DEPARTMENT OF THE INTERIOR
FRANKLIN K. LANE, Secretary

UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, Director

WATER-SUPPLY PAPER 435

SURFACE WATER SUPPLY OF THE UNITED STATES

1916

V. HUDSON BAY AND UPPER MISSISSIPPI RIVER BASINS

NATHAN C. GROVER, Chief Hydraulic Engineer
W. G. HOYT and A. H. HORTON, District Engineers

Prepared in cooperation with the States of
MINNESOTA, WISCONSIN, IOWA, and ILLINOIS

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SURFACE WATER SUPPLY OF HUDSON BAY AND UPPER MISSISSIPPI RIVER BASINS, 1916.

AUTHORIZATION AND SCOPE OF WORK.

This volume is one of a series of fourteen 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 the following authority contained in the organic law (20 Stat. L., p. 394):

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

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

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

Annual appropriations for the fiscal years ending June 30, 1895–1916.

1895	$12,500
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 1916, inclusive	150,000

In the execution of the work many private and State organizations have cooperated, either by furnishing data or by assisting in collecting data. Acknowedgments 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 pages 13 and 14.

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 are made at other points. In

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

DEFINITION OF TERMS.

The volume of water flowing in a stream—the "run-off" or "discharge"—is expressed in various terms, each of which has become associated with a certain class of work. These terms may be divided into two groups—(1) those that represent a rate of flow, as second-feet, gallons per minute, miner's inches, and discharge in second-feet per square mile, and (2) those that represent the actual quantity 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 and acre-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 (p. 9).

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

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

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

The following terms not in common use are here defined:

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

"Control," a term used to designate the section or sections of the stream below the gage which determines 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 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 one day by the number of days.

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

Discharge (second-feet.)	Run-off in 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 one 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 in 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 one 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 in 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 one 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 figures 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 1.1312 feet of 13.5744 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 covers 1 square mile 0.03719 inch deep.

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.

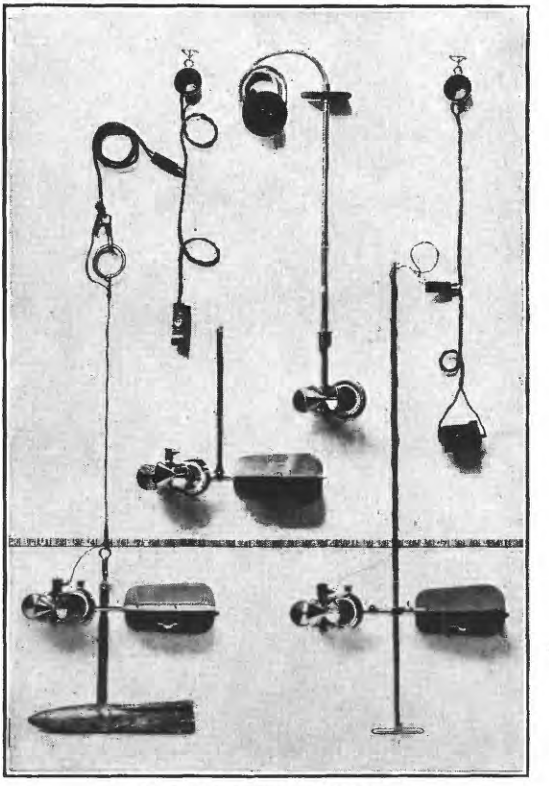
100 California miner's inches for one day equals 4.96 acre-feet.

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

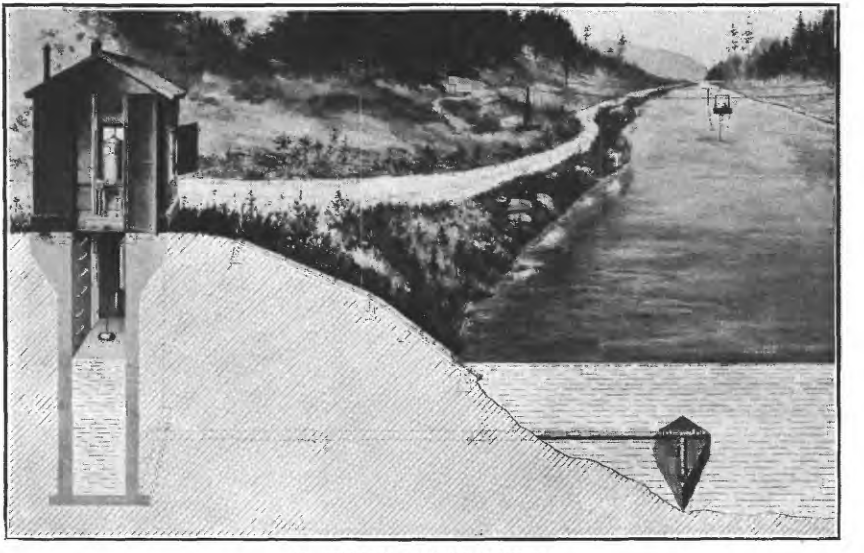
100 Colorado miner's inches equals 19.5 United States gallons per second.

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

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



A. PRICE CURRENT METERS.



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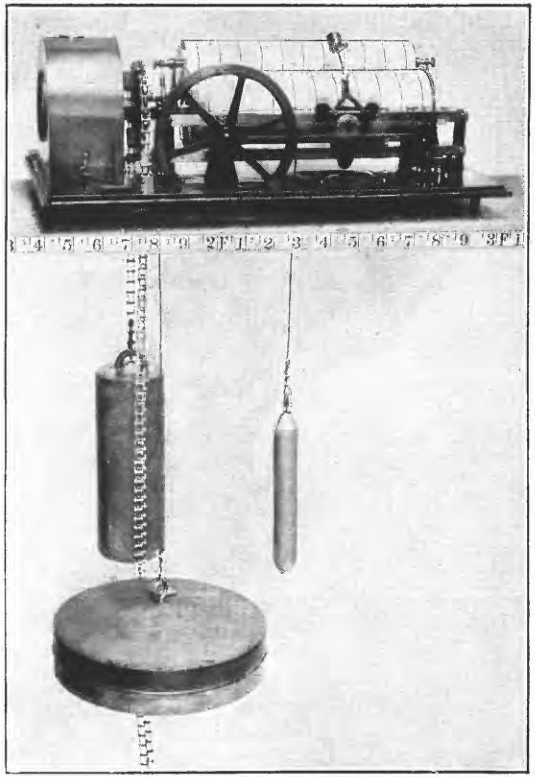

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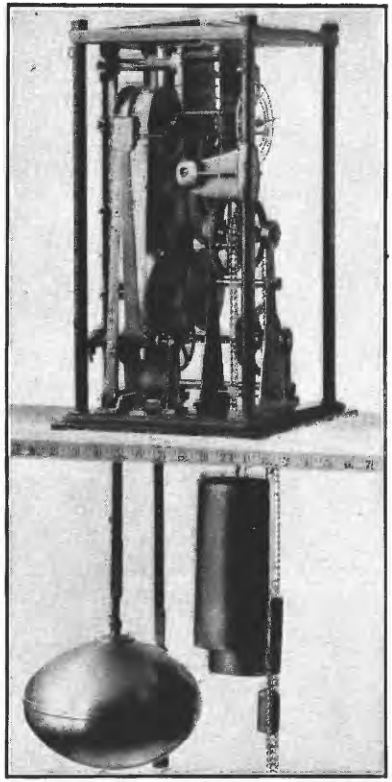
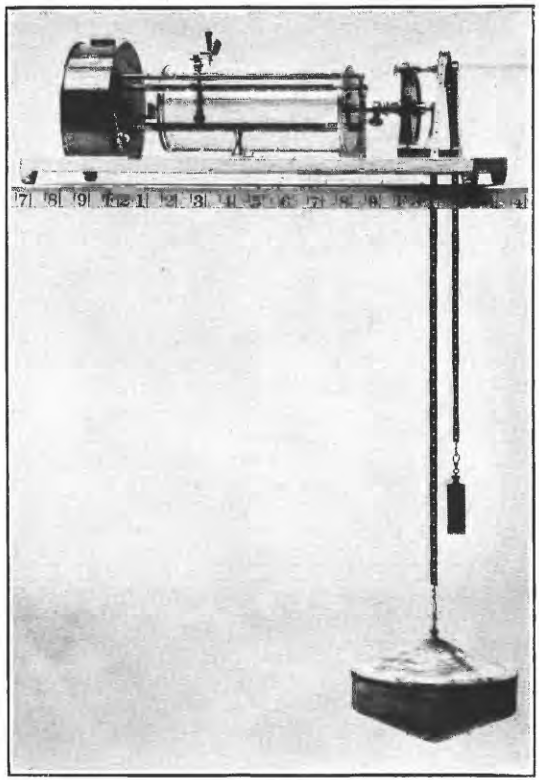


B. GURLEY PRINTING.



C. FRIEZ.

WATER-STAGE RECORDERS.

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.
1⅓ horsepower equals about 1 kilowatt.

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

EXPLANATION OF DATA.

The data presented in this report cover the year beginning October 1, 1915, and ending September 30, 1916. At the first 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 in ponds, lakes, and swamps, and this stored water passes off in the streams during the spring break-up; at the end of September, on the other hand, the only stored water available for run-off is possibly a small quantity in the ground; therefore the run-off for a year beginning October 1 is practically all derived from precipitation in that year.

The base data collected at gaging stations (Pl. I, *B*) 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 (Pl. II) 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.

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 averaging the discharge at regular intervals during the day or by use of the discharge integrator, an instrument operating on the principle of the planimeter and containing as an essential element the rating curve of the station.

In the table of monthly discharge the column headed "Maximum" gives the mean flow for the day when the mean gage height was highest. As the gage height is the mean for the day, it does not indicate correctly the stage when the water surface was at crest height and the corresponding discharge was consequently larger than given in the maximum column. Likewise, in the column headed "Minimum" the quantity given is the mean flow for the day when the mean gage height was lowest. The column headed "Mean" is the average flow in cubic feet for each second during the month. On this average flow computations recorded in the remaining columns, which are defined on page 9, 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 acouracy 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 gage readings, and (5) methods of applying daily gage heights to the rating table to obtain the daily discharge.[1]

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

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

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

COOPERATION.

In Montana the work was done in cooperation with the United States Reclamation Service and Glacier National Park. The station on St. Mary River at Kimball, Alberta, was maintained in cooperation with the Canadian Department of Interior.

In Minnesota the work was carried on in cooperation with the State Drainage Commission, E. V. Willard, acting State drainage engineer, under terms of an act of the legislature of 1909 as embodied in joint resolution 19, which reads as follows:

Whereas the water supplies, water powers, navigation of our rivers, drainage of our lands, and the sanitary condition of our streams and their watersheds generally form one great asset and present one great problem, therefore:

[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.

Be it resolved by the house of representatives, the senate concurring, That the State Drainage Commission be, and is hereby, directed to investigate progress in other States toward the solution of said problem in such States, to investigate and determine the nature of said problems in this State.

The International Joint Commission installed the water-stage recorder and paid the salary of the observer at the station on Kawishiwi River near Winton and the United States Engineer Corps paid the salaries of the observers at the stations on Minnesota River near Montevideo and Chippewa River near Watson.

In Wisconsin the work was carried on in cooperation with the Railroad Commission of Wisconsin, C. M. Larson, chief engineer, and at certain stations with the following organization: Wisconsin-Minnesota Light & Power Co. (Chippewa River at Chippewa Falls, Red Cedar River near Colfax, Red Cedar River at Cedar Falls, Red Cedar River at Menomonie), Chippewa & Flambeau Improvement Co. (Chippewa River at Bishop's Bridge near Winter and West Fork of Chippewa River at Lessard's near Winter).

In Iowa the work was carried on in cooperation with the Iowa Geological Survey, George F. Kay, director, and the Mississippi River Power Co. of Keokuk, Iowa.

In Illinois the work was done in cooperation with the Illinois State Rivers and Lakes Commission.

DIVISION OF WORK.

The data for stations in the Hudson Bay basin, except in Minnesota, were collected and prepared for publication under the direction of W. A. Lamb, district engineer, Helena, Mont., assisted by E. F. Chandler, H. V. Sprague, and D. C. McKay.

The data for stations in the Hudson Bay and Mississippi River basins in Minnesota were collected and prepared for publication under the general direction of W. G. Hoyt, district engineer, Madison, Wis., under the immediate direction of S. B. Soulé, assisted by E. L. Williams, R. B. Kilgore, and Ole Christianson; and by E. F. Chandler, assisted by W. B. Stevens, H. V. Sprague, and D. C. McKay.

For stations in the Mississippi River basin in Wisconsin the data were collected and prepared for publication under the direction of W. G. Hoyt, assisted by E. L. Williams, R. B. Kilgore, H. C. Beckman, and J. O. Entringer.

For stations in the Mississippi River basin in Iowa the data were collected under the general direction of W. G. Hoyt, under the immediate direction of R. H. Bolster, assisted by C. Herlofson and A. Davis.

The data in Mississippi River basin in Illinois were collected under the general direction of W. G. Hoyt, under the immediate direction

of H. C. Beckman, assisted by G. J. Trinkaus, Rector Egeland, and J. B. Fountain.

The report was assembled by B. J. Peterson.

GAGING-STATION RECORDS.

HUDSON BAY DRAINAGE BASIN.

ST. MARY RIVER NEAR BABB, MONT.

[Including diversion from Swiftcurrent Creek.]

LOCATION.—One-fourth mile below outlet of lower St. Mary Lake, 1,000 feet above the diversion dam for the St. Mary canal and 2 miles south of Babb, on Blackfeet Reservation, in Teton County.

DRAINAGE AREA.—278 square miles (includes area of Swiftcurrent Creek above point of diversion into St. Mary Lake).

RECORDS AVAILABLE.—April 9, 1902, to September 30, 1916. Records April 9, 1902, to September 30, 1915, do not include the flow of Swiftcurrent Creek.

GAGE.—Chain gage on right bank. During the winter a temporary low-water gage opposite the chain gage is used. Gages read by employees of the United States Reclamation Service.

DISCHARGE MEASUREMENTS.—Made from cable 560 feet below gage, or by wading.

CHANNEL AND CONTROL.—Control practically permanent; bed of stream composed of firm gravel and cobblestones.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 8.25 feet at 5 p. m. June 21 (discharge 5,610 second-feet); minimum stage probably occurred during the period January 1–18, when the flow was less than 90 second-feet.

1902–1916: Maximum stage estimated at 9.4 feet June 5, 1908 (discharge 7,980 second-feet); minimum stage recorded 1.0 foot April 3–7, 1904 (discharge 20 second-feet).

ICE.—Stage-discharge relation affected by ice for short periods.

DIVERSIONS.—None.

REGULATION.—Natural storage in St. Mary Lakes. The flow of Swiftcurrent Creek was diverted into St. Mary Lake on October 1, 1915. The flow of this stream is slightly regulated by Sherburne Lake reservoir.

ACCURACY.—Stage-discharge relation changed during 1916 owing to construction work in the channel and changes at the diversion dam; affected by ice from December 20 to January 18. Rating curves used as follows: October 1 to January 18, well defined above 430 second-feet and fairly well defined below; January 19 to June 23, well defined between 100 and 3,000 second-feet; June 24 to September 30, well defined between 200 and 5,000 second-feet. Gage read to half-tenths once daily. Daily discharge ascertained by applying gage heights to rating tables except for periods during which stage-discharge relation was affected by ice. Records good.

The diversion dam below the gaging station was constructed by the United States Reclamation Service for the purpose of diverting water from St. Mary River into the St. Mary canal, which carries the water across the divide into the North Fork of Milk River. The water then flows in the natural channel of Milk River through Canada and is finally used for irrigation in the Milk River Valley in Montana. The present capacity of the diversion canal is about 425 second-feet. A storage reservoir was provided on Swiftcurrent Creek by constructing a dam at the outlet of Sherburne Lake. By means of a diversion channel connecting Swiftcurrent Creek and Lower St. Mary Lake, the run-off from Swiftcurrent Creek is made available for diversion through St. Mary canal. The storage capacity of Sherburne reservoir is about 66 000 acre-feet.

Discharge measurements of St. Mary River near Babb, Mont., 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. 24	W. A. Lamb	1.35	133	June 25	Tuttle and Davis	5.70	4,100
Apr. 25	do	2.18	472	July 17	W. A. Lamb	4.20	2,690
May 23	do	3.55	1,340	Aug. 16	do	2.39	1,030
June 10	A. H. Tuttle	4.92	2,410	Sept. 16	do	1.96	711
24	Tuttle and Davis	6.05	4,660	Nov. 23	do	.65	256

Daily discharge, in second-feet, of St. Mary River near Babb, Mont., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	386	490	304	.....	135	168	447	640	1,270	4,540	1,230	877
2	430	450	266	.....	135	168	424	923	1,270	4,210	1,230	877
3	524	440	266	.....	135	168	400	802	1,270	4,320	1,160	1,230
4	626	430	266	.....	135	168	400	923	1,270	4,540	1,160	1,310
5	653	430	248	.....	135	168	400	988	1,340	4,320	1,080	1,480
6	653	420	231	.....	135	168	376	1,060	1,800	4,100	1,080	1,570
7	653	440	231	.....	135	168	376	1,490	1,880	3,770	1,080	1,570
8	600	420	231	.....	135	250	376	1,800	2,040	3,660	1,160	1,570
9	574	460	248	.....	135	331	447	2,130	2,310	3,660	1,160	1,570
10	574	530	266	.....	135	342	447	1,860	2,480	3,550	1,160	1,400
11	549	476	266	.....	152	353	447	1,800	2,650	3,550	1,230	1,160
12	524	453	248	.....	168	364	470	1,720	2,740	3,660	1,230	1,010
13	524	430	231	.....	168	376	470	1,720	2,650	3,660	1,160	877
14	500	408	215	.....	168	376	470	1,490	2,740	3,230	1,160	818
15	476	408	199	.....	168	376	470	1,270	2,830	2,810	1,160	763
16	476	430	199	.....	168	376	494	1,130	3,290	2,600	1,080	763
17	476	430	184	.....	168	376	494	1,060	3,760	2,600	1,010	763
18	476	430	184	.....	168	376	518	1,060	4,760	2,500	1,010	663
19	476	430	184	135	168	376	542	1,060	5,160	2,500	1,010	663
20	476	386	.....	135	168	400	566	988	5,360	2,220	1,010	618
21	453	408	.....	135	168	424	566	988	5,560	2,020	1,010	618
22	430	344	.....	135	168	424	615	1,060	5,260	1,920	940	618
23	430	365	.....	135	168	424	566	1,200	4,760	1,920	877	618
24	430	344	.....	135	168	447	590	1,060	4,760	1,740	877	536
25	453	344	.....	135	168	454	518	1,130	4,210	1,740	877	536
26	453	344	.....	135	168	462	542	1,340	4,100	1,570	877	536
27	453	344	.....	135	168	470	542	1,340	3,990	1,570	877	498
28	430	344	.....	135	168	470	542	1,340	4,100	1,480	877	498
29	430	324	.....	135	168	470	494	1,340	4,320	1,480	877	498
30	430	304	.....	135	.....	470	542	1,270	4,650	1,400	877	498
31	430	.....	.....	135	.....	470	.....	1,270	.....	1,310	877	.....

NOTE.—Discharge Nov. 1-10 estimated at 70 per cent of flow at Kimball, Dec. 20-30, estimated at 145 second-feet, or approximately 90 per cent of flow at Kimball for same period; Jan. 1-18, estimated from flow at Kimball, at 90 second-feet. Discharge interpolated for days on which gage was not read, as follows: Oct. 31, Jan. 20-21, 23, 25-27, 30, 31; Feb. 2-4, 6-7, 9, 11, 13-15, 17-18, 20, 22-24, 26-27; Mar. 2-3, 5-6, 8, 10, 11, 14, 20, 22, 25-26, 28, 30; Apr. 1, 4.

Figures in the above table include the flow of Swiftcurrent Creek which was diverted into St. Mary Lake on Oct. 1, 1915.

Monthly discharge of St. Mary River near Babb, Mont., for the year ending Sept. 30, 1916.

[Drainage area, 278 [a] square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
October	653	386	498	1.79	2.06	30,600
November	530	304	409	1.47	1.64	24,300
December	304	.....	200	.719	.83	12,300
January	.....	.....	109	.392	.45	6,700
February	168	135	156	.561	.60	8,970
March	470	168	349	1.26	1.45	21,500
April	615	376	485	1.74	1.94	28,900
May	2,130	640	1,270	4.57	5.27	78,100
June	5,560	1,270	3,290	11.8	13.17	196,000
July	4,540	1,310	2,840	10.2	11.76	175,000
August	1,230	877	1,050	3.78	4.36	64,600
September	1,570	498	900	3.24	3.62	53,600
The year	5,560	.....	963	3.46	47.15	701,000

[a] Includes drainage area of Swiftcurrent Creek above point of diversion into St. Mary Lake.

NOTE.—Figures in the above table include the flow of Swiftcurrent Creek which was diverted into St. Mary Lake on Oct. 1, 1915.

ST. MARY RIVER NEAR KIMBALL, ALBERTA.

LOCATION.—In the SW. ¼ sec. 25, T. 1 N., R. 25 W. fourth meridian, about 1 mile south of Kimball, Alberta, and about 5 miles north of the international boundary.

DRAINAGE AREA.—472 square miles (measured from topographic maps).

RECORDS AVAILABLE.—January 1, 1913, to September 30, 1916. From September 4, 1902, to December 31, 1912, records were obtained at a point one-fourth of a mile below the boundary line. Records were also obtained by the Irrigation Branch, Department of the Interior, Canada, at a point about three-fourths of a mile below the present station, from 1905 to 1912. The discharge at the three points is practically the same.

GAGE.—A Stevens water-stage recorder with a concrete well and shelter on the right bank used during the open-water season. A Friez recorder was used prior to April 10, 1916. During the winter months a chain gage, located on the highway bridge 2 miles below the station, is used.

DISCHARGE MEASUREMENTS.—Made from a cable three-fourths of a mile below the gage; low-water measurements made by wading near the cable section.

CHANNEL AND CONTROL.—The bed of the stream at the gage and at the control below is composed of boulders and sandstone ledges. The control is formed by an outcropping ledge of sandstone. Stage-discharge relation is affected by a large gravel bar which has formed on the right bank at the control.

EXTREMES OF DISCHARGE.—Maximum stage during year, from water stage recorder, 8.08 feet at 10.30 a. m. June 22 (discharge, 8,930 second-feet); minimum stage, 2.85 feet December 25 (discharge, 140 second-feet).

1902–1916: Maximum stage recorded, 12.75 feet June 5, 1908 (discharge, estimated by comparison with record for station near Babb, 18,000 second-feet); minimum stage recorded, 70 second-feet [1] February 5, 1914.

ICE.—Stage-discharge relation seriously affected by ice. Daily discharge computed from discharge measurements and records of temperature.

[1] Only estimates of mean monthly flow are available for the winter periods from 1902 to 1912, inclusive, and a lower minimum discharge may have occurred during that time.

DIVERSIONS.—The St. Mary canal, constructed by the United States Reclamation Service, will divert water from St. Mary River near Babb, Mont., to the North Fork of Milk River. During June, 1916, water was turned into the canal for priming and puddling. The Alberta Railway & Irrigation Co. canal diverts from St. Mary River about 1 mile below the station.

REGULATION.—The flow of Swiftcurrent Creek will be regulated by the Sherburne Lake reservoir, under construction by the United States Reclamation Service.

ACCURACY.—Stage-discharge relation not permanent; affected by shifting control and ice. Rating curves used as follows: October 1 to November 13, fairly well defined; June 23 to September 30, well defined between 265 and 7,840 second-feet. Stage-discharge relation affected by ice November 14 to March 23. Mean daily gage heights October 1 to November 14 and April 10 to September 30 obtained from recorder graphs by averaging the heights for hourly intervals. Chain gage at highway bridge used November 15 to March 23; staff gage at cable used March 24 to April 8. Daily discharge ascertained by applying mean daily gage heights to rating tables, except for periods during which stage-discharge relation was affected by shifting control or ice. Records good.

COOPERATION.—Station maintained jointly with and computations made by the Irrigation Branch, Department of the Interior of Canada.

Discharge measurements of St. Mary River near Kimball, Alberta, 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.*
Oct. 7	V. A. Newhall [a]	2.85	909	Apr. 25	W. A. Lamb	2.61	696
Nov. 10	W. H. Storey [a]	3.51	576	May 23	Lamb and Tuttle	3.61	1,710
12	do	3.24	530	30	S. H. Frame	3.95	2,000
Dec. 5	do	3.37	336	June 3	do	3.75	1,770
8	do	3.32	317	10	A. H. Tuttle	5.00	3,060
22	do	2.93	185	20	S. H. Frame	7.07	7,820
24	do	2.84	141	23	do	7.60	7,840
27	do	2.85	147	26	do	6.20	4,900
Jan. 10	do	4.55	149	26	A. H. Tuttle	6.25	4,960
12	do	4.53	149	July 5	S. H. Frame	6.40	5,390
Feb. 10	V. A. Newhall	5.07	230	11	do	5.80	4,130
12	do	4.97	226	18	W. A. Lamb	5.10	[b] 3,080
Mar. 15	S. H. Frame [a]	5.17	509	26	S. H. Frame	4.16	1,820
23	do	3.40	589	Aug. 16	do	3.42	1,170
24	do	3.27	621	Sept. 4	do	3.67	1,390
24	do	3.27	542	8	do	4.01	1,710
Apr. 5	do	3.26	543	26	do	2.65	578
24	do	2.66	672	29	do	2.56	511

[a] Engineer, Irrigation Branch, Department of the Interior, Canada.
[b] Measured from bridge below head of Alberta Railway & Irrigation Co. canal and flow of canal added.

NOTE.—Measurements Nov. 10 and 12, Mar. 23 to Apr. 5, are referred to staff gage at cable. Measurements Dec. 5 to Mar. 15 are referred to chain gage at bridge.

Daily discharge, in second-feet, of St. Mary River near Kimball, Alberta, for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	635	630	347	150	232	185	658	1,080	1,980	6,040	1,480	964
2	668	615	341	150	221	190	658	1,160	1,960	5,850	1,430	964
3	755	615	339	152	218	205	630	1,150	1,800	5,890	1,430	1,050
4	815	615	338	153	217	240	580	1,180	1,770	5,760	1,370	1,280
5	894	630	336	154	218	300	532	1,240	2,050	5,430	1,320	1,490
6	950	605	332	154	219	340	530	1,450	2,320	4,520	1,290	1,720
7	922	590	327	153	222	390	543	1,860	2,340	3,980	1,280	1,780
8	915	581	316	151	228	450	560	2,170	2,340	3,980	1,260	1,700
9	867	568	310	149	230	600	575	2,260	2,500	3,990	1,410	1,430
10	834	563	302	149	230	700	590	2,260	2,930	4,060	1,560	1,280
11	822	545	295	149	228	850	672	2,100	3,480	4,160	1,570	1,170
12	815	545	287	149	226	800	672	1,960	3,560	4,040	1,510	1,080
13	761	536	278	149	240	650	680	1,800	3,560	4,080	1,400	996
14	743	526	269	150	300	550	700	1,680	3,640	3,760	1,280	949
15	755	515	259	154	700	510	680	1,600	4,120	3,580	1,200	925
16	755	504	250	157	1,100	512	740	1,530	5,240	3,520	1,150	880
17	743	493	239	159	900	514	650	1,440	6,420	3,410	1,150	815
18	719	482	229	165	750	516	680	1,390	6,880	3,310	1,200	759
19	707	471	218	171	650	520	650	1,390	7,660	3,100	1,170	724
20	684	460	205	178	600	524	672	1,400	7,820	2,860	1,150	675
21	668	449	194	191	550	528	690	1,500	8,520	2,660	1,130	654
22	662	438	185	208	520	532	725	1,600	8,620	2,450	1,100	619
23	656	427	151	225	480	538	672	1,690	7,840	2,330	1,050	612
24	646	416	142	241	360	541	672	1,800	5,890	2,160	1,020	612
25	610	405	140	255	290	615	696	1,990	4,970	2,020	988	592
26	610	394	142	260	240	618	660	2,100	4,990	1,870	1,060	578
27	630	390	147	261	210	620	660	2,140	5,110	1,860	1,050	558
28	646	383	150	260	185	620	740	2,030	5,470	1,800	1,040	544
29	668	372	155	256	180	615	810	1,960	6,520	1,710	1,020	519
30	673	354	154	250	.....	615	945	2,000	6,730	1,640	1,000	490
31	668	.....	153	242	.....	620	.....	2,000	.....	1,540	988	.....

NOTE.—Discharge Apr. 10 to June 22 computed by indirect method for shifting control. Discharge Mar. 24 to Apr. 9 taken directly from rating curve applicable to readings on staff gage at cable. Discharge estimated, because of ice, Nov. 15 to Mar. 23 from study of discharge measurements, gage heights, winter hydrographs, and weather records. Discharge Oct. 3, 10, 28, Nov. 25, 28, Dec. 19, 25, and 28 based on interpolated gage heights. See "Accuracy" in description of station.

Monthly discharge of St. Mary River near Kimball, Alberta, for the year ending Sept. 30, 1916.

[Drainage area, 472 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
October	950	610	739	1.57	1.81	45,400
November	630	354	504	1.07	1.19	30,000
December	347	140	243	.515	.59	14,900
Jaunary	261	149	185	.392	.45	11,400
February	1,100	180	377	.799	.86	21,700
March	850	185	516	1.09	1.26	31,700
April	945	530	664	1.41	1.57	39,500
May	2,260	1,080	1,710	3.62	4.17	105,000
June	8,620	1,770	4,630	9.81	10.94	276,000
July	6,040	1,540	3,460	7.33	8.45	213,000
August	1,570	988	1,230	2.61	3.01	75,600
September	1,780	490	947	2.01	2.24	56,400
The year	8,620	140	1,270	2.69	36.54	921,000

SWIFTCURRENT CREEK AT MANY GLACIER, MONT.

LOCATION.—In sec. 12, T. 35 N., R. 16 W., at outlet of McDermott Lake, at Many Glacier, in Glacier National Park, about 14 miles southwest of Babb, in Teton County.

DRAINAGE AREA.—31.4 square miles (measured on topographic map of Glacier National Park).

RECORDS AVAILABLE.—June 6, 1912, to September 30, 1916.

GAGE.—Vertical staff on left bank at outlet of the lake, read by Oscar Montross, John Johansen, I. E. Patterson, H. Graff, and George Hall.

DISCHARGE MEASUREMENTS.—Made by wading at outlet of lake.

CHANNEL AND CONTROL.—Control is a limestone reef arched upstream at outlet of lake. Just below the control is a fall and cataract.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 4.75 feet at 7 a. m. June 17 (discharge, 1,550 second-feet); minimum stage, 1.40 feet at 4.30 p. m. April 5 (discharge, 35 second-feet).

1912–1916: Maximum stage recorded, 4.75 feet June 17, 1916 (discharge, 1,550 second-feet); minimum discharge recorded, 10.8 second-feet March 19, 1912, by current meter measurement prior to installation of gage.

ICE.—Stage-discharge relation seriously affected by ice.

DIVERSIONS.—None.

REGULATION.—None.

ACCURACY.—Stage-discharge relation practically permanent, but affected by ice in winter. Rating curve well defined between 44 and 825 second-feet, and is an extension above. Gage read to quarter tenths twice daily for greater part of year. Daily discharge ascertained by applying mean daily gage heights to rating table. Records good except for high stages, for which they are fair.

Discharge measurements of Swiftcurrent Creek at Many Glacier, Mont., 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.*
Apr. 24	W. A. Lamb	1.59	57	July 17	W. A. Lamb	2.85	534
June 9	A. H. Tuttle	3.20	597	Aug. 17	do	2.19	180
25	do	3.30	725				

Daily discharge, in second-feet, of Swiftcurrent Creek at Many Glacier, Mont., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	92	125	.....	44	43	159	220	715	212	159
2	141	110	.....	42	41	141	188	770	212	159
3	224	110	.....	40	41	178	204	770	208	208
4	208	107	.....	39	40	251	535	935	204	560
5	182	116	.....	38	37	.....	660	825	193	688
6	185	116	.....	39	38	.....	585	715	178	660
7	141	110	.....	41	38	.....	460	660	172	560
8	125	103	.....	42	39	.....	485	660	178	510
9	112	99	.....	41	42	.....	560	715	292	410
10	110	90	.....	42	48	.....	770	715	315	185
11	112	90	.....	42	53	.....	610	715	242	138
12	110	81	.....	50	59	.....	535	688	201	155
13	107	73	.....	65	60	.....	510	715	185	149
14	112	73	.....	70	59	.....	560	660	193	133
15	112	68	.....	74	70	.....	825	535	204	116
16	103	73	.....	67	70	.....	1,220	510	197	112
17	101	73	.....	67	76	.....	1,520	485	197	97
18	99	65	38	53	70	.....	1,040	460	238	97
19	101	65	38	56	65	.....	1,340	485	260	94
20	92	65	56	59	70	.....	1,280	386	208	99
21	82	63	53	70	60	.....	1,400	362	182	95
22	88	59	48	79	59	.....	880	338	168	92
23	90	63	45	73	54	.....	660	315	193	82
24	84	65	39	71	53	.....	610	292	216	79
25	88	59	41	59	54	.....	715	269	216	79
26	95	53	41	59	70	.....	770	260	224	82
27	107	52	39	50	147	.....	770	251	208	81
28	107	51	41	52	292	.....	990	242	185	79
29	121	50	38	53	460	.....	990	233	178	76
30	125	50	.....	47	185	.....	880	212	178	73
31	121	.....	.....	47	.....	.....	.....	201	168	.....

NOTE.—No gage readings obtained Nov. 27 to Feb. 17, Mar. 1–4 and May 5 to June 3. Daily discharge Nov. 27–30, Mar. 1–4 and June 1–3 determined from records obtained on Swiftcurrent Creek at Sherburne.

Monthly discharge of Swiftcurrent Creek at Many Glacier, Mont., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	224	82	119	7,320
November	125	50	79.2	4,710
February 18–29	56	38	43.1	1,030
March	79	38	53.9	3,310
April	460	37	83.1	4,940
May 1–4	251	141	182	1,440
June	1,520	188	759	45,200
July	935	201	519	31,900
August	315	168	207	12,700
September	688	73	204	12,100

SWIFTCURRENT CREEK AT SHERBURNE, MONT.

LOCATION.—In sec. 35, T. 36 N., R. 15 W., near outlet of Lower Sherburne Lake, at Sherburne, in Teton County.

DRAINAGE AREA.—64.0 square miles (measured on topographic map of Glacier National Park.

RECORDS AVAILABLE.—July 1, 1912, to September 30, 1916.

GAGE.—Staff gage on left bank about 300 feet below the spillway of Sherburne Lake dam; read by employees of United States Reclamation Service. From July 1, 1912, to November 9, 1914, a vertical staff gage was maintained on left bank about 1,000 feet upstream and at a different datum from the present gage.

DISCHARGE MEASUREMENTS.—Made from a footbridge at dam or by wading.

CHANNEL AND CONTROL.—Stream bed is permanent at gage and at control below; banks high and not subject to overflow. An outcropping limestone ledge, somewhat broken and irregular, forms the control.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 7.85 feet at 5 p. m. June 17 (discharge, 2,280 second-feet); minimum stage, 0.5 foot at 8 a. m. and 5 p. m. April 25 (discharge 4.0 second-feet).

1912–1916: Maximum stage recorded, 7.85 feet June 17, 1916 (discharge, 2,280 second-feet); minimum stage, 0.5 foot April 25, 1916 (discharge, 4.0 second-feet).

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

DIVERSIONS.—None.

REGULATION.—Natural flow of stream affected by a temporary dam built at outlet of lake for construction work in connection with the Sherburne Lake storage dam.

ACCURACY.—Stage-discharge relation practically permanent under normal conditions but was affected at times during year by ice and débris on control. Rating curves applicable as follows: October 1 to November 14, November 20 to December 15, February 6 to May 6 and June 22 to September 30, well defined, between 4 and 800 second-feet; May 7 to June 21, well defined between 300 and 800 second-feet. Gage read to hundredths twice daily. Daily discharge ascertained by applying mean daily gage heights to rating table. Records good.

Discharge measurements of Swiftcurrent Creek at Sherburne, Mont., 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.*
Oct. 4	W. A. Lamb	3.10	309	May 22	Lamb and Tuttle	[a] 3.77	384
Nov. 22	do	1.60	71	June 9	A. H. Tuttle	[a] 5.00	771
Jan. 24	do	1.20	32.6	July 17	W. A. Lamb	3.97	584
Mar. 7	do	1.22	37.6	Aug. 17	do	2.68	252
Apr. 24	do	.49	3.8	Sept. 16	do	2.08	132

[a] Stage-discharge relation affected by drift on control.

Daily discharge, in second-feet, of Swiftcurrent Creek at Sherburne, Mont., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	106	150	60	.....	65	106	349	293	1,130	260	210
2	230	158	60	.....	60	100	303	251	1,170	270	375
3	349	158	65	.....	55	93	303	272	1,350	270	494
4	403	158	65	.....	50	93	375	413	1,350	230	526
5	303	150	65	.....	41	87	590	732	1,220	220	766
6	166	166	65	33	41	87	766	770	1,000	230	730
7	201	166	65	37	38	93	922	695	880	220	558
8	201	150	65	37	41	106	770	590	880	220	158
9	183	142	65	33	55	120	624	770	920	281	29
10	183	135	65	37	65	135	440	846	960	349	100
11	183	135	65	37	106	158	362	846	960	349	150
12	120	120	60	33	135	166	104	846	1,260	303	166
13	106	113	60	33	201	183	293	770	1,130	260	158
14	120	142	60	37	183	55	293	770	433	230	158
15	142	138	60	41	166	150	212	846	349	220	142
16	174	134	.....	81	150	201	194	846	526	230	135
17	183	130	.....	135	150	210	177	2,250	590	230	128
18	120	126	.....	135	135	201	186	1,860	590	303	113
19	120	123	.....	120	120	250	231	1,860	558	303	113
20	120	120	.....	120	142	240	315	1,770	433	281	106
21	120	106	.....	106	201	183	362	2,000	403	281	106
22	120	87	.....	106	192	166	387	1,680	403	250	106
23	120	93	.....	93	183	150	338	960	349	230	100
24	142	93	.....	81	166	106	293	730	325	230	120
25	128	135	.....	81	150	4.0	293	880	325	250	113
26	120	166	.....	76	166	4.4	272	1,000	325	270	113
27	183	106	.....	70	158	4.5	251	1,080	349	270	87
28	281	81	.....	70	142	65	251	1,260	325	250	93
29	113	70	.....	65	128	349	293	1,400	281	240	81
30	166	70	.....	.....	120	403	315	1,310	260	230	70
31	210	.....	.....	.....	106	.....	293	.....	260	220	.....

NOTE.—Discharge, Nov. 15–19, interpolated because of ice on control. No records obtained Dec. 16 to Feb. 5.

Monthly discharge of Swiftcurrent Creek at Sherburne, Mont., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	403	106	175	10,800
November	166	70	127	7,560
December 1–15	65	60	63.0	1,870
February 6–29	135	33	70.7	3,370
March	201	38	120	7,380
April	403	4.0	142	8,450
May	922	104	360	22,100
June	2,250	251	1,020	60,700
July	1,350	260	687	42,200
August	349	220	257	15,800
September	766	29	210	12,500

OTTERTAIL RIVER AT GERMAN CHURCH, NEAR FERGUS FALLS, MINN.

LOCATION.—At highway bridge on south line of sec. 31, T. 134 N., R. 42 W., about 5 miles upstream from old station known as "Ottertail River near Fergus Falls," and 8 miles north of Fergus Falls, Ottertail County.

DRAINAGE AREA.—1,300 square miles.

RECORDS AVAILABLE—October 29, 1913, to September 30, 1916. May 9, 1904, to October 22, 1913, for station about 5 miles downstream from the present station. The drainage area at the lower station is only 10 square miles larger than that at the upper and no tributaries intervene.

GAGE.—Chain gage attached to downstream handrail near right bank; read by D. S. Danielson.

DISCHARGE MEASUREMENTS.—Made from downstream side of the bridge.

CHANNEL AND CONTROL.—Bed composed of sand, gravel, and boulders. Rapids about 100 feet below gage form a well defined control, which is practically permanent except for a slight growth of vegetation in the channel at times. Banks at and above gage high; probably not subject to overflow; at the control the land adjacent to the left bank is low and will be overflowed at a stage of about 5 feet.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.0 feet at 8.30 a. m., June 29 (discharge, 982 second-feet); minimum dischare recorded by current-meter measurement made January 28 (discharge, 187 second-feet); the absolute minimum during the year estimated at 181 second-feet, January 20 and February 1.

1914–1916: Maximum stage recorded, 3.0 feet at 8.30 a. m., June 29, 1916 (discharge, 982 second-feet); minimum discharge during period recorded by measurement made February 28, 1914 (discharge, 171 second-feet).

ICE.—Stage-discharge relation seriously affected by ice.

REGULATION.—Fluctuations caused by operation of a number of dams and small mills above station are equalized by small lakes through which the river flows before reaching the station, so that fluctuations are not observed at the gage.

ACCURACY.—Stage-discharge relation permanent, except as affected by ice during winter. Rating curve well defined throughout. Gage read to quarter tenths once daily; as fluctuation in stage is gradual, one reading per day gives good results. Daily discharge ascertained by applying the daily gage height to rating table except for the period when the stage-discharge relation was affected by ice for which it was ascertained by applying to the rating table the mean daily gage heights corrected for ice effect by means of discharge measurements, observer's notes, and weather records. Open-water records good.

Discharge measurements of Ottertail River at German Church, near Fergus Falls, Minn., 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. 8	S. B. Soulé	1.99	383	Mar. 17	S. B. Soulé	3.54	[a] 274
Dec. 24	E. L. Willlams	3.34	[a] 311	Apr. 13	O. Christinson	1.95	376
Jan. 28	S. B. Soulé	2.75	[a] 187	July 21	S. B. Soulé	2.58	714

[a] Ice at control.

Daily discharge, in second-feet, of Ottertail River at German Church near Fergus Falls, Minn., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	434	392	336	269	181	259	362	556	769	837	613	505
2	434	392	336	266	186	254	317	569	769	820	584	505
3	434	392	336	264	192	254	272	584	769	803	584	505
4	434	392	354	261	198	255	270	557	769	837	584	505
5	457	392	354	256	206	256	268	584	769	837	584	505
6	457	392	354	247	222	254	265	584	769	803	570	530
7	434	392	354	237	239	251	261	584	769	803	557	557
8	434	384	354	226	235	249	283	584	769	769	557	585
9	434	384	354	226	231	247	305	584	769	769	530	613
10	434	384	354	229	229	244	326	584	769	769	530	642
11	434	384	336	222	235	242	373	584	769	769	530	642
12	434	373	336	216	239	247	368	613	769	769	557	642
13	434	373	336	212	244	249	362	642	769	769	544	642
14	434	384	336	206	249	261	377	642	769	737	530	642
15	434	384	330	200	259	274	392	704	769	737	530	613
16	434	384	319	196	269	288	392	704	769	704	530	584
17	434	384	319	192	283	291	392	704	769	704	530	584
18	434	384	313	188	280	294	392	704	769	704	530	584
19	434	384	313	185	274	297	425	704	769	704	505	584
20	434	384	313	181	297	300	457	704	769	704	545	584
21	434	336	313	185	322	303	457	737	769	689	584	584
22	434	336	313	188	354	307	468	737	769	673	584	584
23	434	336	310	188	333	318	480	737	769	673	584	584
24	434	336	310	186	313	329	480	737	704	673	557	584
25	434	336	288	190	294	340	480	769	704	673	530	584
26	434	336	288	194	274	351	480	769	704	673	530	584
27	434	336	291	196	272	362	480	769	704	642	530	584
28	413	336	286	187	266	373	505	769	837	642	530	642
29	413	336	280	187	261	384	530	769	982	642	530	642
30	413	336	278	185	.....	396	543	769	908	642	530	613
31	402	.....	272	183	.....	379	.....	769	.....	642	505	.....

NOTE.—Discharge Nov. 21-23 and Nov. 28 to Apr. 10, estimated, because of ice, from discharge measurements, observer's notes, and weather records. Discharge interpolated because gage was not read, Oct. 10, 17, 24, 31, Nov. 17, Apr. 12, 14, 16, 19, 22, 24, 26, 28, 30, May 1, 2, 7, 17, 28, June 2, 9, 11, 14, 25, July 2, 21, 24, 30, Aug. 6, 10, 13, 15, 20, 27, Sept. 4, 8, and 18.

Monthly discharge of Ottertail River at German Church, near Fergus Falls, Minn., for the year ending Sept. 30, 1916.

[Drainage area, 1,300 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	457	402	432	0.332	0.38
November	392	336	369	.284	.32
December	354	272	321	.247	.28
January	269	181	211	.162	.19
February	354	181	256	.197	.21
March	396	242	294	.226	.26
April	543	261	392	.302	.34
May	769	556	671	.516	.59
June	982	704	774	.595	.66
July	837	642	729	.561	.65
August	613	505	549	.422	.49
September	642	505	585	.450	.50
The year	982	181	466	.358	4.87

RED RIVER AT FARGO, N. DAK.

LOCATION.—At the dam half a mile above the highway bridge on Front Street, Fargo, in Cass County, 10 miles above the mouth of Sheyenne River.

DRAINAGE AREA.—6,020 square miles.

RECORDS AVAILABLE.—May 27, 1901, to September 30, 1916.

GAGE.—Vertical staff attached to tree on left bank, about 6 rods above dam; vertical staff for use at low stages attached to piling pier of footbridge at same point, on second pier from left bank; datum about 1.0 foot below crest of dam. Prior to September 1, 1914, vertical staff attached to breakwater for center pier of Front Street bridge was used and is still maintained there by the United States Weather Bureau, but can not be read accurately without a field glass and has less permanent control. The datum of the Front Street gage is such that, if the dam were removed or if the stage is so high as to completely drown the dam, readings on the Front Street gage are about 10.4 feet greater than on the gage at the dam.

DISCHARGE MEASUREMENTS.—Made from footbridge 8 rods upstream from the dam, except at low stage, when the current is too sluggish at that point, and the Front Street bridge is used.

CHANNEL AND CONTROL.—Bed of stream consists of clay and silt; slightly shifting. The dam below the gage forms the control.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year 19.9 feet, April 6 (stage-discharge relation seriously affected by backwater from ice jam). Maximum discharge at 3.30 p. m. July 11, 7,960 second-feet (gage height, 17.34 feet). Minimum stage during open-water periods, 2.85 feet, November 18, 1915 (discharge, 471 second-feet). A lower stage probably occurred during winter.

1901–1916: Maximum stage recorded, that of April 6, 1916. Minimum stage recorded 5.7 feet (gage at Front Street Bridge), November 1, 1910 (discharge, 36 second-feet).

ICE.—Stage-discharge relation affected by ice from middle of November to end of March, but control such that open-season rating curve assumed applicable with small corrections deduced from discharge measurements and records of temperature.

REGULATION.—The dam, which is a tight overflow weir without sluices, was built to maintain a sufficient depth of water for the intake pipe of the waterworks, and raises the water about 5 feet at low stage. There is no power plant or storage nearer than 60 miles above station, and the storage there is not great enough to affect perceptibly discharge at station.

ACCURACY.—Stage-discharge relation slightly shifting; affected by ice during winter. Rating curve well defined between stages of 400 and 2,400 second-feet, and fairly well defined at higher stages. Gage read to hundredths twice daily. Open-water records good.

Discharge measurements of Red River at Fargo, N. Dak., 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. 6	E. F. Chandler	[a] 3.28	697	June 10	V. H. Sprague	5.02	2,140
Apr. 8	do	[b]	7,210	Aug. 24	E. F. Chandler	5.18	2,350
19	V. H. Sprague	[c]	4,400				

[a] Old gage read 9.45 feet. [b] Old gage read 28.79 feet. [c] Old gage read 19.55 feet.

Daily discharge, in second-feet, of Red River at Fargo, N. Dak., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	739	770	.....	4,640	4,560	2,230	4,040	2,520	1,410
2	770	770	.....	5,400	4,120	2,620	4,480	2,430	1,270
3	770	708	.....	5,920	3,760	2,430	4,840	2,020	1,060
4	770	708	.....	6,600	3,440	2,230	5,200	2,020	1,100
5	803	650	.....	7,080	3,300	2,430	5,600	1,810	1,020
6	836	739	.....	7,360	3,180	2,520	5,960	1,810	1,020
7	836	708	.....	7,440	2,900	2,430	6,600	1,710	1,020
8	836	708	.....	7,400	2,620	2,430	7,040	1,600	1,020
9	836	708	.....	7,320	2,430	2,230	7,440	1,550	1,060
10	836	708	.....	7,240	2,230	2,230	7,600	1,460	1,140
11	836	708	.....	7,000	2,020	2,230	7,720	1,460	1,180
12	836	708	.....	6,840	1,920	2,120	7,680	1,810	1,270
13	836	679	.....	6,680	1,810	2,430	7,560	2,020	1,360
14	836	518	.....	6,320	1,860	2,330	7,360	2,120	1,360
15	803	494	.....	6,040	1,920	2,230	7,080	2,020	1,410
16	803	494	.....	5,700	2,020	2,230	6,680	2,020	1,460
17	803	494	.....	5,360	2,120	2,120	6,280	1,550	1,460
18	803	471	.....	4,960	2,120	2,020	5,880	1,360	1,510
19	803	.....	.....	4,520	2,520	2,020	5,520	1,270	1,510
20	803	.....	.....	4,480	2,620	1,920	5,360	1,230	1,460
21	803	.....	.....	4,920	2,620	1,710	5,200	1,100	1,460
22	803	.....	.....	5,360	2,430	1,500	5,000	1,180	1,360
23	739	.....	.....	5,920	2,330	1,500	4,760	1,460	1,360
24	739	.....	.....	6,160	2,230	1,500	4,440	2,020	1,320
25	739	.....	.....	6,320	2,230	1,230	4,160	2,520	1,270
26	739	.....	836	6,360	2,230	1,180	3,840	3,110	1,180
27	770	.....	1,060	6,240	2,230	1,140	3,600	2,620	1,060
28	770	.....	1,060	6,000	2,230	1,140	3,350	2,120	1,100
29	770	.....	2,520	5,600	2,230	3,440	3,240	2,020	1,100
30	770	.....	3,440	5,080	2,230	3,760	2,880	1,810	1,140
31	770	.....	3,840	.....	2,330	.....	2,710	1,550	.....

NOTE.—Stage-discharge relation seriously affected by ice Nov. 18 to Apr. 12. Discharge, Mar. 26 to Apr. 12, estimated from gage heights, observer's notes, and one discharge measurement. Discharge, Apr. 16, May 7, 14, and July 16, interpolated.

Monthly discharge of Red River at Fargo, N. Dak., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	836	739	794	48,800
November 1–18	770	471	652	23,300
March 26–31	3,840	836	2,130	25,400
April	7,440	4,480	6,080	362,000
May	4,560	1,810	2,540	156,000
June	3,760	1,140	2,120	126,000
July	7,720	2,710	5,450	335,000
August	3,110	1,100	1,850	114,000
September	1,510	1,020	1,250	74,400

RED RIVER AT GRAND FORKS, N. DAK.

LOCATION.—At Northern Pacific Railway bridge between Grand Forks, N. Dak., and East Grand Forks, Minn., about half a mile below mouth of Red Lake River, in Grand Forks County.

DRAINAGE AREA.—25,000 square miles.

RECORDS AVAILABLE.—May 26, 1901, to September 30, 1916; gage-height records kept by United States Engineer Corps since 1882, and a few discharge measurements were made by them in early years.

GAGES.—Staff and chain attached to Northern Pacific Railway bridge; same datum. As a rule chain gage is read only during periods of exceptionally low water. Gage of United States Engineer Corps on bridge breakwater at same place as staff gage of United States Geological Survey; datum 5 feet higher.

DISCHARGE MEASUREMENTS.—Made from Great Northern Railway bridge, about one-fifth mile above gage.

CHANNEL AND CONTROL.—Bed composed of clay and silt; shifts slightly.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 41.0 feet at 5 p. m. April 17; stage-discharge relation affected by backwater from ice jam. Maximum discharge, 29,000 second-feet, April 22. Minimum stage during open-water periods, 6.6 feet, October 3 to 4 and November 3 to 11, 1915 (discharge 1,500 second-feet); winter minimum considerably smaller than this. (See estimated flow for January and February, 1916.)

1882–1916: Maximum stage recorded, 50.2 feet, April 10, 1897 (discharge, 43,000 second-feet); minimum stage, 2.6 feet, February 10, 1912 (discharge 100 second-feet).

ICE.—River flows under smooth ice from about middle of November to middle of April; flow usually steady with no fluctuations; since 1905 sufficient discharge measurements have been made each winter to obtain fairly satisfactory summaries of flow. Owing to a gentle current and the fact that the river flows north into cooler regions, the gage reading is usually excessive for a few days or weeks when ice breaks up in the spring, and flow must be determined largely by estimating, unless daily discharge measurements are made; current-meter measurements when river appeared to be open at station have sometimes shown reading more than 6 feet greater than that corresponding to the same discharge when the entire river is open.

REGULATION.—No dams, other obstructions, or rapids below; channel fairly uniform for many miles. Nearest power plant and reservoir affecting flow are at Crookston, 25 miles above, on Red River. About half the water comes from Red Lake River, but storage at Crookston plant is too small to cause perceptible fluctuation at gage. There are no important power plants or reservoirs within a hundred miles above Grand Forks on Red River proper and its tributaries.

ACCURACY.—Stage-discharge relation slightly shifting; affected by ice during winter. Rating curve fairly well defined between 2,500 and 9,000 second-feet. Gage read to half-tenths twice daily. Open-water records good.

Discharge measurements of Red River at Grand Forks, N. Dak., 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.*
Oct. 9	Sprague and McKay	6.78	1,750	Apr. 8[b]	Sprague and McKay	35.46	17,800
Dec. 23[a]	Chandler and McKay	6.97	1,090	16[b]	do	40.77	25,200
Feb. 8[a]	Sprague and Miller	6.15	628	Sept. 30	Wardwell and Dale	10.09	3,450
Mar. 18[a]	Sprague and Miller	7.40	862				

[a] River frozen over. [b] Backwater from ice.

Daily discharge, in second-feet, of Red River at Grand Forks, N. Dak., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Apr.	May.	June.	July.	Aug.	Sept.
1	1,540	1,540	6,340	23,400	8,240	7,300	6,410	5,010
2	1,540	1,540	8,240	22,400	7,840	8,080	5,980	4,600
3	1,500	1,500	10,700	21,200	7,920	9,070	5,630	4,200
4	1,500	1,500	14,100	19,600	8,080	10,100	5,350	3,750
5	1,590	1,500	15,400	18,000	8,400	10,600	5,140	3,490
6	1,670	1,500	16,200	16,500	8,990	10,800	5,010	3,360
7	1,670	1,500	16,700	15,200	8,990	11,800	4,870	3,240
8	1,590	1,500	17,800	13,600	8,730	12,900	4,740	3,180
9	1,590	1,500	18,700	12,500	8,400	13,600	4,600	3,180
10	1,670	1,500	19,700	11,600	8,240	13,800	4,530	3,300
11	1,760	1,500	21,200	10,300	8,240	14,100	4,470	3,490
12	1,720	.....	22,300	8,990	7,920	14,400	4,340	3,620
13	1,670	.....	23,900	8,080	7,300	14,600	4,140	3,810
14	1,630	.....	24,200	7,300	6,850	14,700	4,070	4,140
15	1,590	.....	24,900	6,560	6,770	14,500	4,400	4,530
16	1,670	.....	25,300	5,980	6,560	14,400	4,600	4,670
17	1,670	.....	26,100	6,120	6,270	14,000	4,740	4,620
18	1,630	.....	27,000	6,630	5,840	13,600	4,800	4,580
19	1,590	.....	27,600	7,450	5,630	13,100	4,670	4,530
20	1,590	.....	27,900	8,160	5,420	12,500	4,940	4,470
21	1,590	.....	28,100	8,400	5,280	11,800	5,080	4,400
22	1,590	.....	28,400	8,320	5,140	11,300	5,010	4,270
23	1,630	.....	29,000	8,240	5,010	10,900	4,740	4,200
24	1,630	.....	28,300	8,080	4,870	10,500	4,600	4,070
25	1,630	.....	27,900	8,080	4,870	10,200	4,670	3,940
26	1,630	.....	27,200	8,000	4,940	9,690	4,800	3,810
27	1,590	.....	26,400	8,000	5,210	9,070	5,010	3,750
28	1,630	.....	26,000	8,160	5,700	8,400	5,140	3,680
29	1,590	.....	25,200	8,570	6,270	7,840	5,420	3,560
30	1,590	.....	24,300	8,730	6,700	7,300	5,490	3,460
31	1,540	.....	.....	8,650	.....	6,770	5,280	.....

NOTE.—Stage-discharge relation seriously affected by ice Nov. 12 to Apr. 22; discharge estimated as follows: Nov. 12–30, 1,350 second-feet; Dec. 1–10, 1,200 second-feet; Dec. 11–25, 1,100 second-feet; Dec. 26–31, 1,050 second-feet; Jan. 1–31, 840 second-feet; Feb. 1–29, 670 second-feet; Mar. 1–31, 1,070 second-feet; Apr. 1–22, daily discharge given in above table. Discharge, Sept. 17 and 18, interpolated.

Monthly discharge of Red River at Grand Forks, N. Dak., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	1,760	1,500	1,610	99,000
November	1,540	.....	1,410	83,900
December	.....	.....	1,240	76,200
January	.....	.....	840	51,600
February	.....	.....	670	38,500
March	.....	.....	1,070	65,800
April	29,000	6,340	22,200	1,320,000
May	23,400	5,980	11,000	676,000
June	8,990	4,870	6,820	406,000
July	14,700	6,770	11,300	695,000
August	6,410	4,070	4,920	303,000
September	5,010	3,180	3,960	236,000
The year	29,000	.....	5,580	4,050,000

NOTE.—See footnote to table of daily discharge.

MUSTINKA RIVER NEAR WHEATON, MINN.

LOCATION.—On line between secs. 23 and 26, T. 127 N., R. 47 W., at highway bridge about 600 feet above mouth of Bender's Coulee, a small creek that enters from the left, 3 miles above Lake Traverse (into which the river discharges), and 3 miles southwest of Wheaton, Traverse County.

DRAINAGE AREA.—949 square miles.

RECORDS AVAILABLE.—June 7 to November 30, 1916, when station was discontinued.

GAGE.—Vertical staff gage attached to plank bolted to upstream I-beam piling supporting right end of bridge; read by Fred Schumacher.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge.

CHANNEL AND CONTROL—Bed composed of clay and silt. For about a mile below gage the channel has been artificially excavated, so that depth and width are uniform. Control not well defined. Slope of river from station to Lake Traverse so slight that stage-discharge relation is affected by changes in stage of lake.

EXTREMES OF DISCHARGE.—Maximum stage recorded since gage was installed, 7.9 feet July 7 (discharge, 1,630 second-feet); the flood in the spring of 1916 reached a stage about 14.0 feet above zero of gage, but owing to backwater from Lake Traverse (see paragraph on Channel and Control), discharge at that stage can not be accurately determined; minimum stage recorded, 2.42 feet October 30 to November 4 (discharge, 27 second-feet).

ACCURACY.—Stage-discharge relation affected by backwater from Lake Traverse and changes with stage of that lake. Rating curve poorly defined. Gage read to quarter tenths twice daily. Daily discharge ascertained by applying mean daily gage heights to rating table. Records poor.

Discharge measurements of Mustinka River near Wheaton, Minn., during 1916.

[Made by S. B. Soulé.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
June 7	4.32	259	Aug. 16	3.70	80	Oct. 14	2.58	31
July 2	7.19	1,350	16	3.70	81	14	2.58	32

Daily discharge, in second-feet, of Mustinka River near Wheaton, Minn, for 1916.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Day.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	1,350	206	62	34	27	16	172	674	87	47	33	26
2	.....	1,350	172	58	34	27	17	140	636	74	44	29	26
3	.....	1,430	172	56	34	27	18	118	560	66	40	29	26
4	.....	1,430	172	56	34	27	19	118	560	62	44	29	26
5	.....	1,430	156	51	34	27	20	122	524	58	43	29	.....
6	.....	1,550	140	47	34	27	21	92	470	72	42	29	.....
7	257	1,630	156	50	34	27	22	72	416	100	36	29	.....
8	240	1,590	140	42	33	27	23	172	380	118	36	29	.....
9	240	1,550	118	42	33	27	24	122	380	109	36	29	.....
10	223	1,270	109	50	36	27	25	92	344	104	40	29	.....
11	206	1,030	100	44	33	27	26	100	308	87	36	30	.....
12	206	950	109	44	32	27	27	87	291	78	38	28	.....
13	172	870	109	44	32	27	28	82	274	78	34	28	.....
14	206	750	109	44	31	27	29	416	257	68	34	28	.....
15	206	712	100	47	29	26	30	990	240	64	35	27	.....
							31	.....	240	64	.....	27	.....

NOTE.—Discharge Nov. 20–30, estimated, because of ice, from weather records and discharge of period immediately proceeding, at 25 second-feet.

Monthly discharge of Mustinka River near Wheaton, Minn., for 1916.

[Drainage area, 949 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
June	990	72	202	0.213	0.19
July	1,630	240	821	.865	1.00
August	206	58	108	.114	.13
September	62	34	44	.046	.05
October	36	27	31	.033	.04
November	27	.....	26	.027	.03

WILD RICE RIVER AT TWIN VALLEY, MINN.

LOCATION.—In T. 144 N., R. 44 W., at highway bridge at Twin Valley, Norman County, 2 miles above a small tributary which enters from the right at Heiberg.

DRAINAGE AREA.—805 square miles.

RECORDS AVAILABLE.—June 30, 1909, to September 30, 1916.

GAGE.—Vertical staff; read by Axel Johnson.

DISCHARGE MEASUREMENTS.—Made from bridge, except at extremely low stages, when they are made by wading below bridge.

CHANNEL AND CONTROL.—One channel at all stages; bed composed of sand and silt. Control not well defined; right bank high and wooded; left bank will be overflowed to some extent at stage of 12 feet.

EXTREMES OF DISCHARGE.—Maximum open-water stage recorded, 9.7 feet, June 1 (discharge, 1,670 second-feet); minimum stage recorded, 4.85 feet, November 14 (discharge, 63 second-feet); minimum discharge when river was frozen over, estimated 19 second-feet during the last part of February.

1909–1916: Maximum stage recorded, 20.0 feet at 7 a. m. July 22, 1909 (discharge, about 9,200 second-feet); minimum open-water discharge, 12 second-feet, August 31 and September 1, 1913; minimum winter discharge measured by current meter, 10 second-feet, February 5, 1912; the absolute minimum was probably less than this amount.

ICE.—Stage-discharge relation seriously affected by ice; flow determined from discharge measurements, observer's notes, and weather records.

REGULATION.—Discharge affected by storage created by dams at the lower end of Lower Rice Lake and at the outlet of Twin Lakes.

ACCURACY.—Stage-discharge relation permanent except as affected by ice during winter. Rating curve fairly well defined. Gage read to half tenths twice daily. Daily discharge ascertained by applying mean daily gage heights to rating table. Records good.

Discharge measurements of Wild Rice River at Twin Valley, Minn., 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.*
Oct. 24	E. F. Chandler	5.09	96	Apr. 26	D. C. McKay	8.08	967
Dec. 19	D. C. McKay	5.68	*a* 43	Aug. 2	E. F. Chandler	5.98	288
Feb. 6	V. H. Sprague	6.10	*a* 27	3	.....do.....	5.93	270
Mar. 19	D. C. McKay	6.33	*a* 71				

a Complete ice cover at control.

Daily discharge, in second-feet, of Wild Rice River at Twin Valley, Minn., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	147	94					822	719	1,670	1,530	305	188
2	128	87					900	686	1,530	1,440	268	199
3	128	87					1,170	686	1,260	1,260	256	210
4	128	87					1,170	686	1,170	1,080	280	199
5	128	87					900	654	942	986	280	210
6	124	87					860	654	860	900	256	210
7	110	87					822	622	822	900	256	199
8	110	94					986	591	752	900	244	178
9	110	110	58	44	30	54	1,080	591	686	786	233	157
10	110	110					900	560	654	752	244	280
11	110	110					822	560	622	719	305	256
12	110	128					1,120	530	560	654	318	280
13	110	110					822	500	530	622	331	256
14	110	63					860	500	500	591	331	256
15	119	80					1,080	530	471	500	305	256
16	119	87					1,260	622	471	471	305	233
17	110	94					1,120	622	500	442	268	222
18	110	94					1,080	622	530	399	233	210
19	110	94					942	591	530	1,080	233	199
20	110	80					1,170	560	471	752	222	210
21	102	87				75	1,210	560	413	686	233	188
22	94	68					1,170	560	385	654	244	188
23	94	58					1,120	622	560	500	256	188
24	94	58	50	30	25		1,030	686	860	442	244	178
25	102	50					986	786	1,210	442	244	178
26	102	50				80	942	1,030	1,260	560	233	167
27	94	50				80	900	900	1,080	591	233	165
28	94	50				90	860	822	1,080	442	222	167
29	94	50				100	822	752	1,400	413	222	167
30	94	50				140	752	719	1,490	385	199	157
31	94	.....				331	.....	752	.....	358	188	.....

NOTE.—Discharge, Nov. 15 to Apr. 10, estimated, because of ice, from discharge measurements, observer's notes, and weather records. Braced figures show mean discharge for period indicated.

Monthly discharge, in second-feet, of Wild Rice River at Twin Valley, Minn., for the year ending Sept. 30, 1916.

Month.	Maximum.	Minimum.	Mean.	Month.	Maximum.	Minimum.	Mean.
October	147	94	110	May	1,030	500	654
November	128	50	81	June	1,670	385	842
December	.....	.....	54	July	1,530	358	717
January	.....	.....	37	August	331	188	258
February	.....	.....	28	September	280	157	205
March	331	.....	77				
April	1,260	752	989	The year.	1,670	50	337

DEVILS LAKE NEAR DEVILS LAKE, N. DAK.

LOCATION.—At the biologic station of the University of North Dakota, near Devil's Lake, in Ramsey County, 6 miles southwest of the city of Devil's Lake.

RECORDS AVAILABLE.—June 8, 1901, to September 30, 1916 (fragmentary).

GAGE.—Staff gage on pier at the biologic station. The zero of the gage is at an elevation of 1,393.3 feet above sea level. Previous to 1916 staff gages have been placed at convenient points on piers, but it has been necessary to renew them occasionally, some times every year, because of the fact that they are damaged by ice during the spring break-up. These gages have been reset as near as possible to the correct datum, often by the use of a carpenter's level. Occasionally errors of 0.1 foot in the records have been discovered when accurate checks were made, but no larger errors are likely to occur. The gage is read occasionally by employees of the biologic station.

EXTREMES OF STAGE.—Maximum stage recorded during year, 7.72 feet May 1; minimum stage recorded, 6.9 feet, November 5.

Between 1880 and 1916 the lake fell approximately 16 feet, and its area has decreased about one-half.

REGULATION.—The lake has no outlet. The change in the surface elevation is due to the inflow from the adjacent drainage area and the evaporation.

COOPERATION.—Records are furnished by the North Dakota Biological Survey.

Gage height of Devils Lake near Devils Lake, N. Dak., in 1913–1916.

Date.	Feet.	Date.	Feet.	Date.	Feet.
1913.		1914—Continued.		1916.	
Apr. 8	9.87	July 7	8.88	May 1	7.72
May 5	10.10	Aug. 8	8.35	18	7.54
12	10.10	20	8.16	June 28	7.55
Aug. 14	9.10	26	8.22	July 1	7.62
Sept. 29	8.75	Sept. 19	8.00	7	7.90
Nov. —	8.67	1915.		Aug. 12	7.57
1914.		June 29	7.60	Sept. 4	7.27
Apr. 10	8.62	July 9	7.52	26	7.12
June 20	8.71	20	7.40	Nov. 5	(a)
27	8.83	27	7.30		
		Sept. 7	6.77		

a About 6.90 feet.

RED LAKE RIVER AT THIEF RIVER FALLS, MINN.

LOCATION.—In sec. 33, T. 154[1] N., R. 43 W., one-third mile below dam at Thief River Falls, Pennington County, and a mile below mouth of Thief River, which comes in from the right.

DRAINAGE AREA.—3,430 square miles.

RECORDS AVAILABLE.—July 2, 1909, to September 30, 1916.

GAGE.—Inclined staff gage on left bank; read by H. W. Hoard.

CHANNEL AND CONTROL.—Gravel; practically permanent.

EXTREMES OF DISCHARGE.—Maximum open-water stage recorded 12.2 feet, April 19–21 (discharge, 7,040 second-feet); minimum open-water stage recorded, 4.65 feet, November 4 and 6, 1915 (discharge, 412 second-feet); minimum discharge, when river was frozen over, estimated at 258 second-feet January 14.

1909–1916: Maximum open-water stage recorded, 12.2 feet, April 19–21, 1916 (discharge, 7,040 second-feet); minimum discharge recorded, zero, July 17 and August 27, 1911.

ICE.—Stage-discharge relation seriously affected by ice.

REGULATION.—A short distance above station is a dam owned by the Hansen & Barzen Milling Co., and the city lighting plant. The variation in load on the turbines, due to the operation of the lighting plant at night and of the mill, chiefly during the day, caused fluctuations in the river at the gage.

ACCURACY.—Stage-discharge relation permanent except as affected by ice during winter. Rating curve well defined between 19 and 2,550 second-feet, and fairly well defined between 2,550 and 5,600 second-feet. Gage read to half tenths twice daily. Daily discharge ascertained by applying mean daily gage heights to rating table, except for periods when stage-discharge relation was affected by ice, for which it was ascertained by applying to rating table mean daily gage heights corrected for ice effect by means of discharge measurements, observer's notes, and weather records. Records only fair because of inaccuracy of mean daily gage height as obtained from two readings daily of the gage.

[1] Township location published in previous water-supply papers is in error.

Discharge measurements of Red Lake River at Thief River Falls, Minn., 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.*
Dec. 22[a]	D. C. McKay	6.25	592	Apr. 24	D. C. McKay	11.78	6,730
Feb. 5[a]	do	5.81	349	30	do	10.52	4,770
Mar. 12[a]	do	5.89	379	Aug. 4	E. F. Chandler	5.61	809
Apr. 22[b]	Chandler and McKay	11.83	7,880	Sept. 8	do	6.41	1,280

[a] Complete ice cover at control. [b] Float measurement.

Daily discharge, in second-feet, of Red Lake River at Thief River Falls, Minn., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	472	452	452				605	4,940	2,910	2,200	840	
2	494	452	452				515	4,830	2,880	1,870	840	
3	515	431	452				472	4,830	2,850	2,200	890	
4	538	412	393				560	4,830	2,820	2,110	840	
5	538	452	412				560	4,610	2,820	2,200	840	
6	560	393	452				560	4,610	2,820	2,110	890	
7	560	472	494				560	4,200	2,730	2,280	940	
8	582	472	494				650	3,400	2,640	2,200	940	
9	560	494	515				605	2,820	2,550	2,200	940	
10	538	494	515				605	2,370	2,370	2,200	940	
11	515	494	515				560	2,280	2,280	2,280	940	
12	494	452	560				1,050	2,460	2,280	2,280	1,050	
13	472	452	515				1,950	2,640	2,280	2,370	1,050	
14	452	412	431				2,280	3,000	2,030	2,370	1,050	
15	472	357	472				3,500	2,910	2,030	2,460	1,050	
16	494	393	515	368	373	418	6,440	2,910	2,110	2,370	1,050	1,300
17	515	412	472				6,800	2,820	2,110	2,370	995	
18	494	375	431				6,680	2,910	2,200	2,370	1,050	
19	494	357	431				7,040	3,100	2,110	2,030	1,050	
20	472	340	431				7,040	3,100	2,030	1,790		
21	515	393	512				7,040	3,000	1,950	1,640		
22	494	375	592				6,800	3,000	1,870	1,500		
23	515	375	552				6,680	3,000	2,030	1,430		
24	515	340	512				6,560	2,910	1,950	1,430		
25	515	340	472				5,380	3,000	2,030	1,360	1,340	
26	494	357	458				5,270	2,910	2,110	1,360		
27	538	340	444				5,270	2,820	2,200	1,300		
28	538	357	431				5,200	2,910	2,200	1,230		
29	538	357	441				5,120	2,910	2,200	1,110		
30	472	393	452				5,050	2,820	2,280	1,050		
31	431	.....	462				.....	2,820	.....	790		

NOTE.—Stage-discharge relation affected by ice Nov. 14 to Apr. 18. No gage readings Apr. 28, 29, June 2 and 3; discharge interpolated. No gage readings Aug. 20 to Sept. 30; discharge estimated by comparison with records of flow of Red Lake River at Crookston, Clearwater River at Twin Valley, and Thief River near Thief River Falls. Braced figures show mean discharge for period included.

Monthly discharge, in second-feet, of Red Lake River at Thief River Falls, Minn., for the year ending Sept. 30, 1916.

[Drainage area, 3,430 square miles.]

Month.	Maximum.	Minimum.	Mean.	Month.	Maximum.	Minimum.	Mean.
October	582	431	510	May	4,940	2,280	3,280
November	494	340	406	June	2,910	1,870	2,320
December	592	393	475	July	2,460	790	1,890
January	.....	.....	368	August	.....	840	1,110
February	.....	.....	373	September	.....	.....	1,300
March	.....	.....	418				
April	7,040	472	3,580	The year.	7,040	.....	1,330

RED LAKE RIVER AT CROOKSTON, MINN.

LOCATION.—At new Sampson's Addition highway bridge in Crookston, Polk County, a quarter of a mile below dam and power house of the Crookston Waterworks, Power & Light Co.'s plant. No tributaries enter for several miles.

DRAINAGE AREA.—5,320 square miles.

RECORDS AVAILABLE.—May 19, 1901, to September 30, 1916.

GAGE.—Barrett & Lawrence water-stage recorder on right abutment of bridge; installed in September, 1911; replaced chain gage attached to bridge July 1, 1909 both gages at same datum. Prior to July 1, 1909, gage was on old Sampson's Addition bridge, about 300 feet farther upstream; at ordinary stages this gage read the same as the present one.

CHANNEL AND CONTROL.—Control not well defined; one channel at all stages; slightly shifting.

EXTREMES OF DISCHARGE.—Maximum mean daily stage during year from water-stage recorder, 21.5 feet April 17, (discharge, 14,400 second-feet); minimum mean daily stage from water-stage recorder, 3.45 feet, November 15 (discharge, 363 second-feet); minimum mean daily discharge recorded during period river was frozen over, 289 second-feet, November 23.

1901–1916: Maximum mean daily stage recorded April 17, 1916. A minimum discharge of 10 second-feet was recorded by discharge measurement made January 27, 1912. Flow controlled to such an extent that the minimum recorded discharge has no bearing on the minimum natural flow.

ICE.—Stage-discharge relation seriously affected by ice.

REGULATION.—Considerable diurnal fluctuation at gage is caused by operation of power plant immediately above station. The plant has little storage, so that the mean monthly flow represents nearly the natural flow.

ACCURACY.—Stage-discharge relation shifting, also affected by ice during winter. Rating curve fairly well defined between 382 and 1,320 second-feet and poorly defined between 1,320 and 11,600 second-feet. Operation of water-stage recorder satisfactory except when observer failed to attend to it, as noted in footnote to table of daily discharge. Daily discharge ascertained by applying mean daily gage heights (obtained from gage-height graph by use of planimeter) to the rating table, except for period when stage-discharge relation was affected by ice for which it was ascertained by applying to rating table mean daily gage heights corrected for ice effect by means of discharge measurements, observer's notes, and weather records. Records fair for periods for which gage-height records were obtained and poor for other periods.

Discharge measurements of Red Lake River at Crookston, Minn., 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.*
Oct. 30	E. F. Chandler	3.83	550	Apr. 20	D. C. McKay	17.27	10,400
Jan. 3[a]	D. C. McKay	4.95	536	25	do	15.85	9,270
Feb. 7[a]	V. H. Sprague	4.79	384	Aug. 2	E. F. Chandler	4.77	958
Mar. 17[a]	D. C. McKay	5.22	391	3	do	4.93	918
18[a]	do	5.31	383				

[a] Complete ice cover at control.

Daily discharge, in second-feet, of Red Lake River at Crookston, Minn., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	540	660	421	500	500	500	985	7,190	3,280		1,100	1,320
2	580	620	382	421	500	540	790	6,930	3,280		1,090	1,300
3	660	660	382	460	460	540	1,040	6,500	3,350	3,800	1,040	1,300
4	660	660	745	540	500	580	1,260	6,160	3,280		1,140	1,200
5	660	660	620	500	460	540	1,140	6,000	3,400		1,260	1,200
6	500	540	620	460	460	550	985	5,820			1,140	1,150
7	560	500	620	421	460	560	1,040	5,480			1,200	1,140
8	580	500	620	500	460	560	1,040	5,320	3,600	3,400	1,200	1,440
9	620	560	500	460	500	570	1,200	5,140			1,260	1,620
10	560	660	500	460	460	580	1,560	4,890			1,260	1,690
11	540	700	540	460	460	745	3,270	4,640			1,200	1,820
12	540	660	540	382	421	580	5,740	4,470			1,260	2,280
13	620	480	540	421	540	620	8,180	4,310	3,300	3,100	1,260	2,210
14	580	382	540	421	500	660	10,100	4,150			1,140	2,210
15	660	363	500	421	460	700	12,300	3,990			1,080	2,080
16	620	363	500	382	421	700	13,600	3,910			1,090	2,020
17	620	344	580	382	421	700	14,400	3,830			1,090	1,950
19	620	402	540	382	382	745	14,000	3,590	3,000	2,900	1,260	1,950
19	660	402	540	382	500	660	11,900	3,510			2,140	1,880
20	620	382	620	344	382	790	10,800	3,510			2,210	1,690
21	620	402	660	382	421	835	10,300	3,510			2,210	1,690
22	620	363	660	460	460	790	10,200	3,510			2,210	1,560
23	580	289	580	421	500	885	9,980	3,430	2,700	2,200	2,140	1,500
24	560	326	540	421	460	745	9,710	3,430			2,140	1,560
25	580	363	460	460	460	500	9,350	3,510			2,080	1,500
26	560	382	540	460	460	720	9,080	3,510			1,880	1,500
27	620	460	620	540	382	935	8,900	3,590			1,690	1,500
28	620	500	620	500	500	985	8,630	4,070	3,100	1,600	1,560	1,450
29	620	500	620	620	500	935	8,270	4,150			1,380	1,400
30	620	421	620	500	.....	835	7,730	3,750			1,440	1,400
31	620	.....	540	500	.....	790	.....	3,510	.....	1,200	1,320	.....

NOTE.—Stage-discharge relation affected by ice Nov. 16 to Apr. 27. Water-stage recorder not working satisfactorily June 4 to Aug. 1, Sept. 2–6, 26–30; no gage height records available; discharge determined by comparison with records of flow of Red Lake River at Thief River Falls, Clearwater River at Red Lake Falls, and Wild Rice River at Twin Valley. Braced figures show mean discharge for period indicated.

Monthly discharge, in second-feet, of Red Lake River at Crookston, Minn., for the year ending Sept. 30, 1916.

[Drainage area, 5,320 square miles.]

Month.	Maximum.	Minimum.	Mean.	Month.	Maximum.	Minimum.	Mean.
October	660	500	601	May	7,190	3,430	4,490
November	700	289	483	June	.....	.....	3,170
December	745	382	558	July	.....	.....	2,780
January	620	344	450	August	2,210	1,040	1,470
February	540	382	462	September	2,280	1,140	1,620
March	985	500	690				
April	14,400	790	6,920	The year.	14,400	289	1,970

THIEF RIVER NEAR THIEF RIVER FALLS, MINN.

LOCATION.—In sec. 3, T. 154 N., R. 43 W., at the Drybrook ford, Pennington County, 6 miles north of Thief River Falls. Nearest tributary, outlet of Mud Lake, enters in the northeastern part of T. 156 N., R. 42 W.

DRAINAGE AREA.—1,010 square miles.

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

GAGE.—Chain gage installed August 26, 1915, attached to a cantilever timber fastened to a tree on right bank; inclined staff gage installed September 4, 1913, to replace old inclined staff gage, which was set at incorrect gage datum; used until August 26, 1915. Gage read by T. H. Risteigen. See Water-Supply Paper 325 for history of old gage.

DISCHARGE MEASUREMENTS.—Made from steel highway bridge, 1,000 feet below gage; at low stages made by wading near gage.

CHANNEL AND CONTROL.—Heavy gravel and boulders; nearly permanent; one channel at all stages; banks high and not subject to overflow.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 14.5 feet, April 23 (discharge, 4,080 second-feet); no flow during the last of February.

1909–1916: Maximum stage recorded, April 23, 1916; no flow in October, November, and December, 1910, January, February, and December, 1911, January and February, 1912, and February, 1916.

REGULATION.—Dam at Thief River Falls, at mouth of Thief River, backs up water in Thief River for several miles, but gage is protected from influence of dam by rapids below.

ACCURACY.—Stage-discharge relation permanent except for the effect of ice during winter. Rating curve well defined below 3,800 second-feet. Gage read to half tenths twice daily. Daily discharge ascertained by applying mean daily gage heights to rating table. Records good.

The large flow during September, 1916, was caused by the opening of ditches which drain Thief Lake into the river.

Discharge measurements of Thief River near Thief River Falls, Minn., 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.*
Dec. 21[a]	D. C. McKay	5.50	3.0	Apr. 29	D. C. McKay	13.42	3290
Feb. 5[a]	do	4.0	1.0	Aug. 5	E. F. Chandler	4.64	41
Mar. 12[a]	do	4.06	1.5	Sept. 8	do	6.13	405
Apr. 23	do	14.5	4320				

[a] Complete ice cover at control.

Daily discharge, in second-feet, of Thief River near Thief River Falls, Minn, for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	43	55	23				4	2,500	424	189	50	110
2	44	55	17				4	2,300	472	244	47	105
3	40	57	16	3			4	2,150	456	232	40	99
4	44	55	16				5	1,970	424	196	38	84
5	42	54					5	1,660	379	175	42	70
6	39	55					7	1,530	350	143	40	232
7	36	58				1	9	1,370	322	122	38	364
8	34	60	14				15	1,290	308	120	42	364
9	37	61					13	1,060	295	99	56	379
10	42	62			1		12	815	295	97	76	440
				2								
11	55	66					24	675	282	87	63	640
12	56	57	12				130	572	269	84	48	675
13	57	46	12				780	505	220	79	36	675
14	55	45	10				2,200	472	208	69	32	710
15	52	44	10				2,430	456	208	66	22	606
16	50	42	8				2,850	780	196	65	22	538
17	50	44	6				3,360	1,100	187	63	295	472
18	48	44	4				3,910	1,060	180	68	780	456
19	46	40	3			2	3,960	955	166	69	885	440
20	45	37	3				3,960	920	164	79	850	424
21	41	34	3				3,960	885	162	110	710	394
22	42	32	3				4,020	815	158	126	675	379
23	42	31	3				4,080	780	151	101	640	364
24	49	29	2	1	0		4,020	745	155	84	505	350
25	50	29	2				4,020	710	153	76	364	336
26	50	26	2				3,960	675	155	72	336	322
27	48	25	2				3,800	675	153	69	244	308
28	48	23	2			3	3,580	640	151	62	178	295
29	49	22	3				3,470	572	151	57	169	282
30	50	22	3				3,200	472	149	56	158	256
31	54	.....	3				.....	424	.....	52	138	.....

NOTE.—Discharge, Nov. 12 to Apr. 17, estimated, because of ice, from discharge measurements, observers notes, and weather records. Braced figures show mean discharge for periods indicated.

Monthly discharge, in second-feet, of Thief River near Thief River Falls, Minn., for the year ending Sept. 30, 1916.

Month.	Maximum.	Minimum.	Mean.	Month.	Maximum.	Minimum.	Mean.
October	57	34	46	May	2,500	424	1,020
November	66	22	44	June	472	149	245
December	.....	.....	9	July	244	52	104
January	.....	.....	2.6	August	885	22	246
February	.....	.....	.6	September	710	70	372
March	.....	.....	2				
April	4,080	4	2,060	The year.	4,080	.....	344

CLEARWATER RIVER AT RED LAKE FALLS, MINN.

LOCATION.—In T. 151 N., R. 44 W., at Great Northern Railway bridge at Red Lake Falls, Red Lake County, about 1½ miles above the mouth, and 2 miles below the nearest tributary, a stream coming in from the left.

DRAINAGE AREA.—1,310 square miles.

RECORDS AVAILABLE.—June 18, 1909, to September 30, 1916.

GAGE.—Combination vertical and inclined staff gage; installed September 12, 1911, about half a mile downstream from original gage, as the building of a dam caused several feet of backwater at the old section. New gage set to read 2.23 feet when the original gage read 5.83 feet; read by Leo Steinert.

DISCHARGE MEASUREMENTS.—At medium and high stages made from Great Northern Railway bridge; at low stages by wading about 300 feet below gage.

CHANNEL AND CONTROL.—Bed composed of sand and gravel; smooth; two channels at low stages, united at high stages. Banks high, wooded, and not subject to overflow. Control nearly permanent.

EXTREMES OF DISCHARGE.—Maximum discharge recorded during year, 3,990 second-feet, April 15 and 16; minimum stage recorded, 2.25 feet, August 6 and 7 (discharge, 78 second-feet); minimum discharge when river was frozen over, estimated 50 second-feet, March 6–15.

1909–1916: Maximum discharge recorded, 3,990 second-feet, April 15 and 16, 1916; minimum discharge July 4, 1911, 20 second-feet.

ICE.—Stage-discharge relation seriously affected by ice.

REGULATION.—At low stages flow is affected by the Steinert dam 600 feet above gage. The storage at this plant is small, and only a slight diurnal fluctuation is observed at gage.

ACCURACY.—Stage-discharge relation probably affected somewhat by scouring out of channel during high water in April, so that determinations of low-water discharge during following months may be too low; also affected by ice during winter. Before the change in stage-discharge relation, rating curve was well defined between 53 and 1,165 second-feet and fairly well defined between 1,165 and 3,550 second-feet; for determination of discharge after high water in April, lower part of curve probably not so accurate as the upper. Gage read to half tenths twice daily. Daily discharge ascertained by applying mean daily gage heights to rating table. Records good for open-water periods October to May; fair June to September and for winter period.

Discharge measurements of Clearwater River at Red Lake Falls, Minn., 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.*
Oct. 23	V. H. Sprague	2.46	116	Mar. 13[a]	D. C. McKay	3.85	50
30	E. F. Chandler	2.51	123	Apr. 21	do	6.95	3,520
Dec. 20[a]	D. C. McKay	2.78	90	Aug. 1	E. F. Chandler	2.61	171
Feb. 27[a]	do	3.50	70				

[a] Complete ice cover at control.

Daily discharge, in second-feet, of Clearwater River at Red Lake Falls, Minn., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	110	120	53				120	2,170	1,250	1,520	142	120
2	101	131	53				131	2,080	1,250	1,610	120	101
3	93	142	53		70	60	142	1,980	1,250	1,610	101	101
4	85	142	53				167	1,880	1,340	1,610	101	110
5	85	142	58				167	1,790	1,250	1,430	85	120
6	85	120					167	1,610	1,160	1,250	78	120
7	85	120					212	1,520	1,160	1,080	78	142
8	101	120		70	75	50	229	1,430	1,000	930	93	142
9	101	120	80				307	1,250	895	762	101	131
10	101	120					400	1,250	860	700	110	120
11	120	101					1,610	1,250	795	529	142	101
12	120	101					2,460	1,160	730	502	142	101
13	120	110			85	50	2,460	1,120	700	450	131	120
14	120	101					3,660	1,080	730	450	120	120
15	120	85					3,990	1,160	670	425	101	131
16	142	85	90				3,990	1,250	641	400	101	142
17	142	85					3,770	1,340	556	352	131	142
18	142	78		68	80		3,770	1,250	529	352	142	154
19	142	72					3,550	1,250	502	330	167	167
20	142	72					3,550	1,160	425	307	182	167
21	131	66				60	3,350	1,080	352	266	196	196
22	120	62					3,150	1,000	376	266	229	196
23	131	62		62	75		3,050	968	400	248	196	167
24	142	62					2,950	930	425	229	182	167
25	142	53					2,950	895	450	212	167	167
26	142	53	80			72	2,850	895	502	196	142	154
27	142	53			70	85	2,550	1,790	450	182	142	142
28	142	62		70		85	2,550	1,880	476	167	142	142
29	131	53				101	2,360	1,790	1,000	167	131	120
30	120	53			.....	120	2,360	1,610	1,430	142	120	110
31	120	.....			.....	120	.....	1,430	.....	142	120	.....

NOTE.—Discharge Nov. 14 to Apr. 14 estimated, because of ice, from discharge measurements, observer's notes, and weather records. Braced figures show mean discharge periods indicated.

Monthly discharge, in second-feet, of Clearwater River at Red Lake Falls, Minn., for the year ending Sept. 30, 1916.

Month.	Maximum.	Minimum.	Mean.	Month.	Maximum.	Minimum.	Mean.
October	142	85	120	May	2,170	895	1,400
November	142	53	92	June	1,430	400	785
December	.....	.....	78	July	1,610	142	607
January	.....	.....	68	August	229	78	133
February	.....	.....	76	September	196	101	137
March	120	.....	64				
April	3,990	120	2,100	The year.	3,990	53	470

MOUSE RIVER AT MINOT, N. DAK.

LOCATION.—At the Anne Street footbridge, northwest of Great Northern Railway roundhouse, at Minot, in Ward County.

DRAINAGE AREA.—8,400 square miles.

RECORDS AVAILABLE.—May 5, 1903, to September 30, 1916.

GAGE.—Vertical staff attached to pier nearest left bank of Anne Street footbridge; read by Ephraim Cox. From 1903 to December, 1909, a vertical staff on old footbridge 20 rods above present site. Both gages set at same datum.

DISCHARGE MEASUREMENTS.—Made from the Anne Street Bridge at medium and high stages, or by wading below the dam at the Minneapolis, St. Paul & Sault Ste. Marie Railway tank.

CHANNEL AND CONTROL.—Clay and silt, slightly shifting

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 19.05 feet May 6–7 (discharge, 4,260 second-feet); minimum stage recorded, 3.50 feet February 5 and 11 (discharge, 0.5 second-foot).

1903–1916: Maximum stage recorded, 21.9 feet April 20, 1904 (discharge, 12,000 second-feet); minimum stage recorded, 1.8 feet February 28, 1913 (discharge, 0.1 second-foot).

ICE.—Stage-discharge relation slightly affected by ice.

REGULATION.—A dam 4 feet high at the Minneapolis, St. Paul & Sault Ste. Marie Railway tank, a mile below, raises water at the gage about 3 feet at ordinary low stage. The dam being designed merely to give enough depth of water for the intake-pipe suction, has no sluices, but is not absolutely tight. When the discharge is less than about 5 second-feet, the water level falls below the crest of dam.

ACCURACY.—Stage-discharge relation not permanent; slightly affected by changes in control and by ice. Rating curves, applicable October 1 to March 31 and April 1 to September 30, fairly well defined. Gage read to half-tenths once daily. Discharge ascertained by applying daily gage heights to rating table.

Discharge measurements of Mouse River at Minot, N. Dak., during the year ending Sept. 30, 1916.

[Made by E. F. Chandler.]

Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*
Apr. 27	16.76	2,390
Sept. 5	4.59	22.8

Daily discharge, in second-feet, of Mouse River at Minot, N. Dak., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	5.0	1.0	.....	.....	.....	.....	150	3,320	455	266	59	33
2	5.0	1.0	.....	.....	.....	.....	455	3,580	455	280	53	33
3	3.0	1.0	.....	.....	.....	.....	761	3,830	455	293	37	29
4	3.0	1.0	.....	.....	.....	2.0	1,030	4,080	455	293	33	26
5	3.0	1.0	0.6	.....	0.5	.....	1,020	4,200	455	266	42	26
6	3.0	1.0	.....	.....	.....	.....	966	4,200	428	252	137	29
7	3.0	1.0	.....	0.6	.....	.....	929	4,200	414	266	113	29
8	3.0	1.0	.....	.....	.....	.....	738	4,080	428	293	102	29
9	3.0	1.0	.....	.....	.....	.....	562	3,830	401	320	102	26
10	1.5	1.0	.....	.....	.....	.....	738	3,490	388	293	74	26
11	1.5	1.0	.....	.....	.....	1.5	1,280	3,140	374	293	59	26
12	1.5	1.0	.5	.....	.5	.....	1,370	2,810	347	280	59	23
13	1.5	1.0	.....	.....	.....	.....	1,470	2,480	334	280	59	23
14	1.5	1.0	.....	.6	.....	.....	1,470	2,100	334	266	59	23
15	1.5	1.0	.....	.....	.....	.....	1,380	1,710	320	239	53	26
16	1.5	1.0	.....	.....	.....	.....	1,290	1,400	320	187	53	26
17	1.2	1.0	.....	.....	.....	.....	1,270	1,150	320	187	59	26
18	1.2	1.0	.....	.....	.....	2.0	1,310	1,030	293	187	59	26
19	1.2	1.0	.5	.....	2.0	.....	1,410	784	280	174	53	29
20	1.2	1.0	.....	.....	.....	.....	1,480	714	266	174	53	29
21	1.2	.8	.....	.....	.....	.....	1,550	640	252	162	47	26
22	1.2	.8	.....	.6	.....	.....	1,650	588	239	150	53	23
23	1.2	.8	.....	.....	.....	.....	1,760	562	239	125	53	23
24	1.0	.8	.....	.....	.....	.....	1,890	536	239	102	47	23
25	1.0	.8	.....	.....	.....	8.0	2,070	509	266	92	47	23
26	1.0	.8	.6	.....	3.0	.....	2,220	509	280	102	42	23
27	1.0	.8	.....	.....	.....	.....	2,480	509	266	102	42	26
28	1.0	.8	.....	.....	.....	.....	2,660	509	266	113	42	26
29	1.0	.8	.....	.6	.....	.....	2,880	509	252	113	37	26
30	1.0	.8	.....	.....	.....	.....	3,010	509	252	113	37	26
31	1.0	.....	.....	.....	.....	.....	.....	482	.....	102	33	.....

Monthly discharge of Mouse River at Minot, N. Dak., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
October	5.0	1.0	1.87	115
November	1.0	.8	.93	55
December			.60	37
January			.60	37
February			1.50	86
March			6.0	369
April	3,010	150	1,440	85,700
May	4,200	482	2,000	123,000
June	455	239	336	20,000
July	320	92	205	12,600
August	137	33	58.0	3,570
September	33	23	26.3	1,560
The year	4,200		340	247,000

NOTE.—Mean discharge for December, January, and February, determined from weekly gage heights, and observer's notes on ice conditions. Mean discharge for March ascertained from weekly gage-height records, weather conditions, and flow of stream on April 1.

RAINY LAKE AT RANIER, MINN.

LOCATION.—In sec. 30, T. 71 N., R. 23 W., at foot of Rainy Lake at Ranier, Koochiching County.

RECORDS AVAILABLE.—January 1, 1910, to September 30, 1916.

GAGE.—Vertical staff gage at sawmill, about 500 feet above the Canadian Northern Railway bridge. From June 6 to August 5, 1916, records were read from a temporary staff gage below the Canadian Northern Railway bridge and about 100 feet above the Ranier Ferry Dock. Prior to June 6, 1916, a vertical staff gage in connection with a Haskel water-stage recorder on protecting crib above the Canadian Northern Railway bridge. For further information regarding site and datum of gages from which earlier records were obtained, see Water Supply Papers 325, 355, 385, and 405.

Elevations of zero of gages used during present year referred to what is known as the Minnesota and Ontario datum were as follows:

	Feet.
Gage used prior to June 5	488.00
Gage used June 5 to August 5	494.61
Gage used August 6 to September 30	488.00

Records have all been reduced to a gage whose zero is at 489.00 feet, to correspond to previously published records.

EXTREMES OF STAGE.—Maximum stage recorded during year, 10.99 feet June 10; minimum stage recorded, 5.60 feet April 11.

1910–1916: Maximum stage recorded, 10.99 feet June 10, 1916; minimum stage recorded, 0.85 foot March 22, 1911.

REGULATION.—The stage of Rainy Lake is controlled at the dam and power plant of the Minnesota & Ontario Power Co., at International Falls, 2 miles below the outlet of the lake, water being stored during periods of high run-off and drawn off during periods of low run-off.

COOPERATION.—Gage-height records furnished by Canadian Department of Public Works.

Daily gage height, in feet, of Rainy Lake at Ranier, Minn., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	7.00	7.15	8.05	8.10	7.87	7.10	6.05	8.20	10.75	10.09	9.07	8.40
2	6.97	7.26	8.10	8.10	7.85	7.05	6.00	8.21	10.80	9.95	9.07	8.44
3	7.15	7.30	8.05	8.14	7.85	7.00	5.96	8.30	10.77	9.90	9.07	8.40
4	7.00	7.31	8.05	8.10	7.84	6.97	5.90	8.31	10.85	9.83	8.98	8.53
5	7.00	7.35	8.15	8.12	7.80	6.95	5.83	8.30	10.85	9.76	9.04	8.55
6	6.95	7.35	8.12	8.15	7.82	6.90	5.77	8.31	10.96	9.61	8.94	8.55
7	6.95	.....	.....	8.18	7.80	6.90	5.73	8.75	10.91	9.76	8.95	8.51
8	6.97	7.32	8.10	8.10	7.75	6.85	5.70	8.77	10.91	9.59	8.98	8.50
9	6.97	7.65	8.10	8.04	7.70	6.80	5.90	8.80	10.91	9.58	8.95	8.50
10	7.00	7.58	8.10	8.05	7.70	6.75	5.75	8.85	10.99	9.57	8.75	8.48
11	6.90	7.54	8.10	8.05	7.65	6.71	5.60	8.87	10.96	9.56	8.86	8.44
12	6.93	7.45	8.15	8.02	7.65	6.75	5.65	9.05	10.91	9.49	8.85	8.44
13	6.97	7.62	8.10	8.00	7.60	6.71	5.70	9.15	10.96	9.45	8.81	8.41
14	6.97	7.73	8.10	8.00	7.58	6.67	5.75	9.10	10.91	9.31	8.76	8.36
15	6.98	7.73	8.10	7.90	7.55	6.65	5.80	9.45	10.91	9.26	8.76	8.35
16	6.98	7.80	8.10	8.01	7.53	6.63	5.90	9.60	10.89	9.28	8.76	8.35
17	7.10	7.80	8.10	7.95	7.50	6.61	6.20	9.75	10.83	9.31	8.78	8.35
18	7.03	7.82	8.10	7.93	7.47	6.53	6.50	9.85	10.83	9.21	8.74	8.35
19	6.97	7.81	.....	7.92	7.43	6.50	6.70	9.95	10.75	9.15	8.70	8.33
20	7.08	7.80	8.10	7.95	7.40	6.48	6.90	10.20	10.71	9.21	8.66	8.40
21	6.98	7.85	8.10	7.93	7.37	6.42	7.04	10.30	10.66	9.15	8.68	8.45
22	7.08	7.95	8.10	7.95	7.34	6.35	7.10	10.45	10.57	9.15	8.68	8.50
23	7.18	7.95	8.07	7.97	7.32	6.30	7.35	10.45	10.52	9.11	8.60	8.55
24	7.25	8.00	8.07	7.97	7.30	6.27	7.46	10.75	10.45	9.17	8.62	8.57
25	6.90	8.00	8.12	7.97	7.28	6.25	7.64	10.85	10.41	9.18	8.58	8.56
26	7.12	8.00	8.15	7.95	7.24	6.30	7.78	10.90	10.40	9.21	8.58	8.57
27	7.15	8.00	8.13	.....	7.20	6.26	7.90	11.00	10.39	9.06	8.58	8.56
28	7.18	.....	8.18	7.93	7.15	6.22	8.05	10.37	10.29	9.05	8.49	8.55
29	7.18	8.00	8.15	7.92	7.10	6.18	8.08	10.43	10.25	8.95	8.48	8.57
30	7.18	8.05	8.13	.....	.....	6.15	8.27	10.15	10.11	9.01	8.50	8.56
31	7.17	.....	8.10	7.95	.....	6.10	.....	10.70	.....	9.10	8.45	.....

NOTE.—Gage heights referred to the same gage datum as those previously published in water-supply papers containing records for this drainage basin.

RAINY RIVER AT INTERNATIONAL FALLS, MINN.

LOCATION.—In sec. 34, T. 71 N., R. 24 W., at dam and power house of the Minnesota & Ontario Power Co.

DRAINAGE AREA.—14,600 square miles.

RECORDS AVAILABLE.—March 1, 1907, to September 30, 1916.

DISCHARGE.—Determined by Canadian Department of Public Works from power-house records.

EXTREMES OF DISCHARGE.—Maximum mean daily discharge recorded during year, 37,300 second-feet June 7; minimum mean daily discharge, 4,420 second-feet December 26.

1907–1916: Maximum mean daily discharge recorded 37,300 second-feet, June 7, 1916; minimum discharge recorded 431 second-feet, April 21, 1909.

WINTER FLOW.—Determined from power-house records.

REGULATION.—Except during periods of high discharge, the flow is completely regulated at the dam and power plant of the Minnesota & Ontario Power Co. The plant is run on a 24-hour basis, so that, except on Sunday, the flow is fairly uniform; it is in fact much more uniform than the natural flow, use being made of the storage capacity of Rainy Lake, which has an area of approximately 344 square miles.

COOPERATION.—Estimates of flow through the power house and results of discharge measurements furnished by the Canadian Department of Public Works.

Discharge measurements of Rainy River at International Falls, Minn., during the year ending Sept. 30, 1916.

[Made by R. F. Smallian.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Oct. 13	3.51	7,820	May 28	14.16	32,500
Nov. 4	3.61	8,270	30	14.46	35,100
26	3.59	8,220	June 10	15.21	37,700
Jan. 21	5.66	8,780	July 31	6.96	16,200
Mar. 25	5.16	9,940	Sept. 8	5.41	11,300
Apr. 24	10.61	19,800	30	5.71	12,900
May 6	10.81	19,800			

NOTE.—Measurements made by Department of Public Works, Canada.

Daily discharge, in second-feet, of Rainy River at International Falls, Minn., for the year ending Sept. 30 1916.

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June	July	Aug.	Sept.
1	8,530	6,280	8,310	9,390	9,210	9,910	9,940	14,200	33,300	32,800	12,000	11,700
2	8,400	7,310	8,470	8,030	9,240	9,880	8,540	16,700	34,700	33,100	12,100	10,900
3	5,800	7,620	9,110	7,700	9,000	10,400	9,800	17,300	35,500	33,700	12,100	10,200
4	6,760	8,040	9,110	9,140	9,170	10,700	10,700	17,500	36,300	32,200	12,700	8,000
5	8,130	7,350	6,130	9,370	9,030	8,740	10,700	18,800	36,800	33,500	12,700	10,000
6	8,130	7,340	6,940	9,320	7,650	7,870	10,700	19,800	37,300	31,800	12,400	11,700
7	8,130	5,370	9,230	9,250	7,570	10,100	10,700	20,000	37,300	30,700	11,600	11,400
8	8,100	6,010	9,190	8,780	9,160	9,860	10,700	19,300	36,800	30,500	12,000	11,400
9	8,100	7,440	9,390	7,780	9,240	9,840	7,060	21,200	36,800	29,500	12,000	11,400
10	5,560	7,430	10,000	8,140	9,150	9,840	7,980	21,500	36,900	28,600	11,900	11,100
11	6,540	7,370	9,810	10,100	9,130	9,150	10,500	21,500	37,300	27,600	12,200	9,720
12	8,040	7,370	7,440	10,100	9,140	8,860	10,400	22,400	36,500	27,000	13,600	10,600
13	7,490	7,380	8,100	9,440	7,850	8,110	10,600	23,700	36,700	26,900	13,100	10,700
14	7,150	5,080	9,940	9,250	8,140	9,900	10,500	23,800	36,700	26,300	13,300	11,000
15	6,800	6,110	9,970	9,280	9,920	9,840	9,900	22,600	36,700	25,900	14,000	11,100
16	6,740	6,540	9,930	7,610	9,930	9,840	8,220	22,900	36,900	24,600	14,000	11,100
17	5,680	6,770	9,410	8,230	9,950	10,200	6,360	23,000	36,700	24,100	14,000	10,200
18	5,510	7,420	9,780	10,100	10,500	10,300	6,620	23,000	36,400	22,700	14,000	10,400
19	6,660	7,400	7,700	9,800	10,300	8,870	6,220	23,100	36,300	21,200	13,900	10,600
20	6,460	6,330	8,110	9,060	8,240	8,500	6,420	24,200	36,100	20,500	12,700	6,520
21	7,090	5,280	10,000	8,600	8,310	9,900	6,640	24,900	36,100	19,300	13,500	6,300
22	7,070	6,190	9,470	8,600	10,000	9,930	8,190	26,100	36,200	18,100	14,000	10,300
23	6,440	7,430	9,860	7,510	9,940	9,920	8,320	27,200	35,800	17,600	12,700	12,300
24	5,220	7,440	10,100	7,490	9,950	9,890	8,300	27,200	35,400	17,400	11,400	11,600
25	6,300	7,510	6,420	9,260	9,970	9,920	9,860	28,200	35,500	16,100	11,300	11,200
26	7,320	7,400	4,420	9,250	9,940	9,110	10,200	29,000	35,100	16,500	12,200	11,600
27	7,280	7,480	7,570	9,130	8,970	8,160	10,800	29,600	34,900	16,900	9,990	11,300
28	7,310	5,790	9,350	9,240	8,350	10,100	11,700	31,000	34,900	16,200	11,000	11,400
29	7,270	6,670	9,350	9,250	9,920	10,700	13,200	31,900	34,800	15,400	12,100	11,700
30	7,280	8,300	9,720	7,880	.....	10,100	12,200	32,100	34,800	16,000	12,100	12,500
31	5,170	.....	10,000	7,560	.....	9,940	.....	32,900	.....	12,900	12,200	.....

Monthly discharge in second-feet, of Rainy River at International Falls, Minn., for the year ending Sept. 30, 1916.

Month.	Maximum.	Minimum.	Mean.	Month.	Maximum.	Minimum.	Mean.
October	8,530	5,170	6,980	May	32,900	14,200	23,800
November	8,300	5,080	6,920	June	37,300	33,300	36,000
December	10,100	4,420	8,780	July	33,700	12,900	24,100
January	10,100	7,490	8,830	August	14,000	9,990	12,600
February	10,500	7,570	9,200	September	12,500	6,300	10,700
March	10,700	7,870	9,620				
April	13,200	6,220	9,400	The year	37,300	4,420	13,900

KAWISHIWI RIVER NEAR WINTON, MINN.

LOCATION.—In sec. 20, T. 62 N., R. 11 W., in a pond above the lower dam of the St. Croix Lumber Co., at Kawishiwi Falls, 500 feet above Fall Lake, 3,000 feet below Garden Lake, near the western line of Lake County, 2½ miles east of Winton, St. Louis County.

DRAINAGE AREA.—1,200 square miles.

RECORDS AVAILABLE.—June 21, 1905, to June 30, 1907, and October 14, 1912, to September 30, 1916.

GAGE.—Stevens water-stage recorder installed the last part of September, 1912, by the International Joint Commission, in cooperation with the United States Geological Survey, at a point just above right end of dam; well was attached to timbers which were bolted to the vertical rock wall of right bank of river. Staff gage used as a control of the recording gage was also attached to one of these timbers. The gage shelter was supported by timbers bolted to the horizontal part of the rock wall above all possible high water. On May 27, 1913, the Stevens was replaced by a Friez water-stage recorder. During the high water of June, 1914, well, float, and weight were carried away by logs. At this time a concrete well was installed by the International Joint Commission just below the dam and outside the river channel, and connected with the pool above the dam by a pipe through the dam. The gage was repaired and again put in operation about July 1, 1914. The original gage datum was maintained. The pipe connecting the gage well with the river was burst by freezing in the fall of 1915, and in the spring of 1916 the high water came on so suddenly that it was impossible to make the necessary repairs until the last part of June. Gage inspected by F. W. Byshe.

DISCHARGE MEASUREMENTS.—Made from cable about 1,000 feet above gage.

CHANNEL AND CONTROL.—At the gage a small deep pool is formed by a timber dam without openings, which constitutes the control and is permanent unless the dam is destroyed or alterations are made in the crest. About 200 feet above the dam is an abrupt fall. Banks are not subject to overflow in vicinity of gage. Bed of stream at measuring section is rock and boulders; rough; current swift except at low stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 7.2 feet April 30 and May 7 (discharge, 5,370 second-feet); minimum discharge recorded, 80 second-feet on October 1, 2, and 3.

1905–1907, and 1912–1916: Maximum stage recorded, 7.2 feet April 30 and May 7, 1916 (discharge, 5,370 second-feet); no flow August 24, 25, 30, and 31 and September 1, 1915; and August 6, 8, 1906, and April 23, 24, and 26, 1907.

ICE.—Stage discharge relation not seriously affected by ice; open-channel rating curve assumed applicable. The operation of the water-stage recorder is affected by ice, and the flow from December to March, which is very constant during this part of the year, is determined from one reading of the staff gage weekly.

REGULATION.—The St. Croix Lumber Co. has a dam at the outlet of Garden Lake for controlling the level of water in that lake and for storing water to be used in driving logs over the stretch of rapids between Garden and Fall lakes. This dam is capable of holding the water in Garden Lake about 7 or 8 feet above its natural level at low water before water will flow over the gates. When the water in Garden Lake is held at a high stage, the elevation of water is considerably higher in Farm Lake, and it is understood that the elevation of the surface of White Iron Lake is somewhat affected by the stage of Garden Lake. During the log-driving season, April to November, the water in Garden Lake is held to the elevation of the top of the gates practically all the time. In November some of the gates are opened so that the lake is drawn down to low-water stage and remains so until spring. The St. Croix Lumber Co. has a dam at the outlet of Birch Lake which

controls its elevation and is capable of holding the water about 5 feet above low water. This dam is left open during the winter and until the high water of the spring breakup has passed. It is then closed, and the lake held as high as possible during the summer. There are a number of low dams in Stony River used for sluicing logs off rapids, but these have no storage of importance back of them. Large volumes of water are allowed to pass through the sluices of the dam at the outlet of Garden Lake, for a few hours at a time at regular intervals, when logs are to be driven from Garden Lake to Fall Lake. At other times gates are closed so that there is only a slight flow caused by leakage thorugh the dam, or some of the gates may be partly opened so that water may pass, through and not flow over the crest of the dam.

ACCURACY.—Stage-discharge relation permanent, not affected by ice during winter. Rating curve well defined below 3,290 second-feet; above 3,290 second-feet rating curve was based on a weir formula in which the constant was determined from the rating curve below 3,290 second-feet. Operation of water-stage recorder satisfactory October 1 to November 13, and June 26 to September 30; discharge ascertained by use of discharge integrator; results good. Discharge, November 14 to June 25, ascertained from reading of staff gage to quarter tenths once a week, and observer's notes on artificial regulation. Flow very constant, November 14 to February 29; no artificial regulation; results therefore good. During March and April the flow was irregular, and there was some artificial regulation; results are therefore only roughly approximate for these months. During May and June the stage was continuously high, and there was very little regulation; results fair.

No discharge measurements made at this station during the year.

Daily discharge, in second-feet, of Kawishiwi River near Winton, Minn., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	80	1,250								2,460	204	870
2	80	1,220								2,440	120	1,060
3	80	1,140								2,200	820	1,000
4	300	1,060								1,720	325	1,010
5	94	965								1,710	229	1,460
6	706	880								1,960	460	1,280
7	181	930								1,240	864	1,240
8	214	1,060								1,960	681	1,400
9	372	1,290								1,000	750	1,530
10	446	1,210								1,240	203	1,290
11	878	1,190								1,080	182	1,360
12	1,380	1,200								1,140	190	1,790
13	473	1,180							2,140	918	544	1,260
14	1,060									1,410	624	1,520
15	1,190									290	270	1,690
16	1,300		745	515	395	330	2,130	3,920		378	654	1,200
17	1,420									940	483	1,060
18	1,750									648	586	1,220
19	1,800									412	586	1,040
20	1,960									368	628	1,060
21	1,870									699	880	1,240
22	1,720	1,450								142	790	1,520
23	1,610									113	670	809
24	1,700									260	746	805
25	1,200									260	785	811
26	1,370								2,400	830	590	1,340
27	1,350								2,390	135	408	800
28	1,260								2,540	149	335	808
29	1,250								2,280	155	802	810
30	1,230								2,480	165	952	865
31	900								.....	247	590	.....

Monthly discharge, in second-feet, of Kawishiwi River near Winton, Minn., for the year ending Sept. 30, 1916.

Month.	Maximum.	Minimum.	Mean.	Month.	Maximum.	Minimum.	Mean.
October	1,960	80	1,010	May	5,370	.....	3,920
November	1,450	880	1,310	June	2,540	2,140	2,190
December	.....	.....	745	July	2,460	113	925
January	.....	.....	515	August	952	120	547
February	.....	.....	395	September	1,790	800	1,170
March	.....	.....	330				
April	.....	.....	2,130	The year.	5,370	80	1,260

VERMILION RIVER BELOW VERMILION LAKE, NEAR TOWER, MINN.

LOCATION.—In sec. 2, T. 63 N., R. 17 W., in St. Louis County, about 100 yards below dam at outlet of Vermilion Lake, 4 miles above Twomile Creek, which enters from the west, and 18 miles across Vermilion Lake from Tower.

DRAINAGE AREA.—507 square miles.

RECORDS AVAILABLE.—May 17, 1911, to September 30, 1916.

GAGE.—Vertical staff gage attached to tree at the left bank; read by Mrs. A. E. Shively.

DISCHARGE MEASUREMENTS.—From 1911–1913 made from a cable just below gage; from 1914 to 1916 made from a boat about a mile below gage.

CHANNEL AND CONTROL.—Bed composed of solid rock and large boulders. Heavy falls a short distance below the gage form permanent control; banks are not overflowed to any considerable extent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.8 feet April 29 to May 7 (discharge, 2,050 second-feet); minimum stage recorded, 0.85 foot March 30 to April 30 (discharge, 158 second-feet).

1911–1916: Maximum stage recorded, 3.8 feet April 29 to May 7, 1916 (discharge, 2,050 second-feet); minimum stage recorded, 0.22 foot October 1 and 2, 1914 (discharge, 60 second-feet).

ICE.—Stage-discharge relation not affected by ice, owing to the heavy fall at control and to the proximity to Vermilion Lake.

REGULATION.—At the outlet of Vermilion Lake, a few hundred feet above gage, is a loose rock dam, which is used to raise the water surface of the lake for aid in navigation. This dam has no gates but was repaired on July 19, 1912, thus for a period reducing the flow below normal. From April 28 to May 10, 1914, parts of the dam were removed, and for some time subsequent the flow exceeded normal.

ACCURACY.—Stage-discharge relation permanent, except for a slight effect of ice January 11 to 16. Rating curve well defined; the lower part of the rating curve is probably not quite so accurate as the higher because the section at which the low-water measurements were made is rough. Gage read to quarter tenths daily; fluctuations in stage so gradual that good results are obtained from one reading a day. Daily discharge ascertained by applying the daily gage heights to rating table. Records range from good to excellent, the accuracy probably increasing with the stage.

Discharge measurements of Vermilion River below Vermilion Lake, Minn., during the year ending Sept. 30, 1916.

[Made by S. B. Soulé.]

Date.	Gage height.	Discharge
	Feet.	*Sec.-ft.*
May 10	3.58	1,780
May 11	3.40	1,590

Daily discharge, in second-feet, of Vermilion River below Vermilion Lake, Minn., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	139	208	244	208	208	183	158	2,050	1,360	845	618	257
2	139	198	244	208	208	183	158	2,050	1,360	845	618	244
3	139	198	244	208	208	183	158	2,050	1,360	845	618	244
4	152	187	244	208	208	183	163	2,050	1,360	845	594	257
5	171	187	231	208	208	183	163	2,050	1,360	845	569	257
6	187	183	231	208	208	177	167	2,050	1,360	783	569	304
7	187	183	231	208	208	177	167	2,050	1,260	783	569	358
8	183	183	231	208	208	177	167	1,580	1,160	783	569	397
9	183	183	231	208	208	177	177	1,930	1,070	783	569	437
10	187	187	231	208	208	177	187	1,810	990	783	546	458
11	187	187	231	208	208	171	198	1,580	990	783	523	458
12	187	187	231	208	208	171	208	1,810	990	783	523	458
13	187	198	231	208	208	171	220	1,690	915	783	523	479
14	187	208	231	208	208	171	231	1,690	915	783	523	479
15	187	208	231	208	208	171	257	1,690	915	754	501	437
16	187	208	231	208	208	171	358	1,580	845	754	479	437
17	187	208	231	208	208	171	479	1,580	845	754	479	437
18	198	208	231	208	208	171	594	1,580	845	725	458	437
19	198	208	231	208	208	167	698	1,580	845	725	458	437
20	208	208	220	208	208	167	845	1,580	845	725	437	437
21	208	208	220	208	208	167	990	1,580	845	725	437	437
22	208	231	220	208	208	167	1,160	1,580	845	725	417	437
23	208	231	220	208	187	167	1,260	1,580	845	725	417	437
24	208	231	220	208	187	163	1,360	1,580	845	725	397	397
25	208	231	208	208	187	163	1,470	1,580	845	698	397	437
26	208	231	208	208	187	163	1,580	1,580	845	698	397	397
27	208	231	208	208	183	163	1,690	1,470	845	670	358	397
28	208	244	208	208	183	163	1,930	1,470	845	670	321	397
29	208	244	208	208	183	163	2,050	1,470	845	670	321	397
30	208	244	208	208	.....	158	2,050	1,470	845	644	304	397
31	198	.....	208	208	.....	158	.....	1,470	.....	644	287	.....

NOTE.—Discharge, Jan. 11–16, interpolated because of backwater from ice at gage.

Monthly discharge of Vermilion River below Vermilion Lake, Minn., for the year ending Sept. 30, 1916.

[Drainage area, 507 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	208	139	189	0.373	0.43
November	244	183	208	.410	.46
December	244	208	226	.446	.51
January	208	208	208	.410	.47
February	208	183	203	.400	.43
March	183	158	171	.337	.39
April	2,050	158	710	1.40	1.56
May	2,050	1,470	1,700	3.36	3.87
June	1,360	845	1,000	1.97	2.20
July	845	644	752	1.48	1.71
August	618	287	477	.941	1.08
September	479	244	395	.779	.87
The year	2,050	139	520	1.03	13.98

LITTLE FORK RIVER AT LITTLE FORK, MINN.

LOCATION.—In sec. 9, T. 68 N., R. 25 W., at the lower of the two highway bridges at Little Fork, Koochiching County, about 1½ miles above mouth of Beaver Brook and 2½ miles above Big Fork & International Falls Railway bridge.

DRAINAGE AREA.—1,720 square miles.

RECORDS AVAILABLE.—June 23, 1909, to September 30, 1916.

GAGE.—Vertical staff gage attached to piling supporting the bridge on downstream side, left end; read by G. H. French. During April and May, 1916, temporary staff gages were installed on right bank at the same section; readings from the temporary gages have been reduced to same datum as permanent gage.

DISCHARGE MEASUREMENTS.—Made from the bridge at medium and high stages; at low stages made by wading a short distance above the bridge.

CHANNEL AND CONTROL.—Bed composed of sand, gravel and boulders. Banks high and not subject to overflow. Control permanent up to the summer of 1915, but during the high water in June of that year there was a decided shift.

EXTREMES OF DISCHARGE.—Maximum stage during year, 37.0 feet at 2 p. m. April 18, as determined by leveling from peg driven by observer at crest of flood (discharge determined from study of mean velocities and area curves, and discharge data, including discharge measurement the following day, 19,300 second-feet); minimum discharge, 74 second-feet, March 16.

1909–1916: Maximum stage recorded, 37.0 feet April 18, 1916 (discharge, 19,300 second feet); minimum stage recorded, 4.40 feet September 5, 1910 (discharge about 40 second-feet).

ICE.—Stage-discharge relation seriously affected by ice.

ACCURACY.—Stage-discharge relation changed during the high water in June, 1915. There was also a period of temporary backwater from an unknown cause during July, 1916, as indicated by discharge measurements made July 19. The backwater from ice effect was continued later into the spring of 1916 by a log jam which was formed during the spring break-up and continued nearly through April. Rating curve used October 1, 1914, to June 18, 1915, well defined throughout. Rating curve used June 19, 1915, to September 30, 1916, fairly well defined below 5,670 second-feet and poorly defined above that point. Gage read to quarter tenths twice daily. Daily discharge ascertained by applying mean daily gage heights to rating table except for period when stage-discharge relation was affected by ice for which it was ascertained by applying to rating table mean daily gage heights corrected for ice effect by means of discharge measurements, observer's notes, and weather records. Records prior to June, 1915, good; after that date fair.

Discharge measurements of Little Fork River at Little Fork, Minn., 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. 12	S. B. Soulé	9.50	1,350	May 5	S. B. Soulé	16.30	5,180
Dec. 21[a]	E. L. Williams	7.57	182	July 19	do	7.28	386
Jan. 25[a]	S. B. Soulé	6.88	102	19	do	7.24	365
Mar. 14[a]	do	6.90	78	Sept. 8	do	10.13	1,780
Apr. 19[b]	do	31.33	17,400	8	do	10.16	1,810

[a] Ice at control. [b] Log jam below gage.

Daily discharge, in second-feet, of Little Fork River at Little Fork, Minn., for the years ending Sept. 30, 1915 and 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1914–15.												
1	395	513	482	59	86	182	121	1,030	1,540	7,420	1,000	187
2	368	513	482	58	86	193	160	1,070	1,640	5,390	932	148
3	341	513	482	58	86	193	204	1,190	1,680	3,980	824	122
4	341	545	482	60	86	193	302	1,280	1,640	3,410	722	98
5	315	545	482	58	81	193	395	1,460	1,720	1,990	620	122
6	328	578	452	60	81	204	482	1,540	1,820	1,400	518	167
7	395	578	452	65	81	204	578	1,640	1,900	1,160	455	167
8	452	578	452	69	81	182	719	1,770	2,080	1,040	395	167
9	452	545	423	73	81	182	989	1,900	2,310	1,160	335	167
10	482	545	395	81	81	171	1,320	2,130	2,860	1,200	307	148
11	513	482	395	77	81	150	1,540	2,260	3,600	1,280	281	148
12	545	452	341	78	81	130	1,680	2,260	5,580	1,360	281	187
13	578	452	240	78	81	112	1,540	2,130	6,460	1,360	281	177
14	578	452	150	81	89	112	1,280	2,000	7,180	1,320	281	167
15	647	452	121	82	98	103	989	2,040	7,500	1,240	281	167
16	612	423	112	79	103	98	831	2,860	8,000	1,200	281	158
17	578	423	103	81	109	97	719	4,370	8,000	1,160	307	158
18	545	423	97	82	112	90	683	5,140	8,000	1,080	395	187
19	513	423	94	85	121	86	647	5,300	8,060	1,040	395	177
20	513	452	89	83	130	86	683	5,420	6,820	1,000	395	167
21	482	452	85	85	140	86	719	4,920	5,460	1,080	335	167
22	482	452	82	86	150	88	756	3,380	4,520	1,160	335	167
23	482	423	79	81	160	86	831	2,410	3,860	1,200	365	167
24	578	423	77	84	160	86	949	2,040	3,860	1,200	395	167
25	612	452	74	84	171	92	989	1,900	4,460	1,160	335	198
26	647	452	73	86	171	94	1,030	1,820	5,250	1,080	281	210
27	647	452	71	86	171	112	1,070	1,680	6,960	1,000	281	210
28	612	452	69	86	171	98	1,110	1,540	9,580	896	233	187
29	612	452	67	86	.....	104	1,110	1,460	9,840	860	281	210
30	578	452	66	86	.....	104	1,070	1,460	9,020	1,000	281	233
31	545	.....	66	86	.....	112	.....	1,500	.....	1,040	222	.....
1915–16.												
1	233	518	860	130	92	106	222	7,980	3,860	3,360	335	620
2	233	485	807	130	92	98	187	7,260	3,980	3,410	335	552
3	233	455	773	130	98	98	210	6,590	3,920	3,240	307	518
4	256	455	756	130	98	98	350	5,810	3,780	2,920	307	552
5	256	455	739	130	106	92	502	5,250	3,630	2,390	307	586
6	307	455	722	139	106	92	586	4,640	3,520	1,990	335	722
7	756	425	637	139	106	92	620	4,520	3,410	1,740	395	1,940
8	1,080	518	518	139	106	92	671	4,220	3,300	1,560	722	1,740
9	1,160	620	395	122	106	92	739	4,040	3,190	1,440	968	1,690
10	1,160	756	335	113	106	92	790	3,800	3,140	1,240	1,200	1,480
11	1,160	1,160	281	113	106	80	878	3,630	3,080	1,120	1,200	1,320
12	1,120	1,400	256	106	106	80	1,060	3,460	3,020	1,000	1,120	1,160
13	1,120	1,520	233	106	106	80	2,290	3,190	2,920	860	1,080	1,120
14	1,040	1,560	222	106	106	78	3,520	3,080	2,920	688	1,080	1,240
15	968	1,560	210	106	106	80	7,580	3,020	2,970	620	1,000	1,520
16	932	1,560	198	98	113	74	11,200	3,680	3,080	518	722	1,840
17	860	1,560	198	98	113	80	13,000	5,530	3,080	485	518	1,940
18	790	1,560	198	98	113	80	19,300	5,880	2,970	455	455	1,840
19	756	1,560	187	106	113	80	17,400	5,880	2,860	395	425	1,640
20	790	1,520	187	106	113	86	16,000	5,460	2,920	335	455	1,480
21	860	1,440	183	113	122	92	15,000	4,970	2,920	365	552	1,400
22	860	1,360	167	113	122	92	14,100	4,460	2,920	365	654	1,320
23	824	1,280	167	113	122	92	13,700	4,580	2,970	365	860	1,240
24	756	1,360	158	113	122	86	13,500	4,460	3,080	335	1,480	1,240
25	722	1,440	158	104	122	86	13,500	4,340	3,360	335	1,560	1,280
26	688	1,440	158	106	122	86	12,500	4,160	3,630	365	1,480	1,080
27	654	1,440	148	106	122	92	11,400	4,100	3,580	335	1,160	968
28	586	1,240	148	92	122	98	10,400	4,280	3,520	307	1,080	932
29	586	1,080	139	92	113	130	9,500	4,160	3,360	281	932	824
30	518	968	139	98	.....	139	8,460	3,860	3,300	335	790	824
31	518	.....	139	92	.....	187	.....	3,860	.....	335	722	.....

NOTE.—Discharge Dec. 6, 1914, to Apr. 12, 1915, and Nov. 15, 1915, to Apr. 29, 1916, estimated because of ice, and near the end of the later period, because of a log jam, from discharge measurements, observer's notes, and weather records. Discharge July 1–25, 1916, estimated because of backwater from some unknown cause as indicated by discharge measurement of July 19. Discharge, June 4, 1916, interpolated.

Monthly discharge of Little Fork River at Little Fork, Minn., for the years ending Sept. 30, 1915 and 1916.

[Drainage area, 1,720 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
1914–15.					
October	647	315	509	0.296	0.34
November	578	423	478	.278	.31
December	482	66	230	.134	.15
January	86	58	77	.045	.05
February	171	81	108	.063	.07
March	204	86	130	.076	.09
April	1,680	121	850	.494	.55
May	5,420	1,030	2,350	1.37	1.58
June	9,840	1,540	5,040	2.93	3.27
July	7,420	860	1,670	.973	1.12
August	1,000	222	407	.237	.27
September	233	98	170	.099	.11
The year	9,840	58	1,000	.581	7.91
1915–16.					
October	1,160	233	735	0.427	0.49
November	1,560	425	1,100	.640	.71
December	860	139	336	.195	.22
January	139	92	112	.065	.08
February	122	92	110	.064	.07
March	187	74	95	.055	.06
April	19,300	187	7,310	4.25	4.74
May	7,980	3,020	4,650	2.70	3.11
June	3,980	2,860	3,270	1.90	2.12
July	3,410	281	1,080	.628	.72
August	1,560	307	791	.460	.53
September	1,940	518	1,220	.709	.79
The year	19,300	74	1,730	1.01	13.64

UPPER MISSISSIPPI RIVER BASIN.

MISSISSIPPI RIVER AT ELK RIVER, MINN.

LOCATION.—In sec. 3, T. 121 N., R. 23 W., at highway bridge in town of Elk River, about 2,500 feet below the mouth of Elk River, in Sherburne County.

DRAINAGE AREA.—14,500 square miles.

RECORDS AVAILABLE.—July 22, 1915, to September 30, 1916.

GAGE.—Chain gage bolted to the handrail of bridge, downstream side, near right bank; read by W. H. Ebner.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge.

CHANNEL AND CONTROL.—Bed composed of sand and gravel; control not well defined. Banks high and not subject to overflow.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year 14.8 feet at 8.25 p. m. April 8; this stage followed a moving log and ice jam which produced several feet of backwater; corresponding discharge unknown; maximum stage under conditions of unobstructed channel, 10.8 feet on April 7 (discharge, 27,000 second-feet); minimum stage recorded, 4.2 feet October 2 and 3, and December 3 and 4 (discharge, 5,200 second-feet); absolute minimum discharge undoubtedly occurred during winter and was probably not far from 3,500 second-feet.

1915–16: Maximum stage recorded under unobstructed channel conditions, 10.8 feet April 7, 1916 (discharge, 27,000 second-feet); minimum stage recorded, 4.0 feet August 21, and 27–31, and September 9, 11–13, 23, and 27, 1915 (discharge, 4,620 second-feet); absolute minimum undoubtedly occurred during winter of 1915–16, and was probably not far from 3,500 second-feet.

ICE.—Stage-discharge relation seriously affected by ice; discharge estimated from discharge at Coon Rapids Power Plant, computed by the Minneapolis General Electric Co., allowance being made for the discharge of the Crow and Rum rivers, entering between Coon Rapids and the station.

REGULATION.—Nearest dam above station on the Mississippi is at St. Cloud, 40 miles upstream. An observed systematic diurnal fluctuation at the gage of about 0.1 foot is doubtless due to the regulation at St. Cloud; but most of the effect of regulation is equalized before reaching the station. The flow of the river is controlled by Government dams on the upper river to increase the low-water open-season flow in the interests of navigation.

ACCURACY.—Stage-discharge relation permanent except as affected by ice during winter. Rating curve well defined between 4,620 and 12,400 second-feet and fairly well defined between 12,700 and 26,300 second-feet. Gage read to quarter tenths twice daily. Daily discharge ascertained by applying mean daily gage heights to rating table. Records good at medium and low stages and fair at high stages.

COOPERATION.—Records of discharge at Coon Rapids Power Plant, from which winter discharge is determined, furnished by the Minneapolis General Electric Co.

Discharge measurements of Mississippi River at Elk River, Minn., 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.*
Oct. 20	S. B. Soulé	5.09	7,800	May 19	Soulé and Williams	8.30	19,200
Apr. 8	Williams and Christianson.	10.60	25,300	Aug. 14	S. B. Soulé	4.89	7,250
18	Soulé and Williams	9.59	21,900	Sept. 21	Soulé and Kilgore	6.11	11,200

Daily discharge, in second-feet, of Mississippi River at Elk River, Minn., for the period July 22, 1915, to Sept. 30, 1916.

Day.	July.	Aug.	Sept.	Day.	July.	Aug.	Sept.	Day.	July.	Aug.	Sept.
1915.				1915.				1915.			
1		9,200	4,340	11		5,500	4,620	21		4,620	5,500
2		8,880	4,340	12		5,800	4,620	22	13,400	4,910	4,910
3		8,880	4,620	13		5,800	4,620	23	12,700	4,910	4,620
3		7,930	4,620	14		5,800	4,910	24	12,400	5,200	4,910
5		7,310	4,340	15		5,800	5,200	25	11,400	5,200	4,620
6		7,000	4,620	16		5,200	5,200	26	10,800	4,910	4,910
7		6,700	4,910	16		5,200	4,910	27	10,500	4,620	4,620
8		6,700	4,910	18		5,200	4,910	28	10,200	4,620	4,910
9		6,100	4,620	19		4,910	5,500	29	10,200	4,620	5,500
10		5,800	4,910	20		4,910	4,910	30	9,840	4,620	5,200
								31	9,520	4,620	

Daily discharge, in second-feet, of Mississippi River at Elk River, Minn., for the period July 22, 1915, to Sept. 30, 1916—Continued.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1915–16.												
1	5,500	6,700	6,400					21,500	19,100	18,100	7,310	8,880
2	5,200	6,400	6,100				26,000	21,500	18,800	20,100	6,700	8,880
3	5,200	6,100	5,200					21,500	18,100	21,100	7,000	7,930
4	5,500	6,400	5,200				26,000	21,100	17,100	21,500	7,000	7,930
5	7,620	5,800	6,400				26,300	20,800	16,400	21,500	7,000	7,930
6	8,560	6,400	5,200				26,000	20,500	16,000	20,500	6,700	7,930
7	8,560	5,800	6,400				27,000	20,100	15,400	19,400	6,700	8,240
8	9,200	6,700	5,800				26,300	19,400	14,700	18,100	7,310	8,240
9	9,200	7,000	6,100				24,900	19,100	14,000	17,700	7,310	8,880
10	9,200	6,700	6,400				24,200	18,400	13,400	16,700	7,620	9,200
11	8,880	8,240	8,880				23,500	17,400	13,000	15,700	7,310	8,880
12	8,880	9,840	8,880				22,500	17,100	12,700	14,700	7,310	9,520
13	8,880	10,200					21,800	16,700	12,100	13,700	7,620	10,200
14	8,560	10,200					20,800	16,400	11,800	13,000	7,620	10,200
15	8,560	10,200					20,800	16,700	11,100	12,400	7,620	10,200
16	8,240	9,840					21,100	17,400	10,800	11,800	6,700	10,800
17	7,930	9,520		4,150	3,500	3,800	22,200	18,100	11,400	11,400	7,000	11,400
18	8,240	8,880					22,800	18,100	11,100	11,100	7,620	11,400
19	8,240	8,880					22,500	18,100	10,800	10,500	7,620	11,400
20	7,620	8,240					22,500	18,100	10,800	10,200	7,620	11,400
21	8,240	8,240	4,400				22,800	18,400	10,500	9,520	7,620	11,100
22	8,240	6,700					23,200	19,100	9,840	9,520	9,840	11,100
23	7,930	6,400					23,200	20,100	9,840	8,880	10,200	10,800
24	7,310	7,000					23,200	20,100	9,520	8,240	10,800	10,800
25	7,930	7,310					23,500	21,100	9,840	7,620	10,800	10,500
26	7,620	7,620					23,200	22,200	10,200	7,930	10,800	10,500
27	7,000	7,620					22,800	21,800	11,100	7,930	10,500	9,840
28	7,310	7,930					21,800	21,100	10,800	7,620	10,200	10,200
29	6,700	7,000					21,800	21,100	12,100	7,000	10,200	10,200
30	6,700	5,800					21,800	20,500	16,000	7,310	9,520	9,520
31	7,000	.....					.....	19,800	.....	7,000	9,200	.....

NOTE.—Discharge, Dec. 13 to Apr. 3, estimated, because of ice, by comparison with records of discharge at Coon Rapids Power Plant, furnished by the Minneapolis General Electric Co., allowance being made for the discharge of Crow and Rum rivers, which enter between Coon Rapids and the station.

Monthly discharge of Mississippi River at Elk River, Minn., for the period July 22, 1915, to Sept. 30, 1916.

[Drainage area, 14,500 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
1915.					
July 22–31	13,400	9,520	11,100	0.765	0.28
August	9,200	4,620	5,850	.403	.46
September	5,500	4,340	4,840	.334	.37
1915–16.					
October	9,200	5,200	7,730	.533	.61
November	10,200	5,800	7,660	.528	.59
December	8,880	4,400	5,180	.357	.41
January	.....	.....	4,150	.286	.33
February	.....	.....	3,500	.241	.26
March	.....	.....	3,800	.262	.30
April	27,000	20,800	23,600	1.63	1.82
May	22,200	16,400	19,500	1.34	1.54
June	19,100	9,520	12,900	.890	.99
July	21,500	7,000	13,200	.910	1.05
August	10,800	6,700	8,210	.566	.65
September	11,400	7,930	9,800	.676	.75
The year	27,000	3,500	9,920	.684	9.30

MISSISSIPPI RIVER AT ST. PAUL, MINN.

LOCATION.—At the Chicago Great Western Railway bridge near the foot of Robert Street, St. Paul, 6 miles below mouth of Minnesota River, in Ramsey County.

DRAINAGE AREA.—35,700 square miles.

RECORDS AVAILABLE.—March 1, 1892, to September 30, 1916. Observations of stage begun in 1873 by United States Signal Service and continued by United States Weather Bureau. Many discharge measurements made prior to 1900 by the United States Engineer Corps.

GAGE.—Chain gage installed May 9, 1913, on the handrail, downstream side, of Chicago Great Western Railway bridge, near the foot of Robert Street; read by the United States Weather Bureau. From 1911 to May 9, 1913, gage was a vertical staff gage attached to a piling on left bank of river, about 800 feet upstream from the present gage. Prior to 1911 a vertical staff gage on the Diamond Joe Line wharf, at the foot of Jackson Street, 400 feet below the chain gage, was used. The datum of all three gages is the same, allowance being made for the slight slope in the river between them.

DISCHARGE MEASUREMENTS.—Up to 1915 made from the Chicago, St. Paul, Minneapolis & Omaha Railway bridge 2 miles above station; in November, 1915, and April, 1916, measurements were made from the Chicago Great Western Railway bridge to which the gage is attached. In June, 1916, measurement was made from the Wabasha Street highway bridge, about 1,000 feet above the station.

CHANNEL AND CONTROL.—Bed somewhat shifting. Control not well defined, banks moderately high; have not been overflowed in recent years.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 16.6 feet April 9 (discharge, 73,500 second-feet); minimum open-water stage recorded, 2.1 feet December 19, 1915 (discharge, 6,450 second-feet); absolute minimum undoubtedly occurred when river was frozen over and was somewhat lower.

1892–1916: Maximum stage recorded, 18.0 feet April 6, 1897 (discharge, 80,800 second-feet); highest known discharge, 117,000 second-feet, occurred July 22, 1867; minimum stage recorded, 0.9 foot March 22, 1896 (discharge, 1,420 second-feet).

ICE.—Stage-discharge relation seriously affected by ice; monthly mean flow ascertained from records obtained by United States Engineers Corps at Lock and Dam No. 2, below Minnneapolis, allowance being made for the flow of the Minnesota River.

REGULATION.—During extremely low water regulation of the flow through the turbine at the nearest dam in Minneapolis may cause diurnal fluctuation of stage at St. Paul. Flow is regulated by Government reservoirs on the headwaters at Lake Winnebigoshish, Leach Lake, Pokegama Lake, Sandy Lake, Pine River, and Gull Lake, to increase the low-water open-season flow in the interests of navigation, but the effect of this regulation is very gradual at St. Paul.

ACCURACY.—Stage-discharge relation fairly permanent, except as affected by ice during winter. Rating curve well defined throughout. Gage read once daily to tenths at medium and low stages. This perhaps does not represent the mean daily stage accurately on account of the artificial regulation at power plants in Minneapolis, but occasional additional readings indicate that the error is not large. Daily discharge ascertained by applying the daily gage heights to rating table. Records fair to good, accuracy probably increasing with the stage.

COOPERATION.—Gage-height record furnished by United States Weather Bureau. Data upon which mean monthly flow during winter periods have been based, furnished by United States Engineers Corps.

Discharge measurements of Mississippi River at St. Paul, Minn., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Nov. 4...	Soulé and Williams	3.92	9,960
Apr. 5–6..	Soulé, Christianson and Williams	16.56	74,300
June 9....	Soulé and Williams	10.72	32,300

Daily discharge, in second-feet, of Mississippi River at St. Paul, Minn., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	9,480	10,800	9,700				56,400	53,400	49,000	29,000	16,600	14,900
2	9,480	10,800	9,700				62,000	51,100	46,900	32,500	16,000	14,400
3	9,920	10,600	9,480				65,300	49,700	44,800	35,000	15,200	13,800
4	10,400	10,100	9,260				70,200	47,600	42,200	37,900	14,400	13,600
5	10,600	9,920	9,050				71,900	46,200	40,300	40,300	14,100	13,300
6	11,800	9,700	10,100				73,500	44,800	37,900	41,600	14,600	13,000
7	12,800	10,100	9,700				72,700	43,600	35,600	41,600	13,600	13,300
8	13,000	10,100	10,600				71,900	41,600	34,000	40,300	13,600	13,300
9	13,600	10,400	10,100			7,860	73,500	39,700	32,500	39,100	14,400	13,600
10	13,600	10,600	9,480				68,600	37,900	30,700	36,700	13,800	14,100
11	14,100	10,400	9,050				64,500	35,600	29,000	35,000	13,600	13,800
12	13,800	13,300	9,260				60,400	33,500	27,500	33,000	13,300	13,800
13	13,300	15,800	9,260				58,000	32,000	26,700	31,100	13,600	14,400
14	13,300	16,000	8,630				54,800	30,200	25,600	29,400	13,600	14,600
15	13,000	17,800	8,000		5,900		52,600	30,200	24,800	28,200	13,000	14,600
16	12,500	17,500	7,800	6,250			51,100	30,200	24,500	27,100	12,800	14,600
17	12,800	16,900	6,820			9,920	49,700	31,100	24,100	26,700	12,200	15,200
18	12,000	17,200	7,200			11,300	49,700	32,500	24,500	27,500	12,500	15,500
19	12,500	16,600	6,450			12,200	49,700	33,000	24,500	28,200	13,000	15,800
20	12,500	16,000				13,000	49,700	34,000	23,700	29,000	13,300	15,800
21	12,000	14,900				13,800	50,400	34,500	23,000	28,600	13,300	15,500
22	12,200	13,300				14,100	51,800	36,200	22,300	27,500	13,300	15,500
23	12,800	11,500				14,900	52,600	37,900	21,600	26,700	14,400	14,900
24	12,800	12,200				15,800	54,800	39,700	21,000	25,600	15,200	14,600
25	12,500	13,300	7,070			16,300	58,000	41,000	21,000	24,500	15,500	14,600
26	12,000	13,800				17,500	59,600	44,200	21,600	23,000	15,800	14,100
27	11,800	14,100				19,300	60,400	47,600	22,000	22,300	15,800	14,100
28	11,500	13,600				23,400	61,200	49,700	22,700	21,300	16,000	13,600
29	11,500	12,500				34,000	60,400	50,400	23,700	20,000	15,800	13,600
30	11,000	10,600			.....	40,300	55,600	51,100	24,800	18,700	15,800	13,600
31	10,800	.....			.....	49,700	.....	50,400	.....	17,500	15,200	.....

NOTE.—Discharge, Dec. 20 to Mar. 16, estimated, because of ice, from gage-height records collected by the United States Engineer Corps at Lock and Dam No. 2 below Minneapolis, at which point open-water conditions prevail throughout the winter. In this estimate allowance has been made for the flow of the Minnesota River, which enters between Lock and Dam No. 2, and station.

Monthly discharge of Mississippi River at St. Paul, Minn., for the year ending Sept. 30, 1916.

[Drainage area, 35,700 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	14,100	9,480	12,100	0.339	0.39
November	17,800	9,700	13,000	.364	.41
December	10,600	6,450	8,210	.230	.26
January	.....	.....	6,250	.175	.20
February	.....	.....	5,900	.165	.18
March	49,700	7,860	13,900	.389	.45
April	73,500	49,700	59,700	1.67	1.86
May	53,400	30,200	40,700	1.14	1.31
June	49,000	21,000	29,100	.815	.91
July	41,600	17,500	29,800	.835	.96
August	16,600	12,200	14,300	.400	.46
September	15,800	13,000	14.300	.400	.45
The year	73,500	5,900	20,600	.577	7.84

SANDY RIVER BELOW SANDY LAKE RESERVOIR, MINN.

LOCATION.—At Sandy Lake dam, near Libby post office, Aitkin County, 1 mile above mouth of river.

DRAINAGE AREA.—424 square miles.

RECORDS AVAILABLE.—July 7, 1893, to September 30, 1916.

GAGE.—Vertical staff.

DISCHARGE MEASUREMENTS.—Made by an employee of the United States Engineer Corps at a section a short distance below dam. The section at which measurements are made is not well adapted to measurements of low discharge, the velocities being too low.

DISCHARGE.—Determined from flow through openings of dam and from frequent discharge measurements.

EXTREMES OF DISCHARGE.—Maximum discharge recorded during year, 2,090 second-feet May 6; no flow April 17.

1893–1916: Maximum discharge recorded, 3,738 second-feet July 12, 1897; no flow at frequent intervals from 1893 to 1912, and again on April 17, 1916.

REGULATION.—Flow at station wholly controlled by Sandy Lake reservoir. At low stages area of reservoir 8 square miles, and at high stages 16.5 square miles. These areas, with a range of 9.4 feet, give a capacity of 3,127,900,000 cubic feet.

ACCURACY.—Daily discharge determined by United States Army engineers from gage reading indicating head on dam forming Sandy Lake reservoir and from varying amount of submerged openings, discharge measurements being made from time to time to check the computations. Section at which discharge measurements are made is not adapted to measuring small discharge, as velocities are too low; determination of discharge at very low stages are based entirely upon theoretical formulas. Results below 300 second-feet are only roughly approximate and may be 20 per cent to 25 per cent in error. Records at high stage are considered good.

COOPERATION.—Records of discharge as published are furnished by the United States Engineer Corps, which maintains the station for the purpose of measuring the flow from the Sandy Lake reservoir, one unit in the Government reservoir system at the headwaters of the Mississippi.

Daily discharge, in second-feet, of Sandy River below Sandy Lake Reservoir, Minn., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	75	302	307	259	199	301	79	1,684	739	634	15	512
2	300	302	300	264	200	300	102	1,797	441	832	15	512
3	298	302	304	264	201	301	126	1,897	460	822	15	506
4	300	302	312	263	200	300	149	2,005	461	811	15	501
5	301	300	315	266	200	299	173	2,085	465	724	15	488
6	300	299	312	268	200	301	196	2,091	469	704	15	488
7	a302	301	309	266	201	299	220	1,950	413	675	15	488
8	300	300	300	266	301	301	a244	2,015	496	425	15	488
9	302	300	297	265	299	301	205	1,979	156	76	495	488
10	301	a300	289	265	300	298	166	2,003	156	15	490	410
11	300	302	289	262	302	300	128	2,002	154	15	535	405
12	301	298	280	200	300	299	89	2,083	154	15	530	405
13	299	300	287	200	299	300	50	1,249	155	15	525	405
14	302	300	293	199	301	10	51	1,169	155	15	520	405
15	298	301	295	201	301	10	49	1,145	155	15	520	395
16	302	309	292	199	299	10	51	1,165	157	15	520	395
17	300	293	286	202	302	10	0	1,138	157	15	520	390
18	301	312	274	199	300	10	50	1,159	159	15	525	385
19	300	328	268	201	300	10	50	1,175	161	15	525	348
20	301	a316	268	202	302	10	51	1,173	161	15	520	311
21	301	329	267	201	299	10	49	982	159	15	525	303
22	301	306	267	201	301	301	50	984	260	15	520	295
23	300	336	271	199	302	299	25	985	259	15	520	295
24	299	330	266	202	300	302	131	986	154	15	520	295
25	300	310	264	199	301	299	899	1,022	153	15	520	303
26	299	310	263	201	301	300	1,048	1,022	83	15	509	303
27	300	317	267	201	298	300	a1,579	1,022	85	15	495	295
28	300	329	265	201	302	185	1,689	1,019	85	15	493	295
29	300	336	264	199	300	135	1,800	1,018	93	15	493	220
30	300	324	259	202	.....	110	a1,910	973	267	15	487	223
31	299	.....	261	201	.....	86	.....	756	.....	15	476	.....

a Discharge measurement.

Monthly discharge of Sandy River below Sandy Lake Reservoir, Minn., for the year ending Sept. 30, 1916.

[Drainage area, 424 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	302	75	293	0.691	0.80
November	336	293	310	.731	.82
December	315	259	284	.670	.77
January	268	199	223	.526	.61
February	302	199	276	.651	.70
March	302	10	203	.479	.55
April	1,910	0	380	.896	1.00
May	2,090	756	1,410	3.33	3.84
June	739	83	247	.582	.65
July	832	15	195	.460	.53
August	535	15	384	.906	1.04
September	512	220	385	.908	1.01
The year	2,090	0	384	.906	12.32

NOTE.—Monthly and yearly discharge computed by engineers of the United States Geological Survey.

PINE RIVER BELOW PINE RIVER RESERVOIR, MINN.

LOCATION.—In T. 137 N., R. 27 W., just below dam at outlet of Cross Lake, which is 15 miles above mouth of river, in the central part of Crow Wing County.

DRAINAGE AREA.—452 square miles.

RECORDS AVAILABLE.—January 1, 1895, to September 30, 1916. Records of monthly mean discharge and total monthly discharge from April, 1886, to November, 1893, are published in Report of Chief Engineers, United States Army, for 1894, part 3, p. 1707.

DISCHARGE MEASUREMENTS.—Made by an employee of United States Engineer Corps, stationed at the reservoir.

DISCHARGE.—Determined from daily gage heights representing head on dam, and from records of flow through openings of various sizes in the dam. Discharge measurements are made about once a week to check these determinations.

EXTREMES OF DISCHARGE.—Maximum stage during year, 589 second-feet July 15; minimum discharge recorded, 10 second-feet April 30 to May 19.

1895–1916: Maximum discharge recorded, 1,586 second-feet June 29, 1901; no flow June 8 to 15, 17, 19, and 20, 1906.

WINTER FLOW.—Determinations made as during open-water periods; see paragraph on "Discharge."

REGULATION.—Flow wholly controlled by Government reservoir at station. Area of reservoir at low water, 18 square miles; at high water, 24 square miles. These areas, with a range of 16.15 feet, give a capacity of 7,732,900,000 cubic feet. The dam raised the water in Cross, Pine, Daggett, Rush, Whitefish, Trout, and Hay lakes by varying amounts.

ACCURACY.—Discharge determined by engineers of the United States Engineer Corps from gage readings which indicate head on dam forming the reservoir, and from records of flow through openings of various sizes in the dam. These computations are checked about once a week by discharge measurements made by an employee at the dam. Records good.

COOPERATION.—Records of discharge as published are furnished by United States Engineer Corps which maintains the station for the purpose of measuring the flow from Pine River reservoir, the lowest in the present system of Government reservoirs on the headwaters of the Mississippi.

Daily discharge, in second-feet, of Pine River below Pine River reservoir, Minn., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	502	313	300	*a* 323	253	356	*a* 461	10	*a* 53	*a* 334	*a* 414	*a* 271
2	*a* 298	312	300	322	252	356	461	10	53	360	412	*a* 252
3	300	312	300	321	250	355	461	10	*a* 54	395	410	253
4	302	311	*a* 302	321	249	*a* 355	461	10	56	450	409	254
5	304	311	300	320	*a* 247	355	461	10	57	510	*a* 408	255
6	306	310	299	320	250	355	461	10	59	*a* 565	408	257
7	308	310	298	319	252	356	461	10	60	570	408	258
8	310	310	297	*a* 319	255	357	*a* 462	10	62	*a* 575	408	259
9	*a* 313	310	296	318	278	358	460	10	65	576	408	*a* 260
10	312	311	295	317	285	372	455	10	*a* 69	577	408	260
11	311	311	*a* 294	316	299	*a* 384	452	10	69	579	408	260
12	311	311	293	255	*a* 309	386	451	10	69	580	*a* 407	250
13	310	*a* 312	292	255	309	406	108	10	69	584	407	259
14	310	311	291	255	309	408	109	10	69	587	407	259
15	309	310	290	*a* 252	309	410	*a* 109	10	69	*a* 589	408	259
16	*a* 308	309	290	252	309	412	109	10	215	581	408	*a* 258
17	307	308	289	253	309	414	109	10	*a* 237	573	409	258
18	306	307	*a* 289	253	309	*a* 416	109	10	237	565	409	258
19	306	307	290	254	*a* 309	414	109	10	237	557	*a* 410	258
20	305	*a* 306	291	254	305	412	109	*a* 42	237	549	410	258
21	304	305	292	255	305	410	109	42	236	541	*a* 256	258
22	304	304	293	*a* 255	305	408	*a* 110	42	236	533	259	258
23	*a* 303	303	294	255	305	405	108	42	235	493	262	*a* 259
24	304	302	294	255	305	403	106	45	*a* 234	463	265	259
25	306	302	*a* 295	255	305	*a* 400	102	48	234	*a* 433	268	259
26	307	301	295	255	*a* 313	400	100	50	234	428	*a* 271	259
27	310	300	295	255	323	400	100	*a* 53	234	423	271	258
28	311	300	294	255	328	400	100	55	234	418	271	258
29	312	300	294	*a* 255	355	412	69	57	234	*a* 414	271	258
30	*a* 313	300	293	255	.....	428	10	59	234	414	271	*a* 257
31	313	.....	293	255	.....	440	.....	61	.....	414	271	.....

a Discharge measurement.

Monthly discharge of Pine River reservoir, Minn., for the year ending Sept. 30, 1916.

[Drainage area, 452 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	502	298	314	0.695	0.80
November	313	300	307	.679	.76
December	302	289	294	.650	.75
January	323	252	278	.615	.71
February	355	247	293	.648	.70
March	440	355	392	.867	1.00
April	462	10	243	.538	.60
May	61	10	25	.055	.06
June	237	53	148	.328	.37
July	589	334	504	1.12	1.29
August	414	256	358	.792	.91
September	271	252	258	.571	.64
The year	589	10	285	.631	8.59

CROW WING RIVER AT MOTLEY, MINN.

LOCATION.—Near north border of sec. 18, T. 133 N., R. 31 W., at highway bridge in village of Motley, about a quarter of a mile north of the Northern Pacific Railway station and 2 miles above mouth of Long Prairie River, the nearest tributary, in Cass County.

DRAINAGE AREA.—2,140 square miles.

RECORDS AVAILABLE.—June 10 to November 30, 1909, and April 17, 1913, to September 30, 1916. The records for 1909 consist of discharge measurements and gage heights only.

GAGE.—Chain gage attached to upstream handrail of bridge near right bank; read by S. W. Jacobs. Prior to July 21, 1916, gage was a staff in two sections, the lower section attached to an old log bulkhead which constituted abutment of a former bridge and was about 20 feet above upstream side of bridge at left bank; upper section was attached to an old piling just above lower section.

DISCHARGE MEASUREMENTS.—Made from upstream side of bridge.

CHANNEL AND CONTROL.—Bed composed of sand and gravel; fairly permanent. Banks not subject to overflow.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 11.5 feet April 5 and 6 (discharge, 9,440 second-feet); minimum open-water stage recorded, 6.39 feet November 3, 1915 (discharge, 771 second-feet); minimum discharge during period river was frozen over is estimated at 458 second-feet December 31, 1915.

1913–1916: Maximum stage recorded, 11.5 feet April 5 and 6, 1916 (discharge 9,440 second-feet): minimum open-water stage recorded, 6.0 feet June 17 and 18; 1913 (discharge, 528 second-feet). A flow of 417 second-feet was measured by current meter February 26, 1914; the absolute minimum is probably somewhat lower than this amount.

ICE.—Stage-discharge relation seriously affected by ice.

REGULATION.—Nearest dam above station at outlet of Lower Crow Wing Lake, about 67 miles above Motley; regulation at this point has very little effect at the gage.

ACCURACY.—Stage-discharge relation probably changed a little during high water in April and affected by ice during winter. Rating curve used October 1 to April 2 well defined between 778 and 3,620 second-feet. Rating curve used April 3 to September 30 fairly well defined between 940 and 4,790 second-feet; above

4,790 second-feet it is an extension. Gage read to quarter-tenths twice daily, gage readings July 8 to 20 believed to be unreliable and were not used. Daily discharge ascertained by applying mean daily gage heights to rating table, except for periods when stage-discharge relation was affected by ice, for which it was ascertained by applying to rating table mean daily gage heights corrected for ice effect by means of discharge measurements, observer's notes, and weather records. Records October 1 to November 15 and July 21 to September 30, good; April 3 to July 7, fair; July 8–20, poor; winter records November 16 to April 2 range from fair to good.

Discharge measurements of Crow Wing River at Motley, Minn., 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. 9	S. B. Soulé	6.58	921	Apr. 11	O. Christianson	8.44	3,820
9	do	6.59	931	July 7	S. B. Soulé	7.86	2,920
Dec. 22[a]	E. L. Williams	7.24	580	21	do	6.86	1,250
Jan. 26[a]	S. B. Soulé	7.28	451	Sept. 10	do	6.97	1,490
Mar. 15[a]	do	7.82	493				

[a] Ice at control.

Daily discharge, in second-feet, of Crow Wing River at Motley, Minn. for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	778	794	744	458	476	550	1,180	2,130	2,060	3,770	920	1,290
2	826	778	710	461	498	550	5,300	2,060	2,060	4,110	900	1,290
3	850	771	681	461	498	541	6,590	2,060	1,980	3,940	830	1,290
4	952	794	652	461	520	532	7,540	2,060	1,900	3,770	840	1,230
5	1,240	794	641	461	532	524	9,440	2,060	1,900	3,430	840	1,170
6	1,310	794	641	461	546	515	9,440	2,060	1,830	3,090	920	1,360
7	1,380	794	641	461	560	506	8,490	2,060	1,760	2,840	920	1,480
8	1,240	905	625	454	560	495	7,730	1,980	1,760	2,730	920	1,480
9	1,240	905	609	454	560	487	5,150	1,900	1,690	2,630	900	1,550
10	1,120	952	588	454	569	487	4,450	1,830	1,620	2,520	930	1,480
11	1,120	1,060	588	448	584	479	4,110	1,760	1,620	2,420	995	1,480
12	1,010	1,120	588	454	588	491	4,110	1,760	1,550	2,310	995	1,480
13	952	1,180	560	454	598	491	4,110	1,620	1,480	2,210	940	1,480
14	952	858	550	448	598	491	4,110	1,620	1,480	2,100	910	1,550
15	905	952	472	458	598	491	4,110	1,900	1,480	1,990	920	1,760
16	905	952	476	451	598	491	3,940	2,200	1,550	1,890	900	1,760
17	1,010	952	506	451	614	502	3,770	2,440	1,620	1,780	940	1,690
18	1,010	952	519	444	603	502	3,770	2,600	1,550	1,680	995	1,690
19	1,010	952	524	454	593	506	3,770	2,600	1,550	1,570	1,050	1,620
20	1,010	952	532	447	584	506	3,770	2,520	1,360	1,470	1,050	1,620
21	952	952	560	448	588	515	3,770	2,520	1,170	1,360	1,230	1,550
22	952	952	569	448	588	524	3,770	2,520	1,230	1,230	1,620	1,480
23	905	952	560	441	588	524	3,770	2,680	1,290	1,170	1,900	1,360
24	858	952	550	441	588	537	3,770	2,680	1,420	1,050	1,980	1,420
25	858	952	541	451	574	550	3,430	2,680	1,480	995	1,900	1,360
26	842	952	532	454	574	550	3,430	2,520	1,480	995	1,830	1,360
27	842	952	524	454	574	550	3,000	2,440	1,480	1,050	1,690	1,360
28	842	905	502	448	574	550	2,760	2,360	1,420	1,050	1,550	1,360
29	842	818	532	454	574	560	2,440	2,200	2,200	1,050	1,420	1,360
30	818	778	476	458	.....	652	2,200	2,060	2,920	995	1,420	1,360
31	818	.....	458	472	.....	724	.....	2,060	.....	940	1,360	.....

NOTE.—Discharge, Nov. 16 to Apr. 2, estimated, because of ice, from discharge measurements, observer's notes, and weather records. Discharge, July 8–20 interpolated.

Monthly discharge of Crow Wing River at Motley, Minn., for the year ending Sept. 30, 1916.

[Drainage area, 2,140 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	1,380	778	979	0.458	0.53
November	1,180	771	913	.427	.48
December	744	458	569	.266	.31
January	472	441	454	.212	.24
February	614	476	569	.266	.29
March	724	479	528	.247	.28
April	9,440	1,180	4,570	2.14	2.39
May	2,680	1,620	2,190	1.02	1.18
June	2,920	1,170	1,660	.776	.87
July	4,110	940	2,070	.967	1.11
August	1,980	830	1,180	.551	.64
September	1,760	1,170	1,460	.682	.76
The year	9,440	441	1,430	.668	9.08

LONG PRAIRIE RIVER NEAR MOTLEY, MINN.

LOCATION.—On west line of sec. 19, T. 133 N., R. 31 W., at highway bridge 1 mile south of Motley and 2 miles above mouth of river, in Morrison County.

DRAINAGE AREA.—973 square miles.

RECORDS AVAILABLE.—June 10, 1909, to September 30, 1916.

GAGE.—Chain gage attached to downstream handrail of bridge, near middle of stream; read by Mrs. Clem Thompson, Prior to August 9, 1916, gage was a staff attached to an overhanging stump on right bank of river, about 100 yards above bridge.

DISCHARGE MEASUREMENTS.—Made from downstream side of highway bridge 100 yards below gage; low-stage measurements made by wading a short distance above gage.

CHANNEL AND CONTROL.—Bed composed of light gravel; practically permanent. Left bank low; subject to overflow at extreme flood stages; right bank high and not subject to overflow.

EXTREMES OF DISCHARGE.—Maximum stage during year, 15.0 feet April 5, determined by leveling from flood marks (discharge, estimated, 4,280 second-feet, allowance being made for backwater); minimum open-water stage recorded, 5.4 feet October 23 to November 3, 1915 (discharge, 200 second-feet); minimum discharge when river was frozen over estimated at 78 second-feet February 28 to March 3.

1909–1916: Maximum stage during period, 15.0 feet, April 5, 1916, determined by leveling from flood marks (estimated discharge, 4,280 second-feet, allowance being made for backwater). A discharge of 39 second-feet was measured by current meter on February 27, 1914; absolute minimum probably about 30 second-feet.

ICE.—Stage-discharge relation seriously affected by ice.

ACCURACY.—Stage-discharge relation changed by fill in channel, probably during the last part of the summer of 1915. The effect of this fill was complicated by backwater caused by a varying amount of vegetation which obstructed the channel at the same time. No vegetation obstructed the channel during the summer of 1916. Discharge October 1–31, 1915, determined by indirect method owing to obstruction of the channel by vegetation. Rating curve used November 1 to September 30, fairly well defined from 78 to 1,730 second-feet; above 1,730 second-feet it is an extension determined from area and mean velocity curves. Gage read to half-tenths twice daily. Daily discharge ascertained by applying mean daily gage heights to rating table except for periods when stage-discharge relation was affected by aquatic

plants or ice for which it was ascertained by applying to rating table mean daily gage heights corrected for backwater by means of discharge measurements and, for winter period, observer's notes and weather records. Records good for low-water periods; fair for high-water periods.

Discharge measurements of Long Prairie River near Motley, Minn., 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. 8	S. B. Soulé	5.68	287	Apr. 12	O. Christianson	7.75	1,550
8	do	5.68	292	July 7	S. B. Soulé	8.01	1,740
Dec. 23[a]	E. L. Williams	5.91	152	20	do	6.18	520
Jan. 27[a]	S. B. Soulé	6.10	103	Sept. 9	do	6.20	502
Mar. 16[a]	do	6.64	121				

[a] Control obstructed by ice.

Daily discharge, in second-feet, of Long Prairie River near Motley, Minn., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	212	200	360	120	126	78	570	805	1,070	2,370	380	520
2	212	200	340	120	144	78	805	805	1,140	2,370	340	520
3	212	200	340	120	144	78	1,280	805	1,140	2,370	360	470
4	231	216	340	120	144	83	3,130	805	1,140	2,450	805	470
5	231	216	340	120	138	88	4,280	870	1,070	2,540	805	470
6	231	206	340	120	132	88	3,380	870	1,070	2,620	144	470
7	212	232	340	120	126	88	2,790	895	1,000	1,730	144	446
8	212	232	340	120	120	88	2,370	920	935	1,650	144	470
9	212	248	340	120	114	88	2,050	945	935	1,140	340	495
10	231	265	320	120	109	88	1,890	970	935	1,140	360	545
11	250	265	320	132	109	88	1,730	995	805	1,140	340	545
12	270	265	320	132	109	104	1,580	1,020	870	1,070	360	570
13	270	265	320	120	104	120	1,420	1,040	740	1,000	360	570
14	290	300	300	120	98	124	1,420	1,070	740	935	380	624
15	312	300	282	109	98	128	1,420	1,070	740	870	380	680
16	312	300	248	109	98	132	1,420	1,070	740	870	380	680
17	356	320	216	109	104	138	1,420	1,070	740	870	380	680
18	356	320	200	98	109	144	1,070	1,070	740	740	360	680
19	356	320	185	98	109	144	1,140	1,070	740	740	340	624
20	333	320	170	98	109	144	1,210	1,070	740	680	1,420	624
21	333	340	157	88	109	150	1,210	1,070	740	652	1,420	597
22	290	340	154	88	109	157	1,280	1,070	805	624	570	570
23	178	340	152	88	104	157	870	1,070	805	597	597	520
24	178	360	144	92	98	157	870	1,070	805	597	624	624
25	178	360	144	96	93	171	935	1,000	805	597	652	624
26	178	360	144	99	88	185	1,070	1,000	805	597	652	624
27	178	360	144	103	83	200	1,000	935	805	597	680	624
28	178	360	132	106	78	216	1,000	1,000	870	597	740	597
29	178	360	132	109	78	343	935	1,000	1,420	545	740	570
30	178	360	132	109	.....	470	870	1,000	1,970	545	624	570
31	178	.....	120	109	.....	545	.....	1,070	.....	380	520	.....

NOTE.—Discharge Nov. 28 to Apr. 11, estimated, because of ice, from discharge measurements, observer's notes, and weather records. Discharge Oct. 1–31 determined by indirect method for shifting control because of backwater caused by growth of vegetation in the channel. Discharge May 7–13 and Sept. 8 interpolated.

Monthly discharge of Long Prairie River near Motley, Minn., for the year ending Sept. 30, 1916.

[Drainage area, 973 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	356	178	243	0.250	0.29
November	360	200	291	.299	.33
December	360	120	242	.249	.29
January	132	88	110	.113	.13
February	144	78	110	.113	.12
March	545	78	157	.161	.19
April	4,280	570	1,550	1.59	1.77
May	1,070	805	985	1.01	1.16
June	1,970	740	929	.955	1.07
July	2,620	380	1,150	1.18	1.36
August	1,420	144	527	.542	.63
September	680	446	569	.585	.65
The year	4,280	78	571	.587	7.99

ELK RIVER NEAR BIG LAKE, MINN.

LOCATION.—In sec. 23, T. 33 N., R. 27 W., at highway bridge 4 miles east of Big Lake, Sherburne County, and three-quarters of a mile north of Bailey station on Northern Pacific and Great Northern railways, half a mile above Tebbetts Brook and 4 miles below mouth of St. Francis River.

DRAINAGE AREA.—615 square miles.

RECORDS AVAILABLE.—April 15, 1911, to September 30, 1916.

GAGE.—Vertical staff gage attached to upstream edge of left abutment; read by Michael Tracy. Prior to April 7, 1916, the gage was a staff gage attached to a piling about 10 feet above the upstream edge of bridge, near right bank of river.

DISCHARGE MEASUREMENTS.—At high stages made from the downstream side of bridge; at medium and low stages by wading.

CHANNEL AND CONTROL.—Bed composed of sand and light gravel. Just below gage is a slight rapids which constitutes the control at medium and low stages and at which the bed consists of considerably heavier gravel and cobblestones, and is fairly permanent. From July to October, the channel is obstructed by aquatic plants which cause considerable backwater that increases as the summer advance, and reaches a maximum some time in September. Right bank high and will not be subject to overflow; left bank subject to overflow at a stage of about 9 feet, and some of the water cuts across a point formed by a loop in the river and does not pass under the bridge.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 8.5 feet April 5 (discharge, 4,060 second-feet); minimum discharge, 96 second-feet, several times during January.

1911–1916: Maximum stage recorded, 10 feet at 6.30 p. m., May 7, 1912 (discharge, 5,100 second-feet); minimum open-water stage recorded 0.22 foot July 16, 1911 (discharge, 43.4 second-feet, measured by current meter); a discharge of 39 second-feet was measured by current meter on January 27, 1912.

ICE.—Stage-discharge relation seriously affected by ice.

ACCURACY.—Stage-discharge relation fairly permanent, except as affected by ice during the frozen period and by backwater from aquatic plants in the latter part of the summer. Rating curve well defined throughout. Gage read to quarter tenths twice daily. Daily discharge ascertained by applying mean daily gage heights to rating table except when stage-discharge relation was affected by ice for which it was ascertained by applying to rating table mean daily gage heights corrected for ice effect by means of discharge measurements, observer's notes, and weather records. Records fair.

Discharge measurements of Elk River near Big Lake, Minn., 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.*
Oct. 20	S. B. Soulé	1.01	195	Apr. 15	E. L. Williams	3.57	1,120
Jan. 6[a]	do	1.27	110	May 19	do	2.48	711
Feb. 29[a]	do	1.90	132	July 6	do	5.18	2,020
Apr. 7	Williams and Christianson	6.91	2,940	Aug. 14[b]	S. B. Soulé	1.59	292
				Sept 21	Soulé and Kilgore	1.67	319

[a] Ice at control. [b] Grass at control.

Daily discharge, in second-feet, of Elk River near Big Lake, Minn., for the year endin Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	148	195	283	116	200	132	986	794	1,070	1,970	312	326
2	141	190	283	114	195	132	1,360	757	950	2,450	297	326
3	143	190	269	111	190	136	2,030	720	871	2,690	269	312
4	178	185	269	111	185	136	3,540	683	794	2,510	269	312
5	165	185	269	109	180	136	4,060	647	720	2,270	297	312
6	190	185	269	109	175	136	3,400	612	683	1,970	297	297
7	203	188	229	111	170	141	3,140	545	647	1,740	312	297
8	203	206	229	116	170	146	2,210	545	612	1,530	297	283
9	216	216	229	120	165	153	1,860	545	612	1,330	283	269
10	216	236	229	118	158	153	1,690	496	578	1,200	326	269
11	203	371	229	116	161	146	1,580	464	545	990	326	297
12	203	433	216	120	146	158	1,430	448	528	910	312	297
13	203	448	216	118	141	158	1,330	432	545	757	312	297
14	203	448	203	105	132	165	1,240	448	545	647	297	312
15	190	480	190	98	123	163	1,150	528	545	612	283	326
16	178	496	178	96	130	155	1,150	545	578	545	283	326
17	190	480	165	98	130	160	1,150	578	545	545	269	341
18	190	480	160	96	136	160	1,110	647	545	545	283	341
19	190	448	141	96	136	155	1,070	720	528	496	297	326
20	190	417	130	100	141	160	1,110	720	512	480	297	326
21	203	386	125	100	146	160	1,110	757	480	464	297	312
22	203	283	123	96	153	160	1,110	990	464	448	297	312
23	198	326	118	130	153	165	1,110	1,070	448	417	297	312
24	198	371	118	118	153	170	1,070	1,110	448	402	312	297
25	206	386	118	130	153	206	1,110	1,330	432	386	312	283
26	200	356	118	141	143	211	1,110	1,910	496	371	326	297
27	195	312	118	170	141	216	1,070	1,970	528	341	341	297
28	190	297	118	182	134	242	990	1,740	545	326	341	297
29	198	269	118	198	132	294	950	1,580	871	312	341	297
30	190	211	118	208	.....	506	871	1,380	1,240	297	341	283
31	182	.....	118	206	.....	698	.....	1,200	.....	341	326	.....

NOTE.—Discharge Dec. 7 to Apr. 2 estimated, because of ice, from discharge measurements, observer's notes, and weather records. Discharge Oct. 1–31 and July 11 to Sept. 30, determined by indirect method for shifting channel because of backwater caused by the growth of aquatic plants in the channel.

Monthly discharge of Elk River near Big Lake, Minn., for the year ending Sept. 30, 1916.

[Drainage area, 615 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	216	141	191	0.310	0.36
November	496	185	322	.524	.58
December	283	118	184	.299	.34
January	208	96	124	.202	.23
February	200	123	154	.250	.27
March	698	132	194	.315	.36
April	4,060	871	1,570	2.55	2.84
May	1,970	432	868	1.41	1.63
June	1,240	432	630	1.02	1.14
July	2,690	297	977	1.59	1.83
August	341	269	305	.496	.57
September	341	269	306	.498	.56
The year	4,060	96	485	.789	10.71

CROW RIVER AT ROCKFORD, MINN.

LOCATION.—In sec. 29, T. 119 N., R. 24 W., at highway bridge at Rockford, about 400 feet below dam, not in use at present, about one-third mile below the "Soo" Railway bridge, and about a mile below the junction of the north and south branches. Between the junction and the station are the outlets of Rebecca Lake and Lake Sarah, both very small streams.

RECORDS AVAILABLE.—June 4, 1909, to September 30, 1916.

DRAINAGE AREA.—2,520 square miles.

GAGE.—Vertical staff gage attached to a piling a few feet upstream from right end of bridge; read by G. W. Florida.

DISCHARGE MEASUREMENTS.—At high and medium stages, made from the bridge; at low stages, made by wading about 600 feet below gage.

CHANNEL AND CONTROL.—Bed (for most part) composed of heavy gravel; practically permanent. Banks are not overflowed except during extreme floods.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 15.9 feet at 6 p. m. April 2, and 7 a. m. April 3 (discharge, 10,600 second-feet); minimum discharge, 144 second-feet, January 19 and 20.

1909–1916: Maximum stage recorded, 15.9 feet at 6 p. m. April 2 and 7 a. m. April 3, 1916 (discharge, 10,600 second-feet); minimum open-water stage recorded, 4.55 feet January 29 and February 5, 1911 (discharge, 34 second-feet); absolute minimum probably about 30 second-feet and occurred in February, 1915.

ICE.—Stage-discharge relation seriously affected by ice. Prior to the winter of 1911–12, little ice formed at the control, and the open-water rating curve was applicable throughout the year. Before the dam just above the station was destroyed, the temperature of the large body of water back of the dam was considerably above freezing, and the water did not freeze quickly when released; but since the destruction of the dam natural conditions exist and ice forms.

REGULATION.—On the North, Middle, and South forks of Crow River there are seven power plants with small storage, but the regulation at the various points is so slight that no appreciable effect is observed at the gage. Dam immediately above gage was partly destroyed May 31, 1911, and has not since been repaired.

ACCURACY.—Stage-discharge relation practically permanent except as affected by ice. Rating curve well defined above and fairly well defined below 1,000 second-feet. Gage read to hundredths twice daily. Daily discharge ascertained by applying mean daily gage heights to rating table except for periods when stage-discharge relation was affected by ice, for which it was ascertained by applying to rating table mean daily gage heights corrected for ice effect by means of discharge measurements, observer's notes, and weather records. Records above 1,000 second-feet during open-water period excellent; below 1,000 second-feet only fair, owing to difficulty of obtaining accurate discharge measurements; during period channel was obstructed fair.

Discharge measurements of Crow River at Rockford, Minn., 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. 12[a]	S. B. Soulé	5.85	202	July 7	E. L. Williams	9.30	2,850
Mar. 6[a]	do	5.88	170	Aug. 18	S. B. Soulé	6.08	752
Apr. 4	do	15.76	10,300	Sept. 27	R. B. Kilgore	5.95	584
13	do	11.94	5,380				

[a] Ice at control.

Daily discharge, in second-feet, of Crow River at Rockford, Minn., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	665	445	1,450	257	198	169	9,800	3,510	5,330	2,970	1,190	775
2	692	445	1,310	217	187	179	10,400	3,240	4,930	3,150	1,130	802
3	720	420	1,190	209	217	169	10,400	3,150	4,430	3,150	1,070	802
4	748	420	1,130	202	229	162	10,400	2,970	4,140	3,060	1,070	802
5	720	395	1,070	209	237	162	9,800	2,810	3,780	2,970	1,010	802
6	665	395	1,010	221	229	165	9,060	2,650	3,510	2,970	950	802
7	638	395	950	217	217	179	8,220	2,490	3,330	2,890	950	830
8	638	445	950	225	209	217	7,300	2,410	3,060	2,730	890	802
9	610	500	950	211	217	237	7,050	2,570	2,890	2,570	860	830
10	582	665	950	209	217	244	6,570	2,250	2,730	2,570	950	802
11	582	950	1,010	206	209	257	6,210	2,170	2,490	2,330	860	775
12	555	1,190	950	202	209	237	5,770	2,010	2,650	2,170	830	748
13	528	1,310	935	194	206	217	5,330	1,940	2,810	2,090	830	748
14	528	1,590	905	179	209	198	4,930	2,010	3,060	1,940	775	720
15	500	1,640	845	172	198	187	4,730	2,410	3,060	2,090	748	720
16	500	1,640	755	183	217	198	4,830	2,810	3,150	1,940	692	720
17	528	1,640	695	179	237	237	4,730	2,890	3,150	2,330	665	692
18	555	1,450	638	172	202	217	4,730	2,890	3,060	2,810	638	692
19	582	1,310	583	144	194	245	4,630	2,810	2,970	2,810	665	665
20	610	1,450	555	144	187	270	4,530	2,810	2,810	2,730	748	610
21	610	1,790	528	179	179	279	4,430	2,970	2,730	2,570	775	638
22	610	1,790	500	217	187	323	4,430	3,240	2,570	2,410	748	610
23	582	1,710	473	257	179	445	4,330	3,330	2,650	2,170	720	610
24	582	1,640	445	266	172	637	4,050	3,510	2,650	2,010	720	610
25	555	1,640	420	261	162	1,190	4,050	4,330	2,570	1,870	720	610
26	555	1,130	370	257	158	1,450	3,870	4,730	2,490	1,800	748	610
27	528	1,070	370	245	151	2,410	3,780	5,330	2,410	1,660	748	582
28	500	950	345	257	155	3,510	3,780	6,100	2,330	1,590	720	610
29	472	1,010	300	237	162	5,550	3,780	6,100	2,410	1,450	748	610
30	472	1,130	291	257	.....	9,350	3,600	5,880	2,730	1,380	748	610
31	445	.....	279	237	.....	8,500	.....	5,660	.....	1,250	775	.....

NOTE.—Discharge Nov. 15–17, 21–25 and Dec. 13 to Mar. 31, estimated, because of ice, from discharge measurements, observer's notes, and weather records.

Monthly discharge of Crow River at Rockford, Minn., for the year ending Sept. 30, 1916.

[Drainage area, 2,520 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	748	445	582	0.231	0.27
November	1,790	395	1,090	.432	.48
December	1,450	279	747	.296	.34
January	266	144	214	.085	.10
February	237	151	198	.079	.08
March	9,350	162	1,220	.484	.56
April	10,400	3,600	5,980	2.37	2.64
May	6,100	1,940	3,350	1.33	1.53
June	5,330	2,330	3,100	1,23	1.37
July	3,150	1,250	2,340	.929	1.07
August	1,190	638	829	.329	.38
September	830	582	708	.281	.31
The year	10,400	144	1,690	.671	9.13

MINNESOTA RIVER NEAR MONTEVIDEO, MINN.

LOCATION.—In sec. 17, T. 117 N., R. 40 W., at highway bridge 1 mile south of Montevideo, Chippewa County, 500 feet below mouth of Chippewa River.

DRANIAGE AREA.—6,300 square miles.

RECORDS AVAILAGEL.—July 23, 1909, to September 30, 1916.

GAGE.—Chain gage attached to upstream handrail of bridge, near left bank; read by B. O. Brown. Datum of gage lowered 2 feet September 16, 1909, and 1 foot more July 29, 1910, to avoid negative readings. All gage heights referred to latest datum.

DISCHARGE MEASUREMENTS.—Made from upstream side of bridge.

CHANNEL AND CONTROL.—Gravel and rock; practically permanent. There is a slight rapid just below gage, but the control section is not well defined. Banks medium height, and will be overflowed at a stage of about 14 feet.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 14.41 feet at 8 a.m. April 3 (discharge, 7,570 second-feet); minimum discharge, 109 second-feet, measured by current meter January 15.

1909–1916: Maximum stage recorded, 14.41 feet at 8 a.m. April 3, 1916 (discharge, 7,570 second-feet); minimum recorded discharge, 6.8 second-feet, measured by current meter February 9, 1912.

ICE.—Stage-discharge relation seriously affected by ice.

REGULATION.—No regulation on Minnesota River above station. Regulation of Chippewa River at the plant of the Chippewa Milling Co., in Montevideo, produces a slight fluctuation in the stage of Minnesota River at gage.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined. Gage read to hundredths twice daily. Daily discharge ascertained by applying mean daily gage heights to rating table except for periods when stage-discharge relation was affected by ice, for which it was ascertained by applying to rating table mean daily gage heights corrected for ice effect by means of discharge measurements, observer's notes, and weather records. Records good.

Discharge measurements of Minnesota River near Montevideo, Minn., 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.*
Oct. 23	S. B. Soulé	6.12	963	Mar. 18[a]	S. B. Soulé	7.02	608
23	do	6.13	946	Apr. 1	O. Christianson	14.33	7,380
Jan. 15[a]	do	3.56	109	14	do	13.49	5,200
29[a]	do	3.66	124	Aug. 17	S. B. Soulé	6.75	1,270

[a] Ice at control.

Daily discharge, in second-feet, of Minnesota River near Montevideo, Minn., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	648	876	542	226	116	148	7,210	4,510	4,200	4,510	1,740	1,780
2	621	846	542	134	122	141	7,540	4,400	4,110	4,630	1,570	1,690
3	621	817	542	226	128	134	7,540	4,200	4,030	4,760	1,490	1,690
4	731	788	516	260	134	122	7,540	4,110	3,950	4,760	1,530	1,690
5	817	788	516	242	134	142	7,540	3,950	3,880	4,630	1,530	1,650
6	846	759	490	162	128	162	7,210	3,880	3,690	4,630	1,530	1,610
7	906	731	466	178	122	155	6,890	3,690	3,570	4,630	1,450	1,570
8	936	817	442	210	128	148	6,890	3,570	3,460	4,510	1,380	1,490
9	936	788	418	202	134	148	6,590	3,400	3,300	4,400	1,270	1,450
10	936	731	418	194	134	148	6,310	3,240	3,240	4,200	1,300	1,410
11	967	788	396	178	134	162	6,050	3,130	3,080	4,030	1,300	1,450
12	967	788	396	162	148	148	5,810	2,910	3,020	3,880	1,300	1,450
13	967	759	374	142	155	134	5,590	2,810	2,910	3,810	1,270	1,380
14	936	675	374	122	162	234	5,210	2,760	2,860	3,750	1,270	1,410
15	936	568	418	110	155	334	4,900	2,910	2,810	3,690	1,230	1,410
16	906	594	442	110	148	438	4,900	3,080	2,760	3,570	1,230	1,380
17	936	621	374	110	155	542	4,760	3,240	2,710	3,400	1,200	1,340
18	967	621	354	122	162	675	4,630	3,350	2,710	3,240	1,130	1,340
19	998	594	296	134	162	868	4,630	3,400	2,610	3,130	1,100	1,300
20	1,030	568	296	134	170	1,060	4,760	3,460	2,510	3,020	1,100	1,300
21	1,030	568	296	134	178	1,530	5,050	3,570	2,460	2,910	1,160	1,300
22	998	542	278	122	186	1,650	5,210	3,690	2,410	2,810	1,490	1,300
23	998	516	260	128	194	1,870	5,210	3,810	2,360	2,660	1,650	1,270
24	967	542	278	134	178	1,960	5,210	3,950	2,320	2,560	1,780	1,200
25	967	516	260	134	178	2,320	5,210	4,030	2,320	2,410	1,870	1,160
26	967	594	260	134	178	2,910	5,210	4,110	2,320	2,320	1,870	1,160
27	906	594	260	134	178	4,400	5,050	4,200	2,320	2,230	1,870	1,130
28	906	542	260	134	178	4,630	4,900	4,300	2,410	2,140	1,870	1,130
29	906	542	242	134	163	5,590	4,760	4,300	3,240	2,050	1,870	1,130
30	906	542	226	122	.....	6,310	4,630	4,400	3,950	1,960	1,820	1,100
31	876	.....	226	110	.....	6,890	.....	4,300	.....	1,870	1,780	.....

NOTE.—Discharge, Nov. 16–18 and Nov. 29 to Mar. 26, estimated, because of ice, from discharge measurements, observer's notes, and weather records.

Monthly discharge of Minnesota River near Montevideo, Minn., for the year ending Sept. 30, 1916.

[Drainage area, 6,300 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	1,030	621	904	0.143	0.16
November	876	516	667	.106	.12
December	542	226	370	.059	.07
January	260	110	154	.024	.03
February	194	116	153	.024	.03
March	6,890	122	1,490	.236	.27
April	7,540	4,630	5,760	.914	1.02
May	4,510	2,760	3,700	.587	.68
June	4,200	2,320	3,050	.484	.54
July	4,760	1,870	3,460	.548	.63
August	1,870	1,100	1,480	.235	.27
September	1,780	1,100	1,390	.221	.25
The year	7,540	110	1,880	.298	4.07

MINNESOTA RIVER NEAR MANKATO, MINN.

LOCATION.—In sec. 14, T. 108 N., R. 27 W., in Blue Earth County, at Sibley Park, 2 miles above the center of Mankato, and 1,000 feet below the mouth of Blue Earth River.

DRAINAGE AREA.—14,600 square miles.

RECORDS AVAILABLE.—May 20, 1903, to September 30, 1916.

GAGE.—Chain gage on right bank of river, about 1,000 feet below mouth of Blue Earth River; read by Clarence Staley, observer for United States Weather Bureau. The gage support is a substantial cantilever structure, supported by two heavy posts resting in concrete footings, constructed and maintained by the United States Engineer Corps.

DISCHARGE MEASUREMENTS.—Made from highway bridge in center of Mankato; at low stages made by wading a short distance below gage; at extremely high stages by boat near gage.

CHANNEL AND CONTROL.—Bed composed of sand and light gravel; fairly permanent except during high stage; banks moderately high and not subject to overflow except at stages above gage height 15 feet. Control not well-defined.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 17.0 feet March 28 and 29 (discharge, 30,200 second-feet); minimum discharge, 165 second-feet, March 2 to 4.

1903–1916: Maximum stage recorded, 21.2 feet, June 26, 1908 (discharge, 43,800 second-feet); minimum stage recorded, 0.5 foot August 31, September 1 and 2, 1911 (discharge, 89 second-feet). The highest known stage occurred in 1881, and is shown in Mankato by a well-marked line, approximately 27 feet above the zero of the present gage (discharge, estimated, 65,000 second-feet).

ICE.—Stage-discharge relation seriously affected by ice.

REGULATION.—The nearest dam on the Minnesota River is at Minnesota Falls, 140 miles upstream. A dam on the Blue Earth at Rapidan, a few miles above the mouth, controls flow of that river, which is approximately 20 per cent of that at the Mankato station and produces considerable daily fluctuation at the gage, amounting at times to more than 1 foot.

ACCURACY.—Stage-discharge relation changing slowly a great part of the time; also affected by ice in winter. A marked change probably occurred during the high water in April. Rating curves fairly well defined. Gage read once daily to tenths. This reading does not represent accurately the mean daily stage on account of fluctuations caused by artificial regulation (see paragraph on "Regulation"). Daily discharge ascertained by applying the daily gage heights to rating table except for periods when stage-discharge relation was affected by ice, for which it was ascertained by applying to rating table daily gage heights corrected for ice effect by means of discharge measurements, observer's notes, and weather records. Records for open-water periods fair; for winter period poor.

COOPERATION.—Gage-height record furnished by United States Weather Bureau.

Discharge measurements of Minnesota River near Mankato, Minn., 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.*
Oct. 21	S. B. Soulé	4.78	3,390	Mar. 28	S. B. Soulé	17.13	30,600
Jan. 14[a]	do	2.41	384	Apr. 11	Soulé and Williams	11.41	15,800
Feb. 17[a]	E. L. Williams	2.84	340	Aug. 11	S. B. Soulé	3.63	2,400

[a] Ice at control.

Daily discharge, in second-feet, of Minnesota River near Mankato, Minn., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	2,380	2,010	1,750	815	420	200	25,200	14,500	11,200	6,070	3,790	2,290
2	2,480	1,920	1,590	815	420	165	24,400	14,300	12,000	6,710	3,680	2,290
3	2,880	1,750	1,670	750	380	165	23,400	13,200	10,900	7,050	3,570	2,470
4	3,080	1,750	1,590	690	340	165	22,600	12,900	10,500	7,930	3,460	2,380
5	2,980	1,670	1,590	690	340	200	21,800	12,700	9,880	8,300	3,460	2,290
6	2,680	1,670	1,590	630	340	235	20,600	11,400	9,270	9,270	3,140	2,200
7	2,580	1,590	1,670	630	340	270	19,600	10,500	8,300	8,870	3,140	2,470
8	2,480	1,590	1,750	570	380	305	17,600	9,470	7,570	8,110	2,840	2,380
9	2,780	1,590	1,750	570	380	380	16,900	9,070	7,570	8,300	2,650	2,380
10	2,880	1,510	1,670	630	380	380	15,700	8,490	6,880	9,070	2,940	2,200
11	2,780	1,750	1,590	570	380	470	16,200	7,750	6,550	8,490	2,840	1,950
12	2,680	2,980	1,510	520	340	815	15,000	7,750	6,230	9,270	2,740	1,950
13	2,680	4,270	1,430	570	305	1,590	14,500	7,390	5,920	8,870	2,560	2,030
14	2,580	4,950	1,290	420	305	3,880	13,200	6,710	5,770	9,270	2,110	2,110
15	2,480	4,810	1,290	380	270	7,340	12,700	7,390	6,230	21,600	1,950	2,030
16	2,580	4,530	1,220	380	305	9,850	13,400	8,490	6,550	14,500	1,870	1,950
17	2,780	4,010	1,150	380	305	10,900	15,000	9,670	6,390	11,400	1,950	1,870
18	2,880	3,880	1,010	380	305	12,000	15,200	10,700	6,390	10,700	1,870	1,790
19	2,780	3,880	880	380	305	13,300	16,200	11,200	5,770	9,880	1,790	1,790
20	2,580	3,410	750	380	340	16,200	17,900	10,300	5,330	9,470	1,870	1,720
21	2,780	3,300	880	420	380	15,000	22,900	9,070	5,050	9,670	1,950	1,650
22	2,980	2,980	1,080	420	420	16,700	23,900	9,670	5,050	9,270	2,030	1,650
23	3,080	2,780	1,290	420	420	16,400	23,700	10,900	4,910	8,490	1,870	1,580
24	2,880	2,780	1,360	470	380	16,400	22,100	12,000	4,780	8,110	1,950	1,580
25	2,880	2,880	1,360	470	380	22,700	20,400	13,400	4,650	7,390	1,870	1,510
26	2,780	2,780	1,430	420	340	24,400	19,400	13,400	5,620	7,390	2,030	1,510
27	2,880	2,880	1,150	420	305	28,200	17,200	12,700	5,620	6,710	2,200	1,580
28	2,780	2,880	945	380	305	30,200	16,200	13,800	5,470	6,230	2,380	1,580
29	2,380	2,680	880	380	235	30,200	15,500	13,800	5,620	5,770	2,290	1,510
30	2,010	1,920	750	420	.....	28,200	14,300	12,700	6,070	4,910	2,380	1,510
31	1,920	.....	750	420	.....	26,900	.....	11,800	.....	4,520	2,380	.....

NOTE.—Discharge, Dec. 18 to Mar. 13 estimated, because of ice, from discharge measurements, gage heights, and weather records.

Monthly discharge of Minnesota River near Mankato, Minn., for the year ending Sept. 30, 1916.

[Drainage area, 14,600 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	3,080	1,920	2,690	0.184	0.21
November	4,950	1,510	2,780	.190	.21
December	1,750	750	1,310	.090	.10
January	815	380	509	.035	.04
February	420	235	346	.024	.03
March	30,200	165	10,800	.740	.85
April	25,200	12,700	18,400	1.26	1.41
May	14,500	6,710	10,900	.746	.86
June	12,000	4,650	7,000	.479	.53
July	21,600	4,520	8,760	.600	.69
August	3,790	1,790	2,500	.171	.20
September	2,470	1,510	1,940	.133	.15
The year	30,200	165	5,670	.388	5.28

CHIPPEWA RIVER NEAR WATSON, MINN.

LOCATION.—On line between secs. 10 and 15, T. 118 N., R. 41 W., at highway bridge 2½ miles northeast of Watson, Chippewa County; about 2 miles below mouth of Dry Weather Creek and 10 miles above mouth of river.

DRAINAGE AREA.—1,940 square miles.

RECORDS AVAILABLE.—April 27, 1910, to September 30, 1916. From July 6 to September 17, 1909, four discharge measurements were made at the station.

GAGE.—Chain gage attached to downstream side of bridge, near left bank of river; read by Clifford Bonde.

DISCHARGE MEASUREMENTS.—At medium and high stages made from downstream side of bridge to which gage is attached; at low stages made by wading a short distance above gage.

CHANNEL AND CONTROL.—Bed consists partly of sand and light gravel and partly clay; shifts somewhat. Right bank slopes gradually, and the width of the stream increases rapidly as stage increases from 10 to 12 feet.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 15.1 feet March 29 (discharge, 4,750 second-feet); minimum stage recorded, 6.68 feet October 1, 1915 (discharge, 339 second-feet).

1910–1916: Maximum stage recorded, 15.1 feet March 29, 1916 (discharge, 4,750 second-feet); minimum open-water stage recorded, 3.90 feet August 7, 8, and 9, 1910 (discharge, 5 second-feet; this discharge is less than that given in Water-Supply Paper 285, because of revision of the rating table since that report was issued). A discharge of 1.7 second-feet was measured by current meter February 9, 1912.

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

REGULATION.—There was formerly possibly some slight regulation due to the operation of a flour mill under an 8-foot head at Hagan, but this dam is out at present, so that the flow is natural.

ACCURACY.—Stage-discharge relation changed slightly during high water in the spring of 1916; seriously affected by ice November 15, 1915, to March 26, 1916, when gage readings were discontinued. Rating curve used October 1 to November 14 well defined below 564 second-feet; that used March 27 to September 30 well defined between 358 and 4,250 second-feet. Gage read to hundredths once daily in the afternoon. Daily discharge ascertained by applying daily gage heights to rating table. Records fair.

Discharge measurements of Chippewa River near Watson, Minn., 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.*
Oct. 22	S. B. Soulé	7.90	545	Apr. 14	O. Christianson	12.85	2,270
22	do	7.89	542	Aug. 17	S. B. Soulé	7.47	434
Apr. 1	O. Christianson	14.60	3,980				

Daily discharge, in second-feet, of Chippewa River near Watson, Minn., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	342	422	.....	3,950	1,990	1,830	3,120	556	1,020
2	342	422	.....	3,810	1,880	1,780	3,020	515	986
3	399	406	.....	3,560	1,830	1,730	2,840	535	986
4	456	406	.....	3,440	1,830	1,650	2,750	515	930
5	473	390	.....	3,220	1,690	1,570	2,670	477	903
6	508	374	.....	2,510	1,610	1,490	2,590	496	903
7	508	374	.....	3,020	1,530	1,450	2,370	459	876
8	526	358	.....	2,750	1,450	1,410	2,230	496	849
9	526	374	.....	2,670	1,410	1,300	1,990	496	822
10	545	358	.....	2,670	1,380	1,240	1,930	477	796
11	545	358	.....	2,590	1,200	1,160	1,930	496	744
12	545	358	.....	2,510	1,160	1,930	1,610	477	744
13	526	374	.....	2,370	1,240	1,880	1,610	496	744
14	526	390	.....	2,300	1,300	1,080	1,570	496	744
15	508		.....	2,300	1,380	1,040	1,490	459	744
16	517		.....	2,300	1,530	1,040	1,450	459	744
17	526		.....	2,300	1,530	1,020	1,410	441	744
18	564		.....	2,300	1,570	986	1,270	441	719
19	545		.....	2,370	1,690	986	1,200	424	719
20	564		.....	2,590	1,830	903	1,100	424	719
21	564		.....	2,750	1,930	876	1,020	822	515
22	545	400	.....	2,750	1,830	822	958	903	496
23	545		.....	2,670	1,880	822	876	1,100	477
24	526		.....	2,590	1,930	822	822	1,160	459
25	526		.....	2,510	2,050	822	796	1,100	424
26	526		.....	2,370	1,990	849	744	1,100	407
27	490		2,840	2,300	1,990	876	646	1,080	407
28	490		3,810	2,110	1,930	930	623	1,080	424
29	473		4,750	2,110	1,930	3,220	623	1,080	600
30	439		3,950	2,050	1,880	3,220	578	1,040	600
31	456	.....	3,810	.....	1,880	.....	556	1,040	.....

NOTE.—Discharge, Oct. 3 and 16, interpolated.

Monthly discharge of Chippewa River near Watson, Minn., for the year ending Sept. 30, 1916.

[Drainage area, 1 940 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	564	342	502	0.259	0.30
November	422	358	392	.202	.23
April	3,950	2,050	2,660	1.37	1.53
May	2,050	1,160	1,690	.871	1.00
June	3,220	822	1,360	.701	.78
July	3,120	556	1,560	.804	.93
August	1,160	424	682	.352	.41
September	1,020	407	708	.365	.41

ST. CROIX RIVER AT SWISS, WIS.

LOCATION.—In sec. 33, T. 42 N., R. 15 W., at highway bridge, near Swiss post office, Burnett County, about 2 miles above the point where St. Croix River becomes the boundary line between Wisconsin and Minnesota, 10 miles northeast of Danbury, on Minneapolis, St. Paul & Sault Ste. Marie Railway. Namakagon River enters from the left 3½ miles above station.

DRAINAGE AREA.—1,550 square miles (measured on map issued by Wisconsin Geological and Natural History Survey, edition of 1911; scale, 1 inch = 6 miles).

RECORDS AVAILABLE.—March 20, 1914, to September 30, 1916.

GAGE.—Cast-iron staff gage bolted to concrete pier at left end of bridge; read by Capt. Richard Goldschmidt.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge.

CHANNEL AND CONTROL.—Gravel, smooth; grass grows to some extent during summer, causing a small amount of backwater at gage. Right bank high and not subject to overflow; left bank of medium height and may possibly be overflowed during extremely high stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year and period 1914–1916, 6.73 feet at 6.45 a. m. April 22 (discharge, 8,480 second-feet); minimum discharge, 720 second-feet, January 19–22, 1916.

ACCURACY.—Stage-discharge relation practically permanent except as affected by aquatic grass and ice. Two rating curves used during the year as follows: October 1 to April 8, well defined between 950 and 3,970 second-feet; April 9 to September 30, fairly well defined between 1,000 and 7,500 second-feet. Gage read twice daily, to quarter tenths. Daily discharge, except as noted below, ascertained by applying mean daily gage heights to rating curve. Stage-discharge relation affected by grass about October 1–15, and August 1 to September 30. Corrections made to gage heights before rating table was entered. Stage-discharge relation affected by ice December 11 to April 8; discharge obtained by applying to rating table mean daily gage heights corrected for ice effect by means of discharge measurements, observer's notes, and weather records. Open-water records good except for periods when grass was in channel, for which they are fair. Records for winter fair.

Discharge measurements of St. Croix River at Swiss, Wis., 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*
Dec. 31[a]	E. L. Williams	2.40	955	Apr. 23	S. B. Soulé	6.16	7,380
Feb. 1[a]	do	2.64	887	June 15	E. L. Williams	2.33	2,210
Mar. 6[a]	do	2.64	836	Aug. 28[b]	do	1.35	1,120

[a] Complete ice cover at measuring and control sections.
[b] Control obstructed by growth of aquatic plants.

Daily discharge, in second-feet, of St. Croix River at Swiss, Wis., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	1,160	1,200	1,300	930	920	850	1,920	3,570	2,770	3,450	1,200	1,100
2	1,160	1,160	1,270	890	920	850	2,020	3,330	2,550	3,330	1,160	1,100
3	1,200	1,160	1,040	890	890	840	2,120	3,100	2,350	3,210	1,430	1,070
4	1,410	1,130	1,130	865	890	840	2,220	2,880	2,150	3,100	1,390	1,100
5	1,530	1,100	1,270	840	887	840	2,320	2,770	2,050	2,770	1,310	1,160
6	1,570	1,070	1,380	840	887	835	2,430	2,550	1,860	2,550	1,270	1,240
7	1,610	1,070	1,300	815	887	840	2,540	2,350	1,770	2,250	1,390	1,470
9	1,780	1,340	1,380	790	887	865	2,590	2,350	1,770	1,950	1,390	1,510
9	1,870	1,730	1,380	790	865	890	2,660	2,150	1,950	1,680	1,350	1,510
10	1,780	2,120	1,300	790	865	950	2,880	2,150	1,860	1,590	1,390	1,510
11	1,690	2,650	1,160	790	865	980	3,330	2,050	1,860	1,550	1,470	1,510
12	1,650	3,840	1,130	790	865	1,010	4,230	1,950	1,860	1,470	1,470	1,510
13	1,610	3,230	1,100	790	890	1,040	4,800	1,860	1,860	1,430	1,390	1,550
14	1,530	2,760	1,100	765	890	1,070	4,950	1,950	2,050	1,680	1,350	1,510
15	1,490	2,540	1,070	765	890	1,100	5,100	2,250	2,150	1,950	1,270	1,470
16	1,450	2,320	1,070	765	920	1,130	5,720	2,660	2,050	1,680	1,240	1,510
17	1,410	2,120	1,070	740	950	1,130	6,050	2,550	2,050	1,590	1,200	1,470
18	1,450	1,920	1,070	740	950	1,160	6,050	2,450	1,950	1,510	1,240	1,430
19	1,490	1,820	1,040	720	980	1,200	5,560	2,350	1,950	1,430	1,240	1,350
20	1,530	1,730	1,040	720	1,010	1,200	6,910	2,250	1,860	1,350	1,270	1,350
21	1,490	1,690	1,040	720	1,010	1,240	8,220	2,150	1,640	1,310	1,310	1,350
22	1,410	1,530	1,040	720	980	1,270	8,220	2,350	1,590	1,270	1,350	1,350
23	1,380	1,570	1,040	740	980	1,270	7,450	2,660	1,770	1,240	1,350	1,350
24	1,410	1,610	1,040	740	950	1,300	7,090	2,660	1,770	1,200	1,310	1,350
25	1,340	1,530	1,010	765	920	1,340	6,730	2,550	1,680	1,200	1,240	1,350
26	1,340	1,490	1,010	765	890	1,410	6,220	2,660	1,950	1,430	1,200	1,350
27	1,270	1,450	1,010	790	890	1,490	5,400	2,770	1,950	1,470	1,160	1,310
28	1,240	1,450	980	790	865	1,610	4,650	2,770	1,860	1,510	1,130	1,350
29	1,200	1,450	980	840	855	1,690	4,230	2,770	2,990	1,430	1,100	1,390
30	1,200	1,380	955	890	.....	1,730	3,820	2,880	3,450	1,350	1,100	1,350
31	1,200	.....	955	920	.....	1,820	.....	2,880	.....	1,270	1,070	.....

NOTE.—Stage-discharge relation affected by grass Oct. 1–15, Aug. 1 to Sept. 30; by ice Dec. 1 to Apr. 8.

Monthly discharge of St. Croix River at Swiss, Wis., for the year ending Sept. 30, 1916.

[Drainage area, 1,550 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	1,870	1,160	1,450	0.935	1.08
November	3,840	1,070	1,770	1.14	1.27
December	1,380	955	1,120	.723	.83
January	920	720	797	.514	.59
February	1,010	855	912	.588	.63
March	1,820	835	1,150	.742	.86
April	8,220	1,920	4,610	2.97	3.31
May	3,570	1,860	2,540	1.64	1.89
June	3,450	1,590	2,050	1.32	1.47
July	3,450	1,200	1,810	1.17	1.35
August	1,470	1,070	1,280	.826	.95
September	1,550	1,070	1,360	.877	.98
The year	8,220	720	1,730	1.12	15.21

ST. CROIX RIVER NEAR ST. CROIX FALLS, WIS.

LOCATION.—In sec. 18, T. 34 N., R. 18 W., Polk County, at power plant of Minneapolis General Electric Co., on Wisconsin side of St. Croix River near St. Croix Falls, Wis., about 50 miles above the confluence of St. Croix and Mississippi rivers near Hastings, Minn. Apple River, draining an area wholly in Wisconsin, enters from the left about 20 miles below station; Snake River, draining an area in Minnesota, enters from the right, 35 miles above station.

DRAINAGE AREA.—5,930 square miles.

RECORDS AVAILABLE.—January 10, 1902, to June 30, 1905; January 1, 1910, to September 30, 1916. Data for 1903 published in Water-Supply Paper 98, pp. 176–177, under St. Croix River near Taylors Falls, Minn.

DISCHARGE.—Determination of discharge based on kiliwatt output of dynamo and exciters plus flow over dam and spillway, considered as a weir.

EXTREMES OF DISCHARGE.—Maximum mean daily discharge recorded during year, 35,100 second-feet, April 23; minimum mean daily discharge recorded, 740 second-feet, November 7.

1902–1905 and 1910–1916: Maximum mean daily discharge recorded, 35,100 second-feet, April 23, 1916; minimum mean daily discharge recorded, 75 second-feet, July 17, 1910; the minimum discharge is not natural but caused by regulation.

REGULATION.—Low-water flow controlled by operation of gates of power plant and by storage and release of water at Never's dam several miles upstream.

ACCURACY.—Records have not been checked, nor have discharge measurements been made by engineers of the United States Geological Survey; probably reliable.

COOPERATION.—Records furnished by the Minneapolis General Electric Co.

Daily discharge, in second-feet, of St. Croix River near St. Croix Falls, Wis., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	2,100	2,880	3,300	1,730	1,780	2,070	8,740	20,700	8,740	21,500	3,220	2,450
2	2,230	3,210	3,320	1,030	1,870	2,020	11,700	20,200	8,600	19,300	3,180	2,500
3	1,940	3,350	3,060	2,380	2,210	2,040	14,800	20,000	8,100	19,700	3,170	2,340
4	2,380	3,160	3,030	2,300	1,860	3,080	16,400	19,500	6,180	16,800	2,550	2,330
5	2,280	3,200	1,060	1,780	2,340	1,410	19,000	18,500	5,630	15,700	2,200	2,380
6	2,560	2,910	2,960	2,090	1,610	1,330	17,900	17,500	4,100	12,700	2,290	2,500
7	2,620	740	3,100	2,000	1,740	1,790	18,400	17,100	7,420	8,980	2,670	3,300
8	2,880	2,090	3,110	2,450	1,910	1,820	17,600	17,000	5,340	6,450	3,320	2,950
9	3,180	3,090	4,230	1,490	1,910	1,840	16,300	12,400	6,230	8,940	3,550	3,090
10	4,100	4,290	4,490	1,120	2,000	1,840	15,800	12,400	6,400	7,810	3,350	2,590
11	4,160	10,300	3,120	2,010	1,940	2,770	14,000	9,660	3,820	6,080	3,220	3,050
12	4,010	9,630	1,210	1,780	2,510	1,190	12,700	6,100	5,710	4,680	2,970	3,740
13	4,180	10,900	2,940	1,810	1,330	1,560	13,700	5,090	5,600	4,110	2,260	3,220
14	3,990	11,200	3,710	1,860	1,610	1,820	15,300	3,300	6,330	3,880	2,900	3,820
15	3,390	9,890	2,070	2,090	1,940	1,920	18,200	4,920	6,510	4,070	2,980	3,230
16	3,110	9,180	2,140	1,410	2,100	1,940	20,100	8,460	6,550	5,350	2,980	3,630
17	2,730	8,350	2,180	1,720	1,890	1,920	25,100	9,930	7,500	4,190	2,240	2,630
18	3,550	7,970	2,490	1,640	1,980	2,320	29,600	9,650	6,370	3,970	2,860	3,530
19	3,380	7,540	1,180	1,850	2,550	1,150	29,500	9,990	6,190	4,020	2,570	3,730
20	3,430	5,150	2,280	1,700	1,520	1,650	30,000	14,100	6,430	4,010	2,300	3,640
21	3,980	5,740	1,880	1,680	2,010	1,960	31,600	12,300	5,080	3,940	2,910	3,300
22	3,980	5,230	1,950	2,500	2,020	2,070	35,000	12,600	5,200	3,840	2,950	3,180
23	3,160	3,680	2,520	1,290	2,210	2,140	35,100	15,800	5,570	1,740	2,570	3,340
24	2,070	3,540	2,720	1,620	2,140	2,300	34,500	17,800	5,650	3,400	2,890	2,500
25	2,940	4,650	1,480	1,790	2,120	3,090	31,500	18,300	7,630	3,050	3,200	3,300
26	2,600	5,060	921	1,850	2,550	763	30,400	20,000	6,430	2,900	3,030	3,060
27	3,240	6,380	2,540	1,860	1,420	2,240	27,800	17,700	6,220	3,210	2,630	3,060
28	3,310	3,640	3,050	1,770	2,330	2,590	26,500	16,500	6,260	3,210	2,980	3,100
29	3,370	3,900	2,150	2,180	2,000	3,040	25,100	15,200	10,200	3,060	2,800	3,010
30	3,080	3,630	2,150	1,520	.....	4,290	23,200	12,700	17,200	2,340	2,450	2,590
31	1,450	.....	2,900	1,510	.....	5,030	.....	12,700	.....	3,110	2,460	.....

NOTE.—Discharge computed by the Minneapolis General Electric Co. See "Discharge" in station description.

Monthly discharge of St. Croix River near St. Croix Falls, Wis., for the year ending Sept. 30, 1916.

[Drainage area, 5,930 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	4,180	1,450	3,080	0.519	0.60
November	11,200	740	5,480	.924	1.03
December	4,490	921	2,560	.432	.50
January	2,500	1,030	1,800	.304	.35
February	2,550	1,330	1,980	.334	.36
March	5,030	763	2,160	.364	.42
April	35,100	8,740	22,200	3.74	4.17
May	20,700	3,300	13,800	2.33	2.69
June	17,200	3,820	6,770	1.14	1.27
July	21,500	1,740	6,970	1.18	1.36
August	3,550	2,200	2,830	.477	.55
September	3,820	2,330	3,040	.513	.57
The year	35,100	740	6,040	1.02	13.87

NOTE.—Monthly and yearly discharge computed by engineers of the U. S. Geol. Survey from records of daily discharge furnished by the Minneapolis General Electric Co.

NAMAKAGON RIVER AT TREGO, WIS.

LOCATION.—In sec. 35, T. 40 N., R. 12 W., Washburn County, at Chicago & Northwestern Railway bridge at Trego, about 20 miles above confluence of Namakagon and Totogatic rivers.

DRAINAGE AREA.—420 square miles (measured on map issued by Wisconsin Geological and Natural History Survey, edition of 1911; scale, 1 inch=6 miles).

RECORDS AVAILABLE.—March 11, 1914, to September 30, 1916.

GAGE.—Enameled staff fastened to retaining wall, left bank of river, just above railroad bridge; read by G. E. Krenz.

DISCHARGE MEASUREMENTS.—Made from lower chords of railroad bridge.

CHANNEL AND CONTROL.—Coarse gravel; free from vegetation; banks medium high and not subject to overflow. Small island downstream with rapids on either side forms the control; channel fairly permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.0 feet April 23 (discharge 1,330 second-feet); estimated minimum discharge, 308 second-feet during February and March.

1914–1916: Maximum stage recorded, 3.0 feet April 23, 1916 (discharge, 1,330 second-feet); minimum discharge, 264 second-feet, recorded by current-meter measurement made March 11, 1915.

ACCURACY.—Stage-discharge relation permanent, except for ice. Rating curve well defined between 330 and 1,330 second-feet. Gage read once daily to half tenths. Daily discharge ascertained by applying daily gage heights to rating table, except for period in which stage-discharge relation was affected by ice, for which it was obtained by applying to rating table daily gage heights corrected for ice effect by means of discharge measurements, observer's notes, and weather records. Records good for open-water periods; for winter periods fair.

Discharge measurements of Namakagon River at Trego, Wis., during the year ending Sept. 30, 1916.

[Made by E. L. Williams.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Dec. 30[a]	2.60	350	Apr. 13	2.82	1,180
Jan 25[a]	2.64	369	June 16	2.09	668
Mar. 4[a]	2.35	310			

[a] Complete ice cover at measuring and control section.

Daily discharge, in second-feet. of Namakagon River at Trego, Wis., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	417	564	472	340	417	369	532	1,020	698	1,020	417	417
2	444	444	472	335	393	369	597	1,020	664	873	417	417
3	472	417	532	332	369	338	873	944	664	908	444	417
4	564	417	532	331	381	308	838	944	597	873	417	369
5	532	393	502	329	393	308	944	873	597	733	444	472
6	564	417	502	328	372	308	803	873	698	597	444	502
7	597	417	502	326	350	308	803	838	564	597	417	532
8	597	564	472	325	350	308	768	838	664	597	444	597
9	532	597	472	323	350	308	838	803	664	532	417	597
10	502	664	532	322	350	308	803	768	698	532	472	502
11	502	733	472	323	350	308	873	733	597	532	472	532
12	472	768	532	324	350	308	1,020	733	597	532	502	532
13	472	733	502	326	350	320	1,170	664	664	472	444	564
14	532	733	502	328	384	320	1,170	664	597	472	444	564
15	472	698	417	330	417	332	1,250	698	664	532	417	532
16	444	664	417	332	417	332	1,170	803	664	532	444	502
17	444	597	412	334	417	332	1,170	733	597	502	417	502
18	472	597	408	336	428	350	1,170	768	597	472	417	472
19	472	444	403	338	440	369	1,170	733	597	472	444	472
20	532	472	398	343	416	369	1,170	664	532	472	472	472
21	417	444	393	347	393	369	1,170	698	502	417	472	502
22	472	444	387	352	380	417	1,330	698	472	417	472	532
23	472	564	381	356	369	472	1,330	733	597	417	472	532
24	444	532	375	362	369	532	1,330	664	664	369	472	502
25	502	472	369	369	369	502	1,330	698	597	369	444	472
26	444	564	367	373	338	472	1,170	698	597	597	417	502
27	444	532	364	377	308	534	1,090	733	664	597	417	472
28	444	532	359	381	338	597	1,020	698	664	532	417	597
29	444	502	354	385	369	534	1,020	733	768	502	417	597
30	417	444	350	389	.....	472	1,020	768	768	472	417	597
31	417	.....	345	393	.....	502	.....	733	.....	369	417	.....

NOTE.—Stage-discharge relation affected by ice Dec. 16 to Mar. 24. Discharge, Mar. 25, 27, 29, and 31, interpolated.

Monthly discharge of Namakagon River at Trego, Wis., for the year ending Sept. 30, 1916.

[Drainage area, 420 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	597	417	482	1.15	1.33
November	768	393	545	1.30	1.45
December	532	345	435	1.04	1.20
January	393	322	345	.821	.95
February	440	308	377	.898	.97
March	597	308	386	.920	1.06
April	1,330	532	1,030	2.45	2.73
May	1,020	664	773	1.84	2.12
June	768	472	630	1.50	1.67
July	1,020	369	558	1.33	1.53
August	502	417	440	1.05	1.21
September	597	369	509	1.21	1.35
The year	1,330	308	542	1.29	17.56

KETTLE RIVER NEAR SANDSTONE, MINN.

LOCATION.—Near south line of sec. 34, T. 43 N., R. 20 W., at quarries of Barber Asphalt Co. at Banning, 3 miles above Sandstone, Pine County.

DRAINAGE AREA.—825 square miles.

RECORDS AVAILABLE.—October 18, 1908, to September 30, 1916.

GAGE.—Vertical staff, in two sections, bolted to rock wall on right bank of river, about 300 feet above the steam power house of the Barber Asphalt Co.; read by F. L. Betts.

DISCHARGE MEASUREMENTS.—Made from highway bridge, about a mile above gage.

CHANNEL AND CONTROL.—Solid rock; a decided rapids 50 feet downstream from gage form a permanent control.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 7.7 feet April 24 (discharge, 10,600 second-feet); minimum open-water stage recorded, 1.3 feet, October 1–4, 1915 (discharge, 112 second-feet).

1908–1916: Maximum stage recorded, 7.7 feet, April 24, 1916 (discharge, 10,600 second-feet); minimum stage recorded, 0.7 foot, November 30, 1912 (discharge, about 12 second-feet).

ICE.—Stage-discharge relation seriously affected by ice; not, however, for so long a period as at most gaging stations in the same latitude, owing to the fact that a decided rapids about 50 feet below the gage constitutes the control. The published discharge for winter periods in which the open-channel rating curve is not applicable has been based on gage readings and a comparison of the records with those for Snake River.

ACCURACY.—Stage-discharge relation permanent except as affected by ice. Rating curve well defined from 52 to 5,940 second-feet, above 5,940 second-feet it is an extension. Gage read daily to quarter tenths. Daily discharge ascertained by applying daily gage heights to rating table except for period during which stage-discharge relation was affected by ice. Records obtained by use of rating table good; other records fair.

The following discharge measurement was made by S. B. Soule:

April 26, 1916: Gage height, 6.55 feet; discharge, 5,960 second-feet.

Daily discharge, in second-feet, of Kettle River near Sandstone, Minn., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	112	233	1,300				330	2,200	1,700	4,370	136	160
2	112	216	1,260				442	2,090	1,610	3,870	124	148
3	112	186	1,170				515	1,990	1,520	3,380	112	136
4	117	160	1,130				592	1,890	1,430	2,880	112	136
5		160	1,040				675	1,800	1,340	2,390	124	148
6		136	953				800	1,700	1,170	1,890	136	148
7		136	865				1,010	1,610	1,050	1,430	136	160
8		160	800				1,260	1,520	935	1,090	160	160
9		330	724				1,520	1,520	865	865	148	148
10	330	954	648				1,700	1,520	768	800	136	186
11		1,580	565				2,200	1,610	705	735	124	288
12		2,200	515				3,670	1,610	675	705	112	288
13		2,090	465				4,000	1,520	735	648	101	330
14		2,090	442				4,370	1,610	1,340	565	90	375
15		1,990	420				4,570	1,700	1,610	540	90	375
16	375	1,990	390	80	85	110	4,570	2,200	1,520	515	90	420
17	375	1,890	360				4,570	3,230	1,210	465	90	398
18	375	1,890	330				4,570	3,230	1,170	442	136	375
19	375	1,890	316				4,570	2,690	1,130	420	124	375
20	375	1,890	302				5,040	2,560	1,090	375	112	330
21	375	1,890	288				9,250	2,820	1,050	352	112	288
22	375	1,800	250				9,700	3,090	1,010	330	288	269
23	375	1,700	250				10,200	5,040	935	288	288	250
24	375	1,700	242				10,600	4,370	865	269	269	250
25	330	1,700	233				8,800	4,000	865	250	250	250
26	330	1,610	216				5,610	3,600	1,010	216	233	233
27	288	1,520	216				4,370	3,090	1,340	216	216	216
28	288	1,430	216				3,370	2,690	1,520	201	186	201
29	288	1,390	201				2,440	2,320	2,090	186	160	216
30	269	1,340	186				2,200	2,090	3,520	173	160	216
31	250	.....	173				.....	1,890	.....	160	160	.....

NOTE.—Discharge Jan. 1 to Mar. 31, estimated because of ice, from gage heights, observer's notes, weather records, and comparison with records of Snake River near Pine City. No gage-height records available Oct. 5–15, Nov. 10, 11, 29, 30, Dec. 1, 5, 6, 9, 16, 17, 19, 20, 24, May 21, 26, July 2–5 and 21; discharge interpolated for these dates except Oct. 5–15, for which discharge was determined from a study of precipitation records. Braced figures show mean discharge for periods indicated.

Monthly discharge of Kettle River near Sandstone, Minn., for the year ending Sept. 30, 1916.

[Drainage area, 825 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	375	112	306	0.371	0.43
November	2,200	136	1,280	1.55	1.73
December	1,300	173	531	.644	.74
January	.....	.....	80	.097	.11
February	.....	.....	85	.103	.11
March	.....	.....	110	.133	.15
April	10,600	330	3,920	4.75	5.30
May	5,040	1,520	2,410	2.92	3.37
June	3,520	675	1,260	1.53	1.71
July	4,370	160	1,000	1.21	1.40
August	288	90	152	.184	.21
September	420	136	249	.302	.34
The year	10,600	80	945	1.15	15.60

SNAKE RIVER NEAR PINE CITY, MINN.

LOCATION.—In sec. 26, T. 39 N., R. 21 W., at Changwatana power station of Eastern Minnesota Power Co., 600 feet below dam belonging to that company, 3,500 feet below Cross Lake, 2 miles below Pine City, Pine County, and about 11 miles above the mouth.

DRAINAGE AREA.—915 square miles.

RECORDS AVAILABLE.—June 26, 1913, to September 30, 1916.

GAGE.—Staff gage attached to stone retaining wall in front of the power plant on the left bank of river; read by E. W. Barnum and other employees of the Eastern Minnesota Power Co. This gage is used for determining flow over dam during periods when all of the flow does not pass through the turbines.

DISCHARGE MEASUREMENTS.—At low and medium stages made by wading; at high stages from bridge about 1,800 feet above gage.

CHANNEL AND CONTROL.—Bed composed of rock and heavy gravel. Banks in the vicinity of the gage high; not subject to overflow. Zero flow at stage of 0.2 foot.

DETERMINATION OF FLOW.—Flow determined by adding to the flow through the turbines the flow over the crest to the dam as obtained from readings of the staff gage in the river below the dam. The flow through the turbines is computed from hourly records of the gate openings and head.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 5.40 feet at 8 a. m. April 25 (discharge, 7,070 second-feet); at the same time 245 second-feet passed through the power plant, making the total discharge of the river 7,315 second-feet; minimum mean daily discharge recorded, 55 second-feet January 23.

1913–1916: Maximum stage recorded, 5.40 feet at 8 a. m. April 25, 1916 (discharge, 7,070 second-feet); at the same time 242 second-feet passed through the power plant, making the total discharge of the river 7,315 second-feet; minimum mean daily discharge, 33 second-feet February 11, 1914.

ICE.—All the water goes through the wheels in winter; flow estimated from gate openings and head.

REGULATION.—Power plant at station is operated with a varying load for light and power, causing daily and weekly fluctuations in discharge at low stages. No appreciable regulation above plant.

ACCURACY.—When the flow is less than 200 second-feet, the greater part passes through the power plant and is estimated from turbine gate openings and head on the wheels, an hourly record of which is kept at the plant; records only fair. As the volume of flow increases a large portion passes by the plant as waste; this portion is determined from gage heights read from a gage in the river opposite the power plant. Stage-discharge relation for river gage permanent. Rating curve well defined throughout. Gage read every four hours to hundredths. Daily discharge not passing through power house ascertained by taking the mean of the results obtained by applying each of the 6 daily gage heights to the rating table. Records for this portion of the discharge excellent. Records of total flow at station range from fair for low stages to excellent for high stages.

COOPERATION.—Hourly records of gate openings of turbines and head and readings of river gage are furnished by the Eastern Minnesota Power Co. Results for last part of current year computed by employees of the company by means of the rating curves prepared by the United States Geological Survey. Computations have been checked by the Survey.

Discharge measurements of Snake River near Pine City, Minn., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Apr. 4	O. Christianson	3.86	3,410
25	S. B. Soulé	5.37	6,990

NOTE.—Discharge shows the flow past the river gage; flow through power plant not included.

Daily discharge, in second-feet, of Snake River near Pine City, Minn., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	107	276	442	106	79	102	751	3,240	2,810	2,560	281	322
2	105	260	413	95	89	102	1,530	2,740	2,300	3,200	253	283
3	63	255	390	115	89	94	2,690	2,380	1,920	3,720	229	186
4	131	247	359	115	90	98	3,670	2,060	1,620	3,810	211	268
5	148	241	323	113	96	65	4,990	1,810	1,390	3,730	198	248
6	143	248	322	113	69	100	5,690	1,560	1,190	3,200	140	253
7	211	125	314	111	100	106	5,750	1,370	1,060	2,710	202	243
8	238	278	249	110	96	100	5,280	1,340	931	2,230	196	244
9	272	243	264	78	91	94	4,620	1,120	839	1,830	186	239
10	268	278	270	110	94	86	4,080	1,100	784	1,490	226	137
11	429	564	256	104	96	80	3,560	1,020	677	1,320	211	232
12	464	773	142	101	92	61	3,180	919	649	1,080	205	261
13	475	992	232	99	87	93	3,160	868	634	906	115	277
14	412	1,150	240	96	84	94	3,130	759	610	773	164	320
15	435	1,130	239	96	93	95	3,190	962	615	660	161	342
16	417	1,190	228	96	89	94	3,430	1,200	642	514	176	339
17	380	1,020	159	109	98	94	3,720	1,530	646	508	204	340
18	421	980	135	79	100	99	3,960	1,910	583	433	212	419
19	429	971	93	73	97	69	4,040	2,170	668	418	207	440
20	441	959	116	78	72	99	4,520	2,140	659	378	151	448
21	423	759	124	73	100	112	5,220	2,250	627	292	252	454
22	417	787	113	75	110	111	6,010	2,910	595	232	276	404
23	370	719	127	55	110	111	6,640	3,940	624	166	290	382
24	356	648	120	84	110	115	7,150	4,700	593	210	349	295
25	418	602	91	80	110	122	7,240	5,590	542	228	369	349
26	377	676	72	88	110	72	6,870	6,410	610	266	403	348
27	309	662	119	89	95	115	6,130	6,440	633	309	347	327
28	306	621	124	86	100	137	5,310	5,800	780	346	438	332
29	292	576	126	92	108	141	4,570	5,030	1,220	369	407	303
30	277	468	127	63	.....	272	3,770	4,130	1,740	300	385	281
31	257	.....	126	76	.....	479	.....	3,340	.....	323	357	.....

Monthly discharge of Snake River near Pine City, Minn., for the year ending Sept. 30, 1916.

[Drainage area, 915 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	475	63	316	0.345	0.40
November	1,190	125	623	.681	.76
December	442	72	208	.227	.26
January	115	55	92	.101	.12
February	110	69	95	.104	.11
March	479	61	117	.128	.15
April	7,240	751	4,460	4.87	5.43
May	6,440	759	2,670	2.92	3.37
June	2,810	542	973	1.06	1.18
July	3,810	166	1,240	1.36	1.57
August	438	115	252	.275	.32
September	454	137	311	.340	.38
The year	7,240	61	944	1.03	14.05

APPLE RIVER NEAR SOMERSET, WIS.

LOCATION.—In sec. 21, T. 31 N., R. 19 W., St. Croix County at power plant of St. Croix Power Co., 3½ miles below Somerset, and 2 miles above mouth of river.

DRAINAGE AREA.—550 square miles. (Measured on map issued by Wisconsin Geological and Natural History Survey, edition of 1911; scale, 1 inch=6 miles.)

RECORDS AVAILABLE.—January 1901, to September 30, 1916.

GAGE.—Vertical staff gage; not used in determination of flow.

DISCHARGE.—Discharge of the turbines in second-feet corresponding to the number of kilowatts is determined for each hour during the day from a record of the number of wheels in operation and the load; the sum of the discharge divided by 24 gives the average discharge through the turbines. To this quantity is added the leakage through the average number of wheels idle each day, the sum giving the daily flow through the power house. Water is seldom wasted over the spillway of the dam, but when it is so wasted the quantity is computed from weir formulas and added to the flow through the plant. There is a constant leakage through the gate and flashboards amounting to 3 second-feet. This quantity has not been taken into consideration in determining the published records.

EXTREMES OF DISCHARGE.—Maximum mean daily discharge recorded during year, 1,800 second-feet, April 23; minimum mean daily discharge, 58 second-feet, July 30.

1904–1916: Maximum mean daily discharge, 2,280 second-feet, in June 1905; minimum mean daily discharge, 38 second-feet, May 10, 1910. Due to regulation the minimum discharge has no bearing on the natural minimum flow. No max. imum and minimum records are available for 1901 to 1903.

REGULATION.—There are a number of power plants on Apple River above station The pondage of these plants is small, and though the daily flow may be controlled to some extent the mean monthly flow probably corresponds closely to the natural flow.

ACCURACY. From 1901 to 1909 the discharge through the plant was determined from tables computed from data collected as tests on one of the turbines made at the flume of the Holyoke Water Power Co., Holyoke, Mass. During the summer of 1909 engineers of the St. Croix Power Co. made tests on the water flowing through all the wheels as actually installed by means of a sharp-crested weir 710 inches long about 60 feet below the power house. These tests gave results about 3 per cent larger than the Holyoke tests, and tables based on them have been used in determining the discharge through the plant from 1909 to 1916. During June 1914 a series of current-meter measurements were made by the Wisconsin Railroad Commission and United States Geological Survey, and a rating curve for the tailrace was developed. Twelve tests were then run with different wheels and loads. It was found that the discharge as determined by the current meter and the discharge as ascertained by the company agreed very closely, the percentage difference for the twelve tests ranging from −6.4 to +1.8 per cent, with an average of −2.0 per cent; the discharge as determined by the company being 2 per cent less than that determined by the current meter.

COOPERATION.—Records furnished by the St. Paul Gas Light Co. of St. Paul, Minn., Mr. Fred A. Otto, superintendent.

Daily discharge, in second-feet, of Apple River near Somerset, Wis., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	251	283	297	231	206	253	1,110	1,010	644	525	193	200
2	255	264	289	154	215	219	1,520	941	601	569	175	257
3	212	278	279	247	208	242	1,590	826	610	583	172	194
4	305	287	317	257	209	231	1,700	799	610	596	209	193
5	239	291	239	213	236	207	1,740	738	547	713	314	207
6	257	251	318	207	187	276	1,559	767	551	677	239	230
7	307	141	270	229	200	244	1,320	644	570	645	294	195
8	281	270	304	223	236	242	1,240	639	552	673	285	267
9	330	257	273	165	221	236	1,220	660	533	544	198	315
10	268	271	314	205	248	254	825	674	523	507	250	217
11	341	301	249	203	251	242	775	655	480	484	266	255
12	289	387	238	187	204	211	733	601	499	472	345	178
13	352	366	271	215	219	302	777	496	488	404	116	244
14	290	411	240	186	241	275	762	465	467	474	264	218
15	342	379	233	263	219	280	772	587	507	432	272	250
16	254	380	236	155	280	280	816	628	475	414	260	309
17	390	363	252	228	253	278	803	640	486	457	249	100
18	294	362	273	169	243	291	815	626	436	395	325	293
19	375	345	106	230	246	267	932	639	443	418	309	219
20	372	332	265	218	188	291	996	669	457	358	171	297
21	338	314	231	269	262	313	1,320	642	445	319	204	266
22	281	305	262	202	230	322	1,670	570	461	394	293	287
23	368	319	246	215	247	288	1,800	670	456	339	271	255
24	228	331	288	247	288	324	1,680	660	421	336	297	182
25	327	306	143	236	221	382	1,610	845	433	322	182	301
26	286	343	232	215	277	413	1,570	712	415	329	318	298
27	308	299	208	245	210	496	1,260	764	420	334	121	278
28	250	292	233	185	271	614	1,120	700	457	331	312	288
29	322	274	230	286	212	848	1,130	645	485	395	225	283
30	247	291	222	154	.....	953	1,110	610	466	58	141	344
31	347	.....	256	230	.....	1,060	.....	659	.....	271	201	.....

NOTE.—See note under "Discharge" in station description for account of method by which records are obtained.

Monthly discharge of Apple River near Somerset, Wis., for the year ending Sept. 30, 1916.

[Drainage area, 550 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	390	212	300	0.545	0.63
November	411	141	310	.564	.63
December	318	106	252	.458	.53
January	286	154	215	.391	.45
February	288	187	232	.422	.46
March	1,060	207	359	.653	.75
April	1,800	733	1,210	2.20	2.46
May	1,010	465	683	1.24	1.43
June	644	415	498	.905	1.01
July	713	58	444	.807	.93
August	345	116	241	.438	.50
September	344	100	247	.449	.50
The year	1,800	58	415	.754	10.28

NOTE.—Monthly and yearly discharge determined by engineers of the U. S. Geol. Survey from records of daily discharge furnished by the St. Paul Gas Light Co.

CHIPPEWA RIVER AT BISHOP'S BRIDGE, NEAR WINTER, WIS.

LOCATION.—In sec. 23, T. 39 N., R. 6 W., at highway bridge about 3 miles down stream from the East Fork of Chippewa River (coming in from the left) and 4 miles by road northwest of Winter, Sawyer County.

DRAINAGE AREA.—775 square miles (measured on map issued by Wisconsin Geol. and Nat. Hist. Survey, edition of 1911; scale, 1 inch = 6 miles).

RECORDS AVAILABLE.—February 23, 1912, to September 30, 1916.

GAGE.—From February 23, 1912, to January 27, 1914, a wooden staff gage fastened to a wooden pier on the right bank immediately above bridge. January 27, 1914, to May 28, 1916, a vertical cast-iron staff gage fastened to the same pier with the zero 3.44 feet below the zero of the wooden gage. Since May 28, 1916, chain gage fastened to highway bridge 60 feet below the cast-iron staff gage, and at the same datum; read by John Edberg.

DISCHARGE MEASUREMENTS.—Made from downstream side of highway bridge.

CHANNEL AND CONTROL.—Bed composed of gravel, free from vegetation, and not subject to shift. Control, head of rapids about 1,000 feet below gage; practically permanent. One channel at all stages; banks not subject to overflow.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 9.56 feet at 8 a. m. April 22 (discharge, 6,940 second-feet); estimated minimum discharge, 238 second-feet, January 18.

1913–1916: Maximum stage recorded, 9.56 feet, April 22, 1916, (discharge, 6,940 second-feet); minimum discharge, 200 second-feet, recorded by discharge measurement February 23, 1912.

REGULATION.—Flow modified to some extent by operation of storage reservoir, in sec. 14, T. 41 N., R. 6 W., about 16 miles above station. This reservoir has a capacity of 550,000,000 cubic-feet and is used in connection with reservoirs on the Upper Flambeau River, for the purpose of regulating the flow of the Chippewa River.

ACCURACY.—Stage-discharge relation permanent except as affected by ice during winter. Rating curve well defined between 270 and 6,820 second-feet. Gage read to hundredths twice a day. Discharge ascertained by applying mean daily gage heights to rating table, except for period in which stage-discharge relation was affected by ice, for which it was obtained by applying to rating table mean daily gage heights corrected for ice effect by means of discharge measurements observer's notes, and weather records. Record good for open-water periods; for winter period fair.

Discharge measurements of Chippewa River at Bishop's bridge, near Winter, Wis., during the year ending Sept. 30, 1916.

[Made by E. L. Williams.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Jan. 27 [a]	5.62	304	Apr. 21	9.27	6,370	Aug. 22	4.94	571
Mar. 2 [a]	6.01	304	May 28	5.80	1,260	23	5.08	632

[a] Made through complete ice cover.

Daily discharge, in second-feet, of Chippewa River at Bishop's bridge, near Winter, Wis., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	660	575	575	304	389	305	840	3,400	1,050	1,980	380	380
2	660	575	690	311	364	305	885	3,260	1,050	1,680	360	360
3	660	550	760	304	352	305	930	3,120	1,000	1,520	340	360
4	660	525	602	297	333	305	1,020	2,840	1,200	1,520	340	360
5	1,220	475	500	290	318	305	1,120	2,700	1,250	1,460	322	380
6	1,330	475	500	277	318	310	1,220	2,570	1,100	1,150	322	455
7	1,380	475	500	273	340	320	1,330	2,310	960	1,000	322	675
8	1,560	525	500	257	352	330	1,440	1,860	1,000	790	322	960
9	1,500	602	525	257	372	340	1,680	1,620	1,150	675	340	1,150
10	1,440	630	550	257	368	340	1,740	1,740	1,150	610	340	1,250
11	1,380	840	475	257	356	345	1,860	1,800	1 050	555	340	1,300
12	1,330	975	525	270	368	350	2,050	1,570	1,000	530	340	1,250
13	1,330	975	500	257	360	360	2,570	1,350	960	480	340	1,300
14	1,280	1,020	500	260	356	370	3,120	1,300	1,150	455	340	1,250
15	1,220	1,020	495	257	336	380	3,540	1,400	1,300	455	322	1,200
16	1,170	975	490	251	340	385	3,820	1,570	1,200	455	322	1,100
17	1,170	930	485	244	352	390	4,100	1,570	1,150	430	322	1,000
18	1,220	840	480	238	475	400	4,100	1,570	1,150	430	340	915
19	1,280	800	478	256	470	410	4,100	1,620	1,100	405	340	790
20	1,280	760	475	256	465	425	4,410	1,620	1,050	430	380	750
21	1,220	725	462	264	398	450	5,660	1,570	1,000	380	430	710
22	1,120	760	450	270	425	475	6,820	1,680	960	340	505	675
23	1,020	690	432	270	402	500	6,620	1,740	960	322	640	675
24	930	660	425	284	405	550	6,620	1,520	960	322	675	640
25	840	660	415	287	405	575	6,620	1,300	915	340	640	640
26	760	602	395	301	402	600	6,040	1,300	1,050	530	610	640
27	690	575	380	304	380	630	5,280	1,300	1,250	555	555	675
28	690	575	365	344	360	660	4,410	1,250	1,100	555	505	675
29	630	602	352	364	340	690	4,100	1,150	1,460	530	455	790
30	630	660	330	380	.....	725	3,680	1,150	1,860	455	430	830
31	602	.....	304	450	.....	760	.....	1,100	.....	405	405	.....

NOTE.—Stage-discharge relation affected by ice Dec. 13 to Apr. 8.

Monthly discharge of Chippewa River at Bishop's bridge, near Winter, Wis., for the year ending Sept. 30, 1916.

[Drainage area, 775 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	1,560	602	1,060	1.37	1.58
November	1,020	475	702	.906	1.01
December	760	304	481	.621	.72
January	450	238	287	.370	.43
February	475	318	376	.485	.52
March	760	305	450	.581	.67
April	6,820	810	3,390	4.37	4.88
May	3,400	1,100	1,800	2.32	2.68
June	1,860	915	1,120	1.45	1.62
July	1,980	322	701	.905	1.04
August	675	322	407	.525	.61
September	1,300	360	804	1.04	1.16
The year	6,820	238	961	1.24	16.92

CHIPPEWA RIVER NEAR BRUCE, WIS.

LOCATION.—In sec. 4, T. 35 N., R. 7 W., Rusk County, at the Minneapolis, St. Paul & Sault Ste. Marie Railway bridge 1 mile east of Bruce. Thornapple River enters from the right immediately above station and Flambeau River from the right about 21 miles below.

DRAINAGE AREA.—1,600 [1] square miles (measured on map issued by Wisconsin Geological and Natural History Survey, edition of 1911; scale 1 inch=6 miles.)

RECORDS AVAILABLE.—December 31, 1913, to September 30, 1916.

GAGE.—Chain gage, attached to downstream side of Minneapolis, St. Paul & Sault Ste. Marie Railway bridge; read by H. C. Gardner.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge to which gage is attached.

CHANNEL AND CONTROL.—Bed composed of sand and small gravel; free from vegetation; first and second channels from the west fairly permanent; third channel, nearest east bank, has a tendency to fill during low stages with sand worked in by Thornapple River. Flow, except during extremely high stages is confined within the banks.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 12.3 feet at 5.45 p. m., April 22 (discharge, 13,400 second-feet); minimum discharge estimated at 518 second-feet, February 28.

1910–1916: Maximum stage recorded, 12.3 feet at 5.45 p. m., April 22, 1916 (discharge, 13,400 second-feet); minimum discharge recorded by measurement made March 5, 1914 (discharge, 405 second-feet). It is likely that a minimum of approximately 350 second-feet occurred during the last part of February, 1914.

REGULATION.—Flow modified to some extent by reservoir on the West Fork of Chippewa River, in sec. 14, T. 41 N., R. 6 W. This reservoir has a capacity of 550,000,000 cubic feet and is used in connection with reservoirs on Upper Flambeau River to regulate flow of Chippewa River. No diurnal fluctuation is observed.

[1] Revised since Water-Supply Paper 405 was published.

ACCURACY.—Stage-discharge relation not permanent; affected by ice during winter periods and changes caused by shifting control during periods of low water. Rating curves applicable as follows: October 1 to December 9 poorly defined; April 12 to July 15 well defined from 1,740 to 13,400 second-feet; July 16–31 and August 1–20, poorly defined; August 21 to September 30, fairly well defined between 650 and 2,050 second-feet and poorly defined outside these limits. Gage read to quarter tenths twice daily. Daily discharge ascertained by applying mean daily gage heights to rating table, except for the period in which stage-discharge relation was affected by ice, for which it was obtained by applying to rating table mean daily gage heights corrected for ice effect by means of discharge measurements, observer's notes, and weather records. Records good for periods for which rating curves are well defined; fair for other periods; winter records poor.

Discharge measurements of Chippewa River near Bruce, Wis., during the year ending Sept. 30, 1916.

[Made by E. L. Williams.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Jan. 6[a]	3.08	629	Mar. 1[a]	3.50	549	June 17	4.08	2,760
Feb. 3[a]	3.28	569	Apr. 23	12.10	13,000	Aug. 29[b]	2.17	763

[a] Complete ice cover at measuring and control section.
[b] Made by wading 200 feet below gage.

Daily discharge, in second-feet, of Chippewa River near Bruce, Wis., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	1,080	1,040	1,000	574	570	548	5,880	6,240	2,120	7,230	845	690
2	1,170	1,000	1,000	609	568	560	8,120	5,650	2,590	5,650	808	650
3	1,350	965	925	644	569	567	8,240	5,190	3,360	4,090	845	650
4	1,740	925	1,000	640	550	574	8,240	4,970	3,060	4,200	885	615
5	2,740	885	1,000	636	540	581	8,480	4,530	2,880	2,780	845	615
6	2,640	845	925	629	535	595	7,040	4,200	2,500	2,400	845	730
7	2,740	845	965	630	530	602	5,880	3,870	2,210	2,020	845	1,140
8	2,940	925	925	630	530	609	5,300	3,560	2,500	1,840	845	1,420
9	2,940	1,040	925	626	530	616	5,300	3,060	3,060	1,560	808	1,940
10	2,840	1,170	965	624	530	630	5,080	2,780	2,880	1,480	845	1,940
11	2,640	2,440	957	620	530	644	5,880	2,680	2,400	1,380	885	1,720
12	2,640	4,530	949	616	535	658	6,720	2,500	2,210	1,210	885	1,830
13	2,640	3,980	941	610	540	672	7,620	2,400	2,020	1,170	885	1,940
14	2,640	3,240	925	605	545	786	7,620	2,680	2,120	1,040	845	1,830
15	2,640	2,540	906	595	552	700	7,620	3,360	2,590	1,040	808	1,830
16	2,640	2,240	893	590	560	735	7,880	3,870	2,680	1,020	808	1,720
17	2,440	1,940	877	580	560	770	8,540	3,870	2,680	977	808	1,520
18	2,640	1,840	861	570	570	808	8,960	3,460	2,500	977	808	1,520
19	2,940	1,640	830	560	580	845	8,680	3,260	2,300	938	845	1,420
20	2,840	1,740	822	570	600	925	8,400	3,060	2,020	899	845	1,230
21	2,640	1,640	815	580	770	1,000	9,800	2,970	1,920	825	770	1,140
22	2,340	1,440	802	590	750	1,080	12,700	3,060	1,740	899	810	1,140
23	2,040	1,350	877	600	700	1,260	13,100	4,750	1,740	825	890	1,140
24	1,840	1,440	941	609	650	1,440	11,600	4,310	1,740	790	1,010	1,140
25	1,540	1,440	957	580	560	1,540	10,200	3,560	1,740	790	1,050	1,140
26	1,440	1,440	770	560	540	1,740	9,240	3,260	2,120	1,020	1,010	1,140
27	1,440	1,350	742	545	530	1,940	8,270	3,260	2,680	1,320	1,010	1,140
28	1,260	1,260	728	530	518	2,210	7,100	2,880	2,500	1,320	890	1,140
29	1,260	1,130	686	540	530	2,500	6,360	2,680	3,560	1,230	810	1,140
30	1,080	1,000	630	550	.....	2,880	6,360	2,500	7,490	1,100	730	1,230
31	1,080	.....	574	560	.....	3,660	.....	2,300	.....	899	690	.....

NOTE.—Stage-discharge relation affected by ice Dec. 10 to Apr. 11.

Monthly discharge of Chippewa River near Bruce, Wis., for the years ending Sept, 30, 1914–1916.

[Drainage area, 1,600[a] square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
1914.					
January	.....	.....	574	0.359	0.41
February	.....	.....	397	.248	.26
March	.....	.....	574	.359	.41
April	8,600	1,080	2,710	1.69	1.89
May	8,000	1,640	3,330	2.08	2.40
June	8,000	1,040	2,900	1.81	2.02
July	4,530	1,490	2,210	1.38	1.59
August	2,500	848	1,300	.813	.94
September	3,870	1,460	2,360	1.48	1.65
1914–15.					
October	1,870	825	1,240	0.775	0.89
November	.....	.....	769	.481	.54
December	.....	.....	750	.469	.54
January	.....	.....	585	.366	.42
February	.....	.....	609	.381	.40
March	.....	.....	734	.459	.53
April	4,640	.....	2,940	1.84	2.05
May	5,880	2,460	3,760	2.35	2.71
June	4,970	1,500	3,330	2.08	2.32
July	3,260	985	1,510	.944	1.09
August	2,040	536	934	.584	.67
September	1,480	530	853	.533	.59
The year	5,880	.....	1,500	.938	12.75
1915–16.					
October	2,940	1,080	2,160	1.35	1.56
November	4,530	845	1,640	1.02	1.14
December	1,000	574	875	.547	.63
January	644	530	594	.371	.43
February	770	518	571	.357	.38
March	3,660	548	1,120	.700	.81
April	13,100	5,080	8,010	5.01	5.59
May	6,240	2,300	3,570	2.23	2.57
June	7,490	1,740	2,590	1.62	1.81
July	7,230	790	1,770	1.11	1.28
August	1,050	690	855	.534	.62
September	1,940	615	1,280	.800	.89
The year	13,100	518	2,080	1.30	17.71

[a] Revised since published in previous report.

CHIPPEWA RIVER AT CHIPPEWA FALLS, WIS.

LOCATION.—In the SE. ¼ sec. 6, T. 28 N., R. 8 W., at highway bridge at Chippewa Falls, Chippewa County, 2,500 feet below mouth of Duncan Creek, coming in from the right.

DRAINAGE AREA.—5,600 square miles.

RECORDS AVAILABLE.—June 22, 1888, to September 30, 1916. The gage was originally established by the Chippewa Lumber & Boom Co., which has kept a continuous record since 1889. Since 1904 the United States Weather Bureau has obtained gage readings during the flood season of each year. On June 1, 1906, the United States Geological Survey began making discharge measurements and maintaining gage readings.

GAGE.—On July 27, 1916, a Gurley graph water-stage recorder replaced Friez water-stage recorder which was installed January, 1914, on web between cushing piers supporting first right-hand span and about 10 feet upstream from gage formerly used by United States Weather Bureau; gage referred to original datum.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge.

CHANNEL AND CONTROL.—Heavy gravel; fairly permanent; banks are high and are rarely overflowed.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 13.45 feet at 7 a. m., April 23 (discharge 52,400 second-feet); estimated minimum daily discharge, 800 second-feet February 21 and March 6; absolute winter minimum probably somewhat lower, owing to regulation.

1888–1916: Maximum stage recorded, 26.03 feet December 6, 1896. September 10, 1884, a stage of 26.94 feet was reached; discharge not determined; minimum stage recorded, −0.8 foot July 24, 1910 (discharge, about 460 second-feet).

REGULATION.—Little fluctuation is caused by the operation of power plant about half a mile above gage. Considerable fluctuation is, however, caused by the operation of larger plants above, notably the plant of the Brunet Falls Manufacturing Co., at Cornell, Wis. As a result of storage in the headwaters of Chippewa and Flambeau rivers, the recorded monthly flow does not represent natural flow.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve well defined between 2,030 and 56,200 second-feet; below 2,030 second-feet poorly defined. Operation of water-stage recorder satisfactory throughout year except for short periods indicated by breaks in records, as shown in footnotes to daily-discharge table. Except for periods when stage-discharge relation was affected by ice, daily discharge ascertained by applying to the rating table the mean daily gage heights as obtained by planimeter from gage-height graph, or for days of considerable fluctuation by averaging the results obtained by applying gage height for two-hour intervals to rating table. Daily discharge for periods when stage-discharge relation was affected by ice ascertained by applying to rating table mean daily gage heights corrected for ice effect by means of discharge measurements, observer's notes, and weather records. Records good for open-water periods except extremely low water, for which they are fair; winter records poor.

Discharge measurements of Chippewa River at Chippewa Falls, Wis., 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. 10[a]	E. L. Williams	1.08	2,000	Apr. 23	W. G. Hoyt	13.44	52,500
Feb. 23[b]	do	2.09	2,270	July 24	H. C. Beckman	1.02	2,720
Mar. 17[b]	do	1.40	1,920	25	do	.93	2,450
Apr. 4	do	10.37	[c]34,100	Sept. 23	R. B. Kilgore	1.54	3,750

[a] Made through complete ice cover 3,000 feet below gage; complete ice cover at control.
[b] Made through complete ice cover 1 mile below gage; incomplete ice cover at control.
[c] 66 per cent of discharge was determined by observing the velocity of floating ice; velocity used in determining remainder of discharge was measured by current meter.

Daily discharge, in second-feet, of Chippewa River at Chippewa Falls, Wis., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	6,980	3,960	4,250	2,330	1,360	1,700	20,000	20,800	9,140	19,400	2,740	2,320
2	5,660	3,740	4,370	2,330	1,630	1,700	39,200	19,700	9,140	18,600	2,680	2,320
3	5,790	3,230	3,660	2,380	1,940	2,020	33,500	17,600	11,200	17,300	2,560	2,370
4	6,310	3,470	3,660	2,380	2,110	2,200	32,600	16,000	12,200	14,000	2,760	2,300
5	6,180	3,340	3,550	2,290	2,110	1,700	30,200	15,000	15,300	12,200	2,880	1,410
6	8,270	3,130	3,780	2,200	2,190	800	29,000	13,400	11,500	11,500	3,580	2,350
7	8,560	3,040	3,440	2,200	2,890	2,290	25,600	12,800	10,000	8,560	1,620	2,410
8	9,140	3,380	3,110	2,290	3,550	2,290	24,400	12,200	9,140	7,690	2,340	2,680
9	9,720	3,230	3,110	2,290	3,780	2,200	21,500	11,200	10,300	6,440	2,680	4,780
10	9,430	3,740	3,000	2,000	3,550	2,020	19,400	10,600	10,600	5,530	3,190	5,430
11	8,560	6,850	3,220	1,940	3,000	2,020	18,000	9,720	11,200	5,020	3,020	5,580
12	8,270	14,700	3,000	1,940	2,290	2,110	20,000	8,560	6,720	4,540	3,040	5,560
13	7,980	18,600	3,000	2,020	1,860	1,120	23,000	8,270	7,690	3,960	3,280	5,220
14	10,600	16,300	3,110	2,110	1,010	2,110	25,900	7,690	6,980	3,620	3,510	4,880
15	12,200	14,700	3,000	2,290	2,890	2,200	25,600	9,720	6,720	3,740	3,040	4,660
16	11,500	11,200	2,890	2,480	2,480	2,480	25,200	13,400	7,400	4,660	2,580	4,920
17	10,600	8,850	2,890	2,680	2,680	1,940	27,000	14,700	10,600	2,760	2,390	4,710
18	10,000	8,270	2,800	3,110	2,110	1,940	29,000	14,400	10,900	3,060	2,620	5,100
19	10,000	7,690	2,800	3,550	2,040	2,020	28,200	12,800	10,000	3,270	2,580	4,200
20	10,300	7,400	2,680	2,890	1,780	1,360	28,200	11,500	8,560	2,720	2,660	4,130
21	10,000	6,720	2,680	2,480	800	3,110	32,100	9,140	7,400	2,640	3,800	3,760
22	9,140	5,270	2,580	1,700	2,110	2,680	46,700	10,600	6,720	2,540	3,320	3,850
23	7,690	3,850	2,480	1,630	2,290	2,680	52,100	12,800	6,180	2,450	3,060	3,620
24	7,120	4,540	2,480	1,490	1,940	3,550	46,100	14,700	5,920	2,260	3,110	3,530
25	6,580	5,400	2,480	1,630	1,700	3,660	39,000	13,400	5,530	2,400	3,110	3,550
26	5,790	5,920	2,480	1,700	1,780	6,700	32,100	13,400	6,850	2,540	2,980	3,490
27	4,780	6,850	2,440	1,780	1,630	6,140	27,000	15,000	10,600	2,680	2,620	3,400
28	5,270	7,260	2,380	1,780	950	9,580	24,100	16,300	11,200	3,040	2,760	3,320
29	4,660	5,790	2,290	1,780	1,780	13,400	21,800	14,700	10,300	3,760	2,620	3,690
30	3,960	4,310	2,290	1,630	.....	15,300	20,400	12,800	12,200	4,780	2,450	3,620
31	4,200	.....	2,310	1,360	.....	16,900	.....	10,600	.....	2,030	2,390	.....

NOTE.—No gage-height record available July 25, 26, Aug. 13, and Sept. 27; discharge interpolated. Discharge Apr. 2, June 4, 5, 11, and July 16 is the average obtained by applying gage height for two-hour intervals to rating curve. Determination of discharge July 25, 26, Aug. 12 and 14 based on mean gage-height for partial days. Stage-discharge relation affected by ice Dec. 1 to Mar. 31.

Monthly discharge of Chippewa River at Chippewa Falls, Wis., for the year ending Sept. 30, 1916.

[Drainage area, 5,600 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	12,200	3,960	7,910	1.41	1.63
November	18,600	3,040	6,820	1.22	1.36
December	4,370	2,290	2,970	.530	.61
January	3,550	1,360	2,150	.384	.44
February	3,780	800	2,150	.384	.41
March	16,900	800	3,930	.702	.81
April	52,100	18,000	28,900	5.16	5.76
May	20,800	7,690	13,000	2.32	2.68
June	15,300	5,530	9,270	1.66	1.85
July	19,400	2,030	6,120	1.09	1.26
August	3,800	1,620	2,840	.507	.58
September	5,580	1,410	3,770	.673	.75
The year	52,100	800	7,470	1.33	18.14

WEST FORK OF CHIPPEWA RIVER AT LESSARDS, NEAR WINTER, WIS.

LOCATION.—In sec. 34, T. 40 N., R. 6 W., at Lessards, about a mile above mouth of East Fork of Chippewa River, coming in from the left, and 8 miles by road northwest of the post office of Winter, Sawyer County.

DRAINAGE AREA.—485 square miles (measured on map issued by Wisconsin Geological and Natural History Survey, edition of 1911; scale 1 inch = 6 miles).

RECORDS AVAILABLE.—December 22, 1911, to September 30, 1916.

GAGE.—Sloping gage on right bank installed July 18, 1915, about 100 feet below old vertical staff and metal gage fastened to log booms on right side of river; vertical staff gage used December 22, 1911, to July 17, 1915. Both gages read the same at medium stage of water. Gage read by Miss Ulda Lessard.

DISCHARGE MEASUREMENTS.—Made from a boat at a section 200 feet below sloping gage.

CHANNEL AND CONTROL.—Bed composed of heavy gravel; channel fairly permanent. Banks medium high; seldom overflowed. Control, head of rapids a short distance below gage; during certain periods logs lodge and grass grows on this control, causing backwater.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 7.7 feet at 1.30 p. m., April 22 (discharge, 2,360 second-feet); minimum discharge estimated 150 second-feet, January 13 to 17.

1911–1915: Maximum stage recorded, 7.7 feet at 1.30 p. m., April 22, 1916 (discharge 2,360 second-feet); minimum discharge, 127 second-feet, recorded by current-meter measurement February 23, 1912.

REGULATION.—A dam at the outlet of Moose Lake, T. 41 N., R. 6 W., has a capacity of 550,000,000 cubic feet. This reservoir is operated to increase the low-water flow in the lower Chippewa River.

ACCURACY.—Stage-discharge relation not permanent; affected by ice during winter, grass during July and September, and a change apparently took place in the control during or before the high water of April. Rating curve used October 1 to November 30 fairly well defined between 170 and 1,690 second-feet; April 12 to September 30 fairly well defined between 460 and 2,360 second-feet. Gage read twice daily to quarter-tenths; gage readings unreliable during winter period. Discharge determined as follows: October 1 to November 30 and April 12 to July 9 by applying mean daily gage heights to rating table; December 1 to April 11, when stage-discharge relation was affected by ice, from discharge measurements, observer's notes, weather records, and a comparison with records of flow at Bishop's bridge; July 12 to September 30, when stage-discharge relation was affected by grass, by indirect method. Open-water records fair; winter records poor.

Discharge measurements of West Fork of Chippewa River at Lessards, near Winter, Wis., during the year ending Sept. 30, 1916.

[Made by E. L. Williams.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Dec. 29 [a]	[b] 5.65	227	Mar. 3 [a]	[c] 6.03	206	May 29	[c] 5.81	686
Jan 26 [a]	[b] 6.05	208	Apr. 22	[c] 7.69	2,350	Aug. 22 [d]	[c] 5.31	279

[a] Ice at control
[b] Staff gage readings.
[c] Gage height refers to slope gage.
[d] Stage-discharge relation affected by growth of aquatic plants at control.

Daily discharge, in second-feet, of West Fork of Chippewa River at Lessards, near Winter, Wis., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	356	410		220	300	230	600	1 580	715	1,220	242	260
2	383	410		210	280	220	640	1,580	715	715	242	260
3	465	383		200	260	210	680	1,580	715	648	242	322
4	465	356		190	240	210	720	1,310	785	615	242	345
5	595	356		180	240	210	780	1,310	750	585	242	368
6	670	331		180	240	210	820	1,220	750	525	260	415
7	750	306		170	250	200	880	1,400	715	525	260	440
8	830	306		170	260	200	950	1,400	750	525	280	525
9	1,000	331		160	270	200	1,030	1,310	715	468	280	648
10	960	356		160	280	210	1,120	1,310	715	415	280	648
11	915	383		160	280	210	1,200	1,220	680	369	224	680
12	872	356		160	270	220	1,310	1,140	680	368	224	615
13	750	356		150	260	220	1,400	1,060	715	368	224	615
14	750	331		150	250	230	1,490	980	750	322	224	585
15	750	306		150	240	240	1,580	1,060	750	322	224	585
16	750	306	280	150	250	250	1,760	1,140	785	322	224	585
17	750	282		150	270	260	1,860	1,140	785	322	224	555
18	750	282		160	290	270	1,860	1,180	785	280	224	525
19	750	306		160	310	280	1,860	1,180	785	280	224	495
20	750	331		160	320	300	1,960	1,220	820	300	242	495
21	750	356		160	320	310	2,060	1,220	820	260	242	468
22	750	383		170	310	330	2,160	1,220	820	260	280	415
23	750	383		180	300	340	2,060	1,060	820	260	280	415
24	750	383		180	290	360	2,060	980	820	300	280	415
25	670	383		190	280	380	1,960	900	820	300	300	415
26	595	383		210	270	400	1,860	860	860	260	280	390
27	530	383		220	260	440	1,760	785	900	280	280	390
28	465	356		230	250	470	1,670	750	900	300	280	368
29	410	356		240	240	500	1,670	715	900	260	260	345
30	410	383		270	.....	540	1,670	715	1,180	260	242	345
31	410	.....		300	.....	580	.....	750	.....	280	242	.....

NOTE.—Stage-discharge relation affected by ice Dec. 1 to Apr. 11 and by grass July 10 to Sept. 30.

Monthly discharge of West Fork of Chippewa River at Lessards, near Winter, Wis., for the year ending Sept. 30, 1916.

[Drainage area, 485 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	1,000	356	669	1.38	1.59
November	410	282	351	.724	.81
December	.....	.....	280	.577	.67
January	300	150	185	.381	.44
February	320	240	272	.561	.61
March	580	200	298	.614	.71
April	2,160	600	1,450	2.99	3.34
May	1,580	715	1,140	2.35	2.71
June	1,180	680	790	1.63	1.82
July	1,220	260	404	.833	.96
August	300	224	251	.518	.60
September	680	260	464	.957	1.07
The year	2,160	150	545	1.12	15.33

FLAMBEAU RIVER NEAR BUTTERNUT, WIS.

LOCATION.—In the NW. ¼ SE. ¼ sec. 33, T. 41 N., R. 1 E., about 6 miles southeast of Butternut, Ashland County, and 7 miles upstream from Park Falls.

DRAINAGE AREA.—660 square miles (measured on map issued by Wisconsin Geological and Natural History Survey, edition of 1911; scale, 1 inch = 6 miles).

RECORDS AVAILABLE.—July 30, 1914, to September 30, 1916.

GAGE.—Chain gage supported by built-up cantilever, attached to posts set in right bank of river installed May 26, 1916; read by Miss Mathilda Schulz. Vertical staff gage at same site and datum was used from July 30, 1914 until taken out by ice in spring of 1916.

DISCHARGE MEASUREMENTS.—Made from a cable about 1,550 feet downstream from gage.

CHANNEL AND CONTROL.—Bed at gage composed of mud and rock. Left bank low and subject to overflow; right bank slopes back gradually to high-water mark. At the cable site, 1,500 feet below gage, channel is rocky and banks high. The control section for gage is head of Schultz Rapids about 200 feet below cable and 1,700 feet below gage.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 9.0 feet April 22 and 23 (discharge, 5,430 second-feet); minimum discharge estimated 449 second-feet February 2.

1914–1016: Maximum stage recorded, 9.0 feet April 22 and 23, 1916 (discharge, 5,430 second-feet); minimum discharge, 335 second-feet, recorded by current-meter measurement made November 19, 1914.

REGULATION.—Storage reservoirs are maintained by the Chippewa & Flambeau Improvement Co. on the headwaters of the Flambeau River. Of these reservoirs, Rest Lake, in sec. 9, T. 42 N., R. 5 E., with an allowable capacity of approximately 1,500,000 cubic feet, is the largest.

ACCURACY.—Stage-discharge relation permanent except as affected by ice during winter. Rating curve well defined between 350 and 3,480 second-feet. Gage read twice daily to quarter tenths. Discharge ascertained by applying mean daily gage heights to rating table except for periods in which stage-discharge relation was affected by ice for which it was ascertained by applying to rating table mean daily gage heights corrected for ice effect by means of discharge measurements, observer's notes, and weather records. During brief periods in April and May gage was not in position; discharge for these periods estimated. Records good for open-water periods; for winter, fair.

Discharge measurements of Flambeau River near Butternut, Wis., 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. 2	H. C. Beckman.....	2.57	708	Mar. 8[a]	E. L. Williams.....	3.20	474
Jan. 6[a]	E. L. Williams.....	2.68	618	May 26	.....do.....	3.88	1,400
28[a]	.....do.....	2.69	486	Aug. 24	.....do.....	2.50	630

[a] Made through complete ice cover.

Daily discharge, in second-feet, of Flambeau River near Butternut, Wis., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	600	707	757	673	449	536	1,080	3,000	1,120	1,680	729	500
2	725	738	673	652	460	518	1,170	2,700	1,120	1,740	725	483
3	985	694	673	632	470	483	1,220	2,420	1,120	1,740	725	466
4	1,120	682	673	632	480	483	1,330	2,280	1,100	1,680	725	486
5	1,120	677	739	632	500	483	1,440	2,140	1,080	1,620	712	584
6	1,170	694	805	620	536	483	1,500	2,090	1,080	1,500	703	694
7	1,170	712	760	620	530	474	1,590	2,040	1,080	1,380	694	962
8	1,250	751	716	632	520	474	1,620	1,980	1,100	1,300	686	1,030
9	1,300	760	738	632	510	483	1,740	1,920	1,080	1,200	712	1,100
10	1,220	778	760	652	500	483	1,780	1,870	1,080	1,120	712	1,120
11	1,170	1,010	760	652	490	518	1,800	1,800	1,080	1,030	712	1,120
12	1,080	1,100	760	652	490	554	1,940	1,740	1,080	985	725	1,100
13	1,080	1,170	760	673	480	554	2,070	1,620	1,050	895	720	1,050
14	1,050	1,250	760	673	483	592	2,280	1,560	1,080	868	703	1,010
15	1,030	1,120	805	632	490	592	2,560	1,620	1,080	832	720	985
16	1,010	1,080	850	632	500	612	2,700	1,620	1,050	823	720	962
17	940	1,030	850	592	550	612	2,840	1,560	1,140	800	729	940
18	940	985	850	592	600	632	3,000	1,560	1,140	778	832	895
19	940	940	794	554	800	632	3,160	1,560	1,200	760	846	854
20	918	895	738	554	1,000	632	3,320	1,560	1,300	760	792	800
21	859	850	805	518	800	632	4,130	1,500	1,380	734	725	778
22	814	781	872	518	600	673	5,430	1,560	1,360	725	729	800
23	782	712	816	500	590	716	5,430	1,500	1,300	751	703	805
24	716	804	760	500	580	738	4,230	1,380	1,220	760	686	800
25	677	895	760	500	570	738	3,930	1,330	1,140	716	640	782
26	562	985	760	500	560	738	4,030	1,330	1,200	810	592	769
27	562	1,030	738	483	560	760	4,030	1,280	1,220	828	573	769
28	690	918	738	483	554	805	3,660	1,220	1,200	800	536	769
29	716	890	716	483	550	850	3,400	1,200	1,280	796	511	778
30	716	841	716	483	.....	895	3,160	1,170	1,380	769	500	782
31	716	.....	673	500	.....	985	.....	1,140	.....	747	497	.....

NOTE.—Stage-discharge relation affected by ice Dec. 25 to Apr. 15; gage heights for Apr. 22 and 23 determined by leveling from high-water marks. No gage-height records Nov. 22, 24, May 6–9, and every other day Dec. 1–23; discharge interpolated.

Monthly discharge of Flambeau River near Butternut, Wis., for the year ending Sept. 30, 1916.

[Drainage area, 660 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	1,300	562	923	1.40	1.61
November	1,250	677	883	1.34	1.50
December	872	673	760	1.15	1.33
January	673	483	582	.882	1.02
February	1,000	449	559	.847	.91
March	985	474	625	.947	1.09
April	5,430	1,080	2,720	4.12	4.60
May	3,000	1,140	1,720	2.61	3.01
June	1,380	1,050	1,160	1.76	1.96
July	1,740	716	1,030	1.56	1.80
August	846	497	688	1.04	1.20
September	1,120	466	832	1.26	1.41
The year	5,430	449	1,040	1.58	21.44

FLAMBEAU RIVER NEAR LADYSMITH, WIS.

LOCATION.—In the SE. ¼ sec. 20, T. 35 N., R. 5 W., at H. J. Cornelissen's farm, about 6 miles by road northeast of Ladysmith, Rusk County, 21 miles below mouth of South Fork of Flambeau River,[1] coming in from the left, and 28¾ miles above mouth of river.

DRAINAGE AREA.—1,940 square miles (measured on map issued by Wisconsin Geol. and Nat. Hist. Survey, edition of 1911; scale 1 inch=6 miles).

RECORDS AVAILABLE.—January 2, 1914, to September 30, 1916. From February 15, 1903, to December 2, 1906, records were collected at a station in the city of Ladysmith, three-fourths of a mile south of the Minneapolis, St. Paul & Sault Ste. Marie Railway station, half a mile below dam of the Menasha Pulp Co., and about 6 miles below present station.

GAGE.—Chain, fastened to a cantilever arm, supported by two trees on the left bank of river, on the farm of H. J. Cornelissen; read by H. J. Cornelissen.

DISCHARGE MEASUREMENTS.—Made from cable across river about 200 feet below gage.

CHANNEL AND CONTROL.—Bed composed of gravel and sand; free from vegetation and fairly permanent. At the gage section, channel is divided by a small sandy island in the center; at the cable section the river flows in one channel; banks medium high, wooded, and not subject to overflow. Control not well defined, formed by the channel below gage.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year when channel was clear of ice and logs, 9.6 feet at 7 a. m. April 23 (discharge, 17,400 second-feet); minimum stage recorded, 2.12 feet at 7 a. m. September 5 (discharge, 763 second-feet).

1903–1906 and 1914–1916: Maximum discharge recorded, 17,400 second-feet April 23, 1916; minimum discharge, 390 second-feet December 4, 1904.

ICE.—Large quantities of frazil ice form on the falls and rapids above station and fill channel for a distance of several miles from gage to pond of Paper Co. dam at Ladysmith, seriously affecting the stage-discharge relation, and making discharge measurements almost impossible.

REGULATION.—The Chippewa & Flambeau Improvement Co. operates storage reservoirs on Rest Lake and smaller reservoirs on Manitowish and Turtle rivers and Beau Creek. Weekly fluctuations at the gage are caused by operation of power plants at Park Falls and storage reservoirs; no daily fluctuation has been observed.

ACCURACY.—Stage-discharge relation permanent except as affected by ice. Rating curve well defined between 1,000 and 17,000 second-feet; extended above and below these limits. Gage read once daily to quarter tenths. Daily discharge ascertained by applying daily gage heights to rating curve except for periods in which stage-discharge relation was affected by ice, for which discharge was determined from records of flow of Flambeau River near Butternut and weather records. Records good for open-water periods except at extremely low stages; winter records poor.

Discharge measurements of Flambeau River near Ladysmith, Wis., during the year ending Sept. 30, 1916.

[Made by E. L. Williams.]

Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*
Apr. 24	9.04	15,400
Aug. 30	2.50	1,160

[1] Called Dore Flambeau in Water-Supply Paper 385, p. 136.

Daily discharge, in second-feet, of Flambeau River near Ladysmith, Wis., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	2,970	1,650						7,620	2,670	4,480	1,320	972
2	2,870	1,520						7,140	2,840	5,020	1,230	907
3	2,520	1,360						6,440	3,040	5,210	1,340	835
4	2,720	1,380						5,000	3,110	5,600	1,000	925
5	3,180	1,350						5,600	3,110	5,400	1,180	763
			2,000	1,480	1,080	1,230	9,560					
6	3,330	1,400						5,020	3,260	4,480	1,180	1,100
7	3,560	1,450						4,480	2,580	3,560	1,340	1,580
8	3,640	1,500						4,140	2,740	3,330	1,770	3,040
9	3,560	1,450						4,000	2,840	3,330	1,850	3,180
10	3,480	1,570						3,880	2,610	2,410	1,730	3,260
11	3,180	2,690						3,640	2,510	2,030	1,690	3,330
12	2,970	3,560					9,800	3,480	2,410	2,010	1,680	2,640
13	3,040	3,720					9,520	3,330	2,410	1,790	1,670	2,640
14	3,180	4,220					10,100	3,200	2,050	1,620	1,650	2,700
15	2,970	3,800					10,100	3,480	2,130	1,560	1,230	2,640
			1,750	1,270	1,000	1,220						
16	3,180	2,900					11,000	4,060	2,390	1,560	1,430	2,900
17	2,900	2,580					12,500	4,310	2,640	1,470	1,340	2,540
18	2,900	2,510					11,300	3,970	2,770	1,360	1,280	2,330
19	3,040	2,320					11,000	3,720	2,640	1,400	2,030	2,330
20	3,040	2,290					11,300	3,720	2,700	1,140	2,090	1,910
21	2,870	2,100					12,500	3,400	2,540	1,210	2,210	1,910
22	2,690	2,090					17,000	3,560	2,510	1,280	2,090	2,580
23	2,580	2,030					17,400	3,970	2,510	1,180	1,670	1,790
24	2,460	2,030					15,900	3,800	2,610	1,120	1,620	1,770
25	2,330	2,030					14,200	3,800	2,640	1,000	1,500	1,770
26	2,160	2,040	1,550	1,200	1,350	1,910	12,500	3,260	2,490	1,250	1,280	1,770
27	1,960	2,030					11,300	3,480	2,610	1,620	1,230	1,620
28	1,810	2,220					9,520	3,480	2,490	2,010	1,280	1,620
29	1,670	2,150					8,680	3,110	3,110	1,790	880	1,620
30	1,690	2,150					8,140	3,040	3,180	1,500	835	1,620
31	1,470	.....					.....	2,870	.....	1,250	1,020	.....

NOTE.—Stage-discharge relation affected by ice, Nov. 22–25, and Nov. 30 to Apr. 11. Braced figures show mean discharge for periods included.

Monthly discharge of Flambeau River near Ladysmith, Wis., for the year ending Sept. 30, 1916.

[Drainage area, 1,940 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	3,640	1,470	2,770	1.43	1.65
November	4,220	1,350	2,200	1.13	1.26
December	.....	.....	1,760	.907	1.04
January	.....	.....	1,310	.675	.78
February	.....	.....	1,160	.598	.64
March	.....	.....	1,470	.758	.87
April	17,400	8,140	11,000	5.67	6.33
May	7,620	2,870	4,150	2.14	2.47
June	3,260	2,050	2,670	1.38	1.54
July	5,600	1,000	2,390	1.23	1.42
August	2,210	835	1,470	.758	.87
September	3,340	763	2,020	1.04	1.16
The year	17,400	763	2,850	1.47	20.03

JUMP RIVER AT SHELDON, WIS.

LOCATION.—In sec. 26, T. 33 N., R. 5 W., at highway bridge in the village of Sheldon, Rusk County, about 11 miles above confluence of Jump and Chippewa rivers.

DRAINAGE AREA.—510 square miles (measured on map issued by Wisconsin Geological and Natural History Survey, edition of 1911; scale, 1 inch= 6 miles).

RECORDS AVAILABLE.—July 22, 1915, to September 30, 1916.

GAGE.—Chain gage bolted to downstream handrail of bridge; read by Miss Elsa Dietz.

DISCHARGE MEASUREMETS.—Made from downstream side of bridge.

CHANNEL AND CONTROL.—Heavy gravel; clean and free from vegetation. Right bank high and not subject to overflow; left bank may be overflowed occasionally.

EXTREMES OF DISCHARGE.—Maximum stage recorded July 22, 1915, to September 30, 1916, 9.4 feet at 5 p. m. April 22 (discharge, 8,600 second-feet); minimum discharge, about 18 second-feet January 20.

ACCURACY.—Stage-discharge relation permanent except as affected by ice. Rating curve well defined between 45 and 6,000 second-feet. Gage read to quarter tenths twice daily. Discharge ascertained by applying mean daily gage heights to rating table except for period in which stage-discharge relation was affected by ice, for which it was obtained by applying to rating table mean daily gage heights corrected for ice effect by means of discharge measurements, observer's notes, and weather records. Records good for open-water periods except for extreme flood stages, for which they are fair; winter records fair.

Discharge measurements of Jump River at Sheldon, Wis., during the year ending Sept. 30, 1916.

[Made by E. L. Williams.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Jan. 8 [a]	3.98	90	Apr. 24	7.11	4,390	May 22	4.46	883
Feb. 4 [a]	4.41	76	May 22	4.39	839	Aug. 29 [b]	2.90	45
Mar. 1 [a]	4.54	87						

[a] Complete ice cover at measuring and control sections.
[b] Made by wading 800 feet above gage.

Daily discharge, in second-feet, of Jump River at Sheldon, Wis., for the period July 22, 1915, to Sept. 30, 1916.

Day.	July.	Aug.	Sept.	Day.	July.	Aug.	Sept.	Day.	July.	Aug.	Sept.
1915.				1915.				1915.			
1		215	151	11		840	88	21		143	720
2		540	124	12		575	88	22	480	124	610
3		2,800	114	13		420	97	23	390	124	480
4		4,540	104	14		385	175	24	390	121	420
5		5,570	104	15		285	2,240	25	760	114	360
6		4,880	91	16		256	2,650	26	840	104	1,510
7		3,720	82	17		215	2,110	27	645	100	2,110
8		2,800	85	18		187	1,510	28	480	94	1,740
9		1,980	94	19		167	1,020	29	390	128	1,300
10		1,200	97	20		159	760	30	335	151	930
								31	260	151	

Daily discharge, in second-feet, of Jump River at Sheldon, Wis., for the period July 22, 1915, to Sept. 30, 1916—Continued.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1915-16.												
1	760	285	575	109	38	85	2,370	1,400	1,020	2,240	73	58
2	645	260	251	100	32	80	3,720	1,200	1,510	1,740	60	50
3	540	251	260	100	25	75	4,710	1,020	2,370	1,620	104	45
4	680	233	238	100	76	70	5,050	885	2,370	1,300	104	50
5	1,020	260	238	100	58	60	4,880	720	1,980	840	107	45
6	840	246	226	100	64	50	4,710	575	1,300	540	97	45
7	885	233	215	95	70	55	4,200	510	930	360	82	58
8	1,020	246	215	90	65	60	3,560	540	1,200	251	68	70
9	930	310	215	64	58	60	2,800	575	1,620	215	82	100
10	885	335	215	38	64	55	2,650	610	1,400	167	82	100
11	760	1,620	215	32	70	75	2,950	610	1,020	128	82	85
12	680	3,560	205	25	65	100	3,880	480	760	128	107	85
13	1,300	3,250	195	28	60	110	4,040	420	510	114	97	85
14	2,370	2,370	195	30	50	120	3,560	390	450	104	88	85
15	2,370	1,740	195	30	45	135	3,250	1,200	480	94	76	76
16	1,860	1,200	185	30	60	145	2,950	1,740	480	114	68	94
17	1,400	885	175	28	70	130	3,400	1,620	930	104	68	100
18	1,510	840	175	25	70	120	3,250	1,300	1,020	94	68	118
19	1,510	760	175	22	70	130	2,950	1,020	840	104	68	118
20	1,620	720	165	18	70	140	3,880	885	610	104	68	100
21	1,400	720	155	22	70	150	6,110	760	420	104	68	100
22	1,110	540	155	25	80	160	8,600	885	335	94	60	100
23	885	575	155	28	85	180	6,660	1,510	310	88	55	94
24	720	510	145	30	90	210	4,710	1,400	285	88	55	97
25	610	510	135	30	100	230	3,250	1,020	242	88	44	118
26	540	645	135	30	95	240	2,240	1,300	610	82	44	118
27	450	975	135	34	95	250	1,740	3,250	1,200	73	44	114
28	390	930	126	38	90	260	1,300	2,950	1,020	114	44	285
29	390	680	118	34	90	480	1,110	2,110	975	104	44	335
30	335	615	118	30	.....	840	1,300	1,740	2,240	88	45	285
31	310	.....	118	34	.....	1,510	.....	1,400	.....	73	50	.....

NOTE.—Stage-discharge relation affected by ice Dec. 3 to Apr. 5.

Monthly discharge of Jump River at Sheldon, Wis., for the period July 22, 1915, to Sept. 30, 1916.

[Drainage area, 510 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
1915.					
July 22-31	840	260	497	0.975	0.36
August	5,570	94	1,070	2.10	2.42
September	2,650	82	732	1.44	1.61
1915-16.					
October	2,370	310	991	1.94	2.24
November	3,560	233	879	1.72	1.92
December	575	118	194	.380	.44
January	109	18	48	.094	.11
February	100	25	68	.133	.14
March	1,510	50	205	.402	.46
April	8,600	1,110	3,660	7.18	8.01
May	3,250	390	1,160	2.27	2.62
June	2,370	242	1,010	1.98	2.21
July	2,240	73	366	.718	.83
August	107	44	71	.139	.16
September	335	45	107	.210	.23
The year	8,600	18	727	1.43	19.37

EAU CLAIRE RIVER NEAR AUGUSTA, WIS.

LOCATION.—In sec. 12, T. 26 N., R. 6 E., at Trouble Water Bridge, about 7 miles northeast of Augusta, Eau Claire County. South Fork of Eau Claire River enters from left about 4 miles above station.

DRAINAGE AREA.—500 square miles.

RECORDS AVAILABLE.—July 16, 1914, to September 30, 1916.

GAGE.—Chain gage on downstream side of bridge; read by Albert Wagner.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge during medium and high stages; low-water measurements made by wading at control about 500 feet downstream from bridge.

CHANNEL AND CONTROL.—Bed at bridge and above is sandy and very shifting; a short distance below the gage the channel narrows and a rock outcrop overlain with large boulders forms the control; banks high and not subject to overflow.

EXTREMES OF DISCHARGE.—Maximum stage recorded, when control was unobstructed during year and period 1914–1916: 10.6 feet, at noon April 1, 1916 (discharge, 7,180 second-feet); minimum stage recorded, 0.10 feet at noon September 2, 1916 (discharge, 40 second-feet).

ACCURACY.—Stage-discharge relation practically permanent, except as affected by ice, although slightly different rating curves have been used from time to time, as more measurements have been made. Rating curve used October 1 to March 31 well defined from 80 to 4,000 second-feet; April 1 to September 30 well defined from 80 to 5,500 second-feet; both curves poorly defined outside these limits. Gage read to quarter-tenths daily. Discharge ascertained by applying daily gage heights to rating table, except for period in which stage-discharge relation was affected by ice, for which it was obtained by applying to rating table daily gage heights corrected for ice effect by means of discharge measurements, observer's notes, and weather records. Records good for open-water periods, except for low stages and periods for which gage readings are not available, as indicated in footnote to daily-discharge table; winter records poor.

Discharge measurements of Eau Claire River near Augusta, Wis., 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. 12[a]	E. L. Williams	1.30	75	June 21	E. L. Williams	1.95	558
Feb. 7[a]	do	1.74	55	July 26[b]	H. C. Beckman	.46	105
Mar. 15[a]	do	2.10	93	26[b]	do	.46	98
Apr. 2	H. C. Beckman	8.13	4,680				

[a] Complete ice cover at gage and control. [b] Made by wading at control section.

Daily discharge, in second-feet, of Eau Claire River near Augusta, Wis., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	129	189	710	85	107	80	7,180	985	585	620	69	43
2	117	177	496	83	95	78	5,220	761	1,180	433	66	40
3	133	153	446	81	85	76	4,080	620	2,920	360	60	43
4	172	153	349	79	75	75	3,170	550	1,630	293	73	43
5	213	153	301	77	65	72	2,170	482	1,180	249	83	66
6	201	153	254	75	57	69	1,510	449	833	207	107	57
7	189	153	269	75	57	66	1,130	401	620	186	107	141
8	201	165	254	75	57	67	945	533	869	166	97	369
9	201	189	254	75	57	69	833	499	1,510	153	83	221
10	196		191	75	57	70	761	433	985	141	87	125
11	177		186	75	55	72	725	620	620	129	83	118
12	201		181	75	52	73	797	466	516	129	78	107
13	446		176	73	50	75	797	385	482	118	69	111
14	1,180		171	71	54	84	761	433	466	107	69	107
15	1,290	1,200	167	68	57	93	725	2,080	466	129	66	103
16	826		163	66	60	106	725	2,450	620	125	54	107
17	672		159	68	64	119	1,290	1,510	1,570	166	57	118
18	826		155	70	67	143	1,630	1,130	1,760	308	69	118
19	906		151	72	71	167	1,130	833	1,080	278	78	111
20	672		149	75	75	191	1,510	655	833	166	62	97
21	530	990	143	95	80	215	2,680	516	550	141	57	87
22	463	710	138	119	95	285	3,440	725	433	129	54	87
23	397	672	133	131	95	365	4,280	1,340	353	118	51	87
24	333	530	128	131	95	463	2,240	985	308	107	47	87
25	333	513	123	143	95	564	1,340	833	263	103	43	87
26	285	866	119	143	95	906	905	945	353	103	43	83
27	254	1,760	111	143	95	1,340	797	1,510	1,290	97	43	97
28	227	1,400	103	131	95	2,240	655	1,510	1,130	87	43	166
29	213	826	95	119	95	3,410	725	1,080	690	87	43	141
30	201	710	90	113	.....	4,370	797	869	655	78	43	103
31	189	.....	85	107	.....	5,770	.....	725	.....	73	43	.....

NOTE.—No gage-height record available Nov. 10–20 and Jan. 13 to Feb. 6. Discharge, Nov. 10–20, estimated on basis of records of flow of Black River at Neillsville, and Big Eau Pleine River near Stratford. Stage-discharge relation affected by ice Dec. 10 to Mar. 31.

Monthly discharge of Eau Claire River near Augusta, Wis., for the year ending Sept. 30, 1916.

[Drainage area, 500 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	1,290	117	399	0.798	0.92
November	1,760	.....	789	1.58	1.76
December	710	85	208	.416	.48
January	143	66	93	.186	.21
February	107	50	74	.148	.16
March	5,770	66	702	1.40	1.61
April	7,180	655	1,830	3.66	4 03
May	2,450	385	879	1.76	2 03
June	2,920	263	892	1.78	1.99
July	620	73	180	.360	.42
August	107	43	66	.132	.15
September	369	40	109	.218	.24
The year	7,180	40	517	1.03	14.05

RED CEDAR RIVER NEAR COLFAX, WIS.

LOCATION.—In sec. 27, T. 30 N., R. 11 W., Dunn County, at a highway bridge about 4½ miles north of Colfax. Hay River enters from the right about 11 miles below, and Trout Creek, also from the right, 3½ miles above station.

DRAINAGE AREA.—1,100 square miles (measured on map issued by Wisconsin Geological and Natural History Survey, edition of 1911; scale, 1 inch=6 miles).

RECORDS AVAILABLE.—March 10, 1914, to September 30, 1916.

GAGE.—Chain gage attached to downstream side of bridge; read by Andrew Lundeguam.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge to which gage is attached.

CHANNEL AND CONTROL.—Bed composed of rock and gravel; small amount of grass growth during summer. Left bank high and not subject to overflow; right bank of medium height; may be overflowed during extremely high water. Control not well defined.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 6.8 feet at 1 p. m. March 31 (estimated discharge, 6,990 second-feet); minimum stage recorded, 1.06 feet at 6 p. m. October 1 (discharge, about 456 second-feet).

1914–1916: Maximum stage recorded, 6.8 feet at 1 p. m. March 31, 1916 (discharge, 6,990 second-feet); minimum stage recorded 0.80 foot November 19, 1914 (discharge, about 385 second-feet), apparently caused by temporary holding back of the water by ice.

REGULATION.[1]—The following dams and reservoirs are used to regulate the flow in Red Cedar River. Owing to operation of these reservoirs the flow at the station is not natural.

Reservoirs used to regulate flow of Red Cedar River.

Dam.	Location.	Approximate capacity (millions of cubic feet).
Long Lake	Sec. 24, T. 37 N., R. 11 W	1,000
Cedar Lake	Sec. 21, T. 36 N., R. 10 W	965
Birch Lake	Sec. 25, T. 37 N., R. 10 W	1,174
Bear Lake	Sec. 7, T. 36 N., R. 11 W	280
Chetac Lake	Sec. 20, T. 33 N., R. 10 W	998
		4,417

ACCURACY.—Stage-discharge relation nearly permanent, except as affected by ice during winter, and possibly by grass from June to September. Two rating curves were used during year: October 1 to March 31, well defined between 560 and 4,450 second-feet; April 1 to September 30 well defined between 635 and 4,450 second-feet. Both curves extended outside these limits. Gage read twice daily to quarter-tenths. Discharge ascertained by applying mean daily gage heights to rating table except for period in which stage-discharge relation was affected by ice, for which it was obtained by applying to rating table mean daily gage heights corrected for backwater from ice, by means of discharge measurements, observer's notes, and weather records. Records good for open-water periods October to June; July to September may be only fair because of possible change in stage-discharge relation owing to grass; winter records fair.

[1] From data on file in Engineering Dept. of Railroad Commission of Wisconsin.

Discharge measurements of Red Cedar River near Colfax, Wis., during the year ending Sept. 30, 1916.

[Made by E. L. Williams.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Jan. 11[a]	2.74	737	Mar. 16[a]	3.06	699	Aug. 17[b]	1.51	704
Feb. 8[a]	3.36	688	June 23	1.89	970			

[a] Complete ice cover at control and measuring section. [b] Made by wading at a section near gage.

Daily discharge, in second-feet, of Red Cedar River near Colfax, Wis., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	470	510	670	730	790	730	6,480	1,300	960	4,870	635	635
2	510	560	670	730	790	730	6,310	1,210	1,980	4,450	690	635
3	510	560	560	730	730	730	6,650	1,210	1,880	3,510	690	635
4	670	510	560	730	730	730	5,630	1,120	1,580	2,310	890	585
5	610	510	560	730	730	730	4,170	1,120	1,580	2,090	820	635
6	560	560	560	730	670	730	2,880	1,120	1,680	1,780	750	750
7	610	510	610	730	670	730	2,640	960	1,390	1,040	635	820
8	610	670	560	730	690	730	2,420	1,040	1,780	960	690	820
9	610	730	610	730	690	730	1,980	1,120	1,980	960	690	635
10	610	730	610	730	690	730	1,880	890	1,780	890	690	635
11	510	1,660	610	740	690	730	1,880	960	1,580	960	690	585
12	610	2,760	610	730	730	730	2,200	750	1,580	820	690	820
13	670	1,560	640	730	790	730	1,880	750	1,300	750	750	890
14	670	1,760	640	718	790	730	1,390	890	1,390	890	750	690
15	610	1,370	640	718	850	730	1,480	1,300	1,680	1,120	750	635
16	670	1,010	640	670	850	700	1,980	1,780	1,390	890	690	690
17	730	790	640	670	930	730	1,780	1,390	1,980	820	750	1,000
18	790	790	670	670	930	730	1,780	1,390	1,580	750	690	750
19	930	930	670	670	930	760	1,780	1,210	1,120	820	690	820
20	730	1,190	670	670	930	790	2,420	960	960	820	690	750
21	730	730	670	670	850	850	2,760	960	1,120	750	635	820
22	730	610	670	670	850	930	2,530	1,880	1,040	690	635	820
23	730	790	670	670	790	1,100	2,880	2,310	960	690	635	750
24	730	610	700	670	790	1,370	2,420	1,880	960	635	690	750
25	610	730	700	670	790	1,870	2,310	1,780	820	635	690	635
26	670	610	700	730	730	2,310	1,980	1,980	1,210	820	635	820
27	670	730	700	790	730	3,000	1,780	1,780	1,980	960	635	820
28	610	730	700	930	730	3,770	1,300	1,580	2,200	750	585	820
29	560	610	730	970	730	4,730	1,390	1,980	2,200	690	635	820
30	560	670	730	850	.....	6,140	1,390	1,210	3,770	635	635	820
31	560	.....	730	790	.....	6,990	.....	890	.....	635	635	.....

NOTE.—Stage-discharge relation affected by ice Dec. 11 to Mar. 31.

Monthly discharge of Red Cedar River near Colfax, Wis., for the year ending Sept. 30, 1916.

[Drainage area, 1,100 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	930	470	640	0.582	0.67
November	2,760	510	883	.803	.90
December	730	560	648	.589	.68
January	970	670	732	.665	.77
February	930	670	779	.708	.76
March	6,990	700	1,540	1.40	1.61
April	6,650	1,390	2,680	2.44	2.72
May	2,310	750	1,310	1.19	1.37
June	3,770	820	1,580	1.44	1.61
July	4,870	635	1,270	1.15	1.33
August	890	585	689	.626	.72
September	1,040	585	744	.676	.75
The year	6,990	470	1,120	1.02	13.89

RED CEDAR RIVER AT CEDAR FALLS, WIS.

LOCATION.—In sec. 6, T. 28 N., R. 12 W., Dunn County, at highway bridge in the vicinity of Cedar Falls, 4½ miles above crossing of Chicago, St. Paul, Minneapolis & Omaha Railway.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—April 1, 1909, to September 30, 1915.

GAGE.—Staff, fastened to bridge pier; read twice daily, to half tenths, by Henry Hawkinson.

DISCHARGE MEASUREMENTS.—No discharge measurements have been made at this station, which is maintained to determine fluctuation in stage.

CHANNEL AND CONTROL.—Channel rough and rocky, straight, and free from vegetation; banks high and not subject to overflow.

EXTREMES OF STAGE.—Maximum stage recorded during year, 6.1 feet April 1, 2, and 3; minimum stage, 1 foot, December 25 and 26.

1909–1915: Maximum stage recorded, 6.1 feet April 1–3, 1916; minimum stage recorded 0.6 foot December 15, 1912. Minimum stages are caused by operation of gates in dam above station.

REGULATION.—The operation of storage reservoirs in the headwaters of the river (see "Regulation in station description for Red Cedar River near Colfax, Wis.) together with storage at the power plant above the gaging station, modify the flow, causing considerable diurnal fluctuation, so that mean daily gage heights will not represent the average stage.

COOPERATION.—Gage-height record furnished by Wisconsin & Minnesota Light & Power Co.

No discharge measurements have been made at this station.

Daily gage height, in feet, of Red Cedar River at Cedar Falls, Wis., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	2.65	2.85	2.60	1.65	2.65	2.70	6.05	3.80	3.50	4.85	2.90	3.00
2	2.65	2.85	2.70	1.60	2.65	2.75	6.05	3.60	3.40	5.50	2.90	3.00
3	2.10	2.80	2.70	2.60	2.60	2.70	6.05	3.60	3.95	5.30	2.80	2.30
4	2.60	2.60	2.70	2.55	2.95	2.75	6.00	3.60	3.60	4.80	2.90	2.30
5	2.65	2.60	2.20	2.60	2.60	2.60	5.65	3.40	3.90	4.20	2.60	3.00
6	2.70	2.60	2.60	2.55	1.70	2.90	4.90	3.20	3.80	4.00	2.70	3.00
7	2.65	2.10	2.65	2.60	2.90	2.90	4.65	3.00	3.70	3.40	2.90	2.90
8	2.65	2.60	2.60	2.60	2.95	2.75	4.35	3.30	3.70	3.30	2.90	3.00
9	2.60	2.60	2.60	2.90	2.70	2.80	4.25	3.30	3.80	3.30	2.90	2.90
10	1.80	2.65	2.60	2.95	2.70	2.80	4.30	3.40	3.80	3.10	2.90	2.30
11	2.70	2.70	2.70	2.60	2.50	2.80	3.85	3.40	3.55	3.00	2.80	2.90
12	2.70	2.80	2.25	2.55	2.50	1.60	3.85	3.00	3.80	2.70	2.60	2.90
13	2.75	4.10	2.60	2.90	2.00	2.90	3.85	2.90	3.70	2.90	2.60	2.90
14	2.70	3.90	2.60	2.80	2.80	2.90	3.55	2.45	3.70	2.90	2.80	2.90
15	2.70	3.70	2.60	2.85	2.90	2.90	3.60	3.10	3.70	2.90	2.80	2.70
16	2.70	3.50	2.60	2.10	2.70	2.80	3.40	3.10	3.60	3.10	2.80	2.90
17	2.00	3.45	2.60	2.90	2.70	2.80	4.05	3.65	3.60	3.10	2.90	2.20
18	2.75	3.40	2.65	2.90	2.90	2.80	4.00	3.60	3.30	3.10	2.70	2.60
19	2.80	3.30	1.30	2.90	3.10	1.65	4.05	3.50	3.60	3.10	2.90	2.90
20	2.80	3.30	2.60	2.85	1.80	2.90	4.10	3.40	3.50	3.00	2.50	2.90
21	2.80	3.00	2.60	2.80	3.05	2.80	4.25	3.30	3.40	2.80	3.00	2.90
22	2.80	2.85	2.60	2.85	2.65	2.80	4.70	3.65	3.60	2.70	3.00	2.95
23	2.85	2.70	2.60	1.70	2.60	2.90	4.65	4.10	3.20	2.50	3.00	2.90
24	2.30	2.70	2.60	2.40	2.60	2.80	4.70	4.30	3.05	2.60	3.00	2.00
25	2.80	2.70	1.20	2.65	2.60	2.75	4.55	4.10	3.00	2.60	3.00	3.00
26	2.80	2.70	1.20	2.70	2.50	2.35	4.45	4.20	3.10	2.60	2.90	2.95
27	2.80	2.70	2.55	2.75	1.75	4.50	4.20	4.20	3.65	2.90	2.50	3.05
28	2.85	2.10	2.60	2.65	2.90	5.15	4.00	3.60	3.75	2.80	2.90	3.00
29	2.80	2.70	2.60	2.55	2.60	5.15	3.70	4.05	4.00	2.70	3.00	2.95
30	2.85	2.70	2.60	1.70	.....	5.90	3.40	3.70	4.00	2.60	2.90	2.90
31	2.15	.....	2.60	2.15	.....	6.05	.....	3.60	.....	3.00	3.00	.....

RED CEDAR RIVER AT MENOMONIE, WIS.

LOCATION.—In sec. 21, R. 28 N., R. 13 W., Dunn County, about 900 feet below the power house of Wisconsin & Minnesota Light & Power Co., Menomonie, 13 miles above the confluence of Red Cedar and Chippewa rivers. Wilson Creek discharges from the right into the service reservoir just above station.

DRAINAGE AREA.—1,810 square miles (measured on map issued by Wisconsin Geological & Natural History Survey, edition of 1911; scale, 1 inch=6 miles).

RECORDS AVAILABLE.—June 16, 1907, to September 5, 1908; May 9, 1913, to September 30, 1916.

GAGE.—Barrett & Lawrence water stage recorder installed May 9, 1913, over a wooden intake and well on the right bank of the river about a mile above site of old gage attached to a highway bridge about 200 rods west of the Chicago & North Western Railway station west of Menomonie, which was read from June 16, 1907, to September 5, 1908. No relation between datums of the two gages. Gage inspected by E. Kausrud.

DISCHARGE MEASUREMENTS.—Made from highway bridge about a mile below gage.

CHANNEL AND CONTROL.—Bed at gage composed of heavy gravel. Left bank high and not subject to overflow; right bank of medium height and will be overflowed at flood stages; bed at measuring section sandy and liable to shift; banks high at measuring section and not subject to overflow.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year approximately 7.0 feet March 31 and April 1 (discharge, 12,700 second-feet); minimum stage recorded, 1.3 feet at 4 p. m. December 20 (discharge, about 261 second-feet).

1907–8 and 1913–1916: Maximum discharge, 12,700 second-feet March. 31 and April 1, 1916; minimum discharge, 100 second-feet November 8, 1907.

REGULATION.—Considerable diurnal fluctuation in stage at the gage section is caused by the operation of the power plants of the Wisconsin & Minnesota Light & Power Co. at Menomonie and Cedar Falls, and minor changes are also caused by smaller plants on the tributaries of the Red Cedar River above Menomonie. (See "Regulation" in station description for Red Cedar River at Colfax, Wis.)

ACCURACY.—Stage-discharge relation changed during high water of April, 1916. Rating curve used before March 31 well defined between 530 and 7,730 second-feet; curve used April 1 to September 30 well defined from 610 to 1,900 and 4,800 to 10,000 second-feet, and fairly well defined from 1,900 to 4,800 second-feet. Both curves extended beyond the maximum and minimum limits. Water-stage recorder gave satisfactory results except for brief periods. Daily discharge October 1 to March 31 ascertained by applying to the rating table mean gage heights as obtained with a planimeter from recording gage graph; April 1 to September 30 discharge obtained with discharge integrator. Records good except for periods when gage was not in operation, for which they are poor. Ice does not affect the stage-discharge relation at this station owing to relatively warm water coming from service reservoir. Daily discharge March 30 to April 7 may be somewhat in error owing to incorrect operation of recording gage, the water being so high that observer could not inspect gage or make daily readings.

Discharge measurements of Red Cedar River at Menomonie, Wis., 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.*
Mar. 30	S. B. Soulé	5.93	8,100	Aug. 17	E. L. Williams	2.84	1,240
30	do	6.37	9,850	Sept. 22	R. B. Kilgore	3.00	1,390
June 20	E. L. Williams	3.24	1,500	24	do	2.34	718
July 1	do	5.17	5,250	24	W. G. Hoyt	2.30	702

Daily discharge, in second-feet, of Red Cedar River at Menomonie, Wis., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	818	1,060	1,260	981	1,290	1,050	11,800	2,150	1,560	4,700	1,190	1,450
2	806	1,030	1,150	830	1,140	1,070	11,300	1,660	1,570	5,230	1,240	1,240
3	794	1,250	1,300	968	1,210	1,120	10,400	1,550	2,260	4,680	1,150	990
4	868	1,230	1,220	1,120	1,070	1,110	10,400	1,510	2,180	3,050	1,110	800
5	878	1,150	968	1,100	1,230	842	7,180	1,390	2,540	2,710	1,080	1,080
6	890	994	916	1,050	1,290	1,010	4,820	1,450	2,410	2,400	720	1,360
7	866	734	1,030	1,020	1,360	1,290	3,210	1,220	2,380	2,070	1,170	1,400
8	890	854	1,220	1,080	1,220	1,150	2,220	1,380	1,950	1,730	1,210	1,090
9	866	1,110	1,180	866	1,250	1,180	1,980	1,370	2,120	1,260	1,110	1,110
10	890	1,400	1,210	929	1,180	1,160	2,160	1,470	2,450	1,440		1,110
11	994	1,370	1,140	1,000	818	1,140	2,290	1,200	2,170	1,360		1,150
12	981	1,120	782	1,080	1,070	818	1,950	1,100	2,360	1,380	1,200	1,290
13	994	2,700	942	1,150	722	981	2,300	1,140	2,230	1,380		1,360
14	1,010	2,520	1,050	1,190	1,020	1,150	2,010	1,010	1,770	1,350		1,220
15	1,020	2,270	1,050	1,060	1,230	1,180	1,570	1,000	1,860	1,260		1,260
16	1,140	2,220	1,110	830	1,210	1,190	1,550	1,100	2,330	1,190	1,330	1,220
17	929	1,640	1,120	929	994	1,210	2,170	1,890	1,930	1,520	1,210	890
18	1,070	1,580	1,210	1,260	1,080	1,230	2,080	1,570	2,080	1,470	1,110	1,000
19	1,370	1,540	650	1,260	1,150	942	2,350	1,620	2,010	1,400	1,070	1,150
20	1,250	1,280	542	1,150	955	1,100	2,190	1,600	1,840	1,410	1,020	1,250
21	1,110	1,260	1,150	1,120	942	1,060	2,940	1,200	1,450	1,350	1,030	1,300
22	1,150	1,110	1,070	1,100	1,210	1,540	3,390	1,820	1,700	1,210	1,040	1,280
23	770	782	1,070	866	866	1,060	3,180	1,960	1,480		1,220	1,240
24	994	1,190	1,020	794	854	1,150	4,060	2,810	1,440		1,200	830
25	942	866	314	1,050	890	1,730	2,990	2,330	1,290	1,200	1,220	870
26	1,050	994	298	1,140	916	2,050	2,620	2,390	1,450		1,260	1,250
27	1,140	1,150	818	1,180	602	3,150	2,190	2,370	2,150		990	1,310
28	1,280	1,080	1,050	994	878	6,000	1,860	1,920	2,450	1,260	890	1,310
29	1,160	1,120	1,020	782	1,160	6,030	1,880	2,100	2,950	1,130	1,100	1,390
30	1,320	1,230	942	578	.....	8,530	1,280	1,850	2,880	810	1,170	1,420
31	1,120	.....	968	994	.....	11,300	.....	1,660	.....	1,170	1,280	.....

NOTE.—Recording gage not in operation Oct. 1–2, Dec. 20–25, Jan. 11, July 23–27, and Aug. 10–15. Estimates of discharge based on one gage reading a day, records for Red Cedar River at Cedar Falls, or by interpolation. Discharge Jan. 6, 12, Mar. 28 and 30, based on average gage height for less than 24 hours.

Monthly discharge of Red Cedar River at Menomonie, Wis., for the year ending Sept. 30, 1916.

[Drainage area, 1,810 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	1,370	770	1,010	0.558	0.64
November	2,700	734	1,330	.735	.82
December	1,300	298	993	.549	.63
January	1,260	578	1,010	.558	.64
February	1,360	602	1,060	.586	.63
March	11,300	818	2,110	1.17	1.35
April	11,800	1,250	3,740	2.07	2.31
May	2,810	1,000	1,640	.906	1.04
June	2,950	1,290	2,040	1.13	1.26
July	5,230	810	1,800	.994	1.15
August	1,330	720	1,140	.630	.73
September	1,450	800	1,190	.657	.73
The year	11,800	298	1,590	.878	11.93

ZUMBRO RIVER AT ZUMBRO FALLS, MINN.

LOCATION.—Near east border of sec. 31, T. 110 N., R. 14 W., at highway bridge at Zumbro Falls, about 1,500 feet below mouth of Spring Creek, 6½ miles below mouth of South Branch.

DRAINAGE AREA.—1,120 square miles.

RECORDS AVAILABLE.—June 8, 1909, to September 30, 1916.

GAGE.—Chain attached to upstream handrail of bridge near left end; read by A. H. Sugg.

DISCHARGE MEASUREMENTS.—At high and medium stages made from bridge; at low stages made by wading.

CHANNEL AND CONTROL.—Bed of stream composed of fine sand; shifts considerably; a slight riffle a few hundred feet below gage acts as a partial control during low stages; right bank fairly low and is overflowed during high flood stages; left bank not subject to overflow.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 16.3 feet at 5 p. m. March 25 (discharge, 8,470 second-feet); minimum discharge estimated at 131 second-feet, January 21.

1909–1916: Maximum stage recorded, 16.65 feet at 5.30 p. m. October 11, 1911 (discharge, 9,200 second-feet); minimum stage recorded during open-water periods, 4.50 feet at 8 a. m. January 10 and 21, 1914 (discharge, about 128 second-feet); 106 second-feet was measured by current meter January 27, 1915.

High water of June, 1908, which reached a stage of 26.7 feet above datum of present gage, is marked by a spike in a telephone post near the railroad station at Zumbro Falls; high water of April, 1888, reached a stage of approximately 29.7 feet, as shown by a mark not so well defined as that of the flood of 1908.

ICE.—Stage-discharge relation not seriously affected by ice, except during and after extremely cold weather, when ice forms below the gage and causes backwater for short periods. A short distance above the gage the river receives about 8 second-feet of spring water from Spring Creek, which is warm enough to keep it free from ice for a considerable distance during most winter weather.

REGULATION.—The slight artificial regulation at the power plants above Zumbro Falls is not observable at the gage.

ACCURACY.—Stage-discharge relation fairly permanent except as slightly affected by ice during part of winter. Rating curve well defined between 169 and 2,710 second-feet; extended above 2,710 second-feet by means of area and mean velocity curves. Gage read to hundredths twice daily. Daily discharge ascertained by applying mean daily gage heights to rating table except for periods in which stage-discharge relation was affected by ice for which discharge was ascertained by applying to rating table mean daily gage heights corrected for backwater from ice by means of discharge measurements, observer's notes, and weather records. Records for open-water periods good except for extremely high stages; for winter fair.

Discharge measurements of Zumbro River at Zumbro Falls, Minn., 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.*
Oct. 27	S. B. Soulé	5.41	305	May 22	S. B. Soulé	7.57	1,270
Jan. 18[a]	E. L. Williams	5.35	166	Aug. 2	do	5.29	278
Feb. 10[a]	do	5.19	179				

[a] Ice at control.

Daily discharge, in second-feet, of Zumbro River at Zumbro Falls, Minn., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	322	295	366	233	245	245	1,430	1,370	820	560	282	233
2	322	295	351	210	233	245	1,120	1,020	1,670	500	282	233
3	322	295	336	210	222	245	920	820	1,910	449	270	233
4	336	282	336	233	210	257	780	740	1,490	466	282	257
5	322	282	336	233	196	257	680	660	1,070	432	308	233
6	336	282	322	193	200	257	620	620	870	398	295	233
7	336	282	322	215	202	257	540	580	740	366	282	233
8	322	308	308	215	189	245	500	540	740	366	270	233
9	308	336	308	233	177	257	466	500	870	351	257	233
10	295	449	308	222	177	432	449	483	820	322	282	233
11	308	970	308	200	175	351	449	432	700	322	308	233
12	322	1,170	295	200	165	1,790	432	398	620	366	295	257
13	351	970	233	201	151	8,170	415	398	640	336	257	257
14	466	700	234	202	151	4,590	398	520	620	398	245	245
15	500	540	236	203	155	2,430	432	1,550	560	466	257	233
16	432	500	237	190	155	1,730	466	2,030	600	820	257	233
17	449	483	239	177	169	1,220	1,430	1,270	560	640	257	233
18	560	466	240	164	222	1,790	1,220	1,020	466	1,270	257	210
19	580	466	242	153	245	1,850	1,550	820	432	820	245	210
20	500	466	244	140	270	2,220	5,470	700	432	660	245	222
21	449	432	245	131	282	2,960	6,270	660	415	520	233	210
22	415	382	257	200	282	2,710	3,100	1,170	483	432	257	200
23	366	398	282	222	282	1,430	1,910	1,270	540	398	233	210
24	366	415	257	366	282	2,780	1,370	1,120	500	366	233	210
25	351	415	245	620	282	7,870	1,120	1,020	483	382	233	206
26	322	466	233	466	282	5,370	970	870	780	351	222	210
27	322	466	210	449	257	2,290	820	780	700	336	233	222
28	308	449	206	415	245	1,670	740	870	580	308	222	233
29	322	415	222	366	257	1,490	740	1,170	520	308	233	222
30	308	366	233	336	.....	1,370	1,430	1,550	540	295	233	222
31	295	.....	233	308	.....	1,430	.....	1,070	.....	308	233	.....

NOTE.—Stage-discharge relation affected by ice Dec. 13 to Jan. 24, and Feb. 1–19.

Monthly discharge of Zumbro River at Zumbro Falls, Minn., for the year ending Sept. 30, 1916.

[Drainage area, 1,120 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	580	295	371	0.331	0.38
November	1,170	282	468	.418	.47
December	366	206	272	.243	.28
January	620	131	255	.228	.26
February	282	151	219	.196	.21
March	8,170	245	1,940	1.73	1.99
April	6,270	398	1,270	1.14	1.27
May	2,030	398	902	.805	.93
June	1,910	415	739	.660	.74
July	1,220	295	460	.411	.47
August	308	222	258	.230	.26
September	257	200	228	.204	.23
The year	8,170	131	617	.551	7.49

SOUTH BRANCH OF ZUMBRO RIVER NEAR ZUMBRO FALLS, MINN.

LOCATION.—In sec. 22, T. 109 N., R. 14 W., at Woodville Bridge, 1½ miles above mouth of river, 6 miles below mouth of Middle Branch, and 6 miles southwest of Zumbro Falls, Wabasha County.

DRAINAGE AREA.—821 square miles.

RECORDS AVAILABLE.—June 16, 1911 to September 30, 1916.

GAGE.—Chain gage attached to downstream handrail of bridge near center of river, read by W. M. Whipple.

DISCHARGE MEASUREMENTS.—At high and medium stages made from downstream side of bridge; at low stages made by wading.

CHANNEL AND CONTROL.—Bed consists chiefly of sand and gravel. Control consists of cobble stones and rock at a well-defined riffle a short distance below the gage and is fairly permanent. Near the control, to the right of the channel, a small secondary channel branches off. The scouring out of this channel during the year made change in rating curve necessary.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 11.7 feet at 4 p. m. March 13 (discharge, 8,490 second-feet); minimum discharge estimated, 75 second-feet February 15.

1911–1916: Maximum stage recorded, 11.8 feet at 3:30 p. m. March 25, 1915 (discharge, 8,360 second-feet, is less than the discharge for the slightly lower stage on March 13, 1916, because of a shift in the control in March, 1916); minimum stage recorded, 1.80 feet December 26, 1914 (discharge, 62 second-feet).

ICE.—Stage-discharge relation seriously affected by ice.

REGULATION.—Effects of operation of small power plants above the station not noticeable at gage.

ACCURACY.—Stage-discharge relation changed a little during year as a result of the continuation of cutting an additional channel at control, which has been going on for the past two or three years; also affected by ice during winter. Rating curve fairly well defined. Gage read to quarter-tenths twice daily. Daily discharge ascertained by applying mean daily gage heights to rating table except for periods in which stage-discharge relation was affected by ice for which discharge was ascertained by applying to rating table mean daily gage heights corrected for backwater from ice by means of discharge measurements, observer's notes, and weather records. Records fair.

Discharge measurements of South Branch of Zumbro River near Zumbro Falls, Minn. 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.*
Oct. 26	S. B. Soulé	2.25	224	May 22	S. B. Soulé	3.55	946
Jan. 17[a]	E. L. Williams	2.41	119	Aug. 2	do	2.12	197
Feb. 9[a]	do	2.59	130				

[a] Ice at control.

Daily discharge, in second-feet, of South Branch of Zumbro River near Zumbro Falls, Minn., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	211	219	244	106	240	170	1,360	1,220	793	412	214	150
2	203	211	240	132	162	177	1,100	882	1,100	388	197	143
3	203	211	219	112	162	200	912	706	1,550	346	197	143
4	211	211	215	106	177	274	650	650	1,290	332	239	150
5	219	211	219	148	145	256	437	567	912	318	256	158
6	211	211	219	91	142	162	437	514	793	314	214	154
7	211	203	211	135	116	162	437	488	540	296	205	162
8	211	203	211	148	128	148	412	437	412	278	185	162
9	173	223	192	166	135	156	359	412	678	269	185	170
10	211	322	211	112	125	564	355	388	622	260	205	177
11	211	832	211	109	132	723	350	364	540	256	218	177
12	227	860	192	128	125	2,150	346	336	514	260	201	173
13	269	670	181	81	98	7,940	336	332	462	260	189	173
14	340	485	181	128	84	4,120	332	706	412	296	181	170
15	385	385	162	145	75	2,290	332	2,210	437	364	181	150
16	318	362	145	135	98	1,480	388	2,060	462	462	181	154
17	304	340	142	106	109	1,100	1,220	1,220	462	622	189	173
18	326	362	159	112	98	1,220	1,420	852	412	912	189	173
19	308	340	116	98	162	1,290	973	678	388	622	189	170
20	322	340	101	98	135	1,550	5,820	567	364	437	181	139
21	304	340	148	104	181	2,060	6,620	540	346	364	170	139
22	269	362	148	159	170	2,370	2,890	622	412	336	150	135
23	269	295	132	122	282	1,220	1,830	1,360	462	300	158	139
24	261	295	122	207	300	1,760	1,360	912	462	273	154	154
25	232	300	142	537	256	6,950	1,040	822	412	291	158	143
26	211	340	138	696	232	3,820	852	650	622	264	150	154
27	219	331	128	618	223	2,130	764	594	567	234	158	158
28	211	318	96	539	223	1,620	706	594	462	234	146	135
29	219	274	122	460	200	1,220	594	1,160	388	230	158	146
30	227	227	112	326	.....	1,220	973	1,420	388	226	154	139
31	227	.....	116	326	.....	1,290	.....	912	.....	218	150	.....

NOTE.—Stage-discharge relation affected by ice Dec. 1–3 and Dec. 15 to Feb. 22.

Monthly discharge of South Branch of Zumbro River near Zumbro Falls, Minn., for the year ending Sept. 30, 1916.

[Drainage area, 821 square miles.]

Month	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	385	173	249	0.303	0.35
November	860	203	343	.418	.47
December	244	96	167	.203	.23
January	696	81	209	.255	.29
February	300	75	163	.199	.21
March	7,940	148	1,670	2.03	2.34
April	6,620	332	1,190	1.45	1.62
May	2,210	332	812	.989	1.14
June	1,550	346	589	.718	.80
July	912	218	344	.419	.48
August	256	146	184	.224	.26
September	177	135	155	.189	.21
The year	7,940	75	507	.618	8.40

TREMPEALEAU RIVER AT DODGE, WIS.

LOCATION.—In sec. 11, T. 19 N., R. 10 W., Trempealeau County, at highway bridge in the village of Dodge, 9 miles above mouth of river.

DRAINAGE AREA.—633 square miles (measured on map issued by Wisconsin Geological and Natural History Survey, edition of 1911; scale, 1 inch=6 miles.)

RECORDS AVAILABLE.—December 13, 1913, to September 30, 1916.

GAGE.—Chain gage attached to downstream side of bridge; read by J. Johnson.

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

CHANNEL AND CONTROL.—Sand; likely to shift; both banks of medium height and may be overflowed during extreme floods.

EXTREMES OF DISCHARGE.—Maximum stage during year, 8.1 feet at 5 p. m. March 27 (discharge 3,220 second-feet); minimum discharge about 191 second-feet, January 14–18.

1914–1916: Maximum stage recorded, 8.35 feet June 9, 1914 (discharge, 3,340 second-feet); minimum discharge 163 second-feet, recorded by measurement, January 29, 1915.

REGULATION.—No power plants above station have sufficient capacity to affect natural flow of river.

ACCURACY.—Stage-discharge relation not permanent. Two rating curves used during year. October 1 to March 26, fairly well defined between 236 and 1,650 second-feet. March 27 to September 30 well defined between 196 and 1,800 second-feet; fairly well defined between 1,800 and 3,080 second-feet. Gage read twice daily, to quarter tenths. Discharge ascertained by applying mean daily gage heights to rating table, except during period when stage-discharge relation was affected by ice for which it was obtained by applying to rating table mean daily gage heights corrected for backwater from ice by means of discharge measurements, observer's notes, and weather records. Open-water records good, except at extreme flood stages, for which they are fair. Records for winter fair.

Discharge measurements of Trempealeau River at Dodge, Wis., 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.*
Oct. 29	S. B. Soulé	1.99	299	Mar. 29	E. L. Williams	6.37	1,670
29	do	1.98	299	May 24	S. B. Soulé	3.70	799
Jan. 13[a]	E. L. Williams	2.60	200	24	do	3.60	757
Feb. 11[a]	do	3.09	202	Aug. 16	E. L. Williams	1.63	228
Mar. 10[a]	do	3.85	322	16	do	1.64	234
29	do	6.44	1,700				

[a] Ice at control.

Daily discharge, in second-feet, of Trempealeau River at Dodge, Wis., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	308	284	433	236	408	308	1,180	562	478	420	220	244
2	308	296	433	236	358	284	1,060	506	850	400	196	232
3	308	284	408	260	308	284	940	452	1,060	374	210	232
4	358	296	383	260	284	272	820	426	1,150	348	318	196
5	358	296	383	248	236	272	760	400	1,180	322	322	348
6	333	296	408	248	213	272	674	374	820	309	296	506
7	333	296	358	260	213	272	590	374	618	296	283	426
8	333	296	358	248	213	278	534	426	820	296	322	374
9	308	296	358	236	202	284	506	590	880	283	283	322
10	308	358	346	224	202	322	478	478	850	270	270	296
11	296	695	346	213	202	408	478	562	702	270	283	348
12	308	825	358	213	213	564	478	452	562	270	244	374
13	433	721	346	200	213	773	478	426	478	270	244	374
14	564	590	346	191	224	1,040	452	452	478	270	232	348
15	485	459	333	191	236	1,310	426	880	534	283	244	322
16	459	459	333	191	248	1,310	452	1,240	562	1,360	232	322
17	408	408	333	191	260	1,280	534	1,180	618	1,300	232	296
18	433	433	333	191	308	1,180	562	790	590	760	478	283
19	459	433	320	202	358	982	646	618	562	426	1,000	270
20	408	408	296	213	458	929	1,360	590	452	374	940	270
21	383	433	296	224	616	916	1,300	646	400	322	674	270
22	358	459	308	260	642	903	1,090	760	400	283	426	270
23	358	433	320	308	590	929	880	880	400	270	374	257
24	333	408	320	408	564	955	730	760	374	257	309	244
25	308	433	308	537	511	1,040	646	590	348	257	296	220
26	333	537	284	642	459	1,940	534	674	374	244	283	270
27	308	564	272	669	408	3,080	478	790	702	232	270	296
28	308	511	272	721	358	2,460	452	910	702	220	270	296
29	308	459	272	642	340	1,690	452	730	534	220	257	322
30	296	433	260	564	.....	1,360	562	790	478	220	244	322
31	296	.....	236	459	.....	1,210	.....	646	.....	220	244	.....

NOTE.—Stage-discharge relation affected by ice Dec. 10 to Mar. 26.

Monthly discharge of Trempealeau River at Dodge, Wis., for the year ending Sept. 30, 1916.

[Drainage area, 633 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	564	296	358	0.566	0.65
November	825	284	437	.690	.77
December	433	236	334	.528	.61
January	721	191	319	.504	.58
February	642	202	339	.536	.58
March	3,080	272	939	1.48	1.71
April	1,360	426	684	1.08	1.20
May	1,240	374	644	1.02	1.18
June	1,180	348	632	.998	1.11
July	1,360	220	376	.594	.68
August	1,000	196	340	.537	.62
September	506	196	305	.482	.54
The year	3,080	191	476	.752	10.23

BLACK RIVER AT NEILLSVILLE, WIS.

LOCATION.—In sec. 15, T. 24 N., R. 2 W., at lower highway bridge in city of Neillsville, Clark County. O'Neil Creek enters from the left about a mile above gage and Cunningham Creek, also from the left, about 1½ miles below.

DRAINAGE AREA.—774 square miles (measured on map issued by Wisconsin Geological and Natural History Survey, edition of 1911; scale, 1 inch = 6 miles).

RECORDS AVAILABLE.—April 7, 1905, to March 31, 1909; December 11, 1913, to September 30, 1916.

GAGE.—Chain gage fastened to downstream side of highway bridge; read by A. Bissell.

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

CHANNEL AND CONTROL.—Bed composed of heavy gravel and rock; control at head of rapids a few hundred feet below gage. Banks high and rocky; water will not overflow the banks at gage section.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 12.78 feet at 5 p.m. March 31 (discharge, 11,400 second-feet); minimum estimated discharge, 28 second-feet January and February; owing to diurnal fluctuations at such low stages it is likely that the absolute minimum was less than 28 second-feet.

1905–1909 and 1913–1916: Maximum stage recorded, 19.8 feet June 6, 1905 (discharge, about 29,400 second-feet). It is probable that the maximum discharge which occurred October 6, 1911, exceeded 29,000 second-feet, although data are not available regarding the stage at the gage section during this flood; minimum stage recorded during open-water periods, 2.4 feet October 9, 1905 (discharge, about 20 second-feet).

REGULATION.—Several dams on Black River and tributaries upstream from Neillsville are used to create a head for developing power. The operation of these plants causes a diurnal fluctuation at the gage, especially during the winter when the flow is at a minimum.

ACCURACY.—Stage-discharge relation practically permanent except as affected by ice. Rating curve well defined from 48 to 14,300 second-feet; fairly well defined below 48 second-feet, and extended above 14,300 second-feet. Gage read twice daily to quarter tenths. Discharge ascertained by applying mean daily gage heights to rating curve except for periods in which stage-discharge relation was affected by ice, for which it was ascertained by applying to rating table mean daily gage heights corrected for backwater from ice by means of discharge measurements, observer's notes, and weather records. Records good for open-water periods, except extremely low stages, for which they are fair; winter records poor.

Discharge measurements of Black River at Neillsville, Wis., 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. 7[a]	W. G. Hoyt	3.36	87	June 22	E. L. Williams	3.71	368
Feb. 6[a]	E. L. Williams	3.74	47	Aug. 18[b]	do	2.78	80
Mar. 9[a]	do	4.30	62				

[a] Made through complete ice cover.

[b] Made by wading 300 feet below gage.

Daily discharge, in second-feet, of Black River at Neillsville, Wis., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	95	167	645	78	108	78	10,400	1,360	1,150	1,080	40	33
2	92	150	280	85	78	72	10,400	1,220	3,570	890	36	35
3	98	138	360	92	56	68	9,670	685	3,910	660	34	31
4	110	110	320	92	42	68	7,790	770	3,060	460	34	38
5	112	116	300	85	45	66	5,960	660	2,070	334	118	32
6	136	108	228	85	47	64	4,700	585	1,430	222	198	35
7	150	118	207	87	45	64	3,570	510	1,150	167	190	102
8	148	125	228	72	28	62	2,860	560	3,060	130	118	890
9	172	127	238	61	28	62	2,160	535	3,060	122	100	560
10	184	178	184	66	33	62	1,980	460	2,260	110	84	228
11	181	2,860	210	72	56	64	2,070	560	1,500	81	76	157
12	191	5,640	197	66	92	64	2,360	485	3,260	69	73	125
13	730	4,420	197	37	28	72	2,660	395	830	63	94	104
14	1,720	2,960	195	28	48	78	2,560	685	830	64	94	118
15	1,800	1,980	190	30	42	78	2,360	2,070	660	354	65	195
16	1,430	1,430	186	37	66	78	2,460	2,160	1,720	244	69	192
17	1,150	880	184	40	42	92	3,460	1,800	1,720	950	54	210
18	1,150	880	182	42	92	108	3,060	1,430	1,290	1,980	78	216
19	1,430	1,010	180	48	37	127	2,960	1,080	830	660	58	228
20	1,640	1,360	178	56	42	210	3,460	890	635	315	416	170
21	1,500	1,290	178	66	108	320	6,120	660	438	176	39	132
22	1,290	880	164	78	56	400	9,490	1,220	315	104	45	118
23	760	760	150	92	56	490	6,600	1,770	254	87	41	110
24	590	590	127	127	78	645	4,700	1,500	210	86	42	167
25	490	700	118	210	78	945	3,260	1,290	176	58	40	184
26	445	2,160	108	280	66	1,360	2,070	1,360	890	47	37	134
27	340	3,160	92	320	78	1,890	1,500	2,070	2,360	42	33	160
28	280	2,660	85	320	56	2,860	1,150	1,800	2,070	57	37	1,980
29	245	1,640	78	280	78	4,560	950	1,500	1,360	52	38	1,360
30	217	1,220	78	245	.....	7,280	1,220	1,150	1,080	41	32	660
31	184	.....	78	178	.....	11,000	.....	1,290	.....	42	36	.....

NOTE.—Stage-discharge relation affected by ice Dec. 14 to Mar. 28.

Monthly discharge of Black River at Neillsville, Wis., for the year ending Sept. 30, 1916.

[Drainage area, 774 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	1,800	92	615	0.795	0.92
November	5,640	108	1,330	1.72	1.92
December	645	78	198	.256	.30
January	320	28	111	.143	.16
February	108	28	59	.076	.08
March	11,000	62	1,080	1.40	1.61
April	10,400	950	4,130	5.34	5.96
May	2,160	395	1,110	1.43	1.65
June	3,910	176	1,570	2.03	2.26
July	1,980	41	314	.406	.47
August	416	32	79	.102	.12
September	1,980	31	290	.375	.42
The year	11,000	28	902	1.17	15.87

LA CROSSE RIVER NEAR WEST SALEM, WIS.

LOCATION.—In sec. 32,[1] T. 17 N., R. 6 W., La Crosse County, at highway bridge 2 miles west of West Salem, and 10 miles above mouth of river. Dutch Creek enters from right 6 miles above station.

DRAINAGE AREA.—412 square miles (measured on map issued by Wisconsin Geological and Natural History Survey, edition of 1911; scale 1 inch = 6 miles).

RECORDS AVAILABLE.—December 22, 1913, to September 30, 1916.

GAGE.—Chain gage fastened to concrete guardrail on upstream side of bridge; read by Henry Schucht.

DISCHARGE MEASUREMENTS.—Made from upstream side of bridge at medium and high stages; at low stages made by wading.

CHANNEL AND CONTROL.—Bed heavy gravel and rock. Right bank high and not subject to overflow; left bank above gage low and subject to overflow at flood stages. Channel free from vegetation; control for low stages a rocky riffle with a fall of about 6 inches. Control is drowned out at a stage of about 2.2 feet on the gage as shown by a reversal in the rating curve.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 5.6 feet at 7 a. m. January 29 (discharge estimated, because of backwater from ice, at about 1,700 second-feet); minimum stage recorded, 1.22 feet at 6 p. m. September 3 (discharge, 164 second-feet).

1913–1916: Maximum discharge recorded, 1,800 second-feet February 23, 1915; minimum discharge, about 130 second-feet, recorded November 17, 1914.

REGULATION.—Diurnal fluctuation at the gage, amounting at low stages to from 0.10 to 0.40 foot, is caused by the operation of power plants, especially the Neshonock dam a few miles above station.

ACCURACY.—Stage-discharge relation permanent except as affected by ice. Rating curve well defined between 212 and 1,310 second-feet. Gage read twice daily to quarter tenths. Discharge ascertained by applying mean daily gage heights to rating curve except for periods in which stage-discharge relation was affected by ice, for which it was ascertained by applying to rating table mean daily gage heights corrected for backwater from ice by means of discharge measurements, observer's notes, and weather records. Records good for open-water periods, except for low stages, for which they are fair; winter records poor.

Discharge measurements of La Crosse River near West Salem, Wis., 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. 14[a]	E. L. Williams	1.57	192	Mar. 30	E. L. Williams	1.94	433
Feb. 4[b]	M. F. Rather	2.04	233	30	do	1.94	444
Mar. 11[b]	E. L. Williams	2.74	374	Apr. 15	do	1.42	220

[a] Made through complete ice cover; partial ice cover at control section.
[b] Made from bridge; partial ice cover at control.

[1] Sectional location published in Water-Supply Paper 405, p. 115, is in error.

Daily discharge, in second-feet, of La Crosse River near West Salem, Wis., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	348	281	326	204	461	326	461	350	268	248	196	196
2	326	281	326	239	371	304	461	350	416	230	196	196
3	326	281	304	326	281	239	416	328	551	248	212	170
4	348	281	304	281	233	222	394	308	779	248	248	196
5	326	281	281	281	233	239	371	288	461	248	438	196
6	326	281	281	281	222	260	350	288	350	248	506	196
7	304	260	281	204	222	281	328	288	350	248	461	328
8	304	281	281	204	222	326	328	288	461	230	308	350
9	304	326	281	192	222	348	288	268	461	212	248	288
10	281	348	281	192	239	371	288	268	461	230	248	212
11	304	394	281	204	239	374	288	308	371	230	268	268
12	326	506	281	204	239	595	308	308	350	230	248	308
13	348	506	281	204	239	862	288	288	328	212	212	416
14	371	416	281	192	239	807	288	288	308	230	212	416
15	394	371	281	180	239	595	288	371	308	308	212	308
16	371	326	260	180	281	461	308	461	328	308	230	268
17	326	326	260	204	326	371	371	416	371	288	212	268
18	394	260	281	239	461	326	350	328	328	268	212	268
19	371	326	281	239	638	326	551	328	328	268	212	248
20	348	416	304	281	889	371	638	308	308	248	181	248
21	326	394	326	326	779	371	715	288	288	212	212	248
22	326	371	371	506	835	371	551	328	288	230	196	248
23	326	348	371	779	807	416	438	371	288	181	196	230
24	281	326	326	862	678	416	394	328	288	212	212	212
25	281	348	281	889	638	749	350	288	248	230	196	230
26	260	438	281	916	595	1,230	328	288	308	212	196	248
27	281	506	281	1,500	371	862	328	288	328	212	170	461
28	260	461	281	1,390	371	638	308	248	288	212	196	595
29	281	371	281	1,690	326	461	328	288	268	212	196	807
30	281	416	239	1,060	.....	438	371	308	268	196	196	461
31	260	.....	204	807	.....	461	.....	268	.....	196	181	.....

NOTE.—Stage-discharge relation affected by ice Dec. 14 to Mar. 23.

Monthly discharge of La Crosse River near West Salem, Wis., for the year ending Sept. 30, 1916.

[Drainage area, 412 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	394	260	320	0.777	0.90
November	506	260	358	.869	.97
December	371	204	290	.704	.81
January	1,690	180	492	1.19	1.37
February	889	222	410	.995	1.07
March	1,230	222	465	1.13	1.30
April	715	288	332	.927	1.03
May	461	248	314	.762	.88
June	779	248	358	.869	.97
July	308	181	235	.570	.66
August	506	170	239	.580	.67
September	807	170	303	.735	.82
The year	1,690	170	347	.842	11.45

ROOT RIVER NEAR HOUSTON, MINN.

LOCATION.—In sec. 34, T. 104 N., R. 6 W., at highway bridge 1 mile east of Houston, Houston County, 1 mile above the mouth of South Root River.

DRAINAGE AREA.—1,560 sqaure miles.

GAGE.—Vertical staff bolted to downstream side of stone abutment, right end of bridge, read by Olaf Larson. Prior to June 28, 1913, gage was attached to piling just upstream from right abutment. The datum of the present gage was changed slightly on the date of installation to allow for slight slope in river between the two points.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge.

CHANNEL AND CONTROL.—No well-defined control. Bed of stream is silt and fine sand that scours during floods and gradually fills in afterwards. Banks subject to overflow at stage of about 8.5 feet, the overflow at the gage attaining at times a width of about 5,000 feet. Floods on the south Root, which enters the main Root about a mile below station, at times produce considerable backwater at the gage.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 9.7 feet at 8.30 a.m. March 26 (discharge, 7,970 second-feet); minimum discharge estimated at 260 second-feet, January 13.

1909–1916: Maximum stage recorded, 10.8 feet late at night August 14, 1911 (discharge determined from rating curve based on high-water measurement made in 1915 (15,200 second-feet); minimum open-water stage recorded, 0.80 foot July 17, 1911 (discharge, 267 second-feet); a discharge of 231 second-feet was measured by current meter on January 23. 1914.

ICE.—Stage-discharge relation seriously affected by ice.

REGULATION.—Nearest dam above station is at Rushford. As flow is ample at all times for power generated at that point, it is not held back during certain parts of the day, and the dam has no influence on flow at Houston.

ACCURACY.—Stage-discharge relation changed considerably during year, owing to silting up of the channel during the low water in the fall and by a log lodging in channel in March. Rating curve well defined for high stages, but on account of shifting of control, the lower part is not well defined. Gage read twice daily to hundredths. Daily discharge ascertained by use of indirect method for shifting control. Records fair; accuracy of determinations probably increases with stage. Estimates of discharge for flood stage above 8.9 feet in 1911 as published in Water-Supply Paper 305 are too low on account of an erroneous extension of rating curve above 8.9 feet. The high-water part of the rating curve, based on discharge measurements made June 28 and 29, 1914, at gage heights 9.80 and 6.98 feet, gives the same discharge as the curve used for 1911 at about gage height, 8.9 feet; at gage height 10.0 feet the new curve gives a discharge about 44 per cent larger than that given by rating curve for 1911.

Discharge measurements of Root River near Houston, Minn., 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.*
Oct. 28	S. B. Soulé	2.18	508	Mar. 31	E. L. Williams	3.93	1,230
Jan. 15[a]	E. L. Williams	2.65	306	May 23	S. B. Soulé	4.06	1,470
Feb. 12[a]	do	3.55	428	Aug. 4	do	2.32	549
Mar. 13[a]	do	8.88	3,510				

[a] Ice at control.

Daily discharge, in second-feet, of Root River near Houston, Minn., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	567	468	437	407	888	638	1,370	978	888	638	533	379
2	533	468	468	407	716	638	1,370	1,170	1,530	602	533	379
3	533	468	468	327	676	602	1,170	1,020	1,270	602	500	379
4	533	437	468	407	638	533	978	933	1,170	567	567	352
5	500	437	468	407	567	533	888	843	1,070	602	1,170	379
6	500	437	437	303	567	533	799	843	978	533	757	407
7	500	468	437	327	500	533	757	757	933	533	567	500
8	500	437	437	352	500	500	716	757	933	533	533	567
9	500	468	437	379	468	500	676	716	933	500	500	468
10	500	533	437	352	468	978	676	676	933	500	500	468
11	500	602	437	315	437	1,170	638	676	888	500	500	468
12	500	638	437	352	437	1,120	602	676	757	468	468	567
13	533	716	437	260	407	3,530	602	638	933	468	468	533
14	567	799	379	292	407	3,940	602	799	843	602	437	500
15	533	638	340	303	407	3,080	567	1,530	757	2,620	468	468
16	533	602	315	327	437	2,230	602	3,250	757	3,160	437	437
17	567	567	327	315	468	1,270	602	1,980	843	3,000	437	437
18	567	567	303	340	1,170	1,480	716	1,530	799	1,750	437	407
19	602	567	567	327	1,750	1,320	1,480	1,320	676	1,270	437	407
20	638	567	468	352	1,420	1,220	3,630	1,170	676	1,220	437	407
21	638	533	437	468	1,700	1,530	4,170	1,070	676	1,020	407	407
22	567	500	468	1,270	1,170	1,370	2,490	1,170	716	933	407	407
23	567	500	468	1,640	888	1,270	1,700	1,420	799	843	379	379
24	533	533	379	1,480	1,170	1,270	1,420	1,420	757	757	407	407
25	533	533	379	2,040	1,170	4,440	1,270	1,920	676	757	379	379
26	500	533	352	1,700	978	6,480	1,170	1,580	799	676	407	407
27	500	533	327	2,840	843	3,440	1,070	1,220	757	676	407	468
28	500	500	281	4,590	716	1,980	978	1,020	676	676	379	468
29	500	500	327	2,230	716	1,480	933	933	638	638	379	437
30	468	437	352	1,480	.....	1,270	978	933	638	602	379	407
31	468	.....	379	1,070	.....	1,220	.....	888	.....	602	379	.....

NOTE.—Stage-discharge relation affected by ice Dec. 14 to Mar. 18.

Monthly discharge of Root River near Houston, Minn., for the year ending Sept. 30, 1916.

[Drainage area, 1,560 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	638	468	532	0.341	0.39
November	799	437	533	.342	.38
December	468	281	408	.262	.30
January	4,590	260	892	.572	.66
February	1,750	407	782	.501	.54
March	6,480	500	1,680	1.08	1.24
April	4,170	567	1,190	.763	.85
May	3,250	638	1,160	.744	.86
June	1,530	638	857	.549	.61
July	3,160	468	931	.597	.69
August	1,170	379	484	.310	.36
September	567	352	436	.280	.31
The year	6,480	260	824	.528	7.19

NORTH BRANCH OF ROOT RIVER NEAR LANESBORO, MINN.

LOCATION.—In sec. 6, T. 103 N., R. 9 W., at first highway bridge 1 mile above junction of North and South branches, 3 miles north of Lanesboro, Fillmore County, and about 5 miles below mouth of a small creek that enters from the west.

DRAINAGE AREA.—647 square miles.

RECORDS AVAILABLE.—March 9, 1910, to September 30, 1914; and July 16, 1915, to September 30, 1916.

GAGE.—Chain gage on floor of bridge, downstream side, near right bank; read by Olaf Waage.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge. At extreme flood stages measurements may be made from the railroad bridge just above the junction with the South Branch, and at low stages by wading just above gage.

CHANNEL AND CONTROL.—Bed composed of sand and light gravel. A few hundred feet below gage channel is narrowed by a low island and there is a slight riffle which constitutes control at low stages and is practically permanent. As there is more than 10 feet fall between the station and the mouth of the South Branch, backwater from that stream is improbable. At a stage of 6 feet the river overflows into a channel 1,000 feet back from right bank, at extreme flood stages right bank is overflowed to a width of a quarter of a mile.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 7.2 feet at 7.50 a. m. March 13 (discharge, 5,020 second-feet); minimum discharge estimated at 55 second-feet, March 9.

1910–1916: Maximum stage recorded, 10.3 feet August 13, 1911 (discharge, 9,380 second-feet); minimum stage recorded during open-water periods, 1.71 feet July 4, 1911 (discharge, 38 second-feet).

ICE.—Stage-discharge relation seriously affected by ice.

REGULATION.—Several miles above station is a power plant working under a varying load for light and power; inspection of the morning and evening gage heights indicates that the diurnal fluctuation at the gage is slight.

ACCURACY.—Stage-discharge relation changed during high water in January. Rating curve used before the change fairly well defined; curve used after the change well defined between 200 and 1,500 second-feet, and fairly well defined between 1,500 and 4,000 second-feet. Gage read to quarter tenths twice daily. Daily discharge ascertained by applying mean daily gage heights to rating table, except for periods in which stage-discharge relation was affected by backwater from ice, for which it was ascertained by applying to the rating table mean daily gage heights corrected for backwater from ice by means of discharge measurements, observer's notes, and weather records. Records fair, except for winter period, for which they are poor.

Discharge measurements of North Branch of Root River near Lanesboro, Minn., 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.*
Oct. 28	S. B. Soulé	2.29	210	Mar. 31	E. L. Williams	3.19	718
Jan. 15[a]	E. L. Williams	2.92	132	May 23	S. B. Soulé	3.57	987
Feb. 12[a]	do	2.65	161	Aug. 4	do	2.23	253

[a] Ice at control.

Daily discharge, in second-feet, of North Branch of Root River near Lanesboro, Minn., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	218	165	159	165	463	118	829	673	430	264	234	156
2	204	156	255	86	248	96	703	587	733	261	218	178
3	194	141	159	172	286	86	532	480	559	272	221	123
4	184	141	153	204	286	73	361	406	559	286	244	178
5	194	138	188	198	305	153	384	361	430	261	454	186
6	204	104	135	178	104	82	340	384	430	250	250	200
7	184	132	191	172	118	107	324	332	357	237	272	340
8	184	191	144	191	118	96	309	320	406	250	212	254
9	218	162	175	68	132	55	254	301	454	215	209	186
10	184	132	147	132	118	918	237	305	430	206	225	149
11	194	191	153	178	118	1,040	231	278	361	218	212	250
12	218	305	135	121	132	1,040	237	254	332	209	212	293
13	266	568	126	118	120	5,020	237	258	480	218	209	244
14	266	347	229	99	107	4,360	237	384	332	406	195	231
15	212	326	135	135	96	1,950	231	3,050	324	932	212	215
16	194	266	129	150	73	897	258	2,610	384	3,510	192	198
17	278	251	184	110	112	615	293	969	406	1,260	209	189
18	278	222	248	107	259	644	733	764	340	615	203	231
19	255	229	248	124	215	764	1,210	615	290	505	186	195
20	286	226	212	112	414	644	4,620	532	286	559	212	183
21	278	150	218	168	326	959	2,830	454	301	361	198	183
22	240	236	233	184	184	764	1,260	829	349	353	156	183
23	229	162	184	514	194	559	829	932	384	324	167	189
24	218	226	191	956	326	796	644	764	324	278	189	215
25	212	178	178	1,120	236	5,020	559	644	324	268	195	186
26	204	347	107	1,120	138	3,510	505	532	361	203	186	192
27	172	172	118	4,750	150	1,740	430	480	316	189	133	203
28	184	159	153	1,130	68	862	430	406	275	192	162	183
29	188	124	147	703	112	644	406	406	324	250	186	200
30	175	212	124	532	.....	587	480	406	316	275	141	175
31	172	.....	159	532	.....	703	.....	406	.....	241	167	.....

NOTE.—Stage-discharge relation affected by ice Jan. 10–26 and Feb. 1 to Mar. 10.

Monthly discharge of North Branch of Root River near Lanesboro, Minn., for the year ending Sept. 30, 1916.

[Drainage area, 647 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	286	172	216	0.334	0.38
November	568	104	212	.328	.37
December	255	107	172	.266	.31
January	4,750	68	469	.725	.84
February	463	68	192	.297	.32
March	5,020	55	1,130	1.75	2.02
April	4,620	231	698	1.08	1.20
May	3,050	254	649	1.00	1.15
June	733	275	387	.598	.67
July	3,510	189	447	.691	.80
August	454	133	208	.322	.37
September	340	123	203	.314	.35
The year	5,020	55	416	.643	8.78

WISCONSIN RIVER AT WHIRLPOOL RAPIDS, NEAR RHINELANDER, WIS.

LOCATION.—In sec. 4, T. 35 N., R. 8 E., Lincoln County, at head of Whirlpool Rapids, a mile below mouth of outlet of Crescent Lake, coming in from the right, and about 3 miles downstream from power station of Rhinelander Power Co., 10 miles southwest of Rhinelander.

DRAINAGE AREA.—1,160 square miles (measured on map issued by Wisconsin Geological and Natural History Survey, edition of 1911; scale, 1 inch=6 miles.)

RECORDS AVAILABLE.—September 15, 1915, to September 30, 1916; December 1, 1905, to September 30, 1915, records were collected at a station 3 miles upstream.

GAGE.—Stevens continuous water-stage recorder, on right bank, in wooden shelter, well, and intake.

DISCHARGE MEASUREMENTS.—Made from car and cable about 150 feet upstream from gage.

CHANNEL AND CONTROL.—Bed of stream is heavy gravel and rock; banks medium high and not subject to overflow. Control is head of rapids 100 feet downstream from gage; well defined and permanent.

EXTREMES OF DISCHARGE.—September 15, 1915, to September 30, 1916: maximum stage recorded, 5.61 feet at 10 p. m. April 22 (discharge, 5,250 second-feet); minimum stage recorded 0.85 foot at 5 p. m. August 20 (discharge, 228 second-feet).

1905–1916: Maximum stage recorded, 5.61 feet at 10 p. m. April 22, 1916 (discharge, 5,250 second-feet); minimum discharge recorded, at old station, zero during August and September, 1907, and June, 1908. Minimum flow caused almost entirely by regulation.

REGULATION.—Above station are 14 reservoirs[a] which are operated by the Wisconsin Valley Improvement Co., for regulating the flow in Wisconsin River. The aggregate capacity of these reservoirs is 2.8 billion cubic feet during summer and 3.6 billion cubic feet during winter. In addition to the above reservoirs there are on the Wisconsin River above this station three power plants. Owing to the operation of these various storage reservoirs, and the service reservoirs in connection with the power plants, the flow at the station is not natural.

ACCURACY.—Stage-discharge relation permanent; rating curve well defined between 212 and 5,410 second-feet. Operation of water-stage recorder satisfactory except for periods indicated in footnote to daily-discharge table. Discharge ascertained by use of discharge integrator, except during periods when stage-discharge relation was affected by ice, for which it was ascertained by applying to rating table mean daily gage heights corrected for backwater from ice by means of discharge measurements, observer's notes, and weather records. For a few days in April, when discharge was above 4,180 second-feet, discharge was obtained by averaging hourly discharge. During certain periods of the year the gage did not give satisfactory records, and for these periods discharge was based on gage-height records at site of old gaging station. Open-water records excellent, except for periods when gage was not in operation, for which they are fair. Winter records poor.

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[a] Information concerning these reservoirs, based on maps and data furnished by A. A. Babcock, manager of Wisconsin Valley Improvement Co., and data collected by the Engineering Department of the Railroad Commission of Wisconsin, is contained in U. S. Geol. Survey Water-Supply Paper 405, p. 127.

Discharge measurements of Wisconsin River at Whirlpool Rapids near Rhinelander, Wis., during the period Sept. 7, 1915, to Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
1915.		*Feet.*	*Sec.-ft.*	1916.		*Feet.*	*Sec.-ft.*
Sept. 7[a]	H. C. Beckman	0.96	267	Feb. 8[b]	H. C. Beckman	3.94	1,140
7[a]	do	.97	268	Mar. 13[b]	do	3.31	1,160
7[a]	do	1.80	606	Apr. 19	do	4.54	3,460
Nov. 4	do	1.95	726	23	do	5.50	5,050
				June 14	W. G. Hoyt	3.13	1,740
1916.				Sept. 13	E. L. Williams	2.40	1,060
Jan. 11[b]	do	3.22	916				

[a] Made from boat at cable section. [b] Ice below gage and at control.

Daily discharge, in second-feet, of Wisconsin River at Whirlpool Rapids, near Rhinelander, Wis., for the period Sept. 15, 1915, to Sept. 30, 1916.

Day.	Sept.	Day.	Sept.	Day.	Sept.
1915.		1915.		1915.	
15	1,000	21	1,410	27	1,080
16	1,080	22	1,220	28	1,220
17	1,200	21	1,160	29	1,210
18	1,270	24	1,110	30	965
19	1,200	25	1,140	31	.....
20	1,220	26	1,070		

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1915-16.												
1	1,360	860	1,230	735	1,050	1,050	1,190	3,490	2,110	2,380	1,590	890
2	1,320	672	1,030	735	1,010	1,170	1,270	3,800	2,200	1,760	1,300	855
3	1,240	800	1,010	735	979	1,190	1,360	3,930	2,780	2,510	1,420	1,120
4	1,070	720	1,070	735	915	1,120	1,450	3,320	2,230	2,470	1,310	690
5	990	607	1,070	735	884	1,080	1,550	3,600	3,160	1,980	1,140	820
6	1,040	850	1,200	735	1,010	1,050	1,700	2,810	2,700	1,450	1,190	1,120
7	1,400	657	1,210	735	1,050	1,080	2,050	2,800	2,750	1,520	1,260	1,080
8	1,440	800	1,210	735	1,080	1,080	2,260	3,200	3,420	1,600	1,390	1,160
9	1,270	1,060	1,210	793	1,050	1,120	1,850	2,600	2,950	1,860	1,330	1,280
10	1,000	750	1,250	853	574	1,150	2,240	2,140	2,640	1,270	932	1,160
11	1,080	1,340	1,190	915	679	1,120	2,840	2,460	2,620	1,380	1,270	1,880
12	1,120	1,340	1,080	947	625	1,120	3,510	1,630	2,750	1,220	1,120	1,160
13	1,300	1,430	1,050	947	373	1,120	3,650	1,570	2,610	833	890	1,160
14	1,470	1,420	979	947	373	1,050	3,420	1,340	2,160	900	1,040	1,200
15	1,560	1,450	979	947	393	1,050	3,780	1,240	3,080	1,080	1,380	1,490
16	1,570	1,430	793	915	435	1,020	3,770	1,920	2,850	777	1,020	1,340
17	1,540	1,420	764	915	525	979	3,940	2,350	2,590	757	1,180	1,600
18	1,600	1,400	764	884	625	979	3,500	1,610	3,110	1,240	1,160	1,290
19	1,710	1,420	764	853	764	979	3,390	1,810	2,480	1,200	1,110	1,200
20	1,670	1,540	793	823	915	1,150	4,120	1,580	1,930	1,000	790	1,240
21	1,980	1,600	853	793	947	1,150	4,310	1,280	2,320	1,130	924	1,320
22	1,580	1,420	884	735	947	1,010	5,000	2,250	2,430	1,190	1,310	1,240
23	1,650	1,250	884	735	979	1,030	4,880	2,240	2,020	833	1,020	980
24	1,180	1,190	884	735	979	1,050	4,870	1,780	2,250	880	1,010	1,310
25	1,620	1,270	853	735	1,010	1,120	5,100	1,880	1,680	1,310	1,010	1,160
26	1,420	1,690	853	735	1,050	1,150	4,620	2,080	2,060	1,720	865	1,280
27	1,320	1,750	1,010	793	1,050	1,140	3,890	2,230	1,800	1,780	880	2,000
28	1,290	1,640	1,050	823	1,050	1,120	3,820	1,890	1,670	1,730	817	1,880
29	1,350	1,520	853	884	1,050	947	3,990	2,520	1,680	1,660	1,280	1,860
30	1,200	1,500	735	915	.....	1,050	3,810	2,100	2,020	1,380	965	1,850
31	1,130	.....	735	979	.....	1,270	.....	1,660	.....	1,760	928	.....

NOTE.—Stage-discharge relation affected by ice Dec. 1 to Apr. 6. Recording gage not in operation Oct. 4–9, Aug. 30 to Sept. 15.

Monthly discharge of Wisconsin River at Whirlpool Rapids near Rhinelander, Wis., for the period Sept. 15, 1915, to Sept. 30, 1916.

[Drainage area, 1,160 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
1915.					
September 15-30	1,410	965	1,160	1.00	0.60
1915-16.					
October	1,980	990	1,370	1.18	1.36
November	1,750	607	1,230	1.06	1.18
December	1,250	735	975	.841	.97
January	979	735	822	.709	.82
February	1,080	373	840	.724	.78
March	1,270	947	1,090	.940	1.08
April	5,100	1,190	3,240	2.79	3.11
May	3,930	1,240	2,290	1.97	2.27
June	3,420	1,670	2,440	2.10	2.34
July	2,510	757	1,440	1.24	1.43
August	1,590	790	1,120	.966	1.11
September	2,000	690	1,290	1.11	1.24
The year	5,100	373	1,510	1.30	17.69

WISCONSIN RIVER AT MERRILL, WIS.

LOCATION.—At highway bridge at east end of city of Merrill, Lincoln County, 1,000 feet below power house of Merrill Electric Railway & Power Co. and half a mile below mouth of Prairie River, coming in from the left.

DRAINAGE AREA.—2,630 square miles.

RECORDS AVAILABLE.—November 17, 1902, to September 30, 1916.

GAGE.—Stevens water-stage recorder installed September 11, 1914; November 17, 1902, to June 17, 1903, staff gage; June 17, 1903, to September 10, 1914, chain gage attached to downstream side of highway bridge; datum same since June 17, 1903; records prior to this date questionable.

DISCHARGE MEASUREMENTS.—Made from highway bridge a few feet upstream from recording gage.

CHANNEL AND CONTROL.—Heavy gravel and rock; nearly permanent; small island below gage and small rapids on either side probably constitute control. Banks are fairly high and are rarely overflowed.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 12.8 feet at 7 p. m., April 22 (discharge, 24,100 second-feet); minimum stage recorded, 3.41 feet at 4 p. m. October 3 (discharge, about 655 second-feet).

1912–1916: Maximum stage recorded, approximately 17.5 feet at 5 a. m., July 24, 1912 (discharge, 45,000 second-feet). During the preceding 24 hours, 11.25 inches of rain fell in the vicinity of Merrill. According to C. B. Stewart, consulting engineer, Madison, the run-off of the 700 square miles between Merrill and Tomahawk was at the rate of 65 second-feet per square mile. If the estimate is extended to the entire area above Merrill the flow was 17 second-feet per square mile. Minimum stage recorded for the period, 2.7 feet, July 7, 1910 (discharge, about 389 second-feet).

REGULATION.—Above the gaging station are 17 reservoirs,[1] which are operated by the Wisconsin Valley Improvement Co. for the purpose of regulating the flow in Wisconsin River. The aggregate capacity of these reservoirs is about 6¼ billion cubic feet. In addition to the above reservoirs there are on the Wisconsin and Tomahawk rivers above the station eight dams operated for power.

ACCURACY.—Stage-discharge relation practically permanent; rating curve fairly well defined between 1,600 and 19,400 second-feet. Operation of water-stage recorder satisfactory throughout year. Discharge ascertained by use of discharge integrator except above 8,430 second-feet which was ascertained by applying to rating table mean daily gage heights determined from recording gage graph. Open-water records good; records for winter fair.

Discharge measurements of Wisconsin River at Merrill, Wis., 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. 14[a]	H. C. Beckman	5.06	1,750	Apr. 21	H. C. Beckman	10.98	17,600
Feb. 10[a]	do	5.05	1,760	June 20	W. G. Hoyt	6.38	4,610
Mar. 15[a]	do	5.10	1,850				

[a] Incomplete ice cover at control.

Daily discharge, in second-feet, of Wisconsin River at Merrill, Wis., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	2,700	2,040	3,730	2,100	1,900	2,100	7,010	8,700	4,190	7,000	3,850	2,400
2	3,040	2,070	2,720	2,240	2,000	1,970	7,760	8,300	7,890	8,210	3,000	2,090
3	1,660	1,740	2,500	1,880	1,820	2,120	8,700	8,240	8,430	8,430	3,020	2,090
4	2,650	1,480	2,520	2,000	1,890	2,220	8,590	7,890	9,680	8,160	2,660	1,960
5	2,860	1,860	2,440	2,080	1,780	1,900	8,670	7,240	7,420	6,670	2,590	1,900
6	2,520	1,790	2,360	1,610	1,980	1,920	9,040	7,180	7,630	4,660	2,370	2,100
7	2,330	1,880	2,270	2,040	1,770	2,000	9,040	5,880	6,660	4,060	2,430	2,890
8	2,680	1,640	2,720	1,860	1,840	2,000	8,700	5,690	7,000	3,720	2,480	2,690
9	3,300	1,740	2,340	1,780	2,060	1,890	7,760	5,980	7,630	3,900	2,620	2,890
10	3,380	2,140	2,400	1,930	1,840	1,940	7,680	5,100	6,510	3,600	2,440	3,130
11	2,980	4,140	2,280	1,980	1,940	1,800	9,260	4,520	5,580	2,580	2,230	2,940
12	2,140	5,280	2,320	1,940	1,900	1,900	10,700	4,340	4,560	2,780	2,200	3,300
13	2,740	5,560	2,130	1,900	1,960	1,780	12,100	3,830	5,260	2,490	2,170	2,920
14	3,460	4,900	1,980	1,880	1,830	1,940	12,600	4,000	4,560	2,040	1,910	2,810
15	3,860	4,860	2,100	2,180	1,910	1,940	11,900	4,370	4,260	2,350	1,910	3,100
16	3,720	4,400	2,000	2,370	2,180	1,820	12,100	5,360	5,780	2,790	2,280	3,330
17	3,640	3,430	1,860	2,140	1,980	1,940	12,100	6,340	5,860	2,190	2,190	2,860
18	3,550	3,260	2,160	2,080	2,100	1,920	12,100	5,380	5,950	2,950	2,030	2,810
19	4,430	3,210	2,020	2,070	2,040	1,780	11,100	5,050	5,510	3,070	2,050	2,640
20	4,600	3,440	2,040	1,840	2,000	1,780	13,400	4,260	4,320	4,040	2,040	2,370
21	4,200	3,280	2,100	1,820	2,080	1,840	17,500	3,980	3,550	3,340	1,660	2,660
22	4,110	2,980	2,200	1,860	2,080	2,040	22,500	3,610	3,910	3,340	1,720	2,970
23	3,000	3,030	2,260	1,860	1,920	1,850	20,700	5,370	3,790	3,200	2,090	2,220
24	2,960	2,820	2,220	1,700	2,080	1,810	16,200	4,670	3,280	2,700	2,300	2,250
25	2,560	2,770	2,170	1,840	2,040	1,980	13,800	4,330	3,580	3,020	1,820	2,110
26	2,790	3,820	2,090	1,800	2,010	2,220	13,100	4,500	3,710	4,130	1,840	2,750
27	2,660	5,090	2,070	1,780	2,140	2,140	11,000	5,420	4,670	4,060	1,730	3,460
28	2,370	4,940	2,220	1,840	2,000	2,460	10,300	5,770	3,970	4,020	1,930	4,230
29	2,460	3,720	2,320	1,780	2,040	2,870	10,000	5,500	3,670	3,650	1,700	4,000
30	2,340	3,690	2,320	1,800	.....	3,840	9,740	6,450	4,310	3,580	1,700	3,820
31	2,170	.....	2,000	1,830	.....	6,000	.....	4,340	.....	2,640	1,870	.....

NOTE.—Stage-discharge relation affected by ice Dec. 16 to Apr. 2.

[1] Information concerning these reservoirs, based on maps and data furnished by A. A. Babcock, manager of the Wisconsin Valley Improvement Co., and data collected by the engineering department of the Wisconsin Railroad Commission, is contained in U. S. Geol. Survey Water-Supply Paper 405, p. 127.

Monthly discharge of Wisconsin River at Merrill, Wis., for the year ending Sept. 30, 1916.

[Drainage area, 2,630 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	4,600	2,140	3,060	1.16	1.34
November	5,560	1,480	3,230	1.23	1.37
December	3,730	1,860	2,290	.871	1.00
January	2,370	1,610	1,930	.734	.85
February	2,180	1,770	1,970	.749	.81
March	6,000	1,780	2,180	.829	.96
April	22,500	7,010	11,500	4.37	4.88
May	8,700	3,610	5,540	2.11	2.43
June	9,680	3,280	5,440	2.07	2.31
July	8,430	2,040	3,980	1.51	1.74
August	3,856	1,660	2,220	.844	.97
September	4,230	1,900	2,790	1.06	1.18
The year	22,500	1,480	3,830	1.46	19.84

WISCONSIN RIVER NEAR NEKOOSA, WIS.

LOCATION.—In sec. 15, T. 21 N., R. 5 E, 1½ miles below Nekoosa, Wood County. Tenmile Creek enters from the left, about 4 miles below station, and Big Roche a Cri Creek, also from the left, about 38 miles below station.

DRAINAGE AREA.—5,500 square miles (measured on map issued by Wisconsin Geological and Natural History Survey, edition of 1911; scale 1 inch = 6 miles).

RECORDS AVAILABLE.—May 21, 1914, to September 30, 1916.

GAGE.—Since July 18, 1916, Stevens continuous water-stage recorder, in wooden well and shelter, on right bank of river. May 21 to October 23, 1914, a staff gage 300 feet upstream from water-stage recorder. October 23,1914, to July 18, 1916, a Gurley water-stage recorder in same well and shelter as present Stevens gage. Gage attended by Henry Mans.

DISCHARGE MEASUREMENTS.—Made from cable a short distance upstream from gage house.

CHANNEL AND CONTROL.—Gravel; clean; practically permanent; banks high and will rarely be overflowed.

EXTREMES OF DISCHARGE.—Maximum stage during year, 14.89 feet at 6 a. m. April 24 (discharge, 51,200 second-feet); minimum stage 0.45 foot at 11 a. m. October 7 (discharge, 595 second-feet).

May 21, 1914, to September 30, 1916: Maximum stage recorded, approximately 15.3 feet during the flood of June 6–9, 1914, as determined by levels run to high-water marks after water had receded (discharge, 54,600 second-feet); minimum stage recorded, 0.45 foot at 11 a. m. October 7, 1915 (discharge, 595 second-feet). Minimum flow is due to regulation.

REGULATION.—No storage reservoirs discharge into Wisconsin River between Nekoosa and Merrill. See "Regulation" in station description of Wisconsin River at Merrill (p. 123). Between Nekoosa and Merrill are 12 dams operated for power.

ACCURACY.—Stage-discharge relation practically permanent, except as affected by ice. Rating curve well defined between 1,160 and 52,100 second-feet. Operation of water-stage recorder satisfactory throughout year. Discharge ascertained as follows: October 1 to November 11, November 20 to December 17, and March 29 to April 30, by applying to rating table mean daily gage heights as obtained with planimeter; May 1 to September 30, except for periods when no gage record was obtained, by use of discharge integrator; December 18 to March 28, by apply-

ing to rating table mean daily gage heights corrected for backwater from ice by means of discharge measurements, recording gage records, observer's notes, and weather records. Open-water records when gage was in operation, excellent, except during extremely high and low stages, for which they are good. Records for winter fair.

Discharge measurements of Wisconsin River near Nekoosa, Wis., 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. 17[a]	H. C. Beckman	4.88	2,550	Apr. 3	H. C. Beckman	13.36	40,200
Feb. 12[a]	W. G. Hoyt	4.31	2,650	24	do	14.64	49,900
Mar. 17[a]	H. C. Beckman	3.55	2,570	July 19	do	2.80	4,330
17[b]	do	3.48	2,530				

[a] Made through complete ice cover. [b] Made through incomplete ice cover at cable section.

Daily discharge, in second-feet, of Wisconsin River at Nekoosa, Wis., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	3,040	3,600	7,560	2,570	1,750	2,400	20,400	14,600	8,630	7,660	4,060	2,450
2	3,890	2,880	6,570	2,230	1,750	2,400	34,400	14,200	8,460	9,800	4,060	2,920
3	3,530	3,370	6,470	2,920	2,230	2,230	41,200	13,100	13,100	13,900	4,090	2,260
4	3,400	3,450	5,150	2,570	2,230	2,400	40,000	12,400	20,100	13,700	4,350	2,840
5	3,720	2,660	4,450	2,740	2,230	2,070	32,600	11,800	21,800	11,600	4,100	1,750
6	3,440	2,690	4,410	2,570	1,590	2,740	26,100	11,100	18,400	10,100	4,090	2,290
7	3,810	2,370	3,750	2,400	2,070	2,400	22,100	9,900	14,800	8,200	4,180	3,080
8	3,720	2,730	4,310	2,400	2,400	2,740	19,700	8,930	15,200	5,090	3,180	3,180
9	3,490	2,440	4,130	1,750	2,230	2,400	16,700	8,200	17,600	5,280	3,280	4,280
10	3,070	3,180	3,800	2,400	2,740	2,400	16,100	9,100	20,500	5,360	4,050	4,220
11	3,710	4,170	3,600	2,230	2,570	2,570	15,100	8,400	18,900	5,060	3,460	3,740
12	4,390		3,330	2,400	2,650	2,400	15,700	7,200	14,600	4,950	3,820	4,190
13	4,670		3,300	2,570	3,280	2,570	18,000	5,960	11,700	4,300	3,330	4,740
14	4,070		2,970	2,400	2,920	2,230	20,300	6,080	9,820	3,760	3,450	4,800
15	5,220		3,520	2,570	1,910	2,400	20,800	7,160	9,570	3,330	2,420	4,400
16	6,530	7,600	3,480	2,570	2,570	2,400	20,600	9,600	8,340	3,760	3,400	4,020
17	6,670		2,840	2,550	2,740	2,570	19,800	11,700	9,570	5,480	3,120	4,100
18	5,870		2,570	2,230	2,400	2,230	20,000	11,300	12,000	5,150	3,380	4,300
19	6,960		2,400	2,400	2,400	2,070	20,600	11,800	11,400	4,290	3,040	4,490
20	7,970	6,520	2,740	2,400	2,230	2,920	21,800	8,880	10,500	4,300	2,680	3,740
21	8,820	6,610	2,740	2,070	2,740	2,920	24,200	8,590	8,990	4,720	3,030	3,660
22	8,400	6,230	2,740	1,910	2,230	3,100	33,900	7,840	7,190	5,240	1,730	3,680
23	7,650	6,300	2,570	2,070	2,230	3,100	45,900	7,190	5,980	4,600	3,090	3,590
24	6,550	5,340	2,740	2,070	2,400	3,280	49,700	8,630	5,950	4,200	2,780	3,940
25	4,280	5,670	2,740	1,440	2,230	3,460	40,000	9,800	5,690	4,040	2,780	3,320
26	5,230	6,010	3,280	1,910	2,230	3,830	29,500	8,340	5,280	4,050	2,520	4,200
27	4,390	6,700	2,740	1,910	1,910	5,220	23,200	8,180	6,030	3,880	2,460	4,800
28	4,110	10,700	3,100	1,910	2,570	7,000	20,000	7,960	8,750	4,360	2,460	5,650
29	4,090	11,500	3,280	2,230	2,070	10,200	17,200	8,820	8,480	4,790	1,540	7,200
30	4,130	8,720	2,920	1,750	.....	11,800	15,600	8,470	7,290	4,670	2,570	8,410
31	3,660	.....	3,280	1,910	.....	16,600	.....	7,920	.....	4,360	2,440	.....

NOTE.—Stage-discharge relation affected by ice Dec. 18 to Mar. 28. Gage not in operation Nov. 12-19, Sept. 2, 3, 14-18, and 27-29; discharge interpolated or estimated from record of flow of Wisconsin River at Portage.

Monthly discharge of Wisconsin River at Nekoosa, Wis., for the year ending Sept. 30, 1916.

[Drainage area, 5,500 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	8,820	3,040	4,920	0.895	1.03
November	11,500	2,370	5,820	1.06	1.18
December	7,560	2,400	3,660	.665	.77
January	2,920	1,440	2,260	.411	.47
February	3,280	1,590	2,330	.424	.46
March	16,600	2,070	3,840	.698	.80
April	49,700	15,100	25,400	4.62	5.16
May	14,600	5,960	9,460	1.72	1.98
June	21,800	5,280	11,500	2.09	2.33
July	13,900	3,330	5,930	1.08	1.24
August	4,350	1,540	3,190	.580	.67
September	8,410	1,750	4,010	.729	.81
The year	49,700	1,440	6,830	1.24	16.90

WISCONSIN RIVER AT MUSCODA, WIS.

LOCATION.—In sec. 1, T. 8 N., R. 1 W., at highway bridge 1 mile north of the village of Muscoda, Grant County. Eagle Mill Creek enters from the right about half a mile below and Underwood Creek from the left, 4½ miles above station.

DRAINAGE AREA.—10,300 square miles (measured on map issued by Wisconsin Geological and Natural History Survey, edition of 1911; scale, 1 inch=6 miles).

RECORDS AVAILABLE.—December 21, 1902, to December 31, 1903, and December 4, 1913, to September 30, 1916. Gage heights November 1, 1908, to December 31, 1912, published in United States Weather Bureau bulletin, Daily River Stages, parts 9, 10, and 11.

GAGE.—Chain gage fastened to handrailing on upstream side of bridge; read by William Hessler. Elevation of zero of present gage, approximately 12.62 feet above that of gage maintained December 20, 1902, to December 3, 1913; elevation of gage during period November, 1908, to December 3, 1913, as read by United States Weather Bureau was approximately the same as that of present gage, sea-level elevation of which is approximately 666.2 feet.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 9.18 feet April 29 (discharge, 54,300 second-feet); minimum stage recorded 0.90 foot at 5 p. m. September 4 (discharge, approximately 4,790 second-feet).

1903 and 1914–1916: Maximum stage recorded, 22.70 feet September 23, 1903 (corresponding to 10.1 feet for present gage datum); discharge about 60,500 second-feet; minimum stage recorded 0.7 foot December 2, 1914, and 5 p. m. July 24, 1915 (discharge, about 3,140 second-feet). According to the records of the United States Weather Bureau[1] (see note under Gage) on June 11, 1881, the river reached a stage of 11.1 feet and during August, 1868, zero on gage (discharge not determined owing to possible changes in channel and datum of gage).

REGULATION.—Nearest power plant above station is at Prairie du Sac, about 40 miles distance; since the later part of 1915 considerable diurnal fluctuation has been observed at gage. Owing to regulation by storage in the headwaters, the flow at this station is not natural.

[1] Daily river stages, pt. 10, p. 98, U. S. Dept. Agr.

ACCURACY.—Stage-discharge relation not permanent. Two rating curves used during year: October 1 to March 20, fairly well defined between 4,490 and 13,700 second-feet; March 21 to September 30, fairly well defined between 5,200 and 45,000 second-feet. Gage read twice a day to quarter tenths. Daily discharge ascertained by applying mean daily gage heights to rating table, except for periods when stage-discharge relation was affected by ice, for which it was ascertained by applying to rating table mean daily gage heights corrected for ice effect by means of discharge measurements, observer's notes, and weather records. Open-water records good, except during extremely high and low stages, for which they are fair; results for winter period poor.

Discharge measurements of Wisconsin River at Muscoda, Wis., 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.*
Oct. 19	H. C. Beckman	2.57	8,250	May 24	W. G. Hoyt	4.28	16,200
Feb. 17[a]	Hoyt and Rather	3.18	5,430	Aug. 9	E. L. Williams	2.54	8,640
Apr. 12	Hoyt and Entringer	7.57	38,300				

[a] Ice at control.

Daily discharge, in second-feet, of Wisconsin River at Muscoda, Wis., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	7,320	6,980	10,900	5,330	7,320	7,660	16,700	42,500	12,600	10,100	7,040	4,940
2	8,000	8,000	15,000	5,300	6,980	7,660	18,700	36,800	13,500	10,500	6,700	4,220
3	8,000	6,980	15,900	5,200	6,640	7,660	21,400	27,100	17,200	12,600	4,940	4,220
4	7,660	6,640	10,900	5,100	6,310	8,000	23,100	25,700	18,200	11,800	5,480	4,000
5	8,000	6,640	9,800	5,030	5,980	7,660	26,400	23,100	16,700	10,100	7,760	4,420
6	7,660	6,980	8,350	5,000	5,980	7,150	32,400	19,700	16,700	12,200	8,520	4,690
7	6,980	6,640	9,800	4,900	5,650	8,000	43,500	20,800	18,700	16,700	8,900	6,380
8	6,310	5,980	10,200	4,800	5,330	8,000	47,500	21,400	21,900	18,200	8,900	7,760
9	5,980	5,030	9,800	4,800	5,030	7,660	49,500	15,800	27,100	13,900	8,140	8,140
10	5,980	4,490	9,430	4,750	5,330	7,660	41,500	16,200	33,200	11,800	8,520	6,060
11	5,650	5,330	8,350	4,750	5,330	7,660	37,700	18,700	32,400	8,520	6,700	5,200
12	6,640	6,310	6,980	4,750	5,490	7,660	31,600	13,500	27,800	7,400	6,060	6,380
13	8,350	8,350	6,640	4,750	5,490	8,000	28,500	13,900	24,400	10,500	6,060	6,700
14	8,350	8,000	7,660	4,750	4,890	9,430	23,800	15,800	25,100	10,100	5,480	7,760
15	7,320	8,700	6,640	4,750	5,180	8,700	21,900	17,200	26,400	8,140	6,060	7,400
16	6,310	11,300	5,980	4,900	4,750	8,350	22,500	14,800	29,200	6,700	6,700	6,060
17	5,650	16,300	5,980	5,200	5,430	8,170	23,100	13,000	24,400	6,380	6,700	6,060
18	6,310	16,800	5,030	5,400	5,500	7,830	23,100	15,300	17,700	6,700	6,380	6,380
19	8,000	16,300	6,640	5,700	5,650	7,660	25,700	16,200	17,700	6,060	4,940	7,400
20	10,900	13,300	5,980	5,980	6,640	7,320	29,200	15,800	16,700	5,480	4,940	7,760
21	12,500	12,900	5,650	6,640	5,650	8,900	30,000	16,200	16,200	6,380	4,690	7,400
22	9,060	11,300	5,600	6,980	5,980	8,900	27,800	17,700	15,800	7,400	4,450	6,380
23	8,000	10,900	5,500	7,660	6,310	8,140	27,100	18,700	16,200	7,760	4,690	6,060
24	7,660	10,600	5,400	8,000	6,640	7,400	27,100	16,200	16,200	7,040	4,450	6,060
25	11,300	10,600	5,350	8,350	6,980	10,100	30,800	13,000	15,800	5,760	4,940	6,380
26	12,900	10,600	5,300	8,350	7,320	20,800	33,200	14,800	12,200	5,480	4,690	6,060
27	11,700	12,900	5,300	8,000	5,980	23,100	40,500	16,700	9,300	6,380	4,450	5,480
28	12,500	11,700	5,200	7,660	5,030	20,300	50,500	15,800	7,400	7,040	4,220	4,690
29	7,660	9,800	5,300	7,660	7,660	14,400	53,500	14,400	12,200	5,480	4,690	7,400
30	5,650	10,200	5,350	7,660	.....	14,400	47,500	14,800	12,600	4,690	4,940	6,700
31	6,640	.....	5,350	7,320	.....	15,800	.....	13,900	.....	5,200	4,940	.....

NOTE.—Stage-discharge relation affected by ice, Dec. 21 to Mar. 20.

Monthly discharge of Wisconsin River at Muscoda, Wis., for the year ending Sept. 30, 1916.

[Drainage area, 10,300 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	12,900	5,650	8,090	0.785	0.90
November	16,800	4,490	9,550	.927	1.03
December	15,900	5,030	7,590	.737	.85
January	8,350	4,750	5,980	.581	.67
February	7,660	4,750	5,950	.578	.62
March	23,100	7,150	10,000	.971	1.12
April	53,500	16,700	31,900	3.10	3.46
May	42,500	13,000	18,600	1.81	2.09
June	33,200	7,400	19,000	1.84	2.05
July	18,200	4,690	8,790	.853	.98
August	8,900	4,220	6,000	.583	.67
September	8,140	4,000	6,140	.596	.66
The year	53,500	4,000	11,400	1.11	15.10

TOMAHAWK RIVER NEAR BRADLEY, WIS.

LOCATION.—In sec. 16, T. 36 N., R. 6 E., Oneida County, 2 miles west of Cassion, 4 miles north of Bradley, 4 miles downstream from the mouth of Bearskin Creek, coming in from the right, and 8 miles above mouth of river.

DRAINAGE AREA.—422 square miles.

RECORDS AVAILABLE.—September 18, 1914, to September 30, 1916.

GAGE.—Chain gage fastened to cantilever arm on the right bank; read by Frank Sutherland.

DISCHARGE MEASUREMENTS.—Made from cable about half a mile below gage.

CHANNEL AND CONTROL.—Bed at gage and a short distance below sandy and likely to shift. Control is formed by rapids about 2,000 feet below gage. Bed at cable section heavy gravel; permanent. When a head of 15 feet is maintained in Rice Lake storage dam, in secs. 4 and 9, T. 35 N., R. 6 E., backwater will extend half way up the rapids which are below the gage, and probably affect the stage-discharge relation. The maximum head maintained at the reservoir was 14 feet 11 inches, during July, 1916, which apparently did not affect the control for the gage.

EXTREMES OF DISCHARGE.—1914–1916: Maximum stage recorded, 6.88 feet, April 24, 1916 (discharge 2,190 second-feet); minimum stage recorded, 1.95 feet, September 10 to 13, 1915 (discharge 263 second-feet).

REGULATION.—The following reservoirs are maintained upstream from the station, for the purpose of regulating the flow in Wisconsin River.

Name.	Location of reservoir.	Location of dam.	Area of reservoir.	Drainage area.	Capacity (millions of cubic feet).	
					Summer.	Winter.
			Sq. miles.	*Sq. miles.*		
Squirrel	T. 39 N., R. 5 E.	Sec. 30, T. 39 N., R. 5 E.	3.00	17.07	152	152
Minocqua	Tps. 38–40 N., Rs. 6–7 E.	Sec. 10, T. 39 N., R. 6 E.	11.31	81.60	291	651
			14.31	98.67	443	803

ACCURACY.—Stage-discharge relation practically permanent, except as affected by ice. Rating curve well defined between 240 and 1,970 second-feet. Gage read twice daily to hundredths. Discharge ascertained by applying mean daily gage heights to rating curve, except for periods in which stage-discharge relation was affected by ice, for which it was obtained from discharge measurements, observer's notes, and weather records. Records good for open-water periods; those for winter periods roughly approximate.

Discharge measurements of Tomahawk River near Bradley, Wis., 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. 12[a]	H. C. Beckman	3.20	402	Apr. 20	H. C. Beckman	6.00	1,720
Feb. 9[a]	do	3.63	376	June 15	W. G. Hoyt	3.54	685
Mar. 14[a]	do	3.69	348				

[a] Made through complete ice cover; ice at control.

Daily discharge, in second-feet, of Tomahawk River near Bradley, Wis., for the period Sept. 18, 1914, to Sept. 30, 1916.

Day.	Sept.	Day.	Sept.	Day.	Sept.
1914.		1914.		1914.	
18	619	23	544	28	452
19	619	24	530	29	442
20	589	25	516	30	424
21	574	26	496		
22	559	27	471		

Daily discharge, in second-feet, of Tomahawk River near Bradley, Wis., for the period Sept. 18, 1914, to Sept. 30, 1916—Continued.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1914–15.												
1	408	360						474	408	324	318	370
2	408	360						447	372	308	396	341
3	396	358						447	358	300	516	312
4	384	363						474	338	306	666	308
5	372	367						502	328	316	746	298
			315	300	310	370	555					
6	372	358						502	474	318	780	282
7	408	349						559	681	306	798	275
8	421	347						619	713	298	798	271
9	434	345						634	713	285	763	271
10	434	345						634	666	271	713	263
11	460							604	619	308	634	263
12	502							589	589	421	544	263
13	502							589	589	474	474	265
14	502							574	604	474	421	341
15	502							559	589	681	421	589
		335	305	325	345	400	845					
16	483							619	559	815	447	697
17	474							650	530	886	434	780
18	460							666	502	886	408	850
19	447							650	530	886	384	886
20	447							619	559	850	363	850
21	434							666	604	780	345	798
22	421							730	589	713	328	730
23	408							746	559	619	310	650
24	396							780	516	574	324	589
25	384							798	460	544	345	544
26	384	325	290	320	365	415	690	763	408	516	347	604
27	384							697	372	474	349	650
28	372							619	372	447	345	681
29	372							574	370	421	367	713
30	372							488	345	396	396	713
31	367							447	.....	396	384	.....
1915–16.												
1	713	530	697	447	408	370	516	1,270	681	815	516	336
2	681	530	697	447	408	370	544	1,170	713	886	474	332
3	650	516	697	447	396	370	589	1,120	730	923	447	322
4	650	502	681	447	396	370	650	1,040	746	1,000	434	328
5	650	502	681	434	396	370	697	1,000	746	1,120	408	354
6	634	502	650	434	384	368	780	961	713	1,120	384	372
7	650	516	634	421	376	364	850	1,040	697	1,120	384	502
8	650	559	619	421	376	360	961	1,420	681	1,040	367	604
9	650	559	589	421	376	360	1,060	1,320	697	923	363	619
10	634	574	589	421	375	355	1,140	780	681	815	367	604
11	619	697	559	412	375	349	1,220	730	681	746	372	589
12	634	780	544	402	375	349	1,470	681	650	634	363	589
13	689	815	530	406	375	349	1,520	619	619	530	358	619
14	713	850	530	411	375	348	1,620	604	619	460	349	634
15	730	850	516	416	375	348	1,720	681	666	474	341	650
16	730	886	502	421	375	350	1,770	730	713	502	332	650
17	763	850	502	421	375	350	1,770	746	780	488	322	650
18	780	815	502	421	370	350	1,720	746	815	488	365	619
19	798	780	502	421	370	350	1,720	746	815	474	377	589
20	780	746	488	434	370	360	1,720	713	815	460	372	559
21	780	697	488	434	370	372	1,820	681	780	447	358	544
22	746	589	474	434	370	384	1,920	681	746	421	343	544
23	730	604	474	447	370	384	2,080	713	730	396	343	530
24	697	619	474	447	370	396	2,200	713	713	384	332	530
25	681	666	474	447	370	408	2,140	697	697	372	324	502
26	650	787	460	447	370	421	2,020	713	713	372	320	502
27	619	787	460	434	370	434	1,820	746	697	746	312	604
28	604	733	460	434	370	447	1,620	746	681	746	308	589
29	574	733	460	434	370	460	1,520	746	697	697	304	574
30	559	707	454	421	.....	474	1,370	746	746	650	298	544
31	544	.....	447	421	.....	488	.....	713	.....	574	308	.....

NOTE.—Stage-discharge relation affected by ice Nov. 11, 1914, to Apr. 30, 1915, and Nov. 26, 1915, to Apr. 10, 1916.

Monthly discharge of Tomahawk River near Bradley, Wis. for the period Sept. 18, 1914, to Sept. 30, 1916.

[Drainage area, 422 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
1914.					
September 18–30	619	424	526	125	0.60
1914–15.					
October	502	367	423	1.00	1.15
November	367	.....	338	.801	.89
December	.....	.....	303	.718	.83
January	.....	.....	315	.746	.86
February	.....	.....	327	.775	.84
March	.....	.....	396	.938	1.08
April	.....	.....	697	1.65	1.84
May	798	447	604	1.43	1.65
June	713	328	511	1.21	1.35
July	886	271	503	1.19	1.37
August	798	310	479	1.14	1.31
September	886	263	515	1.22	1.36
The year	886	263	452	1.07	14.53
1915–16.					
October	798	544	677	1.60	1.84
November	886	502	676	1.60	1.78
December	697	447	543	1.29	1.49
January	447	402	429	1.02	1.18
February	408	370	378	.896	.97
March	488	348	382	.905	1.04
April	2,200	516	1,420	3.36	3.75
May	1,420	604	839	1.99	2.29
June	815	619	715	1.69	1.89
July	1,120	372	672	1.59	1.83
August	516	298	363	.860	.99
September	650	322	533	1.26	1.41
The year	2,200	298	635	1.50	20.46

PRAIRIE RIVER NEAR MERRILL, WIS.

LOCATION.—On line between secs. 20 and 29, T. 32 N., R. 7 E., at highway bridge 4½ miles northeast of Merrill, Lincoln County, and about 5½ miles above mouth of river. Haymeadow Creek enters from left about 5 miles above station.

DRAINAGE AREA.—164 square miles (measured on map issued by Wisconsin Geological and Natural History Survey, edition of 1911; scale 1 inch = 6 miles).

RECORDS AVAILABLE.—January 18, 1914, to September 30, 1916.

GAGE.—Chain gage attached to upstream side of bridge; read by Mrs. Meta Krause.

DISCHARGE MEASUREMENTS.—At low stages made by wading; at medium and high stages made from downstream side of bridge to which gage is attached.

CHANNEL AND CONTROL.—Bed composed of gravel; clean and free from vegetation. Left bank high and not subject to overflow; banks wooded. Control not well defined.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 6.1 feet at 8 a. m. April 22 (discharge, 2,290 second-feet); minimum discharge, 73 second-feet March 17–20.

1914–1916: Maximum stage recorded, 6.1 feet April 22, 1916 (discharge, 2,290 second-feet); minimum discharge, 72 second-feet, recorded by discharge measurement made January 4, 1915. Absolute minimum occurred during winter 1914–15 and was probably somewhat less than 72 second-feet.

REGULATION.—None.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined between 103 and 2,200 second-feet. Gage read once a day to half tenths. Daily discharge ascertained by applying daily gage heights to rating curve, except for periods in which stage-discharge relation was affected by ice, for which it was ascertained by applying to rating table daily gage heights corrected for ice effect by means of discharge measurements, observer's notes, and weather records. Records excellent for all open-water periods; good for winter periods.

Discharge measurements of Prairie River near Merrill, Wis., during the year ending Sept. 30, 1916.

[Made by H. C. Beckman.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Jan. 15[a]	1.88	100	Mar. 15[a]	1.73	77	June 20	2.86	396
Feb. 10[a]	1.95	82	Apr. 21	5.69	1,920			

[a] Control partly covered with ice.

Daily discharge, in second-feet, of Prairie River near Merrill, Wis., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	103	133	296	122	91	86	421	496	278	384	137	137
2	101	122	244	128	89	86	655	458	781	366	133	172
3	103	118	228	118	86	83	870	421	963	278	118	159
4	106	118	212	118	86	81	781	384	870	278	110	159
5	110	115	172	115	86	81	696	330	738	184	106	133
6	110	103	159	110	83	81	614	244	574	148	115	118
7	118	101	159	106	83	81	614	278	574	137	115	184
8	115	106	148	106	83	81	535	278	535	118	133	184
9	106	110	148	106	83	79	574	278	535	122	122	212
10	110	133	159	103	83	77	614	261	496	118	118	184
11	115	244	148	101	80	77	696	313	421	128	115	159
12	244	738	137	97	80	77	1060	278	348	118	118	159
13	313	696	133	97	80	77	1060	244	313	110	122	159
14	366	738	128	100	80	77	1010	313	348	106	118	159
15	348	696	137	100	80	77	963	458	384	115	115	159
16	296	696	133	100	80	75	916	402	440	128	110	184
17	313	696	118	100	80	73	870	384	574	159	110	172
18	348	696	122	103	80	73	870	330	614	159	106	159
19	402	655	122	103	80	73	825	313	574	159	103	159
20	330	655	137	103	80	73	1,110	296	421	148	103	137
21	278	421	137	110	80	77	1,780	330	384	133	106	137
22	244	278	133	106	80	77	2,290	330	278	122	103	159
23	212	212	137	103	80	77	1,860	313	244	118	101	184
24	212	198	137	103	80	81	1,280	313	212	115	97	172
25	198	184	133	110	80	86	916	330	212	128	97	159
26	184	348	122	115	83	91	781	313	313	118	93	184
27	159	535	118	115	86	103	655	313	313	128	97	296
28	159	496	115	106	86	118	574	278	278	198	97	384
29	137	384	115	103	86	137	574	261	296	184	101	440
30	137	348	110	97	.....	184	496	296	366	159	97	402
31	137	.....	118	93	.....	313	.....	278	.....	159	93	.....

NOTE.—Stage-discharge relation affected by ice Jan. 4 to Apr. 4.

Monthly discharge of Prairie River near Merrill, Wis., for the year ending Sept. 30, 1916.

[Drainage area, 164 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	402	101	200	1.22	1.41
November	738	101	369	2.25	2.51
December	296	110	149	.909	1.05
January	128	93	106	.646	.74
February	91	80	82.6	.504	.54
March	313	73	93.9	.573	.66
April	2,290	421	899	5.48	6.11
May	496	244	326	1.99	2.29
June	963	212	456	2.78	3.10
July	384	106	162	.988	1.14
August	137	93	110	.671	.77
September	440	118	192	1.17	1.30
The year	2,290	73	261	1.59	21.62

LITTLE RIB RIVER NEAR WAUSAU, WIS.

LOCATION.—In sec. 29, T. 29 N., R. 7 E., at second highway bridge above mouth, a mile above junction with Rib River and about 3½ miles west of Wausau, Marathon County.

DRAINAGE AREA.—76 square miles (measured on map issued by Wisconsin Geological and Natural History Survey, edition of 1911; scale, 1 inch=6 miles).

RECORDS AVAILABLE.—January 10, 1914, to July 8, 1916, when station was discontinued.

GAGE.—Chain gage fastened to downstream side of highway bridge, read by Erwin Hartwig.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge during high water; at low and medium stages by wading.

CHANNEL AND CONTROL.—Bed composed of gravel and sand. Control small rapids on each side of small island about 20 feet below gage. Banks brush covered; left bank high and not subject to overflow; right bank low above gage and will be overflowed around right end of bridge during exceptionally high water.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 9.22 feet at 6.30 a. m. March 31 (discharge, 1,870 second-feet); minimum stage recorded, 1.1 feet at 6 p. m. October 3 (discharge, 11 second-feet).

1914–1916: Maximum stage recorded, 9.85 feet at 6 p. m. June 4, 1914 (discharge, about 1,880 second-feet); minimum stage recorded during open-water periods, 1.18 feet August 6–9, 1915 (discharge, about 6 second-feet); mean of 4 second-feet was estimated for period February 21 to 28, 1914.

ACCURACY.—Stage-discharge relation not permanent. Control shifting. Two rating curves used as follows: October 1 to December 31, fairly well defined between 11 and 830 second-feet; March 27 to July 8, poorly defined between 13 and 1,520 second-feet. Gage read twice a day to quarter tenths. Daily discharge ascertained by applying mean daily gage heights to rating curve. Records fair.

Discharge measurements of Little Rib River near Wausau, Wis., during the year ending Sept. 30, 1916.

[Made by W. G. Hoyt.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Apr. 1	8.02	1,480	June 19	1.66	64
1	7.94	1,390			

Daily discharge in second-feet, of Little Rib River near Wausau, Wis, for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Mar.	Apr.	May.	June.	July.
1	12	21	96	.....	1,370	122	33	534
2	12	20	110	.....	1,250	91	420	474
3	11	20	50	.....	888	66	456	172
4	13	18	43	.....	438	73	188	129
5	13	16	38	.....	324	66	115	83
6	14	16	50	.....	228	58	91	69
7	14	16	33	.....	220	58	100	63
8	15	19	34	.....	172	50	514	49
9	15	20	31	.....	157	45	276	.....
10	14	20	42	.....	180	58	180	.....
11	14	400	26	.....	276	56	136	.....
12	16	482	23	.....	324	36	108	.....
13	125	155	30	.....	260	31	87	.....
14	140	110	21	.....	244	46	81	.....
15	57	90	18	.....	212	260	91	.....
16	33	76	18	.....	196	172	136	.....
17	33	82	20	.....	252	122	108	.....
18	125	63	21	.....	164	91	79	.....
19	245	110	21	.....	164	75	66	.....
20	118	148	21	.....	474	66	50	.....
21	71	96	21	.....	1,130	54	40	.....
22	55	110	21	.....	1,050	136	35	.....
23	45	66	22	.....	456	115	36	.....
24	36	57	22	.....	260	74	36	.....
25	33	58	21	.....	196	62	31	.....
26	30	245	21	.....	164	73	276	.....
27	28	384	21	164	122	66	164	.....
28	26	200	20	340	122	49	78	.....
29	24	155	21	688	93	42	91	.....
30	22	170	22	1,370	150	43	292	.....
31	21	.....	22	1,700	.....	35	.....	.....

NOTE.—No records Jan. 1 to Mar. 26.

Monthly discharge of Little Rib River near Wausau, Wis., for the year ending Sept. 30, 1916.

[Drainage area, 76 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	245	11	46.1	0.606	0.70
November	482	16	115	1.51	1.69
December	110	18	31.6	.416	.48
March 27-31	1,700	164	852	11.2	2.08
April	1,370	93	385	5.07	5.66
May	260	31	77.1	1.01	1.16
June	514	31	146	1.92	2.14
July 1-8	534	49	197	2.59	.77

EAU CLAIRE RIVER AT KELLY, WIS.

LOCATION.—In sec. 13, T. 28 N., R. 8 E., at highway bridge, three-fourths of a mile below Kelly, Marathon County, about a mile above mouth of Big Sandy Creek, which enters from the right, and 4½ miles above mouth of river.

DRAINAGE AREA.—326 square miles (measured on map issued by Wisconsin Geological and Natural History Survey, edition of 1911; scale, 1 inch=6 miles.)

RECORDS AVAILABLE.—January 1, 1914, to September 30, 1916.

GAGE.—Chain gage fastened to downstream side of highway bridge; read by H. A. La Certe.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge at medium and high stages; by wading below bridge at low stages.

CHANNEL AND CONTROL.—Heavy gravel and rock. Gage is in the rapids which form the control. Banks medium high and not subject to overflow.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 5.1 feet April 22 and 23 (discharge, 3,270 second-feet); minimum discharge estimated 40 second-feet January 14, 17, and 18.

1914–1916: Maximum stage recorded, 5.1 feet April 22 and 23, 1916 (discharge, 3,270 second-feet); minimum open-water stage recorded, 0.45 foot, August 13, 14, 15, October 2, 3, 1914 (discharge, about 40 second-feet). Discharge January 14, 17, and 18, 1916, was estimated at 40 second-feet; discharge for winter period probably somewhat below this figure.

ACCURACY.—Stage-discharge relation permanent, except as affected by ice. Rating curve well defined between 71 and 3,150 second-feet. Gage read twice daily, except Sundays, to quarter-tenths. Discharge ascertained by applying mean daily gage heights to rating table, except for periods in which stage-discharge relation was affected by ice, for which it was ascertained by applying to rating table mean daily gage heights corrected for ice effect, by discharge measurements, observer's notes, and weather records. Discharge for practically all Sundays interpolated. Records for open-water periods good; for winter period fair. Owing to revision of rating curve on basis of high-water measurements made in 1916, discharge for 1914, above 1,200 second-feet as published in Water-Supply Paper 385 is too small. The error varies from about 2 per cent at a stage of 1,200 second-feet to 16 per cent at the maximum stage of 2,120 second-feet. The published mean discharge for June, 1914 is 5 per cent too small.

Discharge measurements of Eau Claire River at Kelley, Wis., 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. 13[a]	H. C. Beckman	0.80	41	Apr. 1	W. G. Hoyt	3.58	1,720
Feb. 11[a]	do	1.04	66	22	H. C. Beckman	4.90	3,040
Mar. 16[a]	do	1.02	74	June 19	W. G. Hoyt	2.46	784

[a] Made through complete ice cover; partial ice cover on control.

Daily discharge, in second-feet, of Eau Claire River at Kelly, Wis, for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	82	129	182	a 60	45	49	1,550	499	210	320	129	89
2	78	129	182	a 62	45	51	a 2,000	499	708	a 302	129	87
3	a 78	129	182	65	46	54	2,450	443	1,290	284	142	a 94
4	79	114	182	64	46	57	2,560	390	1,130	252	129	100
5	85	104	a 182	60	47	a 60	2,040	320	990	224	129	104
6	78	104	182	56	a 49	63	1,550	300	677	196	a 129	106
7	93	a 103	155	50	52	58	1,290	320	647	182	129	196
8	94	102	124	46	54	53	1,130	300	1,370	168	129	196
9	94	96	116	a 45	58	54	1,130	300	1,130	a 162	142	182
10	a 99	106	102	44	65	55	925	320	1,060	155	142	a 168
11	104	182	91	43	66	63	1,060	340	800	155	142	155
12	104	925	a 86	40	65	a 71	1,130	320	677	129	142	155
13	182	925	82	41	a 63	78	1,210	365	443	119	129	155
14	238	a 832	84	40	62	76	1,210	471	557	116	129	182
15	238	738	84	42	60	75	1,130	677	1,290	155	129	210
16	210	557	84	a 41	58	74	1,060	738	1,290	a 248	116	210
17	a 238	443	89	40	56	81	1,060	708	1,130	340	104	a 196
18	267	390	87	40	54	88	1,060	587	a 919	267	100	182
19	416	365	a 86	51	52	a 94	1,130	499	708	238	89	196
20	390	365	85	64	a 50	100	2,140	390	528	224	a 88	168
21	390	a 332	81	67	47	106	3,030	390	390	210	87	155
22	300	300	71	71	50	112	3,150	499	340	196	84	168
23	267	252	75	a 81	53	118	2,450	587	320	a 176	84	155
24	a 238	238	79	91	57	124	1,940	617	300	155	87	a 148
25	210	182	a 78	78	61	124	1,370	499	a 292	155	87	142
26	155	182	a 77	78	59	a 183	1,060	443	284	119	87	224
27	155	182	70	58	a 56	240	862	390	300	129	a 84	557
28	155	a 182	71	56	53	300	708	300	284	182	82	557
29	129	182	67	57	50	443	617	267	300	155	85	443
30	129	182	64	47	.....	800	557	267	340	a 142	85	416
31	a 129	.....	60	51	.....	1,180	.....	238	.....	129	85	.....

a Gage not read; discharge interpolated.

NOTE.—Stage-discharge relation affected by ice Dec. 10 to Mar. 31.

Monthly discharge of Eau Claire River at Kelly, Wis., for the year ending Sept. 30, 1916.

[Drainage area, 326 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	416	78	178	0.546	0.63
November	925	96	302	.926	1.03
December	182	60	105	.322	.37
January	91	40	55.8	.171	.20
February	66	45	54.4	.167	.18
March	1,180	49	164	.503	.58
April	3,150	557	1,490	4.57	5.10
May	738	238	428	1.31	1.51
June	1,370	210	690	2.12	2.36
July	340	116	193	.592	.68
August	142	82	111	.340	.39
September	557	87	203	.623	70
The year	3,150	40	329	1.01	13.73

BIG EAU PLEINE RIVER NEAR STRATFORD, WIS.

LOCATION.—In sec. 13, T. 27 N., R. 3 E., at highway bridge at a place known locally as Weber Farm, about 1 mile above Chicago & Northwestern Railway bridge and about 2 miles north of Stratford, Marathon County. Dill Creek enters from the right about 5 miles above station.

DRAINAGE AREA.—223 square miles (measured on map issued by Wisconsin Geol. and Nat. Hist. Survey, edition of 1911; scale, 1 inch=6 miles).

RECORDS AVAILABLE.—July 24, 1914, to September 30, 1916.

GAGE.—Sloping gage reading from 1.0 to 15.6 feet, on right bank of river and vertical staff gage, reading from 15 to 18 feet, at upper end of sloping gage; read by Christian Weber.

DISCHARGE MEASUREMENTS.—At low stages made by wading about 1,000 feet below gage; at medium and high stages made at the highway bridge.

CHANNEL AND CONTROL.—Very heavy gravel and rock; control at head of rapids 400 feet below gage. Banks at gage are high and will be overflowed only at stage of about 15 feet and above.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 8.85 feet at 6 p. m. April 21 (discharge, 5,540 second-feet); minimum open-water stage, 1.5 feet, August and September (discharge, 7 second-feet).

1914–1916: Maximum stage recorded, 8.85 feet at 6 p. m. April 21 (discharge 5,540 second-feet); minimum discharge recorded, 3.0 second-feet, by current-meter measurement February 5, 1915. The flood of June, 1914, reached a maximum height of 20.7 feet as determined by levels run to high-water marks.

ACCURACY.—Stage-discharge relation practically permanent except as affected by ice. Rating curve fairly well defined between 5 and 43 second-feet; well defined between 200 and 4,000 second-feet; poorly defined between 43 and 200 second-feet. Gage read twice daily to quarter tenths. Discharge ascertained by applying mean daily gage heights to rating table, except March 30 to April 7, when stage-discharge relation was affected by ice, for which it was estimated. Records good for high stages during open-water periods; for medium and low stages fair.

Discharge measurements of Big Eau Pleine River near Stratford, Wis., 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.*
Apr. 22	W. G. Hoyt	7.40	3,670	Aug. 18[a]	E. L. Williams	1.76	14
June 21	do	2.09	81				

[a] Made by wading 500 feet below gage.

Daily discharge, in second-feet, of Big Eau Pleine River near Stratford, Wis., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	15	31	280	.....	3,650	258	155	363	7	7
2	15	28	189	.....	2,690	205	2,490	344	7	7
3	15	26	120	.....	2,050	168	1,490	272	77	7
4	15	26	80	.....	1,330	138	780	162	138	7
5	15	26	60	.....	1,180	116	424	98	162	7
6	19	25	43	.....	840	103	258	61	103	7
7	22	22	43	.....	668	87	258	43	198	424
8	22	22	43	.....	591	87	1,970	30	116	382
9	22	26	36	.....	470	81	1,110	22	43	168
10	26	38	36	.....	494	103	591	18	61	87
11	26	1,890	31	.....	720	116	327	16	143	61
12	26	1,730	31	.....	840	87	212	14	73	57
13	470	720	25	.....	780	67	143	11	40	125
14	780	403	22	.....	720	132	120	11	28	138
15	518	280	22	.....	642	780	116	57	26	132
16	310	238	22	.....	616	591	180	40	22	143
17	244	184	22	.....	1,040	424	198	34	18	125
18	542	168	22	.....	668	310	180	34	18	143
19	970	210	.....	.....	616	222	120	26	14	98
20	642	382	.....	.....	1,730	180	81	18	14	73
21	382	310	.....	.....	4,920	155	61	14	11	61
22	249	221	.....	.....	3,450	272	43	12	11	77
23	189	184	.....	.....	1,410	363	34	11	9	125
24	151	194	.....	.....	780	249	28	9	9	103
25	110	189	.....	.....	494	192	26	9	9	73
26	87	1,330	.....	.....	344	258	720	9	9	57
27	66	1,570	.....	.....	272	258	780	9	9	494
28	54	840	.....	.....	218	218	382	9	7	1,180
29	49	447	.....	.....	180	162	266	8	7	382
30	38	327	.....	3,890	258	205	310	7	7	205
31	36	.....	.....	4,920	.....	222	.....	7	7	.....

NOTE.—Stage-discharge relation affected by ice, Dec. 19 to Apr. 7. No gage-height record Dec. 19 to Mar. 29.

Monthly discharge of Big Eau Pleine River near Stratford, Wis., for the year ending Sept. 30, 1916.

[Drainage area, 223 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	970	15	198	0.888	1.02
November	1,890	22	403	1.81	2.02
December 1–18	280	22	62.6	.281	.188
April	4,920	180	1,150	5.16	5.76
May	780	67	220	.987	1.14
June	2,490	26	462	2.07	2.31
July	363	7	57.4	.257	.30
August	198	7	45.3	.203	.23
September	1,180	7	165	.740	.83

PLOVER RIVER NEAR STEVENS POINT, WIS.

LOCATION.—In sec. 21, T. 24 N., R. 8 E., Portage County, at Fast Waters highway bridge, 7 miles above mouth of river.

DRAINAGE AREA.—136 square miles.

RECORDS AVAILABLE.—January 5, 1914, to September 30, 1916.

GAGE.—Metal vertical staff gage bolted to left abutment, downstream side of bridge; read by C. A. Van Order.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge to which gage is attached.

CHANNEL AND CONTROL.—Bed composed of heavy gravel and small rock; permanent and free from vegetation. At high stages banks will be overflowed around bridge. Control not well defined but is probably small rapids below gage.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.45 feet at 6 p. m. April 23 (discharge, 730 second-feet); minimum discharge 56 second-feet, recorded by measurement March 17; absolute minimum for winter probably somewhat less.

1914–1916: Maximum stage recorded, 4.75 feet, June 5, 1914 (discharge, about 1,570 second-feet); minimum discharge 56 second-feet, by current-meter measurement March 17, 1916.

REGULATION.—Two dams are used in connection with grist mills above station, but the plants have little pondage so that flow at gage, except for brief periods, is nearly natural.

ACCURACY.—Stage-discharge relation permanent, except as affected by ice. Rating curve well defined between 116 and 1,370 second-feet. Gage read twice daily to quarter tenths. Discharge ascertained by applying mean daily gage heights to rating curve, except during periods when stage-discharge relation was affected by ice, for which it was determined by applying to rating table mean daily gage heights corrected for ice effect by means of discharge measurements, observer's notes, and weather records. Open-water records good, except at extremely low stages, when diurnal fluctuation may cause some error; winter records fair.

Discharge measurements of Plover River near Stevens Point, Wis., 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. 6[a]	W. G. Hoyt	1.42	87	Mar. 18[a]	H. C. Beckman	1.16	56
Feb. 10[a]	do	2.01	82	July 20	do	1.28	146

[a] Complete ice cover at control and measuring section.

Daily discharge, in second-feet, of Plover River near Stevens Point, Wis., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	100	116	144	86	86	100	332	308	173	262	134	108
2	100	108	134	86	86	93	394	285	308	262	134	116
3	100	108	144	93	86	86	370	239	410	262	116	100
4	108	108	134	93	86	76	332	228	438	216	153	116
5	93	108	134	100	86	76	308	228	424	194	153	116
6	93	100	134	87	81	76	285	228	332	205	144	134
7	116	100	134	86	81	76	274	239	410	216	134	134
8	108	116	125	86	81	76	308	239	466	194	125	153
9	100	116	144	81	81	81	308	216	551	153	134	125
10	100	116	125	81	82	86	285	205	641	173	134	134
11	100	357	108	86	81	93	285	216	551	163	134	134
12	100	239	108	93	81	93	285	194	466	173	134	163
13	116	216	108	100	81	93	274	205	410	153	134	205
14	116	216	108	108	86	86	285	216	332	153	134	173
15	116	173	116	116	86	76	285	250	332	116	134	153
16	116	125	108	134	93	66	285	308	332	153	116	153
17	134	144	100	144	93	58	296	308	357	173	134	153
18	125	125	100	153	100	56	285	285	357	173	134	163
19	134	173	100	163	108	58	308	228	308	153	125	153
20	163	173	100	173	116	58	466	205	332	153	116	134
21	173	173	100	173	116	62	522	239	285	144	116	134
22	153	134	100	184	116	66	711	239	239	144	125	134
23	134	116	100	184	116	76	711	308	239	134	100	125
24	134	134	100	173	116	86	580	308	228	144	108	125
25	116	153	93	153	116	100	522	308	205	134	116	125
26	108	194	93	134	108	125	410	216	228	134	125	116
27	108	216	86	125	108	153	332	239	216	134	116	239
28	116	216	86	116	108	173	285	216	216	153	116	205
29	100	144	86	108	108	194	285	216	239	134	108	173
30	116	134	86	100	.....	239	308	184	239	100	125	173
31	116	.....	86	93	.....	285	.....	173	.....	153	134	.....

NOTE.—Stage-discharge relation affected by ice Dec. 12 to Apr. 6.

Monthly discharge of Plover River near Stevens Point, Wis., for the year ending Sept. 30, 1916.

[Drainage area, 136 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	173	93	117	0.860	0.99
November	357	100	155	1.14	1.27
December	144	86	110	.809	.93
January	184	81	119	.875	1.01
February	116	81	95.6	.703	.76
March	285	56	101	.743	.86
April	711	274	364	2.68	2.99
May	308	173	241	1.77	2.04
June	641	173	342	2.51	2.80
July	262	100	168	1.24	1.43
August	153	100	127	.934	1.08
September	239	100	146	1.07	1.19
The year	711	56	173	1.27	17.35

BARABOO RIVER NEAR BARABOO, WIS.

LOCATION.—In sec. 33, T. 12 N., R. 7 E., at highway bridge 4 miles downstream from Baraboo, Sauk County, 3 miles below creek rising near Devils Lake, coming in from the right, and 15 miles above mouth of river.

DRAINAGE AREA.—572 square miles (measured on map issued by Wisconsin Geological and Natural History Survey, edition of 1911; scale, 1 inch = 6 miles).

RECORDS AVAILABLE.—December 18, 1913, to September 30, 1916.

GAGE.—Chain gage, attached to upstream side of bridge; read by Miss Agnes Schneider.

DISCHARGE MEASUREMENTS.—Made from downstream side of highway bridge to which gage is attached.

CHANNEL AND CONTROL.—Bed composed of sand and silt; no well-defined control. Water is confined to one channel except at extreme flood stages when right bank is overflowed, the flood plain being about 1,000 feet wide.

EXTREMES OF DISCHARGE.—1914–1916: Maximum stage recorded, 12.75 feet at 5.05 p. m., March 27 and 7.50 a. m., June 6, 1916 (discharge, 2,480 second-feet); minimum stage, 0.71 foot, at 7.30 a. m., July 6,, 1916 (discharge 76 second-feet).

REGULATION.—In the vicinity of Baraboo, 4 miles above station are four dams, and there is one at Reedsburg, 18 miles above station. Smaller plants are also operated on the tributaries. The operation of these various plants causes diurnal fluctuation at the gage of about 0.3 foot at low-water stages. Estimates of mean monthly discharge probably represent nearly the natural flow.

ACCURACY.—Stage-discharge relation changed during high water of March, 1916. Rating curve used October 1 to March 6, fairly well defined between 148 and 825 second-feet; extended and roughly approximate above and below these limits. Curve used March 7 to September 30, fairly well defined between 167 and 2,600 second-feet. Gage read to quarter tenths twice daily. Discharge ascertained by applying mean daily gage heights to rating table, except for periods when stage-discharge relation was affected by ice, for which it was obtained by applying to rating table mean daily gage heights corrected for backwater from ice by means of discharge measurements, observer's notes, and weather records. Open-water records good, except for low stages, for which they are fair; winter records poor.

Discharge measurements of Baraboo River near Baraboo, Wis., 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.*
Oct. 27	H. C. Beckman	2.13	225	Aug. 8	E. L. Williams	7.29	1,010
Jan. 3[a]	M. F. Rather	4.72	392	Sept. 22	do	2.08	206
28[a]	H. C. Beckman	11.92	1,600	22	do	2.14	207
June 6	W. G. Hoyt	12.72	2,460				

[a] Open channel at gage section nearly complete ice cover downstream from gage.

Daily discharge, in second-feet, of Baraboo River near Baraboo, Wis., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	379	182	463	232	1,190	267	849	677	266	232	122	172
2	337	196	393	309	568	267	707	865	881	206	128	153
3	267	196	365	393	407	253	632	817	1,130	178	157	150
4	281	246	393	358	379	253	587	677	1,730	220	226	144
5	295	226	288	323	351	253	527	512	2,320	226	737	301
6	274	213	220	407	323	239	467	407	2,460	195	1,190	392
7	281	200	281	351	295	273	422	364	2,260	200	1,030	898
8	267	178	309	302	267	315	378	378	1,730	130	990	950
9	246	174	288	226	253	246	329	336	1,260	162	833	542
10	220	274	253	167	253	452	294	336	1,070	186	602	364
11	220	1,040	267	177	253	542	329	301	1,010	213	849	252
12	239	1,220	260	200	253	527	322	280	817	246	587	273
13	260	1,250	203	188	253	915	350	301	587	246	647	315
14	309	1,250	239	126	253	1,110	336	437	482	252	542	301
15	295	875	260	167	253	1,230	322	833	392	213	350	308
16	260	505	281	139	253	990	350	990	378	183	266	273
17	260	379	281	157	281	950	392	1,110	407	157	220	226
18	295	351	267	167	323	662	437	990	378	193	213	200
19	344	421	212	177	379	392	692	602	350	162	188	232
20	316	463	226	157	449	329	1,110	407	350	174	164	232
21	274	477	260	200	491	422	1,070	350	308	166	176	213
22	274	477	281	379	505	422	1,090	407	301	140	186	200
23	246	463	232	568	505	422	1,030	452	287	112	199	198
24	239	379	239	900	505	512	817	437	273	125	176	154
25	232	379	220	1,040	491	1,110	587	392	246	130	178	178
26	239	491	177	1,220	379	2,120	452	350	315	101	171	198
27	232	875	199	1,430	323	2,460	452	301	252	103	148	452
28	232	950	344	1,600	309	2,290	422	294	287	105	147	512
29	239	826	316	1,520	295	2,180	392	301	280	104	172	572
30	239	605	253	1,280	.....	1,960	378	294	246	100	184	557
31	200	.....	232	1,250	.....	1,330	.....	252	.....	114	176	.....

NOTE.—Stage-discharge relation affected by ice Jan. 1 to Mar. 6.

Monthly discharge of Baraboo River near Baraboo, Wis., for the year ending Sept. 30, 1916.

[Drainage area, 572 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	379	200	267	0.467	0.54
November	1,250	174	525	.918	1.02
December	463	177	274	.479	.55
January	1,600	126	520	.909	1.05
February	1,190	253	381	.666	.72
March	2,460	239	828	1.45	1.67
April	1,110	294	551	.963	1.07
May	1,110	252	498	.871	1.00
June	2,460	246	768	1.34	1.50
July	252	100	170	.297	.34
August	1,190	122	386	.675	.78
September	950	144	330	.577	.64
The year	2,460	100	458	.801	10.88

KICKAPOO RIVER AT GAYS MILLS, WIS.

LOCATION.—In sec. 28, T. 10 N., R. 4 W., at highway bridge immediately below the Norwood mill, in the town of Gays Mills, Crawford County, about 25 miles above mouth of river and 2 miles below mouth of Tainter Creek, which enters from the right.

DRAINAGE AREA.—629 square miles (measured on map issued by Wisconsin Geological and Natural History Survey, edition of 1911; scale, 1 inch=6 miles.)

RECORDS AVAILABLE.—December 25, 1913, to September 30, 1916.

GAGE.—Chain gage fastened to downstream side of bridge; read by N. T. Norwood.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge at medium and high-water stages; low-water measurements made by wading a short distance downstream from gage.

CHANNEL AND CONTROL.—Bed composed of rock covered by a deposit of sand; banks at gage section fairly high and not subject to overflow at ordinary high-water stages. Control at head of small rapids about 300 feet below gage, fairly permanent; the plotting of the discharge measurements indicates that at a stage of about 2 feet on the gage the control is changed to some point below, causing a reversal in the curve.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 10.00 feet at 6 a. m. June 4 (discharge, about 3,460 second-feet); minimum discharge, about 190 second-feet January 12.

1914–1916: Maximum stage recorded, 10.00 feet at 6 a. m. June 4, 1916 (discharge, about 3,460 second-feet); minimum discharge for open-water periods, 0.86 foot at 8 a. m. November 29, 1914 (discharge, 201 second-feet). Absolute minimum probably about 100 second-feet, and occurred during the latter part of January, 1915.

REGULATION.—Mills at Gays Mills just above station, Soldiers Grove, about 7 miles upstream, and at several points above Soldiers Grove use comparatively little storage, so that the recorded flow past the station represents nearly natural conditions. During low stages a small diurnal fluctuation is observed at gage.

ACCURACY.—Stage-discharge relation probably not permanent. Rating curve as used for 1916 well defined between 211 and 485 second-feet; fairly well defined between 485 and 1,340 second-feet; extended above 1,340 second-feet. Gage read twice a day to quarter tenths. Discharge ascertained as follows: October 1 to January 4, March 1–24, and May 25 to September 30, mean daily gage heights applied to rating curve. Discharge January 5 to February 29 ascertained by applying to rating table mean daily gage heights corrected for backwater from ice by means of discharge measurements, observer's notes, and weather records. March 25 to May 25, indirect method used. Open-water records for low and medium stages, except during April and May, good; records for April, May, and for high stages and winter period, poor.

Discharge measurements of Kickapoo River at Gays Mills, Wis., 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. 7[a]	M. F. Rather	1.70	322	May 25	W. G. Hoyt	1.56	380
Mar. 28	E. L. Williams	5.44	1,100	Aug. 10	E. L. Williams	1.88	481

[a] Incomplete ice cover at and below control.

Daily discharge, in second-feet, of Kickapoo River at Gays Mills, Wis., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	405	310	405	418	790	392	518	522	340	405	280	295
2	405	295	355	545	525	355	485	485	2,060	368	265	280
3	405	310	380	518	510	340	405	430	3,260	368	280	265
4	405	265	392	405	470	340	380	380	3,360	340	280	280
5	392	295	368	365	450	340	380	380	1,810	340	560	280
6	380	295	368	331	440	355	340	368	575	340	971	325
7	380	295	355	322	430	340	310	355	527	340	595	910
8	380	295	355	206	405	340	280	340	730	340	392	510
9	368	310	355	214	380	340	280	310	971	340	340	418
10	368	310	355	198	355	510	280	340	760	310	380	340
11	325	850	340	216	325	518	295	325	545	310	418	355
12	340	971	355	190	295	560	295	310	522	355	430	418
13	380	620	355	265	265	1,100	280	325	510	368	355	460
14	405	500	340	292	237	1,200	280	418	510	340	340	418
15	450	405	325	289	265	1,060	280	532	525	325	325	340
16	380	405	355	283	470	522	310	522	525	340	310	340
17	399	405	355	270	527	460	430	450	527	340	310	325
18	418	405	355	232	1,300	418	405	418	518	340	310	310
19	450	440	325	295	1,200	418	470	392	510	368	295	310
20	418	510	355	280	1,060	478	760	392	440	310	295	310
21	380	500	355	405	910	500	730	392	440	310	280	310
22	355	450	340	620	645	522	525	405	518	295	280	310
23	340	405	325	1,060	525	485	500	450	470	265	280	310
24	325	430	340	1,100	522	700	430	392	510	280	280	295
25	380	470	325	1,130	518	1,580	380	380	500	280	280	310
26	325	527	310	1,140	485	1,960	392	380	478	280	280	310
27	325	620	310	1,400	405	2,010	405	380	492	280	280	620
28	325	575	310	1,760	405	1,060	368	368	478	280	280	575
29	325	500	310	1,580	380	485	368	355	418	280	280	478
30	310	450	310	1,370	.....	450	392	355	392	280	280	392
31	295	.....	325	1,160	.....	500	.....	340	.....	280	280	.....

NOTE.—Stage-discharge relation affected by ice Jan. 5 to Feb. 29. Discharge Oct. 17 interpolated.

Monthly discharge of Kickapoo River at Gays Mills, Wis., for the year ending Sept. 30, 1916.

[Drainage area, 629 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	450	295	372	0.591	0.68
November	971	265	447	.711	.79
December	405	310	345	.548	.63
January	1,760	190	608	.967	1.11
February	1,300	237	534	.849	.92
March	2,010	340	666	1.06	1.22
April	760	280	398	.633	.71
May	532	310	393	.625	.72
June	3,360	340	807	1.28	1.43
July	405	265	322	.512	.59
August	971	265	349	.555	.64
September	910	265	380	.604	.67
The year	3,360	190	468	.744	10.11

TURKEY RIVER AT GARBER, IOWA.

LOCATION.—In sec. 36, T. 92 N., R. 4 W., at single-span highway bridge at Garber, Clayton County, about 800 feet above mouth of Wayne Creek, which enters from right.

DRAINAGE AREA.—1,530 square miles (measured on map issued by United States Geological Survey; scale 1 to 500,000).

RECORDS AVAILABLE.—August 29, 1913, to September 30, 1916, except October 1, 1914, to March 30, 1915, when station was temporarily discontinued.

GAGE.—Chain gage attached to handrail on downstream side of bridge; read once daily by E. J. Prolow.

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

CHANNEL AND CONTROL.—Bed is composed of sand and mud; channel shifting. Right bank high and not subject to overflow; left bank will be overflowed only at extreme high stage or at gage height about 21 feet.

EXTREMES OF STAGE.—Maximum stage recorded during year, 22.0 feet at 7 p. m., June 3; minimum stage recorded, 3.55 feet, September 4–6. The highest stage within the last 20 years probably occurred May 18, 1902, when a stage representing about 23.7 feet referred to the gage datum was reached, as indicated by the high-water marks on A. F. Grafe's residence in Garber.

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

REGULATION.—An electric-light plant and gristmill at Elkader probably cause a slight daily fluctuation.

Data inadequate for determining estimates of discharge.

The following discharge measurement was made by C. Herlofson:

July 22, 1916: Gage height, 4.38 feet; discharge, 546 second-feet.

Daily gage height, in feet, of Turkey River at Garber, Iowa, for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	4.6	3.85	4.1	.....	5.8	5.2	4.4	4.7	4.0	3.75
2	4.5	3.8	4.1	.....	5.7	5.3	19.6	4.8	3.8	3.7
3	4.5	3.8	4.0	.....	5.5	5.0	18.3	4.8	3.7	3.7
4	5.3	3.75	4.0	.....	5.3	4.8	9.8	4.8	4.3	3.55
5	4.8	3.75	3.9	.....	5.1	4.5	7.4	4.7	4.4	3.55
6	4.5	3.75	3.9	.....	5.0	4.5	6.4	4.6	4.3	3.55
7	4.3	3.75	3.9	.....	4.9	4.4	6.0	4.6	4.2	4.8
8	4.2	3.75	3.9	.....	4.7	4.3	6.3	4.5	4.1	4.2
9	4.1	3.7	3.85	.....	5.3	4.3	6.0	4.4	4.0	4.0
10	4.1	3.75	3.85	.....	4.7	4.3	5.8	4.4	4.1	3.95
11	4.1	9.5	3.85	.....	4.6	4.1	5.6	4.4	4.2	3.85
12	4.0	7.2	3.85	.....	4.5	3.85	5.4	4.4	3.95	3.9
13	4.1	5.9	3.85	.....	4.4	3.85	5.3	5.1	3.9	3.95
14	4.2	5.5	3.85	.....	4.5	6.5	5.4	4.8	3.85	3.95
15	4.2	5.1	3.85	4.5	4.4	7.1	5.2	4.7	3.95	3.95
16	4.3	4.8	3.9	4.5	4.7	6.4	5.2	4.8	3.95	3.95
17	4.6	4.7	3.9	4.4	4.7	5.9	5.3	4.7	3.85	3.9
18	5.0	4.6	4.4	4.3	4.8	5.4	5.2	4.6	3.85	3.85
19	5.1	4.5	5.1	4.2	5.0	5.1	5.0	4.5	3.85	3.75
20	4.9	4.3	5.4	4.1	4.9	4.7	5.0	4.4	3.85	3.7
21	4.6	4.2	5.4	3.95	8.4	4.6	5.0	4.3	3.8	3.7
22	4.4	4.1	5.1	6.5	7.5	5.1	4.8	4.3	3.75	3.7
23	4.3	4.1	5.1	5.3	7.2	5.7	5.2	4.3	3.75	3.7
24	4.2	4.6	5.1	17.0	5.8	5.4	4.9	4.1	3.7	3.7
25	4.1	4.2	4.8	20.0	4.8	5.3	4.8	4.4	3.7	3.7
26	4.0	4.2	4.7	17.4	4.7	4.9	6.8	4.3	3.65	3.75
27	3.95	4.2	4.7	9.1	4.6	4.7	6.1	4.4	3.65	4.4
28	3.9	4.2	4.7	7.0	4.5	4.5	5.1	4.3	3.65	4.3
29	3.9	4.2	4.6	6.2	4.6	4.4	4.8	4.2	3.65	4.0
30	3.85	4.2	4.6	5.8	4.8	4.4	4.8	4.2	3.65	4.0
31	3.85	.....	4.6	5.7	.....	4.5	.....	4.1	3.8	.....

NOTE.—Stage-discharge relation affected by ice Dec. 16 to about Feb. 29.

MAQUOKETA RIVER BELOW MOUTH OF NORTH FORK OF MAQUOKETA RIVER, NEAR MAQUOKETA, IOWA.

LOCATION.—In the southwest corner of the NE. ¼ sec. 17, T. 84 N., R. 3 E., at Bridgeport Bridge, about 3 miles northeast of Maquoketa, Jackson County; 1,200 feet above mouth of Mill Creek, which enters from the right, and 2 miles below mouth of North Fork of Maquoketa River.

DRAINAGE AREA.—1,600 square miles (measured on map issued by United States Geological Survey; scale, 1 to 500,000). Drainage area at mouth, 1,960 square miles.

RECORDS AVAILABLE.—September 1, 1913, to September 30, 1916, except October, 1914, to March 20, 1915, when station was temporarily discontinued.

GAGE.—Chain gage attached to downstream handrail of bridge 100 feet from right abutment; read once daily by John Strodthoff.

DISCHARGE MEASUREMENTS.—Made from bridge to which gage is attached.

CHANNEL AND CONTROL.—Bed of stream composed of sand; shifting. Two channels at all stages except above 12-foot stage above which there is overflow under pile-trestle approach on the left side.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 22.0 feet at 8 a. m., March 27 (discharge, 21,300 second-feet); minimum stage recorded, 1.8 feet, September 19 (discharge, 340 second-feet).

Prior to 1916: Maximum stage about 23.5 feet, probably in 1905 (discharge, about 24,300 second-feet).

DIVERSIONS.—None.

REGULATION.—None.

ACCURACY.—Stage-discharge relation not permanent. Two rating curves used during 1916; October 1 to March 27, well defined between 325 and 20,000 second-feet; March 28 to September 30, well defined between 300 and 20,000 second-feet. Gage read once daily to hundredths. Discharge except as noted below ascertained by applying daily gage heights to rating curve. December 16 to January 20, and February 3–18, stage-discharge relation affected by ice; discharge based on observer's notes and weather records. Open-water records good; winter records roughly approximate.

The following discharge measurement was made by C. Herlofson:

July 24, 1916: Gage height, 2.48 feet; discharge, 580 second-feet.

Daily discharge, in second-feet, of Maquoketa River below mouth of North Fork of Maquoketa River, near Maquoketa, Iowa, for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	2,510	645	783	1,000	831	783	1,990	909	1,010	675	439	422
2	2,070	645	645	1,000	690	561	1,930	1,540	6,280	632	439	405
3	1,830	602	690	1,000	600	602	1,700	1,540	5,170	632	2,820	372
4	1,830	602	690	1,000	500	523	1,590	1,220	2,570	675	632	405
5	1,650	602	645	800		602	1,480	1,060	1,820	765	511	812
6	1,420	602	602	700		602	1,320	909	1,430	765	550	675
7	1,310	602	602	600		602	1,220	860	1,370	719	474	550
8	1,200	602	602	500		470	1,110	812	1,990	632	439	492
9	1,090	602	602			452	1,060	719	2,160	590	439	439
10	1,040	561	561			561	1,010	719	1,870	570	388	405
					400							
11	982	602	561			561	959	675	1,480	550	422	405
12	930	690	561			561	909	632	1,270	530	439	388
13	1,060	1,650	561			602	909	632	1,110	530	439	405
14	1,200	1,310	435	400		602	860	959	1,220	719	422	388
15	1,140	982	402			602	860	1,010	1,010	570	405	372
16	1,090	831				523	909	959	1,270	511	439	372
17	930	783			1,000	523	909	1,320	1,160	550	439	372
18	4,440	690			2,000	505	909	1,010	1,110	570	405	372
19	1,830	736			2,440	487	959	909	1,010	550	422	340
20	1,420	736		1,000	3,030	470	1,010	812	959	1,930	405	372
21	1,200	736		8,300	3,300	470	1,010	719	909	1,010	405	356
22	1,090	690		8,700	2,570	523	959	719	860	632	372	372
23	982	645		3,980	4,190	602	886	1,930	1,110	590	372	356
24	930	690	450	3,370	3,160	645	812	1,110	812	530	388	356
25	880	690		2,780	2,320	7,530	765	1,010	765	511	372	356
26	880	1,540		2,190	1,540	10,000	719	909	765	492	388	388
27	831	1,260		8,700	930	18,700	719	812	812	474	372	719
28	736	1,260		7,720	783	8,810	675	1,220	909	474	356	719
29	736	1,090		3,780	783	3,250	632	860	812	456	356	530
30	713	930		3,030	.....	2,450	632	812	719	439	372	456
31	690	.....		1,770	.....	2,040	.....	1,320	.....	439	356	.....

NOTE.—Stage-discharge relation affected by ice Dec. 16 to Jan. 20, and Feb. 3–16. Discharge interpolated, Oct. 13, 30, Jan. 25, Apr. 23, July 11, and 25. Braced figures show mean discharge for periods included.

Monthly discharge of Maquoketa River below mouth of North Fork of Maquoketa River, near Maquoketa, Iowa, for the year ending Sept. 30, 1916.

[Drainage area, 1,600 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	4,400	690	1,310	0.819	0.94
November	1,650	561	820	.512	.57
December	.....	.....	521	.326	.38
January	8,700	.....	2,140	1.34	1.54
February	4,190	.....	1,220	.762	.82
March	18,700	452	2,140	1.34	1.54
April	1,990	632	1,050	.656	.73
May	1,930	632	988	.618	.71
June	6,280	719	1,520	.950	1.06
July	1,930	439	636	.398	.46
August	2,820	356	499	.312	.36
September	812	340	446	.279	.31
The year	18,700	.....	1,110	.694	9.42

ROCK RIVER AT AFTON, WIS.

LOCATION.—On line between secs. 22 and 27, T. 2 N., R. 12 E., at highway bridge in Afton, Rock County, about 9 miles above Illinois State line. Bass Creek enters from right three-fourths mile below station.

DRAINAGE AREA.—3,190 square miles (measured on map issued by Wisconsin Geological and Natural History Survey, edition of 1911; scale 1 inch=6 miles).

RECORDS AVAILABLE.—February 5, 1914, to September 30, 1916.

GAGE.—Chain gage fastened to downstream side of bridge; read by Albert Engelke.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge during medium and high stages; at low stages by wading.

CHANNEL AND CONTROL.—Banks medium high and will not be overflowed to any extent at flood stages. Bed composed of gravel and clean silt; practically permanent. Control not well defined.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 9.12 feet at 8 a. m. April 1 and 3 (discharge, 9,080 second-feet); minimum stage recorded 0.70 foot at 7 a. m. July 16 (discharge, 519 second-feet).

1914–1916: Maximum discharge recorded, 9.88 feet at 4 p. m., September 13, 1915 (discharge, 10,300 second-feet); minimum stage recorded, 0.5 foot at 7 a. m., August 16, 1914 (discharge, about 459 second-feet).

REGULATION.—Operation of power plants at Janesville and above causes fluctuations at the gage during low stages.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined between 638 and 10,500 second-feet. Gage read twice daily, to hundredths. Daily discharge ascertained by applying mean daily gage heights to rating curve, except for periods when stage-discharge relation was affected by ice, for which it was ascertained by applying to rating table mean daily gage heights corrected for ice effect by means of discharge measurements, observer's notes, and weather records. Records for open-water periods good; for winter periods poor.

Discharge measurements of Rock River at Afton, Wis., 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. 5	M. F. Rather	3.21	2,000	Aug. 11	E. L. Williams	1.77	978
Feb. 15[a]	H. C. Beckman	9.86	3,760				

[a] Complete ice cover; ice jammed in long stretch of river below bridge.

Daily discharge, in second-feet, of Rock River at Afton, Wis., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	5,810	1,600	3,800	1,820	6,350	2,670	9,200	5,810	2,490	2,490	779	737
2	5,420	1,500	3,920	2,060	6,350	2,400	9,200	5,680	2,400	2,310	742	656
3	5,160	1,710	4,049	1,900	6,350	2,140	9,200	5,680	2,220	2,310	844	710
4	4,770	1,530	4,040	1,820	6,210	1,980	9,050	5,550	2,140	1,980	825	746
5	4,640	1,530	3,800	1,980	6,210	1,980	8,760	5,420	2,060	1,980	806	788
6	4,400	1,460	3,800	2,140	6,070	2,140	8,620	5,550	2,140	1,900	765	769
7	3,920	1,430	3,680	2,220	5,940	1,820	8,470	5,550	2,580	1,780	797	792
8	3,800	1,270	3,560	2,220	5,680	1,740	8,470	5,420	3,560	1,620	742	792
9	3,680	1,050	3,450	2,140	5,420	1,980	7,900	5,030	3,240	1,460	857	848
10	3,240	1,430	3,240	2,060	5,160	1,980	7,330	4,640	3,240	1,460	880	783
11	3,040	1,210	3,240	1,980	4,900	1,900	7,190	4,400	3,680	1,260	926	1,040
12	2,940	1,210	3,040	1,940	4,770	1,740	7,050	4,400	4,040	1,000	912	1,430
13	2,850	1,240	2,940	1,900	4,400	2,060	6,770	4,280	4,160	875	866	1,170
14	2,760	1,330	2,670	1,900	4,160	2,220	6,350	4,160	4,900	779	884	1,500
15	2,670	1,330	2,670	1,900	3,800	1,980	5,940	3,920	4,900	608	866	1,320
16	2,580	1,400	2,580	1,900	3,680	2,310	5,810	3,560	4,770	541	806	1,230
17	2,400	1,400	2,490	1,900	3,450	2,400	5,420	3,680	4,770	688	792	1,100
18	2,400	1,500	2,400	1,940	3,340	2,400	5,290	3,680	4,640	710	802	1,400
19	2,310	1,670	2,400	1,980	3,240	2,310	5,550	3,450	4,520	769	701	1,090
20	2,310	1,530	2,400	2,020	3,040	2,490	5,290	3,340	4,400	751	811	1,000
21	2,140	1,600	2,310	2,140	2,940	2,580	5,420	3,240	4,280	751	806	1,030
22	2,220	1,780	2,310	4,900	2,850	3,040	5,420	3,450	4,160	714	746	1,040
23	2,140	1,980	2,310	4,640	2,760	2,580	5,680	3,040	3,920	608	701	975
24	2,060	2,060	2,220	4,040	2,670	2,760	5,810	3,040	3,680	811	719	985
25	1,980	1,980	2,020	3,680	2,580	4,900	5,550	2,850	3,340	825	746	1,060
26	1,820	2,580	2,020	3,620	2,490	5,420	5,810	2,940	3,240	737	737	1,060
27	1,980	2,940	2,020	6,070	2,490	8,910	5,680	2,850	3,240	696	719	1,100
28	1,980	3,140	1,980	6,490	2,900	7,620	5,420	2,760	2,940	733	792	1,260
29	1,820	3,450	1,980	6,210	2,670	7,900	5,290	2,850	2,760	665	774	1,230
30	1,740	3,450	1,900	6,350	.....	8,470	5,030	2,580	2,670	737	733	1,400
31	1,530	.....	1,860	6,350	.....	8,910	.....	2,670	.....	852	710	.....

NOTE.—Stage-discharge relation affected by ice Dec. 11 to Feb. 29.

Monthly discharge of Rock River at Afton, Wis., for the year ending Sept. 30, 1916.

[Drainage area, 3,190 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	5,810	1,530	2,980	0.934	1.08
November	3,450	1,050	1,780	.558	.62
December	4,040	1,860	2,810	.881	1.02
January	6,490	1,820	3,040	.953	1.10
February	6,350	2,490	4,240	1.33	1.43
March	8,910	1,740	3,410	1.07	1.23
April	9,200	5,030	6,730	2.11	2.35
May	5,810	2,580	4,050	1.27	1.46
June	4,900	2,060	3,500	1.10	1.23
July	2,490	541	1,140	.357	.41
August	996	701	793	.249	.29
September	1,500	656	1,030	.323	.36
The year	9,200	541	2,950	.925	12.58

ROCK RIVER AT ROCKFORD, ILL.

LOCATION.—In sec. 34, T. 44 N., R. 1 E., at highway bridge at Nelson Avenue, Rockford, Winnebago County, about 1 mile below mouth of Kent Creek.

DRAINAGE AREA.—6,520 square miles.

RECORDS AVAILABLE.—July 30, 1914, to September 30, 1916.

GAGE.—Chain gage attached to upstream side of bridge; read by Winton Burrows.

DISCHARGE MEASUREMENTS.—Made from upstream side of bridge.

CHANNEL AND CONTROL.—Coarse gravel and rock; may shift in high stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 13.0 feet at 8 a. m. and 5.30 p. m. March 30, and 8 a. m. March 31 (discharge, 32,000 second-feet); minimum stage, 1.15 feet at 1.30 p. m. August 20 (discharge, 1,000 second-feet).

1914–1916: Maximum stage recorded 15.5 feet February 15, 1915 (discharge not determined because of backwater from ice). Maximum stage recorded during open-water periods 13.0 feet March 30 and 31, 1916 (discharge, 32,000 second-feet); minimum stage, 0.82 foot August 9, 1914 (discharge, 483 second-feet).

REGULATION.—Operation of power plant at dam 2 miles upstream in city of Rockford causes slight fluctuation at gage.

ACCURACY.—Stage-discharge relation changed during high water and ice jam in February; seriously affected by ice during winter. Rating curve used before February 10 well defined above and extended below 960 second-feet; curve used after that date fairly well defined above 2,310 second-feet. Gage read to hundredths twice daily. Fluctuation at gage only slight. Daily discharge ascertained by applying mean daily gage heights to rating tables, except for period when stage-discharge relation was affected by ice for which it was determined from gage heights, observer's notes, weather records, and records of flow of Rock River at Afton, Wis. Records good for open-water periods except for very low stages in July to September; winter records poor.

Discharge measurements of Rock River at Rockford, Ill., during the year ending Sept. 30, 1916.

[Made by H. C. Beckman.]

Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*
Mar. 31	12.78	30,700
Sept. 7	4.09	4,890

Daily discharge, in second-feet, of Rock River at Rockford, Ill., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	13,700	3,490	7,860			9,180	27,800	7,710	5,240	4,450	2,310	2,020
2	13,400	3,200	7,860			7,470	25,800	7,710	5,240	4,640	2,310	1,740
3	12,900	3,200	7,620			6,320	21,800	7,950	5,660	4,450	2,430	1,450
4	12,700	3,340	6,920			5,450	16,200	8,430	5,660	4,260	2,430	1,450
5	10,600	3,340	5,800			5,240	13,700	8,680	5,880	4,080	2,550	2,930
6	9,600	3,490	5,590			4,840	13,100	9,180	6,100	3,750	2,550	3,190
7	8,850	3,340	5,800			4,840	12,000	8,680	8,930	3,460	2,430	4,450
8	7,380	3,490	5,800			4,640	11,500	8,430	10,500	5,040	2,430	4,080
9	6,460	3,340	5,590			4,450	11,000	7,710	10,700	3,190	2,190	3,910
10	6,020	3,200	5,380			4,260	10,500	7,230	11,000	2,930	2,190	3,910
11	6,240	3,200	5,380	4,270		4,260	9,940	6,540	11,000	2,800	2,190	3,750
12	6,020	3,200	5,380			4,080	9,430	6,540	11,000	2,550	2,080	3,600
13	5,800	3,200				3,910	9,180	6,100	10,700	2,430	2,190	3,190
14	5,380	3,340				4,080	8,930	6,320	10,200	2,190	2,430	3,320
15	5,590	3,340			10,600	4,640	8,680	6,540	9,940	2,080	2,430	3,320
16	5,380	3,070				4,450	8,430	6,770	9,430	2,080	2,310	3,190
17	5,380	3,070				4,450	8,430	7,000	9,180	1,970	1,970	3,060
18	4,970	2,940				4,260	8,430	7,470	8,930	1,860	1,700	3,190
19	4,570	2,940				4,260	8,190	7,230	8,680	1,860	1,450	3,320
20	4,770	2,820				4,260	8,190	6,770	8,680	2,080	1,060	3,190
21	4,570	2,580				4,450	8,190	6,320	8,430	2,310	1,270	3,320
22	4,380	2,820	3,400			4,840	8,430	6,100	7,950	2,430	1,500	3,460
23	4,190	3,200				5,040	8,430	5,880	7,950	2,550	1,700	3,460
24	4,000	3,490				5,040	8,680	5,660	7,710	2,550	1,750	
25	4,190	5,590				12,800	8,430	5,450	7,710	2,430	1,970	
26	4,000	6,240		17,800		15,900	8,430	5,240	7,230	2,430	2,080	
27	4,000	6,690				24,600	8,190	5,040	7,000	2,310	1,500	3,500
28	4,000	7,150				29,000	8,190	5,040	6,540	2,310	1,860	
29	4,000	7,380				30,000	7,710	5,240	6,100	2,190	2,080	
30	4,000	7,620				32,000	7,710	4,840	5,660	2,190	2,190	
31	4,000	.....				31,500	.....	5,040	.....	2,310	2,310	.....

NOTE.—Stage-discharge relation affected by ice Dec. 13 to Feb. 29. Discharge, Sept. 1 and 2, interpolated, and Sept. 24-30 estimated, for lack of gage-height records.

Monthly discharge of Rock River at Rockford, Ill., for the year ending Sept. 30, 1916.

[Drainage area, 6,520 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	13,700	4,000	6,490	0.995	1.15
November	7,620	2,580	3,910	.600	.67
December	7,860	.....	4,500	.690	.80
January	.....	.....	9,070	1.39	1.60
February	.....	.....	10,600	1.63	1.76
March	32,000	3,910	9,500	1.46	1.68
April	27,800	7,710	11,100	1.70	1.90
May	9,180	4,840	6,740	1.03	1.19
June	11,000	5,240	8,160	1.25	1.40
July	5,040	1,860	2,840	.436	.50
August	2,550	1,060	2,060	.316	.36
September	.....	.....	3,230	.495	.55
The year	32,000	1,060	6,500	.997	13.56

ROCK RIVER AT LYNDON, ILL.

LOCATION.—In sec. 21, T. 20 N., R. 5 E., at highway bridge known as Lyndon Bridge, in the eastern part of the village of Lyndon, Whiteside County; about 10 miles above Rock Creek and 20 miles below the dam at Sterling.

DRAINAGE AREA.—9,010 square miles.

RECORDS AVAILABLE.—November 24, 1914, to September 30, 1916.

GAGE.—Chain gage attached to bridge; read by John Shepard.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge.

CHANNEL AND CONTROL.—Coarse gravel and rock; probably permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year and period 1915–1916, 18.0 feet January 22 and 23, 1916 (discharge not determined because of backwater from ice). Maximum open-water stage recorded, 17.0 feet at 1 p. m. March 28, 1916 (discharge, 39,500 second-feet); minimum stage recorded, 4.45 feet at 6 p. m. August 27, 1916 (discharge, 1,180 second-feet).

REGULATION.—Operation of power plant in city of Sterling causes fluctuation at gage.

ACCURACY.—Stage-discharge relation practically permanent; seriously affected by ice during winter. Rating curve well defined above and fairly-well defined below 1,850 second-feet. Gage read to hundredths once daily before and twice daily after September 6. Diurnal fluctuation at gage not large. Discharge ascertained by applying mean daily gage heights to rating table, except for period when stage-discharge relation was affected by ice for which it was ascertained from gage heights, observer's notes, weather records and record of flow of Rock River at Rockford, Ill., and Afton, Wis. Records good for open-water periods; poor for winter period.

Discharge measurements of Rock River at Lyndon, Ill., during the year ending Sept. 30, 1916.

[Made by H. C. Beckman.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Mar. 30	16.37	35,800	Sept. 5	5.12	1,900
Apr. 6	12.61	21,200			

Daily discharge, in second-feet, of Rock River at Lyndon, Ill., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	17,100	3,980	8,580				35,000	8,330	6,860	6,860	2,530	2,110
2	15,400	3,980	8,330				33,800	8,080	7,830	5,950	1,350	2,980
3	14,500	3,980	8,080				31,400	10,100	6,170	5,730	2,110	1,660
4	15,100	3,980	7,340				28,600	9,580	5,520	5,110	2,110	2,250
5	13,600	3,630	5,950				24,600	9,830	6,860	4,910	2,110	3,200
6	12,100	3,460	7,100				21,400	9,330	7,100	4,720	1,410	4,160
7	10,400	2,250	6,400			8,000	17,800	8,830	7,340	4,720	2,530	4,530
8	8,830	3,140	5,950				14,500	9,330	12,700	4,910	2,980	5,110
9	8,080	3,630	6,170				13,600	8,830	21,000	3,300	2,680	4,720
10	6,630	3,140	5,950				13,300	8,080	19,200	3,630	2,530	4,530
11	5,520	2,980	5,730	6,500			12,100	7,340	18,200	3,980	5,730	3,460
12	6,630	3,300	4,720				11,500	7,100	16,800	3,980	2,680	2,980
13	5,950	3,300	5,520				10,900	6,860	15,100	3,800	2,390	4,160
14	5,310	2,980	4,530			7,580	10,400	6,170	13,600	3,980	3,980	3,800
15	6,400	3,140	5,730		15,000	3,460	9,580	5,950	13,900	3,300	2,680	3,630
16	6,170	2,830	1,980			6,170	11,800	6,400	13,900	2,110	2,680	3,800
17	5,950	3,460				4,910	8,830	6,860	13,300	2,390	2,680	2,250
18	5,520	3,300				4,530	8,580	6,860	12,700	2,980	2,390	3,800
19	5,110	2,980				4,340	8,080	6,630	10,400	2,530	2,530	2,390
20	5,310	3,300				4,720	7,100	6,400	9,580	2,680	1,720	3,300
21	5,310	3,460				4,340	8,580	5,110	8,080	2,530	2,830	3,460
22	5,730	3,630				4,910	8,830	5,950	9,830	2,390	2,530	2,530
23	5,520	3,980				4,720	8,580	6,170	9,330	2,390	2,390	2,390
24	4,720	3,980	5,270			5,110	8,830	5,730	8,330	2,680	1,720	2,530
25	5,110	4,340				13,300	9,330	5,310	9,080	2,980	1,660	2,680
26	4,910	5,110		20,000		21,400	9,080	5,520	8,830	3,630	1,300	2,530
27	4,720	5,950				31,400	8,830	5,520	9,080	3,140	1,180	2,980
28	4,160	6,860				39,500	8,830	3,460	7,830	2,980	2,110	3,630
29	4,160	8,080			-------	39,000	8,580	5,520	6,860	2,680	2,110	4,340
30	3,980	8,080			-------	36,600	8,330	6,170	6,630	1,980	1,780	4,530
31	3,800	-------			-------	35,400	-------	6,400	-------	2,830	1,850	-------

NOTE.—Stage-discharge relation affected by ice Dec. 17 to Mar. 13. Discharge June 6 and Sept. 5 interpolated.

Monthly discharge of Rock River at Lyndon, Ill., for the year ending Sept. 30, 1916.

[Drainage area, 9,010 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	17,100	3,800	7,480	0.830	0.96
November	8,080	2,250	4,010	.445	.50
December	-------	1,980	5,710	.634	.73
January	-------	-------	11,300	1.25	1.44
February	-------	-------	15,000	1.66	1.79
March	39,500	3,460	12,100	1.34	1.54
April	35,000	7,100	14,000	1.55	1.73
May	10,100	3,460	7,020	.779	.90
June	21,000	5,520	10,700	1.19	1.33
July	6,860	1,980	3,610	.401	.46
August	5,730	1,180	2,360	.262	.30
September	5,110	1,660	3,350	.372	.42
The year	39,500	1,180	8,020	.890	12.10

PECATONICA RIVER AT DILL, WIS.

LOCATION.—In sec. 6, T. 1 N., R. 6 E., at Illinois Central Railroad bridge at Dill (Ramona post office), Green County, about 1 mile below junction of east and west branches of Pecatonica River, and 9 miles above the Illinois State line.

DRAINAGE AREA.—959 square miles (measured on map issued by Wisconsin Geological and Natural History Survey, edition of 1911; scale, 1 inch = 6 miles).

RECORDS AVAILABLE.—February 9, 1914, to September 30, 1916.

GAGE.—Chain gage fastened to downstream side of bridge; prior to August 2, 1916, vertical staff gage on left abutment. Gage read by W. C. Shadewaldt.

DISCHARGE MEASUREMENTS.—At low and medium stages made from upstream side of highway bridge about 400 feet above gage; during extremely high water considerable water overflows to left of highway bridge and measurements are made from railroad bridge to which gage is attached.

CHANNEL AND CONTROL.—Channel sand and mud; undoubtedly shifting; banks only medium high and are overflowed at flood stages. Except during extreme flood stages, all the water passes under the railroad bridge to which gage is fastened. There is little fall in the river below the gage and no well-defined control.

EXTREMES OF DISCHARGE.—Maximum stage during year, 19.1 feet March 27, determined from flood marks by leveling (discharge, about 13,100 second-feet); minimum stage recorded, 0.88 foot at 5 p. m. August 25 (discharge, 304 second-feet).

1914–1916: Maximum stage, 19.1 feet on March 27, 1916, determined from flood marks by leveling (discharge, about 13,100 second-feet); minimum discharge, January 20–31, 1915 (estimated mean discharge, 245 second-feet).

REGULATION.—Operation of dams at Argyle, on the East Branch of Pecatonica River, and at Darlington, on the West Branch of Pecatonica River, cause little if any diurnal fluctuation at the gage.

ACCURACY.—Stage-discharge relation changed during high water of March, 1916; seriously affected by ice during winter. Rating curves used before and after the change well defined between 350 and 1,520 second-feet and fairly well defined between 1,520 and 6,000 second-feet. Extension of curves above 6,000 second-feet based on the records of flow of Pecatonica River at Freeport, Ill. Gage read twice daily to quarter tenths. Discharge ascertained by applying mean daily gage heights to rating table except for period in which stage-discharge relation was affected by ice, for which it was ascertained by applying to rating table mean daily gage heights corrected for ice effect by means of discharge measurements, observer's notes, and weather records. Records good for open-water periods except at extremely high and low stages, for which they are fair; winter records fair.

Discharge measurements of Pecatonica River at Dill, Wis., 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.*
Oct. 26	H. C. Beckman	2.30	663	June 1	H. C. Beckman	1.72	498
26	do	2.30	677	Aug. 1	E. L. Williams	1.02	342
Jan. 4[a]	M. F. Rather	5.89	1,590	2	do	1.27	378
Feb. 17[b]	H. C. Beckman	2.85	628				

[a] Channel open at measuring section; nearly complete ice cover at gage.
[b] Complete ice cover.

Daily discharge, in second-feet, of Pecatonica River at Dill, Wis., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	1,480	625	661	735	1,920	502	1,160	1,040	498	524	335	356
2	1,280	625	661	1,520	1,720	476	960	1,200	1,120	511	378	367
3	1,160	625	625	1,680	1,320	450	846	1,920	1,880	565	378	367
4	1,080	590	625	1,520	735	450	772	772	1,800	537	390	378
5	1,040	590	590	1,360	661	476	735	735	1,320	511	402	596
6	1,000	590	590	1,280	625	502	664	698	698	498	438	1,970
7	960	590	556	556	625	556	630	630	920	474	402	1,000
8	920	590	556	542	608	625	596	630	1,600	462	378	1,000
9	920	556	556	542	590	661	596	630	1,680	462	367	772
10	883	556	556	556	590	661	596	596	1,360	462	390	498
11	883	590	542	528	556	661	596	551	1,000	462	462	390
12	846	698	528	502	542	661	596	537	920	462	426	414
13	846	661	528	489	542	476	596	511	809	462	402	474
14	846	556	515	502	528	400	596	630	846	462	402	462
15	846	556	502	502	528	400	565	772	1,000	462	402	426
16	809	556	502	502	556	400	596	809	846	462	390	402
17	772	556	502	502	625	450	596	698	772	524	402	390
18	1,000	556	502	502	1,720	450	630	596	735	462	378	390
19	1,080	772	502	502	1,880	463	630	551	664	438	378	390
20	883	772	502	556	2,510	476	846	537	630	698	378	390
21	809	698	515	1,120	2,280	476	1,120	537	630	1,320	367	390
22	735	625	528	3,580	1,800	661	883	565	698	1,000	356	390
23	735	556	528	4,330	1,800	809	735	630	772	537	356	378
24	698	556	528	4,330	1,760	625	664	565	772	438	335	402
25	698	625	528	4,180	920	3,730	630	537	664	426	314	390
26	698	1,320	528	2,640	625	5,600	596	551	630	438	323	462
27	698	1,200	502	3,780	590	13,100	596	537	664	426	345	772
28	661	1,080	489	4,800	556	11,400	565	511	630	414	335	883
29	661	846	476	5,180	556	7,300	537	596	565	414	321	596
30	625	698	476	3,380	.....	4,430	630	565	537	426	335	462
31	625	.....	476	2,330	.....	2,100	.....	551	.....	414	345	.....

NOTE.—Stage-discharge relation affected by ice Dec. 11 to Mar. 15. Discharge, Mar. 26–29, when water was above gage, estimated from maximum stage of 19.1 feet, which occurred Mar. 27, and flow of Pecatonica River at Freeport, Ill. The discharge given for Mar. 27 corresponds to the crest stage and may, therefore, be somewhat too high.

Monthly discharge of Pecatonica River at Dill, Wis., for the year ending Sept. 30, 1916.

[Drainage area, 959 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	1,480	625	877	0.915	1.05
November	1,320	556	680	.709	.79
December	661	476	538	.561	.65
January	5,180	489	1,780	1.86	2.14
February	2,510	528	1,010	1.08	1.16
March	[a]13,100	400	1,960	2.04	2.35
April	1,160	537	692	.722	.81
May	1,200	511	651	.679	.78
June	1,880	498	922	.961	1.07
July	1,320	414	521	.543	.63
August	462	314	375	.391	.45
September	1,970	356	552	.576	.64
The year	[a]13,100	314	883	.921	12.52

[a] Crest stage.

PECATONICA RIVER AT FREEPORT, ILL.

LOCATION.—In sec. 32, T. 27 N., R. 8 E., at highway bridge at Hancock Avenue, about half a mile east of Illinois Central Railway station at Freeport, Stephenson County, and about 2 miles above mouth of Yellow Creek.

DRAINAGE AREA.—1,330 square miles.

RECORDS AVAILABLE.—September 10, 1914, to September 30, 1916.

GAGE.—Chain gage attached to upstream side of bridge; read by W. C. Krueger.

DISCHARGE MEASUREMENTS.—Made from upstream side of bridge.

CHANNEL AND CONTROL.—Bed composed of sand and silt; likely to shift; left bank of only medium height and is overflowed during high water; at stages above about 16.0 feet part of the flow passes over the left bank and through East Freeport.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 19.4 feet at 8 a. m. and 4.30 p. m. March 28 (discharge, 17,000 second-feet); minimum stage, 4.2 feet August 26 and 27 (discharge, 423 second-feet).

1914–1916: Maximum stage recorded, 19.4 feet March 28, 1916 (discharge, 17,000 second-feet); minimum stage, 3.1 feet December 12, 1914 (discharge, 278 second-feet).

REGULATION.—A dam and power plant three-fourths mile upstream regulates flow past gage. Only slight diurnal fluctuation is noticeable.

ACCURACY.—Stage-discharge relation practically permanent during open-water periods of the year; seriously affected by ice during winter. Rating curve well defined below 8,000 second-feet and fairly well defined between 8,000 and 18,000 second-feet. Gage read to hundredths twice daily. Daily discharge ascertained by applying mean daily gage heights to rating table except for the winter period, for which discharge was determined from observer's notes, weather records, and the flow of Pecatonica River at Dill, Wis. Records good for open-water periods; fair for winter period.

Discharge measurements of Pecatonica River at Freeport, Ill., during the year ending Sept. 30, 1916.

[Made by H. C. Beckman.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Mar. 28	19.35	[a] 17,000	Sept. 6	12.00	2,600
Apr. 1	7.94	1,270	6	12.05	2,650

[a] 14,000 second-feet measured in regular channel at Stephenson Street bridge; overflow through East Freeport determined as 3,000 second-feet by multiplying area of cross section by mean velocity determined from the velocity of driftwood. Total considered accurate within 10 per cent.

Daily discharge, in second-feet, of Pecatonica River at Freeport, Ill., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	4,270	870	1,020	1,290	3,830	757	7,770	1,040	1,390	894	502	453
2	2,880	870	966	1,680	2,570	632	1,920	1,420	1,770	870	485	502
3	1,890	847	966	2,140	1,920	612	1,590	1,470	1,950	870	469	485
4	1,560	847	942	1,980	1,740	593	1,420	1,390	2,100	847	485	672
5	1,420	824	847	1,740	1,650	612	1,260	1,320	1,620	847	537	1,020
6	1,340	801	779	1,500	1,530	632	1,140	1,090	1,800	801	537	2,520
7	1,290	801	779	942	1,390	652	1,040	1,260	2,020	801	519	2,180
8	1,240	801	757	847	1,040	693	990	990	2,620	779	485	1,340
9	1,190	801	757	757	942	714	936	942	3,120	779	485	1,160
10	1,140	801	824	714	870	779	942	870	2,520	757	1,090	990
11	1,120	801	801	672	847	847	918	801	2,100	757	894	693
12	1,120	801	801	652	801	918	894	801	1,770	757	693	672
13	1,120	894	801	632	779	990	870	870	1,650	847	652	714
14	1,120	894	779	612	757	966	870	1,090	1,860	847	555	672
15	1,120	757	757	593	735	918	847	1,340	1,950	801	537	593
16	1,090	757	757	612	714	847	847	1,530	1,680	801	519	555
17	1,060	942	801	612	714	757	847	1,440	1,470	779	519	574
18	1,090	942	870	612	714	714	847	1,220	1,340	757	519	537
19	1,260	942	757	632	1,090	672	942	847	1,240	757	502	519
20	1,290	1,020	824	632	2,220	632	1,040	779	1,060	1,240	485	502
21	1,160	1,040	714	1,980	2,670	632	1,290	779	990	1,710	485	485
22	1,060	942	735	4,770	2,380	672	1,290	779	966	1,650	485	485
23	1,020	870	757	5,120	2,770	801	1,190	757	1,420	1,560	453	555
24	990	824	757	5,520	2,570	1,160	1,090	870	1,470	1,340	438	574
25	966	801	767	6,140	1,800	3,910	1,020	894	1,060	870	438	519
26	966	1,390	757	6,310	1,340	6,140	966	824	1,040	612	423	735
27	942	2,020	757	6,140	1,190	11,100	918	1,020	1,040	574	423	1,090
28	942	1,830	757	5,970	1,040	17,000	870	966	990	555	453	1,360
29	918	1,470	801	5,380	894	15,300	824	942	966	537	453	1,160
30	894	1,240	870	5,000	.....	11,100	779	1,090	894	574	453	990
31	894	.....	942	4,560	.....	7,310	.....	1,240	.....	537	453	.....

NOTE.—Stage-discharge relation affected by ice Dec. 29 to Mar. 12.

Monthly discharge of Pecatonica River at Freeport, Ill., for the year ending Sept. 30, 1916.

[Drainage area, 1,330 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	4,270	894	1,300	0.977	1.13
November	2,020	757	981	.738	.82
December	1,020	714	813	.611	.70
January	6,310	593	2,480	1.86	2.14
February	3,830	714	1,500	1.13	1.22
March	17,000	593	2,910	2.19	2.52
April	7,770	779	1,270	.955	1.07
May	1,530	757	1,050	.789	.91
June	3,120	894	1,600	1.20	1.34
July	1,710	537	874	.657	.76
August	1,090	423	530	.398	.46
September	2,520	453	844	.635	.71
The year	17,000	423	1,350	1.02	13.78

SUGAR RIVER NEAR BRODHEAD, WIS.

LOCATION.—In sec. 26, T. 2 N., R. 9 E., at highway bridge 2 miles southwest of the village of Brodhead, Green County, about 12 miles above the Illinois State line. Jordan Creek enters from the right 2 miles below, and Little Jordan Creek, also from the right, 4 miles above station.

DRAINAGE AREA.—529 square miles (measured on map issued by Wisconsin Geological and Natural History Survey, edition of 1911; scale, 1 inch = 6 miles).

RECORDS AVAILABLE.—February 7, 1914, to September 30, 1916.

GAGE.—Chain gage attached to downstream side of bridge; read by Arthur Christensen,

DISCHARGE MEASUREMENTS.—Made from upstream side of bridge at medium and high stages; at low stages by wading.

CHANNEL AND CONTROL.—Bed composed of sand and gravel; control not well-defined. Right bank of medium height; rarely overflowed; left bank at and above the gage overflowed at stage of about 7 feet on the gage.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 9.02 feet at 5 p. m. March 26 (discharge, 6,320 second-feet); minimum stage recorded, 1.05 feet September 3 (discharge, about 164 second-feet.)

1914–1916: Maximum stage recorded, 11.4 feet, September 13, 1915 (discharge, about 13,000 second-feet). Minimum stage recorded, 0.4 foot at 10 a. m., Sunday, August, 30, 1914 (water was undoubtedly being held at dam); discharge determined from extension of the rating curve, about 74 second-feet.

ACCURACY.—Stage-discharge relation probably did not change during year except when affected by ice. Rating curve well defined between 228 and 4,500 second-feet. Gage read twice daily to quarter tenths. Discharge ascertained by applying mean daily gage heights to rating curve, except for periods when stage-discharge relation was affected by ice, for which periods it was ascertained by applying to rating table mean daily gage heights corrected for ice effect by means of discharge measurements, observer's notes, and weather records. Records for open-water periods good; for winter period fair.

Discharge measurements of Sugar River near Brodhead, Wis., 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.*
Oct. 25	H. C. Beckman	2.10	375	Feb. 16[b]	H. C. Beckman	2.12	258
26	do	2.02	338	May 31	do	2.10	376
Jan. 4[a]	M. F. Rather	3.38	931	Aug. 12	E. L. Williams	1.72	268

[a] Measurement made from bridge; comparatively little ice at control.
[b] Made through complete ice cover; ice cover at control incomplete.

Daily discharge, in second-feet, of Sugar River near Brodhead, Wis., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	626	335	544	276	544	276	836	752	335	351	255	246
2	626	335	433	710	505	221	710	1,010	367	296	246	246
3	584	322	399	773	584	221	710	710	416	296	246	168
4	544	335	383	752	584	221	626	668	433	255	255	264
5	487	335	367	731	399	208	584	544	383	351	237	264
6	487	308	367	710	416	234	544	451	367	308	219	351
7	433	296	367	710	487	262	505	416	544	284	296	416
8	416	335	351	505	399	248	487	416	1,500	274	264	367
9	399	322	335	399	351	276	451	383	1,450	237	255	351
10	416	335	351	335	335	305	433	383	1,300	335	264	335
11	433	335	335	335	335	335	451	322	965	284	274	308
12	416	335	322	335	335	335	433	351	710	264	274	308
13	433	335	351	320	335	383	416	351	505	274	210	284
14	469	322	322	305	335	443	451	367	544	264	264	284
15	433	335	322	290	335	382	451	544	505	274	264	284
16	399	308	305	248	300	322	487	544	505	255	264	274
17	399	308	305	234	248	296	469	451	451	335	210	210
18	433	335	305	221	416	264	433	351	367	322	237	264
19	487	416	305	234	584	228	469	367	416	255	228	237
20	505	584	290	276	794	284	668	367	351	274	202	228
21	451	626	276	469	1,150	274	794	296	322	383	264	237
22	367	544	276	2,470	836	308	878	383	399	605	255	237
23	367	399	248	4,500	689	335	626	416	544	367	264	237
24	367	367	262	2,790	584	383	487	367	836	335	246	219
25	383	416	262	1,300	433	2,130	451	308	416	284	237	246
26	367	505	248	965	305	5,170	433	335	367	274	255	255
27	335	965	234	1,650	290	6,090	469	383	383	264	180	308
28	335	1,350	248	3,450	305	3,600	469	296	351	264	246	433
29	351	1,150	221	2,470	276	1,890	451	383	351	264	219	399
30	335	752	234	1,650	.....	1,250	383	505	335	246	237	367
31	335	.....	248	794	.....	965	.....	383	.....	264	228	.....

NOTE.—Stage-discharge relation affected by ice Dec. 16 to Mar. 10; discharge, Mar. 15, interpolated.

Monthly discharge of Sugar River near Brodhead, Wis., for the year ending Sept. 30, 1916.

[Drainage area, 529 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	626	335	433	0.819	0.94
November	1,350	296	465	.879	.98
December	544	221	317	.599	.69
January	4,500	221	1,010	1.91	2.20
February	1,150	248	465	.879	.95
March	6,090	208	908	1.72	1.98
April	878	383	535	1.01	1.13
May	1,010	296	445	.841	.97
June	1,500	322	557	1.05	1.17
July	605	237	301	.569	.66
August	296	180	245	.463	.53
September	433	168	288	.544	.61
The year	6,090	168	498	.941	12.81

IOWA RIVER NEAR MARSHALLTOWN, IOWA.

LOCATION.—In T. 84 N., R. 18 W., at the Third Avenue highway bridge, 1 mile north of Marshalltown, Marshall County, and about a mile below site of old gaging station.

DRAINAGE AREA.—1,380 square miles (measured on map issued by United States Geological Survey; scale 1 to 500,000).

RECORDS AVAILABLE.—May 21, 1915, to September 30, 1916; February 23, 1903, to August 8, 1903, at old site a mile above present station.

GAGE.—Chain gage attached to downstream handrail of bridge, 60 feet from right pier; read by B. S. Beehrle.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge, to which gage is attached.

CHANNEL AND CONTROL.—Bed of stream sandy and subject to change; right bank not subject to overflow; left bank will be overflowed at stages above about 13 feet.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 9.6 feet, October 1 (discharge, 4,380 second-feet); minimum stage recorded, 2.23 feet, August 29 (discharge, 86 second-feet.)

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

ACCURACY.—Stage-discharge relation not permanent. One rating curve, which is not well defined, used during 1916. Gage read once daily to hundredths. Discharge October 1 to July 19 ascertained by applying daily gage heights to rating curve. Discharge July 20 to September 30 ascertained by indirect method for shifting control. Records for open-water periods fair.

Discharge measurements of Iowa River near Marshalltown, Iowa, during the year ending Sept. 30, 1916.

[Made by C. Herlofson.]

Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*
Mar. 20	6.51	1,910
July 20	3.39	444

Daily discharge, in second-feet, of Iowa River at Marshalltown, Iowa, for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	4,380	800	800	.....	2,370	1,380	1,020	412	207	109
2	3,840	760	720	.....	1,960	1,960	1,270	461	168	119
3	3,300	760	720	.....	1,840	1,720	1,220	461	168	121
4	2,810	720	640	.....	1,490	1,600	1,490	412	168	136
5	2,300	680	720	.....	1,490	1,380	1,840	885	168	138
6	2,100	640	640	.....	1,440	1,170	2,660	975	168	126
7	1,960	640	600	.....	1,270	930	2,890	1,070	194	119
8	1,840	720	640	.....	1,070	800	2,370	840	181	114
9	1,600	680	600	.....	975	800	1,840	800	168	100
10	1,540	1,380	640	.....	885	720	1,320	565	168	129
11	1,320	1,960	600	.....	885	640	1,170	461	262	155
12	1,170	2,030	600	.....	840	600	885	428	181	168
13	1,270	1,960	530	.....	800	530	800	1,270	194	168
14	1,600	2,100	335	.....	760	1,540	760	461	194	168
15	1,490	2,030	320	.....	800	2,810	680	461	181	181
16	1,380	1,960	.....	.....	930	3,130	640	412	168	168
17	1,380	1,660	.....	.....	1,270	3,300	600	380	155	168
18	1,440	1,380	.....	.....	1,380	2,970	565	428	141	155
19	1,840	1,270	.....	.....	1,490	2,660	530	495	155	138
20	2,160	1,220	.....	1,660	1,900	2,440	495	428	168	129
21	1,720	1,170	.....	1,780	2,030	2,230	495	380	181	133
22	1,900	1,120	.....	1,900	2,230	2,100	444	320	155	131
23	1,720	1,020	.....	2,030	3,050	2,300	444	320	143	126
24	1,070	975	.....	2,100	3,300	2,810	461	290	141	119
25	1,320	930	.....	2,230	2,740	2,510	444	262	112	112
26	1,170	975	.....	2,300	2,370	2,370	428	234	107	114
27	1,070	930	.....	2,370	1,960	2,230	565	207	105	126
28	1,020	885	.....	3,460	1,720	1,720	530	207	101	155
29	930	885	.....	4,290	1,540	1,490	495	194	86	143
30	885	800	.....	3,730	1,380	1,270	461	207	88	126
31	840	.....	.....	2,660	.....	1,070	.....	194	88	.....

NOTE.—Stage-discharge relation affected by ice Dec. 16 to Mar. 17. Discharge, Oct. 2, interpolated.

Monthly discharge of Iowa River at Marshalltown, Iowa, for the year ending Sept. 30, 1916.

[Drainage area, 1,380 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	4,380	840	1,750	1.27	1.46
November	2,100	640	1,170	.848	.95
December 1–15	800	320	607	.440	.25
January	.....	.....	.....	.....	.....
February	.....	.....	.....	.....	.....
March 20–31	4,290	1,660	2,540	1.84	.82
April	3,300	760	1,610	1.17	1.30
May	3,300	530	1,780	1.29	1.49
June	2,890	428	994	.720	.80
July	1,270	194	481	.349	.40
August	262	86	157	.114	.13
September	181	100	136	.099	.11

IOWA RIVER AT IOWA CITY, IOWA.

LOCATION.—In T. 79 N., R. 6 W., at highway bridge about 500 feet below Chicago, Rock Island & Pacific Railway main-line bridge; about three-fourths mile below Iowa State University's power plant, three-fourths mile downstream from old gaging station, which was at the county highway bridge a short distance above dam.

DRAINAGE AREA.—3,140 square miles (measured on map issued by United States Geological Survey; scale, 1 to 500,000).

RECORDS AVAILABLE.—October 30, 1913, to September 30, 1916, at present site; June 11, 1903, to July 21, 1906, at old gaging station.

GAGE.—Chain gage, attached to upstream handrail of bridge about 40 feet from left-hand end of first span from left bank; read by Byron Gibson.

DISCHARGE MEASUREMENTS.—Made from bridge to which gage is attached or from a boat about 1,000 feet below highway bridge.

CHANNEL AND CONTROL.—Bed composed of sand; subject to change. Right bank high and will not be overflowed; left bank will be overflowed at high stage under a pile trestle approach to the bridge and beyond the left end of the approach at extremely high stage.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 13.2 feet, March 26 (discharge, 12,300 second-feet); minimum stage recorded, −.14 foot, September 14 (discharge, 38 second-feet).

Maximum stage ever recorded, about 15 feet (old gage) night of June 2-3, 1903 (discharge, about 20,000 second-feet); minimum discharge 38 second-feet, September 14, 1916.

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

REGULATION.—Considerable diurnal fluctuation at low stages, owing to operation of power plant above station.

ACCURACY.—Stage-discharge relation not permanent; one rating curve used during 1916, well defined between 129 and 11,000 second feet, Gage read once daily, to nearest half tenth. Discharge, except as noted below, ascertained by applying daily gage heights to rating table. No gage readings available April 16–20, and July 9–25; discharge estimated from record of discharge at Marshalltown. Discharge, April 22, interpolated. Records for periods in which discharge was estimated and in which it was less than 129 second-feet fair; for all other periods excellent.

Discharge measurements of Iowa River at Iowa City, Iowa, during the year ending Sept. 30, 1916.

[Made by C. Herlofson.]

Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*
Mar. 27	9.80	8,120
July 25	1.44	657

Daily discharge, in second-feet, of Iowa River at Iowa City, Iowa, for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	10,900	1,980	1,640	.....	4,180	3,080	3,170	888	440	216
2	10,500	1,920	1,570	.....	4,180	3,700	3,800	945	353	272
3	10,000	1,920	1,570	.....	4,380	3,800	3,520	888	272	197
4	9,160	1,780	1,500	.....	4,180	3,700	2,840	888	554	162
5	8,560	1,700	1,380	.....	3,700	3,260	2,280	888	353	46
6	7,060	1,700	1,310	.....	3,260	3,000	2,140	888	272	162
7	5,850	1,640	1,310	.....	2,920	2,920	2,600	833	353	234
8	5,210	1,570	1 240	.....	2,600	2,840	2,760	726	353	180
9	4,900	1,500	1,310	.....	2,440	2,680	2,920		353	197
10	4,280	1,640	1,380	.....	2,280	2,600	3,080		440	216
11	4,180	1,570	1,380	.....	2,140	2,280	3,000		353	216
12	3,990	1,570	1,240	.....	1,840	1,700	2,760		353	129
13	3,990	1,570	1,180	.....	1,920	1,840	2,520		272	114
14	3,800	1,920	1,060	.....	1,840	4,080	2,210		332	38
15	3,700	2,280	945	.....	1,700	3,990	1,840		353	162
16	3,620	2,280	888	.....		3,990	1,640		353	146
17	3,340	2,360	779	.....		4,080	1,840	1,000	440	71
18	3,260	2,520	.....	.....	2,500	3,800	1,700		353	197
19	3,260	2,600	.....	.....		3,700	1,500		312	216
20	3,080	2,600	.....	.....		3,620	1,500		272	197
21	3,080	2,520	.....	.....	1,980	3,620	1,640		292	234
22	2,920	2,520	.....	.....	1,880	3,800	1,500		234	197
23	2,840	2,440	.....	.....	1,780	3,800	1,380		253	197
24	2,680	2,280	.....	.....	2,680	4,080	1,310		253	99
25	2,520	2,140	.....	.....	2,600	3,990	1,180		234	216
26	2,520	1,980	.....	10,500	2,680	3,900	1,120	626	253	58
27	2,440	2,060	.....	9,160	2,760	4,480	1,060	626	197	332
28	2,360	1,980	.....	6,070	2,840	3,900	1,000	578	234	312
29	2,210	1,840	.....	5,630	3,080	3,620	945	578	71	216
30	2,140	1,700	.....	5,100	3,000	3,340	945	462	216	216
31	2,060	.....	.....	4,480	.....	3,340	.....	508	253	.....

NOTE.—Stage-discharge relation affected by ice Dec. 18 to Mar. 25; observations discontinued. A rough estimate of the discharge during this period can be obtained by taking one-half the difference between the discharge at Wapello and the discharge at Cedar Rapids. Discharge, Apr. 22, interpolated.

Monthly discharge of Iowa River at Iowa City, Iowa, for the year ending Sept. 30, 1916.

[Drainage area, 3,140 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	10,900	2,060	4,530	1.44	1.66
November	2,600	1,500	2,000	.637	.71
December 1–17	1,640	779	1,280	.408	.26
January	.....	.....	.....	.....	.....
February	.....	.....	.....	.....	.....
March 26–31	10,500	4,480	6,820	2.17	.48
April	4,380	.....	2,710	.863	.96
May	4,480	1,700	3,440	1.10	1.27
June	3,800	945	2,060	.656	.73
July	.....	462	881	.281	.32
August	554	71	311	.099	.11
September	332	38	182	.058	.06

IOWA RIVER AT WAPELLO, IOWA.

LOCATION.—In sec. 27, T. 74 N., R. 3 W., at highway bridge about half a mile from railroad station at Wapello, Louisa County, and 20 miles from mouth of Iowa River. No important tributaries enter near station.

DRAINAGE AREA.—At gaging station, 12,480 square miles; at mouth, 12,600 square miles (measured on map issued by United States Geological Survey; scale, 1 to 500,000).

RECORDS AVAILABLE.—February 26, 1915, to September 30, 1916.

GAGE.—Chain gage attached near center of first span from right abutment; read by C. W. Warren.

DISCHARGE MEASUREMENTS.—Made from bridge to which gage is attached.

CHANNEL AND CONTROL.—Bed composed of sand and gravel; probably shifts. Right bank high and will not be overflowed; levee along left bank might break or be overtopped at extremely high stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 12.7 feet, March 28 (discharge, 48,900 second-feet); minimum stage recorded, 0.35 foot, September 26 (discharge, 1,390 second-feet); maximum known stage prior to 1916, approximately 14.3 feet about April 3, 1912 (discharge, about 58,000 second-feet). The flood of June, 1892, was much higher.

ICE.—Stage-discharge relation seriously affected by ice.

ACCURACY.—Stage-discharge relation not permanent; two rating curves used during 1916; October 1 to March 28, well defined between 3,700 and 44,700 second-feet; March 29 to September 30, well defined between 1,340 and 57,000 second-feet. Gage read once daily to hundredths. Discharge, except as noted below, obtained by applying daily gage heights to rating curve. Stage-discharge relation affected by ice December 14 to January 25 and February 7–23; discharge ascertained from one discharge measurement, observer's notes, gage heights, and weather records. Records for open-water periods, excellent; for winter, fair.

Discharge measurements of Iowa River at Wapello, Iowa, 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. 9	C. Herlofson	2.47	4,710	June 27	C. Herlofson	2.61	5,590
Jan. 20[a]	Bolster and Herlofson	3.86	1,100	July 26	do	1.50	3,120

[a] Ice in river when measurement was made.

Daily discharge, in second-feet, of Iowa River at Wapello, Iowa, for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	36,300	5,950	6,200	3,000	12,500	12,500	31,700	15,000	11,200	4,840	3,560	1,440
2	35,300	5,950	5,700	3,500	11,800	11,500	31,700	16,100	10,200	4,620	2,600	1,550
3	30,600	5,460	5,460	4,000	10,800	9,900	26,500	16,900	11,200	4,620	2,600	1,500
4	24,400	5,460	4,990	3,500	9,290	8,110	21,300	16,100	10,800	4,620	2,600	1,500
5	21,300	5,220	4,990	3,000	7,820	7,260	19,200	15,400	10,500	4,400	2,780	1,550
6	19,100	4,990	4,760	2,700	6,720	6,720	16,900	14,600	14,600	4,400	2,600	1,870
7	17,500	4,990	4,540	2,400	5,500	5,950	15,400	13,500	18,000	4,190	2,250	1,440
8	15,100	4,540	4,540	2,200	4,000	5,700	13,900	12,200	19,200	3,980	2,090	1,550
9	13,600	4,540	4,540	2,000	3,000	5,460	12,500	10,800	21,300	4,190	2,090	1,550
10	12,200	4,540	4,110	1,800	2,500	5,220	11,200	9,880	20,500	4,840	2,090	1,550
11	10,500	4,320	4,320	1,600	2,000	4,990	10,500	8,660	15,400	4,840	2,420	1,550
12	9,590	4,320	4,110	1,500	2,000	4,990	9,880	8,070	13,200	4,620	2,250	1,550
13	9,290	4,760	4,110	1,400	1,800	5,460	9,570	7,510	11,200	4,190	2,090	1,550
14	9,590	6,720	4,000	1,400	1,800	5,700	8,960	11,800	9,880	4,190	2,020	1,440
15	9,290	7,820	3,800	1,300	1,500	6,200	8,660	14,600	8,960	3,770	1,940	1,440
16	8,690	8,110	3,500	1,200	1,500	6,720	8,360	14,600	8,360	3,770	1,940	1,440
17	8,400	8,400	3,300	1,200	1,800	8,400	8,360	15,400	8,360	3,980	1,940	1,550
18	8,690	8,400	3,000	1,100	2,500	8,690	8,360	15,400	7,510	3,770	1,800	1,550
19	10,500	8,400	2,800	1,100	4,000	10,200	8,070	13,900	6,980	3,770	1,800	1,550
20	9,290	8,110	2,600	1,100	6,000	11,200	8,660	15,000	6,980	3,980	1,740	1,550
21	8,690	7,540	2,500	2,000	8,000	12,500	9,570	16,100	6,980	5,510	1,740	1,500
22	8,690	6,990	2,400	8,000	10,000	12,500	10,200	16,500	6,980	5,060	1,670	1,440
23	8,400	6,720	2,300	15,000	13,000	11,200	10,500	16,200	6,470	3,980	1,610	1,440
24	8,690	6,200	2,200	20,000	15,900	10,500	11,500	16,500	5,980	3,560	1,550	1,440
25	8,400	5,950	2,100	17,000	15,500	10,500	12,500	14,300	5,980	3,360	1,550	1,440
26	8,400	7,820	1,900	16,700	14,700	16,300	14,600	13,500	5,740	3,160	1,550	1,390
27	7,820	8,110	1,800	24,800	14,000	31,600	16,100	13,900	5,510	2,970	1,550	1,800
28	7,260	7,820	1,800	23,900	13,200	48,300	17,700	13,200	5,060	2,780	1,550	1,870
29	6,990	7,260	1,800	20,400	12,900	39,600	16,500	12,500	4,840	2,600	1,500	1,800
30	6,460	6,990	2,000	17,100	.....	33,200	15,000	12,500	4,840	2,600	1,440	1,740
31	6,200	.....	2,500	14,400	.....	30,700	.....	12,500	.....	2,780	1,440	.....

NOTE.—Stage-discharge relation affected by ice Dec. 14 to Jan. 25, and February 7–23.

Monthly discharge of Iowa River at Wapello, Iowa, for the year ending Sept. 30, 1916.

[Drainage area, 12,480 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	36,300	6,200	13,100	1.05	1.21
November	8,400	4,320	6,410	.514	.57
December	6,200	a1,800	3,500	.280	.32
January	24,800	a1,100	7,110	.570	.66
February	15,900	a1,500	7,450	.597	.64
March	48,300	4,990	13,200	1.06	1.22
April	31,700	8,070	14,100	1.13	1.26
May	16,900	7,510	13,700	1.10	1.27
June	21,300	4,840	10,100	.809	.90
July	5,510	2,600	4,000	.321	.37
August	3,560	1,440	2,010	.161	.19
September	1,870	1,390	1,550	.124	.14
The year	48,300	a1,100	8,020	.643	8.75

a Estimated.

CEDAR RIVER AT JANESVILLE, IOWA.

LOCATION.—In sec. 35, T. 91 N., R. 14 W., at the Illinois Central Railroad bridge about one-fourth mile below the highway bridge and 3 miles above junction with Shellrock River.

DRAINAGE AREA.—1,660 square miles (measured on map issued by United States Geological Survey; scale 1 to 500,000).

RECORDS AVAILABLE.—April 26, 1905, to September 30, 1906, and May 28, 1915, to September 30, 1916.

GAGE.—Chain gage attached to upstream guardrail of bridge about the middle of left span; read by James Townsend.

DISCHARGE MEASUREMENTS.—Made from upstream side of railroad bridge.

CHANNEL AND CONTROL.—Bed composed of gravel; slightly shifting. Banks high and not subject to overflow.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 10.35 feet, 7 p. m., June 2 (discharge, 8,800 second-feet); minimum stage recorded, 0.75 foot, November 3 (discharge, estimated 100 second-feet).

1905, 1915–16: Maximum stage recorded, 13.3 feet, March 28, 1906 (discharge, about 22,600 second-feet); minimum stage recorded, 0.75 foot, November 3, 1915 (discharge, estimated 100 second-feet).

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

REGULATION.—May be slight diurnal fluctuation of water level owing to operation of power plant at Waverly, 9 miles above station.

ACCURACY.—Stage-discharge relation not permanent; changes slightly from year to year during high-water periods. Two rating curves used during year, as follows: October 12 to March 26, and March 27 to September 30; both curves well defined between 280 and 7,130 second-feet; extended above 7,130 second-feet. Gage read once daily to hundredths. Discharge, except as noted below, ascertained by applying daily gage heights to rating table. Discharge October 1–11 estimated from records of flow of Shellrock River at Clarksville, Iowa. Records good.

The following discharge measurement was made by C. Herlofson:

July 20, 1916: Gage height, 2.39 feet; discharge, 842 second-feet.

Daily discharge, in second-feet, of Cedar River at Janesville, Iowa, for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	600	427	308	.....	2,630	2,370	615	510	365	152
2	550	427	280	.....	2,630	2,630	8,740	510	300	174
3	490	100	366	.....	2,370	2,460	8,610	640	340	152
4	575	280	308	.....	2,030	1,940	3,820	615	320	194
5	750	255	.....	.....	1,700	1,460	2,030	970	320	188
6	700	255	.....	.....	1,380	1,240	1,860	1,300	280	152
7	600	255	.....	.....	1,240	1,100	1,540	1,040	300	219
8	550	308	.....	.....	1,100	1,040	1,380	790	280	260
9	450	280	.....	.....	970	850	1,240	670	280	240
10	400	308	.....	.....	910	850	1,100	560	260	208
11	400	775	.....	.....	850	790	1,100	480	240	260
12	396	905	.....	.....	790	700	910	1,240	236	340
13	335	1,230	.....	.....	730	700	910	540	230	300
14	427	1,300	.....	.....	730	970	850	480	240	340
15	458	1,160	.....	3,820	670	2,120	790	460	240	300
16	552	970	.....	6,770	790	3,260	790	970	233	260
17	520	775	.....	4,940	1,100	4,620	730	1,380	212	236
18	840	710	.....	3,440	1,620	3,720	790	1,540	230	222
19	905	614	.....	2,420	2,200	2,460	730	1,160	222	226
20	905	583	.....	1,950	2,720	1,860	615	850	170	202
21	905	552	.....	1,440	5,160	1,540	615	700	212	191
22	840	520	.....	1,880	8,350	2,370	590	590	226	180
23	742	458	.....	1,800	7,010	1,540	560	510	188	180
24	646	489	.....	1,950	4,210	2,030	540	480	208	184
25	583	583	.....	4,310	3,350	2,030	480	540	180	188
26	489	552	.....	6,650	3,080	1,700	670	730	174	212
27	489	458	.....	8,610	2,720	1,380	790	590	155	240
28	458	458	.....	6,770	2,280	1,240	590	460	184	240
29	427	427	.....	4,410	2,030	1,040	540	410	194	240
30	427	280	.....	3,170	1,940	1,040	510	365	188	208
31	396	.....	.....	2,460	.....	970	.....	340	188	.....

NOTE.—No gage-height record available Oct. 1–11; discharge estimated on basis of records of discharge of Shellrock River at Clarksville. Discharge Nov. 3 estimated; flow not natural, due to storage at Waverly dam. Stage-discharge relation affected by ice Dec. 5 to Mar. 14; discharge during this period may be roughly approximated by taking one-fifth of the corresponding discharge at Cedar Rapids.

Monthly discharge of Cedar River at Janesville, Iowa, for the year ending Sept. 30, 1916.

[Drainage area, 1,660 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	905	335	574	0.346	0.40
November	1,300	100	556	.335	.37
December 1–4	366	280	316	.190	.03
March 15–31	8,610	1,440	3,930	2.37	1.50
April	8,350	670	2,310	1.39	1.55
May	4,620	700	1,740	1.05	1.21
June	8,740	480	1,500	.904	1.01
July	1,540	340	723	.436	.50
August	365	155	239	.144	.17
September	340	152	223	.134	.15

CEDAR RIVER AT CEDAR RAPIDS, IOWA.

LOCATION.—In T. 83 N., R. 7 W., in the central part of Cedar Rapids, Linn County, about half a mile below dam and between electric-railroad bridge and Seventh Avenue combination railroad and footbridge.

DRAINAGE AREA.—At gaging station, 6,640 square miles; at junction with Iowa River, 7,930 square miles (measured on map issued by United States Geological Survey; scale 1 to 500,000).

RECORDS AVAILABLE.—October 26, 1902, to September 30, 1916.

GAGE.—Inclined staff gage fastened to posts driven in right bank of the river in rear of plant of the Iowa Windmill & Pump Co. plant; read by R. S. Toogood. Elevation of zero of gage from Northwestern Railroad levels, 723.03 feet above sea level.

DISCHARGE MEASUREMENTS.—Made from different bridges in the vicinity of the gage, according to the stage.

CHANNEL AND CONTROL.—Bed composed of rock and gravel; free from vegetation and practically permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 9.9 feet at 7 a. m. March 30 (discharge, 25,300 second-feet); minimum discharge estimated, 800 second-feet, January 15–20.

1902–1916: Maximum stage recorded, 17.2 feet April 1, 1912 (discharge, 54,000 second-feet); minimum stage recorded, 2.5 feet, July 24–28, 1911 (discharge, 410 second-feet).

ICE.—Stage-discharge relation affected by ice, except in very mild winters, when the swift current and the proximity to the power plant keep the measuring section open.

REGULATION.—No power has been developed at dam above gaging station during 1916. The construction of a new dam to replace the old one has been completed and the regimen of flow has been slightly affected as an incident to construction work on the dam and power house. There is no dam for a long distance below Cedar Rapids and no backwater at gaging station.

ACCURACY.—Stage-discharge relation nearly permanent; rating curve well defined. Gage read once daily, to tenths. Discharge, except as noted below, ascertained by applying daily gage heights to rating curve. Stage-discharge relation affected by ice December 12 to January 26, and February 5–21; discharge ascertained from one discharge measurement, observer's notes, and weather records. Open-water records excellent; records during winter fair.

COOPERATION.—Gage-height record furnished by United States Weather Bureau.

Discharge measurements of Cedar River at Cedar Rapids, Iowa, during the year ending Sept. 30, 1916.

Date.	Made by —	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Jan. 21[a]	Bolster and Herlofson	4.33	1,100
July 25	C. Herlofson	3.42	1,690

[a] Stage-discharge relation affected by ice.

Daily discharge, in second-feet, of Cedar River at Cedar Rapids, Iowa, for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	11,600	3,480	3,480	1,800	7,890	7,890	13,100	9,340	4,430	2,870	1,440	950
2	8,970	2,870	3,790	2,000	7,530	6,470	11,200	9,340	6,820	2,870	1,440	950
3	7,890	3,170	2,870	2,200	7,530	6,120	10,400	8,970	6,120	2,590	1,440	950
4	6,820	2,590	3,170	2,000	6,820	5,430	9,340	8,970	7,530	2,590	1,440	810
5	6,120	2,870	2,870	1,800	6,000	3,790	9,340	8,610	10,400	2,590	1,260	810
6	5,430	2,320	2,870	1,600	5,000	3,480	7,890	7,890	17,400	2,590	1,260	810
7	5,430	2,590	2,320	1,500	4,000	3,480	7,170	7,170	15,800	2,590	1,260	950
8	5,090	2,320	2,590	1,400	3,000	3,170	6,470	5,770	11,600	3,790	1,440	950
9	4,430	2,590	2,320	1,300	2,000	2,870	5,770	5,090	9,340	3,170	1,260	950
10	4,110	2,320	2,590	1,200	1,500	2,870	5,430	4,430	7,530	3,170	1,260	950
11	4,110	2,590	2,320	1,100	1,400	2,590	5,090	4,430	6,470	2,590	1,260	950
12	3,790	5,770	2,300	1,000	1,300	2,870	4,430	4,110	5,430	2,590	1,260	950
13	3,480	5,430	2,300	1,000	1,200	3,170	4,760	3,790	5,090	2,070	1,100	1,100
14	4,110	6,120	2,200	900	1,200	3,790	4,110	4,110	4,760	2,590	1,100	1,100
15	4,110	6,470	2,200	800	1,000	6,470	4,430	5,430	4,430	2,590	1,100	1,260
16	4,760	6,470	2,100	800	1,000	6,820	3,790	5,770	4,430	2,590	1,100	1,260
17	4,110	6,120	2,000	800	1,200	7,890	4,110	7,170	3,790	2,070	950	1,260
18	4,430	5,430	1,900	800	1,500	9,710	4,110	9,340	3,790	2,590	950	1,260
19	3,790	5,090	1,800	800	2,000	11,600	5,430	10,400	3,170	2,590	950	1,100
20	4,110	5,090	1,700	800	3,000	10,800	6,120	10,800	3,170	3,790	950	1,100
21	4,760	5,090	1,600	1,100	6,030	8,250	6,820	10,100	2,870	2,590	950	1,100
22	5,430	5,090	1,600	3,000	7,890	7,170	7,530	8,970	2,870	2,590	950	1,100
23	5,430	4,110	1,500	5,000	9,340	6,470	8,970	7,170	2,590	1,840	950	950
24	5,090	4,430	1,400	5,000	11,600	6,820	10,800	6,820	3,480	2,070	1,100	950
25	4,430	3,790	1,400	6,000	12,000	7,530	14,300	7,170	2,870	1,630	950	950
26	4,430	4,110	1,300	7,000	12,000	10,400	14,600	7,530	2,870	1,840	950	950
27	4,110	3,790	1,200	8,970	11,600	17,000	11,600	7,530	2,590	1,440	950	950
28	4,430	4,110	1,200	10,400	9,710	17,000	10,100	6,820	2,870	1,630	950	1,100
29	3,790	3,480	1,200	10,100	8,610	22,500	9,340	6,470	2,870	1,440	810	1,100
30	3,790	4,110	1,200	9,340	.....	25,300	8,970	5,770	3,170	1,630	810	1,100
31	3,170	.....	1,500	8,970	.....	18,600	.....	5,090	.....	1,260	810	.....

NOTE.—Stage-discharge relation affected by ice, Dec. 12 to Jan. 26 and Feb. 5–21.

Monthly discharge of Cedar River at Cedar Rapids, Iowa, for the year ending Sept. 30, 1916.

[Drainage area, 6,640 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	11,600	3,170	5,020	0.756	0.87
November	6,470	2,320	4,130	.622	.69
December	3,790	[a] 1,200	2,090	.315	.36
January	10,400	[a] 800	3,240	.488	.56
February	12,000	[a] 1,000	5,340	.804	.87
March	25,300	2,590	8,330	1.25	1.44
April	14,600	3,790	7,850	1.18	1.32
May	10,800	3,790	7,110	1.07	1.23
June	17,400	2,590	5,680	.855	.95
July	3,790	1,260	2,410	.363	.42
August	1,440	810	1,110	.167	.19
September	1,260	810	1,020	.154	.17
The year	25,300	[a] 800	4,440	.669	9.07

[a] Estimated.

SHELLROCK RIVER NEAR CLARKSVILLE, IOWA.

LOCATION.—In T. 92 N., R. 16 W., at highway bridge 1¼ miles northwest of Clarksville, Butler County, and about 25 miles above junction with Cedar River. No important tributaries enter for several miles up and down stream.

DRAINAGE AREA.—1,660 square miles at station and 2,680 square miles at junction with Cedar River (measured on map issued by United States Geological Survey: scale, 1 to 500,000).

RECORDS AVAILABLE.—May 28, 1915, to September 30, 1916.

GAGE.—Chain gage attached to handrail on upstream side of bridge 75 feet from right abutment; read by Mrs. H. H. Sherburne.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge to which gage is attached.

CHANNEL AND CONTROL.—Bed composed of rock and sand; probably permanent. Right bank high and will not be overflowed; left bank will probably be overflowed during extreme high stage.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year 12.3 feet at 1 p. m. June 2 (discharge, 12,200 second-feet); minimum stage recorded since station was established, 1.2 feet August 29–31, 1916 (discharge, 135 second-feet). In April, 1907, a stage of approximately 16.5 feet was reached (discharge, about 19,000 second-feet).

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

ACCURACY.—Stage-discharge relation practically permanent; rating curve well defined between 200 and 10,000 second-feet; not well defined outside these limits. Gage read once daily to hundredths. Discharge ascertained by applying daily gage heights to rating table. Records excellent except for extremely low and high stages, for which they are fair.

The following discharge measurement was made by C. Herlofson:

July 21, 1916: Gage height, 1.81 feet; discharge, 296 second-feet.

Daily discharge, in second-feet, of Shellrock River near Clarksville, Iowa, for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	538	388	460	.....	2,730	2,940	1,000	565	225	188
2	485	365	620	.....	2,340	2,530	11,200	510	225	165
3	435	365	620	.....	1,980	2,160	7,390	740	225	165
4	510	345	155	.....	1,730	1,810	3,580	935	272	212
5	620	325	410	.....	1,570	1,570	2,440	870	255	200
6	592	225	365	.....	1,420	1,420	1,900	772	225	188
7	538	165	165	.....	1,200	1,280	1,570	620	272	225
8	485	325	365	.....	1,140	1,140	1,340	510	225	212
9	435	592	290	.....	1,060	1,000	1,200	435	212	200
10	388	388	290	.....	1,000	935	1,140	410	212	200
11	388	870	188	.....	935	772	1,060	365	200	255
12	388	1,980	.....	.....	935	710	935	345	200	345
13	460	1,650	.....	.....	935	650	870	325	212	365
14	538	1,420	.....	.....	870	1,140	805	325	212	255
15	538	1,200	.....	.....	870	4,760	772	325	200	240
16	510	935	.....	6,570	870	3,930	740	805	200	225
17	538	870	.....	2,830	2,240	3,140	740	510	200	200
18	1,140	805	.....	2,160	2,160	2,340	740	410	200	188
19	1,280	805	.....	2,060	1,810	1,900	710	365	200	188
20	1,060	740	.....	1,980	4,400	1,570	650	325	200	188
21	1,000	680	.....	1,980	5,640	1,340	592	308	188	188
22	805	592	.....	2,160	4,400	1,420	565	290	188	175
23	710	485	.....	1,900	3,580	2,730	565	290	175	175
24	650	565	.....	2,830	3,040	2,630	565	290	175	165
25	650	650	.....	7,670	3,360	2,340	592	255	175	165
26	565	680	.....	10,700	2,940	2,060	680	255	175	175
27	510	650	.....	6,700	2,630	1,810	710	255	272	290
28	460	565	.....	4,160	2,240	2,340	592	255	240	225
29	435	740	.....	3,580	1,980	1,340	510	255	135	200
30	410	435	.....	3,140	2,160	1,200	510	240	135	188
31	410	.....	.....	2,830	.....	1,140	.....	240	135	.....

NOTE.—Stage-discharge relation affected by ice Dec. 12 to Mar. 15; observations discontinued. The discharge during this period can be roughly approximated by taking one-fifth the corresponding discharge at Cedar Rapids.

Monthly discharge of Shellrock River near Clarksville, Iowa, for the year ending Sept. 30, 1916.

[Drainage area, 1,660 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	1,280	388	596	0.359	0.41
November	1,980	165	693	.417	.47
December 1-11	620	155	357	.215	.09
March 16-31	10,700	1,900	3,950	2.38	1.42
April	5,640	870	2,140	1.29	1.44
May	4,760	650	1,870	1.13	1.30
June	11,200	510	1,560	.940	1.05
July	935	240	432	.260	.30
August	272	135	205	.123	.14
September	365	165	212	.128	.14

SKUNK RIVER AT COPPOCK, IOWA.

LOCATION.—In T. 74 N., R. 8 W., at highway bridge about one-eighth mile above Chicago, Burlington & Quincy Railroad bridge and about one-fourth mile above junction with Crooked Creek.

DRAINAGE AREA.—2,890 square miles (measured on map issued by United States Geological Survey; scale 1 to 500,000).

RECORDS AVAILABLE.—October 21, 1913, to September 30, 1916.

GAGE.—Chain gage attached to downstream side of bridge; read by J. W. Ricks.

DISCHARGE MEASUREMENTS.—Made from bridge to which gage is attached.

CHANNEL AND CONTROL.—Bed composed of gravel and sand; channel likely to shift.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 17.1 feet at 11.30 a. m., March 27 (discharge, 15,000 second-feet); minimum stage recorded, 2.4 feet, September 24–25 (discharge, 105 second-feet).

Maximum stage prior to 1916, approximately 24 feet (discharge, 30,000 second-feet) about the end of May, 1903.

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

ACCURACY.—Stage-discharge relation practically permanent throughout year; may be affected somewhat by drift lodging between two railroad bridges below gage. Rating curve well defined. Gage read once daily to hundredths. Discharge, except as noted below, ascertained by applying daily gage heights to rating curve. Discharge December 17 to January 23 and February 1–23 estimated, because of ice, from observer's notes and weather records. Open-water records excellent; winter records roughly approximate.

Discharge measurements of Skunk River at Coppock, Iowa, during the year ending Sept. 30, 1916.

[Made by C. Herlofson.]

Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*
June 16	5.10	1,150
July 27	3.19	297

Daily discharge, in second-feet, of Skunk River at Coppock, Iowa, for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	9,230	1,450	1,330	800	3,000	5,150	2,800	2,120	3,040	672	378	135
2	10,700	1,390	1,210	1,200	2,000	5,260	2,560	3,120	2,720	672	269	146
3	10,400	1,330	1,090	1,500	1,500	4,440	2,260	2,960	2,260	584	228	228
4	9,520	1,270	1,090	1,800	1,090	3,620	2,050	2,560	2,050	584	228	168
5	8,000	1,210	1,040	2,000	800	2,720	1,910	2,190	1,980	584	228	135
6	6,860	1,210	1,040	1,900	600	2,050	1,700	2,120	2,050	768	203	5,910
7	7,360	1,150	1,040	1,700		1,640	1,640	1,770	5,040	672	215	1,910
8	7,870	1,090	979	1,500		1,640	1,580	1,580	4,150	924	215	584
9	7,870	1,090	979	1,200		1,390	1,450	1,450	3,360	768	191	314
10	7,230	1,090	979	1,000		1,390	1,390	1,330	2,120	627	191	255
11	6,260	1,090	979	800	500	1,390	1,330	1,210	1,700	543	346	241
12	5,150	1,090	979	700		1,510	1,270	1,150	1,580	503	241	412
13	4,640	1,090	924	600		1,450	1,210	1,390	1,390	465	447	203
14	4,060	1,700	818	500		1,580	1,150	5,690	1,330	465	330	191
15	3,280	1,980	768	500		1,640	1,090	6,860	1,210	447	269	168
16	2,720	2,050	672			1,640	1,090	6,140	1,150	429	255	146
17	2,490	1,980			800	1,700	1,090	5,580	1,090	412	255	146
18	3,040	1,840		400	1,000	1,700	1,040	4,940	1,040	627	241	135
19	2,880	1,770			1,200	1,510	1,040	3,440	979	503	215	125
20	2,560	1,640			1,500	1,390	1,210	3,200	870	768	203	115
21	2,420	1,580		3,000	2,000	1,330	1,330	3,360	1,580	412	191	125
22	2,340	1,510		5,000	3,000	1,330	1,390	3,780	1,450	378	191	125
23	2,260	1,450		6,000	4,000	1,330	1,330	4,640	1,390	362	180	125
24	2,260	1,390	500	6,260	5,040	1,330	1,390	3,960	1,580	346	168	105
25	2,120	1,330		7,230	4,640	2,420	1,450	5,040	1,390	314	157	105
26	1,980	2,120		4,340	4,740	8,400	1,390	4,340	1,210	299	157	125
27	1,840	1,980		8,130	4,240	15,000	1,270	3,620	1,040	284	135	269
28	1,700	1,700		8,000	4,060	13,500	1,270	3,530	870	269	135	584
29	1,640	1,640		5,360	4,340	9,810	1,150	3,200	768	255	146	395
30	1,580	1,450		4,530	.....	3,780	1,450	3,200	768	255	135	299
31	1,510	.....		3,700	.....	3,040	.....	3,200	.....	241	135	.....

NOTE.—Stage-discharge relation affected by ice Dec. 17 to Jan. 23, and Feb. 1–23. Braced figures show mean discharge for periods included.

Monthly discharge of Skunk River at Coppock, Iowa, for the year ending Sept. 30, 1916.

[Drainage area, 2,890 square miles.]

Month.	Discharge in second-feet.				Run-off depth in inches (on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	10,700	1,510	4,640	1.61	1.86
November	2,120	1,090	1,490	.516	.58
December	1,330	.....	755	.261	.30
January	8,130	.....	2,620	.907	1.05
February	5,040	.....	1,880	.651	.70
March	15,000	1,330	3,420	1.18	1.36
April	2,800	1,040	1,480	.512	.57
May	6,860	1,150	3,310	1.15	1.33
June	5,040	768	1,770	.612	.68
July	924	241	498	.172	.20
August	447	135	222	.077	.09
September	5,910	105	464	.161	.18
The year	15,000	105	1,890	.654	8.90

SKUNK RIVER AT AUGUSTA, IOWA.

LOCATION.—In T. 69 N., R. 4 W., at highway bridge about one-third mile from Augusta post office, Des Moines County, and about 15 miles from mouth of Skunk River.

DRAINAGE AREA.—At gaging station 4,290 square miles; at mouth 4,350 square miles (measured on map issued by United States Geological Survey; scale 1 to 500,000).

RECORDS AVAILABLE.—September 30 to November 15, 1913; May 27, 1915, to September 30, 1916.

GAGE.—Chain gage attached to downstream handrail of bridge about 95 feet from left abutment; read once daily by L. E. Williamson. Staff gage attached to downstream left side of middle pier, used by engineers of the Hydraulic Engineering Co. of Maine during 1913; datum of gage unknown; gage taken out by ice in spring of 1914.

DISCHARGE MEASUREMENTS.—Made from bridge to which gage is attached.

CHANNEL AND CONTROL.—Bed of stream sandy and subject to change; right bank high and will not be overflowed; left bank will only be overflowed at extremely high stage; remains of old mill dam 600 feet below gage will probably make stage-discharge relation permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 19.1 feet at 3 p. m., January 21; discharge affected by ice gorge below bridge; minimum stage recorded, 1.31 feet, August 8.

Maximum stage prior to 1916, approximately 21 feet about June 1, 1903 (discharge, nearly 40,000 second-feet); minimum discharge recorded, 63 second-feet, November 10, 1913; absolute minimum discharge at this station probably 25 second-feet or less.

ICE.—Stage-discharge relation affected by ice.

Data inadequate for determination of discharge.

Discharge measurements of Skunk River at Augusta, Iowa, during the year ending Sept. 30, 1916.

[Made by C. Herlofson.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Nov. 10	3.23	1,140	Mar. 28	18.04	31,400
Jan. 23[a]	17.51	15,400	June 28	3.33	1,460

[a] Ice present when measurement was made; ice jam 3 or 4 miles below gage.

Daily gage height, in feet, of Skunk River at Augusta, Iowa, for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	9.2	3.7	4.0	3.8	6.1	9.3	6.4	3.7	4.8	3.0	2.11	2.11
2	9.6	3.6	3.7	8.9	.....	10.4	5.6	4.6	4.7	3.1	2.45	2.01
3	9.9	3.5	3.6	9.7	.....	11.4	5.4	5.3	4.8	3.0	2.2	2.06
4	10.0	3.4	3.4	10.5	.....	11.7	4.9	5.3	4.4	2.55	1.91	1.61
5	9.6	3.4	3.4	5.7	7.6	11.1	4.5	4.9	4.1	2.6	1.61	1.66
6	8.6	3.4	3.35	7.2	7.4	10.7	4.4	4.6	11.0	2.7	1.66	7.2
7	7.6	3.4	3.3	.....	6.6	6.1	4.1	4.4	13.9	2.65	1.76	6.2
8	7.7	3.4	3.25	6.2	5.8	5.3	4.0	4.0	10.7	3.0	1.31	4.3
9	8.0	3.35	3.2	6.1	5.5	4.6	4.0	3.9	7.4	2.9	1.76	3.2
10	7.8	3.3	3.2	5.8	5.3	4.3	3.8	3.8	6.9	2.75	2.2	2.85
11	7.6	3.3	3.3	5.5	5.2	3.9	3.7	3.7	4.5	2.6	1.96	2.5
12	6.6	3.25	3.25	4.4	5.1	3.7	3.6	3.6	4.3	2.55	1.96	2.3
13	6.2	3.35	3.15	3.6	4.7	3.7	3.4	7.4	4.0	2.55	2.95	2.13
14	6.0	3.4	2.9	.....	4.5	3.7	3.5	11.8	3.7	2.5	2.9	2.13
15	5.5	3.6	3.0	3.8	4.4	3.7	3.5	12.1	3.5	2.65	2.7	2.13
16	4.9	3.9	3.1	3.8	4.3	3.7	3.5	10.6	3.4	2.55	2.35	2.13
17	4.6	4.0	3.15	.....	5.8	3.8	3.5	8.6	3.5	2.4	2.3	2.13
18	4.6	4.0	3.2	3.8	7.0	3.7	3.5	7.7	3.4	2.5	2.35	1.93
19	4.6	3.9	2.85	3.8	9.8	3.7	3.4	6.6	3.3	2.6	2.35	1.78
20	4.5	3.8	2.85	3.8	9.6	3.8	3.4	5.3	3.2	2.6	2.2	1.63
21	4.4	3.7	2.9	15.6	12.0	3.7	3.6	5.3	4.6	3.3	2.11	1.48
22	4.3	3.6	3.0	17.9	10.5	3.6	3.7	5.5	4.0	2.9	2.01	1.43
23	4.2	3.6	3.1	16.8	10.3	3.6	3.7	5.6	3.8	2.5	1.91	1.43
24	4.2	3.5	3.1	16.3	13.2	3.7	3.5	8.0	4.0	2.4	1.91	1.48
25	4.1	3.4	3.1	12.3	8.4	3.7	3.5	8.4	3.7	2.4	1.86	1.58
26	4.0	5.8	3.1	8.9	7.2	10.0	3.5	7.4	3.7	2.4	1.51	1.53
27	4.0	5.4	3.0	14.8	7.5	16.3	3.5	11.5	3.6	2.35	1.76	2.55
28	3.8	5.0	2.85	14.6	8.1	18.1	3.5	6.3	3.4	2.35	1.91	2.55
29	3.8	4.6	2.85	10.8	9.2	17.1	3.5	5.7	3.1	2.11	1.86	2.8
30	3.7	4.2	2.9	9.4	.....	16.1	3.5	5.3	3.0	2.01	1.76	2.6
31	3.7	.....	.....	6.3	.....	8.9	.....	4.9	.....	1.81	1.76	.....

NOTE.—Stage-discharge relation affected by ice practically all of the period from Dec. 15 to about Feb. 25.

DES MOINES RIVER AT KALO, IOWA.

LOCATION.—In sec. 17, T. 88 N., R. 28 W., at highway bridge at Kalo, Webster County, about 1½ miles east of Otho, a station on the Minneapolis & St. Louis Railroad, and 1½ miles above the mouth of Holiday Creek, which enters from the left.

DRAINAGE AREA.—4,170 square miles (measured on map issued by United States Geological Survey; scale 1 to 500,000).

RECORDS AVAILABLE.—October 18, 1913, to September 30, 1916, except October, 1914, to March 21, 1915, when the station was temporarily discontinued.

GAGE.—Chain gage attached to downstream side of bridge in middle of right span; read by S. C. Fuller.

DISCHARGE MEASUREMENTS.—At high stages made from bridge, to which gage is attached; at low stages by wading.

CHANNEL AND CONTROL.—No well-defined control; channel consists of gravel and is fairly permanent; point of zero flow estimated to be at gage height -1.0 ± 0.2 foot.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 10.3 feet, February 22 (stage-discharge relation probably affected by ice); maximum open-water stage recorded, 10.1 feet, March 29 (discharge, 11,900 second-feet); minimum stage recorded since establishment of station, 0.3 foot, August 31 and September 30, 1916 (discharge, 110 second-feet).

1913–1916: Maximum stage recorded, 14.0 feet Mary 30, 1915 (discharge, 18,500 second-feet).

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

ACCURACY.—Stage-discharge relation probably permanent throughout year. Rating curve well defined between 200 and 12,000 second-feet; below 200 second-feet extended and only roughly approximate. Gage read once daily to quarter tenths. Discharge ascertained by applying daily gage heights to rating curve. Records excellent except those below 200 second-feet which are roughly approximate.

Discharge measurements of Des Moines River at Kalo, Iowa, during the year ending Sept. 30, 1916.

[Made by C. Herlofson.]

Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*
Mar. 19	7.61	7,640
July 19	1.20	420

Daily discharge, in second-feet, of Des Moines River at Kalo, Iowa, for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	3,720	1,560	1,480	.....	8,290	4,240	3,980	1,320	348	130
2	3,340	1,560	1,560	.....	7,970	4,240	5,210	1,250	395	195
3	2,980	1,560	1,480	.....	7,490	4,110	5,800	1,250	420	180
4	3,720	1,400	1,400	.....	7,010	3,850	5,500	1,180	395	168
5	3,980	1,400	1,400	.....	6,700	3,590	4,930	1,180	280	180
6	3,460	1,320	1,400	.....	6,400	3,340	4,110	1,040	325	168
7	2,980	1,400	1,400	.....	5,800	2,860	3,460	970	302	195
8	2,860	1,480	1,400	.....	5,500	2,630	2,980	905	395	240
9	2,740	1,400	1,400	.....	5,350	2,520	2,630	840	420	225
10	2,740	1,640	1,400	.....	5,210	2,300	2,200	775	420	240
11	2,520	3,100	1,320	.....	4,930	2,000	2,000	678	370	370
12	2,410	4,510	1,250	.....	4,790	1,910	1,910	645	348	325
13	2,410	4,510	1,180	.....	4,370	1,820	1,730	645	325	280
14	2,300	4,110	1,110	.....	4,370	2,200	1,640	710	280	280
15	2,300	3,980	1,040	.....	4,110	3,460	1,560	645	280	260
16	2,300	3,850	905	.....	4,370	4,510	1,480	585	280	240
17	3,460	3,720	872	.....	4,370	4,510	1,400	525	240	210
18	4,110	3,340	.....	.....	3,850	4,370	1,320	525	325	168
19	4,370	2,980	.....	7,650	4,510	4,240	1,320	525	225	240
20	3,850	2,740	.....	7,490	4,930	4,110	1,250	470	210	225
21	3,590	2,410	.....	7,010	5,210	4,370	1,180	470	210	168
22	2,980	2,410	.....	7,010	5,210	4,650	1,180	420	225	195
23	2,740	2,200	.....	7,170	5,210	5,210	1,250	370	210	210
24	2,520	2,200	.....	7,970	5,070	5,210	1,400	348	195	195
25	2,410	2,200	.....	9,480	4,930	5,210	1,250	395	180	180
26	2,200	2,100	.....	9,140	4,510	5,350	1,730	420	180	168
27	2,000	2,100	.....	8,800	4,650	5,210	1,640	302	180	370
28	2,000	2,000	.....	11,200	4,240	4,930	1,480	325	180	240
29	1,820	2,000	.....	11,900	4,110	4,930	1,480	470	180	180
30	1,730	1,480	.....	10,800	4,110	4,510	1,400	325	180	110
31	1,730	.....	.....	9,310	.....	4,110	.....	420	110	.....

NOTE.—Stage-discharge relation affected by ice, Dec. 18 to Mar. 18; gage-height observations discontinued.

Monthly discharge of Des Moines River at Kalo, Iowa, for the year ending Sept. 30, 1916.

[Drainage area, 4,170 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	4,370	1,730	2,850	0.683	0.79
November	4,510	1,320	2,420	.580	.65
December 1–17	1,560	872	1,290	.309	.20
March 19–31	11,900	7,010	8,840	2.12	1.02
April	8,290	3,850	5,250	1.26	1.41
May	5,350	1,820	3,890	.933	1.08
June	5,800	1,180	2,340	.561	.63
July	1,320	302	675	.162	.19
August	420	110	278	.067	.08
September	370	110	220	.053	.06

DES MOINES RIVER AT DES MOINES, IOWA.

LOCATION.—In T. 78 N., R. 24 W., at the Walnut Street Bridge at Des Moines, Polk County, about one-third mile above mouth of Raccoon River and 205 miles above the mouth of the Des Moines.

DRAINAGE AREA.—6,180 square miles. Effective area at high stages, including Raccoon River, 9,770 square miles (measured on map issued by United States Geological Survey; scale 1 to 500,000).

RECORDS AVAILABLE.—October 2, 1902, to August 3, 1903; October 1, 1914, to September 30, 1916, at the Walnut Street Bridge. From May 26, 1905, to July 20, 1906, records were collected at the Interurban Bridge near Highland Park, about 5 miles above present station. The United States Weather Bureau has maintained a gage at the Locust Street Bridge from July 1, 1897, to January, 1912, and at the Walnut Street Bridge from January, 1912, to September 30, 1916.

GAGE.—The original Weather Bureau gage is a staff gage at the Locust Street Bridge, one block above the Walnut Street Bridge. In January, 1912, a Friez water-stage recorder was installed by the United States Weather Bureau in and near the south end of the second pier from the east abutment of the Walnut Street Bridge. This gage is set to read the same as Locust Street gage. A copper float in a 9-inch pipe connects with the register at the top, which is graduated to record graphically stages from 0 to 33 feet. Gage zero is 774.74 feet above sea level.

DISCHARGE MEASUREMENTS.—Made at any one of several bridges below the power dam, according to the stage. Channel satisfactory for accurate measurements.

CHANNEL AND CONTROL.—A sheet-piling dam was constructed about 300 feet above the old mouth of Raccoon River about September, 1913. This dam, called a "beauty dam," is for the purpose of raising the low-water stage of the river a few feet, thus improving the appearance of the river through the park along the bank. The pooled water from this dam extends past the gage to the power dam at low water. The dam thus forms a permanent control at low stages. It is drowned out at stages of 8 to 10 feet, depending on the stage in Raccoon River.

EXTREMES OF STAGE.—Maximum stage recorded during year, 10.9 feet, October 1; minimum stage recorded, 1.8 feet, September 5 and 10.

1897–1916: Maximum stage recorded, 22.6 feet, May 31, 1903; minimum stage recorded, 0.8 foot at various times.

ICE.—The effect of the power dam above the station is to improve the conditions of winter flow, but severe winters and occasional ice jams below the gage often seriously affect the stage-discharge relation.

REGULATION.—The Edison Power & Light Co.'s dam, about one-fourth mile above gage, causes slight diurnal fluctuation of stage. The dam is practically drowned out at a stage of 18 feet, although there is a perceptible ripple with a stage of 21 or 22 feet.

COOPERATION.—The gage-height records are furnished by the United States Weather Bureau. Estimates of discharge withheld until additional data are collected.

The following discharge measurement was made by C. Herlofson:

July 18, 1916: Gage height, 2.68 feet; discharge, 900 second-feet.

Daily gage height, in feet, of Des Moines River at Des Moines, Iowa, for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	10.8	5.0	4.9	4.0	a 4.8	4.9	8.5	5.9	6.1	3.8	2.3	1.9
2	9.7	4.8	4.8	4.7	a 4.8	4.6	8.3	6.0	5.9	3.7	2.4	1.9
3	8.7	4.7	4.7	4.6	3.6	4.0	7.9	6.1	5.9	3.6	2.3	1.9
4	7.8	4.7	4.7	4.5	a 3.6	3.9	7.6	6.0	6.5	3.5	2.3	1.9
5	7.0	4.6	4.6	4.4	a 3.6	4.4	7.4	5.8	7.0	3.5	2.2	1.8
6	7.0	4.5	4.5	4.5	3.6	4.1	7.1	5.6	7.0	3.4	2.2	1.9
7	6.8	4.5	4.5	4.4	3.5	4.2	6.9	5.4	6.6	3.4	2.2	1.9
8	6.3	4.5	4.6	4.3	3.5	4.0	6.6	5.2	6.0	3.3	2.2	1.9
9	6.0	4.5	4.6	3.9	3.1	4.1	6.3	5.1	5.6	3.2	2.2	1.9
10	5.9	4.5	4.6	3.9	3.0	4.2	6.2	4.9	5.3	3.1	2.2	1.8
11	5.7	4.8	4.5	3.8	3.3	4.7	6.1	4.8	5.0	2.9	2.3	1.9
12	5.5	5.1	4.5	3.8	3.3	5.6	6.0	4.6	4.9	2.8	2.3	2.0
13	5.5	6.6	3.7	3.8	3.2	6.5	5.9	4.6	4.7	2.8	2.4	2.2
14	5.5	7.2	4.4	3.4	3.1	8.4	5.7	4.6	4.6	3.0	2.3	2.3
15	5.7	7.1	3.7	3.8	3.0	9.2	5.7	5.3	4.5	2.9	2.3	2.2
16	5.6	6.9	3.3	4.0	2.9	9.3	5.7	6.7	4.3	2.8	2.2	2.2
17	5.6	6.7	3.3	3.8	3.0	9.4	5.6	7.4	4.2	2.8	2.2	2.2
18	6.0	6.4	3.3	3.8	4.5	8.1	5.8	7.3	4.1	2.7	2.2	2.1
19	6.9	6.3	3.2	3.7	4.5	8.1	6.0	6.9	4.0	2.6	2.2	2.0
20	7.3	6.1	3.5	3.7	6.4	8.0	6.1	6.5	3.9	2.6	2.1	2.0
21	7.2	5.8	3.4	3.6	7.7	7.8	6.7	6.3	3.8	2.6	2.0	2.0
22	6.8	5.6	3.7	3.8	8.5	7.6	7.7	7.3	3.7	2.6	2.0	1.9
23	6.4	5.4	3.8	4.5	9.4	7.5	7.8	7.7	3.6	2.5	2.0	1.9
24	6.2	5.3	4.0	4.4	9.0	7.4	7.2	7.9	3.6	2.5	2.0	1.9
25	5.9	5.3	4.2	4.4	9.1	7.4	6.9	7.9	3.6	2.4	2.0	1.9
26	5.7	5.2	4.2	a 4.4	7.9	8.2	6.6	7.5	3.7	2.4	2.0	1.9
27	5.6	5.2	4.4	4.8	6.7	9.3	6.4	7.3	3.8	2.4	1.9	1.9
28	5.4	5.2	4.6	a 4.8	5.8	10.0	6.2	7.1	4.0	2.4	1.9	2.1
29	5.3	5.1	4.4	a 4.8	5.2	10.0	6.0	7.0	4.1	2.4	1.9	2.0
30	5.2	5.0	4.0	a 4.8	.....	9.6	5.9	6.6	3.9	2.2	1.9	2.0
31	5.0	.....	3.9	a 4.8	.....	9.5	.....	6.3	.....	2.3	1.9	.....

a Gage read to top of ice.

NOTE.—Stage-discharge relation probably more or less affected by ice from Dec. 20 to about the end of February.

DES MOINES RIVER AT KEOSAUQUA, IOWA.

LOCATION.—In sec. 36, T. 69 N., R. 10 W., at county bridge, Keosauqua, Van Buren County, one-fourth mile above old dam site and Government locks. No important tributary enters Des Moines River for several miles up or down stream.

DRAINAGE AREA.—At gaging station 13,900 square miles; at mouth, 14,300 square miles (revised measurements made from map issued by United States Geological Survey; scale 1 to 500,000.)

RECORDS AVAILABLE.—May 30, 1903, to July 21, 1906; April 5 to December 31, 1910 (United States Engineer Corps); August 3, 1911, to September 30, 1916.

GAGE.—Chain gage attached to an upstream vertical of bridge; read by Frank Schreckengast.

DISCHARGE MEASUREMENTS.—Made from bridge to which gage is attached.

CHANNEL AND CONTROL.—Channel shifts considerably at flood stages. Control is a gravel riffle about one-fourth mile below gage.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 14.2 feet, March 27 (discharge 44,300 second-feet); minimum stage recorded, 0.16 foot, September 5 and 8 (discharge 460 second-feet.)

Maximum stage since 1850 and probably in the last century, 27.9 feet June 1, 1903 (discharge, 97,000 second-feet); maximum stage June 1, 1851, about 24 feet (discharge, about 80,000 second-feet.)

1903–1916: Minimum stage recorded, zero August 28 to September 6, 1911 (discharge, 160 second-feet).

ICE.—Stage-discharge relation seriously affected by ice.

ACCURACY.—Stage-discharge relation fairly permanent for low and medium stages from October 1 to July 18, and a rating curve well defined between 1,500 and 15,000 second-feet and fairly well defined above 15,000 second-feet was used. Subsequent to July 18, the indirect method for shifting control was used. Gage read once daily to half tenths. Stage-discharge relation December 19 to January 1, January 6 to 21, and February 5 to 19, affected by ice; discharge estimated from observer's notes, weather records, and one discharge measurement. Open-water records good; winter records fair.

Discharge measurements of Des Moines River at Keosauqua, Iowa, 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.*
Feb. 15[a]	Herlofson and Wilson..	3.60	1,460	Juiy 18	C. Herlofson.....	1.10	1,970
June 13	C. Herlofson.....	2.86	6,230				

[a] Measurement made under ice cover.

Daily discharge in second-feet, of Des Moines River at Keosauqua, Iowa, for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jnne.	July.	Aug.	Sept.
1	29,200	6,610	5,800	3,000	5,530	12,400	19,500	17,500	10,900	3,470	1,140	636
2	29,500	6,340	5,530	6,070	4,740	10,300	18,200	16,500	10,000	3,470	1,140	636
3	27,800	6,070	5,260	6,070	3,970	8,850	16,900	12,100	9,140	3,470	1,070	607
4	25,600	5,800	5,000	5,000	3,000	6,880	14,900	11,500	8,859	2,990	1,070	578
5	22,200	5,530	4,480	6,070	2,500	6,070	13,700	10,300	8,560	4,220	1,140	470
6	18,800	5,260	4,480	5,000	2,000	5,530	12,400	9,140	14,900	2,990	1,030	512
7	16,200	5,000	4,480	3,500	1,800	5,530	11,800	8,420	14,300	2,660	920	512
8	14,900	4,740	4,480	2,000		5,260	11,200	7,720	11,500	2,560	920	460
9	13,700	4,480	4,480			4,740	10,600	7,160	10,600	2,460	920	512
10	12,400	4,480	4,220			4,740	10,000	6,610	9,140	2,360	920	506
11	11,800	4,480	4,220		1,500	5,000	9,430	6,070	8,000	2,260	1,290	501
12	10,900	4,480	4,220			5,530	9,140	9,430	6,880	2,160	990	501
13	10,300	5,000	4,220			6,610	8,850	15,200	6,070	1,970	1,060	501
14	9,430	6,070	4,220			12,700	8,560	25,300	5,530	1,880	1,140	501
15	9,140	9,430	3,720	1,800	1,460	13,700	8,280	28,100	5,000	1,880	1,210	501
16	8,850	11,800	2,880		2,000	15,200	8,140	21,200	4,740	2,020	1,210	501
17	9,430	11,800	2,160		3,000	17,800	8,000	20,500	4,480	2,160	1,140	800
18	9,720	11,200	2,160		5,000	17,800	7,720	21,500	4,220	1,970	1,070	990
19	9,140	10,600	2,000		10,000	16,500	7,720	17,500	3,970	2,060	990	850
20	9,430	10,000	1,800		13,700	15,200	8,280	14,600	3,720	1,970	955	772
21	11,800	9,140		12,000	14,900	14,900	8,850	14,100	4,220	1,970	920	696
22	13,000	8,560		20,200	14,000	13,700	8,850	13,700	4,480	1,790	772	696
23	13,000	8,000		12,400	29,900	13,000	8,900	14,900	4,220	1,700	772	648
24	12,100	7,160		8,850	28,800	12,700	13,700	29,500	4,480	1,620	772	591
25	11,200	7,160		8,850	25,000	15,600	13,000	24,200	3,970	1,530	708	534
26	10,000	7,720	1,500	9,430	22,200	36,800	11,800	17,500	3,470	1,450	600	523
27	9,140	7,160		16,500	18,200	42,500	10,600	16,200	3,220	1,450	572	811
28	8,280	6,610		13,000	16,200	25,600	9,720	15,100	3,220	1,370	545	753
29	7,720	6,610		11,500	13,700	20,800	9,140	14,000	3,220	1,290	545	695
30	7,440	6,070		7,160	.....	20,800	14,000	13,000	3,470	1,290	545	636
31	6,880	.....		7,160	.....	20,200	.....	12,100	.....	1,290	600	.....

NOTE.—Discharge Nov. 22, Dec. 16, Mar. 19, Apr. 2, 9, 13, 16, May 7, 21, 28, June 4, 11, 18, 25, July 2, 9, 16, 23, 30, Aug. 6, 13, 20, 27, Sept. 3, 10, 24, 28, and 29, interpolated. Discharge Apr. 23, 30, and Sept. 17, estimated. Stage-discharge relation affected by ice Dec. 19, to Jan. 1, Jan. 6–21, and Feb. 5–19. Braced figures show mean discharge for periods included.

Monthly discharge of Des Moines River at Keosauqua, Iowa, for the year ending Sept. 30, 1916.

[Drainage area, 13,900 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	29,500	6,680	13,500	0.971	1.12
November	11,800	4,480	7,120	.512	.57
December	5,800	.....	3,110	.224	.26
January	20,200	.....	5,980	.430	.50
February	29,900	.....	8,690	.625	.67
March	42,500	4,740	14,000	1.01	1.16
April	19,500	7,720	11,100	.799	.89
May	29,500	6,070	15,200	1.09	1.26
June	14,900	3,220	6,620	.476	.53
July	4,220	1,290	2,180	.157	.18
August	1,290	545	925	.066	.08
September	990	460	614	.044	.05
The year	42,500	460	7,420	.534	7.27

RACCOON RIVER AT VAN METER, IOWA.

LOCATION.—In the SW. ¼ sec. 22, T. 78., R. 27 W. at highway bridge about one-third mile from railroad station, about a mile below South Raccoon River, and 30 miles above junction of Raccoon River with Des Moines River.

DRAINAGE AREA.—At gaging station, 3,410 square miles; at mouth, 3, 590 square miles (measured on map issued by United States Geological Survey, scale 1 to 500,000).

RECORDS AVAILABLE.—April 25, 1915, to September 30, 1916.

GAGE.—Chain gage attached to downstream handrail of bridge about 25 feet from right end of bridge; read by E. C. Trindle and Fred Vreeland.

DISCHARGE MEASUREMENTS.—Made from bridge to which gage is attached.

CHANNEL AND CONTROL.—Bed composed of sand; subject to change. River divided into two channels at low and medium stages by an island with the water surface slightly higher in the left channel than in the right at extreme low water; right bank high and not subject to overflow; left bank subject to overflow at a stage of about 13 feet. At extreme high stage this overflow will extend for several thousand feet beyond left end of bridge.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 13.7 feet at 6 a. m., October 1 (discharge, 14,800 second-feet); minimum stage, 1.8 feet, August 29, 1916 (discharge, 60 second-feet).

1915–16: Maximum stage recorded, 15.8 feet, May 29, 1915 (discharge, 22,900 second-feet); minimum stage recorded, 1.8 feet August 29, 1916 (discharge, 60 second-feet). Gage heights published in Water-Supply Paper 405 under "Extremes of discharge," p. 177, should be increased 2.00 feet.

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

ACCURACY.—Stage-discharge relation permanent throughout year. Rating curve well defined between 155 and 15,000 second-feet. Gage read once daily to hundredths. Discharge ascertained by applying gage heights to rating table. Open-water records excellent, except for extremely low stages, for which they are fair.

Discharge measurements of Raccoon River at Van Meter, Iowa, during the year ending Sept. 30, 1916.

[Made by C. Herlofson.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Mar. 18	8.16	5,530	July 19	2.59	341
July 19	2.58	338			

Daily discharge, in second-feet, of Raccoon River at Van Meter, Iowa, for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	14,800	1,760	1,440	.....	2,200	1,280	1,760	625	152	75
2	12,400	1,680	1,360	.....	2,110	1,280	1,680	565	149	72
3	10,500	1,520	1,360	.....	2,020	1,210	1,520	565	104	68
4	9,070	1,520	1,360	.....	1,840	1,210	1,440	505	104	66
5	7,260	1,440	1,280	.....	1,840	1,210	1,520	505	98	64
6	5,840	1,360	1,280	.....	1,680	1,070	1,840	505	134	72
7	4,560	1,360	1,280	.....	1,600	1,000	1,600	450	81	68
8	4,560	1,360	1,280	.....	1,520	940	1,360	395	110	75
9	4,440	1,360	1,280	.....	1,440	875	1,210	340	68	68
10	3,850	1,360	1,280	.....	1,440	810	1,140	290	62	72
11	3,300	1,840	1,280	.....	1,440	745	1,070	320	85	75
12	2,980	2,020	1,210	.....	1,440	715	940	275	62	395
13	2,880	3,740	1,210	.....	1,440	715	875	290	218	450
14	3,190	3,960	1,070	.....	1,440	1,440	810	330	305	535
15	3,620	4,200	940	.....	1,440	2,290	745	395	310	368
16	3,300	4,080	875	.....	1,360	2,880	685	422	245	290
17	3,080	3,520	810	.....	1,360	3,300	655	450	183	240
18	3,520	2,980	745	.....	1,360	3,190	655	422	110	104
19	4,080	2,680	745	3,620	1,360	3,080	655	368	110	195
20	4,680	2,480	.....	3,190	1,680	2,780	625	325	110	91
21	4,680	2,290	.....	2,780	2,200	2,680	595	208	85	110
22	4,200	2,200	.....	2,480	2,980	2,780	565	240	85	81
23	3,620	2,110	.....	2,290	2,380	3,300	625	208	81	81
24	3,190	2,020	.....	2,200	2,290	3,740	685	255	68	85
25	2,880	1,930	.....	2,380	1,840	3,960	715	183	81	75
26	2,780	1,840	.....	2,980	1,600	3,960	745	183	68	81
27	2,380	1,760	.....	3,520	1,440	3,850	745	110	64	125
28	2,200	1,680	.....	3,620	1,280	3,190	810	110	68	75
29	2,020	1,600	.....	2,980	1,140	2,680	745	119	60	63
30	1,930	1,440	.....	2,580	1,210	2,290	685	149	68	395
31	1,840	.....	.....	2,290	.....	1,930	.....	155	64	.....

NOTE.—Stage-discharge relation affected by ice, Dec. 20, to Mar. 18; observations discontinued Jan. 9 to Mar. 4.

Monthly discharge of Raccoon River at Van Meter, Iowa, for the year ending Sept. 30, 1916.

[Drainage area, 3,410 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	14,800	1,840	4,630	1.36	1.57
November	4,200	1,360	2,170	.636	.71
December 1–19	1,440	745	1,160	.340	.24
March 19–31	3,620	2,200	2,840	.833	.40
April	2,980	1,140	1,680	.493	.55
May	3,960	715	2,140	.628	.72
June	1,840	565	990	.290	.32
July	625	110	331	.097	.11
August	310	60	116	.034	.04
September	535	63	154	.045	.05

KANKAKEE RIVER AT MOMENCE, ILL.

LOCATION.—In sec. 24, T. 31 N., R. 13 E., at highway bridge in Momence, Kankakee County, about half a mile below the Chicago & Eastern Illinois Railroad bridge and 1½ miles above Tower Creek.

DRAINAGE AREA.—2,340 square miles.

RECORDS AVAILABLE.—February 22, 1905, to July 20, 1906; December 3, 1914, to September 30, 1916.

GAGE.—Chain gage attached to bridge over left channel; read by Oscar Conrad.

DISCHARGE MEASUREMENTS.—Made from upstream side of bridge across the two channels.

CHANNEL AND CONTROL.—Solid rock; practically permanent; river at gage divided into two channels by an island. Aquatic plants sometimes grow in bed of river during summer. Recent measurements show that there has been a change in the stage-discharge relation as expressed by the rating curve used prior to July 20, 1916.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 7.5 feet at 11 a. m. January 21 (discharge not determined because of backwater from ice). Maximum stage recorded during open-water periods of the year, 6.4 feet at 8 a. m. January 22 (discharge estimated from extension of rating curve, 12,600 second-feet); minimum stage, 1.55 feet August 29, 30, and 31 (discharge, 390 second-feet).

1905–6 and 1915–16: Maximum stage, that of January, 1916. Minimum discharge 360 second-feet, July 13 to 20, 1906.

ACCURACY.—Stage-discharge relation permanent except as slightly affected by growth of aquatic plants in bed of river about October 1 to December 15 and seriously affected by ice during winter. Rating curve well defined between 330 and 3,100 second-feet, and fairly-well defined above 3,100 second-feet. Gage read to hundredths twice daily. Daily discharge ascertained by applying mean daily-gage heights to rating table except for period in which the stage-discharge relation was affected by growth of aquatic plants, when the indirect method for shifting control was used. Records good for open-water periods and roughly approximate for winter period.

Discharge measurements of Kankakee River at Momence, Ill., 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.*
Oct. 30	Willam Kessler.....	1.95	[a] 854	Aug. 15	H. C. Beckman.....	1.89	862
Nov. 23	.....do.....	2.12	[a] 960				

[a] Aquatic growth in bed of river.

Daily discharge, in second-feet, of Kankakee River at Momence, Ill., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	1,240	812	1,150				4,110	1,720	3,850	3,100	840	414
2	1,240	798	1,150				4,110	1,720	3,600	3,100	784	438
3	1,150	784	1,070				4,370	1,720	3,350	3,100	742	438
4	1,070	784	1,070				4,370	1,720	3,100	2,980	700	438
5	990	770	1,070				4,370	1,720	2,860	2,740	700	450
				1,650								
6	990	770	1,070				4,370	1,720	2,860	2,620	700	885
7	915	770	1,070				4,370	1,720	2,860	2,500	674	870
8	915	756	1,070		3,220		4,370	1,620	2,980	2,390	648	870
9	840	756	1,070				4,110	1,620	2,860	2,390	622	870
10	915	756	1,070				4,110	1,620	2,860	2,390	570	870
						1,390						
11	840	770	1,070				3,850	1,620	2,860	2,390	1,620	870
12	784	756	990				3,600	1,620	2,740	2,390	1,420	840
13	812	770	990				3,600	1,620	2,620	2,390	990	812
14	798	770	990				3,350	2,860	2,620	2,390	855	756
15	784	756	1,070				3,350	2,860	2,740	2,390	798	756
16	784	770	1,240	5,870			3,100	2,860	2,980	2,280	756	742
17	812	770	1,240				3,100	2,740	2,980	2,160	674	728
18	812	770	1,240				2,980	2,500	2,860	1,940	635	714
19	812	840					2,980	2,390	2,860	1,830	609	661
20	812	915					2,740	2,390	2,980	1,720	596	622
21	812	915				1,940	2,500	2,280	3,350	1,720	570	583
22	812	990		10,500	1,530	2,860	2,390	2,390	3,850	1,520	570	570
23	812	1,070		4,640		3,350	2,280	2,620	3,600	1,420	522	570
24	812	990		4,370		3,350	2,160	2,860	3,350	1,330	522	546
25	840	990	800	4,370		3,350	1,940	3,350	3,350	1,330	498	546
26	826	1,070		4,640		3,100	1,720	3,350	3,350	1,240	474	534
27	826	1,070		3,600		3,850	1,720	3,600	3,100	1,150	438	661
28	812	1,070		5,180		4,110	1,720	3,600	3,100	1,070	414	990
29	826	1,150		5,180		4,110	1,720	3,600	3,100	990	402	930
30	812	1,150		5,460		4,110	1,720	3,850	3,100	900	390	900
31	812			6,300		4,110		3,850		855	402	

NOTE.—Discharge Oct. 1 to Dec. 15 determined by indirect method for shifting control, because of backwater from aquatic plants growing in bed of river. Discharge Dec. 19 to Jan. 21 and Feb. 1 to Mar. 20 estimated, because of ice, from gage height records, observer's notes, and weather records.

Monthly discharge of Kankakee River at Momence, Ill., for the year ending Sept. 30, 1916.

[Drainage area, 2,340 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	1,240	784	881	0.376	0.43
November	1,150	756	870	.372	.42
December			971	.415	.48
January			4,360	1.86	2.14
February			2,400	1.03	1.11
March	4,110		2,130	.910	1.05
April	4,370	1,720	3,170	1.35	1.51
May	3,850	1,620	2,440	1.04	1.20
June	3,850	2,620	3,090	1.32	1.47
July	3,100	855	2,020	.863	.99
August	1,620	390	682	.291	.34
September	990	414	696	.297	.33
The year		390	1,980	.846	11.47

KANKAKEE RIVER AT CUSTER PARK, ILL.

LOCATION.—In sec. 19, T. 32 N., R. 10 E., at the Wabash Railroad bridge in Custer Park, Will County, about half a mile above Horse Creek and about 15 miles below the dam at Kankakee.

DRAINAGE AREA.—4,870 square miles.

RECORDS AVAILABLE.—November 6, 1914, to September 30, 1916.

GAGE.—Chain gage attached to bridge; read by J. H. Swords.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge.

CHANNEL AND CONTROL.—Solid rock strewn with large boulders and gravel; right half of channel deep, with fissures in bed; left half shallow. Probably permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 11.9 feet at 7 a. m., February 2 (discharge not determined because of backwater from ice); maximum stage during open-water periods, 10.4 feet May 17 and 18 (discharge, 13,600 second-feet); minimum stage, 4.63 feet at 5 p. m. September 9 (discharge, 343 second-feet).

1915–1916: Maximum stage recorded, 12.6 feet July 11, 1915 (discharge, 21,300 second-feet); minimum stage, 4.09 feet November 15, 1914 (discharge not determined); mean discharge for the day, estimated 250 second-feet.

REGULATION.—Operation of power plant at Kankakee causes slight fluctuation at gage.

ACCURACY.—Stage-discharge relation practically permanent; seriously affected by ice during winter. Rating curve well defined above 1,130 second-feet; extended below 1,130 second-feet. Gage read to hundredths twice daily. Daily discharge ascertained by applying mean daily gage heights to rating table. Records for open-water periods good except for stages below 1,100 second-feet; winter records poor.

Discharge measurements of Kankakee River at Custer Park, Ill., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Nov. 1	William Kessler	5.68	1,300
Aug. 14	H. C. Beckman	5.59	1,300

Daily discharge, in second-feet, of Kankakee River at Custer Park, Ill., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	4,150	1,380	1,670				7,580	2,320	7,000	5,130	900	577
2	3,470	1,250	1,600				7,580	2,320	6,720	4,630	900	535
3	3,070	1,130	1,670				7,290	2,320	6,440	4,390	748	512
4	2,690	1,190	1,600				7,000	2,240	5,640	3,680	848	412
5	2,500	1,010	1,670				6,720	2,240	5,130	3,680	848	527
6	2,410	1,130	1,600		8,300		6,720	2,240	4,390	3,270	748	700
7	2,320	1,130	1,600				5,640	2,320	4,390	2,880	797	900
8	2,150	1,130	1,520				5,380	2,500	4,880	2,690	748	848
9	1,820	1,010	1,520				5,130	2,880	6,170	2,320	797	748
10	1,820	1,010	1,450	5,450			4,880	3,680	7,000	2,410	655	900
11	1,740	1,010	1,670				4,630	3,270	7,000	2,410	1,010	848
12	1,670	1,010	1,820			2,220	4,390	2,690	6,720	2,600	1,900	900
13	1,520	1,010	1,450				4,390	2,320	6,170	2,410	1,250	955
14	1,520	1,010					4,150	3,470	5,380	2,410	1,130	900
15	1,600	1,010					3,910	8,790	5,380	2,320	797	955
16	1,600	1,010					3,680	12,600	5,640	2,150	900	900
17	1,450	1,010					3,910	13,300	6,440	2,320	900	848
18	1,600	1,010					3,470	13,300	6,440	2,150	848	848
19	1,520	1,010					3,270	12,000	6,170	2,150	748	900
20	1,520	1,380			3,180		3,270	10,400	5,380	1,900	748	848
21	1,670	1,380					2,880	8,480	6,720	1,600	797	797
22	1,740	1,450	1,000				2,690	7,000	7,580	1,670	700	700
23	1,670	1,600				4,150	2,600	5,900	7,880	1,380	655	700
24	1,670	1,670					4,630	2,690	5,380	7,880	1,670	655	655
25	1,520	1,670					4,880	2,500	4,880	7,000	1,450	655	700
26	1,380	1,670		12,200			5,130	2,600	4,630	5,900	1,380	655	655
27	1,520	1,670					3,470	2,410	4,630	6,170	1,250	655	700
28	1,380	1,740					8,480	2,500	4,880	6,170	1,130	610	900
29	1,250	1,670					8,790	2,410	5,640	5,900	1,130	610	900
30	1,250	1,670			.....		8,480	2,320	6,720	5,130	955	568	955
31	1,250	.....			.....		5,130	.....	7,000	.....	1,010	568	.....

NOTE.—Discharge Dec. 14 to Mar. 22 estimated, because of ice, from gage heights, observer's notes, and weather records.

Monthly discharge of Kankakee River at Custer Park, Ill., for the year ending Sept. 30, 1916.

[Drainage area, 4,870 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	4,150	1,250	1,890	0.388	0.45
November	1,740	1,010	1,270	.261	.29
December	1,820	.....	1,250	.257	.30
January	.....	.....	7,850	1.61	1.86
February	.....	.....	4,950	1.02	1.10
March	8,790	.....	3,290	.676	.78
April	7,580	2,320	4,290	.881	.98
May	13,300	2,240	5,560	1.14	1.31
June	7,880	4,390	6,160	1.26	1.41
July	5,130	955	2,340	.480	.55
August	1,900	568	818	.168	.19
September	955	412	774	.159	.18
The year	.....	412	3,360	.690	9.40

DES PLAINES RIVER AT LEMONT, ILL.

LOCATION.—In sec. 20, T. 37 N., R. 11 E., at concrete highway bridge at Stephens Street, about a quarter of a mile north of main section of Lemont, Cook County; 8 miles above junction of Des Plaines River and the Chicago Drainage canal.

DRAINAGE AREA.—705 square miles.

RECORDS AVAILABLE.—November 4, 1914, to September 30, 1916.

GAGE.—Enamel staff gage, attached to bridge; read by William Weck, Jr.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge.

CHANNEL AND CONTROL.—Solid rock; aquatic plants cover bed of river during summer. A concrete dam forming a new control was built across the channel about 500 feet below the gage August 20.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 6.1 feet January 23 (discharge not determined because of backwater from ice). Maximum stage recorded during open-water periods, 5.9 feet at 9 a. m. and 5 p. m. June 10 (discharge, 3,380 second-feet); minimum stage, 0.73 foot at 5 a. m. August 5 (discharge, 7 second-feet).

1915–1916: Maximum stage recorded, same as for 1916; minimum stage, 0.60 foot November 26, 1914 (discharge, 3.9 second-feet; measured by current meter).

ACCURACY.—Stage-discharge relation permanent; affected by growth of aquatic plants in channel during October, July, and August; seriously affected by ice during winter; changed by construction of concrete dam about 500 feet below gage August 20. Rating curve used till August 20 fairly well defined between 60 and 3,140 second-feet, and fairly well defined beyond these limits; curve used after that date fairly well defined. Gage read to hundredths twice daily. Daily discharge ascertained by applying mean daily gage heights to rating tables except for periods in which the stage-discharge relation was affected by growth of aquatic plants, for which the indirect method for shifting control was used. Records good except for periods when ice or aquatic plants were present.

Discharge measurements of Des Plaines River at Lemont, Ill., 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.*
Oct. 23	William Kessler	1.75	279	Aug. 11	H. C. Beckman	0.98	*a* 28.2
Nov. 13	do	1.00	65.2	Sept. 13	do	2.55	18.6
26	do	1.32	142	13	do	2.55	23.3
June 15	H. C. Beckman	5.05	2,330				

a Grass growing in channel.

NOTE.—After Aug. 20, 1916, the control consisted of a concrete dam about 500 feet downstream from gage.

Daily discharge, in second-feet, of Des Plaines River at Lemont, Ill., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	500	146	413				2,590	298	335	659	15	
2	478	135	413				2,380	354	335	554	12	
3	456	130	354				2,280	456	298	465	9	32
4	434	130	316				1,990	500	298	854	7	
5	413	122	335				1,810	478	279	932	7	
6	373	122	335			200	1,560	478	225	725	10	35
7	316	122	316				1,320	413	434	527	10	37
8	279	122	298		900		1,180	354	1,900	373	13	39
9	225	122	279				1,120	298	3,020	260	12	31
10	192	115		445			887	242	3,380	205	10	27
11	192	110					613	225	3,260	168	15	21
12	162	94				148	500	192	3,020	151	27	14
13	148	70				170	456	192	2,790	132	24	21
14	138	62				192	393	208	2,590	120	15	12
15	125	50				192	354	279	2,380	105	13	17
16	115	42				208	335	456	2,180	70	18	23
17	110	25				225	335	500	1,990	83	18	23
18	128	18				260	316	456	1,900	57	18	20
19	171	52				225	373	354	1,720	48	13	17
20	225	115	170			237	478	298	1,480	64	10	12
21	298	148				248	545	279	1,400	70		14
22	279	208				260	636	192	1,250	85		11
23	279	168			235	279	636	186	1,120	70		18
24	316	125				298	590	177	1,000	62		12
25	335	138				410	545	165	780	37		11
26	354	135		1,920		522	478	148	780	34	20	12
27	354	151				1,320	434	192	832	32		12
28	335	174				2,690	373	157	1,060	27		18
29	298	225				3,140	354	140	943	23		17
30	225	335				3,020	335	157	832	23		21
31	180	.....			.....	2,790	.....	174	.....	21		.....

NOTE.—Discharge Oct. 1–20 and July 1 to Aug. 20 determined by indirect method for shifting control because of aquatic plants growing in channel. Discharge Dec. 10 to Mar. 11 estimated, because of ice, from gage heights, observer's notes, and weather records. No gage-height record for Mar. 13, 16, 20, 21, 23, and 25; discharge interpolated. Discharge Aug. 21 to Sept. 5, while pond behind dam was filling, was estimated. Braced figures show mean discharge for periods indicated.

Monthly discharge of Des Plaines River at Lemont, Ill., for the year ending Sept. 30, 1916.

[Drainage area, 705 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	500	110	272	0.386	0.44
November	335	18	124	.176	.20
December	413	.....	219	.311	.36
January	.....	.....	968	1.37	1.58
February	.....	.....	579	.821	.89
March	3,140	.....	614	.871	1.00
April	2,590	316	873	1.24	1.38
May	500	140	290	.411	.47
June	3,380	225	1,460	2.07	2.31
July	932	21	227	.322	.37
August	.....	7	16.0	.023	.03
September	39	.....	21.8	.031	.03
The year	3,380	7	470	.667	9.06

DES PLAINES RIVER AT JOLIET, ILL.

LOCATION.—In the NE. ¼ sec. 9, T. 35 N., R. 10 E., at Jackson Street Bridge, Joliet, Will County, about 1,200 feet upstream from Cass Street Bridge.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—December 3, 1914, to September 30, 1916; on original chain gage September 5 to December 19, 1914.

GAGE.—Gurley seven-day water-stage recorder, installed December 3, 1914. Chain gage attached to upstream side of bridge at Cass Street read from September 5 to December 19, 1914.

DISCHARGE MEASUREMENTS.—Made from upstream side of Cass Street Bridge.

CHANNEL AND CONTROL.—Channel excavated in solid rock, with a concrete wall on either side; probably permanent.

EXTREMES OF DISCHARGE.—Maximum mean daily discharge during days of record for the year, 13,200 second-feet, June 10, minimum mean daily discharge, 5,880 second-feet, March 5.

1914–1916: Maximum mean daily discharge during days of record, 13,200 second-feet, June 10, 1916; minimum mean daily discharge, 5,420 second-feet, April 25, 1915.

DIVERSIONS.—Water is diverted to the Illinois & Michigan canal at Dam No. 1, about 100 feet above the gage.

REGULATION.—Flow past the gage is largely regulated by the operation of the power plant of the Chicago Sanitary District at Lockport, which utilizes the flow of the Chicago Drainage Canal and, to a lesser extent, by the operation of the Economy Light & Power Co.'s plant, about 100 feet above gage.

ACCURACY.—Stage-discharge relation permanent; not affected by ice during winter. Rating curve well defined. Operation of the water-stage recorder satisfactory throughout year, except during extremely cold periods of the winter, for which no records are given. Daily discharge ascertained by use of discharge integrator. Records excellent.

The following discharge measurement was made by H. C. Beckman:

August 12, 1916: Gage height, 5.08 feet; discharge, 9,410 second-feet. The flow in the Illinois & Michigan canal, diverting water around the gage, was 374 second-feet, as measured by current meter.

Daily discharge, in second-feet, of Des Plaines River at Joliet, Ill., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	8,500	7,890	8,480	(a)	9,330	8,070	10,800	7,460	7,850	9,620	9,110	7,410
2	8,120	7,810	8,520	6,820	9,100	7,750	10,300	7,260	7,830	9,350	9,000	7,700
3	8,100	7,780	8,590	8,420	8,670	7,930	10,600	7,550	7,710	9,490	8,390	8,130
4	8,370	7,600	8,140	8,820	b8,450	7,280	10,000	7,100	7,600	9,480	8,740	8,100
5	8,250	7,830	7,780	8,800	b7,740	5,880	9,760	7,250	7,950	10,000	8,540	7,860
6	8,260	7,130	8,200	9,030	6,980	7,890	9,260	7,480	8,280	9,760	8,650	8,330
7	8,080	6,830	8,780	(a)	(a)	7,670	8,830	7,570	8,730	9,300	8,700	8,320
8	8,230	7,340	8,210	(a)	(a)	7,550	8,570	7,270	10,900	9,140	8,880	(a)
9	7,700	7,700	8,180	6,320	(a)	7,920	7,530	7,570	12,800	9,490	8,790	(a)
10	7,600	8,130	8,950	8,180	(a)	7,500	8,130	7,530	13,200	9,310	8,420	8,390
11	7,790	7,950	7,780	8,360	(a)	6,990	7,940	7,300	13,000	9,290	8,940	8,430
12	6,930	8,230	6,580	8,030	b7,640	6,080	7,640	7,700	11,800	9,150	8,300	8,190
13	7,140	7,820	8,000	(a)	6,590	7,560	7,580	7,620	11,600	9,210	8,900	8,180
14	7,170	6,700	8,460	(a)	8,080	8,000	7,810	8,180	11,300	9,240	8,940	8,480
15	7,290	8,060	8,730	(a)	7,590	8,020	7,050	8,270	9,430	8,920	8,680	8,540
16	6,980	8,350	8,430	6,640	7,790	7,950	6,570	7,660	(a)	9,510	8,690	7,400
17	7,450	8,100	7,940	(a)	8,120	7,870	7,290	7,980	(a)	9,010	8,550	7,750
18	7,770	8,270	7,480	(a)	7,940	7,170	7,440	7,850	9,510	9,400	8,360	7,710
19	7,510	8,260	(a)	(a)	7,450	6,030	7,380	8,120	9,800	9,450	8,280	7,810
20	7,460	8,040	(a)	(a)	6,560	8,080	7,600	7,920	9,290	9,210	7,840	7,830
21	7,280	6,540	(a)	(a)	8,140	8,050	7,730	7,860	9,940	9,270	8,720	8,040
22	7,480	8,430	(a)	(a)	7,860	7,320	7,400	8,160	10,500	9,100	8,720	8,050
23	7,540	8,630	(a)	13,000	8,220	7,600	7,120	8,500	10,300	8,720	8,370	6,570
24	7,400	8,480	(a)	12,100	8,150	8,180	7,460	7,610	9,500	9,110	8,480	7,310
25	7,850	6,700	(a)	11,400	8,170	7,820	7,660	7,580	9,220	9,100	8,650	7,700
26	7,840	8,420	6,640	10,600	7,720	7,510	7,640	7,700	9,770	9,000	8,380	7,460
27	7,970	8,220	(a)	10,600	6,530	10,300	7,610	8,700	10,200	8,760	8,240	7,420
28	7,940	6,560	(a)	10,800	8,320	12,300	7,470	7,890	9,970	8,850	8,670	7,620
29	7,890	8,040	(a)	9,430	7,890	12,400	6,970	7,800	9,500	8,690	8,300	7,740
30	7,380	8,530	(a)	8,920	.....	12,200	7,340	7,740	10,100	7,480	8,350	7,100
31	6,800	.....	(a)	10,600	.....	11,700	.....	8,150	.....	8,900	7,560	.....

a No record.
b Discharge partly estimated because of incomplete gage record.

NOTE.—Daily discharge in the above table does not include the flow in the Illinois & Michigan canal (see "Diversions" in the station description).

Monthly discharge of Des Plaines River at Joliet, Ill., for the year ending Sept. 30, 1916.

Month.	Discharge in second-feet.			Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.		Maximum.	Minimum.	Mean.
October	8,500	6,800	7,680	May	8,700	7,100	7,750
November	8,630	6,540	7,810	June	13,200	.....	.....
March	12,400	5,880	8,210	July	10,000	7,480	9,170
April	10,800	6,570	8,080	August	9,110	7,560	8,550

NOTE.—Discharge in the above table does not include flow of the Illinois & Michigan canal, which diverts water around the gage. See "Diversions" in station description and measurement of flow in the canal made Aug. 12.

FOX RIVER AT ALGONQUIN, ILL.

LOCATION.—In the NW. ¼ sec. 34, T. 43 N., R. 8 E. third principal meridian, at Chicago Street Bridge in Algonquin, McHenry County. about 100 feet above Public Service Co.'s dam and 500 feet above Crystal Lake outlet.

RECORDS AVAILABLE.—October 1, 1915, to September 30, 1916.

DRAINAGE AREA.—Not measured.

GAGE.—Enamel staff gage, attached to concrete abutment of bridge; read to hundredths twice daily by Edward Pedersen.

CHANNEL AND CONTROL.—Control is a concrete dam about 100 feet below gage; permanent.

DISCHARGE MEASUREMENTS.—Made from upstream side of bridge; at low stages made by wading below dam.

EXTREMES OF STAGE.—Maximum stage recorded during year, 5.3 feet at 6 p. m. March 31; minimum stage, 0.98 foot August 7 and 8.

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

DIVERSIONS.—Water diverted to operate grist mill at dam, which runs an average of about 4 hours a day, except Sundays, during September to March, inclusive. If total used for each day were uniformly distributed it would probably average less than 5 second-feet and never exceed 8 second-feet.

Date inadequate for determination of discharge.

Discharge measurements of Fox River at Algonquin, Ill., 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.*
Oct. 2[a]	William Kessler	2.82	2,730	Nov. 22[a]	William Kessler	1.46	639
2	do	2.84	2,420	29	do	1.88	993
12	do	2.29	1,460	Sept. 8	H. C. Beckman	1.22	368
16	do	2.18	1,380	8	do	1.22	353
27	do	1.88	1,010				

[a] Measurement made at railway bridge 1,000 feet below gage.

Daily gage height, in feet, of Fox River at Algonquin, Ill., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	2.8	1.70	1.95	1.41	3.2	2.2	4.7	2.35	1.6	1.8	1.02	1.14
2	2.85	1.65	2.0	1.45	3.0	2.2	4.5	2.3	1.6	1.75	1.02	1.14
3	2.85	1.65	2.0	1.49	3.0	2.1	4.4	2.25	1.6	1.7	1.00	1.14
4	2.8	1.60	2.0	1.55	2.95	2.0	4.3	2.25	1.55	1.65	1.00	1.14
5	2.75	1.60	1.95	1.6	2.85	1.95	4.1	2.25	1.55	1.65	.99	1.15
6	2.7	1.60	1.9	1.7	2.85	1.95	4.0	2.25	1.6	1.6	.98	1.18
7	2.65	1.55	1.85	1.7	2.8	1.85	3.8	2.25	1.9	1.55	.98	1.20
8	2.6	1.5	1.8	1.7	2.75	1.75	3.7	2.25	2.25	1.49	.99	1.22
9	2.55	1.5	1.8	1.7	2.7	1.7	3.5	2.2	2.65	1.42	1.04	1.22
10	2.4	1.48	1.75	1.7	2.65	1.65	3.3	2.15	2.75	1.37	1.12	1.22
11	2.35	1.44	1.75	1.7	2.65	1.65	3.0	2.1	2.75	1.33	1.17	1.22
12	2.3	1.40	1.7	1.7	2.6	1.7	2.9	2.05	2.8	1.29	1.18	1.24
13	2.25	1.40	1.7	1.7	2.55	1.7	2.8	2.05	2.8	1.25	1.18	1.24
14	2.25	1.40	1.7	1.65	2.5	1.75	2.75	2.0	2.8	1.20	1.18	1.24
15	2.20	1.40	1.65	1.65	2.4	1.8	2.65	1.95	2.8	1.15	1.18	1.24
16	2.15	1.42	1.65	1.6	2.3	1.85	2.6	1.9	2.75	1.11	1.18	1.24
17	2.15	1.44	1.6	1.55	2.15	1.85	2.5	1.85	2.75	1.10	1.18	1.31
18	2.15	1.46	1.55	1.55	2.1	1.9	2.4	1.8	2.7	1.10	1.17	1.35
19	2.20	1.46	1.5	1.5	2.05	1.9	2.35	1.8	2.65	1.10	1.16	1.36
20	2.15	1.49	1.5	1.5	2.05	1.9	2.35	1.8	2.6	1.10	1.16	1.36
21	2.15	1.48	1.48	1.65	2.05	1.85	2.35	1.8	2.55	1.10	1.16	1.36
22	2.10	1.46	1.46	1.8	2.1	2.0	2.35	1.8	2.5	1.08	1.16	1.38
23	2.05	1.46	1.46	2.10	2.25	1.9	2.4	1.75	2.4	1.07	1.16	1.40
24	2.0	1.46	1.44	2.5	2.30	1.95	2.4	1.7	2.3	1.06	1.16	1.41
25	1.95	1.50	1.42	2.85	2.35	2.2	2.45	1.65	2.25	1.06	1.16	1.41
26	1.90	1.6	1.42	2.95	2.4	2.55	2.45	1.6	2.2	1.06	1.15	1.42
27	1.9	1.65	1.42	3.3	2.4	3.3	2.5	1.6	2.1	1.05	1.15	1.42
28	1.85	1.75	1.41	3.5	2.35	3.8	2.45	1.6	2.05	1.04	1.14	1.43
29	1.85	1.9	1.40	3.5	2.25	4.1	2.4	1.6	2.0	1.04	1.14	1.44
30	1.8	1.95	1.38	3.4	.....	4.3	2.35	1.7	1.95	1.03	1.14	1.44
31	1.75	.....	1.38	3.3	.....	4.8	.....	1.65	.....	1.03	1.14	.....

FOX RIVER AT WEDRON, ILL.

LOCATION.—In sec. 9, T. 34 N., R. 4 E., at highway bridge at Wedron, La Salle County, about 1,000 feet above Buck Creek.

DRAINAGE AREA.—2,500 square miles.

RECORDS AVAILABLE.—November 5, 1914, to September 30, 1916.

GAGE.—Chain gage attached to bridge; read by Burt Hathaway.

DISCHARGE MEASUREMENTS.—Made from upstream side of bridge.

CHANNEL AND CONTROL.—Bed of river at measuring section is soft and probably shifts. Control about 1,000 feet downstream composed of coarse gravel and large boulders; seldom shifts.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 15.4 feet at 5 p. m. February 3 (discharge not determined because of backwater from ice). Maximum open-water stage recorded, 13.8 feet at 6 a. m. March 28 (discharge, 16,700 second-feet); minimum stage recorded during year, 5.71 feet at 6 p. m. September 9 (discharge, 280 second-feet).

1915–16: Maximum stage recorded, same as for 1916. Minimum stage recorded, 5.62 feet November 20, 1914 (discharge, 105 second-feet, by current-meter measurement).

REGULATION.—Slight diurnal fluctuation is caused by operation of power plants at and above Montgomery.

ACCURACY.—Stage-discharge relation changed slightly by high water and ice jams during winter; seriously affected by ice during winter. Rating curve used to January 20 well defined; curve used after that date well defined between 275 and 11,300 second-feet, and fairly well defined beyond these limits. Gage read to hundredths twice daily. Diurnal fluctuation only slight. Daily discharge ascertained by applying mean daily gage heights to rating tables. Records good for open-water periods and poor for winter period.

Discharge measurements of Fox River at Wedron, Ill., during the year ending Sept. 30, 1916.

[Made by H. C. Beckman.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Mar. 29	11.33	9,420	Aug. 24	5.85	355
Aug. 24	5.91	388			

Daily discharge, in second-feet, of Fox River at Wedron, Ill., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	3,200	1,140	1,810				9,340	2,170	1,360	1,040	428	417
2	3,200	1,190	1,700				9,340	2,300	1,930	954	502	411
3	3,030	1,000	1,700				8,530	2,300	1,460	997	423	428
4	3,030	1,090	1,490				8,010	2,170	1,260	954	405	417
5	2,870	1,040	1,700				7,230	2,050	1,080	871	399	360
6	2,870	1,000	1,640				6,710	1,930	1,260	830	394	638
7	2,720	1,000	1,700				5,980	1,930	3,020	790	377	603
8	2,570	1,040	1,540				5,520	1,820	6,220	751	394	568
9	2,430	1,000	1,540			1,800	5,080	1,820	8,270	712	377	568
10	2,300	910	1,490	1,370			4,660	1,660	6,460	790	399	568
11	2,170	910	1,390				4,250	1,560	5,520	712	502	411
12	2,170	865	1,340				3,680	1,460	5,080	603	502	471
13	2,050	820	1,240				3,500	1,510	4,450	568	471	638
14	2,050	694	1,240				3,330	2,570	5,300	603	423	568
15	1,930	616	1,140		2,700		3,020	1,360	5,980	603	440	535
16	1,810	1,000	1,090				2,720	2,050	4,660	568	502	535
17	1,810	865	1,190			1,220	2,720	1,660	4,450	535	434	568
18	1,930	865	1,040			1,260	2,570	1,510	4,050	568	423	502
19	2,300	1,000	1,000			1,310	2,430	1,460	3,680	568	399	603
20	2,050	1,190				1,260	2,570	1,410	3,500	568	399	568
21	1,930	1,090				1,360	2,430	1,410	4,450	603	411	568
22	1,810	955				2,050	2,170	1,360	3,860	568	502	568
23	1,810	1,090				1,820	2,170	1,510	3,680	535	535	568
24	1,590	955				2,570	2,170	1,310	3,170	535	411	568
25	1,590	1,000	950			5,520	2,300	1,260	2,720	471	394	502
26	1,640	1,000		7,400		5,080	2,170	1,220	2,430	440	399	638
27	1,490	1,440				14,000	2,170	1,180	2,570	471	382	638
28	1,390	1,490				15,500	2,170	1,040	2,300	434	382	568
29	1,340	1,490				9,900	2,170	954	2,050	428	440	568
30	1,340	1,700			.....	8,800	2,050	1,310	1,930	751	440	568
31	1,240	.....			.....	8,530	.....	1,310	.....	344	411	.....

NOTE.—Discharge Dec. 20 to Mar. 16 estimated, because of ice, from gage heights and weather records.

Monthly discharge of Fox River at Wedron, Ill., for the year ending Sept. 30, 1916.

[Drainage area, 2,500 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	3,200	1,240	2,120	0.848	0.98
November	1,700	616	1,050	.420	.45
December	1,810	.....	1,240	.496	.57
January	.....	.....	3,510	1.40	1.61
February	.....	.....	2,700	1.08	1.16
March	15,500	.....	3,520	1.41	1.63
April	9,340	2,050	4,110	1.64	1.83
May	2,570	954	1,630	.652	.75
June	8,270	1,080	3,600	1.44	1.61
July	1,040	344	650	.260	.30
August	535	377	429	.172	.20
September	638	360	538	.215	.24
The year	.....	344	2,080	.832	11.33

VERMILION RIVER NEAR STREATOR, ILL.

LOCATION.—In sec. 1, T. 30 N., R. 3 E. third principal meridian, at highway bridge known as Bridge No. 3, about 1½ miles south of Streator, La Salle County, and 100 feet below the Santa Fe Railway bridge.

DRAINAGE AREA.—1,080 square miles.

RECORDS AVAILABLE.—July 27, 1914, to September 30, 1916.

GAGE.—Chain gage attached to highway bridge; read by Mark Morse.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge.

CHANNEL AND CONTROL.—Gravel and rocks; probably permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 22.4 feet at 4 p. m. January 21 (discharge estimated from extension of rating curve, 16,000 second-feet); minimum stage, 0.49 foot, August 23 and August 30 to September 2 (discharge, 0.9 second-foot).

1914–1916: Maximum stage recorded, 22.4 feet January 21, 1916, (discharge estimated from extension of rating curve, 16,000 second-feet); minimum stage 0.45 foot August 16 and 17, 1914 (discharge, 0.7 second-foot).

ACCURACY.—Stage-discharge relation practically permanent; seriously affected by ice during periods in December, January, and February. Rating curve well defined between 300 and 2,500 second-feet, and fairly well defined between 10 and 300 second-feet and between 2,500 and 12,000 second-feet. Gage read to hundredths twice daily until August 22, and once daily after that date. Daily discharge ascertained by applying mean daily gage heights to rating table. Records good except for extreme low stages and for periods of ice effect, for which they are poor.

Discharge measurements of Vermilion River near Streator, Ill., during the year ending Sept. 30, 1916.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Jan. 22	Trinkaus and Bardon	17.74	[a] 11,300
Aug. 23[b]	H. C. Beckman	.62	2.2

[a] Much ice and debris floating. [b] Measurement made by wading.

Daily discharge, in second-feet, of Vermilion River near Streator, Ill., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	1,300	133	205			620	1,910	265	1,130	495	7.7	0.9
2	1,130	129	171			434	1,800	265	1,650	434	7.3	.9
3	930	123	171			404	1,550	278	1,750	389	6.0	1.6
4	818	115	150			404	1,350	305	1,350	434	4.7	1.8
5	716	107	148			464	1,130	291	1,050	375	3.3	1.8
6	620	105	125			495	1,010	265	930	291	2.8	1.3
7	557	104	131			783	891	305	1,970	240	3.6	1.2
8	495	102	127		1,230	783	749	375	2,210	205	4.2	1.0
9	464	95	125			588	684	783	2,640	169	3.3	1.6
10	419	91	111			557	620	716	2,510	152	2.4	1.3
11	389	95	117	1,350		532	557	588	1,850	135	8.6	1.0
12	346	88	129			506	526	464	1,650	127	45	1.0
13	346	78				481	495	404	1,500	100	19	1.8
14	318	77				455	464	1,130	1,250	86	6.9	2.0
15	291	77				430	434	2,640	1,170	74	3.9	1.8
16	278	75			526	404	464	3,880	1,090	65	2.4	1.8
17	278	75			495	419	434	3,720	854	55	3.0	2.5
18	291	75			495	495	375	2,990	749	48	1.9	2.4
19	291	83			557	404	389	2,390	684	23	1.4	1.8
20	278	100			557	434	407	1,700	652	2.4	1.2	1.4
21	265	121	85	13,100	557	389	375	1,300	1,850	1.2	2.5	1.4
22	240	125		12,800	557	419	346	1,090	1,910	4.9	3.6	1.3
23	216	121		5,240	652	434	305	891	3,270	11	.9	1.0
24	204	107		3,880	749	434	305	783	2,990	14	1.0	2.5
25	193	105		3,200	749	495	291	749	1,750	16	1.0	1.6
26	182	117		2,570	749	557	278	652	1,600	14	1.3	1.6
27	171	117		2,990	620	1,800	278	684	1,130	16	1.3	1.6
28	167	129		2,640	495	2,920	265	818	818	14	1.3	2.5
29	158	152		2,570	495	2,570	252	1,050	716	12	1.2	3.0
30	150	165		3,560	.....	2,150	228	1,050	588	12	.9	2.5
31	146	.....		5,400	.....	1,970	.....	1,130	.....	9	.9	.....

NOTE.—Discharge, Mar. 11–15, interpolated; Dec. 13 to Jan. 20, and Feb. 1–15 estimated, because of ice, from gage heights, weather records, and odserver's notes.

Monthly discharge of Vermilion River near Streator, Ill., for the year ending Sept. 30, 1916.

[Drainage area, 1,080 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	1,300	146	408	0.378	0.44
November	165	75	106	.098	.11
December	205	.....	107	.099	.11
January	13,100	.....	2,740	2.54	2.93
February	.....	.....	921	.853	.92
March	2,920	389	782	.724	.83
April	1,910	228	639	.592	.66
May	3,880	265	1,100	1.02	1.18
June	3,270	588	1,510	1.40	1.56
July	495	1.2	130	.120	.14
August	45	.9	4.98	.0046	.005
September	3.0	.9	1.66	.0015	.002
The year	13,100	.9	704	.652	8.89

SPOON RIVER AT SEVILLE, ILL.

LOCATION.—In sec. 24, T. 6 N., R. 1 E., fourth principal meridian, at the Toledo, Peoria & Western Railway bridge about a quarter of a mile east of the railway station at Seville, Fulton County.

DRAINAGE AREA.—1,600 square miles.

RECORDS AVAILABLE.—July 24, 1914, to September 30, 1916.

GAGE.—Chain gage attached to bridge; read to hundredths once daily, by A. E. Myers till January 8, and by J. M. Lance after that date.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge; low-water measurements are made by wading below dam at railroad station.

CHANNEL AND CONTROL.—Control is a loose rock dam, about 2 miles downstream from gage, used to create a reservoir for the pumping station of the Toledo, Peoria & Western Railway.

EXTREMES OF STAGE.—Maximum stage recorded during the year, 26.0 feet at 7 a. m. January 23; minimum stage, 2.00 feet at 6 a. m. July 29.

1914–1916: Maximum stage recorded, 26.0 feet January 23, 1916; minimum stage, 1.35 feet July 31 and August 28 and 29, 1914.

DIVERSIONS.—Water pumped from reservoir at the pumping station of the Toledo Peoria & Western Railway; amount not known.

ICE.—Stage-discharge relation affected by ice during part of winter.

Data inadequate for determination of discharge.

The following discharge measurement was made by H. C. Beckman:

August 21, 1916: Gage height, 2.80 feet; discharge, 128 second-feet.

Daily gage height, in feet, of Spoon River at Seville, Ill., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	4.3	3.2	4.9	11.2	8.8	4.7	8.0	4.4	6.5	5.4	2.60	2.20
2	4.0	3.1	4.9	11.2	6.9	4.3	9.0	4.6	6.2	5.3	2.70	2.20
3	4.1	3.0	4.9	12.0	6.0	4.3	8.5	4.7	9.8	5.3	3.1	2.25
4	3.9	3.0	4.7	12.0	9.0	4.0	7.7	4.6	9.8	5.1	3.0	2.20
5	3.8	2.90	4.5	11.0	9.6	4.0	7.1	4.6	7.3	5.0	2.80	2.30
6	3.8	3.0	4.3	10.0	9.3	4.3	6.5	4.4	6.1	4.3	2.80	4.2
7	3.7	3.0	4.3	9.0	9.0	4.9	6.2	4.3	6.9	3.6	2.70	3.85
8	3.7	3.0	4.4	7.0	8.1	4.3	6.0	4.2	8.0	3.3	3.1	3.5
9	3.3	3.0	4.5	5.4	8.0	4.5	5.8	4.1	7.5	3.6	2.70	3.1
10	6.6	3.0	4.3	5.6	7.8	4.2	5.5	4.0	7.5	3.6.	2.60	2.80
11	5.0	3.0	4.3	4.9	7.7	4.3	5.3	3.9	7.1	3.5	3.3	2.60
12	4.8	2.90	4.45	7.5	7.4	4.1	5.2	3.8	6.5	3.5	4.2	2.55
13	3.4	2.90	4.4	9.2	6.9	4.0	5.1	4.9	6.0	3.4	5.5	4.2
14	3.5	2.80	4.2	8.5	6.4	4.1	5.2	9.6	5.7	3.4	4.3	4.9
15	3.6	2.80	4.2	8.0	6.3	4.0	5.0	9.1	5.4	3.4	3.7	4.6
16	3.5	2.70	4.2	8.0	6.1	3.9	4.9	8.6	5.4	3.3	3.1	3.5
17	3.4	2.69	4.2	7.5	8.5	3.8	5.0	7.0	6.1	3.2	3.0	3.5
18	3.0	2.69	4.4	7.1	12.5	3.9	5.0	6.2	5.5	3.2	3.6	2.85
19	3.7	2.80	4.3	6.8	12.3	3.9	4.8	5.7	5.0	3.1	3.2	2.60
20	3.6	3.0	4.2	6.5	7.5	3.8	4.9	5.4	4.8	3.1	2.90	3.5
21	3.6	3.0	4.15	22.4	6.5	3.8	5.2	5.6	11.0	3.0	2.80	2.60
22	3.4	3.0	3.3	24.4	6.3	4.0	5.2	5.4	11.9	3.0	2.70	2.50
23	3.0	3.1	3.4	26.0	6.9	4.0	5.0	5.7	7.8	3.0	2.65	2.40
24	2.90	3.2	4.0	23.0	10.5	4.1	4.8	6.7	6.5	2.80	2.95	2.50
25	2.90	3.3	4.0	20.3	8.5	4.1	4.6	9.8	5.3	2.80	2.70	2.40
26	2.80	4.0	4.0	7.5	5.6	4.6	4.6	8.1	5.7	2.50	2.55	2.40
27	2.90	5.8	4.0	12.8	5.0	7.8	4.6	9.5	5.4	2.40	2.55	2.50
28	2.60	6.7	3.8	15.0	4.7	13.2	4.5	11.8	5.0	2.40	2.50	2.90
29	2.80	6.0	3.8	17.0	4.4	13.0	4.4	8.5	4.8	2.00	2.40	3.1
30	3.3	5.0	3.7	15.3	.....	10.7	4.3	7.7	4.6	2.80	2.30	2.85
31	3.2	.....	3.7	11.5	.....	9.1	.....	7.3	.....	2.60	2.20	.....

NOTE.—Stage-discharge relation probably affected by ice about Jan. 5 to Feb. 20.

SANGAMON RIVER AT MONTICELLO, ILL.

LOCATION.—In sec. 12, T. 18 N., R. 5 E., third principal meridian, at the Illinois Central Railroad bridge about half a mile west of Monticello, Piatt County.

DRAINAGE AREA.—550 square miles.

RECORDS AVAILABLE.—February 4, 1908, to December 31, 1912; June 23, 1914, to September 30, 1916.

GAGE.—Chain gage attached to downstream side of bridge; read by David Coay.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge and wooden trestle approach.

CHANNEL AND CONTROL.—Measuring section is at a pool; control consists of fine gravel; likely to shift.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 13.7 feet January 31 and February 1 (discharge, 5,020 second-feet); minimum stage, 1.6 feet at 7 a. m. September 5 (discharge, 5 second-feet).

Maximum stage recorded during periods of records, 15.2 feet May 14, 1908 (discharge, 9,280 second-feet); maximum stage during flood of March to April, 1913, 17.7 feet March 25 (discharge not known); minimum stage recorded during periods of records, 1.5 feet July 31, August 1 and 3, 1914 (discharge, 1 second-foot).

ACCURACY.—Stage-discharge relation changed slightly during high water in February and March, 1916; affected by ice during periods in December, January, and February. Rating curves fairly well defined between 5 and 3,200 second-feet. Gage read to hundredths once daily. Daily discharge ascertained by applying mean daily gage heights to rating table. Record good except for extreme low stages, and for periods of ice effect, for which they are poor.

Discharge measurements of Sangamon River at Monticello, Ill., during the year ending Sept. 30, 1916.

[Made by H. C. Beckman.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
June 13	3.69	140	Aug. 17	1.93	14.3
14	3.61	128	17	1.93	13.7

Daily discharge, in second-feet, of Sangamon River at Monticello, Ill., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	322	69	60			599	862	159	526	109	11	6.5
2	306	69	52			544	822	159	439	96	11	6.5
3	266	69	52			456	782	159	354	83	12	6.5
4	226	69	51			388	736	170	290	113	12	6.5
5	226	69	49			405	599	159	226	113	12	5.0
6	210	65	48		1,930	422	562	159	194	87	12	9.2
7	165	65	48			526	526	154	210	72	11	8.0
8	165	65	43			782	490	148	194	59	11	10
9	158	65	48			715	448	148	194	54	10	10
10	140	65	48			618	405	138	194	48	10	10
11	140	65	73	1,150		544	371	128	176	43	16	10
12	134	65	96		490	508	371	138	159	39	14	8.0
13	134	63	100		430	473	338	138	138	39	14	8.0
14	124	62	100		371	422	322	154	128	37	14	8.0
15	119	62	100		338	422	322	170	138	34	21	8.0
16	100	62	100		322	456	306	490	138	34	16	8.0
17	104	60	109		473	456	290	736	148	35	16	8.0
18	114	55	86		618	456	274	736	133	36	16	8.0
19	114	73	93		695	448	258	526	119	29	15	6.5
20	114	73	100		666	439	274	388	104	25	14	6.5
21	124	78	100		637	422	290	339	109	27	14	6.5
22	109	78	100		618	439	242	292	104	22	14	6.5
23	104	74	104	1,910	834	422	218	274	338	22	14	6.5
24	100	69	109	2,140	891	388	194	226	490	21	13	6.5
25	100	62		1,760	1,290	354	194	194	439	21	10	6.5
26	96	62		1,160	1,190	396	170	194	388	11	10	6.5
27	91	60	110	1,070	998	439	170	210	242	17	9.0	6.5
28	86	57		1,220	807	675	170	333	226	16	8.0	8.0
29	86	62		1,440	675	1,040	159	456	194	16	7.4	8.0
30	82	60		3,230	.....	1,130	159	562	148	14	6.5	8.0
31	86	.....		5,020	.....	1,040	.....	562	.....	12	6.5	.....

NOTE.—Discharge interpolated for Oct. 3, Nov. 23, Dec. 19, Jan. 30, June 19, and for Sundays between Feb. 23 and Sept. 30; estimated for Dec. 25–31, Jan. 1–22, and Feb. 1–11, because of ice, from gage heights and weather records.

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Monthly discharge of Sangamon River at Monticello, Ill., for the year ending Sept. 30, 1916.

[Drainage area, 550 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	322	82	143	0.260	0.30
November	78	55	65.7	.119	.13
December	.....	43	85.1	.155	.18
January	5,020	.....	1,430	2.60	3.00
February	.....	322	1,160	2.11	2.28
March	1,130	354	543	.987	1.14
April	862	159	377	.685	.76
May	736	128	284	.516	.59
June	526	104	229	.416	.46
July	113	11	44.6	.081	.09
August	21	6.5	12.3	.022	.03
September	10	5.0	7.6	.014	.02
The year	5,020	5.0	363	.660	8.98

SANGAMON RIVER AT RIVERTON, ILL.

LOCATION.—In the southeast corner of the SW. ¼ sec. 9, T. 16 N., R. 4 W. third principal meridian, at the Wabash Railroad bridge about a quarter of a mile west of Riverton, Sangamon County, and 2½ miles below the mouth of South Fork.

DRAINAGE AREA.—2,560 square miles.

RECORDS AVAILABLE.—February 13, 1908, to December 31, 1912; August 7, 1914, to September 30, 1916.

GAGE.—Chain gage attached to bridge; read by J. H. Steele.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge.

CHANNEL AND CONTROL.—Measuring section is at a pool; control consists of fine gravel and shifts slightly.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 27.8 feet at 8 a. m. February 3 (discharge, 20,800 second-feet); minimum stage, 7.18 feet at 8 a. m. September 23 (discharge, 17 second-feet).

1908–1912; 1914–1916: Maximum stage recorded, 27.8 feet February 3, 1916 (discharge, 20,800 second-feet); high water of 1883 reached a height of approximately 32 feet on the present gage, and that of 1875 is said to have been one-half foot lower (discharge not estimated); minimum stage recorded, 6.9 feet October 3–15, 1915 (discharge, 3 second-feet).

ACCURACY.—Stage-discharge relation practically permanent; probably affected by ice at times in December and January. Rating curve well defined between 44 and 4,400 second-feet, and fairly well defined between 4,400 and 16,000 second-feet. Gage read to hundredths once daily. Daily discharge ascertained by applying daily gage heights to rating table. Records good except for extremely high and low stages and for periods of ice effect for which they are poor.

Discharge measurements of Sangamon River at Riverton, Ill., during the year ending Sept. 30, 1916.

[Made by H. C. Beckman.]

Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*
Aug. 18	7.80	83.9
18	7.81	84.7

Discharge, in second-feet, of Sangamon River at Riverton, Ill., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	1,060	263	240	920	16,500	4,310	2,160	792	1,500	728	83	24
2	990	263	240	3,200	20,400	3,490	2,320	792	1,710	728	55	20
3	920	252	240	5,330	20,800	2,920	2,380	760	1,620	634	133	20
4	824	240	240	6,220	17,200	2,480	2,300	760	1,240	542	85	20
5	728	228	228	6,450	13,700	2,100	2,210	856	1,060	460	83	24
6	728	228	217	6,680	12,100	1,920	2,000	792	1,200	460	76	24
7	603	240	217	6,560	10,700	2,320	1,870	792	1,420	359	56	53
8	603	228	217	6,220	9,280	2,760	1,750	792	1,620	359	91	63
9	572	228	199	5,520	7,860	2,870	1,620	728	1,710	311	99	65
10	542	217	196	4,840	5,900	2,920	1,540	696	1,580	287	70	65
11	486	217	194		4,620	2,820	1,420	665	1,310	287	71	33
12	460	212	287		4,010	2,600	1,350	665	990	263	83	34
13	460	217	665		3,260	2,380	1,310	665	990	240	71	35
14	434	217	760		2,650	2,160	1,200	665	888	194	152	32
15	434	208	792		2,210	2,000	1,200	728	792	240	85	32
16	384	206	824	6,520	1,960	1,920	990	760	696	172	91	31
17	384	206	824		2,380	1,790	1,100	792	696	172	82	27
18	359	206	920		3,200	1,750	1,020	856	696	199	73	23
19	384	208	990		3,490	1,710	1,020	1,020	696	181	65	23
20	384	217	920		3,720	1,620	1,060	1,130	728	172	56	24
21	384	228	920	8,010	3,900	1,620	1,100	1,130	824	263	55	27
22	384	240	856	8,780	3,950	1,540	1,060	1,020	2,980	217	55	31
23	359	240	792	8,620	4,490	1,540	990	888	3,430	513	56	17
24	335	240	760	7,720	5,520	1,460	990	856	3,040	384	56	19
25	335	240	728	7,180	6,450	1,390	955	824	2,870	183	55	19
26	311	240		6,680	6,680	1,390	920	760	990	172	55	19
27	287	228		6,450	5,800	1,540	920	792	2,480	133	55	47
28	287	217	555	6,450	5,420	1,870	888	1,020	1,960	133	44	166
29	287	217		6,800	4,910	1,790	824	1,350	1,460	99	35	80
30	287	240		8,780	.....	1,920	824	1,420	1,020	91	22	78
31	263	.....		11,500	.....	2,050	.....	1,540	.....	70	25	.....

NOTE.—Discharge, Apr. 4 and Aug. 17–19, interpolated; Dec. 26–31, and Jan. 11–20 estimated, because of ice, from gage heights, weather records, and observer's notes.

Monthly discharge of Sangamon River at Riverton, Ill., for the year ending Sept. 30, 1916.

[Drainage area, 2,560 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	1,060	263	492	0.192	0.22
November	263	206	228	.089	.10
December	990	194	542	.212	.24
January	11,500	920	6,580	2.57	2.96
February	20,800	1,960	7,350	2.87	3.10
March	4,310	1,390	2,160	.844	.97
April	2,380	824	1,380	.539	.60
May	1,540	665	881	.344	.40
June	3,430	696	1,470	.574	.64
July	728	70	298	.116	.13
August	152	22	70.1	.027	.03
September	166	17	39.2	.015	.02
The year	20,800	17	1,770	.691	9.41

SANGAMON RIVER NEAR OAKFORD, ILL.

LOCATION.—In sec. 6, T. 19 N., R. 7 W., third principal meridian, at highway bridge 3 miles northeast of Oakford, Menard County, 2½ miles above the Chicago, Peoria & St. Louis Railway bridge, and 1¼ miles above the mouth of Crane Creek.

DRAINAGE AREA.—5,000 square miles.

RECORDS AVAILABLE.—October 26, 1909, to June 30, 1911; December 10, 1911, to March 31, 1912; and August 25, 1914, to September 30, 1916.

GAGE.—Chain gage attached to bridge; read to hundredths twice daily by Androv Peterson to March 4, and by E. G. Duvall after March 12.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge.

CHANNEL AND CONTROL.—Bed composed of sand and fine gravel; shifting. The river for some distance above and below station has been dredged and straightened, thus increasing the slope considerably and disturbing the regimen of flow.

EXTREMES OF STAGE.—Maximum stage recorded during parts of year for which records were obtained, 19.1 feet at 10 a. m. February 5; minimum stage 0.65 foot at 2 p. m. September 27.

Maximum stage recorded during periods of records, 20.6 feet October 4, 1911 (discharge, 26,300 second-feet); minimum stage recorded, 0.1 foot, December 21, 22, 24, 25, and 31, 1914 (discharge not determined).

ICE.—Stage-discharge relation may have been affected by ice during parts of winter.

Data inadequate for determination of daily discharge.

The following discharge measurement was made by H. C. Beckman:

August 19, 1916: Gage height, 1.24 feet; discharge, 301 second-feet.

Daily gage height, in feet, of Sangamon River near Oakford, Ill., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	5.7	2.7	2.2	5.0	.....	.....	8.2	4.1	6.6	4.0	1.40	.....
2	5.7	2.7	2.1	7.6	.....	9.8	8.1	4.1	6.4	3.6	1.40	.....
3	5.4	2.6	2.05	10.3	.....	8.8	8.0	4.1	6.2	3.4	1.35	0.90
4	5.2	2.6	2.05	11.8	18.6	8.0	8.0	4.1	5.9	3.2	1.30	.82
5	5.0	2.6	2.1	12.0	19.1	.....	7.7	4.1	5.4	3.0	1.20	.80
6	4.7	2.5	2.2	12.1	.....	.....	7.4	4.1	5.2	2.8	1.20	.80
7	4.5	2.5	2.3	12.0	17.3	.....	7.0	4.0	5.6	2.6	1.20	.80
8	4.3	2.45	2.2	11.7	.....	.....	6.7	3.9	5.8	2.5	1.85	.78
9	4.1	2.4	2.2	11.4	14.2	.....	6.4	3.8	6.0	2.4	1.55	.80
10	4.0	2.35	2.2	11.0	.....	.....	6.2	3.7	5.8	2.3	1.35	.75
11	3.9	2.35	2.3	10.5	.....	.....	6.0	3.6	5.4	2.2	1.85	.75
12	3.8	2.4	2.4	11.0	.....	7.5	5.8	3.6	5.1	2.2	2.1	.75
13	3.7	2.4	2.6	12.5	.....	7.4	5.6	3.7	4.8	2.2	2.25	.82
14	3.7	2.4	2.7	12.2	.....	7.0	5.5	5.8	4.6	2.25	1.9	.78
15	3.6	2.4	3.1	12.7	.....	6.8	5.4	6.2	4.4	2.2	1.7	.75
16	3.5	2.35	3.6	14.1	.....	6.6	5.4	6.9	4.2	2.05	1.35	.75
17	3.5	2.3	3.5	15.5	.....	6.4	5.2	6.9	4.0	1.95	1.30	.75
18	3.4	2.25	3.5	14.8	.....	6.3	5.0	6.5	4.0	1.85	1.30	.75
19	3.4	2.3	3.5	15.2	.....	6.2	4.9	6.1	3.9	1.8	1.30	.75
20	3.4	2.35	3.6	15.9	.....	6.0	4.9	5.8	3.8	1.75	1.08	.75
21	3.3	2.35	3.6	16.6	.....	5.9	4.9	5.7	3.9	1.9	1.14	.75
22	3.3	2.35	3.7	18.8	.....	5.9	4.8	5.6	4.3	2.0	1.12	.75
23	3.2	2.35	3.6	17.7	.....	5.9	4.8	5.2	6.2	2.1	1.09	.....
24	3.2	2.35	3.6	17.3	.....	5.8	4.6	5.2	6.9	2.05	1.04	.70
25	3.2	2.25	3.3	16.5	.....	5.6	4.6	5.2	6.6	1.95	1.00	.70
26	3.2	2.5	3.3	14.8	.....	.....	4.5	5.1	6.2	1.75	1.00	.68
27	3.0	3.0	3.1	13.7	.....	.....	4.5	5.9	5.6	1.7	1.00	.65
28	2.9	2.8	3.1	13.2	.....	.....	4.4	6.3	5.7	1.6	1.00	.70
29	2.8	2.45	3.0	13.1	.....	.....	4.3	6.4	5.2	1.6	1.00	.74
30	2.8	2.3	3.0	.....	.....	.....	4.2	6.6	4.8	1.5	1.00	.80
31	2.8	.....	3.3	.....	.....	.....	.....	7.0	.....	1.40	.97	.....

NOTE.—Stage-discharge relation possibly affected by ice during parts of winter. Accuracy of gage readings March to September, doubtful.

SOUTH FORK OF SANGAMON RIVER NEAR TAYLORVILLE, ILL.

LOCATION.—In sec. 8, T. 12 N., R. 2 W., at the Wabash Railroad bridge about 3½ miles southwest of Taylorville, Christian County, and about a quarter of a mile upstream from highway bridge known as Half Acre Bridge.

DRAINAGE AREA.—427 square miles.

RECORDS AVAILABLE.—February 11, 1908, to December 31, 1912; August 8, 1914, to September 30, 1916.

GAGE.—Chain gage attached to bridge; read to hundredths once daily by Louis Seelbach. On September 2, 1909, gage datum was lowered 2 feet. The gage heights to August 10, 1909, refer to old datum; those from August 11 to September 1, 1909, are of no value because of backwater from a construction dam built and used during that period. Gage heights from September 2, 1909, to December 31, 1912, refer to new datum. On August 8, 1914, the datum was changed by an unknown amount, all bench marks being destroyed during construction of a new concrete steel-plate girder bridge. Gage heights subsequent to August 8, 1914, refer to the datum used in reestablishing the gage on that date.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge; at low stages by wading below gage.

CHANNEL AND CONTROL.—In August, 1909, a drainage ditch was dug along the river in the vicinity of the station, which straightened the course of the stream, but coincided with the original channel at the gaging section. Though the cross-section of the channel at the measuring section was not changed, the stage-discharge relation was considerably affected by the change in slope. Subsequent to 1912 a new bridge was built, and since then the stage-discharge relation has again changed. Measuring section is in a pool; control likely to shift.

EXTREMES OF STAGE.—Maximum stage recorded during year, 16.1 feet at 1 p. m. January 31; minimum stage, 1.14 feet September 15, 25, and 27.

1914–1916: Maximum stage recorded, 16.1 feet January 31, 1916; minimum stage, 0.56 foot October 6, 1914.

Data inadequate for determination of discharge.

Discharge measurements of South Fork of Sangamon River near Taylorville, Ill., during the year ending Sept. 30, 1916.

[Made by H. C. Beckman.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
June 8	5.32	321	Sept. 15	1.17	[a]1.0
13	3.26	[a]76	15	1.17	[a].9

[a] Measurement made by wading below gage. Brush in channel may have caused backwater.

Daily gage height, in feet, of South Fork of Sangamon River near Taylorville, Ill., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	3.3	3.2	3.3	4.9	15.2	6.4	4.8	3.7	3.6	3.7	1.64	1.23
2	3.1	3.2	3.3	9.0	12.3	.....	4.8	3.7	3.6	3.35	1.47	1.33
3	3.0	3.15	3.25	10.2	11.0	5.7	4.8	3.7	3.7	3.1	1.64	1.29
4	2 95	3.2	3.3	10.7	10.1	5.4	4.7	3.8	3.8	2.9	1.54	1.25
5	2.8	3.2	3.25	10.2	9.2	5.2	4.6	3.9	3.6	2.9	1.45	1.22
6	2.7	3.2	3.25	9.6	8.5	5.4	4.5	3.8	3.6	2.75	1.35	1.36
7	2.65	3.2	3.25	9.0	7.2	6.8	4.4	3.7	3.45	2.7	1.28	2.6
8	2.6	3.2	3.2	8.5	6.3	7.8	4.4	3.6	5.3	2.5	1.34	2.65
9	2.55	3.25	3.2	7.9	5.8	7.5	4.3	3.5	5.0	2.4	1.52	2.05
10	2.5	3.2	3.25	7.4	5.4	7.0	4.3	3.4	4.5	2.35	1.40	1.54
11	2.45	3.2	3.6	7.4	5.2	6.5	4.3	3.3	3.9	2.25	1.36	1.32
12	2.45	3.25	4.4	9.4	5.2	6.2	4.2	3.3	3.7	2.2	1.44	1.22
13	2.50	3.3	5.2	13.0	5.3	5.9	4.1	3.3	3.45	2.15	1.46	1.23
14	2.55	3.3	5.2	13.4	5.1	5.8	4.0	3.3	3.2	2.6	1.62	1.18
15	2.6	3.3	4.7	12.5	4.8	5.6	4.0	3.4	3.1	2.85	1.84	1.14
16	2.65	3.3	4.4	11.6	4.8	5.4	3.9	3.6	3.05	2.4	1.90	1.16
17	2.7	3.25	4.8	10.9	5.9	5.2	3.9	4.6	3.0	2.3	1.88	1.15
18	2.75	3.25	5.7	10.3	6.8	4.9	3.8	4.2	2.95	2.3	1.81	1.16
19	3.05	3.3	6.0	9.7	7.8	5.0	3.8	3.8	2.9	2.15	1.48	1.16
20	3.2	3.45	5.6	8.9	7.7	4.8	3.8	3.5	3.2	2.1	1.36	1.16
21	3.2	3.45	5.0	8.6	7.4	4.7	4.2	3.4	7.3	3.45	1.30	1.22
22	3.1	3.45	4.8	9.1	7.4	4.7	4.2	3.35	9.3	2.6	1.27	1.20
23	3.1	3.4	4.6	9.6	8.4	4.7	4.1	3.3	10.0	2.45	1.24	1.18
24	3.05	3.35	4.6	9.6	8.9	4.6	4.0	3.25	9.7	2.2	1.23	1.16
25	3.05	3.35	4.6	9.1	9.1	4.6	3.8	3.2	9.0	2.0	1.21	1.14
26	3.05	3.25	4.0	8.4	9.0	4.6	3.8	3.15	7.1	1.88	1.21	1.15
27	3.05	3.3	4.5	7.9	8.4	4.7	3.9	3.2	5.8	1.79	1.23	1.14
28	3.1	3.3	4.4	8.4	7.6	5.0	3.9	3.3	5.0	1.70	1.20	1.37
29	3.1	3.3	4.6	9.0	6.9	5.0	3.8	3.6	4.5	1.64	1.22	1.28
30	3.15	3.3	4.9	11.4	.....	5.0	3.7	3.7	4.1	1.58	1.20	1.22
31	3.2	.....	4.8	16.0	.....	4.9	.....	3.6	.....	1.49	1.21	.....

NOTE.—Stage-discharge relation probably affected by ice about Dec. 25 to Jan. 8.

KASKASKIA RIVER AT VANDALIA, ILL.

LOCATION.—In sec. 16, T. 6 N., R. 1 E. third principal meridian, at highway bridge at east end of Main Street, Vandalia, Fayette County, about 3½ miles above Hickory Creek.

DRAINAGE AREA.—1,980 square miles.

RECORDS AVAILABLE.—February 26, 1908, to December 31, 1912; August 11, 1914, to September 30, 1916.

GAGE.—Chain gage attached to bridge; read by Wilson Haley.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge.

CHANNEL AND CONTROL.—Measuring section is at a pool; may shift.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 22.0 feet, January 31 (discharge, 14,400 second-feet); minimum stage recorded, 0.53 foot September 26 (discharge, 19 second-feet).

1908–1912; 1914–1916: Maximum stage recorded, 22.2 feet May 27, 1915 (discharge, 14,800 second-feet); minimum stage, 0.38 foot August 12, 1914 (discharge, 13 second-feet). The flood of 1875 is said to have reached a height of 22.8 feet on the present gage.

ACCURACY.—Stage-discharge relation practically permanent; affected by ice during parts of winter; probably not seriously affected by the breaks which occurred in levee in May, 1915. Rating curve well defined between 270 and 10,800 second-feet, and fairly well defined beyond these limits. Gage read to hundredths once daily. Daily discharge ascertained by applying daily gage heights rating table. Records good for open-water periods and poor for periods of ice effect.

Discharge measurements of Kaskaskia River at Vandalia, Ill., 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.*
June 7	H. C. Beckman	9.31	2,210	Sept. 16	H. C. Beckman	0.82	36
23	W. G. Hoyt	17.34	7,010				

Daily discharge, in second-feet, of Kaskaskia River at Vandalia, Ill., for the years ending Sept. 30, 1914–1916.

Day.	Aug.	Sept.	Day.	Aug.	Sept.	Day.	Aug.	Sept.
1914.								
1		71	11	31	494	21	52	57
2		67	12	13	455	22	78	55
3		64	13	168	168	23	52	48
4		73	14	84	155	24	40	48
5		62	15	60	111	25	46	42
6		155	16	62	108	26	411	38
7		3,120	17	52	98	27	172	36
8		3,550	18	40	89	28	103	34
9		817	19	33	44	29	82	32
10		501	20	33	62	30	58	31
						31	62	

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1914-15.												
1	30	43	56		4,330	1,070	222	222	8,060	2,840	701	3,440
2	30	44	58			912	207	192	6,560	1,040	1,690	2,300
3	28	44	60			790	207	730	5,490	701	5,010	1,940
4	27	47	64		6,990	730	200	760	5,010	593	5,420	1,520
5	28	46	84		6,460	790	192	496	3,990	673	5,140	1,240
6	28	44	86		6,090	820	200	344	2,940	593	3,140	1,040
7	27	43	93		5,420	790	200	376	2,260	407	2,220	1,040
8	27	60	93		1,660	673	200	646	1,760	3,390	2,040	1,100
9	520	78	91		1,340	619	192	429	1,440	4,890	1,860	1,040
10	673	80	102		1,240	619	207	386	1,200	2,890	1,940	1,040
11	520	82	96		1,100	568	214	364	1,170	4,830	2,420	1,010
12	287	78	89		1,040	568	238	343	2,580	6,270	1,900	790
13	189	75	91		1,040	520	222	321	1,940	7,320	1,300	701
14	93	71	84		976	496	214	300	4,090	7,100	1,010	593
15	78	68			912	473	207	278	2,260	5,210	1,140	544
16	84	66		95	790	451	200	262	1,070	2,620	1,040	520
17	207	60			568	429	189	222	850	1,980	2,700	544
18	153	58			544	386	168	181	760	1,980	4,290	496
19	108	55			520	407	163	153	619	1,580	4,140	646
20	84	52			473	386	153	2,660	568	1,550	4,040	1,300
21	75	50			473	365	143	3,440	4,770	1,200	14,600	1,240
22	66	50			429	354	192	1,380	5,850	912	12,600	1,170
23	60	52	32		3,840	344	1,450	730	4,530	760	9,660	1,100
24	56	55			5,350	324	1,200	619	1,410	646	8,320	1,040
25	55	52			3,240	305	790	520	790	568	7,440	880
26	48	55			1,800	365	496	4,890	673	568	6,880	912
27	43	55			1,520	270	365	14,800	593	451	6,360	850
28	43	50			1,270	254	287	12,900	850	496	5,770	790
29	43	50			.....	222	254	11,000	3,790	701	5,700	730
30	44	52			.....	222	238	11,300	4,410	880	5,210	673
31	42	.....			.....	222	.....	9,660	.....	673	4,190	.....

Daily discharge, in second-feet, of Kaskaskia River at Vandalia, Ill., for the years ending Sept. 30, 1914–1916—Continued.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1915–16.												
1	619	192	165			2,260	912	429	1,100	520	214	59
2	544	189	161			2,100	944	407	1,380	451	120	51
3	496	181	159			1,830	1,040	407	1,480	407	84	50
4	473	173	157			1,580	1,040	451	1,380	365	78	48
5	451	165	154			1,440	976	473	1,300	324	70	47
6	407	165	151	4,930		1,480	880	407	1,410	296	65	45
7	386	170	148			2,500	850	386	2,220	278	61	67
8	354	166	147			2,460	820	386	1,620	262	64	39
9	324	172	143			1,830	790	365	1,040	238	61	37
10	296	154	142		5,130	1,580	790	344	820	214	56	35
11	278	160	175			1,480	760	324	701	200	50	34
12	296	175	473			1,380	730	314	593	192	54	55
13	305	230	646			1,100	673	305	544	184	61	53
14	324	214	880			1,270	646	296	473	175	60	43
15	334	207	880			1,240	619	305	473	170	912	36
16	324	200	850			1,170	593	314	451	160	151	29
17	314	192	1,640			1,100	568	365	1,040	159	123	28
18	270	189	2,420	5,940		1,040	544	386	1,170	158	98	26
19	262	182	2,020			1,010	544	429	2,060	160	76	24
20	254	172	1,520		2,740	976	520	473	2,260	254	69	24
21	246	168	1,100			2,940	912	593	496	4,350	429	53	22
22	246	165	1,070			2,890	880	593	520	6,090	270	50	22
23	238	163	1,040			3,140	880	568	496	7,100	173	47	21
24	230	160	944			4,140	880	544	451	5,350	147	43	20
25	230	165	880			3,790	820	520	429	2,020	127	41	20
26	222	172	790	5,350	3,290	790	496	344	1,480	125	37	19
27	214	168	820	5,280	3,090	880	473	354	1,100	117	36	24
28	207	175		5,770	2,740	1,040	473	386	820	120	36	23
29	207	173	725	6,660	2,500	1,010	473	429	673	117	36	22
30	200	168		9,180	.....	976	451	701	568	107	33	22
31	200	.....		14,400	.....	912	.....	820	.....	214	31	.....

NOTE.—No gage-height record for Feb. 18, May 11–14, Aug. 8, and Dec. 17, 1915; discharge interpolated. Discharge Dec. 15, 1914, to Feb. 3, 1915, Dec. 28, 1915, to Jan. 25, 1916, and Feb. 1–19, 1916, estimated, because of ice, from gage heights, observer's notes, and weather records. Braced figures show mean discharge for periods indicated.

Monthly discharge of Kaskaskia River at Vandalia, Ill., for the years ending Sept. 30, 1914–1916.

[Drainage area, 1,980 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
1914.					
August 11–31	411	13	82.5	0.042	0.03
September	3,550	31	356	.180	.20
1914–15.					
October	673	27	122	.062	.07
November	82	43	57.2	.029	.03
December	.....	.....	54.5	.028	.03
January	.....	.....	95.0	.048	.06
February	.....	429	2,430	1.23	1.33
March	1,070	222	508	.257	.30
April	1,450	143	314	.159	.18
May	14,800	153	2,610	1.32	1.52
June	8,060	568	2,740	1.38	1.54
July	7,320	407	2,140	1.08	1.24
August	14,600	701	4,510	2.28	2.63
September	3,440	496	1,070	.540	.60
The year	14,800	.....	1,390	.702	9.53

Monthly discharge of Kaskaskia River at Vandalia, Ill., for the years ending Sept. 30, 1914–1916—Continued.

Month.	Discharge in second-feet.				Run-off (depth in inches on drianage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
1915–16.					
October	619	200	315	0.159	0.18
November	230	154	178	.090	.10
December	2,420	142	728	.368	.42
January	14,400	.....	5,970	3.02	3.48
February	.....	.....	4,440	2.24	2.42
March	2,500	790	1,320	.667	.77
April	1,010	451	681	.344	.38
May	820	296	419	.212	.24
June	7,100	451	1,770	.894	1.00
July	520	107	229	.116	.13
August	912	31	95.8	.048	.06
September	67	19	34.8	.018	.02
The year	14,400	19	1,340	.677	9.20

KASKASKIA RIVER AT NEW ATHENS, ILL.

LOCATION.—In the W. ½ NE. ¼ sec. 28, T. 2 S., R. 7 W. third principal meridian, at Illinois Central Railroad bridge about 600 feet north of railroad station at New Athens, St. Clair County, about a mile below mouth of Silver Creek and 3 miles above mouth of Lively Creek.

DRAINAGE AREA.—5,220 square miles.

RECORDS AVAILABLE.—January 23, 1907, to December 31, 1912; June 22, 1914, to September 30, 1916. Gage height of river was taken on Wednesday and Thursday mornings from January 23, 1907, to October 28, 1909, by C. J. von Roth Roffy for the New Athens Journal, and by whom they were published. Record authentic. Gage heights have been reduced to the present datum; maximum error probably not more than 0.4 foot, decreasing with increase of stage.

GAGE.—Chain gage attached to bridge; read by Henry Hoffman.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge to which gage is attached, or from highway bridge about 500 feet downstream.

CHANNEL AND CONTROL.—Sand and gravel; may shift.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 33.3 feet at noon February 3 (discharge, 54,800 second-feet); minimum stage, 2.75 feet at noon September 27 (discharge, 185 second-feet).

Maximum stage recorded during periods of records, 35.7 feet August 26, 1915 (discharge, 63,100 second-feet); minimum stage, 2.08 feet August 10, 1914 (discharge, 102 second-feet).

ACCURACY.—Stage-discharge relation practically permanent; affected by backwater from Mississippi River when height on gage of United States Weather Bureau at Chester, Ill., is above about 18.5 feet; probably not affected by ice during winter. Rating curve used during periods of no backwater from the Mississippi, fairly well defined between 86 and 12,400 second-feet. Gage read to hundredths once daily. Daily discharge during periods of no backwater ascertained by applying daily gage heights to rating table; during periods of backwater determined from daily gage heights at New Athens and Chester by slope method described in Water-Supply Paper 345, page 53. Records fair; determinations of discharge may be somewhat too large for last part of January and early part of February, and somewhat too small during April to June, inclusive, because of uncertainty regarding effect of backwater.

Published estimates of discharge for the following periods may be considerably too large, the excess depending on the amount of backwater produced at New Athens: January 21–28, June 14–18, July 19 to August 3, 1907; May 17 to July 23, 1908; March 14, April 21 to May 1, May 11–17, June 12 to July 27, 1909; May 10–13, June 12–15, 1910; March 22 to May 11, and June 19–22, 1912.

Discharge measurements of Kaskaskia River at New Athens, Ill., during the year ending Sept. 30, 1916.

[Made by H. C. Beckman.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
June 6	15.85	a 5,810	Sept. 18	3.16	252
9	18.15	a 7,440			

a Backwater from Mississippi River when measurement was made. (See "Accuracy" in station description.)

Daily discharge, in second-feet, of Kaskaskia River at New Athens, Ill., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	1,360	376	450	4,790	47,400	5,580	1,930	718	2,450	1,450	287	476
2	702	376	425	7,600	52,100	4,790	1,900	650	2,840	1,060	267	450
3	744	376	400	8,510	54,800	4,190	1,800	650	3,580	860	267	400
4	720	353	400	9,010	53,800	3,360	1,760	742	2,570	1,470	267	376
5	670	353	376	9,700	51,300	3,520	1,760	605	1,880	1,830	267	476
6	576	353	376	10,400	51,000	4,310	1,800	1,020	5,020	1,860	257	476
7	490	353	353	11,000	41,000	5,300	1,760	988	7,940	1,800	247	450
8	920	330	353	10,500	35,500	5,790	1,660	955	8,590	1,200	267	450
9	800	330	353	10,100	29,300	6,470	1,590	868	7,120	990	353	503
10	740	330	330	9,820	24,400	6,470	1,530	794	6,350	860	680	830
11	680	400	800	9,700	21,700	5,160	1,460	670	5,300	740	353	860
12	620	590	1,640	16,500	19,900	3,850	1,430	576	3,530	680	257	680
13	620	710	1,800	26,200	20,300	3,200	1,360	534	2,520	650	830	503
14	620	680	1,640	30,300	20,600	2,800	1,270	523	2,040	620	4,070	400
15	590	680	1,760	31,300	16,100	2,600	1,220	512	1,740	620	8,130	330
16	560	680	1,850	32,000	14,800	2,450	1,160	620	1,490	650	23,700	308
17	590	620	4,070	33,000	13,700	2,400	1,110	854	1,260	680	28,900	267
18	560	531	5,370	32,700	13,000	2,300	1,140	1,040	1,160	620	29,300	257
19	590	503	5,930	31,700	12,400	2,210	1,180	1,370	1,060	620	28,200	247
20	590	476	6,150	30,300	11,800	2,120	1,250	1,520	1,220	620	24,800	228
21	560	476	5,650	28,600	11,400	2,030	1,370	1,440	1,520	531	22,000	228
22	503	450	4,310	26,500	10,800	1,940	1,540	1,360	1,840	531	18,600	219
23	503	450	3,000	24,800	10,100	1,850	1,450	1,180	2,520	476	10,300	210
24	476	400	2,400	23,000	9,700	1,760	1,410	997	4,080	920	4,370	202
25	450	400	2,030	21,000	9,090	1,720	1,340	864	5,070	830	1,640	193
26	450	650	2,030	19,400	8,220	1,720	1,660	805	5,360	620	990	193
27	450	710	2,120	20,000	8,510	1,940	1,050	780	5,010	503	800	185
28	425	635	2,120	19,400	7,650	2,030	894	940	4,540	400	1,400	353
29	400	560	2,080	19,700	6,620	2,030	832	1,590	3,500	353	890	257
30	400	503	2,120	24,600	.....	1,700	768	2,080	2,190	319	710	228
31	400	.....	2,400	38,400	.....	1,930	.....	2,340	.....	298	590	.....

NOTE.—No gage-height record for Nov. 28, Jan. 6, May 7, 13, and 21, June 18, and July 16; discharge interpolated. Discharge Oct. 1–7, Jan. 15 and 25–31, Feb. 1–9 and 24–29, and Mar. 30 to July 6, determined by slope method, because of backwater from Mississippi River. (See "Accuracy" in station description.)

Monthly discharge of Kaskaskia River at New Athens, Ill., for the year ending Sept. 30, 1916.

[Drainage area, 5,220 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).
	Maximum.	Minimum.	Mean.	Per square mile.	
October	1,360	400	605	0.116	0.13
November	710	330	488	.093	.10
December	6,150	330	2,100	.402	.46
January	38,400	4,790	20,300	3.89	4.48
February	54,800	6,620	23,700	4.54	4.90
March	6,470	1,700	3,210	.615	.71
April	1,930	768	1,410	.270	.30
May	2,340	512	987	.189	.22
June	8,590	1,060	3,510	.672	.75
July	1,860	298	828	.159	.18
August	29,300	247	6,900	1.32	1.52
September	860	185	374	.072	.08
The year	54,800	185	5,310	1.02	13.83

BIG MUDDY RIVER AT PLUMFIELD, ILL.

LOCATION.—In the W. ½ sec. 20, T. 7 S., R. 2 E., at highway bridge at Plumfield, Franklin County, about 6 miles west of West Frankfort, 1½ miles below mouth of Middle Fork, and 2 miles below station formerly maintained at the Chicago, Burlington & Quincy Railroad bridge.

DRAINAGE AREA.—753 square miles.

RECORDS AVAILABLE.—August 18, 1914, to September 30, 1916; June 16, 1908, to September 30, 1912, and November 1 to December 31, 1912, maintained at the Chicago, Burlington & Quincy Railroad bridge.

GAGE.—Chain gage attached to bridge; read to hundredths twice daily by Louis Robertson.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge.

CHANNEL AND CONTROL.—Probably permanent; low-water control is about a quarter of a mile below gage. On August 18, 1914, point of zero flow was at a stage of 0.6 foot.

EXTREMES OF STAGE.—Maximum stage recorded during year, 30.2 feet at 5 p. m. February 1; minimum stage, 0.91 foot at 5 p. m. October 25.

1914–1916: Maximum stage recorded, 30.2 feet February 1, 1916; minimum stage August 18 to 26, 1914, when there was no flow past the gage.

ICE.—Stage-discharge relation probably affected by ice during parts of winter.

Data inadequate for determination of discharge.

Discharge measurements of Big Muddy River at Plumfield, Ill., during the year ending Sept. 30, 1916.

[Made by H. C. Beckman.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
June 10	13.72	1,970	Sept. 19	1.28	12.0
Sept. 19	1.28	11.4			

Daily gage height, in feet, of Big Muddy River at Plumfield, Ill., for the year ending Sept. 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	2.6	0.97	1.50	14.5	30.0	3.4	3.25	1.80	5.6	1.70	1.14	4.1
2	2.65	.94	1.44	16.0	29.9	3.35	3.0	1.76	5.6	1.52	1.30	2.7
3	2.38	.95	1.40	17.0	29.0	3.6	3.5	1.79	10.6	1.46	1.12	2.44
4	2.08	.97	1.35	17.4	28.1	3.8	5.1	1.78	11.1	1.34	1.22	2.55
5	1.76	.98	1.29	17.3	27.1	5.2	4.8	1.80	10.6	1.25	1.36	2.28
6	1.60	.96	1.24	16.7	26.1	6.5	4.0	1.78	11.0	4.0	1.31	2.21
7	1.48	.98	1.24	15.7	25.0	10.2	3.3	1.72	12.6	3.9	1.22	2.12
8	1.37	1.00	1.26	14.3	23.8	11.7	3.15	1.68	13.0	2.85	1.15	2.22
9	1.32	.98	1.24	11.5	22.3	12.6	3.6	1.79	13.4	2.3	1.10	6.8
10	1.24	.98	1.22	9.3	20.7	13.1	4.0	1.80	13.8	1.91	1.10	8.5
11	1.16	1.06	3.3	10.9	18.9	12.4	3.9	1.70	14.3	1.69	1.07	6.5
12	1.11	2.02	7.4	13.7	17.0	9.3	3.6	1.61	13.8	1.58	1.06	3.6
13	1.10	1.80	8.2	16.0	15.6	5.9	3.15	1.53	12.3	3.15	1.13	2.48
14	1.14	1.45	7.7	17.6	14.8	4.2	2.85	1.48	9.7	2.22	3.6	2.04
15	1.11	1.68	5.9	18.1	14.3	3.8	2.6	3.9	5.2	3.4	7.9	1.80
16	1.08	1.61	7.0	18.3	13.6	3.7	2.35	10.1	6.1	2.85	9.4	1.62
17	1.04	1.48	13.5	18.5	13.0	3.6	2.18	9.4	6.7	2.40	10.0	1.48
18	1.02	1.62	15.0	17.7	12.5	3.5	2.05	7.9	5.9	2.20	10.4	1.38
19	1.00	2.7	16.6	16.3	12.3	3.3	1.94	5.2	6.5	2.95	10.7	1.28
20	.98	5.2	17.1	14.3	11.6	3.15	1.98	3.3	6.1	4.9	11.8	1.21
21	.96	4.1	16.6	11.6	9.4	2.95	4.0	2.95	5.0	3.35	12.6	1.14
22	.94	2.65	15.5	11.1	6.9	2.85	5.9	3.15	5.4	3.3	12.9	1.10
23	.93	2.14	13.0	11.5	5.8	2.75	4.5	2.85	4.2	2.9	12.5	1.06
24	.92	1.94	9.2	11.7	7.6	2.7	3.5	2.65	4.7	2.39	10.0	1.00
25	.92	1.87	8.8	11.5	8.5	2.8	3.1	2.42	4.3	1.98	6.6	1.00
26	.92	1.76	10.0	10.7	7.8	3.4	2.75	2.47	3.8	1.68	4.1	.98
27	.92	1.67	10.6	9.6	6.2	5.8	2.41	2.14	3.2	1.46	2.9	.97
28	.94	1.60	10.3	11.8	4.8	6.5	2.18	1.90	2.6	1.35	4.9	2.02
29	.93	1.58	9.5	15.7	3.9	5.5	2.02	1.82	2.18	1.22	7.5	2.00
30	.94	1.54	11.0	22.6	.....	4.5	1.90	1.72	1.90	1.12	8.2	2.28
31	.96	.....	12.6	27.8	.....	3.7	.....	4.3	.....	1.07	7.0	.....

NOTE.—Stage-discharge relation probably somewhat affected by ice during parts of winter.

MISCELLANEOUS MEASUREMENTS.

Miscellaneous measurements in upper Mississippi River drainage basin in year ending Sept. 30, 1916.

Date.	Stream.	Tributary to—	Locality.	Gage height.	Discharge.
				Feet.	*Sec.-ft.*
Oct. 28	South Branch of Root River.	Root River	Lanesboro, Minn	.....	170
Sept. 25	Chippewa River	Mississippi River	Cornell, Wis	[a]956.04	3,010
Apr. 28	Wisconsin River	....do	Portage, Wis	[b]10.92	49,300
May 9	....do	....do	....do	[b]5.48	13,100
Aug. 15	....do	....do	....do	[b]2.73	4,650
June 27	Illinois River	....do	Peoria, Ill	[c]17.45	30,700
Aug. 22	....do	....do	....do	[c]11.10	11,900

[a] Staff gage of Fargo Engineering Co., Cornell, Wis.
[b] Staff gage of U. S. Army Engineers, at Portage, Wis.
[c] Staff gage of U. S. Army Engineers, at Peoria, Ill.

INDEX.

STREAM-GAGING STATIONS

AND

PUBLICATIONS RELATING TO WATER RESOURCES

PART V. HUDSON BAY AND UPPER MISSISSIPPI RIVER DRAINAGE BASINS

6342°—18—WSP 435——14

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, monographs, professional papers, and annual reports.

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 slope 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, published in three volumes:
A, Pacific slope basins in Washington and upper Columbia River basin.
B, Snake River basin.
C, Lower Columbia River basin and Pacific slope basins in Oregon.

HOW GOVERNMENT REPORTS MAY BE OBTAINED OR CONSULTED.

Water-supply papers and other publications of the United States Geological Survey containing data in regard to the water resources of the United States may be obtained or consulted as indicated below:

1. Copies may be obtained free of charge by applying to the Director of the Geological Survey, Washington, D. C. The edition printed for free distribution is, however, small and is soon exhausted.

2. Copies may be purchased at nominal cost from the Superintendent of Documents, Government Printing Office, Washington, D. C., who will 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:

Albany, N. Y., Room 18, Federal Building.
Atlanta, Ga., Post Office Building.
Boston, Mass., 2500 Customhouse.
St. Paul, Minn., Old Capitol Building.
Madison, Wis., care of Railroad Commission of Wisconsin.
Helena, Mont., Montana National Bank Building.
Topeka, Kans., 25 Federal Building.
Denver, Colo., 403 New Post Office Building.
Salt Lake City, Utah, 421 Federal Building.
Boise, Idaho, 615 Idaho Building.
Portland, Oreg., 416 Couch Building.
Tacoma, Wash., 406 Federal Building.
San Francisco, Cal., 328 Customhouse.
Los Angeles, Cal., 619 Federal Building.
Phoenix, Ariz., 417 Fleming Building.
Austin, Tex., Old Post Office Building.
Honolulu, Hawaii, 14 Capitol Building.

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

STREAM-FLOW REPORTS.

Stream-flow records have been obtained at more than 4,100 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 and 1894.
16th A, pt. 2	Descriptive information only	
B 140	Descriptions, measurements, gage heights, ratings, and monthly discharge (also many data covering earlier years).	1895.
W 11	Gage heights (also gage heights for earlier years)	1896.
18th A, pt. 4	Descriptions, measurements, ratings, and monthly discharge (also similar data for some earlier years).	1895 and 1896.
W 15	Descriptions, measurements, and gage heights, eastern United States, eastern Mississippi River, and Missouri River above junction with Kansas.	1897.
W 16	Descriptions, measurements, and gage heights, western Mississippi River below junction of Missouri and Platte, and western United States.	1897.
19th A, pt. 4	Descriptions, measurements, ratings, and monthly discharge (also some long-time records).	1897.
W 27	Measurements, ratings, and gage heights, eastern United States, eastern Mississippi River, and Missouri River.	1898.
W 28	Measurements, ratings, and gage heights, Arkansas River and western United States.	1898.
20th A, pt. 4	Monthly discharge (also for many earlier years)	1898.
W 35 to 39	Descriptions, measurements, gage heights, and ratings	1899.
21st A, pt. 4	Monthly discharge	1899.
W 47 to 52	Descriptions, measurements, gage heights, and ratings	1900.

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

Report.	Character of data.	Year.
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.

In these papers and in the following lists the stations are arranged in downstream order. The main stem of any river is determined by measuring or estimating its drainage area—that is, the headwater stream having the largest drainage area is considered the continuation of the main stream, and local changes in name and lake surface are disregarded. All stations from the source to the mouth of the main stem of the river are presented first, and the tributaries in regular order from source to mouth follow, the streams in each tributary basin being listed before those of the next basin below.

In exception to this rule the records for Mississippi River are given in four parts, as indicated on page III, and the records for large lakes are taken up in order of streams around the rim of the lake.

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

Year.	I North Atlantic slope basins (St. John River to York River).	II South Atlantic slope and eastern Gulf of Mexico basins (James River to the Mississippi).	III Ohio River basin.	IV St. Lawrence River and Great Lakes basins.	V Hudson Bay and upper Mississippi River 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 drainage basins.		
												Pacific slope basins in Washington and upper Columbia River basin.	Snake River basin.	Lower Columbia River basin and Pacific slope basins in Oregon.
1899 [a]	35	[b] 35, 36	36	36	36	[c] 36, 37	37	37	[d] 37, 38	38, [e] 39	38, [f] 39	38	38	38
1900 [g]	47, [h] 48	48	48, [i] 49	49	49	49, [j] 50	50	50	50	51	51	51	51	51
1901	65, 75	65, 75	65, 75	65, 75	[k] 65, 66, 75	66, 75	[k] 65, 66, 75	66, 75	66, 75	66, 75	66, 75	66, 75	66, 75	66, 75
1902	82	[b] 82, 83	83	[l] 82, 83	[k] 83, 85	84	[k] 83, 84	84	85	85	85	85	85	85
1903	97	[b] 97, 98	98	97	[k] 98, 99, [m] 100	99	[k] 98, 99	99	100	100	100	100	100	100
1904	[n] 124, [o] 125, [p] 126	[p] 126, 127	128	129	[k] 128, 130	130, [q] 131	[k] 128, 131	132	133	133, [r] 134	134	135	135	135
1905	[n] 165, [o] 166, [p] 167	[p] 167, 168	169	170	171	172	[k] 169, 173	174	175, [s] 177	176, [r] 177	177	178	178	[t] 177, 178
1906	[n] 201, [o] 202, [p] 203	[p] 203, 204	205	206	207	208	[k] 205, 209	210	211	212, [r] 213	213	214	214	214
1907–8	241	242	243	244	245	246	247	248	249	250, [r] 251	251	252	252	252
1909	261	262	263	264	265	266	267	268	269	270, [r] 271	271	272	272	272
1910	281	282	283	284	285	286	287	288	289	290	291	292	292	292
1911	301	302	303	304	305	306	307	308	309	310	311	312	312	312
1912	321	322	323	324	325	326	327	328	329	330	331	332–A	332–B	332–C
1913	351	352	353	354	355	356	357	358	359	360	361	362–A	362–B	362–C
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. Tables of monthly discharge for 1899 in Twenty-first Annual Report, Part IV.
[b] James River only.
[c] Gallatin River.
[d] Green and Gunnison rivers and Grand River above junction with Gunnison.
[e] Mohave River only.
[f] Kings and Kern rivers and south Pacific slope drainage basins.
[g] Rating tables and index to Water-Supply Papers 47–52 and data on precipitation, wells, and irrigation in California and Utah contained in Water-Supply Paper 52. Tables of monthly discharge for 1900 in Twenty-second Annual Report, Part IV.
[h] Wissahickon and Schuylkill rivers to James River.
[i] Scioto River.
[j] Loup and Platte rivers near Columbus, Nebr., and all tributaries below junction with Platte.
[k] Tributaries of Mississippi from east.
[l] Lake Ontario and tributaries to St. Lawrence River proper.
[m] Hudson Bay only.
[n] New England rivers only.
[o] Hudson River to Delaware River, inclusive.
[p] Susquehanna River to Yadkin River, inclusive.
[q] Platte and Kansas rivers.
[r] Great Basin in California except Truckee and Carson river basins.
[s] Below junction with Gila.
[t] Rogue, Umpqua, and Siletz rivers only.

PART V.—HUDSON BAY AND UPPER MISSISSIPPI RIVER DRAINAGE BASINS.

PRINCIPAL STREAMS.

The Hudson Bay and upper Mississippi River basins include streams whose waters reach Hudson Bay and the Mississippi above its junction with the Ohio (except the Missouri). The principal streams flowing into Hudson Bay from the United States are St. Mary River, Red River, and Rainy River. The principal tributaries of the upper Mississippi are Crow Wing, Sauk, Crow, Rum, Minnesota, St. Croix, Chippewa, Zumbro, Black, Root, Wisconsin, Wapsipinicon, Rock, Iowa, Des Moines, Illinois, and Kaskaskia rivers. These streams drain wholly or in part the States of Illinois, Indiana, Iowa, Minnesota, Missouri, Montana, North Dakota, South Dakota, and Wisconsin.

In addition to the list of gaging stations and the annotated list of publications relating specifically to the section, these pages contain a similar list of reports that are of general interest in many sections and cover a wide range of hydrologic subjects, and also brief references to reports published by State and other organizations. (See p. XVII.)

GAGING STATIONS.

NOTE.—Dash after a date indicates that station was being maintained September 30, 1916. Period after a date indicates discontinuance.

HUDSON BAY DRAINAGE BASIN.

St. Mary River near Babb (formerly dam site), Mont., 1902–
St. Mary River below Swiftcurrent Creek, at Babb, Mont., 1901–2; 1910–1915.
St. Mary River near Kimball, Alberta, 1902–
Swiftcurrent Creek near Babb (formerly Wetzel), Mont., 1902–1910.
Swiftcurrent Creek at Many Glacier, Mont., 1912–
Swiftcurrent Creek at Sherburne, Mont., 1912–
Kennedy Creek near Babb (formerly Wetzel), Mont., 1903–1907.
Ottertail River at German Church, near Fergus Falls, Minn., 1913–
Ottertail River near Fergus Falls, Minn., 1904–1913.
Red River near Fergus Falls, Minn., 1909–10.
Red River at Fargo, N. Dak., 1901–
Red River at Grand Forks, N. Dak., 1901–
Red River at Pembina, N. Dak., 1901.
Red River at Emerson, Manitoba, 1900–1902.
Mustinka River near Wheaton, Minn., 1916.
Pelican River near Fergus Falls, Minn., 1909–1912.
Sheyenne River at Haggart, N. Dak., 1902–1907.
Wild Rice River at Twin Valley, Minn., 1909–
Devils Lake near Devils Lake, N. Dak., 1901–1912.
Red Lake River at Thief River Falls, Minn., 1909–

UPPER MISSISSIPPI RIVER BASIN.

REPORTS ON WATER RESOURCES OF THE HUDSON BAY AND UPPER MISSISSIPPI RIVER BASINS.

PUBLICATIONS OF THE 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 prices 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.

*21. Wells of northern Indiana, by Frank Leverett. 1899. 82 pp., 2 pls.
Discusses, by counties, glacial deposits and sources of well waters; many well sections.

*44. Profiles of rivers in the United States, by Henry Gannett. 1901. 100 pp., 11 pls. 15c.
Gives elevations and distances along Red River (of the North), and Minnesota, Skunk, Iowa, Des Moines, Illinois, and Rock rivers; also brief descriptions.

*57. Preliminary list of deep borings in the United States, Part I (Alabama-Montana), by N. H. Darton. 1902. 60 pp. 5c.

*61. Preliminary list of deep borings in the United States, Part II (Nebraska-Wyoming), by N. H. Darton. 1902. 67 pp. 5c.
A revised edition of Nos. 57 and 61, was published in 1905 as Water-Supply Paper 149 (q. v.).

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.

102. Contributions to the hydrology of eastern United States, 1903; M. L. Fuller, geologist in charge. 1904. 522 pp. 30c.
Contains brief reports on wells and springs of Minnesota 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, material penetrated, temperature, use, and quality; many miscellaneous analyses.

*103. A review of the laws forbidding pollution of inland waters in the United States, by E. B. Goodell. 1904. 120 pp.
Cites statutory restrictions of water pollution in Iowa, Illinois, North Dakota, South Dakota, and Wisconsin. Superseded by 152.

*114. Underground waters of eastern United States; M. L. Fuller, geologist in charge. 1905. 285 pp., 18 pls. 25c.
Contains brief reports as follows: Missouri, by E. M. Shepard; Iowa, by W. H. Norton; Minnesota, by C. W. Hall; Wisconsin district, by Alfred R. Schultz; Illinois, by Frank Leverett; Indiana, by Frank Leverett; each of these reports describes briefly the topography of the area, the relation of the geology to the water supplies, and gives list of pertinent publications; lists also principal mineral springs.

117. The lignite of North Dakota and its relation to irrigation, by F. A. Wilder. 1905. 59 pp., 8 pls. 10c.
Describes the thickness, extent, variations, and fuel value of the lignite and its use for pumping water, the area, soils and lignite of the river flats, and the status of irrigation in the State.

*122. Relation of the law to underground waters, by D. W. Johnson. 1905. 55 pp. 5c.
Cites legislative acts affecting underground waters in South Dakota and Wisconsin.

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

Contains two reports relating to areas draining to Hudson Bay or upper Mississippi River:

Water resources of Mineral Point quadrangle, Wisconsin, by U. S. Grant. Describes springs, streams, and shallow and deep wells.

Water supplies at Waterloo, Iowa, by W. H. Norton. Summarizes results of investigations to determine availability of artesian water to replace the surface supply from Cedar River; discusses necessity of test wells, supplementary supplies, artesian head, and permanency of flow.

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), the location, depth, diameter, yield, height of water, and other features of 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.

152. A review of the laws forbidding pollution of the inland waters in the United States (second edition), by E. B. Goodell. 1905. 149 pp. 10c.

Cites statutory restrictions of water pollution in Iowa, Illinois, North Dakota, South Dakota, and Wisconsin.

*156. Water powers of northern Wisconsin, by L. S. Smith. 1906. 145 pp., 5 pls. 25c.

Describes by river systems the drainage, geology, topography, rainfall and run-off, water powers, and dams.

*162. Destructive floods in the United States in 1905, with a discussion of flood discharge and frequency and an index of flood literature, by E. C. Murphy and others. 1906. 105 pp., 4 pls. 15c.

Contains accounts of floods in southeastern Minnesota, on Devils Creek, Iowa, and in Des Moines County, Iowa; gives estimates of flood discharge and frequency on Illinois River and on Mississippi River at St. Paul.

*193. The quality of surface waters in Minnesota, by R. B. Dole and F. F. Wesbrook. 1907. 171 pp., 7 pls. 25c.

Describes by river basins the topography, geology, and soils, the industrial and municipal pollution of the streams, and gives notes on the municipalities; contains many analyses.

*194. Pollution of Illinois and Mississippi Rivers by Chicago sewage (a digest of the testimony taken in the case of the State of Missouri *v.* the State of Illinois and the Sanitary District of Chicago), by M. O. Leighton. 1907. 369 pp., 2 pls.

Scope indicated by amplification of title.

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

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

*227. Geology and underground waters of South Dakota, by N. H. Darton. 1909. 156 pp., 15 pls. 40c.

Describes physical features, geologic formations, water horizons, and, by counties, deep wells and well prospects; gives notes on construction and management of artesian wells.

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, Minnesota, Chippewa, Wisconsin, Rock, Iowa, Cedar, Des Moines, Illinois, Kankakee, Fox, Sangamon, Kaskaskia, and Big Muddy rivers.

239. The quality of the surface waters of Illinois, by W. D. Collins. 1910. 94 pp., 3 pls. 10c.

Discusses the natural and economic features that determine the character of the streams, describes the larger drainage basins, and the methods of collecting and analyzing the samples of water, and discusses each river in detail with reference to its source and course and the quality of water; includes short chapters on municipal supplies and industrial uses.

254. The underground waters of north-central Indiana, by S. R. Capps, with a chapter on the chemical character of the waters, by R. B. Dole. 1910. 279 pp., 7 pls. 40c.

Describes relief, drainage, vegetation, soils, and crops, industrial development, geologic formations; sources, movements, occurrence, and volume of ground water; methods of well construction and lifting devices; discusses, in detail for each county, surface features and drainage, geology and ground water, city, village, and rural supplies, and gives records of wells and analyses of waters. Discusses also, under chemical character, methods of analyses and expression of results, mineral constituents, effect of the constituents on waters for domestic, industrial, and medicinal uses, methods of purification, chemical composition; many analyses and field assays.

256. Geology and underground waters of southern Minnesota, by C. W. Hall, O. E. Meinzer, and M. L. Fuller. 1911. 406 pp., 18 pls. 60c.

Discusses the physiography of the State, geologic formations and their water-bearing capacity, artesian conditions, the mineral quality of the underground waters, types of wells, finishing wells in sand, drilling in quartzite, fluctuation in yield and head, "blowing" and "breathing" wells, freezing of wells, drainage by wells, hydraulic rams, and scientific prospecting for water, municipal supplies, power, storage and distribution, consumption of water, prices, sanitation. Gives by counties details concerning surface features, rocks, yield, head, and quality of water, and summaries and analyses.

293. Underground water resources of Iowa, by W. H. Norton, W. S. Hendrixson, H. E. Simpson, O. E. Meinzer, and others. 1912. 994 pp., 18 pls. 70c.

Describes the relief, drainage, temperature, and precipitation of the State and the geologic formations; discusses the geologic occurrence of ground waters, artesian phenomena and yield of artesian wells, the chemical composition of ground waters, municipal, domestic; and industrial water supplies, and mineral waters; gives details concerning topography, geology, ground waters, and city and village supplies by districts and counties.

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

(*i*) Gazetteer of surface waters of Iowa, by W. G. Hoyt and H. J. Ryan, pp. 169–221.

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 spring and well waters from Nashville and Macomb, Ill., and Story City, Iowa.

417. Profile surveys of rivers in Wisconsin, prepared under the direction of W. H. Herron, acting chief geographer. 1917. 16 pp., 32 pls. 45c.

Contains brief description of general features of drainage of Wisconsin and of the rivers surveyed, but consists chiefly of maps showing "not only the outlines of the river banks, the islands, the positions of rapids, falls, shoals, and existing dams, and the crossings of all ferries and roads, but the contours of banks to an elevation high enough to indicate the possibility of using the stream" for the development of power by low or medium heads.

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.

*Sixteenth Annual Report of the United States Geological Survey, 1894–95. 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 to 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:

Preliminary report on artesian waters of a portion of the Dakotas, by N. H. Darton, pp. 603–694, pls. 69 to 107. Gives an outline of the geologic relations; describes the water horizons and the extent of the artesian water, and gives details concerning wells and prospects by counties; discusses the origin, amount, pressure, head, and composition of the artesian waters, the use of artesian water for power, and gives details concerning artesian irrigation by counties; contains also remarks on the construction and management of artesian wells.

*The water resources of Illinois, by Frank Leverett, pp. 695–849, pls. 108 to 113. Describes the physical features of the State, and the drainage basins, including Illinois, Des Plaines, Kankakee, Fox, Illinois-Vermilion, Spoon, Mackinaw, and Sangamon rivers, Macoupin Creek, Rock River, tributaries of the Mississippi in western Illinois, Kaskaskia, Big Muddy, and tributaries of the Wabash; discusses the rainfall and run-off, navigable waters and water powers, the wells supplying water for rural districts, and artesian wells; contains tabulated artesian well data and water analyses.

Eighteenth Annual Report of the United States Geological Survey, 1896–97, 5 parts in 6 vols. *Pt. IV, Hydrography, x, 756 pp., 102 pls. $1.75. Contains:

*The water resources of Indiana and Ohio, by Frank Leverett, pp. 419–560, pls. 33 to 37. Describes the Wabash, Whitewater, Great Miami, Little Miami, Scioto, Hocking, Muskingum, and Beaver rivers, and lesser tributaries of the Ohio in Indiana and Ohio, the streams discharging into Lake Erie and Lake Michigan, and streams flowing to the upper Mississippi through the Illinois; discusses shallow and drift wells, the flowing wells from the drift and deeper artesian wells, and gives records of wells at many of the cities; describes the mineral springs, and gives analyses of the waters; contains also tabulated lists of cities using surface waters for water works, and of cities and villages using shallow and deep-well waters; discusses the source and quality of the city and village supplies, and gives precipitation tables for various points.

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.

*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 Illinois and Iowa, and detailed records of wells in Boone, Dupage, Henry, and La Salle counties, Ill., and Des Moines and Scott counties, Iowa. 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 Illinois, Indiana, Iowa, Minnesota, Missouri, North Dakota, South Dakota, and Wisconsin; and detailed records of wells in Brown, Hancock, La Salle, Pike, and Schuyler counties, Ill.; Blackhawk, Floyd, Louisa, Mahaska, Scott, and Wapello counties, Iowa; and Hennepin, Ottertail, and Pine counties, Minn. The wells of which detailed sections are given were selected because they afford valuable stratigraphic information.

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.

[1] Index maps showing areas in the Hudson Bay and upper Mississippi River basins covered by topographic maps and by geologic folios will be mailed on receipt of request addressed to the Director, U. S. Geological Survey, Washington, D. C.

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 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 octavo edition (6 by 9 inches). Owing to a fire in the Geological Survey building May 18, 1913, the stock of geologic folios was more or less damaged by fire and water, but 80 or 90 per cent of the folios are usable. They will be sold at the uniform price of 5 cents each, with no reduction for wholesale orders. This rate applies to folios in stock from 1 to 184, inclusive (except reprints), also to the library edition of folio 186. The library edition of folios 185, 187, and higher numbers sells for 25 cents a copy, except that some folios which contain an unusually large amount of matter sell at higher prices. The octavo edition of folio 185 and higher numbers sells for 50 cents a copy. A discount of 40 per cent is allowed on an order for folios or for folios together with topographic maps amounting to $5 at the retail rate.

All the folios contain descriptions of the drainage of the quadrangles. The folios in the following list contain also a brief discussion 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.

117. Casselton-Fargo, North Dakota-Minnesota. 5c.

Gives a somewhat detailed account of the water supply, including descriptions and logs of principal wells and tabulated well records; contains artesian-water maps showing areas which will probably yield flowing wells.

*145. Lancaster-Mineral Point, Wisconsin-Iowa-Illinois.

Discusses the springs, shallow and deep wells, streams and water power; gives analyses of artesian water from well at Dubuque, Iowa.

168. Jamestown-Tower (Jamestown, Eckelson, and Tower quadrangles), North Dakota.[1] 5c.

Discusses shallow, deep, and artesian wells; head, pressure, power, volume, and character of the water, and gives a tabulated list of representative wells; contains an artesian-water mad showing areas in which flowing wells may probably be obtained.

185. Murphysboro-Herrin, Illinois.[1] Library edition, 25c., Octavo edition, 50e.

188. Tallula-Springfield, Illinois.[1] Library edition, 25c., Octavo edition, 50c.

Discusses wells and the wholesomeness of the water; gives analyses of water from wells in the city of Springfield.

195. Belleville-Breese, Illinois. 25c.

Discusses wells and gives analyses of water from springs and wells.

[1] Issued in two editions; specify which edition is wanted.

MISCELLANEOUS REPORTS.

Other Federal bureaus and State and other organizations have from time to time published reports relating to the water resources of the various sections of the country. Notable among those pertaining to the Hudson Bay and upper Mississippi River basins are the reports of the State surveys of Illinois and North Dakota, the Wisconsin Geological and Natural History Survey and the Railroad Commission of Wisconsin, the Illinois Water-Supply Commission, and the Rivers and Lakes Commission of Illinois, and the water-power report of the Tenth Census (vol. 17). The following reports deserve special mention:

Contributions to the physical geography of the United States, Part I. On the physical geography of the Mississippi Valley, with suggestions for the improvement of navigation of the Ohio and other rivers, by Charles Ellet, jr.: Smithsonian Pub. 13, Washington, 1850.

The Mississippi and Ohio rivers, by Charles H. Ellet. 1853.

Report upon the physics and hydraulics of the Mississippi River, by A. A. Humphreys and H. L. Abbott.

The mineral content of Illinois waters, by Edward Barstow, J. A. Udden, S. W. Parr, and George T. Palmer: Illinois State Geol. Survey Bull. 10, 1909.

Water resources of the East St. Louis district, by Isaiah Bowman: Illinois State Geol. Survey Bull. 5, 1907.

Chemical and biological survey of waters of Illinois, by Edward Bartow: Univ. Illinois Pub. 3, 6, 7, 1906–1909.

Chemical survey of the waters of Illinois, report for the years 1897–1902, by A. W. Palmer, with report on Geology of Illinois as related to its water supply, by Charles W. Rolfe: Univ. Illinois Pub.

Report and plans for the reclamation of lands subject to overflow in the Kaskaskia River Valley, Illinois; begun under the direction of the Internal Improvement Commission; completed and published under the direction of the Rivers and Lakes Commission of Illinois, by Jacob A. Harman. 1912.

Diversion of the waters of the Great Lakes by way of the sanitary and ship canal of Chicago: A brief of the facts and issues, by Lyman E. Cooley, Chicago, 1913.

The State of Missouri *vs.* the State of Illinois and the Sanitary district of Chicago, before Frank S. Bright, Commissioner of the Supreme Court of the United States. 1904.

The mineral waters of Indiana, their location, origin, and character, by W. S. Blatchley: Indiana Dept. Geology and Nat. Res. Twenty-sixth Ann. Rept., 1901.

Report of the water resources investigation of Minnesota by the State drainage commission, 1910.

Report of the commission on conservation [Montana] on bills relating to the public lands, water rights, and the protection and preservation of the forests, 1911.

Governor's message relating to conservation [in Montana] on bills relating to public lands, water rights, and the protection and preservation of the forests.

Water resources of the Devils Lake region, North Dakota, by E. J. Babcock: North Dakota Geol. Survey, Second Bienn. Rept., 1903.

The water powers of Wisconsin, by Leonard S. Smith: Wisconsin Geol. and Nat. Hist. Survey Bull. 20. Madison, Wis., 1908.

Report of the Railroad Commission of Wisconsin to the legislature on water powers. Madison, Wis., 1915.

Many of these reports can be obtained by applying to the several organizations, and most of them can be consulted in the public libraries of the larger cities.

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GEOLOGICAL SURVEY HYDROLOGIC REPORTS OF GENERAL INTEREST.

The following list comprises reports not readily classifiable by drainage basins and covering a wide range of hydrologic investigations:

WATER-SUPPLY PAPERS.

*1. Pumping water for irrigation, by H. M. Wilson. 1896. 57 pp., 9 pls.

Describes pumps and motive powers, windmills, water wheels, and various kinds of engines; also storage reservoirs to retain pumped water until needed for irrigation.

*3. Sewage irrigation, by G. W. Rafter. 1897. 100 pp., 4 pls. (See Water-Supply Paper 22.) 10c.

Discusses methods of sewage disposal by intermittent filtration and by irrigation; describes utilization of sewage in Germany, England, and France, and sewage purification in the United States.

*8. Windmills for irrigation, by E. C. Murphy. 1897. 49 pp., 8 pls. 10c.

Gives results of experimental tests of windmills during the summer of 1896 in the vicinity of Garden, Kansas; describes instruments and methods and draws conclusions.

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

Discusses efficiency of pumps and water lifts of various types.

*20. Experiments with windmills, by T. O. Perry. 1899. 97 pp., 12 pls. 15c.

Includes tables and descriptions of wind wheels, compares wheels of several types, and discusses results.

*22. Sewage irrigation, Part II, by G. W. Rafter. 1899. 100 pp., 7 pls. 15c.

Gives résumé of Water-Supply Paper 3; discusses pollution of certain streams, experiments on purification of factory wastes in Massachusetts, value of commercial fertilizers, and describes American sewage-disposal plants by States; contains bibliography of publications relating to sewage utilization and disposal.

*41. The windmill; its efficiency and economic use, Part I, by E. C. Murphy. 1901. 72 pp., 14 pls. 5c.

*42. The windmill; its efficiency and economic use, Part II, by E. C. Murphy. 1901. 75 pp. (73–147), 2 pls. (15–16). 10c.

Nos. 41 and 42 give details of results of experimental tests with windmills of various types.

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

*56. Methods of stream measurement. 1901. 51 pp., 12 pls. 15c.

Describes the methods used by the Survey in 1901–2. (See also Nos. 64, 94, and 95.)

*64. Accuracy of stream measurements, by E. C. Murphy. 1902. 99 pp., 4 pls. (See No. 95.) 10c.

Describes methods of measuring velocity of water and of measuring and computing stream flow, and compares results obtained with the different instruments and methods; describes also experiments and results at the Cornell University hydraulic laboratory. A second, enlarged edition published as Water-Supply Paper 95.

*67. The motions of underground waters, by C. S. Slichter. 1902. 106 pp., 8 pls. 15c.

Discusses origin, depth, and amount of ground waters; permeability of rocks and porosity of soils; causes, rates, and laws of motions of ground water; surface and deep zones of flow, and recovery of waters by open wells and artesian and deep wells; treats of the shape and position of the water table; gives simple methods of measuring yield of flowing wells; describes artesian wells at Savannah, Ga.

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

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

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

Treats of measurements of rainfall and laws and measurements of stream flow; gives formulas for rainfall, run-off, and evaporation; discusses effects of forests on rainfall and run-off.

87. Irrigation in India (second edition), by H. M. Wilson. 1903. 238 pp., 27 pls. 25c.

First edition was published in Part II of the Twelfth Annual Report.

93. Proceedings of first conference of engineers of the Reclamation Service, with accompanying papers, compiled by F. H. Newell, Chief Engineer. 1904. 361 pp. 25c. [Requests for this report should be addressed to the U. S. Reclamation Service.]

Contains the following papers of more or less general interest:
Limits of an irrigation project, by D. W. Ross.
Relation of Federal and State laws to irrigation, by Morris Bien.
Electrical transmission of power for pumping, by H. A. Storrs.
Correct design and stability of high masonry dams, by Geo. Y. Wisner.
Irrigation surveys and the use of the plane table, by J. B. Lippincott.
The use of alkaline waters for irrigation, by Thomas H. Means.

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

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

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

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

*103. A review of the laws forbidding pollution of inland waters in the United States, by E. B. Goodell. 1904. 120 pp. (See No. 152.)

Explains the legal principles under which antipollution statutes become operative, quotes court decisions to show authority for various deductions, and classifies according to scope the statutes enacted in the different States.

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

Contains the following reports of general interest. The scope of each paper is indicated by its title.

Description of underflow meter used in measuring the velocity and direction of underground water, by Charles S. Slichter.

The California or "stovepipe" method of well construction, by Charles S. Slichter.

Approximate methods of measuring the yield of flowing wells, by Charles S. Slichter.

Corrections necessary in accurate determinations of flow from vertical well casings, from notes furnished by A. N. Talbot.

113. The disposal of strawboard and oil-well wastes, by R. L. Sackett and Isaiah Bowman. 1905. 52 pp., 4 pls. 5c.

The first paper discusses the pollution of streams by sewage and by trade wastes, describes the manufacture of strawboard, and gives results of various experiments in disposing of the waste. The second paper describes briefly the topography, drainage, and geology of the region about Marion, Ind., and the contamination of rock wells and of streams by waste oil and brine.

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

Contains reports on "Occurrence of underground waters," by M. L. Fuller, discussing sources, amount, and temperature of waters, permeability and storage capacity of rocks, water-bearing formations, recovery of water by springs, wells, and pumps, essential conditions of artesian flows, and general conditions affecting ground waters in eastern United States.

119. Index to the hydrographic progress reports of the United States Geological Survey, 1888 to 1903, by J. C. Hoyt and B. D. Wood. 1905. 253 pp. 15c.

120. Bibliographic review and index of papers relating to underground waters published by the United States Geological Survey, 1879–1904, by M. L. Fuller. 1905. 128 pp. 10c.

*122. Relation of the law to underground waters, by D. W. Johnson. 1905. 55 pp. 5c.

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

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

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

143. Experiments on steel-concrete pipes on a working scale, by J. H. Quinton. 1905. 61 pp., 4 pls. 5c.

Scope indicated by title.

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

Contains brief reports of general interest as follows:

Drainage of ponds into drilled wells, by Robert E. Horton. Discusses efficiency, cost, and capacity of drainage wells, and gives statistics of such wells in southern Michigan.

Construction of so-called fountain and geyser springs, by Myron L. Fuller.

A convenient gage for determining low artesian heads, by Myron L. Fuller.

146. Proceedings of second conference of engineers of the Reclamation Service, with accompanying papers, compiled by F. H. Newell, Chief Engineer. 1905. 267 pp. 15c. [Inquiries concerning this report should be addressed to the Reclamation Service.]

Contains brief account of the organization of the hydrographic [water-resources] branch and the Reclamation Service, reports of conferences and committees, circulars of instruction, and many brief reports on subjects closely related to reclamation, and a bibliography of technical papers by members of the service. Of the papers read at the conference those listed below (scope indicated by title) are of more or less general interest.

Proposed State code of water laws, by Morris Bien.

Power engineering applied to irrigation problems, by O. H. Ensign.

Estimates on tunneling in irrigation projects, by A. L. Fellows.

Collection of stream-gaging data, by N. C. Grover.

Diamond-drill methods, by G. A. Hammond.

Mean-velocity and area curves, by F. W. Hanna.

Importance of general hydrographic data concerning basins of streams gaged, by R. E. Horton.

Effect of aquatic vegetation on stream flow, by R. E. Horton.

Sanitary regulations governing construction camps, by M. O. Leighton.

Necessity of draining irrigated 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 irrigated 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 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 fluctuations due to rainfall and evaporation, barometric changes, temperature changes, changes in rivers, changes in lake level, tidal changes, effects of settlement, irrigation, dams, underground-water developments, and to indeterminate causes.

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

Gives account of work in 1905; lists publications relating to underground waters, and contains the following brief reports of general interest:

Significance of the term "artesian," by Myron L. Fuller.
Representation of wells and springs on maps, by Myron L. Fuller.
Total amount of free water in the earth's crust, by Myron L. Fuller.
Use of fluorescein in the study of underground waters, by R. B. Dole.
Problems of water contamination, by Isaiah Bowman.
Instances of improvement of water in wells, by Myron L. Fuller.

*162. Destructive floods in the United States in 1905, with a discussion of flood discharge and frequency and an index to flood literature, by E. C. Murphy and others. 1906. 105 pp., 4 pls. 15c.

*163. Bibliographic review and index of underground-water literature published in the United States in 1905, by M. L. Fuller, F. G. Clapp, and B. L. Johnson. 1906. 130 pp. 15c.

Scope indicated by title.

*179. Prevention of stream pollution by distillery refuse, based on investigations at Lynchburg, Ohio, by Herman Stabler. 1906. 34 pp., 1 pl. 10c.

Describes grain distillation, treatment of slop, sources, character, and effects of effluents on streams; discusses filtration, precipitation, fermentation, and evaporation methods of disposal of wastes without pollution.

*180. Turbine water-wheel tests and power tables, by R. E. Horton. 1906. 134 pp., 2 pls. 20c.

Scope indicated by title.

*185. Investigations on the purification of Boston sewage, * * * with a history of the sewage-disposal problem, by C.-E. A. Winslow and E. B. Phelps. 1906. 163 pp. 25c.

Discusses composition, disposal, purification, and treatment of sewages and tendencies in sewage-disposal practice in England, Germany, and the United States; describes character of crude sewage at Boston, removal of suspended matter, treatment in septic tanks, and purification by intermittent sand filtration and in beds of coarse material; gives bibliography.

*186. Stream pollution by acid-iron wastes, a report based on investigations made at Shelby, Ohio, by Herman Stabler. 1906. 36 pp., 1 pl.

Gives history of pollution by acid-iron wastes at Shelby, Ohio, and of resulting litigation; discusses effect of acid-iron liquors o sewage-purification processes, recovery of copperas from acid-iron wastes, and other processes for removal of pickling liquor.

*187. Determination of stream flow during the frozen season, by H. K. Barrows and R. E. Horton. 1907. 93 pp., 1 pl. 15c.

Scope indicated by title.

*189. The prevention of stream pollution by strawboard waste, by E. B. Phelps. 1906. 29 pp., 2 pls.

Describes manufacture of strawboard, present and proposed methods of disposal of waste liquors, laboratory investigations of precipitation and sedimentation, and field studies of amounts and character of water used, raw material and finished product, and mechanical filtration.

*194. Pollution of Illinois and Mississippi rivers by Chicago sewage (a digest of the testimony taken in the case of the State of Missouri *v.* The State of Illinois and the Sanitary District of Chicago), by M. O. Leighton. 1907. 369 pp., 2 pls.

Scope indicated by amplification of title.

*200. 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 ground water, artesian conditions, and oil and gas bearing formations; gives history of well drilling in Asia, Europe, and the United States; describes in detail the various methods and the machinery used; discusses loss of tools and geologic difficulties; contamination of well waters and methods of prevention; tests of capacity and measurement of depth; and costs of sinking wells.

*258. Underground water papers, 1910, by M. L. Fuller, F. G. Clapp, G. C. Matson, Samuel Sanford, and H. C. Wolff. 1911. 123 pp., 2 pls. 15c.

Contains the following papers (scope indicated by titles) of general interest:
Drainage by wells, by M. L. Fuller.
Freezing of wells and related phenomena, by M. L. Fuller.
Pollution of underground waters in limestone, by G. C. Matson.
Protection of shallow wells in sandy deposits, by M. L. Fuller.
Magnetic wells, by M. L. Fuller.

274. Some stream waters of the western United States, with chapters on sediment carried by the Rio Grande and the industrial application of water analyses, by Herman Stabler. 1911. 188 pp. 15c.

Describes collection of samples, plan of analytical work, and methods of analyses; discusses soap-consuming power of waters, water softening, boiler waters, and water for irrigation.

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

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

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

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

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

Discusses methods of measuring the winter flow of streams.

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

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

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

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

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

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

*375. Contributions to the hydrology of the United States, 1915; N. C. Grover, chief hydraulic engineer. 1916. 181 pp., 9 pls. 15c.

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

* (*c*) The relation of stream gaging to the science of hydraulics, by C. H. Pierce and R. W. Davenport, pp. 77–84.

(*e*) A method for correcting river discharge for changing stage, by B. E. Jones, pp. 117–130.

(*f*) Conditions requiring the use of automatic gages in obtaining records of stream flow, by C. H. Pierce, pp. 131–139.

*400. Contributions to the hydrology of the United States, 1916; N. C. Grover, chief hydraulic engineer. 1917. 108 pp., 7 pls. Contains:

(a) The people's interest in water-power resources, by G. O. Smith, pp. 1–8.
* (c) The measurement of silt-laden streams, by R. C. Pierce, pp. 39-51.
(d) Accuracy of stream-flow data, by N. C. Grover and J. C. Hoty, pp. 53–59.

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

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

425. Contributions to the hydrology of the United States, 1917; N. C. Grover, chief hydraulic engineer. 1918. Contains:

* (c) Hydraulic conversion tables and convenient equivalents, pp. 71–94. 1917.

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. 368–561, pls. 107 to 146. See Water-Supply Paper 87.

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

*American irrigation engineering, by H. M. Wilson, pp. 101–349, pls. 111 to 145. Discusses the economic aspects of irrigation, alkaline drainage, silt and sedimentation; gives brief history of legislation; describes perennial canals in Idaho, California, Wyoming, and Arizona; discusses water storage at reservoirs of the California and other projects, subsurface sources of supply, pumping, and subirrigation.

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

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

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

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

*Principles and conditions of the movements of ground water, by F. H. King, pp. 59–294, pls. 6 to 16. Discusses the amount of water 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 medium 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 and population, and transportation facilities of the region, the relation of agriculture, lumbering, mining, and power development to erosion and denudation, and the nature, effects, and remedies of erosion; gives details of conditions in Holston, Nolichucky, French Broad, Little Tennessee, and Hiwassee river basins, along Tennessee River proper, and in the basins of the Coosa-Alabama system, Chattahoochee, Savannah, Saluda, Broad, Catawba, Yadkin, New, and Monongahela rivers.

86. The transportation of débris by running water, by G. K. Gilbert, based on experiments made with the assistance of E. C. Murphy. 1914. 263 pp., 3 pls. 70c.

The results of an investigation which was carried on in a specially equipped laboratory at Berkeley, Cal., and was undertaken for the purpose of learning "the laws which control the movement of bed load and especially to determine how the quantity of load is related to the stream slope and discharge and to the degree of comminution of the débris."

105. Hydraulic-mining débris in the Sierra Nevada, by G. K. Gilbert. 154 pp., 34 pls. 1917. 50c.

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

BULLETINS.

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

Defines mineral waters, lists the springs by States, and gives tables of analyses.

*319. Summary of the controlling factors of artesian flows, by Myron L. Fuller. 1908. 44 pp. 7 pls. 10c.

Describes underground reservoirs, the sources of ground waters, the confining agents, the primary and modifying factors of artesian circulation, the essential and modifying factors of artesian flow, and typical artesian systems.

*479. The geochemical interpretation of water analyses, by Chase Palmer. 1911. 31 pp. 5c.

Discusses the expression of chemical analyses, the chemical character of water and the properties of natural waters; gives a classification of waters based on property values and reacting values, and discusses the character of the waters of certain rivers as interpreted directly from the results of analyses; discusses also the relation of water properties to geologic formations, silica in river water, and the character of the water of the Mississippi and the Great Lakes and St. Lawrence River as indicated by chemical analyses.

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.