar. 30 to Sept. 30, from rating curve well defined below 250 second-feet; Dec. 19 to Mar. 29, from rating curve based on two winter measurements which showed that slight backwater existed. Jan. 15–17 and Feb. 27, discharge interpolated because of temporary ice jam. June 16, July 16 and 29, discharge interpolated, as gage was not read.

Monthly discharge of South Fork of Arkansas River at Poncha, Colo., for the year ending Sept. 30, 1915.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
October	52	8	21.2	1,300	B.
November	50	30	38.4	2,280	B.
December	37	26	29.1	1,790	C.
January	35	26	32.1	1,970	D.
February	41	32	33.5	1,860	D.
March	37	25	31.8	1,960	D.
April	168	25	41.3	2,460	B.
May	215	30	94.0	5,780	B.
June	335	81	202	12,000	B.
July	151	6	59.6	3,660	B.
August	55	9	24.1	1,480	B.
September	41	7	17.8	1,060	B.
The year	335	6	52.0	37,600	

PONCHA CREEK AT PONCHA, COLO.

LOCATION.—In sec. 10, T. 49 N., R. 8 E., at single-span highway bridge near Poncha, in Chaffee County, about one-fourth mile above mouth of creek.

DRAINAGE AREA.—89 square miles (measured on Forest atlas).

RECORDS AVAILABLE.—January 14, 1911, to September 30, 1915.

GAGE.—Vertical staff on downstream side of left abutment; read twice daily by J. M. Cuenin. Gage originally 20 feet upstream on opposite bank, moved to present site May 6, 1914, and datum lowered 1.00 foot.

DISCHARGE MEASUREMENTS.—Made from bridge at high and by wading at ordinary stages.

CHANNEL AND CONTROL.—Bed composed of coarse gravel which shifts slightly. Control not well defined. Banks will overflow to a small extent during extreme high water.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.0 feet on nights of June 3 and 13 (determined from high-water mark on gage (discharge, 250 second-feet); minimum stage recorded, 1.10 feet from November 30 to December 18 (discharge, 4 second-feet).

WINTER FLOW.—Discharge relation not affected by ice as creek is kept open by springs.

DIVERSIONS.—There are court decrees for diversion of 7 second-feet above station, but none below.

REGULATION.—None.

ACCURACY.—Results considered good except for high water, for which they are fair; rating curve well defined, control permanent in 1915, and gage-height record reliable except for high stages, for which the mean stage derived from readings, morning and evening and the maximum stage for the 24-hour period, may be somewhat in error as a result of diurnal fluctuations due to alternate melting and freezing of snow on the headwaters.

Discharge measurements of Poncha Creek at Poncha, Colo., during the year ending Sept. 30, 1915.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 8	R. H. Fletcher	1.20	5.4	Mar. 1	R. H. Fletcher	1.26	7.3
Jan. 18	T. J. Watkins	1.31	7.6	July 21	W. R. King	1.52	17

Daily discharge, in second-feet, of Poncha Creek at Poncha, Colo., for the year ending Sept. 30, 1915.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June.	July.	Aug.	Sept.
1	6	11	4	7	7	9	9	80	152	50	28	11
2	6	11	4	7	6	6	8	52	172	50	23	10
3	6	13	4	7	6	6	8	47	172	45	15	11
4	8	13	4	7	6	8	9	32	114	35	18	11
5	6	13	4	7	6	9	11	24	123	44	19	11
6	6	10	4	7	6	7	11	18	117	47	18	10
7	6	8	4	7	6	6	11	11	92	37	20	10
8	6	8	4	7	7	6	11	5	87	37	21	11
9	7	8	4	7	8	6	11	37	108	37	25	10
10	6	9	4	7	8	6	11	32	132	24	21	9
11	6	9	4	7	10	6	15	32	172	26	20	9
12	6	9	4	7	9	6	18	65	162	26	18	9
13	6	5	4	6	7	7	24	84	152	26	15	8
14	6	4	4	7	8	8	27	104	119	24	16	9
15	6	16	4	8	6	10	27	119	123	27	17	10
16	6	16	4	10	6	9	27	142	105	22	16	12
17	5	4	4	14	6	7	24	142	87	17	13	10
18	10	4	4	11	6	6	30	162	87	16	13	10
19	7	4	8	10	6	6	30	108	110	15	13	10
20	9	5	9	7	6	6	28	72	96	15	13	10
21	21	4	8	6	7	6	28	75	99	16	15	10
22	15	4	7	6	7	6	39	72	92	17	11	10
23	15	4	7	6	7	6	37	72	90	16	15	10
24	15	4	6	6	9	6	37	99	80	17	19	10
25	13	6	6	6	9	6	37	110	80	31	13	16
26	15	5	6	6	9	6	42	87	72	26	13	17
27	13	7	6	6	6	6	47	87	68	52	12	12
28	13	6	6	6	6	7	52	80	62	37	12	12
29	12	5	7	6	.....	11	58	87	52	29	12	13
30	12	4	7	6	.....	10	152	117	49	21	13	14
31	12	.....	7	6	.....	12	.....	132	.....	22	10	.....

NOTE.—Discharge determined from a well-defined rating curve. Discharge June 16, July 16 and 29, interpolated, as gage was not read.

Monthly discharge of Poncha Creek at Poncha, Colo., for the year ending Sept. 30, 1915.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
October	21	5	9.2	566	B.
November	16	4	7.6	452	B.
December	9	4	5.2	320	B.
January	14	6	7.2	443	B.
February	10	6	7.0	389	B.
March	12	6	7.2	443	B.
April	152	8	29.3	1,740	B.
May	162	5	77.0	4,730	C.
June	172	49	108	6,430	C.
July	52	15	29.2	1,800	B.
August	28	10	16.4	1,010	B.
September	17	8	10.8	643	B.
The year	172	4	26.1	19,000	

WEST BEAVER CREEK NEAR VICTOR, COLO.

LOCATION.—In sec. 30, T. 16 S., R. 68 W., at the Skagway power station of the Arkansas Valley Railway Light & Power Co., about 7 miles southeast of Victor, in Fremont County.

DRAINAGE AREA.—70 square miles.

RECORDS AVAILABLE.—January 1, 1905, to September 30, 1915.

DETERMINATION OF DISCHARGE.—Water used through power house is brought by pipe line from reservoir 3½ miles upstream; quantity measured hourly by weir, and a quantity representing the gain or loss in the reservoir during the period is added or subtracted. To determine the natural flow of the stream the seepage through the dam is measured by weir and added to the total quantity thus obtained. This method takes no account of evaporation from the surface of the reservoir.

DIVERSIONS.—Above the power reservoir are three reservoirs from which the town of Victor obtains its municipal supply. In the upper basin are four reservoirs from which water is diverted into Lake Moraine and thence by natural channels to Colorado Springs, where it is used as municipal supply. Filings for these diversions from the basin—52 second-feet by ditch and 5 second-feet by pipe line—have not yet been adjudicated. The town of Altman, for municipal supply, has also filed on five reservoir sites in the upper basin, having a combined capacity of 2,300 acre-feet. Below the power plant there are adjudicated decrees for diversions of 57 second-feet from Beaver Creek, which is formed by East and West Beaver creeks. In addition there is an irrigation reservoir in operation which has a filing for 4,760 acre-feet.

COOPERATION.—Records are furnished through courtesy of Arkansas Valley Railway Light & Power Co., and are said to be probably correct within 5 per cent.

Monthly discharge of West Beaver Creek River near Victor, Colo., for the year ending Sept. 30, 1915.

Month.	Mean discharge in second-feet.	Run-off (total in acre-feet).	Month.	Mean discharge in second-feet.	Run-off (total in acre-feet).
October	15.6	959	May	37.3	2,290
November	9.54	568	June	63.2	3,760
December	9.74	599	July	29.9	1,840
January	5.23	322	August	27.6	1,700
February	3.13	174	September	16.2	964
March	7.60	467			
April	57.74	3,430	The year	23.6	17,100

CANADIAN RIVER NEAR SANCHEZ, N. MEX.

LOCATION.—In sec. 8, T. 17 N., R. 24 E., 1 mile below the old Sánchez ruins, 2 miles north of Sanchez post office, 1½ miles below the mouth of Canyon Largo, 5 miles south of the mouth of Mora River, and 30 miles northwest of Bell Ranch post office, in the eastern part of San Miguel County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 15, 1912, to December 31, 1914, when station was discontinued.

GAGE.—Stevens water-stage recorder on right bank, installed November 3, 1914; prior to that date a Barrett & Lawrence water-stage recorder 100 feet downstream from site of present gage, on right bank; gages referred to different datums.

DISCHARGE MEASUREMENTS.—Made by wading at low and from cable at medium stages; high-water discharge computed by applying Kutter's formula to measurements of slope and cross section.

CHANNEL AND CONTROL.—Bed composed of rock, gravel, and sand; shifting. Banks high and not subject to overflow. Apparently no well-defined control.

EXTREMES OF DISCHARGE.—1912–1914: Maximum stage recorded, 25 feet June 12, 1913 (discharge, determined from slope and cross section, 82,700 second-feet); minimum stage recorded, 1.00 foot at times in April and May, 1913 (discharge, 2.0 second-feet).

WINTER FLOW.—Discharge relation not seriously affected by ice; open-channel rating curve assumed applicable except for periods of extreme low temperature, for which slight reductions are made.

DIVERSIONS.—Quantity of water diverted above station not known, but a large part of the flow is believed to be diverted for irrigation.

REGULATION.—Flow somewhat regulated during low and medium stages by storage works in the upper drainage basin used in connection with irrigation. No known water-power plants above this point which would affect the flow at the station.

ACCURACY.—Results considered fair. Extreme high-water discharge can not be measured with a current meter, and the accuracy of the high-water estimates is lowered by the use of the slope and cross-section method. Gage heights obtained by means of water-stage recorders which have not at all times given good results on account of faulty design. Channel subject to slight shifting, which has at times destroyed the discharge relation.

Discharge measurements of Canadian River near Sanchez, N. Mex., during the period Oct. 1 to Dec. 31, 1914.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 17	R. J. Hank	1.44	58.6	Dec. 7	C. J. Emerson	4.00	93.5
Nov. 1	do	2.09	158				

Daily discharge, in second-feet, of Canadian River near Sanchez, N. Mex., for the period Oct. 1 to Dec. 31, 1914.

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1	28	164	98	11	24	.....	90	21	84	.....	99
2	28	152	98	12	28	.....	73	22	101	.....	103
3	24	142	98	13	33	.....	54	23	101	.....	90
4	24	.....	98	14	38	.....	70	24	218	.....	131
5	20	120	97	15	44	.....	55	25	605	.....	125
6	20	.....	96	16	56	.....	50	26	555	.....	125
7	20	.....	94	17	69	.....	50	27	580	.....	120
8	20	.....	105	18	76	.....	60	28	445	.....	105
9	20	.....	127	19	84	.....	92	29	352	.....	90
10	20	.....	120	20	84	.....	106	30	265	.....	82
								31	203	.....	86

NOTE.—Discharge determined as follows: Oct. 1 to Nov. 3, Nov. 5, Dec. 5–15, and Dec. 19–31, by indirect method for shifting channels; Dec. 1–4, from information furnished by the observer and climatic data; Dec. 16–18, estimated on account of slight effect of ice.

Monthly discharge of Canadian River near Sanchez, N. Mex., for the period Oct. 1 to Dec. 31, 1914.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
October	605	20	138	8,480	C.
November	164	.....	[a] 115	6,840	D.
December	131	50	93.1	5,720	B.
The period	.....	.....	.....	21,000	

[a] Estimated from climatic data and information furnished by gage reader.

CHICORICA CREEK NEAR RATON, N. MEX.

LOCATION.—In sec. 28, T. 30 N., R. 24 E., 500 feet above the St. Louis, Rocky Mountain & Pacific Railway bridge; 10 miles southeast of Raton, above Raton and Una del Gato creeks, in northeastern part of Colfax County.

DRAINAGE AREA.—84 square miles (measured on topographic maps).

RECORDS AVAILABLE.—July 29, 1910, to December 31, 1914, when station was discontinued.

GAGE.—Stevens water-stage recorder on left bank, about 500 feet above railway bridge; installed June 8, 1914, at new datum; July 29, 1910, to May 4, 1914, Friez water-stage recorder attached to downstream side of railway bridge; May 5 to June 7, 1914, vertical staff gage referred to original datum.

DISCHARGE MEASUREMENTS.—Made from railway bridge at high water; at ordinary stages by wading.

CHANNEL AND CONTROL.—Bed composed of clay and gravel; subject to extreme changes. Banks clay, nearly vertical, and not subject to overflow. An artificial concrete control was constructed September 25, 1914, a few feet below the gage, to improve the channel. At low stages there appears to be a slight change in the discharge relation, due possibly to growth of moss on crest of control.

EXTREMES OF DISCHARGE.—1910–1914: Maximum stage recorded, 11.2 feet June 12, 1913 (approximate discharge, determined from slope and cross section, 6,100 second-feet); stream dry for extended periods within the years of record.

WINTER FLOW.—Discharge relation seriously affected by ice; flow estimated from discharge measurements, observer's notes, and records of precipitation and temperature.

DIVERSIONS.—A large part of the normal flow is diverted for irrigation in the vicinity of Raton, which accounts for the long periods of no flow at the station.

REGULATION.—No information.

ACCURACY.—Results considered fair. Prior to the installation of concrete control the discharge relation constantly changed and it was extremely difficult to obtain discharge measurements because of the erratic flow. The water-stage recorder eliminated the errors caused by fluctuation, and the control partly eliminated the changes in channel. Extreme discharge has for the most part been estimated from slope and cross section.

Discharge measurements of Chicorica Creek, near Raton, N. Mex., during the period Oct. 1 to Dec. 31, 1914.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 27	J. E. Powers	0.98	1.6	Dec. 9	R. J. Hank	1.07	2.0
31	do	1.03	3.8	14	J. E. Powers	1.07	[a]1.3
Nov. 7	do	1.00	2.6				

[a] Estimated; discharge relation affected by ice.

Daily discharge, in second-feet, of Chicorica Creek near Raton, N. Mex., for the period Oct. 1 to Dec. 31, 1914.

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1	2.2	4.0	3.0	11	1.8	2.4	1.8	21	1.4	2.4	2.4
2	2.4	3.0	3.4	12	1.8	2.4	1.6	22	1.5	2.4	2.2
3	2.4	3.0	2.6	13	1.7	2.2	1.5	23	1.6	2.6	2.2
4	2.6	2.8	3.0	14	1.7	2.2	1.3	24	1.4	2.6	2.0
5	2.4	3.0	3.2	15	1.6	3.4	1.3	25	1.2	2.8	2.0
6	2.2	2.6	3.4	16	1.6	3.4	1.2	26	1.0	2.8	2.0
7	2.2	2.6	4.3	17	1.5	2.6	1.2	27	1.6	3.2	2.0
8	2.1	2.6	3.4	18	1.5	2.2	1.2	28	2.2	3.0	1.8
9	2.0	2.6	2.0	19	1.4	2.4	2.0	29	2.4	3.4	1.8
10	1.9	2.2	2.0	20	1.4	2.4	2.5	30	2.8	3.2	1.5
								31	3.8		1.5

NOTE.—Discharge determined as follows: Oct. 1–7, 20, 23, and Oct. 26 to Dec. 9 by indirect method for shifting channels; Dec. 10–31 estimated, on account of ice; for remainder of October, estimated from information furnished by the hydrographer and from climatic data.

Monthly discharge of Chicorica Creek near Raton, N. Mex., for the period Oct. 1 to Dec. 31, 1914.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
October	3.8	1.0	1.91	117	C.
November	4.0	2.2	2.75	164	C.
December	4.3	1.2	2.17	133	C.
The period				414	

CIMARRON RIVER AT UTE PARK, N. MEX.

LOCATION.—In sec. 19, T. 27 N., R. 18 E., at highway bridge in Ute Park 300 feet north of St. Louis, Rocky Mountain & Pacific Railway depot, half a mile below mouth of Ute Creek, in western part of Colfax County.

DRAINAGE AREA.—235 square miles (measured on General Land Office map).

RECORDS AVAILABLE.—July 14, 1907, to December 31, 1914, when station was discontinued.

GAGE.—Friez water-stage recorder attached to downstream side of middle pier of highway bridge; prior to September, 1909, a vertical staff gage, to datum of which the water-stage recorder was referred.

DISCHARGE MEASUREMENTS.—Made from bridge at high stages; at ordinary stages by wading about 100 feet above gage.

CHANNEL AND CONTROL.—Bed composed of gravel and sand; subject to slight changes; channel is rather rough, so that high-water measurements are somewhat inaccurate. Banks of medium height and not subject to overflow.

EXTREMES OF DISCHARGE.—Maximum stage recorded October 1 to December 31, 1914, 0.60 foot October 27 to 29 (discharge, 23 second-feet); minimum stage, 0.32 foot November 22 and 23 (discharge, 7.0 second-feet).

1907–1914: Maximum stage recorded, 1.85 feet May 1, 1914 (discharge, 480 second-feet); minimum stage recorded, 0.24 foot February 25 to 28, 1911 (discharge, 2.0 second-feet).

WINTER FLOW.—Discharge relation seriously affected by ice; flow estimated from discharge measurements, observer's notes, and records of precipitation and temperature.

DIVERSIONS.—Only a very small part of the flow is diverted above station but most of the normal flow is diverted below.

REGULATION.—Flow at station not affected by regulation by controlling works above.

ACCURACY.—Results considered good. The slight changes in channel and errors introduced by rough channel during extreme high stages do not materially affect the accuracy of results. The changes in channel are not large and the discharge measurements under ordinary conditions are made by wading at a good section. Accuracy of winter records is reduced somewhat by the extreme effect of ice and the inability to operate the water-stage recorder.

Discharge measurements of Cimarron River at Ute Park, N. Mex., during the period Oct. 1 to Dec. 31, 1914.

[Made by J. E. Powers.]

Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*
Oct. 28	0.60	23.3
Dec. 15[a]	1.10	9.7

[a] Discharge relation affected by ice.

Daily discharge, in second-feet, of Cimarron River at Ute Park, N. Mex., for the period Oct. 1 to Dec. 31, 1914.

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1	12	21	9.7	11	17	15	9.7	21	21	7.9	9.5
2	11	22	9.7	12	18	13	9.7	22	21	7.0	9.5
3	11	21	9.7	13	18	12	9.7	23	21	7.0	9.5
4	12	20	9.7	14	18	12	9.7	24	22	7.3	9.0
5	14	20	9.7	15	19	11	9.7	25	22	7.9	9.0
6	16	21	9.7	16	19	9.1	9.5	26	22	7.6	9.0
7	16	21	9.7	17	19	9.4	9.5	27	23	7.6	9.0
8	16	20	9.7	18	20	9.7	9.5	28	23	8.2	9.0
9	17	17	9.7	19	20	9.1	9.5	29	23	9.1	9.0
10	17	16	9.7	20	20	8.5	9.5	30	22	11	9.0
								31	21	.....	9.0

NOTE.—Discharge determined as follows: Oct. 1–3, Oct. 6, and Oct. 28 to Dec. 1, by indirect method for shifting channels; Oct. 4–5 and 7–27, estimated from information furnished by hydrographer and from climatic data; Dec. 2–31, estimated, on account of ice.

Monthly discharge of Cimarron River at Ute Park, N. Mex., for the period Oct. 1 to Dec. 31, 1914.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
October	23	11	18.4	1,130	D.
November	22	7.0	12.9	768	B.
December	9.7	9.0	9.47	582	C.
The period				2,480	

RAYADO RIVER ABOVE ABREU'S RANCH, NEAR CIMARRON, N. MEX.

LOCATION.—Near sec. 29, T. 25 N., R. 18 E., at the mouth of the box canyon, 6 miles above Abreu's ranch house, 15 miles southwest of Cimarron, in southwestern part of Colfax County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 4, 1911, to December 31, 1914, when station was discontinued. From June 17, 1908, to May 5, 1911, a station was maintained three-fourths of a mile above Abreu's ranch house. No streams enter between the two points, but it is possible that some of the flow is lost by sinking into the sand.

GAGE.—Stevens water-gage recorder attached to tree on right bank; installed July 17, 1913, and referred to new datum; Friez water-stage recorder on left bank, about 100 feet above present site, May 4, 1911, to June 10, 1913, when it was washed out by a severe flood; June 17 to July 12, 1913, vertical staff gage, readings on which were referred to datum of present gage.

DISCHARGE MEASUREMENTS.—Made by wading a short distance above the gage.

CHANNEL AND CONTROL.—Bed composed of rock with pockets of sand and gravel. Left bank high and not subject to overflow; right bank subject to overflow at extreme stages; both banks heavily wooded. Control not well defined but changes in the section are slight and may be partly accounted for by displacement of rocks in the bed at times of high water.

EXTREMES OF DISCHARGE.—1911–1914: Maximum stage June 10, 1913 (gage height not obtained, but data derived from consideration of slope and cross section several miles downstream indicate that 2,000 to 3,000 second-feet of water passed the station at the maximum stage of this flood); minimum stage recorded, 0.60 foot (original datum) last of December, 1912, 0.70 foot (original datum) last of January and first of February, 1913, and 0.26 foot November 23, 1913 (discharge, 1.0 second-foot.)

WINTER FLOW.—Discharge relation seriously affected by ice; flow estimated from discharge measurements, observer's notes, and records of precipitation and temperature.

DIVERSIONS.—None above station.

REGULATION.—There are no power plants or controlling works above the station.

ACCURACY.—Results considered good during the open-water period, low during winter months. The gage height record reliable and accurate. The change in discharge relation is not large, and does not lower the accuracy of final results to a large extent.

Discharge measurements of Rayado River above Abreu's ranch, near Cimarron, N. Mex., during the period Oct. 1 to Dec. 31, 1914.

[Made by J. E. Powers.]

Date.	Gage height.	Discharge
	Feet.	*Sec.-ft.*
Oct. 29	0.85	11.8
Dec. 16[a]	.40	5.6

[a] Discharge relation affected by ice.

Daily discharge, in second-feet, of Rayado River above Abreu's ranch, near Cimarron, N. Mex., for the period Oct. 1 to Dec. 16, 1914.

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1	7.0	11	6.0	11	7.8	7.2	.....	21	9.5	4.2	.....
2	7.2	11	.....	12	7.5	5.6	.....	22	11	4.8	.....
3	7.8	10	.....	13	7.8	5.8	.....	23	11	6.0	.....
4	13	9.8	.....	14	7.8	6.6	.....	24	11	7.0	.....
5	12	9.0	.....	15	7.8	5.2	.....	25	13	5.0	.....
6	9.8	8.8	.....	16	7.5	4.8	5.5	26	16	4.7	.....
7	9.0	8.5	.....	17	7.2	7.5	.....	27	14	6.4	.....
8	8.8	7.8	.....	18	6.8	6.4	.....	28	13	5.4	.....
9	8.2	7.8	.....	19	6.6	7.5	.....	29	13	6.4	.....
10	7.8	7.0	.....	20	6.4	6.2	.....	30	12	6.0	.....
								31	11	.....	.....

NOTE.—Discharge determined by indirect method for shifting channels. Discharge relation affected by ice Dec. 2-31.

Monthly discharge of Rayado River above Abreu's ranch, near Cimarron, N. Mex., for the period Oct. 1 to Dec. 31, 1914.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
October	16	6.4	9.62	592	B.
November	11	4.2	6.98	415	B.
December	.....	.....	[a] 5.00	307	D.
The period	.....	.....	.....	1,310	

[a] Estimated from climatic data and information furnished by the hydrographer.

URRACA CREEK NEAR CIMARRON, N. MEX.

LOCATION.—Near sec. 35, T. 26 N., R. 18 E., at proposed reservoir site, 5 miles upstream from Urraca ranch headquarters, 8 miles southwest of Cimarron, in the western part of Colfax County.

DRAINAGE AREA.—6.3 square miles (private survey).

RECORDS AVAILABLE.—November 25, 1912, to December 31, 1914, when station was discontinued.

GAGE.—Friez water-stage recorder on the left bank at the proposed reservoir site.

DISCHARGE MEASUREMENTS.—Made by wading about 100 feet above gage.

CHANNEL AND CONTROL.—Left bank a solid rock wall above and below gage; right bank made up of rock and gravel, slightly sloping; both banks high and not subject to overflow. An artificial concrete control was installed September 21, 1914, a few feet below the gage; previously the discharge relation was affected by changes in channel. Bed composed of rock and bowlders with pockets of sand and gravel.

EXTREMES OF DISCHARGE.—1912–1914: Maximum stage recorded, 5.1 feet at 11.30 p. m. June 10, 1913 (discharge not computed); minimum stage recorded, 1.00 foot February 1–5, 1913 (discharge, 0.3 second-foot).

WINTER FLOW.—Discharge relation seriously affected by ice; flow estimated from discharge measurements, observer's notes, and records of precipitation and temperature.

DIVERSIONS.—None above station.

REGULATION.—None; no power plants above station.

ACCURACY.—Results considered good since the installation of the artificial control. The accuracy of winter records is low because of the extreme ice effect and the difficulty encountered in operating the water-stage recorder.

The following discharge measurement was made by J. E. Powers:
October 29, 1914: Gage height, 1.45 feet; discharge, 2.2 second-feet.

Daily discharge, in second-feet, of Urraca Creek near Cimarron, N. Mex., for the period Oct. 1 to Nov. 30, 1914.

Day.	Oct.	Nov.	Day.	Oct.	Nov.	Day.	Oct.	Nov.
1	1.2	2.1	11	1.2	1.6	21	1.9	1.3
2	1.2	2.2	12	1.2	1.5	22	2.2	1.3
3	1.1	2.1	13	1.2	1.5	23	2.6	1.3
4	1.6	2.0	14	1.3	1.5	24	2.3	1.3
5	1.3	1.9	15	1.3	1.3	25	2.8	1.3
6	1.3	1.8	16	1.3	1.2	26	2.4	1.3
7	1.2	1.8	17	1.2	1.2	27	2.2	1.2
8	1.2	1.8	18	1.2	1.2	28	2.3	1.2
9	1.2	1.7	19	1.2	1.4	29	2.3	1.2
10	1.2	1.7	20	1.2	1.4	30	2.3	1.2
						31	2.2	.....

NOTE.—Discharge determined as follows: Oct. 1 to Nov. 20 and Nov. 27 from a curve fairly well defined between extremes of stage for the period; for remainder of November estimated from information furnished by the observer and climatic data. Discharge relation affected by ice Dec. 1–31.

Monthly discharge of Urraca Creek near Cimarron, N. Mex., for the period Oct. 1 to Dec. 31, 1914.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
October	[1]2.8	1.1	1.62	100	B.
November	2.2	1.2	1.52	90	C.
December	.....	.....	[a]1.00	61	D.
The period	.....	.....	.....	251	

[a] Estimated from climatic data and information furnished by the gage reader.

EAST FORK OF OCATE RIVER AT OCATE, N. MEX.

LOCATION.—In the SE. ¼, sec. 2, T. 22 N., R. 18 E., at Ocate, 500 feet above confluence with West Fork of Ocate River, 25 miles northwest of Wagon Mound, in northwestern part of Mora County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—September 28 to December 31, 1914, when station was discontinued.

GAGE.—Overhanging chain gage attached to posts on the right bank; read morning and evening by Vidal Mondragon.

DISCHARGE MEASUREMENTS.—Made by wading.

CHANNEL AND CONTROL.—Channel straight above and below gage, right bank high, left bank low and subject to overflow. Bed is composed of clay, no marked control for the section.

EXTREMES OF STAGE.—Maximum stage recorded during period of record, 1.35 feet, October 24; minimum stage recorded, 1.10 feet several days in November and December.

WINTER FLOW.—Discharge relation seriously affected by ice.

DIVERSIONS.—Water is diverted for irrigation above the station, and diversion is proposed by the Lake Charlotte Irrigation Co. from the main stream—Ocate River—about 3 miles below this station.

REGULATION.—No power plants above station.

ACCURACY.—Gage-height records published considered reliable.

Data inadequate for determining daily discharge.

Discharge measurements of East Fork of Ocate River at Ocate, N. Mex., during the period Oct. 1 to Dec. 31, 1914.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Nov. 3	J. E. Powers	1.20	6.7
Dec. 10[a]	R. J. Hank	1.20	5.1

[a] Discharge relation affected by ice.

Daily gage height, in feet, of East Fork of Ocate River at Ocate, N. Mex., for the period Oct. 1 to Dec. 31, 1914.

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1	1.11	1.20	1.10	11	1.15	1.15	1.15	21	1.20	1.10	1.10
2	1.18	1.19	1.11	12	1.11	1.14	1.20	22	1.25	1.12	1.10
3	1.21	1.22	1.11	13	1.16	1.14	1.14	23	1.24	1.12	1.12
4	1.15	1.20	1.11	14	1.20	1.14	1.10	24	1.35	1.11	1.18
5	1.20	1.19	1.10	15	1.20	1.12	1.10	25	1.28	1.14	1.20
6	1.20	1.18	1.19	16	1.18	1.11	1.10	26	1.26	1.10	1.29
7	1.18	1.19	1.16	17	1.16	1.11	1.10	27	1.25	1.10	1.30
8	1.12	1.18	1.19	18	1.16	1.11	1.10	28	1.20	1.10	1.22
9	1.16	1.18	1.19	19	1.16	1.11	1.10	29	1.21	1.14	1.29
10	1.12	1.10	1.20	20	1.19	1.10	1.12	30	1.20	1.11	1.22
								31	1.21	.....	1.10

NOTE.—Discharge relation affected by ice Dec. 10–22.

WEST FORK OF OCATE RIVER AT OCATE, N. MEX.

LOCATION.—In the SE. ¼ sec. 2, T. 22 N., R. 18 E., 400 feet above confluence with East Fork of Ocate River, at Ocate, 25 miles northwest of Wagon Mound, in northwestern part of Mora County.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—September 28 to December 31, 1914, when station was discontinued.

GAGE.—Inclined staff gage attached to post on left bank—read daily, morning and evening, by Vidal Mondragon.

DISCHARGE MEASUREMENTS.—Made by wading.

CHANNEL AND CONTROL.—One channel at all stages. Right bank high and rocky; left bank low and subject to overflow. Bed composed of clay; probably subject to shift.

EXTREMES OF STAGE.—Maximum stage recorded, 1.85 feet December 23; minimum, 0.20 foot (ice) December 15, 16, and 21.

WINTER FLOW.—Discharge relation seriously affected by ice.

DIVERSIONS.—Some water is diverted for irrigation above the station, and diversion is proposed by the Lake Charlotte Irrigation Co. from the main stream—Ocate River—about 3 miles below this point.

REGULATION.—Flow not affected by controlling works or power plants above the station.

ACCURACY.—Gage-height record considered reliable.

Data inadequate for determining daily discharge.

Discharge measurements of West Fork of Ocate River at Ocate, N. Mex., during the period Oct. 1 to Dec. 31, 1914.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Nov. 3	J. E. Powers	0.85	[a] 0.4
Dec. 10	R. J. Hank	.60	[a] .2

[a] Estimated.

Daily gage height, in feet, of West Fork of Ocate River at Ocate, N. Mex., for the period Oct. 1 to Dec. 31, 1914.

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1	1.05	0.50	0.45	11	0.50	0.55	0.55	21	0.50	0.55	0.20
2	1.02	.75	.35	12	.25	.40	.60	22	.88	.55	.95
3	1.05	.50	.40	13	.50	.55	.40	23	.75	.70	1.85
4	1.05	.50	.40	14	.62	.40	.30	24	1.02	.65	1.55
5	.88	.45	.40	15	.62	.40	.20	25	1.00	.45	1.35
6	.62	.45	.50	16	.62	.35	.20	26	1.00	.50	1.35
7	.88	.45	.45	17	.62	.40	.25	27	.75	.40	1.20
8	.50	.50	.50	18	.88	.40	.90	28	.75	.35	1.35
9	.75	.45	.55	19	.50	.40	.30	29	.75	.40	.82
10	.62	.45	.80	20	.38	.45	.40	30	.75	.40	.75
								31	.75		.65

NOTE.—Discharge relation affected by ice Dec. 10–21.

SWEETWATER CREEK NEAR COLMOR, N. MEX.

LOCATION.—In the NE. ¼ sec. 10, T. 23 N., R. 20 E., 100 feet upstream from highway bridge on the Springer-Ocate road, 8 miles west of Colmor, 15 miles southwest of Springer, near the county line between Mora and Colfax counties.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—March 17 to December 31, 1914, when station was discontinued.

GAGE.—Stevens water-stage recorder on left bank, 100 feet above highway bridge.

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

CHANNEL AND CONTROL.—Bed composed of hard clay; both banks vertical and not subject to overflow. One channel at all stages. Rock riffles below the gage may serve as a control.

EXTREMES OF DISCHARGE.—Maximum stage recorded, 3.70 feet, May 2 (discharge not computed); minimum, 0.26 foot August 18 (discharge, 0.1 second-foot).

WINTER FLOW.—Discharge relation seriously affected by ice; flow estimated from discharge measurements and records of precipitation and temperature.

DIVERSIONS.—Several small diversions above station. The Lake Charette Irrigation Co.'s proposed diversion is about 5 miles above the gage.

REGULATION.—No power plants or controlling works above station.

ACCURACY.—Results considered approximate. The erratic flow at this point prevented a complete rating of the station and the discharge was interpolated between discharge measurements.

Discharge measurements of Sweetwater Creek near Colmer, N. Mex., during the period Oct. 1 to Dec. 31, 1914.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Nov. 7	J. E. Powers	0.5	[a] 0.2
Dec. 11	R. J. Hank	.5	[a] .2

[a] Estimated.

Daily discharge, in second-feet, of Sweetwater Creek near Colmor, N. Mex., for period Oct. 1 to Dec. 31, 1914.

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1	0.2	0.2	0.2	11	0.2	0.2	0.2	21	0.8	0.2	0.2
2	.2	.2	.2	12	.2	.2	2	22	1.0	.2	.2
3	.2	.2	.2	13	.2	.2	.2	23	2.0	.2	.2
4	.3	.2	.2	14	.2	.2	.2	24	2.5	.2	.2
5	.3	.2	.2	15	.2	.2	.2	25	3.0	.2	.2
6	.3	.2	.2	16	.2	.2	.2	26	1.0	.2	.2
7	.3	.2	.2	17	.2	.2	.2	27	.5	.2	.2
8	.2	.2	.2	18	.2	.2	.2	28	.3	.2	.2
9	.2	.2	.2	19	.3	.2	.2	29	.2	.2	.2
10	.2	.2	.2	20	.5	.2	.2	30	.2	.2	.2
								31	.2	.....	.2

NOTE.—Discharge determined as follows: Oct. 1 to Dec. 11 from discharge measurements and gage record for the period; Dec. 12–31 interpolated from records of near-by stations and climatic data.

Monthly discharge of Sweetwater Creek near Colmor, N. Mex., for the period Oct. 1 to Dec. 31, 1914.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
October	3.0	0.2	0.53	33	D.
November	.2	.2	.20	12	D.
December	.2	.2	.20	12	D.
The period	.....	.....	.....	57	

MORA RIVER NEAR SHOEMAKER, N. MEX.

LOCATION.—In T. 18 N., R. 21 E., at entrance of box canyon, 8 miles east of Shoemaker, 20 miles south of Wagon Mound, 20 miles above mouth of river, below all important tributaries and diversions, near line between Mora and San Miguel counties.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—October 1 to December 31, 1914, when station was discontinued.

GAGE.—Stevens water-stage recorder attached to a projecting rock ledge on the left bank.

DISCHARGE MEASUREMENTS.—Made by wading or from cable 100 feet below gage.

CHANNEL AND CONTROL.—Channel straight above and below the gage; banks high and not subject to overflow. Bed composed of coarse gravel and sand; permanent at low and medium stages. Rapids below the gage serve as a control and change only during extreme floods.

EXTREMES OF DISCHARGE.—Maximum stage recorded during period of record, 1.77 feet, October 26 (discharge, 187 second-feet); minimum stage, 0.91 foot October 1 and 2 (discharge, 15 second-feet).

WINTER FLOW.—Discharge relation seriously affected by ice; flow estimated from discharge measurements, observer's notes, and records of precipitation and temperature.

DIVERSIONS.—Considerable water is diverted for irrigation above the station.

REGULATION.—Flow principally unregulated, except by diversions for irrigation.

ACCURACY.—Results considered good during the open-water period. Gage-heights recorded are accurate and reliable and good discharge measurements can be made. The discharge relation is permanent during normal flows.

Discharge measurements of Mora River near Shoemaker, N. Mex., during the period Oct. 1 to Dec. 31, 1914.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Oct. 2	R. J. Hank	0.90	14.5	Dec. 1	C. J. Emerson	1.30	64.7
Nov. 6	J. E. Powers	1.33	71.5	Dec. 18[a]	J. E. Powers	1.50	45.1

[a] Discharge relation affected by ice.

Daily discharge, in second-feet, of Mora River near Shoemaker, N. Mex., for the period Oct. 1, to Dec. 31, 1914.

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1	15	85	65	11	34	62	48	21	40	56	33
2	15	83	65	12	34	56	41	22	41	58	26
3	19	77	69	13	34	55	34	23	79	56	34
4	27	75	60	14	35	56	34	24	87	56	40
5	30	79	53	15	35	56	28	25	145	58	41
6	40	73	58	16	35	58	23	26	187	58	44
7	42	75	65	17	35	56	34	27	171	60	48
8	38	73	62	18	38	58	45	28	136	56	67
9	32	67	56	19	42	58	40	29	97	56	87
10	33	65	48	20	40	55	37	30	81	58	97
								31	85	.....	83

NOTE.—Discharge determined as follows: Oct. 1 estimated; Oct. 2 to Dec. 8 from a well-defined curve; Dec. 9–31 estimated because of ice.

Monthly discharge of Mora River near Shoemaker, N. Mex., for the period Oct. 1 to Dec. 31, 1914.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
October	187	15	58.1	3 570	B.
November	85	55	63.1	3 750	A.
December	97	23	50.5	3 110	C.
The period	.....	.....	.....	10 400	

RED RIVER BASIN.

MEDICINE BLUFF CREEK NEAR LAWTON, OKLA.

LOCATION.—In sec. 18, T. 3 N., R. 12 W., at Medicine Park, 12 miles northwest of Lawton, in Comanche County; nearest tributary, Little Medicine Bluff Creek, enters a few hundred yards above.

DRAINAGE AREA.—Approximately 110 square miles.

RECORDS AVAILABLE.—November 26, 1912, to September 30, 1915.

GAGE.—Stevens water-stage recorder installed February 16, 1915, at left bank, one-third mile below Medicine Park Hotel; original gage was vertical staff on left bank a short distance below hotel, and set to datum 0.68 foot higher than that of the present gage; fall between the two points, 0.18 foot.

DISCHARGE MEASUREMENTS.—Made from cable 100 yards above gage or by wading at control.

CHANNEL AND CONTROL.—Channel composed of sand and gravel overlying bedrock; control is rock ledge in the lowest part of which, for a width of 10 feet, are bowlders; control practically permanent. Banks high and not subject to overflow.

EXTREMES OF DISCHARGE.—Maximum stage during year from water-stage recorder 9.85 feet at 2 p. m., April 25 (discharge, 5,000 second-feet); minimum stage, 0.66 foot from January 7 to February 4 (discharge, 0.1 second-foot).

WINTER FLOW.—Discharge relation not affected by ice.

DIVERSIONS.—The Lawton waterworks diverts about 1.6 second-feet from Medicine Bluff Creek in Lawton Reservoir.

REGULATION.—Flow controlled to a great extent by Lawton Reservoir, 1⅛ miles upstream; capacity, 14,000 acre-feet.

NATURAL RUN-OFF.—To show natural run-off of Medicine Bluff Creek, computations have been made which include flow past gage, daily loss from evaporation, gain or loss by storage, and diversion for Lawton waterworks.

ACCURACY.—Results considered excellent for high stages; for low stages the actual error is small but the percentage error may be high. Rating curve is well defined, control permanent, and gage height record reliable.

Discharge measurements of Medicine Bluff Creek, near Lawton, Okla., during the year ending Sept. 30, 1915.

[Made by F. B. King.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Apr. 10	[a] 2.54	52	Apr. 27	[c] 4.33	487
Apr. 26	[b] 5.30	1,140	June 27	2.25	36

[a] Old gage, 2.05 feet. [b] Old gage, 4.98 feet. [c] Old gage 3.92 feet.

Daily discharge, in second-feet, of Medicine Bluff Creek, near Lawton, Okla., for the year ending Sept. 30, 1915.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	1.8	1.8	0.8	1.2	0.1	15	0.4	115	29	33	12	10
2	2.1	2.1	.8	1.2	.1	11	.5	205	29	43	12	10
3	2.1	2.1	.8	1.2	.1	58	.4	132	44	24	11	10
4	2.1	2.1	.8	1.2	.1	30	.4	92	.....	46	11	10
5	2.1	2.1	.8	1.2	4	15	.4	92	.....	11	11	9
6	2.1	2.1	.8	1.2	1.2	12	.4	310	.....	10	11	9
7	2.1	2.2	.8	1.2	.8	8	1.5	310	.....	11	12	9
8	2.1	2.1	.8	1.2	.8	5	4.6	173	.....	10	12	8
9	2.1	2.1	.8	1.2	.6	5	37	136	224	10	12	8
10	2.1	2.1	.8	10	.6	5	34	108	156	10	10	8
11	2.1	2.1	.8	10	.6	4.6	26	88	122	10	10	9
12	2.1	2.1	.8	.6	.6	5	11	71	100	10	12	8
13	1.4	2.1	.5	.6	1.2	4.8	11	61	111	10	13	8
14	1.0	2.1	.2	.6	1.2	3.8	11	53	92	10	6	8
15	1.0	2.1	.4	.2	1.2	6	27	29	71	10	2.6	8
16	1.0	12	.5	.2	1.1	3	52	21	66	11	7	9
17	1.2	5	.6	.1	1.1	2.2	51	26	66	11	11	8
18	1.2	.8	.6	.1	1.1	2.6	52	12	19	11	14	8
19	1.2	7	.8	.1	.9	12	58	74	12	11	8	8
20	1.2	.8	.8	.1	6	1.6	76	635	12	13	8	8
21	1.2	.8	.8	.1	6	4	66	328	13	12	8	8
22	1.2	.8	.8	.1	15	7	215	173	14	12	8	15
23	1.5	.8	.8	.1	8	1.2	202	122	14	12	9	11
24	1.8	.8	1.3	.1	6	.8	165	86	15	12	9	69
25	1.4	.8	1.3	.1	6	6	2,960	59	16	12	9	700
26	2.2	.8	1.3	.1	11	9	1,220	77	23	12	14	361
27	2.0	.8	1.3	.1	82	.9	430	82	29	12	12	192
28	1.8	.8	1.3	.1	29	.7	251	35	29	11	10	128
29	1.8	.8	1.2	.1	.....	.7	173	41	30	12	43	105
30	1.8	.8	1.2	.1	.....	13	139	47	25	11	29	66
31	1.8	.....	1.2	.1	.....	.6	.....	53	.....	12	10	.....

NOTE.—Discharge determined from two well-defined rating curves, applicable as follows: Oct. 1 to Feb. 20, and Feb. 21 to Sept. 30. Discharge July 9, 10, Sept. 17 and 18, interpolated, as water-stage recorder did not work properly.

Monthly discharge of Medicine Bluff Creek near Lawton, Okla., for the year ending Sept. 30, 1915.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
October	2.2	1.0	1.70	104	
November	12	.8	2.16	129	
December	1.3	.2	.85	52	
January	10	.1	1.11	68	
February	82	.1	6.66	370	
March	58	.6	8.18	503	
April	2,960	.4	209	12,400	A.
May	635	12	124	7,620	A.
July	46	10	14.4	885	
August	43	2.6	11.8	726	
September	700	8	60.9	3,620	A.

NOTE.—Results considered excellent for high stages. For periods of low water the actual error is very small but the percentage error may be high. Record for June incomplete.

Corrected monthly discharge of Medicine Bluff Creek near Lawton, Okla., for the year ending Sept. 30, 1915.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	3.2	0.0	0.84	52
November	4	.1	2.54	151
December	28	1	5.26	323
January	31	1.7	6.15	378
February	248	2.5	31.1	1,730
March	186	.0	48.3	2,970
April	3,890	6	227	13,500
May	1,700	.0	151	9,280
July	.61	2	19.9	1,220
August	137	1	40.7	2,500
September	676	1	72.8	4,330

NOTE.—Record corrected for storage, evaporation, and the diversion to Lawton.

LITTLE MEDICINE BLUFF CREEK NEAR LAWTON, OKLA.

LOCATION.—One hundred and fifty feet below west line of sec. 18, T. 3 N., R. 12 W., one-half mile above the mouth of the creek and 12½ miles northwest of Lawton, in Comanche County.

DRAINAGE AREA.—Approximately 10 square miles.

RECORDS AVAILABLE.—November 26, 1912, to September 30, 1915.

GAGE.—Vertical staff on left bank, one-half mile above mouth of creek; read once daily by W. S. Kesler and J. B. Lenertz; 200 feet upstream is a gage referred to same datum, which is read by observer during flood to determine slope between it and regular gage.

DISCHARGE MEASUREMENTS.—Made by wading near gage.

CHANNEL AND CONTROL.—Channel composed of ledge rock overlaid by sand; control is rock ledge just below gage. Between the station and the crest of the small dam on Medicine Bluff Creek just below Little Medicine Bluff Creek, there is a fall of about 8 feet.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.5 feet at 1.30 p. m., April 9 (discharge, 565 second-feet); gage washed out by flood later; minimum stage, 0.10 foot, October 15–22; October 29–November 6; December 13–17; July 12–19; July 21 to August 8; August 10–17; 21–23; and September 3–21 (discharge, 0.1 second-foot).

WINTER FLOW.—Discharge relation not affected by ice.

DIVERSIONS.—None.

REGULATION.—None.

ACCURACY.—Results considered fair. Rating curve well defined and control permanent, but owing to flashy character of stream mean daily stage based on one or two readings may be considerably in error.

No discharge measurements were made at this station during the year.

Daily discharge, in second-feet, of Little Medicine Bluff Creek near Lawton, Okla., for the year ending Sept. 30, 1915.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	0.2	0.1	0.2	0.6	0.4	14	0.6	.....	0.8	1.3	0.1	0.2
2	.2	.1	.2	.6	.4	8.3	.6	.....	.8	.8	.1	.2
3	.2	.1	.2	.6	.3	45	.6	.....	.8	.4	.1	.1
4	.2	.1	.2	.6	.3	23	.6	.....	5.0	1.3	.1	.1
5	.2	.1	.2	.6	.3	15	.6	.....	12.0	.8	.1	.1
6	.2	.1	.2	.6	.3	9	2.4	.....	4.2	.4	.1	.1
7	.2	.2	.2	.6	.3	7.2	4.2	.....	5.5	.2	.1	.1
8	.2	.2	.2	.4	.3	6.2	5.0	15	48.0	.2	.1	.1
9	.2	.2	.2	.4	.3	6.2	59	9	39.0	.2	.2	.1
10	.2	.2	.2	.4	.3	5.5	35	7.2	12.0	.2	.1	.1
11	.2	.2	.2	.4	.3	5.0	9	7.2	5.5	.2	.1	.1
12	.2	.2	.2	.4	.3	6.2	6.2	3.5	4.2	.1	.1	.1
13	.2	.2	.1	.4	1.6	5.5	5.0	3.0	2.2	.1	.1	.1
14	.2	.2	.1	.4	1.3	5.0	4.2	2.2	.8	.1	.1	.1
15	.1	.2	.1	.4	1.1	3.5	3.5	1.3	.8	.1	.1	.1
16	.1	.2	.1	.4	.8	3.0	3.0	.8	.8	.1	.1	.1
17	.1	.2	.1	.4	.8	3.0	2.7	1.6	.4	.1	.1	.1
18	.1	.2	.2	.4	.8	2.7	3.0	.4	.4	.1	.2	.1
19	.1	.2	.2	.3	.6	2.7	3.5	2.2	.4	.1	.2	.1
20	.1	.2	.2	.3	9	2.2	15	3.0	.4	.2	.2	.1
21	.1	.2	.2	.3	6.2	2.2	6.2	12	.4	.1	.1	.1
22	.1	.2	.2	.3	17	1.6	233	7.2	.4	.1	.1	.2
23	.2	.2	.2	.3	8.3	1.6	33	4.2	.4	.1	.1	.4
24	.2	.2	.4	.3	5.5	1.6	14	3.0	.4	.1	.2	33
25	.2	.2	.4	.3	4.2	1.1	.....	1.6	.2	.1	.2	431
26	.2	.2	.4	.3	9	1.1	.....	1.6	2.2	.1	.3	59
27	.2	.2	.6	.3	59	1.1	.....	2.2	1.3	.1	.4	45
28	.2	.2	.6	.3	23	.8	.....	2.2	2.2	.1	.4	28
29	.1	.2	.6	.3	.....	.8	.....	1.3	1.3	.1	.8	9
30	.1	.2	.6	.3	.....	.8	.....	1.3	2.2	.1	.8	3
31	.1	.....	.6	.4	.....	.6	.....	1.3	.....	.1	.4	.....

NOTE.—Discharge computed from rating curve well defined below 250 second-feet. No estimate Apr. 25 to May 7, because gage was washed out on Apr. 5 and gage readings were not resumed until May 8.

Monthly discharge of Little Medicine Bluff Creek near Lawton, Okla., for the year ending Sept. 30, 1915.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	0.2	0.1	0.16	10
November	.2	.1	.18	11
December	.6	.1	.27	17
January	.6	.3	.41	25
February	59	.3	5.43	302
March	45	.6	6.18	380
April 1–24	233	.6	18.7	990
May 8–31	15	.4	3.93	187
June	48	.2	5.17	308
July	1.3	.1	.26	16
August	.8	.1	.20	12
September	431	.1	20.4	1,210

EVAPORATION STATION NEAR LAWTON, OKLA.

LOCATION.—In a somewhat sheltered bay on the west side of Lawton Reservoir, 12 miles northwest of Lawton, in Comanche County.

RECORDS AVAILABLE.—February 20, 1913, to September 30, 1915.

EQUIPMENT FOR MEASUREMENT.—A galvanized iron pan 3 feet square and 18 inches deep floating in the center of a skeleton raft about 75 feet from the shore; in the center of the pan is a vertical needle point which is the reference point for measuring evaporation. Rainfall measured by rain gage on raft.

Daily evaporation, in inches, at Lawton reservoir near Lawton, Okla., for the year ending Sept. 30, 1915.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	0.18	0.12	0.06	0.04	0.03	0.10	0.12	0.10	0.32	0.32	0.03	0.39
2	.17	.10	.09	.03	.02	.00	.10	.16	.22	.36	.37	.41
3	.15	.08	.12	.02	.02	.05	.11	.12	.27	.28	.38	.38
4	.14	.06	.08	.02	.05	.02	.16	.15	.25	.30	.36	.40
5	.12	.08	.06	.02	.07	.14	.10	.18	.20	.31	.38	.39
6	.18	.09	.04	.04	.09	.10	.09	.21	.21	.28	.40	.39
7	.16	.04	.03	.05	.08	.11	.09	.24	.08	.30	.40	.39
8	.14	.15	.08	.04	.05	.12	.06	.26	.38	.32	.40	.38
9	.09	.12	.06	.06	.07	.06	.06	.28	.37	.26	.30	.40
10	.15	.15	.07	.02	.08	.04	.14	.27	.41	.23	.36	.42
11	.16	.10	.05	.05	.06	.06	.12	.20	.38	.27	.37	.41
12	.20	.06	.06	.08	.03	.02	.15	.21	.37	.27	.34	.39
13	.22	.07	.04	.05	.02	.07	.16	.22	.28	.30	.37	.40
14	.21	.12	.02	.06	.06	.05	.15	.27	.20	.32	.37	.37
15	.18	.14	.04	.07	.09	.00	.14	.24	.31	.33	.39	.45
16	.18	.13	.03	.04	.10	.11	.15	.29	.27	.31	.43	.38
17	.16	.15	.02	.06	.14	.09	.10	.28	.47	.37	.36	.40
18	.14	.14	.03	.07	.11	.11	.08	.19	.48	.36	.38	.41
19	.10	.12	.02	.06	.08	.11	.08	.16	.38	.30	.33	.33
20	.08	.11	.01	.06	.03	.13	.09	.16	.42	.28	.36	.31
21	.09	.13	.02	.07	.06	.12	.08	.15	.39	.27	.38	.30
22	.06	.09	.03	.10	.05	.15	.05	.26	.31	.32	.42	.24
23	.01	.07	.01	.08	.10	.13	.09	.26	.33	.35	.33	.24
24	.09	.04	.00	.05	.07	.14	.12	.37	.28	.36	.18	.27
25	.11	.05	.01	.03	.08	.15	.09	.42	.27	.35	.37	.16
26	.14	.04	.02	.02	.00	.12	.08	.36	.27	.37	.35	.28
27	.18	.00	.00	.02	.04	.10	.10	.27	.28	.38	.34	.29
28	.15	.05	.00	.03	.09	.08	.09	.38	.31	.40	.33	.31
29	.10	.05	.05	.02	.....	.10	.12	.33	.38	.38	.34	.23
30	.11	.06	.03	.03	.....	.00	.08	.30	.35	.37	.34	.22
31	.13	.....	.03	.00	.....	.13	.....	.27	.....	.28	.37	.....

NOTE.—Evaporation estimated May 4–8, 26, 30, June 4, 5, 26, 30, July 4, 20, Aug. 9, 20, 27, 29, Sept. 22 as wind destroyed record. Observer reported ice in pan Dec. 13–31, Jan. 24–31.
Records represent gross evaporation and not evaporation less rainfall.

Monthly evaporation, in inches, at Lawton reservoir near Lawton, Okla., for the year ending Sept. 30, 1915.

October	4.28	May	7.56
November	2.72	June	9.44
December	1.21	July	9.99
January	1.39	August	10.83
Febraury	1.77	September	10.34
March	2.71		
April	3.15	The year	65.30

INDEX.

STREAM-GAGING STATIONS

AND

PUBLICATIONS RELATING TO WATER RESOURCES

PART VII.—LOWER MISSISSIPPI RIVER BASIN

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, and 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 slope basins.
II. South Atlantic and eastern 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 slope basins in California.
XII. North Pacific slope basins (in three parts).

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 on application 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., Customhouse.
Albany, N. Y., Room 18, Federal Building.
Atlanta, Ga., Post Office Building.
St. Paul, Minn., Old Capitol Building.
Madison, Wis., care of Railroad Commission of Wisconsin.
Helena, Mont., Montana National Bank Building.
Denver, Colo., 403 New Post Office Building.
Salt Lake City, Utah, Federal Building.
Boise, Idaho, 615 Idaho Building.
Phoenix, Ariz., 417 Fleming Building.
Austin, Tex., Old Post Office Building.
Portland, Oreg., 416 Couch Building.
Tacoma, Wash., Federal Building.
San Francisco, Cal., 328 Customhouse.
Los Angeles, Cal., Federal Building.
Honolulu, Hawaii, Kapiolani Building.

A list of the Geological Survey's publications may be obtained by applying to the Director, United States Geological Survey, Washington, D. C.

STREAM-FLOW REPORTS.

Stream-flow records have been obtained at more than 3,800 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	Descriptions, measurements, gage heights, and ratings	1893 to 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.

Stream-flow data in reports of the United States Geological Survey—Continued.

Report.	Character of data.	Year.
W 27	Measurements, ratings, and gage heights, eastern United States, eastern Mississippi River, and Missouri River.	1908.
W 28	Measurements, ratings, and gage heights, Arkansas River and western United States.	1908.
20th A, pt. 4	Monthly discharge (also for many earlier years)	1908.
W 35 to 39	Descriptions, measurements, gage heights, and ratings	1909.
21st A, pt. 4	Monthly discharge	1909.
W 47 to 52	Descriptions, measurements, gage heights, and ratings	1910.
22d A, pt. 4	Monthly discharge	1910.
W 65, 66	Descriptions, measurements, gage heights, and ratings	1911.
W 75	Monthly discharge	1911.
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.

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 following table gives, by years and drainage basins, the numbers of the papers on surface-water supply published from 1899 to 1913. 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 1915, are published in Water-Supply Papers 97, 124, 165, 201, 241, 261, 281, 301, 321, 351, 381, and 401, which contain records for the New England streams from 1903 to 1915. Results of miscellaneous measurements are published by drainage basins.

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Number of water-supply papers containing results of stream measurements, 1899–1915.

Year.	I North Atlantic slope (St. John River to York River).	II South Atlantic and eastern Gulf of Mexico (James River to the Mississippi).	III Ohio River.	IV St. Lawrence River and Great Lakes.	V Hudson Bay and upper Mississippi River.	VI Missouri River.	VII Lower Mississippi River.	VIII Western Gulf of Mexico.	IX Colorado River.	X Great Basin.	XI Pacific slope in California.	XII North Pacific slope basins.		
												Pacific slope in Washington and upper Columbia River.	Snake River basin.	Lower Columbia River and Pacific slope 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, 78	66, 75
1902	82	[b] 82, 83	83	[b] 82, 83	[k] 83, 85	84	[k] 83, 84	84	85	85	85	85	85	85
1903	97	[b] 97, 98	98	97	[h]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, [t] 177	176, [r] 177	177	178	178	[j] 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

[a] Rating tables and index to Water-Supply Papers 35–39 contained in Water-Supply Paper 39. Estimates 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 slope 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. Estimates 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.

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.

The exceptions to this rule occur in the records for Mississippi River, which are given in four parts, as indicated on page III, and in the records for large lakes, where it is simpler to take up the streams in regular order around the rim of the lake than to cross back and forth over the lake surface.

PART VII. LOWER MISSISSIPPI RIVER BASIN.

PRINCIPAL STREAMS.

The principal streams flowing to the Mississippi below the mouth of the Missouri on the west and the Ohio on the east, are Meramec, White, Arkansas (whose chief tributaries are Huerfano, Purgatory, Cimarron, Verdigris, Neosho, and Canadian rivers), Yazoo, Homochitto, and Red rivers. The streams drain wholly or in part the States of Arkansas, Colorado, Kansas, Kentucky, Louisiana, Mississippi, Missouri, New Mexico, Oklahoma, Tennessee, and Texas.

In addition to the 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. xx.)

GAGING STATIONS.

NOTE.—Dash after a date indicates that station was being maintained Sept. 30, 1915; period after a date indicates discontinuance.

MERAMEC RIVER BASIN.

Meramec River near Meramec, Mo., 1903–1906.
Meramec River near Eureka, Mo., 1903–1906.
Meramec River (Station No. 1) at Fenton, Mo., 1903.
Meramec River (Station No. 2) below Fenton, Mo., 1903.
  Dry Fork of Meramec River near St. James, Mo., 1903.
  Spring Branch:
    Meramec Spring near Meramec, Mo., 1903–1906.
  Courtois Creek at Scotia, Mo., 1905–1906.

WHITE RIVER BASIN.

White River at Beaver, Ark., 1909–10.
White River near Branson, Mo., 1909–10.
White River near Lead Hill, Ark., 1909–10.
White River near Cotter, Ark., 1909–10.
  Buffalo River near Gilbert, Ark., 1909–10.
  North Fork River near Henderson, Ark., 1909–10.
  Black River:
    Eleven Point River:
      Greer Spring at Greer, Mo., 1904.
  Little Red River near Pangburn, Ark., 1909–10.

ARKANSAS RIVER BASIN.

Arkansas River, East Fork (head of Arkansas River), near Leadville, Colo., 1890; 1911–
Arkansas River at Granite, Colo., 1897–1899; 1910–
Arkansas River at Salida, Colo., 1895–1903; 1909–

Arkansas River tributaries—Continued.
Cimarron River near Kenton, Okla., 1904–5.
Cimarron River near Garrett, Okla., 1905–1907.
Cimarron River near Waynoka, Okla., 1903–1905.
Verdigris River near Independence, Kans., 1904.
Verdigris River near Liberty, Kans., 1895–1903.
Verdigris River near Catoosa, Okla., 1903–1905.
Fall River at Fall River, Kans., 1904–5.
Neosho River near Neosho Rapids, Kans., 1904.
Neosho River near Iola, Kans., 1895–1903.
Neosho River near Humboldt, Kans., 1904.
Neosho River (or Grand River) near Fort Gibson, Okla., 1899; 1903–1905.
Canadian River near Sanchez, N. Mex., 1912–1914.
Canadian River at Logan, N. Mex., 1904–5; 1908–1914.
Canadian River at Calvin, Okla., 1905–1908.
Chicorica Creek near Raton, N. Mex., 1910–1914.
Una del Gato Creek near Raton, N. Mex., 1910–1913.
Cimarron River at Ute Park, N. Mex., 1907–1914.
Cimarron River at Springer, N. Mex., 1907–1909.
Rayado River near Cimarron, N. Mex., 1911; 1913; 1914.
Rayado River above Abreu's ranch, near Cimarron, N. Mex., 1911–1914.
Rayado River at Abreu's ranch, near Cimarron, N. Mex., 1908–9.
Rayado River below Abreu's ranch, near Cimarron, N. Mex., 1912–13.
Rayado River near Springer, N. Mex., 1907–1909.
Urraca Creek near Cimarron, N. Mex., 1912–1914.
East Fork of Ocate River at Ocate, N. Mex., 1914.
Ocate River at Ocate, N. Mex., 1914.
West Fork of Ocate River, at Ocate, N. Mex., 1914.
Sweetwater Creek near Colmar, N. Mex., 1914.
Mora River and La Cueva canal at La Cueva, N. Mex., 1903–1911.
Mora River near Weber, N. Mex., 1903–4.
Mora River near Watrous, N. Mex., 1894–1896.
Mora River near Shoemaker, N. Mex., 1914.
Sapello River at Sapello, N. Mex., 1903–4.
Sapello Mill tailrace at Sapello, N. Mex., 1903–4.
Sapello River at Los Alamos, N. Mex., 1903–1911.
Manuelitos River near Sapello, N. Mex., 1903–4.
Pajarito Creek near Hanley, N. Mex., 1911–1913.
Pajarito Creek below Vigil Creek near Hanley, N. Mex., 1912–13.
Ute Creek near Logan, N. Mex., 1904–1906; 1909–1914.
Beaver Creek (head of North Fork of Canadian River) at Beaver, Okla. 1904–5.
North Fork of Canadian River near Woodward, Okla., 1903–1906.
North Fork of Canadian River near El Reno, Okla., 1902–1908.
North Fork of Canadian River near Oklahoma, Okla., 1899.
North Fork of Canadian River near Eufaula, Okla., 1899.

ARKANSAS RIVER CANALS.

Oxford Farmers canal near Nepesta, Colo., 1902–3.
Colorado-Kansas canal near Prowers, Colo., 1903.
Keese ditch near Prowers, Colo., 1903.

YAZOO RIVER BASIN.

Tallahatchie River (head of Yazoo River) at Batesville, Miss., 1906–1912.
Tallahatchie River at Phillip, Miss., 1908–1913.
Yazoo River at Greenwood, Miss., 1908–1913.
Yazoo River at Yazoo City, Miss., 1900–1905.
Coldwater River at Savage, Miss., 1908–1912.
Yalobusha River at Grenada, Miss., 1906; 1908–1912.
Sunflower River near Ruleville, Miss., 1909–1912.
Sunflower River at Baird, Miss., 1908–1912.

HOMOCHITTO RIVER BASIN.

Homochitto River at Rosetta, Miss., 1906.

RED RIVER BASIN.

Red River at Arthur City, Tex., 1905–1911.
Salt Fork of Red River at Mangum, Okla., 1905–6.
Turkey Creek [Deep Red Run] at Olustee, Okla., 1905–1908.
North Fork of Red River near Granite, Okla., 1903–1908.
North Fork of Red River near Snyder, Okla., 1905.
North Fork of Red River near Headrick, Okla., 1905–1908.
Elm Fork of Red River near Mangum, Okla., 1905–1908.
Elk Creek near Hobart, Okla., 1904–1908.
Otter Creek near Mountain Park, Okla., 1903–1908.
Horse Creek near Mountain Park, Okla., 1905–6.
Dry Fork of Otter Creek near Mountain Park, Okla., 1905–6.
Cache Creek:
Medicine Bluff Creek near Lawton, Okla., 1912–
Little Medicine Bluff Creek near Lawton, Okla., 1912–
Evaporation station near Lawton, Okla., 1913–
Wichita River at Wichita Falls, Tex., 1910–11.
Washita River at Anadarko, Okla., 1902–1908.
Washita River near Pauls Valley, Okla., 1899.
Ouachita River near Malvern, Ark., 1903–1905.
Ouachita River near Arkadelphia, Ark., 1905–6.

REPORTS ON WATER RESOURCES OF THE LOWER MISSISSIPPI RIVER BASIN.

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.

*5. Irrigation practice on the Great Plains, by E. B. Cowgill. 1897. 39 pp., 12 pls. 10c.

Describes reservoirs for storm and pumped waters, ditching, methods of distributing water, cultivation and subirrigation, duty of water, and winter irrigation.

*6. Underground waters of southwestern Kansas, by Erasmus Haworth. 1897. 65 pp., 12 pls. 15c.

Describes physiography, drainage, geologic formations and water supply, and irrigation development in Meade, Dodge, and Garden quadrangles, including all of Meade County, nearly all of Seward, Haskell, and Gray counties, about one-third of Ford County, and one-fourth of Finney County; discusses waters of Dakota sandstone and of the Tertiary formations.

*43. Conveyance of water in irrigation canals, flumes, and pipes, by Samuel Fortier. 1901. 86 pp., 15 pls. 15c.

Describes the location and construction of various types of canals for irrigation.

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" give 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 edition was published in 1905 as Water-Supply Paper 149 (q. v.). 5c.

74. Water resources of the State of Colorado, by A. L. Fellows. 1902. 151 pp., 14 pls. 25c.

Discusses under South Platte, Arkansas, Rio Grande, San Juan, Grand, and Green River divisions, drainage and irrigation, and gives records of stream flow.

96. Destructive floods in the United States in 1903, by E. C. Murphy. 1904. 81 pp., 13 pls. 15c.

Contains notes on early floods in Mississippi Valley.

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.

102. Contributions to the hydrology of eastern United States, 1903; M. L. Fuller, geologist in charge. 1904. 522 pp. 30c.

Contains brief reports on springs and wells of Arkansas and Missouri. The reports comprise tabulated well records giving information as to location, owner, depth, yield, head, etc., supplemented by notes as to elevation above sea, materials penetrated, temperature, use, and quality; many miscellaneous analyses.

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, including Red and Canadian rivers.

*107. Water powers of Alabama, with an appendix on stream measurements in Mississippi, by B. M. Hall. 1904. 253 pp., 9 pls. 20c.

Appendix contains gage heights, rating tables, estimates of monthly discharge of Yazoo River.

110. Contributions to the hydrology of eastern United States, 1904; M. L. Fuller, geologist in charge, 1905. 211 pp., 5 pls. 10c.

Contains a "Summary of the water supply of the Ozark region in northern Arkansas, by George I. Adams"; describes the drainage and some of the immense springs of the area, many of which have been developed as resorts.

114. Underground waters of eastern United States; M. L. Fuller, geologist in charge. 1905. 285 pp., 18 pls. 25c.

Contains brief reports as follows:
Mississippi, by L. C. Johnson.
Louisiana and southern Arkansas, by A. C. Veatch.
Northern Arkansas, by A. H. Purdue.
Each of these reports discusses the geologic formation as related to water supply, treats particularly of the mineral waters, and gives a list of the principal publications.

145. Contributions to the hydrology of eastern United States, 1905; M. L. Fuller, geologist in charge. 1905. 220 pp., 6 pls. 10c.

Contains five short reports relating to areas draining to the lower Mississippi River:

Water resources of the Joplin district, Missouri-Kansas, by W. S. Tangier Smith. Describes topography, geology, streams, springs, and wells; gives analyses of waters.

Water resources of the Winslow quadrangle, Arkansas, by A. H. Purdue. Area includes a few square miles of Oklahoma, discusses water-bearing formation and the quality of spring and well waters.

Notes on certain hot springs of the southern United States, by Walter Harvey Weed. Gives an account of the history, topography, geology, flow, temperature, and composition of the Hot Springs of Arkansas, including many analyses.

Notes on certain large springs of the Ozark region, Missouri and Arkansas, compiled by Myron L. Fuller. Treats briefly of the conditions under which the springs emerge, and of their flow, temperature, and quality.

Water resources of the contact region between the Paleozoic and Mississippi embayment deposits in northern Arkansas, by A. H. Purdue. Describes geology and water resources of a belt 12 to 15 miles wide extending along the western edge of the Mississippi embayment deposits from Arkansas River northward to the Missouri line. Considers source of water, amount, chemical character and use of water, prospects for flowing wells, etc.

147. Destructive floods in the United States in 1904, by E. C. Murphy and others. 1905. 206 pp., 18 pls. 15c.

Describes floods on Kansas, Neosho, Verdigris, Osage, Arkansas, Canadian, and Purgatory rivers, discussing the streams, precipitation, damages, prevention of future damages, etc.

*148. Geology and water resources of Oklahoma, by C. N. Gould. 1905. 178 pp., 22 pls. 20c.

Describes topography, geology, climate, streams, springs, deep wells (water and oil and gas), and artesian water, and discusses the water supply by counties; treats of irrigation from reservoirs, springs, and wells; gives analyses of well waters and table of well records.

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 and 61; mentions also principal publications relating to deep borings.

*153. The underflow in Arkansas Valley in western Kansas, by C. S. Slichter. 1906. 90 pp., 3 pls. 15c.

Discusses origin and extent of the underflow, fluctuations of ground-water level, the chemical composition of the waters (including analyses); gives results of measurements at various points and summaries and details of pumping tests.

*154. The geology and water resources of the eastern portion of the Panhandle of Texas, by C. N. Gould. 1906. 64 pp., 15 pls. 10c.

Discusses topography, geology, streams, springs, ground waters, and irrigation; gives details by counties.

159. Summary of the underground-water resources of Mississippi, by A. F. Crider and L. C. Johnson. 1906. 86 pp., 6 pls. 20c.

Describes geography, topography, and general geology of the State; discusses the source, depth of penetration, rate of percolation, and recovery of underground waters, artesian requisites, and special conditions in the Coastal Plain formations; gives notes on wells by counties, deep-well records, and selected records in detail; treats of sanitary aspect of wells and gives analyses.

*160. Underground-water papers. 1906; M. L. Fuller, geologist in charge. 1906. 104 pp., 1 pl.

Contains brief report entitled "Drainage of wet lands in Arkansas by wells," by A. F. Crider.

*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 account of flood on Purgatory River, Colorado, and estimates of flood flow and discharge of Arkansas River at Pueblo, Colo.; contains also index to literature on flood flow in American streams.

*164. Underground waters of Tennessee and Kentucky west of Tennessee River and of an adjacent area in Illinois, by L. C. Glenn. 1906. 173 pp., 7 pls. 25c.

Describes physical features, static level, and uses of waters, artesian conditions, and source properties of underground water; discusses topography, geology, and water resources by counties; gives logs of wells, analyses of waters, bibliography of most important reports.

*191. The geology and water resources of the western portion of the Panhandle of Texas, by C. N. Gould. 1907. 70 pp., 7 pls. 15c.

Describes the topography and general geology of the area, the deep-seated waters, springs, and streams, and the use of the waters for irrigation; discusses details of topography, geology, and water supply by counties.

*195. Underground waters of Missouri, their geology and utilization, by E. M. Shepard. 1907. 224 pp., 6 pls. 30c.

Describes the topography and geology of the State, the waters of the various formations, and discusses the water supplies by districts and counties; gives statistics of city water supplies, analyses of waters, and many well records.

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 Mississippi, Arkansas, and Red rivers.

273. Quality of the water supplies of Kansas, by H. N. Parker, with a preliminary report on stream pollution by mine waters in southeastern Kansas, by E. H. S. Bailey. 1911. 375 pp., 1 pl. 30c.

Describes the topographic and geologic features of the State and the artesian basins; discusses the significance of mineral constituents and classification of waters; gives details concerning quality of underground water by counties and surface water by drainage basins.

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 method of analyses; discusses soap-consuming power of waters, water softening, boiler waters, and water for irrigation; gives results of analyses of samples of water from Sapello River, Salt, North, and Elm forks of Red River, and Turkey Creek.

276. Geology and underground waters of northeastern Texas, by C. H. Gordon. 1911. 78 pp., 2 pls. 10c.

Describes geography, physiography, and geology of area comprising Bowie, Red River, Lamar, Delta, Hopkins, Franklin, Titus, Morris, Camp, and Cass counties; discusses the source and availability of underground waters, artesian waters of the various formations, and reviews the geographic relations, geology, and water resources by counties.

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.

*345. Contributions to the hydrology of the United States, 1914. N. C. Grover, chief hydraulic engineer. 1915. 225 pp., 17 pls. 30c.

(*a*) Preliminary report on ground water for irrigation in the vicinity of Wichita, Kans., by O. E. Meinzer, pp. 1–9.

(*b*) Ground water for irrigation in the vicinity of Enid, Okla., by A. T. Schwennesen, pp. 11–23, pl. i.

(*d*) Ground water for irrigation in the valley of North Fork of Canadian River near Oklahoma City, Okla., by A. T. Schwennesen, pp. 41–51.

399. Geology and ground waters of northeastern Arkansas, by L. W. Stephenson and A. F. Crider, with a discussion of the chemical character of the waters by R. B. Dole. 1916. 315 pp., 11 pls. 35c.

Describes the physiography of Arkansas, the character and distribution of the geologic formations, the streams, lakes, ponds, and swamps, the source, disposal, quantity, and distribution of the ground waters and their economic uses; gives details by counties; discusses, under chemical character of the waters, standards of classification, methods of purification, and the quality of surface and ground water; contains bibliography and gives many geologic sections and analyses of waters.

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, 1888–89, 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 purposes of irrigation; includes an account of the methods of topographic and hydraulic work, the segregation work on reservoir sites and irrigable lands, fields 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, pp. xiv, 395, 30 plates 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.

*Engineering, pp. 111–200. Gives an account of the surveys in the Arkansas division.

*The arid lands, pp. 201–289. Includes a report on artesian irrigation on the Great Plains, 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 Colorado and New Mexico, and on reservoir sites.

Twelfth Annual Report of the United States Geological Survey, 1890–91, J. W. Powell, Director. 1891. 2 parts. Pt. II. Irrigation, pp. xviii, 576, 93 pls. $2.00. Contains:

*Report upon the location and survey of reservoir sites during the fiscal year ended June 30, 1891, by A. H. Thompson, pp. 1–212, Pls. LIV–LVII. Describes reservoir sites in Chaffee, Custer, Fremont, Park, El Paso, Pueblo, Huerfano, Las Animas, Bent, Otero, Baca, Kiowa, and Lake counties, Colo.

*Hydrography of the arid regions, by F. H. Newell, pp. 213–361, Pls. LVIII–CVI. Discusses the available water supply of the arid regions, the duty of water, flood waters, relation of rainfall to river flow; classifies the drainage basins; and describes the rivers of the Arkansas River basin.

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, pp. xi, 486, 77 pls. $1.85. Contains:

*Engineering results of irrigation survey by H. M. Wilson, pp. 351–427, Pls. CXLVII–CLXXXII. Describes work at Twin Lakes reservoir and Twin Lakes dam, Colorado.

*Report upon the construction of topographic maps and the selection and survey of reservoir sites in the hydrographic basin of Arkansas River, Colo., by A. H. Thompson, pp. 429–444.

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, pp. xix, 598, 43 pls. $1.25. Contains:

The public lands and their water supply, by F. H. Newell, pp. 457–533, Pls. XXXV–XXXIX. 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.

Seventeenth Annual Report of the United States Geological Survey, 1895–96, Charles D. Walcott, Director. 1896. 3 parts in 4 vols. *Pt. II. Economic geology and hydrography, xxv, 864 pp., 113 pls. $2.35. Contains:

The underground water of the Arkansas Valley in eastern Colorado, by G. K. Gilbert, pp. 551–601, Pls. LVI–LXVIII. Describes the geology and topography of the district, the general conditions under which artesian water occurs, the gathering grounds, capacity, distribution, and quality of the water of the Dakota sandstone, the water of the upland sands, the terraces, and the dune sands, and the underflow of rivers and creeks.

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, pp. 768, 156 pls. $2.35. Contains:

*The High Plains and their utilization, by W. D. Johnson, pp. 601–741, Pls. CXIII–CLVI. Describes the area lying in an irregular belt lying 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, Pt. IV, pp. 631–669, Pls. LI–LXV. ($2.20.)

*Pt. VII, Texas, pp. 666, 71 pls. $1.90. Consists of:

Geography and geology of the Black and Grand Prairies, Texas, with detailed descriptions of the Cretaceous formations and special reference to artesian waters, by Robert T. Hill. Describes an area in Texas and southern Indian Territory [Oklahoma], comprising about 50,000 square miles; describes relief, drainage, and soils; gives a résumé of principles governing underground water; describes the artesian well systems of Texas and gives details of artesian conditions in Black and Grand Prairies by counties; treats briefly of the chemical qualities of the artesian waters aud gives analyses.

Twenty-second Annual Report of the United States Geological Survey, 1900–1901, Charles D. Walcott, Director. 1901. (Parts III and IV, 1902.) 4 parts. Pt. IV, Hydrography, 690 pp., 65 pls. Contains:

*The High Plains and their utilization (conclusion of paper in Twenty-first Ann. Rept., pt. iv), by W. D. Johnson, pp. 631–669, Pls. LI–LXV.

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. Record 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 the geologist; describes the general methods of work; gives tabulated records of wells in Arkansas, Colorado, New Mexico, Oklahoma, Kansas, Missouri, Tennessee, and Texas, and detailed records of wells in Otero County, Colo.; Greenwood, Montgomery, and Neosho counties, Kans.; and St. Louis County, Mo. These wells were selected because they give definite stratigraphic information.

*298. Record of deep-well drilling for 1905, by M. L. Fuller and Samuel Sanford. 1906. 299 pp. 25c.

Gives an account of progress in the collection of well records and samples; contains tabulated records of wells in Arkansas, Colorado, Kansas, Kentucky, Louisiana, Mississippi, Missouri, New Mexico, Oklahoma, Tennessee, and Texas; and detailed records of wells in Hempstead County, Ark.; Fremont and Pueblo counties, Colo.; Allen, Chase, Coffey, and McPherson counties, Kans.; Panola County, Miss.; Nowata, Washington, Tulsa Murray, Okmulgee, and Pawnee counties, Okla.; and Clay and Roberts counties, Tex. The wells of which detailed sections are given were selected because they afford valuable stratigraphic information.

PROFESSIONAL PAPERS.

Professional 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 with an asterisk may, however, be purchased from the SUPERINTENDENT OF DOCUMENTS, WASHINGTON, D. C. Professional papers are of quarto size.

*32. Preliminary report on the geology and underground water resources of the central Great Plains, by N. H. Darton. 1905. 433 pp., 72 pls. $1.80.

Describes altitudes and slopes, climate, drainage, stratigraphic structure, historical geology, and the water horizons; discusses deep wells and prospects (by counties and towns) in South Dakota, Nebraska, central and western Kansas, eastern Colorado, and eastern Wyoming; discusses also the occurrence of coal, petroleum and natural gas, salt, gypsum, gold, iron ore, and other minerals.

*46. Geology and underground water resources of northern Louisiana and southern Arkansas, by A. C. Veatch. 1906. 422 pp., 51 pls. $1.50.

Describes the historical geology and topographic development of a portion of the Coastal Plain; discusses the fundamental principles governing underground waters and their application to this region; contains account of methods and costs of well making, gives well predictions and a short discussion of the underground conditions in each county, and data in regard to wells arranged in tables by counties, followed by notes giving sections, analyses of waters, etc.; contains also a dictionary of altitudes, arranged by counties.

*52. Geology and underground waters of the Arkansas Valley in eastern Colorado, by N. H. Darton. 1906. 90 pp., 28 pls.

Describes the stratigraphic, structural, and historical geology of the Arkansas Valley and the relation of the geologic formations to the underground waters; discusses the source, depths, areas of flow, head, quantity, and quality of the waters of the "Dakota" sandstone, and the waters of the "Red Beds" and Morrison formations, the Laramie and associated formations, the later Tertiary deposits, and the dune sands. "An extension of the preliminary examination of the region by G. K. Gilbert in 1894 and 1895." See Seventeenth Annual Report, part 2, 1896, pp. 551–601.

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 description 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 geologic 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 level 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.

[1] Index maps showing areas in the lower Mississippi River basin 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.

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 areas 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 geologic 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 (except reprints), 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 at higher prices. The octavo edition of folio 185 and higher numbers sells for 50 cents a copy, except folio 193, which sells for 75 cents a copy. A discount of 40 per cent is allowed on an order for folios or for folios together with topographic maps amounting to $5 or more at the retail 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.

36. Pueblo, Colorado. 5c.

Describes the relations of geologic formations to underground waters.

58. Elmoro, Colorado. 5c.

Discusses artesian water of the Dakota formation.

68. Walsenburg, Colorado. 5c.

Describes artesian waters.

*71. Spanish Peaks, Colorado. 5c.

Describes artesian waters of the area.

122. Tahlequah, Oklahoma-Arkansas. 5c.

Gives a brief account of the springs and underground waters.

*132. Muscogee, Oklahoma. 5c.

Discusses springs, wells, and surface waters.

*135. Nepesta, Colorado. 5c.

Discusses the source, head, and chemical properties of the artesian waters, gives records of deep borings, and treats briefly on irrigation by ditches from Arkansas River; gives analyses of water from wells at Pueblo and from a spring at Fowler.

148. Joplin district, Missouri-Kansas. (Reprinted in 1914.) 50c.

Discusses the water power of Spring River, Shoal Creek, and Center Creek, the municipal water supplies of Carthage, Webb City, Joplin, and Galena, and the dug wells and springs of the country districts, and artesian wells.

186. Apishapa, Colorado.[1]

Mentions briefly the development of irrigation in the quadrangle; discusses water-bearing beds, artesian head, and the most favorable places for borings for artesian waters.

198. Castle Rock, Colorado. 25c.

Describes storage of water near the head of Monument Creek (tributary to Arkansas River) and treats briefly of the underground waters.

[1] Issued in two editions—library (18 by 22 inches), 5c. and octavo (6 by 9 inches), 50c. Specify edition desired.

MISCELLANEOUS REPORTS.

Other Federal bureaus, State and other organizations have from time to time published reports relating to water resources of various sections of the country. Notable among those pertaining to the lower Mississippi River drainage basin are the reports of the State geologists of Kansas, Tennessee, Louisiana, and Texas, the Mississippi Agricultural Experiment Station, the Chief of Engineers, United States Army, the Mississippi River Commission, and the Tenth Census, volume 17. The following reports deserve special mention:

Special report on well waters in Kansas, by Erasmus Haworth, State geologist; Kansas Univ. Geol. Survey Bull. 1, 1913.

Report of the Board of irrigation survey and experiment for 1895 and 1896 to the Legislature of Kansas, 1897.

Report on the underground waters of Louisiana, by G. D. Harris, A. C. Veatch, and others: Louisiana Geol. Survey Bull. 1, 1905.

Geology and underground water resources of northern Louisiana, with notes on adjoining districts, by A. C. Veatch: Louisiana Geol. Survey Bull. 4, 1906.

Report on water purification investigation and on plans proposed for sewerage waterworks systems: New Orleans Sewerage and Water Board, 1903.

Water powers of Arkansas: A preliminary report on White River and some of its tributaries, by W. N. Gladson. 1911.

Preliminary report upon the drainage of lands overflowed by the North and Middle forks of Forked Deer River and Rutherford Fork of Obion River in Gibson County, Tenn., by A. E. Morgan and S. H. McCrory: Tennessee Geol. Survey Bull. 3-B, 1910.

The delta of the Mississippi: the physics of the river, the control of its floods, and the redemption of the alluvion, by Col. Caleb G. Forshey, Cambridge, 1873.

Report upon the physics and hydraulics of the Mississippi River, by A. A. Humphreys and H. L. Abbot: Prof. Papers Corps Top. Eng. U. S. Army, No. 4, 1861.

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.

Describes 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, Kansas; 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. 10c.

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, makes comparisons of 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 No. 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.

32. Water resources of Puerto Rico, by H. M. Wilson. 1899. 48 pp., 17 pls. 15c.

Describes briefly topography, climate, rivers, irrigation methods, soils, forestation, water power, and transportation facilities.

*41. The windmill; its efficiency and economic use, Part I, by E. C. Murphy. 1901. 72 pp., 14 pls. 15c.

*42. The windmill; its efficiency and economic use, Part II, by E. C. Murphy. 1901. 75 pp., 2 pls. 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.

*44. Profiles of rivers in the United States, by Henry Gannett. 1901. 100 pp., 11 pls. 15c.

Gives elevations and distances along rivers of the United States, also brief descriptions of many of the streams. Arrangement geographic. Many river profiles are scattered through other reports on surface waters in various parts of the United States.

*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.

Discusses origin, depth, and amount of underground waters; permeability of rocks and porosity of soils; causes, rates, and laws of motions of underground 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 well; 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.

77. The water resources of Molokai, Hawaiian Islands, by Waldemar Lindgren. 1903. 62 pp., 4 pls. 10c.

Describes briefly the topography, geology, coral reefs, climate, soils, vegetation, forests, fauna of the island, the springs, running streams, and wells, and discusses the utilization of the surface and underground waters.

*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 rainfall, run-off, and evaporation formulas; discusses effect 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.

Contains, in addition to an account of the organization of the hydrographic [water-resources] branch of the United States Geological Survey, and the reports of the conference, 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 A. 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.

Experiment relating to problems of well contamination at Quitman, Ga., by S. W. McCallie.

Notes on the hydrology of Cuba, by M. L. Fuller.

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., 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 report 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 underground waters in eastern United States.

115. River surveys and profiles made during 1903, by W. C. Hall and J. C. Hoyt. 1905. 115 pp., 4 pls. 10c.

Contains results of surveys made to determine location of undeveloped power sites.

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.

Scope indicated by title.

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.

Scope indicated by title.

*122. Relation of the law to underground waters, by D. W. Johnson. 1905. 58 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.

Scope indicated by title.

144. The normal distribution of chlorine in the natural waters of New York and New England, by D. D. Jackson. 1905. 31 pp., 5 pls. 10c.

Discusses common salt in coast and inland waters, salt as an index to pollution of streams and wells, the solutions and methods used in chlorine determinations, and the use of the normal chlorine map; gives charts and tables for chlorine in the New England States and New York.

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.

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 land, 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 areas 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. 10c.

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 fluctuation due to rainfall and evaporation, barometric changes, temperature 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 of 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, by C.-E. A. Winslow and E. B. Phelps. 1906. 163 pp. 25c.

Discusses composition, disposal, purification, and treatment of sewages and recent 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 in intermittent sand filtration and 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 resulting litigation; discusses effect of acid-iron liquors on 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. 5c.

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. 40c.

Scope indicated by amplification of title.

*196. Water supply of Nome region, Seward Peninsula, Alaska, 1906, by J. C. Hoyt and F. F. Henshaw. 1907. 52 pp., 6 pls. 15c.

Gives results of measurements of flow of Alaskan streams, discusses available water supply for ditch and pipe lines and power development; presents notes for investors.

*200. Weir experiments, coefficients, and formulas (revision of paper No. 150), by R. E. Horton. 1907. 195 pp., 38 pls. 35c.

Scope indicated by title.

*218. Water-supply investigations in Alaska, 1906–7 (Nome and Kougarok regions Seward Peninsula; Fairbanks district, Yukon-Tanana region), by F. F. Henshaw and C. C. Covert. 1908. 156 pp., 12 pls. 25c.

Describes the drainage basins, gives results of observations at the gaging stations, and discusses the water supply of the ditches and pipe lines, and possibilities of development; gives also meteorological records.

*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.

228. Water-supply investigations in the Yukon-Tanana region, Alaska, 1907 and 1908 (Fairbanks, Circle, and Rampart districts), by C. C. Covert and C. E. Ellsworth. 1909. 108 pp., 7 pls. 20c.

Describes the drainage basins; gives results of observations at gaging stations; discusses the water supplies of the ditches and pipe lines and possibilities of hydraulic development.

*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 N. 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 bureau of hydraulics and agricultural improvement 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 underground 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.

259. The underground waters of southwestern Ohio, by M. L. Fuller and F. G. Clapp, with a discussion of the chemical character of the waters, by R. B. Dole. 1912. 228 pp., 9 pls. 35c.

Describes the topography, climate, and geology of the region, the water-bearing formations, the source, mode of occurrence, and head of the waters, and municipal supplies; gives details by counties; discusses in supplement, under chemical character, method of analysis and expression of results, mineral constituents, effect of the constituents on waters for domestic, industrial, or medicinal uses, methods of purification, chemical composition; many analyses and field assays. The matter in the supplement was also published in Water-Supply Paper 254 (The underground waters of north-central Indiana).

280. Gaging stations maintained by the United States Geological Survey, 1888–1910 and Survey publications relating to water resources, compiled by B. D. Wood. 1912. 102 pp. 10c.

314. Surface water supply of Seward Peninsula, Alaska, by F. F. Henshaw and G. L. Parker, with a sketch of the geography and geology by P. S. Smith, and a description of methods of placer mining by A. H. Brooks. 1913. 317 pp., 17 pls. 45c.

Contains results of work at gaging stations.

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.

318. Water resources of Hawaii, 1909–1911, by W. F. Martin and C. H. Pierce. 1913. 552 pp., 15 pls. 50c.

Describes the general features of the islands and gives results of measurements of streams and of observations of rainfall and evaporation; contains a gazetteer.

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.

336. Water resources of Hawaii, 1912, by C. H. Pierce and G. K. Larrison. 392 pp. 50c.

Contains results of stream measurements on the islands in 1912.

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.

342. Surface water supply of the Yukon-Tanana region, Alaska, by C. E. Ellsworth and R. W. Davenport. 1915. 343 pp., 13 pls. 45c.

Presents results of 6 years' observations of the water supply of the Yukon-Tanana region, discusses climate and precipitation, and gives station records.

*345. Contributions to the hydrology of the United States, 1914. N. C. Grover, chief hydraulic engineer. 1915. 225 pp., 17 pls. 30c.

(*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.

(*f*) The discharge of Yukon River at Eagle, Alaska, by E. A. Porter and R. W. Davenport, pp. 67–77, Pls. IV–V. 5c.

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.

372. A water-power reconnaissance in south-central Alaska, by C. E. Ellsworth and R. W. Davenport, with a section on southeastern Alaska, by J. C. Hoyt. 1915. 173 pp., 22 pls. 25c.

373. Water resources of Hawaii, 1913, by G. K. Larrison. 1915. 190 pp. 20c.

Contains results of stream measurements on the islands in 1913.

*375. Contributions to the hydrology of the United States, 1915. N. C. Grover, chief hydraulic engineer. 1916. 181 pp., 9 pls.

(*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 of correcting river discharge for a 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.

Three papers presented at the conference of engineers of the water-resources branch in December, 1914.

400. Contributions to the hydrology of the United States, 1916. N. C. Grover, chief hydraulic engineer.

(*a*) The people's interest in water-power resources, by G. O. Smith, pp. 1–8.

(*c*) The measurement of silt-laden streams, by Raymond C. Pierce, pp. 39–51.

(*d*) Accuracy of stream-flow data, by N. C. Grover and J. C. Hoyt, pp. 53–59.

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. 125–173, Pl. XXI. 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, xviii, 576 pp., 93 pls. $2. Contains:

*Irrigation in India, by H. M. Wilson, pp. 363–561, Pls. CVII to CXLVI. (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, pp. xi, 486, 77 plates. $1.85. Contains:

*American irrigation engineering, by H. M. Wilson, pp. 101–349, Pls. CXI to CXLVI. Discusses the economical 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 scurces 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, pp. xx, 597, 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. III and IV. 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 theoretical nature, pp. v, 958, 172 plates. $2.65. Contains:

*Principles and conditions of the movements of ground water, by F. H. King, pp. 59–294, Pls. VI to XVI. Discusses the amount of waters stored in sandstone, in soil, and in other rocks, 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 media, and through sands, 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. XVII. Scope indicated by title.

Twentieth Annual Report of the United States Geological Survey, 1898–99, Charles D. Walcott, Director. 1899. (Parts II, III, IV, V, and VII, 1900.) 7 parts in 8 vols. and separate case for maps with Pt. V. *Pt. IV, Hydrography, vii, 660 pp., 75 plates. $1.40. Contains:

*Hydrography of Nicaragua, by A. P. Davis, pp. 563–637, Pls. LXIV to LXX. Describes the topographic features of the boundary, the lake basin, and Rio San Juan; gives a brief résumé of the boundary dispute; discusses rainfall, temperature, and relative humidity, evaporation, resources, and productions; the ship, railway, and canal projects; gives the history of the investigations by the Canal Commission, and results of measurements on the Rio Grande, on streams tributary to Lake Nicaragua, and on Rio San Juan and its tributaries.

Twenty-second Annual Report of the United States Geological Survey, 1900–01, Charles D. Walcott, Director. 1901. (Parts III and IV, 1902.) 4 parts. Pt. IV, Hydrography, 690 pp., 65 pls. $2.20. Contains:

*Hydrography of the American Isthmus, by A. P. Davis, pp. 507–630, Pls. XXXVII to L. Describes the physiography, temperature, rainfall, and winds of Central America; discusses the hydrography of the Nicaragua Canal route and the Panama Canal route; gives estimated monthly discharges of many of the streams, rainfall, and evaporation tables at various points.

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, Chattahoochee, Savannah, Saluda, Broad, Catawba, Yadkin, New, and Monongahela rivers.

86. The transportation of débris 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.

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 so far as available.

*264. Record of deep-well drilling for 1904, by M. L. Fuller, E. F. Lines, and A. C. Veatch. 1905. 106 pp. 10c.

*298. Record of deep-well drilling for 1905, by M. L. Fuller and Samuel Sanford. 1906. 299 pp. 25c.

Bulletins 264 and 298 discuss the importance of accurate well records to the driller, to owners of oil, gas, and water wells, and to the geologist; describes the general methods of work; gives tabulated records of wells by States, and detailed records selected as affording valuable stratigraphic information.

*319. Summary of the controlling factors of artesian flows, by Myron L. Fuller, 1908. 10c.

Describes underground reservoirs, the sources of underground 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.

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.