PARTMENT OF THE INTERIOR
FRANKLIN K. LANE, Secretary

ED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, Director

WATER-SUPPLY PAPER 437

SURFACE WATER SUPPLY OF THE UNITED STATES

1916

PART VII. LOWER MISSISSIPPI RIVER BASIN

NATHAN C. GROVER, Chief Hydraulic Engineer
ROBERT FOLLANSBEE, District Engineer

WASHINGTON
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ILLUSTRATIONS.

SURFACE WATER SUPPLY OF THE LOWER MISSISSIPPI RIVER BASIN, 1916.

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, 1916.

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, 1895–1917.

1895	$12,500
1896	20,000
1897 to 1900, inclusive	50,000
1901 to 1902, inclusive	100,000
1903 to 1906, inclusive	200,000
1907	150,000
1908 to 1910, inclusive	100,000
1911 to 1917, 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. Acknowledgements 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 4,100 points in the United States and also at many points in Alaska and the Hawaiian Islands. In July, 1916, 1,290 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 depths 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:

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

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

The "point of zero flow" for a given gaging station is that point on the gage—the gage height—to which the surface of the river 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 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 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.
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 quckly: $\frac{\text{Second-feet} \times \text{fall in feet}}{11}$ = 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, 1915, and ending September 30, 1916. 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 bread-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 stage-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.

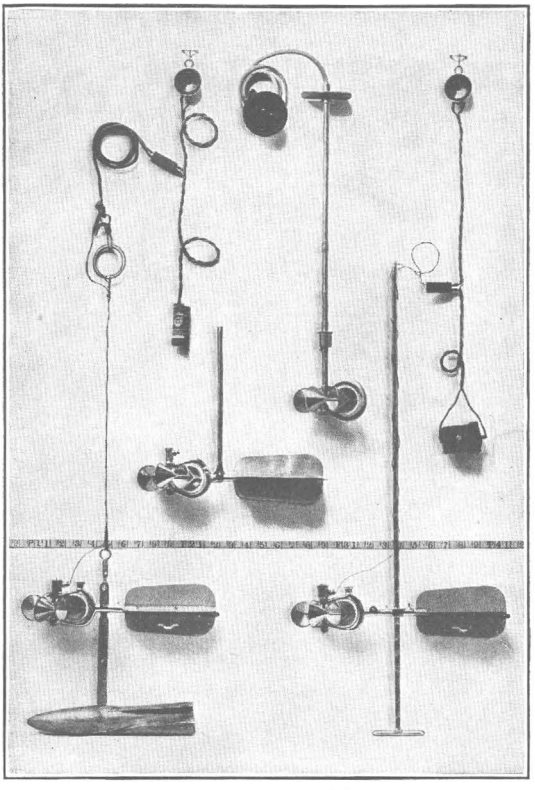
The table of daily discharge gives the discharge in second-feet corresponding to the mean of the gage heights read each day. At stations on streams subject to sudden or rapid diurnal fluctuation the discharge obtained from the rating table and the mean daily gage height may not be the true mean discharge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

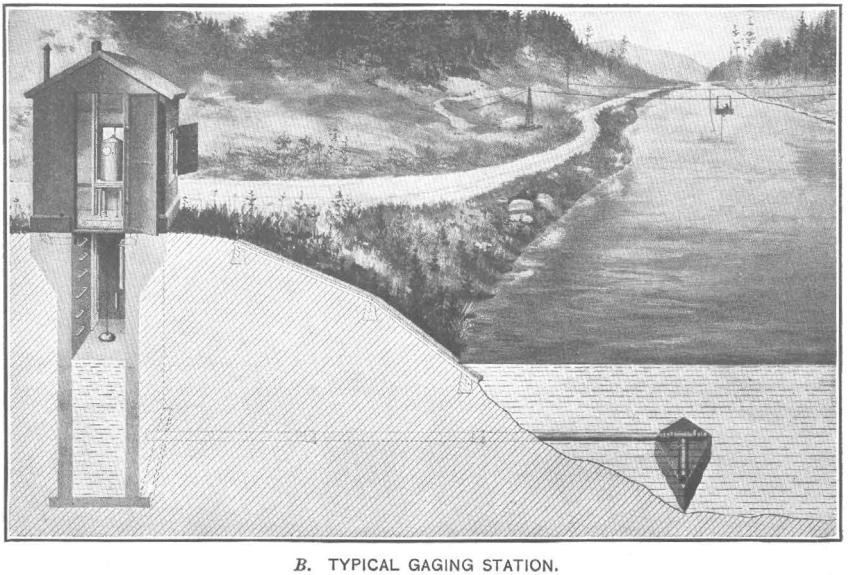
ACCURACY OF FIELD DATA AND COMPUTED RESULTS.

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

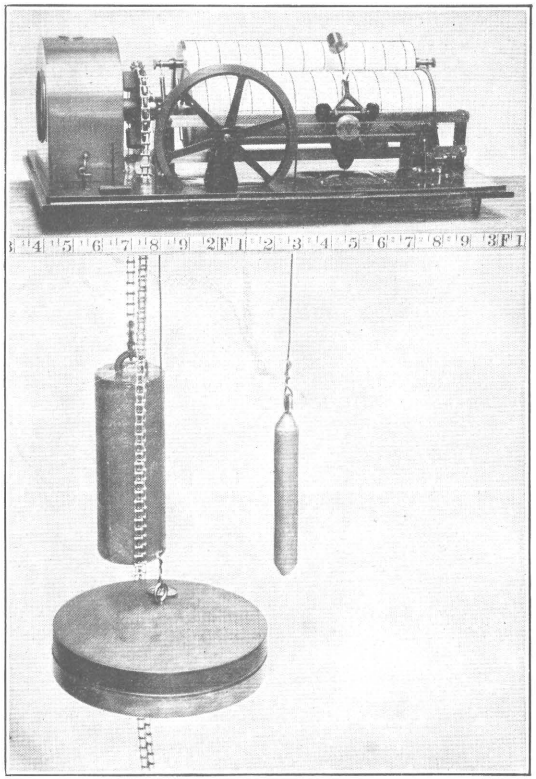
A paragraph in the description of the station or footnotes added to the tables gives information regarding the (1) permanence of the stage-discharge relation, (2) precision with which the discharge rating curve is defined, (3) refinement of gage readings, (4) frequency of



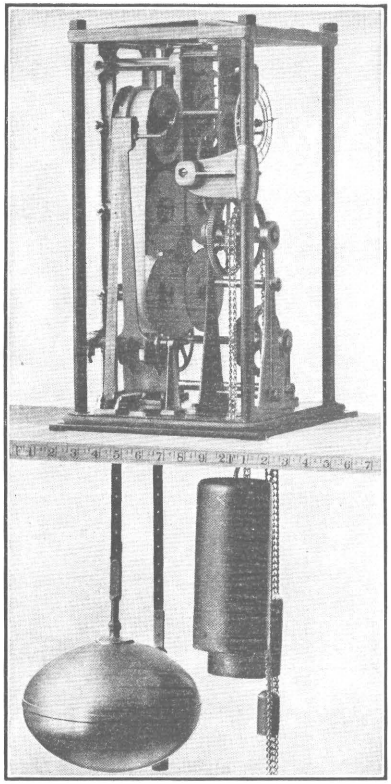
A. PRICE CURRENT METERS.



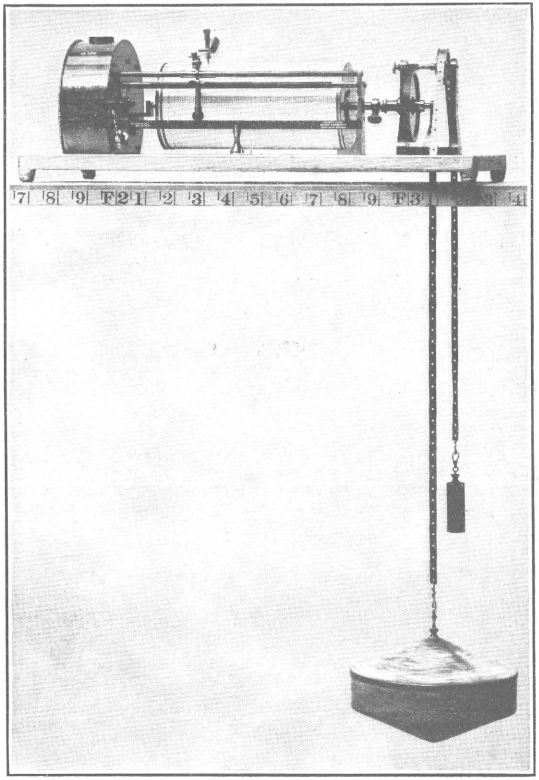
B. TYPICAL GAGING STATION.



A. STEVENS.



B. GURLEY PRINTING.



C. FRIEZ

WATER-STAGE RECORDERS.

gage readings, and (5) methods of applying daily gage heights to the rating table to obtain the daily discharge.[1]

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

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

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

COOPERATION.

In Colorado the State engineer paid the observers on Arkansas River at Granite and Salida. The United States Forest Service furnished readings on South Fork of Arkansas River and Poncha Creek at Poncha, and winter readings on East Fork of Arkansas River and Tennessee Fork near Leadville.

The Arkansas Valley Railway, Light & Power Co. furnished complete records for West Beaver Creek near Victor.

Mr. B. B. McReynolds, superintendent of the water department, Colorado Springs, furnished records of flow of streams in the Pikes Peak region.

The United States Reclamation Service paid for the maintenance of the stations on Medicine Bluff Creek near Lawton, Okla., and Little Medicine Bluff Creek near Lawton, Okla., and at the Evaporation station in Lawton Reservoir, Okla.

[1] For a more detailed discussion of the accuracy of stream-flow data, see Grover, N. C., and Hoyt, J. C., Accuracy of stream-flow data: U. S. Geol. Survey Water-Supply Paper 400, pp. 53–59, 1916.

DIVISION OF WORK.

The data were collected and prepared for publication under the direction of Robert Follansbee, by W. R. King, T. J. Watkins, H. W. Fear, P. V. Hodges, H. K. Smith, and J. H. Baily.

The manuscript was reviewed by H. J. Dean.

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, 1916.

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

DISCHARGE MEASUREMENTS.—Made from bridge or by wading.

CHANNEL AND CONTROL.—Channel composed of coarse gravel and small boulders. Control 30 feet downstream from gage; practically permanent. Banks low and subject to overflow at extremely high water.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 1.3 feet June 12 (discharge, 328 second-feet); minimum discharge recorded, 7 second-feet April 3 and 14; actual minimum may have occurred during winter months when observations are discontinued.

ICE.—Stage-discharge relation seriously affected by ice; observations discontinued 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 increased to 3 second-feet.

REGULATION.—None.

ACCURACY.—Stage-discharge relation practically permanent; affected by ice during winter. Rating curve well defined between 10 and 250 second-feet. Gage read to quarter-tenths twice daily. Owing to high altitude of drainage area (9,700 feet), alternate melting and freezing at certain seasons probably causes considerable diurnal fluctuation, and mean daily gage heights based on morning and evening readings may be somewhat in error. Daily discharge ascertained by applying mean daily gage heights to rating table. Results good.

The following discharge measurement was made by W. R. King:

June 10, 1916: Gage height, 1.01 feet; discharge, 193 second-feet.

Daily discharge, in second-feet, of East Fork of Arkansas River near Leadville, Colo., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Apr.	May.	June.	July.	Aug.	Sept.
1	23	20	.....	35	191	82	75	82
2	25	22	.....	35	212	82	99	82
3	25	28	7	23	251	55	91	79
4	25	27	.....	23	274	43	72	75
5	28	23	.....	25	225	62	84	59
6	27	28	.....	32	153	49	91	53
7	23	32	.....	82	191	34	104	55
8	22	34	.....	172	216	35	88	49
9	21	.....	.....	183	256	59	99	38
10	20	.....	.....	199	274	82	91	48
11	18	.....	.....	172	279	99	75	49
12	17	.....	.....	161	328	110	62	43
13	17	.....	.....	161	270	99	66	48
14	18	.....	7	161	274	117	99	48
15	16	.....	.....	161	242	110	93	32
16	15	.....	.....	146	251	99	75	38
17	18	.....	.....	146	225	84	60	41
18	22	.....	.....	161	172	99	66	68
19	25	.....	.....	161	199	88	66	62
20	28	.....	.....	114	191	93	55	59
21	32	.....	.....	88	191	75	70	45
22	32	.....	10	66	146	75	91	37
23	28	.....	.....	62	140	53	88	48
24	28	.....	.....	66	127	70	91	48
25	25	.....	22	82	127	55	96	49
26	20	.....	.....	75	107	75	82	41
27	22	.....	35	99	99	59	79	38
28	18	.....	.....	114	75	75	75	30
29	14	.....	.....	127	70	99	82	25
30	16	.....	.....	140	70	99	66	23
31	18	.....	.....	168	.....	93	75	.....

Monthly discharge of East Fork of Arkansas River near Leadville, Colo., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	32	14	22.1	1,360
November 1–8	34	20	26.8	425
May	199	23	111	6,820
June	328	70	194	11,500
July	117	34	77.7	4,780
August	104	55	80 8	4,970
September	82	23	49.7	2,960

ARKANSAS RIVER AT GRANITE, COLO.

LOCATION.—In sec. 31, T. 11 S., R. 79 W., at Granite, in Lake County, below mouth 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, 1916.

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

DISCHARGE MEASUREMENTS.—Made from highway bridge near railroad station or by wading.

CHANNEL AND CONTROL.—Bed composed of coarse gravel and small boulders. Control shifts at intervals, but practically permanent after winter of 1915–16. Banks not subject to overflow.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, from inclined gage, 3.8 feet for several days in June (discharge, 1,660 second-feet); minimum discharge occurs during winter months.

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

DIVERSIONS.—Court decrees for diversions of 74 second-feet from the Arkansas between this station and the junction of Tennessee and East forks.

REGULATION.—Discharge affected by operation of Twin Lakes reservoir, which has a storage decree for 20,645 acre-feet.

ACCURACY.—Stage-discharge relation practically permanent after winter of 1915-16; affected by ice during winter. Rating curve used during October and November fairly well defined throughout, and after March 16, well-defined between 60 and 1,600 second-feet. From March 10 to April 27 water-stage recorder was operating satisfactorily and mean daily gage heights were determined by inspection of gage-height graph. For remainder of year staff gage was read to tenths once daily. Daily discharge was ascertained by applying directly to rating table mean daily gage heights during operation of water-stage recorder, or one reading per day from staff gage. Results fair.

Discharge measurements of Arkansas River at Granite, Colo., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec-ft.*			*Feet.*	*Sec.-ft.*
Nov. 24	W. R. King.....	1.46	86	June 23	W. R. King.....	3.40	1,260
May 11	H. E. Turner.....	3.10	858	July 23	.....do.....	2.64	639
June 5	Robert Follansbee....	3.60	1,460				

Daily discharge, in second-feet, of Arkansas River at Granite, Colo., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	115	85	.....	148	490	910	1,460	1,560	280
2	104	76	.....	148	490	910	1,460	1,560	240
3	94	85	.....	148	490	910	1,460	1,560	240
4	85	76	.....	148	490	1,360	1,460	1,170	240
5	94	85	.....	148	402	1,460	1,460	1,170	240
6	94	85	.....	130	430	1,460	1,460	1,170	240
7	85	94	.....	130	430	1,450	1,410	1,170	165
8	85	85	.....	130	615	1,460	1,360	1,170	165
9	85	85	.....	115	755	1,460	1,560	1,170	165
10	85	85	200	130	830	1,560	1,560	1,170	200
11	85	76	430	182	990	1,660	1,560	1,170	240
12	85	85	490	220	1,080	1,660	1,460	1,170	200
13	94	85	490	220	1,260	1,560	1,360	1,170	200
14	94	85	430	220	1,360	1,660	1,360	1,170	200
15	104	85	460	220	1,360	1,660	1,360	1,170	165
16	127	85	460	200	910	1,660	1,360	1,170	165
17	115	85	490	220	910	1,660	1,360	685	165
18	104	85	490	302	910	1,560	1,360	685	165
19	94	85	520	100	685	1,560	1,360	685	165
20	94	85	490	182	685	1,560	1,260	685	165
21	94	85	490	240	755	1,560	830	685	165
22	115	85	460	260	755	1,560	830	430	165
23	115	85	490	325	755	1,460	615	430	130
24	104	86	490	350	755	1,460	615	430	165
25	94	86	490	375	755	1,360	550	430	130
26	94	86	260	402	755	1,360	550	430	165
27	94	86	115	490	615	1,360	550	430	200
28	85	86	148	430	615	1,260	550	430	200
29	94	86	165	430	650	1,360	615	325	200
30	104	86	148	430	685	1,460	685	325	130
31	94	.....	148	.....	910	.....	1,260	325	.....

NOTE.—Stage-discharge relation affected by ice Nov. 13–20; discharge estimated; observations discontinued for remainder of winter. Discharge estimated Nov. 21–23, 25–30, and interpolated May 29, June 29, July 7, 29, and Aug. 25. Indirect methods for shifting control used October and November.

Monthly discharge of Arkansas River at Granite, Colo., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	127	85	97.1	5,970
November	94	76	84.6	5,030
March 10–31	520	115	380	16,600
April	490	100	239	14,200
May	1,360	402	761	46,800
June	1,660	910	1,440	85,700
July	1,560	550	1,160	71,300
August	1,560	325	881	54,200
September	280	130	188	11,200

ARKANSAS RIVER AT SALIDA, COLO.

LOCATION.—In sec. 32, T. 50 N., R. 9 E., 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, 1916.

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

DISCHARGE MEASUREMENTS.—Made from highway bridge.

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

EXTREMES OF DISCHARGE.—Maximum stage during year, from water-stage recorder, 4.75 feet at 10 a. m. June 14 (discharge, 3,080 second-feet); minimum stage, 0.40 foot February 1 (discharge, 192 second-feet).

ICE.—Stage-discharge relation not affected by ice, as river is kept open by springs.

DIVERSIONS.—Court decrees for diversions of 202 second-feet from the Arkansas 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.—Stage-discharge relation not permanent but shifts through narrow limits; not affected by ice. Rating curves fairly well defined between 200 and 3,000 second-feet. Daily discharge ascertained by applying to rating tables mean daily gage heights determined by inspection of gage-height graph. Results good.

Discharge measurements of Arkansas River at Salida, Colo., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Jan. 19	T. J. Watkins	0.80	284	June 21	W. R. King	4.48	2,810
Feb. 17	do	.59	242	30	H. E. Turner	4.25	2,210
Apr. 18	Thos. Grieve, jr	1.12	403	July 24	W. R. King	2.49	1,080
June 6	Robert Follansbee	3.75	2,220				

Daily discharge, in second-feet, of Arkansas River at Salida, Colo., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	368	300	270	282	192	238	264	679	1,510	2,590	2,500	520
2	350	300	270	240	203	226	264	708	1,550	2,540	2,320	545
3	332	300	285	264	226	203	264	651	1,510	2,540	2,110	496
4	315	300	270	294	251	214	264	651	1,830	2,410	2,110	496
5	315	300	270	291	251	278	264	708	2,070	2,360	2,030	496
6	315	300	270	291	238	251	251	767	2,190	2,150	1,950	496
7	285	315	242	245	251	214	251	925	2,190	2,110	1,910	496
8	332	285	242	245	251	226	264	1,100	2,110	2,110	1,790	473
9	350	300	255	288	238	264	251	1,350	2,190	2,280	1,710	452
10	385	300	270	285	238	292	251	1,510	2,320	2,590	1,590	473
11	350	255	255	270	251	292	264	1,630	2,540	2,500	1,130	596
12	350	242	255	218	238	596	292	1,910	2,720	2,460	1,100	623
13	368	270	270	228	203	651	292	1,990	2,860	2,360	1,310	596
14	350	242	285	240	203	623	307	1,950	2,900	2,190	1,550	570
15	332	270	300	267	214	545	322	1,830	2,770	2,030	1,630	570
16	350	285	270	264	214	570	307	1,590	2,820	1,750	1,630	570
17	385	270	285	238	226	570	322	1,130	2,860	1,750	1,350	545
18	385	255	255	264	238	596	338	990	2,860	1,750	1,200	496
19	402	270	242	278	238	651	373	925	2,900	1,590	1,130	496
20	368	285	230	264	238	651	355	860	2,860	1,430	1,060	473
21	350	300	242	251	238	679	452	892	2,770	1,350	958	452
22	332	285	270	226	238	623	545	892	2,590	1,310	892	410
23	350	270	285	264	238	679	520	860	2,360	1,130	737	430
24	332	300	242	264	226	623	570	737	2,190	1,060	828	430
25	350	285	242	264	214	520	623	651	2,070	990	797	430
26	332	285	255	251	214	520	651	679	2,070	958	767	430
27	315	285	218	238	238	307	708	737	2,150	958	737	452
28	300	230	242	251	238	307	828	797	2,230	990	708	430
29	300	255	285	226	238	307	860	892	2,320	990	651	430
30	315	300	285	226	.....	278	767	958	2,460	1,550	596	430
31	315	.....	300	214	.....	278	.....	1,240	.....	2,190	570	.....

NOTE.—Indirect methods for shifting control used Jan. 1-18 and June 22 to Sept. 30.

Monthly discharge of Arkansas River at Salida, Colo., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	402	285	341	21,000
November	315	230	281	16,700
December	300	218	263	16,200
January	294	214	256	15,700
February	251	192	230	13,200
March	679	203	428	26,300
April	860	251	409	24,300
May	1,990	651	1,070	65,800
June	2,900	1,510	2,360	140,000
July	2,590	958	1,840	113,000
August	2,500	570	1,330	81,800
September	623	410	493	29,300
The year	2,900	192	777	563,000

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, 1916.

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

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

CHANNEL AND CONTROL.—Bed rough and composed of small boulders; 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, 1.35 feet at 7.30 p. m. June 2 (discharge, 209 second-feet); minimum stage, 0.20 foot October 12 (discharge, 4 second-feet).

ICE.—Stage-discharge relation seriously affected by ice; data insufficient for determination of winter flow.

DIVERSIONS.—Court decrees for diversions of 24 second-feet above the station; also a decree for diversion of 18.5 second-feet from the basin of Eagle River to that of Tennessee Fork above station. No water was diverted from Eagle River basin during 1916, so far as known.

ACCURACY.—Stage-discharge relation practically permanent; affected by ice. Rating curve fairly well defined between 10 and 200 second-feet. Gage read to quarter-tenths twice daily. Daily discharge ascertained by applying mean daily gage height to rating table. Results good.

Discharge measurements of Tennessee Fork near Leadville, Colo., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Jan. 13	T. J. Watkins	[a] 0.62	6.4
Feb. 11	....do	[a] .48	9.1
June 10	W. R. King	1.26	183

[a] Stage-discharge relation affected by ice.

Daily discharge, in second-feet, of Tennessee Fork near Leadville, Colo., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	10	7	.....	.....	166	194	52	65	22
2	10	7	.....	.....	88	200	52	80	25
3	11	10	.....	32	93	166	71	80	26
4	10	10	.....	.....	90	160	71	71	31
5	10	10	.....	.....	117	144	88	63	30
6	10	11	.....	.....	125	149	80	65	27
7	9	11	.....	.....	160	117	93	63	22
8	8	12	.....	.....	155	133	90	58	17
9	7	16	.....	.....	144	144	84	46	18
10	6	14	.....	.....	149	180	71	42	18
11	5	.....	.....	.....	180	172	65	27	21
12	4	.....	.....	.....	172	172	71	35	17
13	8	.....	.....	.....	152	172	65	43	22
14	10	.....	.....	32	125	155	52	52	21
15	8	.....	.....	.....	133	152	56	45	17
16	8	.....	.....	.....	133	117	56	32	17
17	8	.....	.....	.....	100	133	42	34	27
18	8	.....	.....	.....	102	133	46	21	42
19	7	.....	30	.....	102	125	35	30	42
20	8	.....	30	.....	58	107	34	25	38
21	10	.....	.....	.....	58	71	34	25	46
22	10	.....	.....	48	50	52	18	18	38
23	11	.....	.....	.....	52	35	16	18	30
24	11	.....	.....	.....	71	35	19	27	25
25	10	.....	.....	194	88	30	35	22	18
26	10	.....	.....	.....	110	22	19	19	15
27	9	.....	32	224	141	17	30	20	14
28	9	.....	.....	.....	155	22	35	22	12
29	9	.....	.....	.....	158	32	38	19	8
30	8	.....	.....	.....	172	35	93	18	8
31	8	.....	.....	.....	188	.....	71	18	.....

Monthly discharge of Tennessee Fork near Leadville, Colo., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	11	4	8.71	536
November 1-10	16	7	10.8	214
May	188	50	122	7,500
June	200	17	113	6,720
July	93	16	54.3	3,340
August	80	18	38.8	2,390
September	46	8	23.8	1,420

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, 1916. From September 23, 1910, to September 13, 1911, a station was maintained in sec. 21, a mile above present site.

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

DISCHARGE MEASUREMENTS.—Made from bridge or by wading.

CHANNEL AND CONTROL.—Channel composed of boulders; very rough. Control practically permanent; short distance below gage. Banks high; overflow unlikely.

EXTREMES OF STAGE.—Maximum stage recorded during year, 2.1 feet at 6 a. m., June 20; minimum stage, 0.53 foot at 6 a. m., April 7.

ICE.—Stage-discharge relation not affected by ice; hot springs keep creek open.

DIVERSIONS.—Court decrees for diversions of 148 second-feet from Cottonwood Creek, of which 28 second-feet are above gaging station.

REGULATION.—None.

Estimates of discharge are withheld from publication until additional data are obtained.

Discharge measurements of Cottonwood Creek below Hot Springs, near Buena Vista, Colo., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Jan. 17	T. J. Watkins	0.61	22.6
June 23	W. R. King	1.50	238
July 27	do	1.10	92

Daily gage height, in feet, of Cottonwood Creek below Hot Springs, near Buena Vista, Colo., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	0.85	0.71	0.68	0.62	0.59	0.57	0.58	0.82	1.45	.....	1.38	0.94
2	.84	.70	.66	.64	.61	.57	.59	.87	1.45	1.52	1.25	.92
3	.82	.70	.66	.64	.60	.57	.60	.75	1.48	1.52	1.22	.92
4	.79	.70	.65	.63	.60	.56	.59	.82	1.55	1.48	1.28	.90
5	.78	.69	.65	.63	.60	.58	.58	.85	1.48	1.42	1.20	.90
6	.78	.69	.66	.62	.60	.56	.59	.95	1.45	1.42	1.18	.90
7	.79	.70	.66	.60	.60	.56	.56	1.05	1.4	1.38	1.18	.90
8	.78	.70	.66	.61	.60	.57	.58	1.18	1.38	1.40	1.15	.90
9	.78	.70	.65	.62	.60	.58	.58	1.25	1.5	1.40	1.15	.88
10	.78	.69	.65	.63	.60	.59	.59	1.35	1.65	1.42	1.12	.86
11	.79	.64	.65	.63	.59	.59	.60	1.35	1.75	1.35	1.10	.98
12	.80	.58	.65	.58	.59	.59	.59	1.30	1.8	1.28	1.10	.92
13	.79	.60	.65	.60	.58	.60	.63	1.20	1.9	1.32	1.10	.92
14	.78	.58	.65	.60	.58	.60	.61	1.18	1.9	1.28	1.20	.92
15	.80	.62	.65	.60	.59	.58	.60	1.08	1.9	1.25	1.15	.90
16	.80	.62	.65	.60	.58	.58	.60	.95	1.9	1.28	1.15	.88
17	.80	.62	.....	.60	.58	.58	.66	1.02	2.0	1.25	1.12	.87
18	.79	.65	.65	.62	.58	.59	.68	.95	2.0	1.25	1.10	.86
19	.80	.68	.65	.59	.58	.61	.68	1.00	2.0	1.22	1.08	.86
20	.80	.70	.65	.58	.58	.62	.64	1.02	2.0	1.2	1.05	.85
21	.80	.69	.65	.58	.57	.65	.62	.98	2.0	1.15	1.03	.84
22	.79	.69	.65	.59	.57	.62	.69	.98	1.9	1.12	1.00	.83
23	.79	.69	.65	.60	.58	.64	.75	.92	1.65	1.10	.96	.84
24	.79	.69	.65	.60	.57	.62	.77	.92	1.55	1.08	1.00	.85
25	.78	.68	.65	.60	.57	.58	.80	1.00	1.6	1.05	1.00	.85
26	.76	.68	.65	.60	.56	.58	.84	1.02	1.55	1.08	1.00	.84
27	.76	.69	.62	.60	.58	.60	.88	1.02	1.55	1.1	.99	.82
28	.74	.64	.65	.61	.58	.60	.92	1.05	1.6	1.1	.96	.82
29	.74	.66	.65	.60	.58	.60	.98	1.08	1.6	1.08	.96	.80
30	.74	.68	.65	.62	.....	.60	.88	1.18	1.55	1.3	1.00	.80
31	.73	.....	.65	.59	.....	.62	.....	1.28	.....	1.25	.96	.....

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, 1916.

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

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

CHANNEL AND CONTROL.—Channel composed of coarse gravel; control a short distance below gage at small rapids which are practically permament. Banks not subject to overflow.

EXTREMES OF DISCHARGE.—Maximum stage during year from water-stage recorder, 2.96 feet at 7 p. m., June 10 (discharge, 393 second-feet); minimum stage, 0.92 foot February 12 (discharge, 7 second-feet).

ICE.—Stage-discharge relation not seriously affected by ice except for occasional short periods.

DIVERSIONS.—No court decrees for diversions 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.—Stage-discharge relation permanent; affected by ice for short periods from November to February. Rating curve well defined between 6 and 200 second-feet. Operation of water-stage recorder satisfactory except from February 20 to March 10 and September 17 to 24. Daily discharge ascertained by applying to rating table mean daily gage height determined by inspection of gage-height graph. Results excellent, except for very high water periods for which they are good.

Discharge measurements of Chalk Creek (upper station), near St. Elmo, Colo., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Jan. 18	T. J. Watkins	1.11	10.4
June 23	W. R. King	2.23	184

Daily discharge, in second-feet, of Chalk Creek (upper station), near St. Elmo, Colo., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	26	13	9	10	7	8	12	58	175	175	99	32
2	23	16	10	10	7	8	12	53	175	168	109	30
3	22	15	10	9	8	7	12	47	182	162	90	30
4	19	17	10	9	8	7	12	53	185	150	79	29
5	17	18	10	9	8	7	12	70	170	143	74	27
6	18	23	10	9	8	8	11	101	178	134	79	30
7	17	20	10	9	8	8	12	131	175	136	84	32
8	18	13	10	8	8	8	12	145	182	143	70	32
9	16	11	9	8	8	8	10	162	219	150	67	46
10	17	11	10	8	8	9	13	165	243	148	67	53
11	15	10	11	8	7	9	16	152	246	131	60	36
12	14	10	11	8	7	9	17	162	255	140	58	45
13	15	10	10	9	7	9	19	165	273	122	86	40
14	16	9	10	10	7	18	18	127	267	116	101	32
15	16	9	10	12	7	18	19	101	252	109	80	32
16	16	9	10	11	7	11	19	86	255	114	79	37
17	14	9	10	12	8	10	19	80	258	105	74	36
18	15	9	10	11	8	10	26	80	261	95	62	34
19	14	10	9	10	8	10	26	87	255	88	58	33
20	16	10	10	9	8	10	25	87	237	84	56	32
21	14	10	13	9	8	12	25	79	222	79	53	30
22	13	10	12	9	8	9	29	75	201	82	47	28
23	15	10	10	8	8	11	42	70	190	77	47	26
24	18	10	10	8	8	11	50	72	190	70	47	24
25	18	10	10	8	8	10	54	82	192	67	46	22
26	14	10	10	8	8	10	62	90	192	65	41	20
27	13	10	10	8	8	10	75	101	195	68	38	19
28	12	9	10	8	8	11	88	118	192	65	36	17
29	13	9	9	7	8	11	88	131	190	82	35	18
30	12	9	9	7	.....	12	60	152	185	129	35	16
31	13	.....	9	7	.....	11	.....	172	.....	103	36	.....

NOTE.—Stage-discharge relation affected by ice Nov. 13 to Dec. 3, Dec. 16–20, Jan. 1, 7, 12–14, Jan. 20 to Feb. 5 and Feb. 13–29; discharge estimated from discharge measurements, observer's notes, and weather records. Discharge estimated Mar. 1–10, and Sept. 17–24, when gage did not operate.

Monthly discharge of Chalk Creek (upper station), near St. Elmo, Colo., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (tota in acre-feet)
	Maximum.	Minimum.	Mean.	
October	26	12	16.1	990
November	23	9	11.6	690
December	13	9	10.0	615
January	12	7	8.9	547
February	8	7	7.7	443
March	18	7	10.0	615
April	88	10	29.8	1,770
May	172	47	105	6,460
June	273	170	213	12,700
July	175	65	113	6,950
August	109	35	64.3	3,950
September	53	16	30.6	1,820
The year	273	7	51.7	37,600

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 March 31, 1916, when station was discontinued. 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 by W. P. Abbott.

DISCHARGE MEASUREMENTS.—Made from bridge or by wading.

CHANNEL AND CONTROL.—Channel composed of small boulders; rough. Control, which is somewhat shifting, is just below gage. Overflow of banks not likely.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 1.15 feet October 2 (discharge, 48 second-feet); minimum stage, 0.75 foot March 22 (discharge, 18 second-feet).

ICE.—Stage-discharge relation not seriously affected by ice except for short periods.

DIVERSIONS.—No court decrees for diversions from Chalk Creek between the upper station and this one; decrees for 133 second-feet below.

REGULATION.—None.

ACCURACY.—Stage-discharge relation not permanent; shifts through narrow limits; affected by ice for short periods from November to March. Rating curve not well defined. Gage read to hundredths twice daily. Daily discharge ascertained by applying mean daily gage height to rating table. Results fair.

The following discharge measurement was made by T. J. Watkins:

January 18, 1916: Gage height, 0.85 foot; discharge, 24.4 second-feet.

Daily discharge, in second-feet, of Chalk Creek near St. Elmo, Colo., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
1	48	28	26	25	22	22	16	32	28	26	23	24	24
2	48	25	27	25	22	22	17	33	28	26	22	22	21
3	45	25	28	25	22	23	18	34	27	26	22	20	22
4	42	25	25	25	22	24	19	34	26	26	22	42	22
5	36	28	25	25	22	26	20	33	26	26	22	34	22
6	32	30	25	25	22	28	21	32	27	25	22	25	22
7	32	31	25	25	22	28	22	32	28	25	22	22	21
8	36	32	25	22	22	25	23	32	25	25	22	20	25
9	36	32	28	24	22	25	24	31	25	25	22	20	25
10	35	32	28	25	20	22	25	30	25	25	22	20	25
11	34	32	25	22	20	22	26	30	25	25	22	20	25
12	34	31	25	23	20	22	27	30	25	25	22	21	25
13	34	30	25	25	26	22	28	26	26	25	22	22	25
14	32	30	25	25	32	20	29	25	26	25	22	22	25
15	36	29	22	24	26	20	30	26	26	25	22	.....	25
							31	27	.....	25	22	.....	25

NOTE.—Discharge estimated Nov. 12–19, 25–29, Dec. 1–2, 17–24, 27–31, Jan. 1, 12, 15–17, 21–22, 29–31, Feb. 1–4, 25–26, 29, and Mar. 1–2, because of ice. Discharge interpolated Oct. 1, 3, 10, 17, 20, 24, Nov. 7, 21, Dec. 5, 12, 26, Jan. 2, 9, 23, Feb. 6, 11, 13, 16–17, 20, 27, Mar. 3–5, 12, 19, and 25–27. Indirect methods for shifting control used during open-water periods.

Monthly discharge of Chalk Creek near St. Elmo, Colo., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	48	25	33.8	2,080
November	32	25	27.8	1,650
December	28	22	25.5	1,570
January	25	22	23.2	1,430
February	42	20	23.3	1,340
March	28	20	23.5	1,440
The period				9,510

SOUTH FORK OF ARKANSAS RIVER AT PONCHA, COLO.

LOCATION.—In sec. 10, T. 49 N., R. 9 E., at single-span highway bridge about half a mile from Poncha, in Chaffee County. Nearest tributary, Poncha Ceeek, enters one-fourth mile below.

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

RECORDS AVAILABLE.—January 14, 1911, to September 30, 1916.

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

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

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

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.2 feet during nights of June 14 and 15, as determined from high water marks on gage (discharge, 385 second-feet); minimum stage, 0.60 foot at 4.30 p. m. April 11 and 22 (discharge, 5 second-feet).

ICE.—Stage-discharge relation only slightly affected by ice as river is kept open by springs.

DIVERSIONS.—Court decrees for diversions of 32 second-feet from the South Fork above station, and 29 second-feet below; also for 85 second-feet from the North Fork, which enters above.

REGULATION.—None.

ACCURACY.—Stage-discharge relation not permanent; shifts through narrow limits; affected by ice for short periods from November to February. Rating curve well defined below 250 second-feet. Gage read to hundredths twice daily, and during certain periods the maximum stage which occurs during the night is also determined from water marks. Daily discharge is ascertained by applying to rating table mean daily gage height determined from either two or three readings. Results good except for winter period, for which they are fair.

Discharge measurements of South Fork of Arkansas River at Poncha, Colo., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec-ft.*			*Feet.*	*Sec.-ft.*
Nov. 24	W. R. King	1.28	47.2	June 6	Robert Follansbee	1.78	108
Jan. 20	T. J Watkins	1.14	32.8	21	W. R. King	2.20	166
Feb. 17	....do	1.15	35.8				

Daily discharge, in second-feet, of South Fork of Arkansas River at Poncha, Colo., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	32	17	48	41	38	46	15	76	135	120	102	15
2	24	17	49	41	43	48	29	62	135	106	130	12
3	21	17	50	41	50	48	32	60	143	113	102	7
4	26	13	52	41	50	48	26	59	160	93	72	8
5	26	13	43	41	49	46	23	67	143	96	62	7
6	22	15	60	50	50	48	13	87	135	81	67	12
7	25	25	48	55	46	39	14	128	128	81	67	12
8	24	21	46	55	46	46	11	135	135	83	57	12
9	24	16	46	55	49	43	7	143	151	96	52	13
10	26	13	50	55	50	44	7	186	235	117	52	13
11	22	14	46	50	50	48	6	160	265	110	57	14
12	22	30	52	41	50	38	7	151	255	98	52	16
13	26	48	46	41	46	36	12	143	285	102	72	27
14	26	58	46	45	41	37	8	151	310	109	89	26
15	27	62	43	50	41	39	6	120	310	119	83	24
16	28	55	44	50	46	38	6	100	285	107	78	22
17	31	50	46	45	46	39	6	87	245	106	62	21
18	31	55	48	47	50	33	7	60	265	81	62	20
19	28	58	49	50	46	37	8	51	265	76	47	19
20	26	57	50	50	41	35	7	81	245	76	50	17
21	26	50	52	47	46	36	6	59	196	76	46	16
22	26	50	50	45	46	32	5	53	186	81	46	15
23	26	53	52	41	46	30	8	38	168	76	35	18
24	25	48	46	33	41	20	7	26	151	65	37	19
25	27	50	48	33	37	20	10	33	151	32	39	18
26	26	58	48	33	41	13	18	26	151	26	35	15
27	26	60	46	33	46	14	19	30	160	19	28	13
28	20	43	45	41	46	14	35	29	151	18	25	12
29	20	44	44	38	46	13	46	32	143	14	20	10
30	18	46	43	38	.....	13	70	81	120	109	20	11
31	18	.....	48	35	.....	20	.....	113	.....	123	20	.....

NOTE.—Discharge estimated, because of ice, Nov. 29–30, Dec. 1–3, 15–20, 27, Jan. 8–22, 28, Feb. 4, from hydrograph comparison with Arkansas River at Salida. Discharge interpolated Oct. 14, Dec. 28, 29, and Sept. 7–10, and 14–21. Indirect methods for shifting control used July 30 to Sept. 30.

Monthly discharge of South Fork of Arkansas River at Poncha, Colo., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	32	18	25.0	1,540
November	62	13	38.5	2,290
December	60	43	47.9	2,950
January	55	33	43.9	2,700
February	50	37	45.6	2,620
March	48	13	34.2	2,100
April	70	5	15.8	940
May	186	26	84.7	5,210
June	310	120	194	11,500
July	123	14	84.2	5,180
August	130	20	57.0	3,500
September	27	7	15.5	922
The year	310	5	57.1	41,500

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, 1916.

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

DISCHARGE MEASUREMENTS.—Made from bridge or by wading.

CHANNEL AND CONTROL.—Bed composed of coarse gravel which shifts slightly; no well-defined control. Banks are overflowed to a small extent during extremely high water.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 2.9 feet during night of June 4, determined from high water mark on gage (discharge, 247 second-feet); minimum stage, 1.00 foot at 8 a. m. November 12 (discharge, 2 second-feet).

ICE.—Stage-discharge relation only slightly affected by ice as creek is kept open by springs.

DIVERSIONS.—Court decrees for diversions of 7 second-feet above station but none below.

REGULATION.—None.

ACCURACY.—Stage-discharge relation practically permanent; not affected by ice except from January 31 to February 3. Rating curve well-defined below 150 second-feet. Gage read to hundredths twice daily and during certain periods the maximum stage which occurs during the night is also determined from water marks. Daily discharge ascertained by applying to rating table mean daily gage height determined from either two or three readings. Results good.

Discharge measurements of Poncha Creek at Poncha, Colo., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Nov. 24	W. R. King	1.45	12.3	June 6	Robert Follansbee	2.18	81
Jan. 20	T. J. Watkins	1.32	8.8	21	W. R. King	2.05	60
Feb. 17	do	1.35	11.1				

Daily discharge, in second-feet, of Poncha Creek at Poncha, Colo, for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	13	9	10	8	8	8	7	37	114	34	34	13
2	12	11	9	8	8	8	9	38	116	33	54	13
3	11	11	9	8	8	10	15	27	131	31	40	10
4	12	11	9	8	8	9	19	35	142	31	30	11
5	12	11	10	8	8	12	14	39	120	34	26	11
6	12	11	9	8	8	9	14	53	116	30	35	18
7	11	13	8	8	8	6	10	78	92	30	32	17
8	11	12	8	8	8	10	10	100	83	29	29	16
9	11	10	8	8	8	12	11	114	83	29	21	16
10	11	9	9	8	8	13	14	131	86	33	21	15
11	11	6	7	8	8	12	16	131	86	29	26	14
12	12	5	7	8	8	13	17	131	83	25	20	14
13	11	6	7	8	8	13	18	120	83	33	26	11
14	12	5	8	8	8	11	16	120	90	25	25	11
15	12	5	8	8	9	10	16	104	97	25	22	10
16	13	6	8	8	8	10	16	85	83	24	21	10
17	13	6	8	8	9	12	17	80	80	29	20	9
18	13	8	8	8	9	12	22	100	80	22	19	9
19	13	7	10	8	9	14	25	76	72	21	17	8
20	12	10	9	8	8	16	16	80	74	20	19	8
21	12	11	8	8	8	17	18	76	76	20	19	7
22	12	11	8	8	8	13	22	72	64	18	16	7
23	12	12	8	8	8	12	26	78	59	18	17	11
24	11	11	8	8	8	12	25	64	54	18	18	9
25	12	8	8	8	8	10	38	68	51	16	18	8
26	11	5	8	8	8	12	42	83	51	16	18	8
27	10	10	8	8	8	10	42	83	52	16	17	7
28	10	5	8	8	8	14	55	83	47	17	17	7
29	10	8	8	8	8	14	59	83	42	16	16	7
30	9	10	8	8	.....	14	60	118	35	31	22	7
31	9	.....	8	8	.....	14	.....	131	.....	48	14	.....

NOTE.—Discharge estimated Jan. 31 to Feb. 3, because of ice; interpolated Oct. 14, Dec. 28, 29, Sept. 7-10, and 14-21.

Monthly discharge of Poncha Creek at Poncha, Colo., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	13	9	11.5	707
November	13	5	8.77	522
December	10	7	8.29	510
January	8	8	8.0	492
February	9	8	8.14	468
March	17	6	11.7	719
April	60	7	23.0	1,370
May	131	27	84.5	5,200
June	142	35	81.4	4,840
July	48	16	25.8	1,590
August	54	14	23.5	1,440
September	18	7	10.7	637
The year	142	5	25.5	18,500

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, 1916.

METHOD OF DETERMINING FLOW.—Water used through power house is brought by pipe line from reservoir 3½ miles upstream; quantity is 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 near Victor, Colo., for the year ending Sept. 30, 1916.

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	12.0	738	May	24.6	1,510
November	7.45	443	June	13.8	821
December	5.49	338	July	7.63	469
January	4.00	246	August	18.1	1,110
February	6.76	389	September	9.14	544
March	8.22	505			
April	8.31	494	The year	10.5	7,600

BOEHMER CREEK NEAR PIKES PEAK, COLO.

LOCATION.—In the NW. ¼ sec. 32, T. 14 S., R. 68 W., 3½ miles south of Pikes Peak, El Paso County, above Little Beaver and Sackett creeks. Elevation of station, 11,000 feet.

DRAINAGE AREA.—7.2 square miles (measured on topographic map). Of this area approximately 75 per cent is located above timber line. To the natural drainage has been added that of West Beaver Creek above Strickler tunnel intake.

RECORDS AVAILABLE.—October 1, 1909, to September 30, 1916.

DETERMINATION OF DISCHARGE.—Flow measured by sharp-crested weir, 60 inches long, with complete end contraction. A stake is driven into bed of stream in pool above weir, so that its head is level with crest of weir; depth of water over stake is measured by steel scale. Discharge is computed by Francis formula.

REGULATION.—Flow regulated by series of three reservoirs having an aggregating capacity of 1,400 acre-feet; reservoirs operated by Colorado Springs water department.

DIVERSIONS.—Water diverted above weir for use in Victor is measured and added to flow over Boehmer Creek weir to show total run-off.

COOPERATION.—Monthly discharge computed from records collected by Colorado Springs Water Department.

Monthly discharge of Boehmer Creek near Pikes Peak, Colo., for the years ending Sept. 30, 1910–1916.

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
1909–10.						
October	7.93	4.12	6.54	0.908	1.05	402
November	6.23	2.00	5.17	.718	.80	308
December	5.60	3.84	4.50	.625	.72	277
January	4.40	2.50	3.19	.444	.51	196
February	3.10	2.82	3.02	.419	.44	168
March	5.25	2.85	3.64	.506	.58	224
April	11.7	5.72	4.50	.625	.70	268
May	27.8	5.69	13.6	1.89	2.18	836
June	15.0	6.23	8.28	1.15	1.28	493
July	15.0	4.12	7.13	.990	1.14	438
August	22.3	6.67	10.9	1.51	1.74	670
September	7.99	3.57	6.18	.859	.96	368
The year	27.8	2.00	6.42	.891	12.10	4,650
1910–11.						
October	5.29	2.80	4.04	.561	.65	248
November	3.71	2.56	3.24	.450	.50	193
December	3.00	2.60	2.84	.394	.45	175
January	2.80	.90	1.51	.210	.24	92.8
February	2.00	1.26	1.75	.243	.25	97.2
March	2.00	.98	1.45	.201	.23	89.2
April	6.56	1.65	2.70	.375	.42	161
May	18.6	5.29	11.5	1.60	1.84	707
June	8.28	5.60	7.62	1.06	1.18	453
July	29.8	3.30	14.4	2.00	2.31	885
August	22.4	9.36	18.5	2.57	2.96	1,140
September	16.6	3.81	7.22	1.00	1.12	430
The year	29.8	.90	6.45	.896	12.14	4,670
1911–12.						
October	10.1	.90	7.32	1.02	1.18	450
November	1.35	.14	.53	.074	.08	31.5
December	1.82	1.82	1.82	.252	.29	112
January	3.81	1.82	2.71	.376	.43	167
February	.....	.....	2.30	.319	.34	132
March	.....	.....	.60	.0834	.10	36.9
April	2.86	2.59	2.73	.379	.42	162
May	28.0	2.61	8.56	1.19	1.37	526
June	21.0	4.47	16.3	2.26	2.52	970
July	10.8	5.87	6.78	.942	1.09	417
August	9.00	7.37	8.11	1.13	1.30	499
September	6.62	1.58	3.38	.468	.52	201
The year	28.0	.....	5.10	.709	9.64	3,700

Monthly discharge of Boehmer Creek near Pikes Peak, Colo., for the years ending Sept. 30, 1910–1916—Continued.

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
1912–13.						
October	6.25	2.07	4.37	0.606	0.70	269
November	16.6	2.76	7.37	1.02	1.14	439
December	8.21	1.58	3.98	.552	.64	245
January	1.58	1.13	1.43	.198	.23	87.9
February	1.58	1.13	1.35	.187	.19	75.0
March	1.80	1.80	1.80	.250	.29	111
April	2.19	2.19	2.19	.304	.34	130
May	6.62	2.27	3.46	.480	.55	213
June	8.62	3.50	5.77	.800	.89	343
July	21.7	5.22	10.2	1.42	1.64	627
August	13.6	5.15	9.42	1.31	1.51	579
September	15.6	6.62	13.0	1.80	2.01	774
The year	21.7	1.13	5.38	.746	10.13	3,890
1913–14.						
October	11.9	3.50	6.49	.902	1.04	399
November	3.20	2.61	2.93	.407	.45	174
December	2.61	2.07	2.40	.333	.38	148
January	2.07	1.58	1.90	.264	.30	117
February	1.58	1.58	1.58	.219	.23	87.8
March	1.58	1.58	1.58	.219	.25	97.2
April	2.07	1.58	1.98	.275	.31	118
May	50.0	2.07	19.3	2.68	3.09	1,190
June	50.0	21.2	37.8	5.24	5.85	2,250
July	54.6	15.0	37.2	5.16	5.95	2,290
August	49.7	13.8	25.7	3.57	4.12	1,580
September	15.3	6.60	9.32	1.29	1.44	555
The year	54.6	1.58	12.4	1.72	23.23	9,010
1914–15.						
October	14.6	3.50	4.92	.683	.79	303
November	3.81	2.61	3.23	.448	.50	192
December	2.61	1.82	2.22	.308	.36	136
January	1.35	1.35	1.35	.187	.22	83.0
February	1.35	1.35	1.35	.187	.19	75.0
March	1.35	1.35	1.35	.187	.22	83.0
April	1.35	1.35	1.35	.187	.21	80.3
May	27.1	2.20	12.9	1.79	2.06	793
June	29.6	17.2	22.4	3.11	3.47	1,330
July	32.6	24.2	27.0	3.75	4.32	1,660
August	34.3	20.6	27.6	3.83	4.42	1,700
September	17.3	11.0	12.9	1.79	2.00	768
The year	34.3	1.35	9.95	1.38	18.76	7,200
1915–16.						
October	8.82	4.14	5.15	.714	.82	317
November	8.45	1.32	4.48	.622	.69	267
December	1.82	1.58	1.79	.248	.29	110
January	1.10	1.10	1.10	.153	.18	67.6
February	1.35	1.10	1.23	.171	.18	70.8
March	3.20	1.10	1.34	.186	.21	82.4
April	4.14	3.20	3.57	.495	.55	212
May	14.6	3.81	5.57	.773	.89	342
June	4.72	2.28	3.69	.512	.57	220
July	3.17	1.81	2.39	.332	.38	147
August	12.5	2.63	7.64	1.06	1.22	470
September	16.6	4.20	7.39	1.03	1.15	440
The year	16.6	1.10	3.78	.525	7.12	2,750

NOTE.—Attention is called to the fact that the monthly discharge in second-feet per square mile and the run-off depth in inches do not represent the natural flow from the basin because of artificial storage. The mean of the yearly discharges represents closely the mean natural run-off for the period as effect of storage is eliminated.

LITTLE BEAVER CREEK NEAR PIKES PEAK, COLO.

LOCATION.—In the NW. ¼ of NW. ¼, sec. 32, T. 14 S., R. 68 W., just above mouth of creek 3½ miles south of Pikes Peak, El Paso County, Little Beaver Creek enters Boehmer Creek from the west 0.3 mile above reservoir No. 4. Elevation of station, 11,000 feet.

DRAINAGE AREA.—1.00 square mile (measured on topographic map). Approximately 25 per cent of area above timber line; remainder sparsely timbered.

RECORDS AVAILABLE.—October 1, 1909, to September 30, 1916.

DETERMINATION OF DISCHARGE.—Flow measured by sharp-crested weir, 24 inches long, with complete end contraction. A stake is driven into bed of stream in pool above weir, so that its head is level with crest of weir; depth of water over stake is measured by steel scale. Discharge is computed by Francis formula.

DIVERSIONS.—None.

REGULATION.—None.

COOPERATION.—Monthly discharge computed from records collected by Colorado Springs Water Department.

Monthly discharge of Little Beaver Creek near Pikes Peak, Colo., for the year ending Sept. 30, 1910–1916.

Month.	Discharge in second-feet.				Depth in inches on drainage area.	Total in acre-feet.
	Maximum.	Minimum.	Mean.	Per square mile.		
1909–10.						
October	0.72	0.36	0.51	0.51	0.59	31.4
November	.36	.16	.28	.28	.31	16.7
December	.36	.22	.27	.27	.31	16.6
January	.36	.36	.36	.36	.42	22.1
February	.36	.22	.23	.23	.24	12.8
March	.29	.24	.24	.24	.28	14.8
April	.36	.29	.30	.30	.33	17.9
May	9.26	3.64	6.44	6.44	7.42	396
June	.94	.46	.71	.71	.79	42.2
July	.46	.10	.20	.20	.23	12.3
August	.30	.30	.30	.30	.35	18.4
September	.20	.20	.20	.20	.22	11.9
The year	9.26	.10	.85	.85	11.49	613
1910–11.						
October	.16	.16	.16	.16	.18	9.8
November	.16	.16	.16	.16	.18	9.5
December	.10	.10	.10	.10	.12	6.1
January	.06	.06	.06	.06	.07	3.7
February	.06	.06	.06	.06	.06	3.3
March	.06	.06	.06	.06	.07	3.7
April	1.04	.19	.69	.69	.77	41.1
May	1.78	.22	1.13	1.13	1.30	69.5
June	1.65	1.10	1.37	1.37	1.53	81.5
July	1.40	1.00	1.27	1.27	1.46	78.1
August	1.28	.54	1.02	1.02	1.18	62.7
September	.72	.45	.53	.53	.59	31.5
The year	1.78	.06	.55	.55	7.51	400
1911–12.						
October	.46	.16	.35	.35	.40	21.5
November	.22	.16	.21	.21	.23	12.5
December	.16	.16	.16	.16	.18	9.8
January	.16	.16	.16	.16	.18	9.8
February	.00	.00	.00	.00	.00	.0
March	.16	.16	.16	.16	.18	9.8
April	.00	.00	.00	.00	.00	.0
May	.76	.76	.76	.76	.88	46.7
June	3.10	1.00	2.14	2.14	2.39	127
July	1.53	.63	.89	.89	1.03	54.7
August	.93	.45	.63	.63	.73	38.7
September	.63	.22	.31	.31	.35	18.4
The year	3.10	.00	.48	.48	6.55	349

Monthly discharge of Little Beaver Creek near Pikes Peak, Colo., for the year ending Sept. 30, 1910–1916—Continued.

Month.	Discharge in second-feet.				Depth in inches on drainage area.	Total in acre-feet.
	Maximum.	Minimum.	Mean.	Per square mile.		
1912–13.						
October	0.29	0.10	0.21	0.21	0.24	12.9
November	.19	.06	.11	.11	.12	6.5
December	.00	.00	.00	.00	.00	.0
January	.00	.00	.00	.00	.00	.0
February	.00	.00	.00	.00	.00	.0
March	.00	.00	.00	.00	.00	.0
April	.00	.00	.00	.00	.00	.0
May	1.00	.00	.36	.36	.42	22.1
June	2.50	1.28	1.71	1.71	1.91	102
July	5.00	.63	1.20	1.20	1.38	73.8
August	1.00	.63	.75	.75	.86	46.1
September	.93	.45	.55	.55	.61	32.7
The year	5.00	.00	.41	.41	5.54	296
1913–14.						
October	.65	.40	.54	.54	.62	33.2
November	.54	.22	.34	.34	.38	20.2
December	.10	.10	.10	.10	.12	6.1
January	.00	.00	.00	.00	.00	.0
February	.00	.00	.00	.00	.00	.0
March	.00	.00	.00	.00	.00	.0
April	.00	.00	.00	.00	.00	.0
May	5.00	.00	1.73	1.73	1.99	106
June	8.36	2.73	5.70	5.70	6.36	339
July	3.62	1.28	2.17	2.17	2.50	133
August	3.28	1.28	2.30	2.30	2.65	141
September	1.28	.29	.64	.64	.71	38.1
The year	8.36	.00	1.13	1.13	15.33	817
1914–15.						
October	.45	.22	.34	.34	.39	20.9
November	.29	.00	.24	.24	.27	14.3
December	.00	.00	.00	.00	.00	.0
January	.00	.00	.00	.00	.00	.0
February	.00	.00	.00	.00	.00	.0
March	.00	.00	.00	.00	.00	.0
April	.00	.00	.00	.00	.00	.0
May	2.34	.00	.83	.83	.96	51.0
June	10.2	3.28	5.71	5.71	6.37	340
July	3.28	.93	1.57	1.57	1.81	96.5
August	1.28	.63	.94	.94	1.08	57.8
September	.63	.45	.54	.54	.60	32.1
The year	10.2	.00	.85	.85	11.48	613
1915–16.						
October	.54	.16	.41	.41	.47	25.2
November	.10	.10	.10	.10	.11	6.0
December	.06	.00	.02	.02	.02	1.2
January	.00	.00	.00	.00	.00	.0
February	.00	.00	.00	.00	.00	.0
March	.06	.00	.02	.02	.02	1.2
April	.06	.06	.06	.06	.07	3.6
May	1.60	.06	.45	.45	.52	27.7
June	.81	.81	.81	.81	.90	48.2
July	.63	.36	.49	.49	.56	30.1
August	.72	.45	.56	.56	.65	34.4
September	.45	.29	.33	.33	.37	19.6
The year	1.60	.00	.27	.27	3.67	197

SACKETT CREEK NEAR PIKES PEAK, COLO.

LOCATION.—In the SE. ¼ NW. ¼ sec. 32, T. 14 S., R. 68 W., just above mouth of creek, 4 miles southeast of Pikes Peak, El Paso County. Sackett Creek enters Boehmer Creek from the north a short distance above reservoir No. 4. Elevation of station, 11,000 feet.

DRAINAGE AREA.—0.65 square mile (measured on topographic map). Approximately 30 per cent of area above timber line, and remainder sparsely timbered.

RECORDS AVAILABLE.—October 1, 1909, to September 30, 1916.

DETERMINATION OF DISCHARGE.—Flow measured by sharp-crested weir 24 inches long with complete end contraction. A stake is driven into bed of stream in pool above weir, so that its head is level with crest of weir; depth of water over stake is measured by steel scale. Discharge is computed by Francis formula.

DIVERSIONS.—None.

REGULATION.—None.

COOPERATION.—Monthly discharge computed from records collected by Colorado Springs Water Department.

Monthly discharge of Sackett Creek near Pikes Peak, Colo., for the years ending Sept. 30, 1910–1916.

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
1909–10.						
October	0.87	0.22	0.66	1.01	1.16	40.6
November	.70	.12	.29	.447	.50	17.3
December	.22	.22	.22	.338	.39	13.5
January	.22	.22	.22	.338	.39	13.5
February	.22	.12	.15	.231	.24	8.3
March	.34	.20	.23	.354	.41	14.1
April	1.76	.34	.55	.846	.94	32.7
May	2.73	.96	1.58	2.43	2.80	97.2
June	1.65	.40	1.03	1.58	1.76	61.3
July	.40	.12	.17	.261	.30	10.5
August	.87	.12	.39	.600	.69	24.0
September	.22	.22	.22	.338	.38	13.1
The year	2.73	.12	.48	.734	9.96	346
1910–11.						
October	.12	.12	.12	.184	.21	7.4
November	.10	.10	.10	.154	.17	6.0
December	.10	.10	.10	.154	.18	6.1
January	.00	.00	.00	.00	.00	.0
February	.00	.00	.00	.00	.00	.0
March	.00	.00	.00	.00	.00	.0
April	.22	.22	.22	.338	.38	13.1
May	6.28	.22	1.59	2.45	2.82	97.8
June	1.14	.55	.78	1.20	1.34	46.4
July	2.13	.34	1.14	1.75	2.02	70.1
August	7.35	.50	1.27	1.95	2.25	78.1
September	.49	.22	.34	.523	.58	20.2
The year	6.28	.00	.48	.733	9.95	345
1911–12.						
October	.30	.06	0.14	.215	0.25	8.6
November	.36	.36	.36	.553	.62	21.4
December	.00	.00	.00	.00	.00	.0
January	.00	.00	.00	.00	.00	.0
February	.00	.00	.00	.00	.00	.0
March	.06	.06	.06	.0923	.11	3.7
April	.00	.00	.00	.00	.00	.0
May	.76	.76	.76	1.17	1.35	46.7
June	3.10	1.28	2.06	3.17	3.54	123
July	1.65	.54	.89	1.37	1.58	54.7
August	1.10	.29	.54	.831	.96	33.2
September	1.88	.19	.32	.492	.55	19.0
The year	3.10	.00	.43	.657	8.96	310

Monthly discharge of Sackett Creek near Pikes Peak, Colo., for the years ending Sept. 30, 1910–1916—Continued.

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
1912–13.						
October	0.26	0.06	0.15	0.231	0.27	9.2
November	.06	.06	.06	.0923	.10	3.6
December	.00	.00	.00	.00	.00	.0
January	.00	.00	.00	.00	.00	.0
February	.00	.00	.00	.00	.00	.0
March	.00	.00	.00	.00	.00	.0
April	.00	.00	.00	.00	.00	.0
May	1.10	.00	.58	.892	1.03	35.7
June	1.65	.63	.89	1.37	1.53	53.0
July	3.62	.36	.85	1.31	1.51	52.3
August	.72	.45	.55	.846	.98	33.8
September	.54	.36	.47	.723	.81	28.0
The year	3.62	.00	.30	.458	6.23	216
1913–14.						
October	.63	.16	0.40	.615	0.71	24.6
November	.36	.06	.23	.354	.40	13.7
December	.00	.00	.00	.00	.00	.0
January	.00	.00	.00	.00	.00	.0
February	.00	.00	.00	.00	.00	.0
March	.00	.00	.00	.00	.00	.0
April	.00	.00	.00	.00	.00	.0
May	5.83	.00	1.99	3.06	3.53	122
June	6.64	1.65	3.18	4.89	5.46	189
July	2.34	.82	1.48	2.28	2.63	91.0
August	2.64	1.53	1.93	2.97	3.42	119
September	1.28	.16	.41	.631	.70	24.4
The year	6.64	.00	.81	1.24	16.85	584
1914–15.						
October	.45	.10	0.17	.261	0.30	10.5
November	.10	.06	.07	.108	.12	4.2
December	.00	.00	.00	.00	.00	.0
January	.00	.00	.00	.00	.00	.0
February	.00	.00	.00	.00	.00	.0
March	.00	.00	.00	.00	.00	.0
April	.00	.00	.00	.00	.00	.0
May	5.00	.00	1.65	2.54	2.93	101
June	7.49	1.53	3.34	5.14	5.74	199
July	2.00	.54	.98	1.51	1.74	60.3
August	1.00	.45	.69	1.06	1.22	42.4
September	.45	.45	.45	.692	.77	26.8
The year	7.49	.00	.61	.944	12.82	444
1915–16.						
October	.29	.06	.22	.338	.39	13.5
November	.06	.00	.02	.0307	.03	1.2
December	.00	.00	.00	.00	.00	.0
January	.00	.00	.00	.00	.00	.0
February	.00	.00	.00	.00	.00	.0
March	.06	.00	.02	.0307	.04	1.2
April	.06	.06	.06	.0923	.10	3.6
May	1.78	.06	.83	1.28	1.48	51.0
June	1.00	.63	.97	1.49	1.66	57.7
July	.36	.16	.20	.307	.35	12.3
August	.36	.16	.15	.231	.27	9.2
September	.10	.10	.10	.154	.17	6.0
The year	1.78	.00	.21	.330	4.49	156

LION CREEK NEAR HALFWAY, COLO.

LOCATION.—In the NW. ¼ sec. 15, T. 14 S., R. 68 W., at mouth of creek half a mile southwest of Halfway, El Paso County. Lion Creek enters Ruxton Creek from the west. Elevation of station, 9,250 feet.

DRAINAGE AREA.—2.00 square miles (measured on topographic map). Includes all area above the crater apparently tributary to Sheep Creek. Approximately 30 per cent of area above timber line, and remainder sparsely timbered.

RECORDS AVAILABLE.—April 1, 1908, to September 30, 1916.

DETERMINATION OF DISCHARGE.—Flow measured by sharp-crested weir 30 inches long with complete end contraction. A stake is driven into bed of stream in pool above weir, so that its head is level with crest of weir; depth of water over stake is measured by steel scale. Discharge is computed by Francis formula.

DIVERSIONS.—None.

REGULATION.—None.

COOPERATION.—Monthly discharge computed from records collected by Colorado Springs Water Department.

Monthly discharge of Lion Creek near Halfway, Colo., for the years ending Sept. 30, 1908–1916.

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
1908.						
April	1.06	0.45	0.65	0.325	0.36	38.7
May	.80	.37	.60	.300	.35	36.9
June	52	.30	.43	.215	.24	25.6
July	.92	.27	.46	.230	.27	28.3
August	1.60	.41	.78	.390	.45	48.0
September	1.02	.45	.71	.355	.40	42.2
The period						220
1908-9.						
October	.96	.74	.89	.445	.51	54.7
November	.87	.60	.75	.375	.42	44.6
December	.74	.60	.65	.325	.37	40.0
January	.65	.56	.58	.290	.33	35.7
February	.65	.48	.58	.290	.30	32.2
March	.65	.56	.61	.305	.35	37.5
April	1.38	.60	.78	.390	.44	46.4
May	1.16	.74	.86	.430	.50	52.9
June	1.08	.48	.73	.365	.41	43.4
July	.91	.45	.59	.295	.34	36.3
August	1.71	.56	1.00	.500	.58	61.5
September	3.90	1.27	2.37	1.18	1.32	141
The year	3.90	.45	.86	.432	5.87	626
1909-10.						
October	2.27	1.49	1.87	.935	.108	115
November	1.49	.87	1.26	.630	.70	75.0
December	1.08	.92	1.00	.500	.58	61.5
January	.96	.74	.86	.430	.50	52.9
February	.87	.69	.76	.380	.40	42.2
March	1.43	.48	.91	.455	.52	56.0
April	1.16	.69	1.00	.500	.56	59.5
May	1.27	1.02	1.09	.545	.63	67.0
June	1.38	.78	.87	.435	.49	51.8
July	1.60	.69	.94	.470	.54	57.8
August	1.43	.87	1.12	.560	.65	68.9
September	1.38	1.06	1.22	.610	.68	72.6
The year	2.27	.48	1.08	.539	7.33	780
1910-11.						
October	1.22	.87	1.03	.515	.59	63.3
November	.69	.45	.56	.280	.31	33.3
December	.69	.24	.60	.300	.35	36.9
January	56	.41	.50	.250	.29	30.7
February	.48	.21	.40	.200	.21	22.2
March	.65	.21	.43	.215	.25	26.4
April	1.06	.37	.57	.285	.32	33.9
May	.56	.37	.46	.230	.27	28.3
June	1.06	.27	.38	.190	.21	22.6
July	.69	.30	.53	.265	.31	32.6
August	2.67	.41	1.36	.680	.78	83.6
September	1.60	1.10	1.32	.660	.74	78.6
The year	2.67	.21	.68	.340	4.63	492

Monthly discharge of Lion Creek near Halfway, Colo., for the years ending Sept. 30, 1908–1916—Continued.

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
1911–12.						
October	1.60	0.97	1.11	0.555	0.64	68.2
November	1.10	.79	.95	.475	.53	56.5
December	.91	.67	.78	.390	.45	48.0
January	.73	.61	.65	.325	.37	40.0
February	.67	.51	.60	.300	.32	34.5
March	.87	.56	.66	.330	.38	40.6
April	2.10	.61	1.07	.535	.60	63.7
May	3.31	.85	1.40	.700	.81	86.1
June	3.41	.91	1.33	.665	.74	79.1
July	2.23	.91	1.43	.715	.82	87.9
August	2.38	1.63	1.95	.975	1.12	120
September	2.10	1.38	1.54	.770	.86	91.6
The year	3.41	.51	1.12	.562	7.64	816
1912–13.						
October	1.60	1.10	1.32	.660	.76	81.2
November	1.24	.79	1.02	.510	.57	60.7
December	.85	.27	.62	.310	.36	38.1
January	.79	.46	.65	.325	.37	40.0
February	.73	.61	.67	.335	.35	37.2
March	1.75	.46	.61	.305	.35	37.5
April	2.40	.56	1.20	.600	.67	71.4
May	2.75	.67	.95	.475	.55	58.4
June	1.10	.46	.70	.350	.39	41.7
July	2.75	.36	.62	.310	.36	38.1
August	2.10	.56	1.08	.540	.62	66.4
September	1.90	1.03	1.37	.685	.76	81.5
The year	2.75	.27	.90	.450	6.11	652
1913–14.						
October	1.63	1.10	1.40	.700	.81	86.1
November	1.30	1.03	1.12	.560	.62	66.6
December	1.03	.79	.93	.465	.54	57.2
January	.79	.67	.72	.360	.42	44.3
February	.79	.61	.65	.325	.34	36.1
March	.85	.61	.70	.350	.40	43.0
April	2.07	.85	1.38	.690	.77	82.1
May	5.17	1.75	2.28	1.14	1.31	140
June	5.62	1.63	2.49	1.24	1.38	148
July	4.21	2.41	3.39	1.70	1.96	208
August	4.31	2.93	3.70	1.85	2.13	228
September	2.93	1.90	2.40	1.20	1.34	143
The year	5.62	.61	1.77	.883	12.02	1,280
1914–15.						
October	2.10	1.63	1.79	.895	1.03	110
November	1.75	1.17	1.45	.725	.81	86.3
December	1.30	.97	1.08	.540	.62	66.4
January	1.03	.67	.86	.430	.50	52.9
February	.91	.73	.80	.400	.42	44.4
March	.97	.61	.76	.380	.44	46.7
April	2.93	.67	1.19	.595	.66	70.8
May	2.93	1.63	2.09	1.04	1.20	129
June	2.23	1.60	1.86	.930	1.04	111
July	2.93	1.83	2.26	1.13	1.30	139
August	3.31	1.90	2.55	1.28	1.48	157
September	2.75	1.90	2.22	1.11	1.24	132
The year	3.31	.61	1.58	.787	10.74	1,150
1915–16.						
October	2.07	1.38	1.68	.840	0.97	103
November	1.45	1.17	1.28	.640	.71	76.2
December	1.17	.91	1.04	.520	.60	64.0
January	.97	.67	.85	.425	.49	52.3
February	.91	.67	.78	.390	.42	44.9
March	1.03	.56	.76	.380	.44	46.7
April	1.17	.67	.88	.440	.49	52.4
May	1.45	.79	1.15	.575	.66	70.7
June	1.03	.56	.76	.380	.42	45.2
July	6.32	.51	.97	.485	.56	59.6
August	1.90	1.10	1.45	.725	.84	89.2
September	1.63	1.17	1.46	.730	.81	86.9
The year	6.32	.51	1.09	.545	7.41	791

SHEEP CREEK NEAR HALFWAY, COLO.

LOCATION.—In the SW. ¼ sec. 11, T. 14 S., R. 68 W., a quarter of a mile west of Halfway, El Paso County. No tributary between station and mouth a short distance below. Sheep Creek enters Ruxton Creek from the west a short distance above Halfway. Elevation of station, 9,100 feet.

DRAINAGE AREA.—0.73 square mile (measured on topographic map). Does not include any area above the Crater as this is most probably tributary to Lion Creek. Practically all below timber line, but sparsely timbered.

RECORDS AVAILABLE.—April 1, 1908, to September 30, 1916.

DETERMINATION OF DISCHARGE.—Flow measured by sharp-crested weir 30 inches long with complete end contraction. A stake is driven into bed of stream in pool above weir, so that its head is level with crest of weir; depth of water over stake is measured by steel scale. Discharge is computed by Francis formula.

DIVERSIONS.—None.

REGULATION.—None.

COOPERATION.—Monthly discharge computed from records collected by Colorado Springs Water Department.

Monthly discharge of Sheep Creek near Halfway, Colo., for the years ending Sept. 30, 1908–1916.

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
1908.						
April	0.30	0.18	0.27	0.369	0.41	16.1
May	.45	.26	.46	.629	.73	28.3
June	.30	.16	.23	.315	.35	13.7
July	.24	.13	.18	.246	.28	11.1
August	1.27	.15	.51	.698	.80	31.4
September	.56	.45	.48	.656	.73	28.6
The period						129
1908–9.						
October	.45	.27	.33	.451	.52	20.3
November	.27	.18	.22	.301	.34	13.1
December	.24	.21	.22	.301	.35	13.5
January	.24	.21	.21	.287	.33	12.9
February	.24	.13	.16	.219	.23	8.9
March	.18	.13	.14	.192	.22	8.6
April	.52	.15	.25	.342	.38	14.9
May	.48	.26	.34	.465	.54	20.9
June	.41	.21	.32	.438	.49	19.0
July	.52	.18	.28	.383	.44	17.2
August	.96	.30	.63	.862	.99	38.7
September	2.20	.92	1.47	2.01	2.24	87.5
The year	2.20	.13	.38	.521	7.07	276
1909–10.						
October	1.06	.52	.79	1.08	1.24	48.6
November	.52	.18	.44	.602	.67	26.2
December	.37	.27	.30	.411	.47	18.4
January	.24	.21	.23	.315	.36	14.1
February	.21	.18	.18	.246	.26	10.0
March	.60	.18	.34	.465	.54	20.9
April	.65	.24	.46	.629	.70	27.4
May	.69	.52	.62	.848	.98	38.1
June	.60	.30	.45	.616	.69	26.8
July	.78	.41	.47	.643	.74	28.9
August	.82	.45	.63	.862	.99	38.7
September	.65	.45	.54	.739	.82	32.1
The year	1.06	.18	.46	.624	8.46	330

Monthly discharge of Sheep Creek near Halfway, Colo., for the years ending Sept. 30, 1908–1916—Continued.

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
1910–11.						
October	0.48	0.37	0.40	0.547	0.63	24.6
November	.37	.21	.31	.424	.47	18.4
December	.30	.24	.27	.369	.43	16.6
January	.30	.13	.20	.273	.31	12.3
February	.13	.08	.10	.137	.14	5.6
March	.13	.08	.11	.150	.17	6.8
April	.41	.13	.22	.301	.34	13.1
May	.45	.18	.28	.383	.44	17.2
June	.37	.08	.15	.205	.23	8.9
July	.69	.08	.35	.478	.55	21.5
August	1.60	.61	.82	1.12	1.29	50.4
September	.73	.51	.57	.780	.87	33.9
The year	1.60	.08	.32	.433	5.87	229
1911–12.						
October	.73	.41	.51	.698	.80	31.4
November	.46	.32	.37	.506	.56	22.0
December	.36	.23	.29	.397	.46	17.8
January	.23	.16	.20	.274	.32	12.3
February	.16	.13	.15	.205	.22	8.6
March	.27	.16	.20	.274	.32	12.3
April	1.03	.20	.39	.533	.59	23.2
May	2.93	.56	1.23	1.68	1.94	75.6
June	2.23	.79	1.27	1.74	1.94	75.6
July	1.98	1.03	1.32	1.81	2.09	81.2
August	1.63	.91	1.31	1.79	2.06	80.6
September	1.10	.67	.80	1.09	1.22	47.6
The year	2.93	.13	.67	.920	12.52	488
1912–13.						
October	1.45	.51	.64	.876	1.01	39.4
November	.56	.36	.44	.602	.67	26.2
December	.36	.13	.25	.342	.39	15.4
January	.20	.13	.17	.233	.27	10.5
February	.13	.10	.13	.178	.19	7.2
March	.51	.05	.16	.219	.25	9.8
April	1.38	.23	.64	.876	.98	38.1
May	1.24	.46	.63	.862	.99	38.7
June	.79	.32	.49	.671	.75	29.2
July	1.17	.20	.45	.616	.71	27.7
August	1.03	.46	.65	.890	1.03	40.0
September	1.03	.56	.73	1.00	1.12	43.4
The year	1.45	.05	.45	.615	8.36	326
1913–14.						
October	.91	.56	.67	.917	1.06	41.2
November	.56	.32	.43	.588	.66	25.6
December	.36	.27	.33	.451	.52	20.3
January	.27	.23	.26	.356	.41	16.0
February	.27	.20	.22	.301	.31	12.2
March	.36	.23	.29	.397	.46	17.8
April	1.75	.36	1.01	1.38	1.54	60.1
May	3.31	1.10	2.33	3.19	3.68	143
June	2.57	1.52	2.13	2.91	3.25	127
July	3.70	1.83	2.69	3.68	4.24	165
August	3.31	1.10	2.14	2.93	3.38	132
September	1.45	.79	1.03	1.41	1.57	61.3
The year	3.70	.20	1.13	1.55	21.08	822

Monthly discharge of Sheep Creek near Halfway, Colo., from the years ending Sept. 30, 1908–1916—Colorado.

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
1914–15.						
October	0.79	0.56	0.72	0.986	1.14	44.3
November	.67	.36	.53	.725	.81	31.5
December	.46	.27	.34	.465	.54	20.9
January	.32	.23	.25	.342	.39	15.4
February	.20	.16	.20	.274	.29	11.1
March	.36	.20	.23	.315	.36	14.1
April	3.06	.27	.96	1.31	1.46	57.1
May	3.12	1.38	2.11	2.88	3.32	130
June	2.84	1.03	1.80	2.46	2.74	107
July	1.83	1.10	1.41	1.93	2.22	86.7
August	2.10	1.30	1.71	2.34	2.70	105
September	1.75	1.03	1.25	1.71	1.91	74.4
The year	3.12	.16	.96	1.32	17.88	698
1915–16.						
October	.97	.67	.79	1.08	1.24	48.6
November	.67	.46	.54	.739	.82	32.1
December	.46	.27	.36	.492	.57	22.1
January	.36	.23	.26	.356	.41	16.0
February	.27	.23	.24	.328	.35	13.8
March	.27	.20	.24	.328	.38	14.8
April	1.03	.23	.41	.561	.63	24.4
May	1.38	.73	1.10	1.50	1.73	67.6
June	.91	.27	.54	.739	.82	32.1
July	4.52	.27	.57	.780	.90	35.0
August	2.40	.97	1.22	1.67	1.92	75.0
September	1.03	.67	.79	1.08	1.21	47.0
The year	4.52	.20	.59	.807	10.98	428

SOUTH RUXTON CREEK AT HALFWAY, COLO.

LOCATION.—In the SW. ¼ sec. 11, T. 14 S., R. 68 W., just above hydroelectric intake at Halfway, El Paso County. No surface tributary between station and mouth, a short distance below. South Ruxton Creek enters Ruxton Creek from the south at Halfway. Elevation of station, 9,000 feet.

DRAINAGE AREA.—3.95 square miles (measured on topographic map). Practically all below timber line and heavily timbered.

RECORDS AVAILABLE.—June 1, 1906, to September 30, 1916.

DETERMINATION OF DISCHARGE.—Flow measured by two sharp-crested weirs, with complete end contraction. Discharge is computed by Francis formula. The main weir is one-third mile above the mouth of the creek and a short distance above the hydroelectric intake which has a capacity of 4.63 second-feet. The second weir is halfway between the main weir and the mouth of the creek and measures the inflow chiefly from springs below the intake and a small amount of seepage. At all times except during high water the capacity of the intake is sufficient to take the entire flow passing the main weir, and the flow at the two weirs is combined to give the total run-off of the basin. During high water the excess passing the intake and recorded at the lower weir does not represent increased flow between the weirs, and is discarded. In its place is used a constant quantity based on inflow and seepage at other times.

DIVERSIONS.—None.

REGULATION.—None.

COOPERATION.—Monthly discharge computed from records collected by Colorado Springs Water Department.

Monthly discharge of South Ruxton Creek at Halfway, Colo., for the years ending Sept. 30, 1906–1916.

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
1906.						
June	3.50	1.60	2.23	0.565	0.63	133
July	6.08	1.90	3.59	.909	1.05	221
August	3.70	2.57	2.95	.746	.86	181
The period						535
1906–7.						
October	2.93	1.30	2.04	.516	.59	125
November	3.70	2.07	2.86	.724	.81	170
December	2.40	1.45	1.85	.468	.54	114
January	1.45	1.17	1.34	.339	.39	82.4
February	1.30	.79	1.09	.276	.29	60.5
March	1.30	.67	1.00	.253	.29	61.5
April	1.75	.79	1.18	.299	.33	70.2
May	3.12	1.17	2.35	.595	.69	144
June	5.40	2.49	3.89	.985	1.10	231
July	5.17	2.07	2.57	.651	.75	158
August	5.40	2.38	3.50	.887	1.02	215
September	2.40	1.75	1.96	.496	.55	117
The year	5.40	.67	2.11	.541	7.35	1,550
1907–8.						
October	1.90	1.30	1.50	.380	0.44	92.2
November	1.98	1.03	1.19	.301	.34	70.8
December	1.03	.79	.91	.231	.27	56.0
January	1.45	.73	.86	.218	.25	52.9
February	.84	.67	.74	.188	.20	42.0
March	1.17	.67	.83	.210	.24	51.6
April	1.45	.36	.93	.236	.26	55.3
May	1.38	.28	.87	.220	.25	53.5
June	.79	.56	.70	.177	.20	41.7
July	2.00	.67	1.17	.296	.34	71.9
August	7.29	2.00	4.30	1.09	1.26	264
September	4.95	2.07	2.90	.734	.82	173
The year	7.29	.28	1.41	.357	4.87	1,020
1908–9.						
October	2.07	1.39	1.60	.405	.47	98.4
November	1.75	.85	1.22	.309	.34	72.6
December	1.17	.97	1.04	.263	.30	64.0
January	1.03	.91	.97	.246	.28	59.6
February	.98	.91	.95	.241	.25	52.8
March	1.10	.91	.95	.241	.28	58.4
April	1.90	.98	1.31	.332	.37	78.0
May	2.40	1.45	1.96	.496	.57	121
June	3.06	2.10	2.51	.635	.71	149
July	2.84	1.83	2.14	.542	.62	132
August	4.73	2.24	3.14	.795	.92	193
September	10.1	4.10	6.15	1.56	1.74	366
The year	10.1	.85	1.99	.505	6.85	1,440
1909–10.						
October	3.90	2.10	2.88	.729	.84	177
November	2.24	.98	1.81	.458	.51	108
December	1.60	.98	1.43	.362	.42	87.9
January	1.38	1.17	1.27	.321	.37	78.1
February	1.17	.98	1.06	.268	.28	58.9
March	2.07	.98	1.25	.316	.36	76.9
April	2.94	1.17	1.80	.456	.51	107
May	3.60	2.58	3.08	.780	.90	189
June	4.31	2.58	3.31	.838	.94	197
July	2.84	2.07	2.48	.628	.72	152
August	3.90	2.40	2.89	.732	.84	178
September	2.76	1.60	2.08	.527	.59	124
The year	4.31	.98	2.12	.535	7.28	1,530

Monthly discharge of South Ruxton Creek at Halfway, Colo., for the years ending Sept. 30, 1906–1916—Continued.

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
1910–11.						
October	1.75	1.38	1.56	0.395	0.46	95.9
November	1.52	1.17	1.28	.324	.36	76.2
December	1.24	.98	1.08	.273	.31	66.4
January	1.10	.85	1.00	.253	.29	61.5
February	1.03	.73	.91	.231	.24	50.5
March	1.30	.67	.96	.243	.28	59.0
April	1.60	.41	1.10	.279	.31	65.5
May	1.52	1.30	1.44	.365	.42	88.5
June	1.75	1.24	1.37	.347	.39	81.5
July	4.95	1.45	2.35	.595	.69	144
August	4.52	1.75	2.52	.638	.74	155
September	1.90	1.24	1.49	.377	.42	88.7
The year	4.95	.41	1.43	.360	4.91	1,030
1911–12.						
October	1.52	.91	1.19	.301	.35	73.2
November	1.30	.85	.98	.248	.28	58.3
December	.97	.74	.79	.200	.23	48.6
January	.79	.67	.73	.185	.21	44.9
February	.79	.61	.67	.170	.18	38.5
March	.79	.61	.68	.172	.20	41.8
April	1.63	.61	.99	.251	.28	58.9
May	4.31	1.17	2.52	.638	.74	155
June	6.80	2.67	3.95	1.00	1.12	235
July	5.18	2.76	3.33	.843	.97	205
August	3.50	2.07	2.80	.708	.82	172
September	2.23	1.60	1.78	.451	.50	106
The year	6.80	.61	1.69	.431	5.88	1,240
1912–13.						
October	1.90	1.24	1.42	.359	.41	87.3
November	1.52	.98	1.16	.293	.33	69.0
December	.98	.73	.87	.220	.25	53.5
January	.85	.73	.74	.188	.22	45.5
February	.73	.67	.71	.180	.19	39.4
March	1.63	.56	.72	.182	.21	44.3
April	1.75	.67	1.15	.291	.32	68.4
May	2.10	1.17	1.40	.355	.41	86.1
June	3.31	1.24	2.20	.558	.62	131
July	4.21	1.60	2.53	.641	.74	156
August	3.50	1.63	2.48	.628	.72	152
September	3.60	2.67	3.05	.772	.86	181
The year	4.21	.56	1.54	.389	5.28	1,110
1913–14.						
October	2.93	1.60	1.95	.494	0.57	120
November	1.75	.97	1.36	.345	.38	80.9
December	1.52	1.03	1.20	.304	.35	73.8
January	1.45	.97	1.03	.261	.30	63.3
February	1.03	.85	.90	.228	.24	50.0
March	1.17	.73	.97	.246	.28	59.6
April	4.52	1.17	2.91	.736	.82	173
May	9.37	3.90	7.25	1.84	2.12	446
June	11.5	7.67	9.60	2.43	2.71	571
July	8.38	5.62	6.72	1.70	1.96	413
August	8.31	4.10	5.72	1.45	1.67	352
September	4.00	2.57	3.28	.831	.93	195
The year	11.5	.73	3.59	.905	12.33	2,600

Monthly discharge of South Ruxton Creek at Halfway, Colo., for the years ending Sept. 30, 1906–1916—Continued.

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
1914–15.						
October	2.57	1.83	2.28	0.578	0.67	140
November	2.38	1.24	1.87	.474	.53	111
December	1.75	1.30	1.48	.375	.43	91.0
January	1.30	1.17	1.25	.316	.36	76.9
February	1.30	1.03	1.13	.286	.30	62.8
March	1.10	.97	1.02	.258	.30	62.7
April	4.73	1.10	2.09	.530	.59	124
May	9.37	3.90	6.41	1.62	1.87	394
June	10.1	7.38	8.94	2.26	2.52	532
July	7.17	4.10	4.96	1.26	1.45	305
August	5.97	4.52	5.38	1.36	1.57	331
September	5.28	3.06	3.78	.957	1.07	225
The year	10.1	.97	3.39	.856	11.66	2,460
1915–16.						
October	3.06	2.38	2.70	.683	.79	166
November	2.40	1.63	1.94	.491	.55	115
December	1.75	1.31	1.56	.395	.46	95.9
January	1.45	1.17	1.30	.329	.38	79.9
February	1.45	1.03	1.20	.304	.33	69.0
March	1.52	.61	1.12	.284	.33	68.9
April	2.57	.73	1.40	.355	.40	83.3
May	3.90	1.98	3.15	.798	.92	194
June	3.70	2.10	2.76	.698	.78	164
July	3.70	1.83	2.04	.517	.60	125
August	6.44	3.70	5.16	1.31	1.51	317
September	4.41	2.40	3.25	.824	.92	193
The year	6.44	.61	2.30	.582	7.97	1,670

CABIN CREEK NEAR HALFWAY, COLO.

LOCATION.—In the SW. ¼ NW. ¼ sec. 11, T. 14 S., R. 68 W., just above hydroelectric intake, about three-eighths mile north of Halfway, El Paso County. Cabin Creek enters Ruxton Creek half a mile below Halfway. Elevation of station, approximately 9,000 feet.

DRAINAGE AREA. 2.4 square miles (measured on topographic map). Approximately 15 per cent of area above timber line and remainder sparsely timbered.

RECORDS AVAILABLE. October 1, 1906, to September 30, 1916.

DETERMINATION OF DISCHARGE.—Flow measured by two sharp-crested weirs with complete end contraction. Discharge is computed by Francis formula. The main weir is about one-third of a mile above the mouth of the creek and just above the hydroelectric intake. The second weir is 50 feet above the mouth of the creek and measures the flow from springs and small tributaries entering below the intake. Except during high water the measured flow at the weirs is combined to give the total run-off from the basin. During high water the record from the lower weir is discarded and the inflow estimated. (See description of South Ruxton Creek at Halfway, Colo.)

DIVERSIONS.—None.

REGULATION.—None.

COOPERATION.—Monthly discharge computed from records collected by Colorado Springs Water Department.

Monthly discharge of Cabin Creek near Halfway, Colo., for the year ending Sept. 30, 1907–1916.

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
1906–7.						
October	4.10	2.57	3.24	1.35	1.56	199
November	3.50	1.60	2.38	.992	1.11	142
December	1.60	.91	1.19	.496	.57	73.2
January	1.45	.51	.70	.292	.34	43.0
February	.67	.46	.56	.233	.24	31.1
March	.61	.46	.50	.208	.24	30.7
April	1.30	.46	.68	.283	.32	40.5
May	2.07	1.10	1.67	.696	.80	103
June	3.06	.97	1.71	.713	.80	102
July	4.10	.85	1.29	.538	.62	79.3
August	2.75	1.45	1.96	.816	.94	121
September	1.45	.91	1.04	.434	.48	61.9
The year	4.10	.46	1.42	.590	8.02	1,030
1907–8.						
October	1.17	.79	.87	.363	.42	53.5
November	.85	.41	.56	.233	.26	33.3
December	.46	.36	.40	.167	.19	24.6
January	.36	.16	.28	.117	.13	17.2
February	.23	.10	.19	.0792	.09	10.9
March	.79	.20	.32	.133	.15	19.7
April	.67	.27	.38	.158	.18	22.6
May	.85	.41	.52	.217	.25	32.0
June	.46	.20	.32	.133	.15	19.0
July	.61	.10	.30	.125	.14	18.4
August	2.57	.27	1.14	.475	.55	70.1
September	2.07	1.17	1.45	.604	.67	86.3
The year	2.57	.10	.56	.242	3.19	408
1908–9.						
October	1.24	.67	.86	.359	.41	52.9
November	.73	.32	.51	.213	.24	30.3
December	.36	.27	.32	.133	.15	19.7
January	.27	.20	.25	.104	.12	15.4
February	.34	.13	.22	.0917	.10	12.2
March	.32	.20	.22	.0917	.11	13.5
April	1.24	.27	.61	.254	.28	36.3
May	1.24	.73	.93	.388	.45	57.2
June	2.23	1.10	1.54	.642	.72	91.6
July	1.39	.67	.98	.408	.47	60.3
August	3.41	.67	1.91	.796	.92	117
September	6.32	2.57	4.04	1.68	1.87	240
The year	6.32	.13	1.02	.431	5.83	746
1909–10.						
October	2.57	1.24	1.77	.737	.85	109
November	1.17	.56	.79	.329	.37	47.0
December	.61	.36	.48	.200	.23	29.5
January	.41	.23	.30	.125	.14	18.4
February	.46	.16	.33	.138	.14	18.3
March	1.03	.32	.60	.250	.29	36.9
April	1.52	.56	1.01	.421	.47	60.1
May	1.98	1.45	1.67	.696	.80	103
June	2.07	1.17	1.51	.629	.70	89.8
July	1.90	.91	1.29	.538	.62	79.3
August	1.60	.97	1.27	.529	.61	78.1
September	1.60	1.10	1.35	.562	.63	80.3
The year	2.57	.16	1.04	.431	5.85	750
1910–11.						
October	1.38	.91	1.07	.446	.51	65.8
November	1.03	.67	.85	.355	.40	50.6
December	.73	.51	.62	.258	.30	38.1
January	.56	.41	.52	.217	.25	32.0
February	.34	.21	.29	.121	.13	16.1
March	.61	.46	.51	.213	.25	31.4
April	1.10	.56	.75	.313	.35	44.6
May	1.17	.73	.99	.413	.48	60.9
June	2.23	.61	.89	.371	.41	53.0
July	4.31	.61	1.87	.779	.90	115
August	3.70	1.63	2.74	1.14	1.31	168
September	1.83	1.17	1.38	.575	.64	82.1
The year	4.31	.21	1.05	.437	5.93	758

Monthly discharge of Cabin Creek near Halfway, Colo., for the year ending Sept. 30, 1907–1916—Continued.

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
1911–12.						
October	1.90	0.85	1.10	0.458	0.53	67.6
November	1.03	.67	.82	.342	.38	48.8
December	.73	.56	.64	.267	.31	39.4
January	.51	.16	.31	.129	.15	19.1
February	.32	.13	.22	.0917	.10	12.7
March	.73	.27	.39	.162	.19	24.0
April	2.93	.46	.93	.388	.43	55.3
May	6.08	1.10	2.92	1.22	1.41	180
June	7.04	2.93	4.22	1.76	1.96	251
July	5.40	2.93	3.77	1.57	1.81	232
August	4.95	2.23	3.57	1.49	1.72	220
September	2.40	1.30	1.74	.725	.81	104
The year	7.04	.13	1.73	.719	9.80	1,250
1912–13.						
October	1.75	.97	1.22	.508	.59	75.0
November	1.30	.61	.94	.392	.44	55.9
December	.73	.20	.47	.196	.23	28.9
January	.36	.16	.28	.117	.13	17.2
February	.32	.23	.28	.117	.12	15.6
March	.97	.20	.27	.112	.13	16.6
April	2.40	.27	1.13	.472	.53	67.2
May	3.22	.91	1.38	.575	.66	84.8
June	2.75	1.03	1.38	.575	.64	82.1
July	2.57	.61	1.44	.600	.69	88.5
August	3.31	1.75	2.10	.875	1.01	129
September	2.57	1.24	2.02	.842	.94	120
The year	3.31	.16	1.08	.450	6.11	781
1913–14.						
October	2.23	1.03	1.51	.629	.73	92.8
November	1.38	.61	.96	.400	.45	57.1
December	.85	.61	.74	.308	.36	45.5
January	.67	.51	.59	.246	.28	36.3
February	.56	.46	.50	.208	.22	27.8
March	.85	.51	.61	.254	.29	37.5
April	3.22	.73	1.99	.830	.93	118
May	7.38	2.93	5.12	2.13	2.46	315
June	9.37	4.52	6.51	2.71	3.02	387
July	10.1	4.31	6.81	2.84	3.27	419
August	6.68	2.93	4.60	1.92	2.21	283
September	2.67	1.63	2.05	.854	.95	122
The year	10.1	.46	2.68	1.17	15.17	1,940
1914–15.						
October	1.60	.97	1.34	.558	.64	82.4
November	1.30	.67	.96	.400	.45	57.1
December	.79	.41	.56	.233	.27	34.4
January	.85	.36	.47	.196	.23	28.9
February	.46	.41	.44	.184	.19	24.4
March	.56	.36	.43	.179	.21	26.4
April	3.90	.51	1.52	.634	.71	90.4
May	5.62	2.38	4.27	1.78	2.05	263
June	7.29	5.40	6.47	2.70	3.01	385
July	6.08	3.70	4.83	2.01	2.32	297
August	5.74	3.50	4.72	1.97	2.27	290
September	4.31	2.23	3.04	1.27	1.42	181
The year	7.29	.36	2.43	1.01	13.77	1,760
1915–16.						
October	2.10	1.24	1.65	.688	.79	101
November	1.17	.91	1.04	.434	.48	61.9
December	.91	.73	.80	.334	.39	49.2
January	.73	.56	.62	.258	.30	38.1
February	.61	.46	.55	.229	.25	31.6
March	.79	.46	.59	.246	.28	36.3
April	1.90	.61	1.02	.425	.47	60.7
May	3.06	1.63	2.56	1.07	1.23	157
June	2.49	.97	1.68	.700	.78	100
July	3.12	.85	1.16	.484	.56	71.3
August	4.21	2.10	2.87	1.20	1.38	176
September	2.84	1.52	2.09	.872	.97	124
The year	4.21	.46	1.40	.580	7.88	1,010

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, 1916.

GAGE.—Stevens water-stage recorder installed February 16, 1915, on 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 boulders; control practically permanent. Banks high and not subject to overflow.

EXTREMES OF DISCHARGE.—Maximum stage during year, from water-stage recorder, 5.1 feet October 15 (discharge, 985 second-feet); minimum stage, 1.33 feet at 12 noon September 28 (discharge, 0.4 second-foot).

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

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

REGULATION.—Flow controlled to a great extent by Lawton reservoir, which is 1⅓ miles upstream; capacity, 14,000 acre-feet.

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

ACCURACY.—Stage-discharge relation practically permanent; not affected by ice. Rating curve well defined below 1,500 second-feet. Operation of water-stage recorder satisfactory except for occasional short periods. Daily discharge ascertained by applying to rating table mean daily gage height determined by inspection of gage-height graph. Results excellent for medium and high stages. For low stages the actual error is small, but the percentage error may be large.

Discharge measurements of Medicine Bluff Creek near Lawton, Okla., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Nov. 18	Robert Follansbee	2.03	11.1
Apr. 16	J. B. Lenertz	3.80	281
May 12	Robert Follansbee	1.62	3.4

Daily discharge, in second-feet, of Medicine Bluff Creek near Lawton, Okla., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	34	23	16	10	55	13	24	43	21	20	13	6
2	24	22	11	11	14	24	21	13	23	19	13	71
3	23	21	11	10	26	11	16	19	21	19	13	13
4	64	20	11	11	32	3.2	18	8	20	20	13	11
5	18	19	11	12	60	1.4	25	12	17	26	12	11
6	11	18	11	11	34	.8	26	13	15	26	12	4.6
7	23	16	11	11	30	17	44	12	16	26	13	.9
8	12	33	11	11	23	3.2	36	17	16	26	12	4.8
9	11	20	11	11	33	2.2	24	13	16	27	12	6
10	11	12	16	11	22	6	21	32	16	27	12	6
11	11	19	13	14	29	14	19	8	16	28	14	8
12	13	12	11	33	113	12	17	3.2	17	28	15	6
13	12	11	10	12	64	12	19	3.6	17	24	16	7
14	12	64	10	11	55	64	101	8	18	31	15	7
15	175	12	10	14	45	13	495	24	18	34	16	6
16	648	13	13	18	35	12	282	12	18	11	15	6
17	373	31	9	8	25	12	169	15	18	16	13	6
18	350	18	9	13	15	12	126	16	18	13	10	6
19	300	12	9	7	10	13	98	16	18	15	11	6
20	250	11	9	8	3	12	92	16	18	14	12	6
21	150	22	9	8	2.2	15	47	15	18	13	12	3.4
22	100	10	10	8	10	17	47	15	18	12	12	3.2
23	55	10	10	8	18	15	56	15	18	12	12	9
24	56	11	19	8	7	15	44	15	18	12	12	18
25	58	15	10	8	6	16	34	15	77	12	12	3
26	60	11	10	71	17	24	60	15	63	12	12	2.1
27	50	14	23	200	4.8	17	27	15	49	12	12	1.5
28	41	14	10	116	24	20	16	15	35	12	12	.5
29	32	11	10	118	6	13	12	15	21	12	12	.9
30	24	11	10	73	.....	14	32	15	20	12	10	.9
31	24	.....	10	98	.....	14	.....	18	.....	13	8	.....

NOTE.—Discharge estimated Oct. 18–22, 24–25, 27, Nov. 1–6, Feb. 14–19, June 17, 19–24, 26–28.

Monthly discharge of Medicine Bluff Creek near Lawton, Okla., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	648	11	97.6	6,000
November	64	10	17.9	1,070
December	23	9	11.4	701
January	200	7	31.1	1,910
February	113	2.2	28.2	1,620
March	64	.8	14.1	867
April	495	12	68.3	4,060
May	43	3.2	15.2	935
June	77	15	23.1	1,370
July	34	11	18.8	1,160
August	16	8	12.5	769
September	71	.5	8.03	494
The year	648	.5	28.9	21,000

Corrected monthly discharge of Medicine Bluff Creek near Lawton, Okla., for the year ending Sept. 30, 1916.

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	103	6,330	May	24.4	1,500
November	19.4	1,150	June	23.3	1,390
December	10.6	652	July	21.6	1,330
January	40.9	2,510	August	8.0	492
February	36.7	2,110	September	9.1	541
March	11.5	707			
April	83.7	4,980	The year	32.7	23,700

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

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., half a mile above the mouth of creek and 12½ miles northwest of Lawton, in Comanche County.

DRAINAGE AREA.—Approximately 10 square miles.

RECORDS AVAILABLE.—November 26, 1912, to September 30, 1916.

GAGE.—Vertical staff on left bank; read by J. B. Lenertz. Upstream 200 feet 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 with sand; control is rock ledge just below gage. Between station and crest of 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, 0.97 foot April 15 and September 2 (discharge, 41 second-feet). Stream dry most of July and August.

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

DIVERSIONS.—None.

REGULATION.—None.

ACCURACY.—Stage-discharge relation permanent; not affected by ice. Rating curve well-defined below 200 second-feet. Gage read to quarter-tenths twice daily. Discharge ascertained by applying mean daily gage height to rating table. Results considered only fair as a very slight error in actual discharge would be a large percentage error.

The following discharge measurement was made by Robert Follansbee:

May 11, 1916: Gage height, 0.18 foot; estimated discharge, 0.3 second-foot.

Daily discharge, in second-feet, of Little Medicine Bluff Creek near Lawton, Okla., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept.
1	1.6	0.2	0.3	0.2	17	0.3	0.2	0.3	0.2	0.2	.....	0.3
2	1.0	.2	.3	.2	10	.3	.3	.3	.2	.2	.....	41
3	.6	.2	.3	.2	3.5	.2	.3	.6	.2	.1	.....	6.2
4	.3	.2	.3	.2	1.6	.2	.3	.6	.2	.1	.....	1.6
5	.3	.2	.3	.2	1.6	.2	6	.3	.2	.1	.....	.2
6	.3	.2	.3	.2	1.6	.3	.6	.3	.2	.1	.....	.2
7	.3	.2	.3	.2	1.6	.6	.6	.3	.2	.1	.....	.3
8	.3	.2	.3	.2	1.0	.6	.6	.3	.1	.1	.....	.2
9	.3	.2	.3	.3	1.0	.6	.6	.3	.1	.1	.....	.2
10	.3	.2	.3	.3	.6	.6	.6	.3	.2	.1	.....	.2
11	.3	.2	.3	.3	.6	.6	.6	.3	.2	.....	.....	.6
12	.3	.2	.2	.3	.6	.6	.6	.3	.2	.....	.....	1.0
13	.3	.2	.2	.3	.6	.6	2.5	.3	.2	.....	.....	.6
14	.3	.2	.2	.3	.3	.3	4.8	.3	.2	.....	.....	.3
15	4.8	.2	.2	.3	.3	.3	41	.3	.2	.....	.....	.2
16	3.5	.3	.2	.3	.3	.3	35	.3	.1	.....	.....	.2
17	3.5	.3	.2	.3	.3	.3	25	.3	.1	.....	.....	.2
18	1.6	.3	.2	.2	.3	.3	9.4	.6	.1	.....	.....	.2
19	1.0	.3	.2	.2	.6	.3	3.5	.6	.2	.....	.....	.2
20	1.0	.3	.2	.3	.6	.2	2.5	1.0	.2	.3	.....	.2
21	1.0	.3	.2	.6	1.0	.2	1.6	1.0	.2	.2	.....	.2
22	.6	.3	.2	.6	1.0	.2	1.0	.6	.2	.2	.....	.2
23	.6	.3	.2	.6	1.0	.2	.6	.6	.2	.2	.....	.2
24	.6	.3	.2	.6	1.0	.2	.3	.6	.2	.1	.....	.2
25	.3	.3	.2	1.0	.6	.2	.3	.3	3.0	.1	.....	.2
26	.3	.3	.2	.2	.6	.2	.3	.3	.6	.....	.....	.2
27	.2	.3	.2	.2	.6	.2	.2	.3	.3	.....	.....	.2
28	.2	.3	.2	.2	.6	.2	.2	.3	.3	.....	.....	.2
29	.2	.3	.2	.2	.6	.2	.2	.2	.2	.....	.....	.1
30	.2	.3	.2	.2	.....	.2	.2	.2	.2	.....	.....	.1
31	.2	.....	.2	25	.....	.2	.....	.2	.....	.....	0.3	.....

NOTE.—Channel practically dry July 11–19, and July 26 to Aug. 30. Discharge interpolated Oct. 27.

Monthly discharge of Little Medicine Bluff Creek near Lawton, Okla., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (in acre-feet).
	Maximum.	Minimum.	Mean.	
October	4.8	0.2	0.85	52
November	.3	.2	.25	15
December	.3	.2	.24	15
January	25	.2	1.11	68
February	17	.3	1.74	100
March	.6	.2	.32	20
April	41	.2	4.48	267
May	.9	.2	.40	25
June	3.0	.1	.30	18
July	.3	.0	.07	4
August	.3	.0	.01	0
September	41	.1	1.86	111
The year	41	0	.96	695

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, 1916.

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. New needle installed May 4, 1916, with point 3 inches below top of pan. Old point was 7 inches below top. Rainfall measured by rain gage on raft.

Daily evaporation, in inches, at Lawton reservoir, near Lawton, Okla., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	0.31	0.19	0.12	0.04	0.02	0.03	0.00	0.12	0.47	0.29	0.37	0.06
2	.29	.20	.07	.05	.02	.02	.06	.10	.46	.32	.36	.23
3	.30	.19	.13	.05	.02	.04	.07	.14	.49	.33	.38	.41
4	.27	.21	.14	.05	.02	.04	.08	.17	.17	.37	.37	.34
5	.30	.20	.16	.03	.02	.05	.06	.20	.31	.33	.39	.33
6	.27	.18	.00	.00	.02	.05	.07	.19	.33	.30	.37	.31
7	.23	.22	.06	.00	.02	.06	.07	.21	.01	.31	.35	.12
8	.24	.19	.09	.00	a.03	.06	.05	.28	.44	.30	.36	.29
9	.23	.21	.10	.03	.04	.05	.06	.47	.47	.32	.38	.32
10	.23	.18	.08	.03	.03	.07	.10	.49	.47	.37	.37	.33
11	.27	.20	.06	.04	.04	.06	.13	.51	.48	.34	.39	.07
12	.32	.21	.07	.03	.02	.06	.10	.19	.37	.33	.38	.08
13	.26	.18	.07	.03	.03	.07	.10	.27	.36	.33	.38	.29
14	.26	.17	.08	.03	.03	.05	.09	.23	.40	.36	.37	.28
15	.23	.14	.00	.03	.04	.06	.03	.31	.40	.37	.39	.31
16	.21	.16	.06	.03	.04	.07	.08	.37	.40	.37	.36	.29
17	.25	.17	.07	.03	.03	.08	.06	.29	.39	.34	.38	.30
18	.27	.19	.05	.03	.02	.08	.08	.07	.41	.34	.37	.29
19	.28	.22	.08	.02	.04	.09	.09	.30	.46	.19	.35	.28
20	.26	.20	.07	.02	.04	.10	.08	.07	.48	.32	.37	.30
21	.24	.16	.06	.02	.03	.09	.11	.38	.47	.30	.37	.27
22	.27	.18	.09	.02	.03	.07	.12	.37	.49	.33	.38	.24
23	.23	.19	.08	.02	.02	a.08	.12	.47	.50	.34	.37	.23
24	.23	.17	.03	.02	.04	.09	.11	.40	.46	.33	.35	.20
25	.24	.14	.05	.02	.05	.04	.13	.38	.35	.36	.36	.19
26	.21	.17	.03	.02	.04	.04	.12	.33	.41	.37	.38	.21
27	.19	.13	.02	.02	.02	.07	.14	.41	.39	.34	.34	.18
28	.20	.12	a.02	.02	.02	.08	.15	.40	.38	.36	.35	.15
29	.20	.14	a.02	.02	.03	.07	.14	.43	.31	.37	.37	.14
30	.19	.13	.03	.02	.....	.06	.04	.50	.30	.36	.36	.16
31	.18	.....	.00	.02	.....	.00	.....	.43	.....	.35	.10	.....

a Estimated.

NOTE.—Reservoir frozen over Jan. 1 to Feb. 5, and evaporation estimated.

Monthly evaporation, in inches, at Lawton reservoir, near Lawton, Okla., for the year ending Sept. 30, 1916.

October	7.66	March	1.88	August	11.17
November	5.34	April	2.64	September	7.20
December	1.99	May	9.48		
January	.79	June	11.83	The year	71.17
February	.85	July	10.34		

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, 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., 2500 Customhouse.
Albany, N. Y., Room 18, Federal Building.
Atlanta, Ga., Post Office 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, 421 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., 406 Federal Building.
San Francisco, Cal., 328 Customhouse.
Los Angeles, Cal., 619 Federal Building.
Honolulu, Hawaii, Kapiolani Building.
Topeka, Kansas, 25 Federal 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.	1898.
W 28	Measurements, ratings, and gage heights, Arkansas River and western United States.	1898.
20th A, pt. 4	Monthly discharge (also for many earlier years)	1898.
W 35 to 39	Descriptions, measurements, gage heights, and ratings	1899.
21st A, pt. 4	Monthly discharge	1899.
W 47 to 52	Descriptions, measurements, gage heights, and ratings	1900.
22d A, pt. 4	Monthly discharge	1900.
W 65, 66	Descriptions, measurements, gage heights, and ratings	1901.
W 75	Monthly discharge	1901.
W 82 to 85	Complete data	1902.
W 97 to 100	do	1903.
W 124 to 135	do	1904.
W 165 to 178	do	1905.
W 201 to 214	do	1906.
W 241 to 252	do	1907–8.
W 261 to 272	do	1909.
W 281 to 292	do	1910.
W 301 to 312	do	1911.
W 321 to 332	do	1912.
W 351 to 362	do	1913.
W 381 to 394	do	1914.
W 401 to 414	do	1915.
W 431 to 444	do	1916.

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 1916. 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 1916, are published in Water-Supply Papers 97, 124, 165, 201, 241, 261, 281, 301, 321, 351, 381, 401, and 431, which contain records for the New England streams from 1903 to 1916. Results of miscellaneous measurements are published by drainage basins.

Numbers of water-supply papers containing results of stream measurements, 1899–1916.

Year.	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII		
												North Pacific slope basins.		
	North Atlantic slope (St. John River to York River).	South Atlantic and eastern Gulf of Mexico (James River to the Mississippi).	Ohio River.	St. Lawrence River and Great Lakes.	Hudson Bay and upper Mississippi River.	Missouri River.	Lower Mississippi River.	Western Gulf of Mexico.	Colorado River.	Great Basin.	Pacific slope in California.	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
1916	431	432	433	434	435	436	437	438	439	440	441	442	443	444

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 pp. XX–XXV.)

GAGING STATIONS.

NOTE.—Dash after a date indicates that station was being maintained Sept. 30, 1916; 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., 1905–6.

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.
Big Sandy Creek near Kit Carson, Colo., 1910–1912.
Big Spring Creek near Arena, Colo., 1910–1912.
Walnut River near Arkansas City, Kans., 1902–3.
Salt Fork of Arkansas River near Alva, Okla., 1904–5.
Salt Fork of Arkansas River near Tonkawa, Okla., 1903–1905.
Medicine Lodge River near Kiowa, Kans., 1895–96.
Cimarron River near Arkalon, Kans., 1895–96; 1903–1905.
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., 1904–05; 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 water, 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 methods of analysis; 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.

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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. 1.

(*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, field and office methods, and brief descriptions of the topography of some of the river basins.

Eleventh Annual Report of the United States Geological Survey, 1889–90, J. W. Powell, Director. 1891. 2 parts. Pt. II. Irrigation, xiv, 395 pp., 30 pls. and maps. $1.25. Contains:

*Hydrography, pp. 1-110. Discusses scope of work, methods of stream measurement, rainfall and evaporation, and describes the more important streams.

*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, xviii, 576 pp., 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. 54–57. 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. 58–106. 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, xi, 486 pp., 77 pls. $1.85. Contains:

*Engineering results of irrigation survey by H. M. Wilson, pp. 351–427, Pls. 147–182. Describes work at Twin Lakes reservoir and Twin Lakes dam, Colorado.

*Report upon the construction of topographic maps and the selection and survey of reservoi. 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, xix, 598 pp., 43 pls. $1.25. Contains:

The public lands and their water supply, by F. H. Newell, pp. 457–533, Pls. 35–39. Describes general character of the public lands, the lands disposed of (railroad, grant, and swamp lands and private miscellaneous entries), lands reserved (Indian, forest, and military reservations), the vacant lands, and the rate of disposal of vacant lands; discusses the streams, wells, and reservoirs as sources of water supply; gives details for each State.

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. 56–68. 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, 768 pp., 156 pls. $2.35. Contains:

*The High Plains and their utilization, by W. D. Johnson, pp. 601–741, Pls. 113–156. Describes the area situated 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 tle 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. 51–65. ($2.20.)

*Pt. VII, Texas, 666 pp., 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 and 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. 4), by W. D. Johnson, pp. 631–669, Pls. 51–65.

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. 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 octave 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.

[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.

*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. Muskogee, 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.

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,

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

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, Kans.; describes instruments and methods and draws conclusions.

*14. New tests of certain pumps and water lifts used in irrigation, by O. P. Hood, 1898. 91 pp., 1 pl. 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.

*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.

*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 wells; describes artesian wells at Savannah, Ga.

72. Sewage pollution in the metropolitan area near New York City and its effect on inland water resources, by M. O. Leighton. 1902. 75 pp., 8 pls. 10c.

Defines "normal" and "polluted" waters and discusses the damage resulting from pollution.

*80. The relation of rainfall to run-off, by G. W. Rafter. 1903. 104 pp. 10c.

Treats of measurement 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 H. Means.

*94. Hydrographic manual of the United States Geological Survey, prepared by E. C. Murphy, J. C. Hoyt, and G. B. Hollister. 1904. 76 pp., 3 pls. 10c.

Gives instruction for field and office work relating to measurements of stream flow by current meters. See also No. 95.

*95. Accuracy of stream measurements (second, enlarged edition), by E. C. Murphy. 1904. 169 pp., 6 pls.

Describes methods of measuring and computing steam flow and compares results derived from different instruments and methods. See also No. 94.

103. A review of the laws forbidding polultion 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.

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.

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. 55 pp. 5c.

Defines and classifies underground waters, gives common-law rules relating to their use, and cites State legislative acts affecting them.

140. Field measurements of the rate of movement of underground waters, by C. S. Slichter. 1905. 122 pp., 15 pls. 15c.

Discusses the capacity of sand to transmit water, describes measurements of underflow in Rio Hondo, San Gabriel, and Mohave River valleys, Cal., and on Long Island, N. Y.; gives results of tests of wells and pumping plants, and describes stovepipe method of well construction.

143. Experiments on steel-concrete pipes on a working scale, by J. H. Quinton. 1905. 61 pp., 4 pls.

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.

146. Proceedings of second conference of engineers of the Reclamation Service—Con.
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 flourescein 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.

*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.

*226. The pollution of streams by sulphite-pulp waste, a study of possible remedies, by E. B. Phelps. 1909. 37 pp., 1 pl. 10c.

Describes manufacture of sulphite pulp, the waste liquors, and the experimental work leading to suggestions as to methods of preventing stream pollution.

*229. The disinfection of sewage and sewage filter effluents, with a chapter on the putrescibility and stability of sewage effluents, by E. B. Phelps. 1909. 91 pp., 1 pl. 15c.

Scope indicated by title.

*234. Papers on the conservation of water resources. 1909. 96 pp., 2 pls. 15c.

Contains the following papers, whose scope is indicated by their titles: Distribution of rainfall, by Henry Gannett; Floods, by M. O. Leighton; Developed water powers, compiled under the direction of W. M. Steuart, with discussion by M. O. Leighton; Undeveloped water powers, by M. O. Leighton; Irrigation, by F. H. Newell; Underground waters, by W. C. Mendenhall; Denudation, by R. B. Dole and Herman Stabler; Control of catchment areas, by H. N. Parker.

*235. The purification of some textile and other factory wastes, by Herman Stabler and G. H. Pratt. 1909. 76 pp. 10c.

Discusses waste waters from wool scouring, bleaching and dyeing cotton yarn, bleaching cotton piece goods, and manufacture of oleomargarine, fertilizer, and glue.

236. The quality of surface waters in the United States, Part I. Analyses of waters east of the one hundredth meridian, by R. B. Dole. 1909. 123 pp. 10c.

Describes collection of samples, methods of examination, preparation of solutions, accuracy of estimates, and expression of analytical results.

238. The public utility of water powers and their governmental regulation, by René Tavernier and M. O. Leighton. 1910. 161 pp. 15c.

Discusses hydraulic power and irrigation, French, Italian, and Swiss legislation relative to the development of water powers, and laws proposed in the French Parliament; reviews work of 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 cost 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.

*315. The purification of public water supplies, by G. A. Johnson. 1913. 84 pp., 8 pls. 10c.

Discusses ground, lake, and river waters as public supplies, development of waterworks systems in the United States, water consumption, and typhoid fever; describes methods of filtration and sterilization of water and municipal water softening.

334. The Ohio Valley flood of March–April, 1913 (including comparisons with some earlier floods), by A. H. Horton and H. J. Jackson. 1913. 96 pp., 22 pls. 20c.

Although relating specifically to floods in the Ohio Valley, this report discusses also the causes of floods and the prevention of damage by floods.

337. The effects of ice on stream flow, by William Glenn Hoyt. 1913. 77 pp., 7 pls. 15c.

Discusses methods of measuring the winter flow of streams.

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

(e) A method of determining the daily discharge of rivers of variable slope, by M. R. Hall, W. E. Hall, and C. H. Pierce, pp. 53–65.

364. Water analyses from the laboratory of the United States Geological Survey, tabulated by F. W. Clarke, chief chemist. 1914. 40 pp. 5c.

Contains analyses of waters from rivers, lakes, wells, and springs in various parts of the United States, including analyses of the geyser water of Yellowstone National Park, hot springs in Montana, brines from Death Valley, water from the Gulf of Mexico, and mine waters from Tennessee, Michigan, Missouri and Oklahoma, Montana, Colorado and Utah, Nevada and Arizona, and California.

371. Equipment for current-meter gaging stations, by G. J. Lyon. 1915. 64 pp., 37 pls. 20c.

Describes methods of installing automatic and other gages and of constructing gage wells, shelters, and structures for making discharge measurements and artificial controls.

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

(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.

416. The divining rod, a history of water witching, with a bibliography, by Arthur J. Ellis. 1917. 59 pp. 10c.

A brief paper published "merely to furnish a reply to the numerous inquiries that are continually being received from all parts of the country" as to the efficacy of the divining rod for locating underground water.

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. 21. Scope indicated by title.

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

*Irrigation in India, by H. M. Wilson, pp. 363–561, Pls. 107–146. See Water-Supply Paper 87.

Thirteenth Annual Report of the United States Geological Survey, 1891–92, J. W. Powell, Director. 1892. (Pts. II and III, 1893.) 3 parts. *Pt. III, Irrigation, xi, 486 pp., 77 pls. $1.85. Contains:

*American irrigation engineering, by H. M. Wilson, pp. 101–349, Pls. 111–146. 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 sources of supply, pumping, and subirrigation.

Fourteenth Annual Report of the United States Geological Survey, 1892–93, J. W. Powell, Director. 1893. (Pt. II, 1894.) 2 parts. *Pt. II, Accompanying papers, xx, 597 pp., 73 pls. $2.10. Contains:

*The potable waters of eastern United States, by W J McGee, pp. 1–47. Discusses cistern water, stream waters, and ground waters, including mineral springs and artesian wells.

*Natural mineral waters of the United States, by A. C. Peale, pp. 49–88, Pls. 3 and 4. Discusses the origin and flow of mineral springs, the source of mineralization, thermal springs, the chemical composition and analysis of spring waters, geographic distribution, and the utilization of mineral waters; gives a list of American mineral spring resorts; contains also some analyses;

Nineteenth Annual Report of the United States Geological Survey, 1897–98, Charles D. Walcott, Director. 1898. (Parts II, III, and V, 1899.) 6 parts in 7 vols. and separate cases for maps with Pt. V. *Pt. II, Papers chiefly of a theoretic nature, v, 958 pp., 172 pls. $2.65. Contains:

*Principles and conditions of the movements of ground water, by F. H. King, pp. 59–294, Pls. 6–16. 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. 17. Scope indicated by title.

PROFESSIONAL PAPERS.

*72. Denudation and erosion in the southern Appalachian region and the Monongahela basin, by L. C. Glenn. 1911. 137 pp., 21 pls. 35c.

Describes the topography, geology, drainage, forests, climate, 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's slope and discharge and to the degree of comminution of the débris."

A highly technical report.

105. Hydraulic mining débris in the Sierra Nevada, by G. K. Gilbert. 154 pp., 34 pls. 1917.

Presents the results of an investigation undertaken by the United States Geological Survey in response to a memorial from the California Miners' Association asking that a particular study be made of portions of the Sacramento and San Joaquin valleys affected by detritus from torrential streams. The report deals largely with geologic and physiographic aspects of the subject, traces the physical effects, past and future, of the hydraulic mining of earlier decades, the similar effects which certain other industries induce through stimulation of the erosion of the soil, and the influence of the restriction of the area of inundation by the construction of levees. Suggests cooperation by several interests for the control of the streams now carrying heavy loads of débris.

BULLETINS.

*32. Lists and analyses of the mineral springs of the United States (a preliminary study), by A. C. Peale. 1886. 235 pp.

Defines mineral waters, lists the springs by States, and gives tables of analyses so far as available.

*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.

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