DEPARTMENT OF THE INTERIOR
FRANKLIN K. LANE, Secretary

UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, Director

Water-Supply Paper 405

# SURFACE WATER SUPPLY OF THE UNITED STATES

## 1915

## PART 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, 1915.

## 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, 1915.

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, 1895–1915.*

| | |
|---|---|
| 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 1915, inclusive | 150,000 |

In the execution of the work many private and State organizations have cooperated, either by furnishing data or by assisting in collecting data. Acknowledgments for cooperation of the first kind are made in connection with the description of each station affected; cooperation of the second kind is acknowledged on page 13.

Measurements of stream flow have been made at about 3,800 points in the United States and also at many points in Alaska and the Hawaiian Islands. In July, 1915, 1,350 gaging stations were being maintained by the Survey and the cooperating organizations. Many miscellaneous discharge measurments 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 of water, as run-off in depth of inches, acre-feet, and millions of cubic feet. The principal terms used in this series of reports are second-feet, second-feet per square mile, run-off in inches, acre-feet, and millions of cubic feet. They may be defined as follows:

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

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

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

The following terms not in common use are here defined:

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

"Control," "controlling section," and "point of control," terms used to designate the section or sections of the stream below the gage which determine the discharge relation at the gage. It should be noted that the control may not be the same section or sections at all stages.

The "point of zero flow" for a 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 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 1.131 feet of 13.752 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.
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-feet.
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.
$1\frac{1}{3}$ horsepower equals about 1 kilowatt.

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

## EXPLANATION OF DATA.

The data presented in this report cover the year beginning October 1, 1914, and ending September 30, 1915. At the 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 comprises 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 neasurements are published.

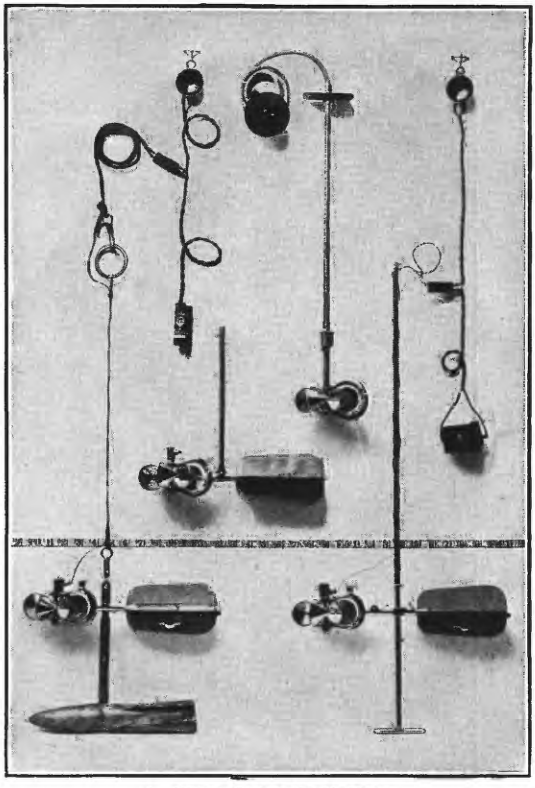
The description of the station gives, in addition to statements regarding location and equipment, information in regard to any conditions that may affect the constancy of the discharge relation, covering such subjects as the occurrence of ice, the use of the stream for log driving, shifting of channel,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

The table of daily discharge gives the discharge in second-feet corresponding to the mean of the gage heights read each day. At stations on streams subject to sudden or rapid diurnal fluctuation the discharge obtained from the rating table and the mean daily gage height may not be the true mean discharge for the day. If such stations are equipped with water-stage recorders the mean daily discharge may be obtained by 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 essentia element the rating curve of the station.

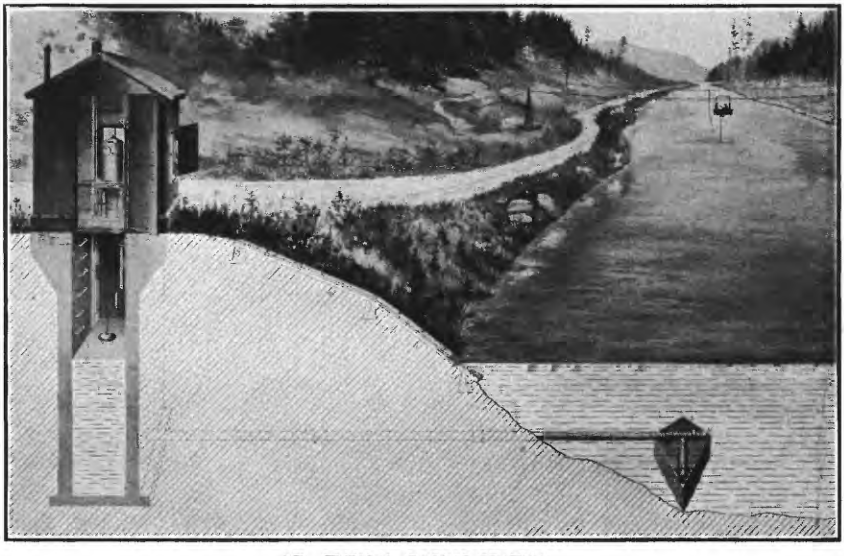
In the table of monthly discharge the column headed "Maximum" gives the mean flow for the day when the mean gage height was highest. As the gage height is the mean for the day, it does not indicate correctly the stage when the water surface was at crest height and the corresponding discharge was consequently 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 8, are based.

## ACCURACY OF FIELD DATA AND COMPUTED RESULTS.

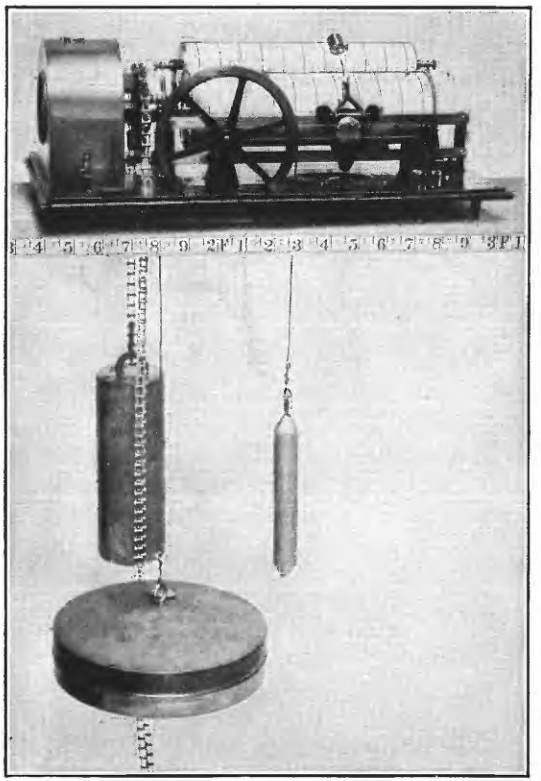
The accuracy of stream-flow data depends primarily (1) on the permanency of the discharge relation and (2) on the accuracy of observation of stage, measurements of flow, and interpretation of records.



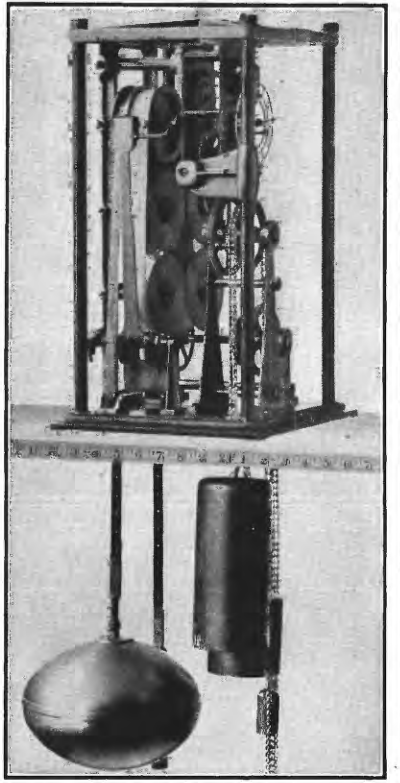
*A*. PRICE CURRENT METERS.



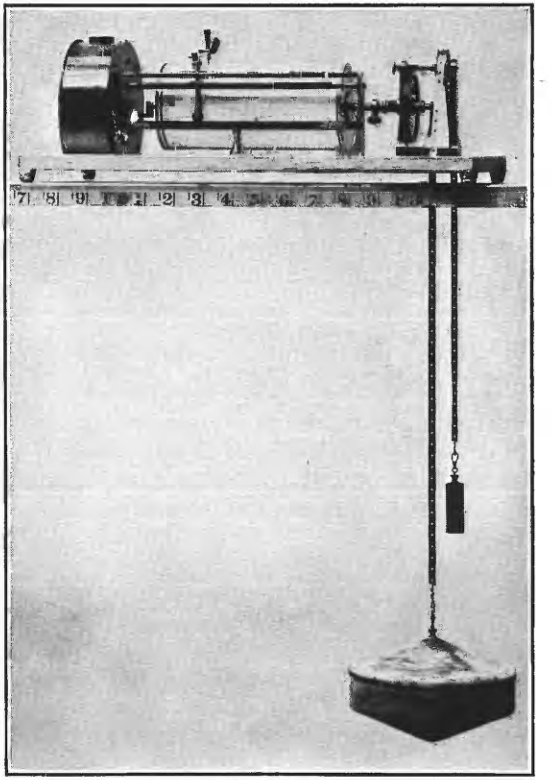
*B*. TYPICAL GAGING STATION.



*A.* STEVENS.



*B.* GURLEY PRINTING.



*C.* FRIEZ.

WATER-STAGE RECORDERS.

Footnotes added to the daily discharge tables give information regarding the probable accuracy of the rating tables used, and an accuracy column is inserted in the monthly discharge table. For the rating tables, "well defined" indicates, in general, that the rating is probably accurate within 5 per cent; "fairly well defined," within 10 per cent; "poorly defined" or "approximate," within 15 to 25 per cent. These notes are very general and are based on the plotting of the individual measurements with reference to the mean rating curve.

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

The monthly means for any station may represent with high accuracy the quantity of water flowing past the gage, but the figures showing discharge per square mile and depth of run-off in inches may be subject to gross errors caused by the inclusion of large non-contributing districts in the measured drainage area, by lack of informatiom 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. The station on St. Mary River at Kimball, Alberta, was maintained in cooperation with the department of the interior, Canada.

In Minnesota the work was carried on in cooperation with the State Drainage Commission, E. V. Willard, acting State drainage engineer, and at certain stations, with the following organizations: U. S. Army Engineer Corps (Chippewa River near Watson, Minn., and Minnesota River at Montevideo, Minn.); U. S. Weather Bureau (Minnesota River near Mankato, Minn., and Mississippi River at St. Paul, Minn.); Eastern Minnesota Power Co. (Snake River near Pine City, Minn.); International Joint Commission (Kawishiwi River near Winton, Minn.).

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 organizations: Wisconsin-Minnesota Light & Power Co. (Chippewa River at Chippewa Falls, Wis., Red Cedar River near Colfax, Wis., Red Cedar River at Cedar Falls, Wis., Red Cedar River at Menomonie, Wis.); Chippewa & Flambeau Improvement Co. (Chippewa River at Bishop's Bridge, near Winter, Wis., and West Fork of Chippewa River at Lessard's, near Winter, Wis.).

In Iowa the State Geological Survey, George F. Kay, director, cooperated, and in Illinois the work was done in cooperation with the State of Illinois 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, Ole Christianson, and L. W. Burdick.

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. Soule, assisted by E. F. Chandler, H. T. Critchlow, Ole Christianson, W. B. Stevenson, and L. W. Burdick.

For stations in the Mississippi River basin in Wisconsin the data were collected and prepared for publication under the direction of W. G. Hoyt, district engineer, assisted by G. H. Canfield, H. C. Beckman, H. T. Critchlow, M. F. Rather, and J. O. Entringer.

The data in the Mississippi River basin in Iowa were collected and prepared for publication under the general direction of W. G. Hoyt, district engineer, and under the immediate direction of R. H. Bolster, assisted by D. V. Egbert, C. Herlofson, and A. Davis.

The data in the Mississippi River basin in Illinois were collected and prepared for publication under the direction of A. H. Horton, district engineer, assisted by B. J. Peterson, William Kessler, H. W. Fear, and M. I. Walters.

The manuscript was assembled by B. J. Peterson.

# GAGING-STATION RECORDS.

## HUDSON BAY DRAINAGE BASIN.

### ST. MARY RIVER NEAR BABB, MONT.

LOCATION.—Near dam site one-fourth mile below outlet of lower St. Mary Lake, 1 mile above mouth of Swiftcurrent Creek, and about 2 miles south of Babb, on Blackfeet Reservation, in Teton County.

DRAINAGE AREA.—177 square miles.

RECORDS AVAILABLE.—April 9, 1902, to September 30, 1915.

GAGE.—Chain gage on right bank, read twice a day during the open season and twice a week during the winter by employees of the United States Reclamation Service. In winter months a temporary low-water gage opposite the chain gage was read.

DISCHARGE MEASUREMENTS.—Made from cable 300 feet below gage. Low-water measurements made by wading one-fourth mile above gage.

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

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.5 feet at 7 a. m. July 3 (discharge, 1,330 second-feet); minimum stage recorded, 0.67 foot March 11 and 16 (discharge, 55 second-feet).

1902–1915: 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).

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

DIVERSIONS.—None.

REGULATION.—Natural storage in St. Mary lakes.

ACCURACY.—Records good.

*Discharge measurements of St. Mary River near Babb, Mont., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Dec. 16 | B. E. Jones | 1.27 | [a]162 | July 18 | B. E. Jones | 2.71 | 808 |
| Feb. 18 | W. A. Lamb | .77 | [a]66 | Aug. 11 | W. A. Lamb | 2.36 | 602 |
| June 23 | do | 3.17 | 1,100 | | | | |

[a] Ice along shores; control clear.

*Daily discharge, in second-feet, of St. Mary River near Babb, Mont., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 405 | 396 | 215 | 114 | 83 | 64 | 76 | 600 | 854 | 1,260 | 680 | 365 |
| 2 | 386 | 386 | 215 | 109 | 82 | 62 | 76 | 680 | 854 | 1,260 | 680 | 476 |
| 3 | 406 | 386 | 184 | 101 | 81 | 60 | 76 | 794 | 916 | 1,330 | 653 | 524 |
| 4 | 426 | 425 | 184 | 96 | 80 | 57 | 79 | 794 | 980 | 1,260 | 653 | 574 |
| 5 | 445 | 425 | 170 | 92 | 80 | 58 | 83 | 854 | 1,050 | 1,260 | 653 | 524 |
| 6 | 425 | 490 | 215 | 86 | 80 | 59 | 87 | 854 | 1,110 | 1,180 | 653 | 500 |
| 7 | 445 | 515 | 199 | 81 | 80 | 59 | 91 | 794 | 1,110 | 1,180 | 626 | 524 |
| 8 | 405 | 515 | 199 | 78 | 78 | 59 | 100 | 794 | 1,110 | 1,110 | 626 | 476 |
| 9 | 425 | 515 | 191 | 74 | 77 | 59 | 109 | 794 | 1,110 | 1,110 | 600 | 476 |
| 10 | 386 | 468 | 184 | 77 | 77 | 55 | 115 | 916 | 1,110 | 1,050 | 600 | 453 |
| 11 | 405 | 490 | 177 | 80 | 77 | 55 | 122 | 1,050 | 1,050 | 1,050 | 600 | 430 |
| 12 | 377 | 490 | 170 | 80 | 76 | 56 | 128 | 1,050 | 980 | 980 | 600 | 430 |
| 13 | 349 | 468 | 164 | 80 | 76 | 56 | 140 | 1,110 | 980 | 916 | 574 | 386 |
| 14 | 367 | 445 | 157 | 70 | 74 | 56 | 152 | 1,110 | 916 | 916 | 574 | 430 |
| 15 | 349 | 425 | 157 | 59 | 71 | 55 | 161 | 1,110 | 916 | 854 | 574 | 365 |
| 16 | 367 | 425 | 170 | 59 | 70 | 55 | 170 | 1,110 | 916 | 794 | 549 | 324 |
| 17 | 405 | 405 | 179 | 59 | 69 | 55 | 190 | 1,050 | 916 | 794 | 549 | 304 |
| 18 | 425 | 386 | 189 | 62 | 66 | 56 | 219 | 980 | 1,050 | 794 | 549 | 304 |
| 19 | 490 | 386 | 199 | 66 | 66 | 56 | 248 | 916 | 1,110 | 736 | 524 | 344 |
| 20 | 515 | 349 | 184 | 74 | 66 | 56 | 286 | 854 | 1,110 | 736 | 524 | 344 |
| 21 | 540 | 368 | 199 | 78 | 66 | 56 | 324 | 794 | 1,110 | 680 | 524 | 365 |
| 22 | 540 | 386 | 199 | 80 | 65 | 57 | 386 | 794 | 1,110 | 653 | 524 | 386 |
| 23 | 515 | 367 | 170 | 83 | 66 | 57 | 430 | 736 | 1,110 | 653 | 500 | 365 |
| 24 | 540 | 349 | 184 | 84 | 66 | 57 | 476 | 736 | 1,050 | 680 | 500 | 365 |
| 25 | 515 | 331 | 164 | 84 | 66 | 66 | 500 | 736 | 1,110 | 653 | 500 | 344 |
| 26 | 490 | 297 | 144 | 84 | 65 | 66 | 500 | 736 | 1,180 | 736 | 476 | 344 |
| 27 | 445 | 263 | 128 | 86 | 65 | 67 | 476 | 736 | 1,260 | 736 | 476 | 365 |
| 28 | 425 | 248 | 111 | 86 | 64 | 68 | 476 | 736 | 1,260 | 736 | 453 | 344 |
| 29 | 405 | 233 | 119 | 84 | ..... | 68 | 500 | 736 | 1,260 | 736 | 453 | 365 |
| 30 | 386 | 218 | 119 | 83 | ..... | 69 | 524 | 736 | 1,260 | 736 | 408 | 344 |
| 31 | 405 | ..... | 119 | 83 | ..... | 72 | ..... | 794 | ..... | 680 | 408 | ..... |

NOTE.—Discharge determined as follows: Oct. 1 to Nov. 30, 1914, from a well-defined rating curve; Dec. 1, 1914, to Sept. 30, 1915, from a rating curve well defined above 430 second-feet and fairly well defined at lower stages. Discharge interpolated on the following days, when gage was not read: Oct. 3, 4, 12, 25; Nov. 1, 8, 21, 23–24, 26, 28, 29; Dec. 9–11, 13, 17, 18, 25, 27, 30; Jan. 1, 4, 6, 8, 10, 12, 14, 16–18, 22, 24, 26, 27, 29–31; Feb. 2, 4, 6, 8, 10, 12, 14, 16, 19, 21, 23, 25, 26, 28; Mar. 3, 5, 7, 9, 10, 12, 14, 15, 17, 18, 21, 22, 24, 25, 27, 29, 31; Apr. 2, 4–6, 8, 11, 13, 15, 18, 20, and 29.

*Monthly discharge of St. Mary River near Babb, Mont., for the year ending Sept. 30, 1915.*

[Drainage area, 177 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off. | | Accuracy. |
|---|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | Depth in inches on drainage area. | Total in acre-feet. | |
| October | 540 | 349 | 433 | 2.45 | 2.82 | 26,600 | B. |
| November | 515 | 218 | 395 | 2.23 | 2.49 | 23,500 | B. |
| December | 215 | 111 | 173 | .977 | 1.13 | 10,600 | B. |
| January | 114 | 59 | 81.0 | .458 | .53 | 4,980 | B. |
| February | 83 | 64 | 72.7 | .411 | .43 | 4,040 | B. |
| March | 72 | 55 | 59.7 | .337 | .39 | 3,670 | B. |
| April | 524 | 76 | 243 | 1.37 | 1.53 | 14,500 | B. |
| May | 1,110 | 600 | 854 | 4.82 | 5.56 | 52,500 | A. |
| June | 1,260 | 854 | 1,060 | 5.99 | 6.68 | 63,100 | A. |
| July | 1,330 | 653 | 911 | 5.15 | 5.94 | 56,000 | A. |
| August | 680 | 408 | 557 | 3.15 | 3.63 | 34,200 | A. |
| September | 574 | 304 | 405 | 2.29 | 2.56 | 24,100 | B. |
| The year | 1,330 | 55 | 439 | 2.48 | 33.69 | 318,000 | |

ST. MARY RIVER BELOW SWIFTCURRENT CREEK, AT BABB, MONT.

LOCATION.—About a mile below mouth of Swiftcurrent Creek, at Babb, on Blackfeet Reservation, in Teton County.

DRAINAGE AREA.—298 square miles.

RECORDS AVAILABLE.—July 14, 1901, to October 18, 1902; May 13, 1910, to September 30, 1915.

GAGE.—Stevens water-stage recorder on right bank opposite Babb post office. From July 14, 1901, to October 18, 1902, a staff gage on the left pier of a highway bridge about 100 feet above the present gage, and at a different datum, was used. This gage was destroyed by the flood of June 5, 1908. From May 13, 1910, to July 18, 1911, a staff gage was maintained on the left bank about 75 feet below the original gage and at a different datum. A temporary chain gage was used for low-water readings. From July 19, 1911, to April 21, 1915, an overhanging chain gage was maintained on the right bank at the same datum and location as the present water-stage recorder, and at the same datum as the staff gage on left bank, but on account of channel conditions the gages do not read the same.

DISCHARGE MEASUREMENTS.—Made from the cable 50 feet above gage; low-water measurements made by wading. A small overflow channel from Swiftcurrent Creek is measured from a foot-bridge.

CHANNEL AND CONTROL.—Bed of stream composed of gravel and cobblestones; shifts slightly. A small overflow channel from Swiftcurrent Creek enters about 100 feet below gage on left bank.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 6.4 feet June 26 to 29 (discharge 1,860 second-feet); minimum stage recorded, 3.8 feet February 7, 19, 20, 22 to 28, March 1 to 3, 5, 6, and 14 to 18 (discharge 90 second-feet).

1901–1902 and 1910–1915: Maximum stage recorded 6.5 feet July 4, 1902 (discharge, 6,690 second-feet); minimum stage recorded, 3.48 feet March 15 to 25, 1912 (discharge, 64 second-feet).

WINTER FLOW.—Discharge relation slightly affected by ice; flow estimated.

DIVERSIONS.—None.

REGULATION.—Natural storage in St. Mary and Sherburne Lakes.

ACCURACY.—Results apparently good.

*Discharge measurements of St. Mary River below Swiftcurrent Creek, at Babb, Mont., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Nov. 7 | W. A. Lamb | 5.28 | 905 | May 26 | W. A Lamb | 5.56 | 1,050 |
| Dec. 16 | B. E. Jones | 4.17 | [a] 207 | June 22 | do | 6.12 | 1,560 |
| Feb. 19 | W. A. Lamb | 3.80 | [b] 90 | July 18 | B. E. Jones | 5.52 | 1,030 |
| 24 | do | 5.22 | 766 | Aug. 10 | Lamb and Hoyt | 5.22 | 826 |

[a] Ice at gage, but probably not enough to cause any backwater.
[b] Channel practically free from ice.

NOTE.—Measurements do not include the overflow from Swiftcurrent Creek, of which the following measurement was made July 18, 1915: Gage height 4.81 feet; discharge, 4.9 second feet.

*Daily discharge, in second-feet, of St. Mary River below Swiftcurrent Creek, at Babb, Mont., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 670 | 598 | 340 | 185 | 115 | 90 | 122 | 1,420 | 1,190 | 1,760 | 950 | 625 |
| 2 | 778 | 610 | 320 | 202 | 122 | 90 | 143 | 1,420 | 1,280 | 1,760 | 915 | 685 |
| 3 | 852 | 641 | 290 | 185 | 132 | 90 | 185 | 1,330 | 1,360 | 1,760 | 915 | 950 |
| 4 | 740 | 740 | 260 | 150 | 115 | 95 | 202 | 1,240 | 1,460 | 1,760 | 915 | 988 |
| 5 | 705 | 840 | 250 | 150 | 115 | 90 | 220 | 1,240 | 1,560 | 1,660 | 880 | 915 |
| 6 | 705 | 941 | 250 | 115 | 132 | 90 | 260 | 1,420 | 1,560 | 1,660 | 880 | 810 |
| 7 | 705 | 965 | 240 | 122 | 90 | 102 | 292 | 1,620 | 1,560 | 1,560 | 845 | 745 |
| 8 | 697 | 890 | 235 | 122 | 102 | 102 | 300 | 1,720 | 1,560 | 1,560 | 845 | 685 |
| 9 | 687 | 777 | 220 | 132 | 95 | 115 | 300 | 1,720 | 1,560 | 1,560 | 845 | 715 |
| 10 | 677 | 778 | 220 | 132 | 95 | 115 | 300 | 1,720 | 1,560 | 1,560 | 810 | 715 |
| 11 | 677 | 815 | 220 | 132 | 95 | 102 | 300 | 1,720 | 1,360 | 1,460 | 810 | 685 |
| 12 | 647 | 815 | 210 | 115 | 95 | 102 | 345 | 1,720 | 1,360 | 1,360 | 810 | 655 |
| 13 | 647 | 740 | 220 | 115 | 95 | 115 | 395 | 1,620 | 1,360 | 1,280 | 810 | 625 |
| 14 | 670 | 740 | 230 | 150 | 92 | 90 | 450 | 1,720 | 1,280 | 1,190 | 810 | 598 |
| 15 | 745 | 740 | 240 | 145 | 90 | 90 | 478 | 1,830 | 1,360 | 1,100 | 810 | 520 |
| 16 | 927 | 670 | 240 | 140 | 90 | 90 | 505 | 1,620 | 1,460 | 1,020 | 810 | 520 |
| 17 | 966 | 600 | 230 | 135 | 90 | 90 | 505 | 1,520 | 1,460 | 1,020 | 778 | 520 |
| 18 | 1,040 | 568 | 220 | 135 | 90 | 90 | 630 | 1,420 | 1,660 | 1,020 | 778 | 625 |
| 19 | 1,120 | 535 | 220 | 130 | 90 | 102 | 630 | 1,330 | 1,660 | 988 | 778 | 745 |
| 20 | 1,080 | 535 | 220 | 125 | 90 | 102 | 630 | 1,240 | 1,660 | 915 | 745 | 745 |
| 21 | 1,030 | 568 | 202 | 125 | 102 | 102 | 630 | 1,160 | 1,560 | 915 | 778 | 685 |
| 22 | 1,010 | 535 | 202 | 125 | 90 | 102 | 770 | 1,070 | 1,560 | 915 | 745 | 685 |
| 23 | 988 | 480 | 202 | 120 | 90 | 115 | 770 | 990 | 1,560 | 915 | 745 | 625 |
| 24 | 915 | 440 | 190 | 120 | 90 | 115 | 735 | 990 | 1,560 | 915 | 715 | 625 |
| 25 | 807 | 410 | 185 | 120 | 90 | 115 | 770 | 1,070 | 1,760 | 950 | 685 | 625 |
| 26 | 760 | 390 | 175 | 115 | 90 | 122 | 735 | 1,070 | 1,860 | 988 | 685 | 570 |
| 27 | 715 | 370 | 150 | 115 | 90 | 122 | 735 | 1,070 | 1,860 | 988 | 685 | 570 |
| 28 | 710 | 360 | 150 | 115 | 90 | 102 | 735 | 1,070 | 1,860 | 1,020 | 655 | 520 |
| 29 | 660 | 350 | 185 | 122 | ..... | 115 | 840 | 1,160 | 1,860 | 1,020 | 655 | 520 |
| 30 | 610 | 340 | 185 | 115 | ..... | 115 | 1,160 | 1,020 | 1,760 | 988 | 655 | 520 |
| 31 | 617 | ..... | 178 | 132 | ..... | 102 | ..... | 988 | ..... | 950 | 655 | ..... |

NOTE.—Discharge determined as follows: Oct. 1–7, 16–20, and Nov. 7–22, from rating curve fairly well defined between 100 and 900 second-feet; Oct. 8–15, 21–31, Nov. 1–6, 23–30, Dec. 1–9, and 24–26, estimated because of unreliable gage heights from records obtained at stations above Swiftcurrent Creek and near Kimball, Alberta; Dec. 21–23 and Dec. 27 to May 29, except Feb. 10–18, which was estimated, from rating curve fairly well defined between 100 and 2,700 second-feet; May 30 to Sept. 30, from rating curve fairly well defined between 300 and 2,700 second-feet.

*Daily discharge, in second-feet, of Swiftcurrent Creek overflow at Babb, Mont., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Apr. | May. | June. | July. | Aug. |
|---|---|---|---|---|---|---|---|
| 1 | 1.9 | 11.5 | ..... | 8.7 | 8.7 | 26 | 4.7 |
| 2 | 3.3 | 10.1 | ..... | 11.5 | 11.5 | 26 | 4.7 |
| 3 | 4.7 | 8.7 | ..... | 15 | 15 | 26 | 3.3 |
| 4 | 2.8 | 10.1 | 1.5 | 26 | 15 | 23 | 3.3 |
| 5 | 2.3 | 10.1 | 2.3 | 20 | 15 | 20 | 3.3 |
| 6 | 2.3 | 8.7 | 3.3 | 20 | 20 | 15 | 2.3 |
| 7 | 2.3 | 8.7 | 3.3 | 23 | 20 | 15 | 2.3 |
| 8 | 2.8 | 4.7 | 3.3 | 23 | 20 | 15 | 2.3 |
| 9 | 3.3 | 4.7 | 4.7 | 23 | 11.5 | 13.2 | 2.3 |
| 10 | 3.3 | 3.3 | 4.7 | 26 | 11.5 | 13.2 | 2.3 |
| 11 | 3.3 | 2.3 | 4.7 | 26 | 8.7 | 11.5 | 2.3 |
| 12 | 3.3 | 2.3 | 4.7 | 26 | 8.7 | 6.5 | 2.3 |
| 13 | 3.3 | 1.5 | 4.7 | 26 | 11.5 | 4.7 | 2.3 |
| 14 | 4.7 | 1.5 | 4.7 | 26 | 11.5 | 4.7 | 2.3 |
| 15 | 4.7 | ..... | 4.7 | 33 | 11.5 | 4.7 | .8 |
| 16 | 5.6 | ..... | 4.7 | 26 | 11.5 | 3.3 | .8 |
| 17 | 6.5 | ..... | 4.7 | 20 | 15 | 3.3 | .8 |
| 18 | 7.6 | ..... | 6.5 | 15 | 8.7 | 3.3 | .8 |
| 19 | 8.7 | ..... | 8.7 | 11.5 | 10 | 3.3 | .8 |
| 20 | 8.7 | ..... | 11.5 | 8.7 | 11 | 3.3 | .8 |
| 21 | 11.5 | ..... | 11.5 | 6.5 | 13 | 4.7 | .8 |
| 22 | 11.5 | ..... | 11.5 | 4.7 | 14 | 4.7 | .2 |
| 23 | 11.5 | ..... | 11.5 | 3.3 | 15 | 4.7 | .2 |
| 24 | 13.2 | ..... | 8.7 | 2.3 | 15 | 4.7 | .2 |
| 25 | 13.2 | ..... | 6.5 | 1.5 | 20 | 4.7 | .2 |
| 26 | 15 | ..... | 4.7 | .8 | 33 | 4.7 | ..... |
| 27 | 15 | ..... | 4.7 | .8 | 36 | 4.7 | ..... |
| 28 | 15 | ..... | 4.7 | 1.5 | 33 | 6.5 | ..... |
| 29 | 20 | ..... | 6.5 | 1.5 | 30 | 6.5 | ..... |
| 30 | 20 | ..... | 8.7 | 3.3 | 26 | 6.5 | ..... |
| 31 | 13.2 | ..... | ..... | 4.7 | ..... | 4.7 | ..... |

NOTE.—Daily discharge determined from a poorly defined rating curve. Discharge Oct. 1 to Nov. 6 estimated; approximate only, as gage-height record for this period is unreliable. Discharge June 19–22 interpolated.

*Combined daily discharge, in second-feet, of St. Mary River and Swiftcurrent Creek overflow at Babb, Mont., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 672 | 610 | 340 | 185 | 115 | 90 | 122 | 1,430 | 1,200 | 1,790 | 955 | 625 |
| 2 | 781 | 620 | 320 | 202 | 122 | 90 | 143 | 1,430 | 1,290 | 1,790 | 920 | 685 |
| 3 | 857 | 650 | 290 | 185 | 132 | 90 | 185 | 1,340 | 1,380 | 1,790 | 918 | 950 |
| 4 | 743 | 750 | 260 | 150 | 115 | 95 | 204 | 1,270 | 1,480 | 1,780 | 918 | 988 |
| 5 | 707 | 850 | 250 | 150 | 115 | 90 | 222 | 1,260 | 1,580 | 1,680 | 883 | 915 |
| 6 | 707 | 950 | 250 | 115 | 132 | 90 | 263 | 1,440 | 1,580 | 1,680 | 882 | 810 |
| 7 | 707 | 974 | 240 | 122 | 90 | 102 | 295 | 1,640 | 1,580 | 1,580 | 847 | 745 |
| 8 | 700 | 895 | 235 | 122 | 102 | 102 | 303 | 1,740 | 1,580 | 1,580 | 847 | 685 |
| 9 | 690 | 782 | 220 | 132 | 95 | 115 | 305 | 1,740 | 1,570 | 1,570 | 847 | 715 |
| 10 | 680 | 781 | 220 | 132 | 95 | 115 | 305 | 1,750 | 1,570 | 1,570 | 812 | 715 |
| 11 | 680 | 817 | 220 | 132 | 95 | 102 | 305 | 1,750 | 1,370 | 1,470 | 812 | 685 |
| 12 | 650 | 817 | 210 | 115 | 95 | 102 | 350 | 1,750 | 1,370 | 1,370 | 812 | 655 |
| 13 | 650 | 742 | 220 | 115 | 95 | 115 | 400 | 1,650 | 1,370 | 1,280 | 812 | 625 |
| 14 | 675 | 742 | 230 | 150 | 92 | 90 | 455 | 1,750 | 1,290 | 1,190 | 812 | 598 |
| 15 | 750 | 740 | 240 | 145 | 90 | 90 | 483 | 1,860 | 1,370 | 1,100 | 811 | 520 |
| 16 | 933 | 670 | 240 | 140 | 90 | 90 | 510 | 1,650 | 1,470 | 1,020 | 811 | 520 |
| 17 | 972 | 600 | 230 | 135 | 90 | 90 | 510 | 1,540 | 1,480 | 1,020 | 779 | 520 |
| 18 | 1,050 | 568 | 220 | 135 | 90 | 90 | 636 | 1,440 | 1,670 | 1,020 | 779 | 625 |
| 19 | 1,130 | 535 | 220 | 130 | 90 | 102 | 639 | 1,340 | 1,670 | 991 | 779 | 745 |
| 20 | 1,090 | 535 | 220 | 125 | 90 | 102 | 642 | 1,250 | 1,670 | 918 | 746 | 745 |
| 21 | 1,040 | 568 | 202 | 125 | 102 | 102 | 642 | 1,170 | 1,570 | 920 | 779 | 685 |
| 22 | 1,020 | 535 | 202 | 125 | 90 | 102 | 782 | 1,070 | 1,570 | 920 | 745 | 685 |
| 23 | 1,000 | 480 | 202 | 120 | 90 | 115 | 782 | 993 | 1,580 | 920 | 745 | 625 |
| 24 | 928 | 440 | 190 | 120 | 90 | 115 | 743 | 992 | 1,580 | 920 | 715 | 625 |
| 25 | 820 | 410 | 185 | 120 | 90 | 115 | 776 | 1,070 | 1,780 | 955 | 685 | 625 |
| 26 | 775 | 390 | 175 | 115 | 90 | 122 | 740 | 1,070 | 1,890 | 993 | 685 | 570 |
| 27 | 730 | 370 | 150 | 115 | 90 | 122 | 740 | 1,070 | 1,900 | 993 | 685 | 570 |
| 28 | 725 | 360 | 150 | 115 | 90 | 102 | 740 | 1,070 | 1,890 | 1,030 | 655 | 520 |
| 29 | 680 | 350 | 185 | 122 | ..... | 115 | 846 | 1,160 | 1,890 | 1,030 | 655 | 520 |
| 30 | 630 | 340 | 185 | 115 | ..... | 115 | 1,170 | 1,020 | 1,790 | 994 | 655 | 520 |
| 31 | 630 | ..... | 178 | 132 | ..... | 102 | ..... | 993 | ..... | 955 | 655 | ..... |

*Combined monthly discharge of St. Mary River and Swiftcurrent Creek overflow at Babb, Mont., for the year ending Sept. 30, 1915.*

[Drainage area, 298 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off. | | Accuracy. |
|---|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | Depth in inches on drainage area. | Total in acre-feet. | |
| October | 1,130 | 630 | 800 | 2.68 | 3.09 | 49,200 | C. |
| November | 974 | 340 | 629 | 2.11 | 2.35 | 37,400 | C. |
| December | 340 | 150 | 222 | .745 | .86 | 13,600 | C. |
| January | 202 | 115 | 134 | .450 | .52 | 8,240 | C. |
| February | 132 | 90 | 98.6 | .331 | .34 | 5,480 | C. |
| March | 122 | 90 | 103 | .346 | .40 | 6,330 | B. |
| April | 1,170 | 122 | 508 | 1.70 | 1.90 | 30,200 | A. |
| May | 1,860 | 992 | 1,380 | 4.63 | 5.34 | 84,800 | A. |
| June | 1,900 | 1,200 | 1,570 | 5.27 | 5.88 | 93,400 | A. |
| July | 1,790 | 918 | 1,260 | 4.23 | 4.88 | 77,500 | A. |
| August | 955 | 655 | 788 | 2.64 | 3.04 | 48,500 | A. |
| September | 988 | 520 | 667 | 2.24 | 2.50 | 39,700 | A. |
| The year | 1,900 | 90 | 682 | 2.29 | 31.10 | 494,000 | |

ST. MARY RIVER NEAR KIMBALL, ALBERTA.

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

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

RECORDS AVAILABLE.—January 1, 1913, to September 30, 1915. From September 4, 1902, to December 31, 1912, records were obtained at a point one-fourth of a mile below the boundary line. The discharge at the two points is practically the same.

GAGE.—Friez water-stage recorder with a concrete well and shelter on the right bank is used during the open-water season; in the winter months a chain gage on the highway bridge 2 miles below the station is used. A chain gage on the left bank was used at the old station near the boundary line.

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

CHANNEL AND CONTROL.—The bed of the stream at the gage and at the control is composed of bowlders and sandstone ledges. The control is formed by an outcropping ledge of sandstone; 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, 4.8 feet at 3 p. m. June 26 (discharge, 2,930 second-feet); minimum stage, from chain gage, 4.65 feet February 22 (discharge, 93 second-feet).

1902–1915: Maximum stage recorded, 12.75 feet June 5, 1908 (discharge, 18,000 second-feet, estimated by comparison with record of station near Babb); minimum stage recorded: February 5, 1914; discharge, 70 second-feet[1] (discharge relation affected by ice).

WINTER FLOW.—Discharge relation seriously affected by ice. Discharge computed from discharge measurements and temperature records.

DIVERSIONS.—None.

REGULATION.—Practically none.

ACCURACY.—Rating curve good; results excellent.

COOPERATION.—Station is being maintained jointly with the Commissioner of Irrigation of the Department of the Interior of Canada.

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

*Discharge measurements of St. Mary River near Kimball, Alberta, during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 1 | O. H. Hoover | 2.78 | 700 | Apr. 3 | J. E. Degnan | 1.95 | 255 |
| 10 | do | 2.80 | 700 | 19 | V. A. Newhall | 2.86 | 788 |
| 16 | do | 3.18 | 1,036 | 21 | do | 3.02 | 918 |
| Nov. 12 | do | 2.89 | 791 | 23 | do | 3.04 | 954 |
| 26 | do | 2.30 | 422 | 24 | W. A. Lamb | 3.06 | 890 |
| Dec. 14 | do | 2.37 | 267 | May 5 | V. A. Newhall | 3.76 | 1,634 |
| Jan. 1 | do | 5.04 | 181 | 10 | do | 4.12 | 2,051 |
| 19 | J. E. Degnan | 5.46 | 150 | 22 | do | 3.50 | 1,326 |
| 21 | do | 5.15 | 161 | 27 | W. A. Lamb | 3.54 | 1,390 |
| Feb. 8 | do | 5.29 | 120 | June 10 | V. A. Newhall | 4.42 | 2,406 |
| 8 | do | 5.29 | 143 | 11 | do | 4.21 | 2,020 |
| 10 | do | 5.19 | 112 | 16 | do | 4.26 | 2,233 |
| 26 | do | 4.78 | 116 | July 12 | do | 3.75 | 1,659 |
| 27 | do | 4.88 | 117 | 13 | do | 3.67 | 1,512 |
| Mar. 6 | do | 4.70 | 109 | 15 | B. E. Jones | 3.56 | 1,380 |
| 15 | do | 5.03 | 136 | 16 | V. A. Newhall | 3.50 | 1,350 |
| 18 | do | 5.28 | 253 | Aug. 3 | do | 3.38 | 1,253 |
| 25 | do | 4.53 | 141 | 6 | do | 3.26 | 1,150 |
| 29 | do | 1.61 | 176 | 9 | W. A. Lamb | 3.20 | 1,004 |
| Apr. 2 | do | 1.88 | 244 | 17 | V. A. Newhall | 3.05 | 934 |

NOTE.—Gage heights of measurements from Jan. 1 to Mar. 25 refer to winter gage at highway bridge. Gage heights of other measurements refer to water-stage recorder.

*Daily discharge, in second-feet, of St. Mary River near Kimball, Alberta, for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 690 | 645 | 367 | 181 | 148 | 114 | 212 | 1,420 | 1,461 | 2,514 | 1,360 | 654 |
| 2 | 731 | 691 | 362 | 180 | 146 | 112 | 240 | 1,637 | 1,483 | 2,436 | 1,300 | 780 |
| 3 | 752 | 795 | 366 | 182 | 143 | 108 | 266 | 1,730 | 2,306 | 2,514 | 1,240 | 1,694 |
| 4 | 788 | 919 | 316 | 184 | 140 | 108 | 286 | 1,682 | 2,397 | 2,358 | 1,193 | 1,494 |
| 5 | 802 | 944 | 310 | 185 | 137 | 109 | 306 | 1,626 | 2,475 | 2,189 | 1,155 | 1,250 |
| 6 | 780 | 1,012 | 302 | 186 | 133 | 110 | 326 | 1,516 | 2,475 | 2,078 | 1,117 | 1,060 |
| 7 | 759 | 1,012 | 290 | 186 | 130 | 111 | 334 | 1,430 | 2,345 | 2,066 | 1,070 | 966 |
| 8 | 724 | 1,012 | 277 | 185 | 126 | 113 | 348 | 1,549 | 2,358 | 2,030 | 1,060 | 874 |
| 9 | 717 | 927 | 272 | 183 | 121 | 117 | 322 | 1,886 | 2,280 | 1,982 | 1,060 | 882 |
| 10 | 710 | 840 | 272 | 180 | 115 | 121 | 334 | 2,054 | 2,488 | 1,934 | 1,043 | 924 |
| 11 | 697 | 818 | 273 | 177 | 110 | 125 | 318 | 2,126 | 2,202 | 1,718 | 1,018 | 858 |
| 12 | 671 | 780 | 269 | 173 | 110 | 129 | 322 | 2,054 | 2,078 | 1,615 | 1,000 | 802 |
| 13 | 678 | 802 | 267 | 169 | 110 | 131 | 339 | 2,102 | 2,006 | 1,516 | 1,009 | 780 |
| 14 | 724 | 780 | 267 | 165 | 111 | 133 | 388 | 2,215 | 2,090 | 1,494 | 1,043 | 758 |
| 15 | 832 | 780 | 260 | 160 | 111 | 137 | 448 | 2,150 | 2,163 | 1,430 | 958 | 712 |
| 16 | 1,020 | 848 | 250 | 157 | 111 | 150 | 497 | 1,982 | 2,254 | 1,350 | 950 | 654 |
| 17 | 1,205 | 780 | 239 | 153 | 111 | 175 | 543 | 1,826 | 2,228 | 1,538 | 932 | 660 |
| 18 | 1,255 | 731 | 238 | 151 | 111 | 218 | 647 | 1,790 | 2,475 | 2,054 | 907 | 758 |
| 19 | 1,186 | 731 | 239 | 150 | 107 | 253 | 765 | 1,648 | 2,397 | 1,910 | 898 | 890 |
| 20 | 1,120 | 697 | 235 | 155 | 102 | 262 | 890 | 1,505 | 2,280 | 1,483 | 1,018 | 882 |
| 21 | 1,056 | 671 | 223 | 164 | 96 | 265 | 907 | 1,400 | 2,163 | 1,310 | 992 | 826 |
| 22 | 1,012 | 537 | 219 | 166 | 93 | 260 | 941 | 1,340 | 2,102 | 1,270 | 907 | 742 |
| 23 | 969 | 445 | 221 | 166 | 95 | 220 | 932 | 1,270 | 2,030 | 1,250 | 866 | 750 |
| 24 | 911 | 435 | 221 | 166 | 104 | 180 | 916 | 1,280 | 2,042 | 1,240 | 818 | 735 |
| 25 | 848 | 445 | 216 | 165 | 114 | 142 | 890 | 1,350 | 2,488 | 1,240 | 795 | 720 |
| 26 | 810 | 430 | 207 | 164 | 116 | 140 | 890 | 1,360 | 2,670 | 1,360 | 758 | 668 |
| 27 | 780 | 405 | 200 | 160 | 116 | 150 | 874 | 1,380 | 2,605 | 1,380 | 742 | 654 |
| 28 | 745 | 390 | 193 | 158 | 117 | 160 | 866 | 1,370 | 2,488 | 1,626 | 742 | 634 |
| 29 | 724 | 375 | 188 | 154 | ..... | 165 | 890 | 1,390 | 2,384 | 1,549 | 728 | 628 |
| 30 | 684 | 371 | 185 | 151 | ..... | 162 | 1,018 | 1,450 | 2,306 | 1,549 | 690 | 582 |
| 31 | 678 | ..... | 183 | 149 | ..... | 191 | ..... | 1,450 | ..... | 1,410 | 682 | ..... |

NOTE.—Discharge determined as follows: Dec. 5–31, from readings on the staff gage at the cable; Jan. 1 to Mar. 28 (ice present) from chain-gage readings at the highway bridge below the station; estimated Nov. 30; Dec. 1; Jan. 2, 10, 17, 24, 25, 29, and 31; Feb. 2; Mar. 7, 9, 14, and 17; Apr. 11; May 16; June 5, 6, 12, 19, 26, and 27; July 18 and 19; Aug. 15 and 16; Sept. 4, 11, and 12. Well-defined rating curves applicable from Oct. 1 to Dec. 5, and from Mar. 29 to Sept. 30.

*Monthly discharge of St. Mary River near Kimball, Alberta, for the year ending Sept. 30, 1915.*

[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 | 1,255 | 671 | 841 | 1.782 | 2.05 | 51,711 |
| November | 1,012 | 375 | 702 | 1.488 | 1.66 | 41,772 |
| December | 367 | 183 | 256 | .542 | .62 | 15,741 |
| January | 186 | 149 | 168 | .356 | .41 | 10,330 |
| February | 148 | 93 | 117 | .248 | .26 | 6,498 |
| March | 265 | 108 | 157 | .333 | .38 | 9,654 |
| April | 1,018 | 212 | 575 | 1.22 | 1.36 | 34,215 |
| May | 2,215 | 1,270 | 1,645 | 3.49 | 4.02 | 101,145 |
| June | 2,670 | 1,461 | 2,251 | 4.77 | 5.32 | 133,940 |
| July | 2,514 | 1,240 | 1,722 | 3.648 | 4.21 | 105,882 |
| August | 1,360 | 682 | 969 | 2.053 | 2.37 | 59,581 |
| September | 1,694 | 582 | 842 | 1.784 | 1.99 | 50,102 |
| The year | 2,670 | 93 | 857 | 1.82 | 24.65 | 620,571 |

## SWIFTCURRENT CREEK AT MANY GLACIER, MONT.[1]

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

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

RECORDS AVAILABLE.—June 6, 1912, to September 30, 1915.

GAGE.—A vertical staff on left bank at outlet of the lake; read once a day by Oscar Montross.

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

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

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.1 feet, May 8 (discharge, 600 second-feet); minimum stage recorded, 1.75 feet September 13 and 15 (discharge, 76 second-feet).

1912–1915: Maximum stage recorded, 4.25 feet May 28, 1913 (discharge, 1,150 second-feet); minimum discharge recorded, 10.8 second-feet March 19, 1912, by current meter measurement, prior to installation of gage.

WINTER FLOW.—Discharge relation seriously affected by ice.

DIVERSIONS.—None.

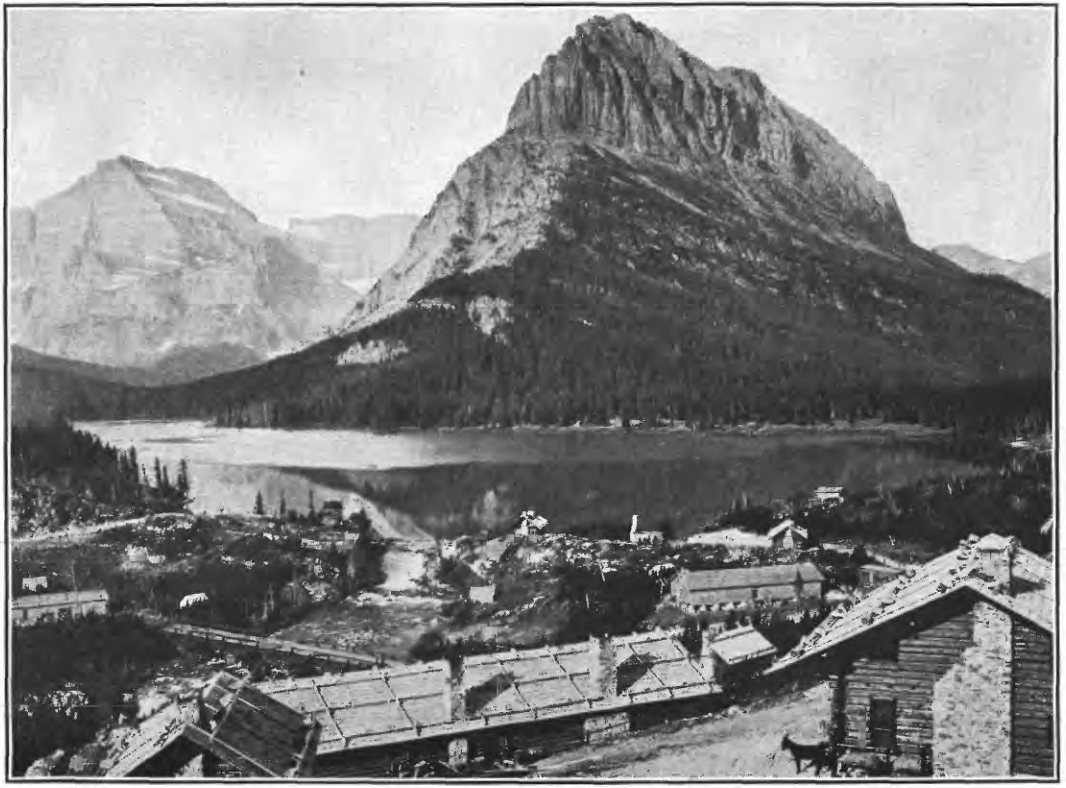
REGULATION.—None.

ACCURACY.—Results good.

*Discharge measurements of Swiftcurrent Creek at Many Glacier, Mont., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* |
| July 17 | B. E. Jones | 2.06 | 141 |
| Aug. 11 | Lamb and Hoyt | 2.14 | 160 |

[1] Published in previous reports under name "Swiftcurrent Creek at McDermott Lake, Mont."



McDERMOTT LAKE FROM MANY GLACIER CAMP, MONT.

*Daily discharge, in second-feet, of Swiftcurrent Creek at Many Glacier, Mont., for the year ending Sept. 30, 1915.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Day. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 314 | 222 | 406 | 177 | 125 | 16 | ..... | 360 | 360 | 151 | 151 | 99 |
| 2 | ..... | 406 | 314 | 360 | 177 | 138 | 17 | ..... | 314 | 397 | 157 | 151 | 138 |
| 3 | ..... | 550 | 360 | 268 | 183 | 245 | 18 | ..... | 268 | 454 | 143 | 138 | 161 |
| 4 | ..... | 406 | 406 | 291 | 183 | 222 | 19 | ..... | 268 | 351 | 151 | 151 | 202 |
| 5 | ..... | 406 | 464 | 268 | 151 | 173 | 20 | ..... | 268 | 360 | 138 | 138 | 161 |
| 6 | ..... | 454 | 324 | 291 | 167 | 167 | 21 | ..... | 268 | 360 | 167 | 151 | 146 |
| 7 | ..... | 550 | 360 | 351 | 177 | 146 | 22 | ..... | 268 | 360 | 191 | 151 | 125 |
| 8 | ..... | 600 | 314 | 314 | 167 | 114 | 23 | ..... | 183 | 314 | 202 | 138 | 105 |
| 9 | ..... | 406 | 277 | 277 | 183 | 116 | 24 | ..... | 183 | 360 | 202 | 141 | 112 |
| 10 | ..... | 268 | 314 | 314 | 151 | 95 | 25 | 314 | 183 | 337 | 183 | 148 | 94 |
| 11 | ..... | 222 | 245 | 277 | 167 | 99 | 26 | 268 | 222 | 478 | 177 | 135 | 95 |
| 12 | ..... | 222 | 231 | 231 | 157 | 92 | 27 | 268 | 183 | 502 | 177 | 141 | 94 |
| 13 | ..... | 268 | 183 | 183 | 138 | 76 | 28 | 222 | 202 | 383 | 195 | 143 | 84 |
| 14 | ..... | 314 | 277 | 191 | 167 | 84 | 29 | 222 | 291 | 430 | 191 | 125 | 94 |
| 15 | ..... | 314 | 291 | 151 | 148 | 76 | 30 | 183 | 314 | 360 | 161 | 114 | 84 |
| | | | | | | | 31 | ..... | 245 | ..... | 177 | 125 | ..... |

NOTE.—Discharge determined from rating curve fairly well defined between 84 and 314 second-feet.

*Monthly discharge of Swiftcurrent Creek at Many Glacier, Mont., for the year ending Sept. 30, 1915.*

[Drainage area, 31.4 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off. | | Accuracy. |
|---|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | Depth in inches on drainage area. | Total in acre-feet. | |
| April 25–30 | 314 | 183 | 246 | 7.83 | 1.75 | 2,930 | B. |
| May | 600 | 183 | 314 | 10.0 | 11.53 | 19,300 | C. |
| June | 502 | 183 | 346 | 11.0 | 12.27 | 20,600 | C. |
| July | 406 | 138 | 224 | 7.13 | 8.22 | 13,800 | B. |
| August | 183 | 114 | 153 | 4.87 | 5.62 | 9,410 | B. |
| September | 245 | 76 | 125 | 3.98 | 4.44 | 7,440 | B. |
| The period | ..... | ..... | ..... | ..... | ..... | 73,400 | |

## SWIFTCURRENT CREEK AT SHERBURNE, MONT.[1]

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

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

RECORDS AVAILABLE.—July 1, 1912, to September 30, 1915.

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

DISCHARGE MEASUREMENTS.—Low-water measurements made by wading; high-water measurements made from a footbridge at the dam.

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

[1] Published in previous reports under name of "Swiftcurrent Creek at Sherburne Lake, Mont."

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 4.6 feet June 26 (discharge, 816 second-feet); minimum stage recorded, 1.8 feet September 16 (discharge, 90 second-feet).

1912–1915: Maximum stage recorded, 7.8 feet May 28, 1913 (discharge, 1,850 second-feet); minimum stage recorded, December 15, 1912 (discharge estimated at 47 second-feet; discharge relation affected by ice). Records do not include a large part of the winter flow, when the minimum discharge is somewhat lower.

WINTER FLOW.—Discharge relation not seriously affected by ice except for short periods.

DIVERSION.—None.

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

ACCURACY.—Results apparently good.

*Discharge measurements of Swiftcurrent Creek at Sherburne, Mont., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Nov. 7 | W. A. Lamb | 6.50 | 503 | June 21 | W. A. Lamb | 3.60 | 461 |
| Dec. 16 | B. E. Jones | 2.45 | 47 | July 18 | B. E. Jones | 2.65 | 221 |
| Apr. 23 | W. A. Lamb | 3.21 | 387 | Aug. 11 | Lamb and Hoyt | 2.64 | 222 |
| May 25 | do | 2.98 | 298 | | | | |

NOTE.—Gage height of measurement of Nov. 7 refers to old gage; backwater from Sherburne Lake dam on this date. Gage heights of subsequent measurements refer to new staff gage below the dam.

*Daily discharge, in second-feet, of Swiftcurrent Creek at Sherburne, Mont., for the year ending Sept. 30, 1915.*

| Day. | Nov. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|
| 1 | ..... | ..... | 420 | 325 | 525 | 264 | 155 |
| 2 | ..... | ..... | 556 | 378 | 525 | 253 | 164 |
| 3 | ..... | ..... | 656 | 300 | 494 | 253 | 231 |
| 4 | ..... | ..... | 588 | 325 | 464 | 264 | 325 |
| 5 | ..... | ..... | 464 | 392 | 392 | 253 | 288 |
| 6 | ..... | ..... | 351 | 464 | 378 | 231 | 231 |
| 7 | ..... | ..... | 300 | 494 | 392 | 231 | 148 |
| 8 | ..... | ..... | 364 | 464 | 435 | 231 | 155 |
| 9 | 288 | ..... | 556 | 464 | 435 | 231 | 155 |
| 10 | 288 | ..... | 732 | 406 | 435 | 231 | 164 |
| 11 | 288 | ..... | 773 | 231 | 378 | 210 | 155 |
| 12 | 288 | ..... | 656 | 351 | 325 | 210 | 140 |
| 13 | 276 | ..... | 588 | 325 | 210 | 210 | 140 |
| 14 | 276 | ..... | 525 | 338 | 231 | 210 | 140 |
| 15 | 276 | ..... | 464 | 378 | 231 | 220 | 101 |
| 16 | 276 | ..... | 392 | 464 | 210 | 210 | 90 |
| 17 | ..... | ..... | 351 | 525 | 231 | 210 | 113 |
| 18 | ..... | ..... | 325 | 621 | 210 | 190 | 276 |
| 19 | ..... | ..... | 288 | 588 | 200 | 190 | 312 |
| 20 | ..... | ..... | 242 | 556 | 210 | 190 | 276 |
| 21 | ..... | ..... | 220 | 494 | 231 | 190 | 200 |
| 22 | ..... | ..... | 210 | 406 | 253 | 190 | 155 |
| 23 | ..... | ..... | 200 | 378 | 253 | 190 | 155 |
| 24 | ..... | 300 | 231 | 406 | 264 | 190 | 155 |
| 25 | ..... | 242 | 300 | 621 | 264 | 155 | 140 |
| 26 | ..... | 242 | 300 | 816 | 253 | 140 | 140 |
| 27 | ..... | 210 | 351 | 773 | 253 | 155 | 126 |
| 28 | ..... | 210 | 325 | 693 | 276 | 155 | 126 |
| 29 | ..... | 231 | 378 | 621 | 288 | 148 | 126 |
| 30 | ..... | 276 | 231 | 588 | 276 | 148 | 113 |
| 31 | ..... | ..... | 140 | ..... | 264 | 140 | ..... |

NOTE.—Discharge Nov. 9–16, 1914, and Apr. 24 to Sept. 30, 1915, determined from rating curve well defined between 71 and 494 second-feet and poorly defined at other stages.

*Monthly discharge of Swiftcurrent Creek at Sherburne, Mont., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| November 9–16 | 288 | 276 | 282 | 4,470 | C. |
| April 24–30 | 300 | 210 | 244 | 3,390 | A. |
| May | 773 | 140 | 402 | 24,700 | B. |
| June | 816 | 231 | 473 | 28,100 | B. |
| July | 525 | 200 | 316 | 19,400 | A. |
| August | 264 | 140 | 203 | 12,500 | A. |
| September | 325 | 90 | 173 | 10,300 | A. |

NOTE.—From June 1 to June 30 a total of 1,560 acre-feet of water was stored in Sherburne Lake by a temporary construction dam; 134 acre-feet was stored Aug. 25 to Sept. 18, and released during the period Sept. 18–20.

### 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 the old station known as "Ottertail River near Fergus Falls" and about 8 miles north of Fergus Falls, Ottertail County.

DRAINAGE AREA.—1,300 square miles.

RECORDS AVAILABLE.—October 29, 1913, to September 30, 1915. May 9, 1904, to October 22, 1913, about 5 miles downstream from the present station. The drainage area at the lower station is only 10 square miles larger, and no tributaries intervene.

GAGE.—Chain gage attached to the downstream hand rail near the right bank; read once daily, to quarter-tenths, by D. S. Danielson.

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

CHANNEL AND CONTROL.—Bed of stream sand and gravel with some bowlders; rapids about 100 feet below the gage from a well-defined control, which is practically permanent except for a slight growth of vegetation in the channel at times. Both banks at and above the gage are high and will probably never overflow; at the control section the land adjacent to the left bank is low and will overflow at a stage of about 5 feet.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 2.8 feet July 19 and 20 (discharge 837 second-feet); minimum discharge recorded by measurement made March 30, discharge 250 second-feet; the absolute minimum during year probably was about 230 second-feet.

Maximum stage recorded, 1914–15: 2.8 feet July 19 and 20, 1915 (discharge 837 second-feet); minimum discharge during period recorded by measurement made February 28, 1914 (discharge 171 second-feet).

WINTER FLOW.—Discharge relation seriously affected by ice. Flow estimated from discharge measurements, observer's notes, and climatic records.

REGULATION.—Fluctuations, caused by the operation of a number of dams and small mills above the 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.—Results apparently excellent. The control is nearly permanent, but discharge relation is affected during brief periods by backwater from aquatic plants; fluctuation is so gradual that one reading of the gage per day represents accurately the mean stage.

*Discharge measurements of Ottertail River at German Church, near Fergus Falls, Minn., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Dec. 18[a] | S. B. Soulé | 3.19 | 362 | June 30 | S. B. Soulé | 2.64 | 733 |
| Jan. 22[a] | do | 3.0 | 277 | Sept. 17[b] | H. T. Critchlow | 2.18 | 464 |
| Mar. 30 | do | 1.55 | 250 | | | | |

[a] Made through complete ice cover.

[b] Small growth of aquatic plants in section.

*Daily discharge, in second-feet, of Ottertail River at German Church, near Fergus Falls, Minn., for the years ending Sept. 30, 1914–15.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1913–14. | | | | | | | | | | | | |
| 1 | ..... | 354 | 362 | | | | 245 | 288 | 319 | 557 | 480 | 373 |
| 2 | ..... | 354 | 362 | | | | 237 | 288 | 319 | 530 | 480 | 373 |
| 3 | ..... | 354 | 362 | | | | 237 | 294 | 326 | 530 | 480 | 373 |
| 4 | ..... | 362 | 362 | | | | 237 | 294 | 336 | 530 | 480 | 373 |
| 5 | ..... | 354 | 362 | | | | 249 | 294 | 336 | 530 | 480 | 373 |
| 6 | ..... | 354 | 373 | | | | 226 | 304 | 326 | 557 | 480 | 373 |
| 7 | ..... | 354 | 392 | | | | 237 | 304 | 336 | 557 | 480 | 373 |
| 8 | ..... | 354 | 373 | | | | 249 | 304 | 354 | 557 | 480 | 373 |
| 9 | ..... | 354 | 319 | | | | 226 | 294 | 362 | 557 | 457 | 373 |
| 10 | ..... | 354 | 319 | | | | 237 | 294 | 373 | 557 | 434 | 373 |
| 11 | ..... | 362 | 304 | | | | 216 | 304 | 373 | 557 | 434 | 373 |
| 12 | ..... | 362 | 319 | | | | 249 | 313 | 362 | 530 | 434 | 354 |
| 13 | ..... | 362 | 336 | | | | 249 | 313 | 362 | 505 | 434 | 413 |
| 14 | ..... | 354 | 336 | | | | 261 | 313 | 354 | 505 | 434 | 413 |
| 15 | ..... | 354 | 354 | | | 180 | 274 | 313 | 354 | 505 | 434 | 413 |
| 16 | ..... | 354 | 345 | 280 | 190 | | 237 | 319 | 354 | 505 | 434 | 413 |
| 17 | ..... | 362 | 336 | | | | 237 | 313 | 392 | 505 | 434 | 413 |
| 18 | ..... | 362 | 336 | | | | 261 | 313 | 392 | 505 | 434 | 392 |
| 19 | ..... | 362 | 336 | | | | 249 | 313 | 392 | 505 | 434 | 373 |
| 20 | ..... | 373 | 373 | | | | 249 | 304 | 392 | 505 | 434 | 373 |
| 21 | ..... | 373 | | | | | 249 | 304 | 434 | 505 | 434 | 373 |
| 22 | ..... | 373 | | | | | 226 | 304 | 392 | 505 | 434 | 373 |
| 23 | ..... | 373 | | | | | 249 | 304 | 413 | 505 | 457 | 373 |
| 24 | ..... | 373 | | | | | 256 | 304 | 557 | 505 | 434 | 373 |
| 25 | ..... | 373 | | | | | 256 | 319 | 557 | 505 | 434 | 373 |
| 26 | ..... | 373 | 350 | | | | 256 | 313 | 557 | 505 | 434 | 373 |
| 27 | ..... | 373 | | | | | 261 | 313 | 584 | 505 | 434 | 373 |
| 28 | ..... | 373 | | | | | 266 | 313 | 557 | 505 | 413 | 373 |
| 29 | 354 | 373 | | | | | 288 | 313 | 557 | 505 | 413 | 373 |
| 30 | 354 | 373 | | | | 261 | 288 | 313 | 557 | 530 | 392 | 373 |
| 31 | 354 | ..... | | | | 253 | ..... | 319 | ..... | 530 | 392 | ..... |
| 1914–15. | | | | | | | | | | | | |
| 1 | 392 | 434 | 392 | | | | 261 | 313 | 392 | 704 | 736 | 557 |
| 2 | 392 | 434 | 392 | | | | 256 | 313 | 392 | 704 | 736 | 557 |
| 3 | 392 | 434 | 392 | | | | 266 | 347 | 413 | 704 | 704 | 530 |
| 4 | 354 | 434 | 392 | | | | 283 | 354 | 413 | 736 | 704 | 530 |
| 5 | 354 | 434 | 392 | | | | 283 | 354 | 434 | 704 | 704 | 530 |
| 6 | 354 | 434 | 392 | | | | 274 | 354 | 434 | 736 | 704 | 505 |
| 7 | 354 | 434 | 392 | | | | 274 | 354 | 392 | 736 | 704 | 480 |
| 8 | 373 | 434 | 392 | | | | 274 | 354 | 434 | 736 | 673 | 480 |
| 9 | 373 | 413 | | | | | 274 | 354 | 457 | 769 | 673 | 480 |
| 10 | 392 | 413 | | | | | 274 | 354 | 480 | 769 | 642 | 480 |
| 11 | 413 | 434 | | | | | 266 | 354 | 480 | 769 | 642 | 480 |
| 12 | 413 | 434 | | | | | 266 | 354 | 584 | 769 | 642 | 480 |
| 13 | 413 | 434 | | | | | 274 | 354 | 584 | 769 | 642 | 480 |
| 14 | 413 | 434 | | | | 265 | 283 | 373 | 584 | 803 | 642 | 480 |
| 15 | 413 | 434 | | | | | 274 | 384 | 613 | 803 | 642 | 480 |
| 16 | 413 | 434 | | 243 | 335 | | 274 | 378 | 642 | 803 | 642 | 480 |
| 17 | 413 | | | | | | 283 | 373 | 642 | 769 | 642 | 480 |
| 18 | 413 | | | | | | 283 | 373 | 613 | 803 | 613 | 480 |
| 19 | 413 | | | | | | 274 | 373 | 584 | 837 | 584 | 457 |
| 20 | 413 | 407 | 305 | | | | 274 | 392 | 584 | 837 | 584 | 457 |
| 21 | 434 | | | | | | 274 | 392 | 613 | 803 | 584 | 434 |
| 22 | 434 | | | | | | 274 | 392 | 613 | 769 | 584 | 434 |
| 23 | 434 | | | | | | 294 | 392 | 613 | 769 | 584 | 434 |
| 24 | 434 | 392 | | | | | 313 | 392 | 613 | 769 | 584 | 434 |
| 25 | 434 | 392 | | | | | 313 | 392 | 613 | 769 | 584 | 434 |
| 26 | 434 | 399 | | | | 266 | 313 | 392 | 642 | 769 | 584 | 434 |
| 27 | 434 | 406 | | | | 264 | 313 | 384 | 642 | 769 | 584 | 434 |
| 28 | 434 | 413 | | | | 262 | 304 | 392 | 736 | 769 | 584 | 434 |
| 29 | 434 | 413 | | | | 260 | 304 | 392 | 736 | 769 | 642 | 434 |
| 30 | 434 | 392 | | | | 259 | 313 | 392 | 704 | 736 | 584 | 434 |
| 31 | 434 | ..... | | | | 260 | ..... | 392 | ..... | 736 | 557 | ..... |

NOTE.—Discharge, except as noted below, determined from a rating curve well defined between 237 and 837 second-feet. July 1 to Oct. 20, 1914, by the indirect method for shifting channel as aquatic plants in the channel caused backwater at the gage; Dec. 21, 1913, to Mar. 29, 1914, Nov. 17–23, and Dec. 9, 1914, to Mar. 25, 1915, estimated because of ice, from discharge measurements, observer's notes, and weather records. Braced figures show mean discharge for period included. Discharge interpolated Dec. 16, 1913, Mar. 31, Apr. 1, 3, Oct. 30, Nov. 5–6, 13, 15, 26, 27, and Dec. 4, 1914, Mar. 27–29, 31, May 16, 23, 30, July 11, Aug. 26, Sept. 9, 11, 17, 24, and 26, 1915.

*Monthly discharge of Ottertail River at German Church, near Fergus Falls, Minn., for the years ending Sept. 30, 1914–15.*

[Drainage area, 1,300 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| 1913–14. | | | | | | |
| November | 373 | 354 | 363 | 0.279 | 0.31 | B. |
| December | ..... | ..... | 349 | .268 | .31 | B. |
| January | ..... | ..... | 280 | .215 | .25 | C. |
| February | ..... | ..... | 190 | .146 | .15 | C. |
| March | ..... | ..... | 185 | .142 | .16 | C. |
| April | 288 | 216 | 249 | .192 | .21 | A. |
| May | 319 | 288 | 306 | .235 | .27 | A. |
| June | 584 | 319 | 409 | .315 | .35 | A. |
| July | 557 | 505 | 522 | .402 | .46 | B. |
| August | 480 | 392 | 443 | .341 | .39 | B. |
| September | 413 | 354 | 379 | .292 | .33 | B. |
| 1914–15. | | | | | | |
| October | 434 | 354 | 408 | 0.314 | 0.36 | B. |
| November | ..... | ..... | 419 | .322 | .36 | B. |
| December | ..... | ..... | 327 | .252 | .29 | C. |
| January | ..... | ..... | 243 | .187 | .22 | C. |
| February | ..... | ..... | 335 | .258 | .27 | C. |
| March | ..... | ..... | 264 | .203 | .23 | C. |
| April | 313 | 256 | 283 | .218 | .24 | A. |
| May | 392 | 313 | 370 | .285 | .33 | A. |
| June | 736 | 392 | 556 | .428 | .48 | A. |
| July | 837 | 704 | 764 | .588 | .68 | A. |
| August | 736 | 557 | 636 | .489 | .56 | A. |
| September | 557 | 434 | 474 | .365 | .41 | B. |
| The year | 837 | ..... | 423 | .325 | 4.43 | |

RED RIVER AT FARGO, N. DAK.

LOCATION.—At the dam half a mile above the highway bridge connecting Front Street, Fargo, N. Dak., with Moorhead, Minn., 10 miles above mouth of Sheyenne River.

DRAINAGE AREA.—6,020 square miles.

RECORDS AVAILABLE.—May 27, 1901, to September 30, 1915.

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 1.16 feet below crest of dam. Prior to September 1, 1914, the United States Weather Bureau vertical staff attached to the breakwater for the center pier of the Front Street bridge was used, but can not be read accurately without a field glass.

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

CHANNEL AND CONTROL.—Channel consists of clay and silt; shifts slightly. Dam below gage forms the control.

EXTREMES OF DISCHARGE.—Maximum stage recorded during the year, 6.0 feet (15.8 feet on Front Street gage), July 3 (discharge, 3,110 second-feet); minimum stage recorded, 2.55 feet, November 16 (discharge, 346 second-feet).

1901–1915: Maximum stage recorded 29.8 feet March 31, 1907 (discharge, 5,820 second-feet); minimum stage recorded, 5.7 feet, November 1, 1910 (discharge, 36 second-feet).

WINTER FLOW.—Discharge relation affected by ice from the middle of November to the end of March, but control such that open-water rating curve assumed appli-

cable with small corrections deduced from discharge measurements and records of temperature.

REGULATION.—The dam, which is a tight overflow weir without sluices, was built for the purpose of maintaining 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 the station, and the storage there is not great enough to affect perceptibly the discharge at the station.

ACCURACY.—Records good since September 1, 1914; prior to that date only fair, because of the inaccessibility of gage, resulting small errors in observations, and changes in rating curve caused by lack of permanence in channel.

*Discharge measurements of Red River at Fargo, N. Dak., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Dec. 26 | L. W. Burdick | [a]9.01 | 394 | Aug. 2 | E. F. Chandler | 4.01 | 1,190 |
| Feb. 25 | Ole Christianson | [a]8.90 | 307 | 18 | do | 3.74 | 1,040 |
| Apr. 14 | do | 3.58 | 833 | Sept. 24 | V. H. Sprague | 3.31 | 732 |
| July 12 | E. F. Chandler | 4.49 | 1,700 | | | | |

[a] Old gage; river frozen.

*Daily discharge, in second-feet, of Red River at Fargo, N. Dak., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|
| 1 | 543 | 622 | 622 | 770 | 770 | 2,880 | 1,230 | 943 |
| 2 | 543 | 622 | 803 | 770 | 708 | 3,110 | 1,230 | 906 |
| 3 | 543 | 622 | 1,040 | 739 | 708 | 3,110 | 1,230 | 871 |
| 4 | 543 | 595 | 1,270 | 708 | 708 | 3,110 | 1,230 | 836 |
| 5 | 543 | 622 | 1,500 | 708 | 708 | 2,710 | 1,230 | 836 |
| 6 | 543 | 622 | 1,600 | 836 | 679 | 2,520 | 1,230 | 836 |
| 7 | 543 | 622 | 1,920 | 836 | 679 | 2,120 | 1,140 | 836 |
| 8 | 543 | 595 | 2,230 | 836 | 679 | 2,120 | 1,140 | 803 |
| 9 | 543 | 595 | 2,430 | 906 | 708 | 1,920 | 1,140 | 770 |
| 10 | 543 | 595 | 2,020 | 906 | 708 | 1,810 | 1,140 | 770 |
| 11 | 569 | 543 | 1,720 | 906 | 770 | 1,810 | 1,120 | 770 |
| 12 | 569 | 595 | 1,410 | 836 | 770 | 1,810 | 1,100 | 770 |
| 13 | 595 | 595 | 1,230 | 836 | 770 | 1,810 | 1,060 | 770 |
| 14 | 622 | 595 | 906 | 836 | 1,230 | 1,710 | 1,060 | 803 |
| 15 | 650 | 595 | 650 | 770 | 1,600 | 1,600 | 1,060 | 803 |
| 16 | 622 | 349 | 650 | 708 | 2,230 | 1,500 | 1,060 | 803 |
| 17 | 595 | ..... | 650 | 708 | 2,430 | 1,600 | 1,060 | 803 |
| 18 | 622 | ..... | 650 | 739 | 2,620 | 1,810 | 1,020 | 803 |
| 19 | 595 | ..... | 650 | 708 | 2,620 | 2,020 | 980 | 803 |
| 20 | 595 | ..... | 595 | 836 | 2,520 | 1,920 | 980 | 770 |
| 21 | 595 | ..... | 543 | 836 | 2,230 | 1,810 | 943 | 770 |
| 22 | 595 | ..... | 543 | 803 | 2,120 | 1,710 | 943 | 770 |
| 23 | 569 | ..... | 518 | 770 | 2,020 | 1,600 | 943 | 739 |
| 24 | 595 | ..... | 494 | 770 | 2,020 | 1,560 | 980 | 708 |
| 25 | 595 | ..... | 494 | 770 | 1,860 | 1,460 | 980 | 708 |
| 26 | 622 | ..... | 518 | 770 | 1,700 | 1,410 | 943 | 708 |
| 27 | 622 | ..... | 543 | 770 | 1,810 | 1,360 | 943 | 708 |
| 28 | 595 | ..... | 543 | 770 | 2,430 | 1,230 | 906 | 770 |
| 29 | 595 | ..... | 622 | 739 | 2,430 | 1,320 | 906 | 770 |
| 30 | 595 | ..... | 770 | 770 | 2,620 | 1,320 | 906 | 739 |
| 31 | 622 | ..... | ..... | 770 | ..... | 1,230 | 906 | ..... |

NOTE.—Daily discharge determined from a rating curve well defined below 1,800 second-feet and poorly defined for higher stages; discharge interpolated Apr. 3, 4, and 11; June 25; Aug. 11; and Sept. 8, 10, and 12.

*Monthly discharge of Red River at Fargo, N. Dak., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 650 | 543 | 583 | 35,800 | A. |
| November | 622 | ..... | 532 | 31,700 | C. |
| December | ..... | ..... | 410 | 25,200 | D. |
| January | ..... | ..... | 340 | 10,900 | D. |
| February | ..... | ..... | 310 | 17,200 | D. |
| March | ..... | ..... | 390 | 24,000 | D. |
| April | 2,430 | 494 | 1,000 | 59,500 | A. |
| May | 906 | 708 | 788 | 48,500 | A. |
| June | 2,620 | 679 | 1,530 | 91,000 | A. |
| July | 3,110 | 1,220 | 1,900 | 117,000 | A. |
| August | 1,220 | 906 | 1,060 | 65,200 | A. |
| September | 943 | 708 | 790 | 46,900 | A. |
| The year | 3,110 | ..... | 805 | 573,000 | |

NOTE.—Discharge from Nov. 17 to Mar. 31 estimated from Weather Bureau records, two discharge measurements, and occasional gage-height observations.

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.

DRAINAGE AREA.—25,000 square miles.

RECORDS AVAILABLE.—May 26, 1901, to September 30, 1915; gage-height records kept by United States Engineer Corps since 1882, and a few discharge measuremets 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.—Clay and silt; shifts slightly.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 30.8 feet July 3 (discharge 21,500 second-feet); minimum stage recorded, 5.4 feet, October 4 (discharge 1,030 second-feet; 6.4 feet February 13—discharge, 686 second-feet).

1882–1915: Maximum stage recorded, 50.2 feet April 10, 1897 (discharge, 43,000 second-feet; minimum stage recorded, 2.6 feet February 10, 1912 (discharge, 100 second-feet).

WINTER FLOW.—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. On account of 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 largely estimated unless daily discharge measurements are made; actual measurements when river appeared to be open at station have sometimes shown the reading to be 8 feet greater than would be necessary for same discharge when the entire river is open.

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

ACCURACY.—Winter records are fair; all others good.

*Discharge measurements of Red River at Grand Forks, N. Dak., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Jan. 9 | Ole Christianson | 6.65 | a 842 | June 14 | Chandler and Sprague | 9.17 | 2,950 |
| Feb. 20 | do | 6.70 | a 754 | July 15 | E. F. Chandler | 18.06 | 8,380 |
| Apr. 16 | E. F. Chandler | 11.54 | 4,140 | | | | |

a River frozen over.

*Daily discharge, in second-feet, of Red River at Grand Forks, N. Dak., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1,070 | 1,500 | ..... | 2,150 | 2,100 | 2,700 | 20,400 | 3,750 | 1,720 |
| 2 | 1,070 | 1,420 | ..... | 2,420 | 2,050 | 2,590 | 21,300 | 3,680 | 1,670 |
| 3 | 1,030 | 1,420 | ..... | 2,930 | 2,150 | 2,480 | 21,500 | 3,560 | 1,670 |
| 4 | 1,030 | 1,420 | ..... | 3,700 | 2,370 | 2,370 | 21,300 | 3,430 | 1,670 |
| 5 | 1,030 | 1,420 | ..... | 4,470 | 2,370 | 2,260 | 20,800 | 3,300 | 1,670 |
| 6 | 1,070 | 1,420 | ..... | 5,210 | 2,370 | 2,150 | 19,100 | 3,180 | 1,630 |
| 7 | 1,070 | 1,460 | ..... | 5,840 | 2,530 | 2,100 | 19,100 | 2,990 | 1,590 |
| 8 | 1,030 | 1,380 | ..... | 6,850 | 2,590 | 2,100 | 17,700 | 2,870 | 1,540 |
| 9 | 1,110 | 1,340 | ..... | 7,450 | 2,590 | 2,150 | 16,100 | 2,820 | 1,500 |
| 10 | 1,180 | 1,340 | ..... | 8,650 | 2,700 | 2,200 | 14,300 | 2,700 | 1,500 |
| 11 | 1,180 | 1,340 | ..... | 9,950 | 2,990 | 2,260 | 12,500 | 2,590 | 1,500 |
| 12 | 1,260 | 1,420 | ..... | 8,650 | 3,180 | 2,310 | 10,000 | 2,480 | 1,460 |
| 13 | 1,260 | 1,420 | ..... | 7,070 | 3,300 | 2,480 | 9,950 | 2,370 | 1,500 |
| 14 | 1,300 | 1,380 | ..... | 5,840 | 3,430 | 2,700 | 9,160 | 2,260 | 1,590 |
| 15 | 1,300 | 1,300 | ..... | 5,080 | 3,560 | 3,430 | 9,070 | 2,150 | 1,500 |
| 16 | 1,340 | 1,260 | ..... | 4,400 | 3,560 | 4,600 | 9,250 | 2,100 | 1,460 |
| 17 | 1,340 | ..... | ..... | 3,680 | 3,490 | 5,910 | 8,990 | 2,100 | 1,500 |
| 18 | 1,380 | ..... | ..... | 3,180 | 3,810 | 7,000 | 8,490 | 2,100 | 1,540 |
| 19 | 1,460 | ..... | ..... | 2,820 | 4,340 | 7,610 | 7,920 | 2,050 | 1,670 |
| 20 | 1,380 | ..... | ..... | 2,640 | 4,740 | 8,080 | 7,360 | 2,000 | 1,670 |
| 21 | 1,340 | ..... | ..... | 2,420 | 4,600 | 8,240 | 6,850 | 1,950 | 1,500 |
| 22 | 1,340 | ..... | ..... | 2,260 | 4,400 | 8,240 | 6,480 | 1,900 | 1,500 |
| 23 | 1,380 | ..... | ..... | 2,200 | 4,140 | 8,080 | 6,200 | 1,900 | 1,500 |
| 24 | 1,420 | ..... | ..... | 2,150 | 3,880 | 7,760 | 5,910 | 1,850 | 1,540 |
| 25 | 1,420 | ..... | ..... | 2,100 | 3,680 | 7,370 | 5,490 | 1,850 | 1,500 |
| 26 | 1,420 | ..... | ..... | 2,000 | 3,560 | 7,150 | 5,140 | 1,810 | 1,500 |
| 27 | 1,380 | ..... | 1,540 | 2,050 | 3,300 | 8,820 | 4,940 | 1,810 | 1,500 |
| 28 | 1,420 | ..... | 1,670 | 2,150 | 3,180 | 12,700 | 4,670 | 1,850 | 1,500 |
| 29 | 1,420 | ..... | 1,760 | 2,150 | 3,050 | 16,000 | 4,400 | 1,810 | 1,500 |
| 30 | 1,420 | ..... | 1,810 | 2,150 | 2,930 | 18,600 | 4,200 | 1,760 | 1,460 |
| 31 | 1,380 | ..... | 1,900 | ..... | 2,820 | ..... | 3,880 | 1,760 | ..... |

NOTE.—Discharge Mar. 27 to Apr. 4 determined by indirect method; for other periods from a well-defined rating curve.

*Monthly discharge of Red River at Grand Forks, N. Dak., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 1,460 | 1,030 | 1,270 | 77,800 | B. |
| November | 1,500 | ..... | 1,350 | 80,300 | C. |
| December | ..... | ..... | 1,170 | 71,700 | D. |
| January | ..... | ..... | 780 | 48,000 | D. |
| February | ..... | ..... | 740 | 41,100 | D. |
| March | ..... | ..... | 1,170 | 71,800 | D. |
| April | 9,950 | 2,000 | 4,150 | 247,000 | B. |
| May | 4,740 | 2,050 | 3,220 | 198,000 | A. |
| June | 18,600 | 2,100 | 5,750 | 342,000 | A. |
| July | 21,500 | 3,880 | 11,000 | 679,000 | A. |
| August | 3,750 | 1,760 | 2,410 | 148,000 | A. |
| September | 1,720 | 1,460 | 1,550 | 92,200 | A. |
| The year | 21,500 | ..... | 2,900 | 2,100,000 | |

NOTE.—Discharge Nov. 17 to Mar. 26 estimated from discharge measurements, temperature records, observer's notes, and occasional gage readings.

## 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, 1915.

GAGE.—Vertical staff gage read twice daily, morning and evening, by Axel Johnson.

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

CHANNEL AND CONTROL.—One channel at all stages; channel composed of sand and silt; no well defined control; right bank high and wooded; left bank will overflow to some extent at stage of 12 feet.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 11.0 feet at 8 a. m. June 28, and 8 a. m. June 29 (discharge, 2,250 second-feet); minimum discharge estimated at 20 second-feet for the last part of January.

1909–1915: Maximum stage recorded, 20.0 feet at 7 a. m. July 22, 1909 (discharge, approximately 9,200 second-feet); minimum discharge recorded during open-water periods, 12 second-feet, August 31 and September 1, 1913; minimum discharge measured during winter periods, by current meter, 10 second-feet, February 5, 1912; the absolute minimum was probably less than this amount.

WINTER FLOW.—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.—Rating curve fairly well defined; condition of channel, fairly permanent; gage-height record reliable; discharge records apparently good.

*Discharge measurements of Wild Rice River at Twin Valley, Minn., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Nov. 14 | L. W. Burdick | 5.29 | 120 | July 24 | E. F. Chandler | 6.97 | 553 |
| Dec. 27[a] | do | 5.97 | 57 | 25[b] | do | 6.82 | 498 |
| June 23 | Ole Christianson | 7.55 | 671 | | | | |

[a] Made through complete ice cover. [b] Made by wading one-fourth mile below gage.

*Daily discharge, in second-feet, of Wild Rice River at Twin Valley, Minn., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 119 | 80 | | | | | | 114 | 305 | 1,880 | 385 | 157 |
| 2 | 119 | 74 | | | | | | 102 | 279 | 1,520 | 385 | 138 |
| 3 | 119 | 58 | | | | | 300 | 147 | 279 | 1,250 | 358 | 110 |
| 4 | 119 | 58 | | | | | | 151 | 233 | 1,160 | 358 | 97 |
| 5 | 110 | 58 | | | | | | 199 | 245 | 1,080 | 331 | 138 |
| 6 | 110 | 58 | 95 | 45 | 25 | 45 | 686 | 199 | 279 | 986 | 305 | 110 |
| 7 | 110 | 80 | | | | | 900 | 292 | 292 | 986 | 292 | 110 |
| 8 | 110 | 110 | | | | | 686 | 442 | 257 | 942 | 279 | 132 |
| 9 | 110 | 110 | | | | | 358 | 500 | 257 | 900 | 279 | 128 |
| 10 | 124 | 110 | | | | | 305 | 560 | 279 | 860 | 279 | 128 |
| 11 | 128 | 102 | | | | | 279 | 591 | 270 | 822 | 279 | 128 |
| 12 | 128 | 119 | | | | | 199 | 591 | 358 | 752 | 279 | 143 |
| 13 | 128 | 110 | | | | | 178 | 560 | 591 | 719 | 279 | 147 |
| 14 | 128 | 119 | | | | | 167 | 560 | 942 | 752 | 257 | 167 |
| 15 | 128 | | 60 | 25 | 30 | 50 | 157 | 560 | 986 | 719 | 233 | 167 |
| 16 | 119 | | | | | | 143 | 622 | 900 | 686 | 210 | 157 |
| 17 | 119 | 105 | | | | | 132 | 560 | 900 | 654 | 199 | 147 |
| 18 | 119 | | | | | | 124 | 500 | 900 | 622 | 188 | 151 |
| 19 | 119 | | | | | | 163 | 530 | 900 | 622 | 188 | 147 |
| 20 | 119 | | | | | | 151 | 530 | 822 | 591 | 188 | 147 |
| 21 | 119 | | | | | | 123 | 530 | 786 | 560 | 199 | 147 |
| 22 | 119 | | | | | | 119 | 500 | 752 | 622 | 199 | 147 |
| 23 | 119 | | | | | | 124 | 471 | 719 | 686 | 199 | 147 |
| 24 | 119 | | | | | | 124 | 413 | 686 | 560 | 210 | 128 |
| 25 | 128 | | | | | | 147 | 385 | 654 | 500 | 188 | 138 |
| 26 | 128 | 100 | 55 | 20 | 50 | 80 | 147 | 385 | 654 | 471 | 188 | 138 |
| 27 | 128 | | | | | | 138 | 358 | 1,520 | 442 | 178 | 138 |
| 28 | 138 | | | | | | 147 | 358 | 2,060 | 442 | 188 | 138 |
| 29 | 128 | | | | | | 138 | 344 | 2,200 | 413 | 188 | 147 |
| 30 | 119 | | | | | | 119 | 318 | 2,060 | 399 | 188 | 147 |
| 31 | 110 | | | | | | ..... | 305 | ..... | 385 | 167 | ..... |

NOTE.—Discharge computed as follows: Oct. 1 to Nov. 14, and Apr. 6 to Sept. 30, from a rating curve fairly well defined between 50 and 2,200 second-feet; Nov. 15 to Apr. 5 estimated, because of ice from discharge measurements, observor's notes, and weather records. Braced figures show mean discharge for period included.

*Monthly discharge of Wild Rice River at Twin Valley, Minn., for the year ending Sept. 30, 1915.*

[Drainage area, 805 square miles.]

| Month. | Discharge in second-feet. | | | Month. | Discharge in second-feet. | | |
|---|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | Maximum. | Minimum. | Mean. |
| October | 138 | 110 | 121 | May | 622 | 102 | 409 |
| November | 119 | 58 | 95.9 | June | 2,200 | 233 | 746 |
| December | ..... | ..... | 69.5 | July | 1,880 | 385 | 774 |
| January | ..... | ..... | 29.7 | August | 385 | 167 | 247 |
| February | ..... | ..... | 33.9 | September | 167 | 97 | 139 |
| March | ..... | ..... | 59.0 | | | | |
| April | 900 | 119 | 249 | The year | 2,200 | ..... | 249 |

## RED LAKE RIVER AT THIEF RIVER FALLS, MINN.

LOCATION.—In T. 153 N., R. 43 W., one-third mile below the dam at Thief River Falls, Pennington County, and about 1 mile below the mouth of Thief River coming in from the right.

DRAINAGE AREA.—3,430 square miles.

RECORDS AVAILABLE.—July 2, 1909, to September 30, 1915.

GAGE.—Inclined staff gage located on left bank; read twice daily, morning and evening, to half-tenths by H. W. Hoard.

CHANNEL AND CONTROL.—Gravel; nearly permanent.

EXTREMES OF DISCHARGE.—Maximum discharge during year estimated at 2,880 second-feet, June 29; minimum stage recorded during year, 3.28 feet, November 15 and 16 (discharge, approximately 45 second-feet.)

1909–1915: Maximum discharge recorded, June 9, 1911; discharge, 3,820 second-feet; minimum discharge, zero, July 17 and August 27, 1911.

WINTER FLOW.—Discharge relation seriously affected by ice; flow determined from discharge measurements, observer's notes, and weather records.

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

ACCURACY.—Results are only fair owing to fluctuations in stage and unreliable gage-height record during parts of the year.

*Discharge measurements of Red Lake River at Thief River Falls, Minn., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Nov. 14 | Ole Christianson | 4.87 | 507 | July 23 | E. F. Chandler | 5.79 | 960 |
| Dec. 29[a] | do | 5.74 | 316 | Aug. 25 | W. B. Stevenson | 4.76 | 506 |
| Feb. 7[a] | do | 5.53 | 282 | Sept. 17 | E. F. Chandler | 4.84 | 495 |
| June 19 | do | 6.67 | 1,400 | | | | |

[a] Made through complete ice cover.

*Daily discharge, in second-feet, of Red Lake River at Thief River Falls, Minn., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 290 | 560 | | | | | | 538 | 718 | | | 340 |
| 2 | 340 | 538 | | | | | | 560 | 695 | | | 340 |
| 3 | 242 | 494 | | | | | 710 | 650 | 628 | | | 452 |
| 4 | 258 | 538 | | | | | | 628 | 582 | | | 452 |
| 5 | 306 | 538 | | | | | | 650 | 582 | | | 412 |
| 6 | 323 | 494 | | | | | 560 | 718 | 582 | | | 375 |
| 7 | 323 | 472 | | | | | 494 | 740 | 560 | | 530 | 340 |
| 8 | 323 | 515 | | | | | 452 | 650 | 560 | | | 306 |
| 9 | 412 | 452 | 320 | | | | 431 | 790 | 582 | | | 306 |
| 10 | 431 | 472 | | | | 570 | 393 | 790 | 628 | | | 323 |
| 11 | 431 | 431 | | | | | 538 | 790 | 605 | | | 375 |
| 12 | 393 | 393 | | | | | 538 | 840 | 740 | | | 375 |
| 13 | 393 | 323 | | | | | 582 | 790 | 1,050 | | | 393 |
| 14 | 412 | 136 | | | | | 740 | 790 | 1,330 | | | 412 |
| 15 | 412 | 45 | | | | | 790 | 840 | 1,360 | | 538 | 452 |
| 16 | 393 | 45 | | 215 | 370 | | 790 | 890 | 1,360 | 1,280 | 538 | 494 |
| 17 | 431 | 73 | | | | | 940 | 765 | 1,360 | | 494 | 582 |
| 18 | 431 | | | | | | 940 | 740 | 1,360 | | 494 | 538 |
| 19 | 412 | | | | | | 995 | 765 | 1,230 | | 538 | 560 |
| 20 | 431 | | | | | | 940 | 790 | 1,230 | | 452 | 538 |
| 21 | 412 | | | | | | 995 | 790 | 1,110 | | 375 | 515 |
| 22 | 538 | | | | | | 940 | 790 | 1,110 | | 494 | 494 |
| 23 | 538 | | | | | | 890 | 840 | 1,170 | | 452 | 515 |
| 24 | 538 | 120 | 220 | | | | 890 | 890 | 1,110 | | 452 | 538 |
| 25 | 560 | | | | | 450 | 790 | 890 | 1,110 | | 452 | 515 |
| 26 | 472 | | | | | | 718 | 840 | 1,110 | | 412 | 494 |
| 27 | 431 | | | | | | 628 | 890 | | | 452 | 494 |
| 28 | 538 | | | | | | 582 | 840 | 2,400 | | 452 | 494 |
| 29 | 472 | | | | | | 582 | 790 | | | 375 | 472 |
| 30 | 494 | | | | | | 538 | 740 | | | 375 | 452 |
| 31 | 472 | ..... | | | | | ..... | 718 | ..... | | 452 | ..... |

NOTE.—Discharge computed as follows: Oct. 1 to Nov. 17, Apr. 6 to June 26, and Aug. 15 to Sept. 30, from a rating curve fairly well defined between 47 amd 2,960 second-feet; Nov. 18 to Apr. 5 estimated, because of ice, from discharge measurements, observer's notes, and weather records. From June 27 to Aug. 14 gage was read by a substitute observer who apparently recorded the gage heights 1 foot too large; gage heights for this period (except Aug. 10–14, for which discharge was estimated) were reduced before rating curve was applied. Braced figures show mean discharge for period included.

*Monthly discharge of Red Lake River at Thief River Falls, Minn., for the year ending Sept. 30, 1915.*

[Drainage area, 3,430 square miles.]

| Month. | Discharge in second-feet. | | | Month. | Discharge in second-feet. | | |
|---|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | Maximum. | Minimum. | Mean. |
| October | 560 | 242 | 415 | May | 890 | 538 | 762 |
| November | 560 | 45 | 269 | June | ..... | 560 | 1,140 |
| December | ..... | ..... | 275 | July | ..... | ..... | 1,280 |
| January | ..... | ..... | 215 | August | ..... | 375 | 491 |
| February | ..... | ..... | 370 | September | 582 | 306 | 445 |
| March | ..... | ..... | 524 | | | | |
| April | 995 | 393 | 708 | The year | ..... | 45 | 575 |

RED LAKE RIVER AT CROOKSTON, MINN.

LOCATION.—At New Sampson's addition highway bridge in Crookston, Minn., less than quarter of a mile below the 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, 1915.

GAGE.—Barrett & Lawrence water-stage recorder, on right abutment of bridge, installed in September, 1911, replacing chain gage which was attached to bridge July 1, 1909. Datum of both gages maintained the same. Prior to July 1, 1909, the gage was on the old Sampson's addition bridge about 20 rods above present gage; this gage read the same as the present one at ordinary stages.

CHANNEL AND CONTROL.—No well-defined control; flow confined to one channel at all stages; slightly shifting.

EXTREMES OF DISCHARGE.—Maximum stage during year from water-stage recorder, 14.25 feet on June 29 (discharge, 8,160 second-feet); minimum stage, 3.4 feet October 4 (discharge, 344 second-feet).

1901–1915: Maximum stage recorded 20.97 feet April 5, 1906 (discharge 14,200 second-feet); a flow of 10 second-feet was recorded by discharge measurement made January 27, 1912; the flow is controlled to such an extent that the minimum recorded discharge has no bearing on the minimum natural flow.

WINTER FLOW.—Discharge relation seriously affected by ice; flow determined from discharge measurements, observer's notes, and weather records. See note under "Winter flow" in Water-Supply Paper 325, p. 43.

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

ACCURACY.—Channel not permanent; rating curve poorly defined; gage-height record good; results only fair.

*Discharge measurements of Red Lake River at Crookston, Minn., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 17 | Ole Christianson | 4.21 | 707 | June 22 | Ole Christianson | 7.62 | 2,660 |
| Nov. 13 | do | 3.98 | 610 | July 2 | do | 12.28 | 6,280 |
| Jan. 2[a] | do | 4.68 | 314 | 24 | E. F. Chandler | 6.19 | 1,750 |
| Feb. 9[a] | do | 5.17 | 339 | | | | |

[a] Made through complete ice cover.

*Daily discharge, in second-feet, of Red Lake River at Crookston, Minn., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 421 | 620 | | | | | | 835 | 985 | 7,020 | 1,140 | 540 |
| 2 | 440 | 660 | | | | | 960 | 935 | 885 | 6,500 | 1,200 | 560 |
| 3 | 421 | 620 | | | | | | 935 | 835 | 5,910 | 1,090 | 500 |
| 4 | 344 | 700 | | | | | 1,380 | 935 | 790 | 5,400 | 1,040 | 660 |
| 5 | 382 | 660 | | | | | 1,560 | 935 | 745 | 4,890 | 985 | 540 |
| 6 | 480 | 700 | 550 | 400 | 380 | 480 | 1,950 | 985 | 885 | 4,550 | 935 | 580 |
| 7 | 500 | 660 | | | | | 2,210 | 835 | 885 | 4,150 | 935 | 660 |
| 8 | 560 | 580 | | | | | 2,410 | 935 | 935 | 3,830 | 885 | 700 |
| 9 | 560 | 745 | | | | | 2,980 | 935 | 985 | 3,430 | 935 | 660 |
| 10 | 660 | 580 | | | | | 2,410 | 1,040 | 885 | 3,120 | 835 | 660 |
| 11 | 580 | 700 | | | | | 1,950 | 1,040 | 885 | 3,050 | 885 | 620 |
| 12 | 580 | 660 | | | | | 1,760 | 1,040 | 935 | 2,900 | 660 | 790 |
| 13 | 440 | 620 | | | | | 1,620 | 1,090 | 1,040 | 2,690 | 560 | 660 |
| 14 | 460 | 620 | | | | | 1,560 | 1,200 | 1,440 | 2,830 | 560 | 580 |
| 15 | 520 | 540 | | | | | 1,380 | 1,260 | 2,020 | 2,830 | 520 | 580 |
| 16 | 540 | | 475 | 405 | 520 | 510 | 1,260 | 1,380 | 2,480 | 2,550 | 580 | 480 |
| 17 | 580 | | | | | | 1,200 | 1,760 | 2,690 | 2,480 | 580 | 560 |
| 18 | 540 | 620 | | | | | 1,140 | 2,410 | 2,830 | 2,280 | 540 | 620 |
| 19 | 540 | | | | | | 935 | 2,550 | 2,830 | 2,140 | 540 | 660 |
| 20 | 540 | | | | | | 835 | 2,280 | 2,690 | 2,140 | 580 | 660 |
| 21 | 580 | | | | | | 835 | 2,020 | 2,690 | 2,140 | 540 | 580 |
| 22 | 520 | | | | | | 790 | 1,760 | 2,620 | 2,140 | 520 | 460 |
| 23 | 700 | | | | | | 790 | 1,500 | 2,550 | 1,950 | 580 | 560 |
| 24 | 660 | | | | | | 790 | 1,500 | 2,410 | 1,690 | 620 | 560 |
| 25 | 660 | | | | | | 790 | 1,560 | 2,280 | 1,620 | 580 | 560 |
| 26 | 620 | 535 | 380 | 350 | 460 | 630 | 935 | 1,500 | 2,340 | 1,560 | 620 | 620 |
| 27 | 660 | | | | | | 985 | 1,440 | 4,980 | 1,500 | 580 | 580 |
| 28 | 620 | | | | | | 985 | 1,380 | 7,520 | 1,380 | 520 | 620 |
| 29 | 580 | | | | | | 935 | 1,320 | 7,860 | 1,380 | 520 | 620 |
| 30 | 620 | | | | | | 790 | 1,140 | 7,440 | 1,040 | 540 | 560 |
| 31 | 620 | | | | | | ..... | 1,090 | ..... | 1,260 | 480 | ..... |

NOTE.—Discharge determined from a fairly well defined rating curve. Discharge Nov. 16 to Apr. 3 estimated, because of ice, from gage heights, discharge measurements, observer's notes, and climatic records. Braced figures show mean discharge for period included.

*Monthly discharge of Red Lake River at Crookston, Minn., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Accuracy. | Month. | Discharge in second-feet. | | | Accuracy. |
|---|---|---|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | | Maximum. | Minimum. | Mean. | |
| October | 700 | 344 | 546 | B. | May | 2,550 | 835 | 1,340 | B. |
| November | ..... | ..... | 604 | C. | June | 7,860 | 745 | 2,380 | B. |
| December | ..... | ..... | 465 | D. | July | 7,020 | 1,040 | 2,980 | B. |
| January | ..... | ..... | 384 | D. | August | 1,200 | 480 | 712 | B. |
| February | ..... | ..... | 453 | D. | September | 790 | 460 | 600 | B. |
| March | ..... | ..... | 545 | D. | | | | | |
| April | 2,980 | ..... | 1,330 | C. | The year | 7,860 | ..... | 1,030 | |

THIEF RIVER NEAR THIEF RIVER FALLS, MINN.

LOCATION.—In sec. 3, T. 154 N., R. 43 W., at the Drybrooke 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, 1915.

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; was used until August 26, 1915. Gage read twice daily, morning and evening, by T. H. Risteigen. See Water-Supply Paper No. 325, page 45, for history of old gage.

DISCHARGE MEASUREMENTS.—Made from steel highway bridge 60 rods below the gage; at low stages made by wading near the gage.

CHANNEL AND CONTROL.—Heavy gravel and bowlders; nearly permanent; one channel at all stages; both banks high and will not overflow.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 10.66 feet at 6 p. m. June 30 (discharge, 1,920 second-feet); minimum stage recorded during open-water periods, 4.38 feet at 7 p. m. September 17 (discharge, 25 second-feet).

1909–1915: Maximum stage recorded, 10.68 feet, July 19, 1909 (discharge, 1,970 second-feet); no flow past the gage during October, November, and December, 1910; January, February, and December, 1911; January and February, 1912.

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

ACCURACY.—Results fair during open-water periods.

*Discharge measurements of Thief River near Thief River Falls, Minn., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Dec. 28[a] | Ole Christianson | 5.56 | 66 | July 22 | E. F. Chandler | 6.08 | 348 |
| Feb. 6[a] | do | 4.46 | 43 | Sept. 18 | do | 4.56 | 40 |
| June 18 | do | 6.83 | 586 | | | | |

[a] Made through complete ice cover.

*Daily discharge, in second-feet, of Thief River near Thief River Falls, Minn., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 48 | 127 | | | | | 196 | 147 | 149 | 1,860 | 171 | 36 |
| 2 | 31 | 129 | | | | | 208 | 134 | 147 | 1,830 | 164 | 35 |
| 3 | 59 | 122 | | | | | 244 | 132 | 134 | 1,550 | 162 | 34 |
| 4 | 55 | 110 | | | | | 394 | 130 | 124 | 1,100 | 160 | 32 |
| 5 | 52 | 115 | | | | | 990 | 126 | 178 | 1,060 | 151 | 30 |
| 6 | 56 | 129 | | | | | 1,060 | 116 | 220 | 955 | 136 | 30 |
| 7 | 56 | 122 | | | | | 990 | 112 | 220 | 850 | 122 | 32 |
| 8 | 59 | 58 | 60 | | | | 850 | 126 | 208 | 572 | 116 | 31 |
| 9 | 73 | 53 | | | | | 675 | 151 | 208 | 472 | 112 | 30 |
| 10 | 77 | 75 | | | | | 538 | 173 | 208 | 394 | 106 | 29 |
| 11 | 75 | 86 | | | | | 232 | 189 | 208 | 336 | 101 | 28 |
| 12 | 82 | | | | | | 171 | 282 | 220 | 308 | 97 | 28 |
| 13 | 92 | | | | | | 171 | 322 | 538 | 295 | 92 | 28 |
| 14 | 95 | | | | | | 160 | 269 | 780 | 295 | 82 | 28 |
| 15 | 97 | | | | | | 158 | 256 | 640 | 336 | 76 | 27 |
| 16 | 117 | | | 42 | 33 | 59 | 128 | 282 | 606 | 364 | 78 | 27 |
| 17 | 97 | | | | | | 114 | 572 | 606 | 350 | 73 | 26 |
| 18 | 90 | | | | | | 106 | 640 | 606 | 322 | 69 | 37 |
| 19 | 90 | | | | | | 76 | 572 | 572 | 295 | 63 | 37 |
| 20 | 90 | | | | | | 60 | 409 | 538 | 322 | 60 | 35 |
| 21 | 88 | 74 | | | | | 60 | 336 | 505 | 336 | 57 | 34 |
| 22 | 97 | | | | | | 84 | 322 | 505 | 394 | 55 | 34 |
| 23 | 108 | | | | | | 112 | 269 | 424 | 364 | 63 | 34 |
| 24 | 120 | | 65 | | | | 118 | 244 | 364 | 282 | 73 | 31 |
| 25 | 144 | | | | | | 130 | 232 | 336 | 269 | 89 | 32 |
| 26 | 139 | | | | | | 140 | 208 | 336 | 256 | 27 | 38 |
| 27 | 144 | | | | | | 153 | 196 | 1,340 | 256 | 32 | 38 |
| 28 | 139 | | | | | | 153 | 184 | 1,830 | 244 | 35 | 35 |
| 29 | 132 | | | | | | 160 | 178 | 1,660 | 232 | 35 | 37 |
| 30 | 112 | | | | | | 160 | 171 | 1,900 | 208 | 35 | 39 |
| 31 | 124 | | | | | | ..... | 164 | ..... | 184 | 37 | ..... |

NOTE.—Discharge, except as noted below, determined from fairly well defined rating curves. Nov. 12 to Mar. 31 estimated, because of ice, from gage heights, discharge measurements, and climatic records. Braced figures show mean discharge for periods included.

*Monthly discharge of Thief River near Thief River Falls, Minn., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Accuracy. | Month. | Discharge in second-feet. | | | Accuracy. |
|---|---|---|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | | Maximum. | Minimum. | Mean. | |
| October | 144 | 31 | 91.5 | B. | May | 640 | 112 | 247 | A. |
| November | ..... | ..... | 84.4 | D. | June | 1,900 | 124 | 550 | B. |
| December | ..... | ..... | 62.6 | | July | 1,860 | 184 | 545 | B. |
| January | ..... | ..... | 42 | | August | 171 | 27 | 88.0 | B. |
| February | ..... | ..... | 33 | | September | 39 | 26 | 32.4 | C. |
| March | ..... | ..... | 59 | | | | | | |
| April | 1,060 | 60 | 293 | B. | The year | 1,900 | ..... | 178 | |

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, 1915.

GAGE.—Combination vertical and inclined staff gage, installed September 12, 1911, about half a mile downstream from the original gage; set to read 2.23 feet when the original gage read 5.83 feet; read twice daily, morning and evening, to tenths, by Leo Steinert. The new gage was placed on account of the building of a dam which caused several feet of backwater at the old section.

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

CHANNEL AND CONTROL.—Smooth sand and gravel channel; nearly permanent; two channels at low stages, uniting at high stages; both banks high, wooded, and not subject to overflow.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 6.9 feet June 29 (discharge approximately 3,320 second-feet); minimum discharge recorded by discharge measurement made December 30 (discharge, 35 second-feet).

1909–1915: Maximum stage recorded, 6.9 feet June 29, 1915 (discharge approximately 3,320 second-feet); minimum discharge, July 4, 1911, estimated at 20 second-feet.

WINTER FLOW.—Discharge relation seriously affected by ice; flow determined from discharge measurements, observer's notes, and weather records.

REGULATION.—At low stages the flow is affected by the Steinert dam, 40 rods above the gage. The storage at this plant is small, and only a slight diurnal fluctuation is observed at the gage.

ACCURACY.—Rating curve well defined; gage-height records reliable; channel fairly permanent. Results good for open-water periods; approximate for winter poriod.

*Discharge measurements of Clearwater River at Red Lake Falls, Minn., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Dec. 30[a] | Ole Christianson | 3.97 | 35 | Aug. 24 | W. B. Stevenson | 2.38 | 122 |
| Feb. 8[a] | .....do | 4.87 | 57 | 27 | .....do | 2.19 | 62 |
| June 21 | .....do | 4.44 | 1,130 | | | | |

[a] Made through complete ice cover.

*Daily discharge, in second-feet, of Clearwater River at Red Lake Falls, Minn., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 142 | 196 | | | | | | 266 | 400 | 2,870 | 352 | 101 |
| 2 | 142 | 196 | | | | | | 266 | 352 | 2,690 | 352 | 101 |
| 3 | 142 | 196 | | | | | 510 | 266 | 307 | 2,510 | 352 | 85 |
| 4 | 142 | 196 | | | | | | 286 | 286 | 2,510 | 286 | 78 |
| 5 | 142 | 196 | | | | | | 307 | 266 | 2,330 | 248 | 72 |
| 6 | 142 | 196 | | | | | 1,520 | 330 | 266 | 2,330 | 229 | 72 |
| 7 | 142 | 196 | | | | | 1,610 | 400 | 248 | 2,150 | 196 | 72 |
| 8 | 154 | 196 | 70 | | | | 1,610 | 425 | 229 | 2,150 | 196 | 78 |
| 9 | 167 | 196 | | | | | 1,700 | 450 | 229 | 2,060 | 167 | 85 |
| 10 | 196 | 196 | | | | | 1,700 | 450 | 229 | 1,840 | 167 | 101 |
| 11 | 196 | 196 | | | | | 1,700 | 502 | 266 | 1,610 | 131 | 101 |
| 12 | 196 | 196 | | | | | 1,700 | 476 | 400 | 1,430 | 120 | 101 |
| 13 | 196 | 196 | | | | | 1,340 | 450 | 502 | 1,430 | 142 | 101 |
| 14 | 196 | 167 | | | | | 556 | 450 | 730 | 1,610 | 120 | 110 |
| 15 | 196 | 93 | | | | | 352 | 450 | 828 | 1,430 | 120 | 120 |
| 16 | 196 | 85 | | 50 | 50 | 60 | 307 | 612 | 1,080 | 1,250 | 120 | 120 |
| 17 | 196 | 85 | | | | | 286 | 860 | 1,250 | 1,080 | 120 | 120 |
| 18 | 196 | 85 | | | | | 266 | 930 | 1,160 | 930 | 101 | 120 |
| 19 | 167 | 85 | | | | | 266 | 828 | 1,160 | 895 | 101 | 110 |
| 20 | 167 | 85 | | | | | 266 | 670 | 1,120 | 860 | 101 | 110 |
| 21 | 167 | 93 | | | | | 266 | 670 | 1,080 | 795 | 85 | 110 |
| 22 | 167 | 110 | | | | | 229 | 584 | 1,040 | 762 | 93 | 101 |
| 23 | 182 | | 45 | | | | 229 | 529 | 968 | 700 | 101 | 101 |
| 24 | 196 | | | | | | 229 | 556 | 930 | 641 | 101 | 101 |
| 25 | 196 | | | | | | 229 | 502 | 930 | 612 | 110 | 101 |
| 26 | 196 | 100 | | | | | 266 | 502 | 930 | 556 | 120 | 101 |
| 27 | 196 | | | | | | 266 | 502 | 2,690 | 556 | 101 | 101 |
| 28 | 196 | | | | | | 266 | 502 | 3,230 | 502 | 101 | 101 |
| 29 | 196 | | | | | | 266 | 450 | 3,320 | 502 | 101 | 101 |
| 30 | 196 | | | | | | 266 | 425 | 3,230 | 450 | 85 | 120 |
| 31 | 196 | ..... | | | | | ..... | 400 | ..... | 376 | 93 | ..... |

NOTE.—Discharge determined as follows: Oct. 1 to Nov. 22 and Apr. 6 to Sept. 30, from a rating curve well defined between 72 and 1,200 second-feet; Nov. 23 to Apr. 5 estimated, because of ice, from discharge measurements, observer's notes, and weather records. Braced figures show mean discharge for period included.

*Monthly discharge of Clearwater River at Red Lake Falls, Minn., for the year ending Sept. 30, 1915.*

[Drainage area, 1,310 square miles.]

| Month. | Discharge in second-feet. | | | Month. | Discharge in second-feet. | | |
|---|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | Maximum. | Minimum. | Mean. |
| October | 196 | 142 | 177 | May | 930 | 266 | 493 |
| November | 196 | 85 | 141 | June | 3,320 | 229 | 989 |
| December | ..... | ..... | 57.1 | July | 2,870 | 376 | 1,370 |
| January | ..... | ..... | 50.0 | August | 352 | 85 | 155 |
| February | ..... | ..... | 50.0 | September | 120 | 72 | 99.9 |
| March | ..... | ..... | 60.0 | | | | |
| April | 1,700 | 229 | 675 | The year | 3,320 | ..... | 361 |

## PEMBINA RIVER AT NECHE, N. DAK.

LOCATION.—At highway bridge 20 rods east of Great Northern Railway bridge two-thirds of a mile north of Neche, N. Dak.

DRAINAGE AREA.—2,940 square miles.

RECORDS AVAILABLE.—April 29, 1903, to September 30, 1915, when station was discontinued.

GAGE.—Vertical staff bolted to the concrete abutment at the north end of the railway bridge. At low stages this gage is sometimes not reached by the water, and readings are then made on sections of vertical staff attached to the abutment and piling at the north end of the highway bridge.

DISCHARGE MEASUREMENTS.—Made from the highway bridge; at very low stages made by wading at some section below the Great Northern dam.

CHANNEL AND CONTROL.—Channel consists of clay and silt; slightly shifting; control, loose rock dam about one-third mile below gage.

EXTREME OF DISCHARGE.—Maximum stage recorded during year, 6.0 feet, April 8 (discharge, 154 second-feet); minimum stage recorded, 3.1 feet, August 13 (discharge, 5 second-feet).

1903–1915: Maximum stage recorded, 20.9 feet May 2, 1904 (discharge, 3,870 second-feet); minimum stage recorded, 1.3 feet September 15, 1911 (discharge, 1.0 second-foot).

WINTER FLOW.—The ordinary winter discharge is less than the leakage through the loose-rock dam and estimates can not be made from gage observations without numerous discharge measurements. Approximate estimates of winter flow are made from observers' notes and temperature records by comparison with stations on other streams.

REGULATION.—The water is raised at low stages from 1 to 2 feet at the gage by a loose-rock dam about 3 feet high, one-third mile below, constructed to give sufficient depth of water for the intake of the Great Northern Railway water tank. There is considerable leakage through the dam, but no permanent determination of the effect of the dam can be made because it is liable to be somewhat disturbed at its crest by ice run or spring floods in any year. There are no reservoirs or power plants that affect the flow.

ACCURACY.—Records only fair this year on account of the varying effect of the dam at low stages and the large percentage error in low-stage discharge caused by small errors in gage-height observations.

The following discharge measurements were made by E. F. Chandler: July 20: Gage height 3.87 feet; discharge, 24.2 second-feet; September 6: Gage height 2.79 feet; discharge, 1.9 second-feet.

*Daily discharge, in second-feet, of Pembina River at Neche, N. Dak., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 29 | 29 | | | | | 25 | 25 | 29 | 22 | 16 | 9 |
| 2 | 29 | 29 | | | | | 25 | 25 | 25 | 22 | 16 | 9 |
| 3 | 22 | 29 | | | | | 29 | 25 | 25 | 22 | 13 | 9 |
| 4 | 17 | 29 | | | | | 34 | 25 | 25 | 22 | 11 | 9 |
| 5 | 17 | 29 | | | | | 48 | 25 | 25 | 22 | 11 | 9 |
| 6 | 22 | 29 | | | | | 70 | 25 | 25 | 22 | 9 | 9 |
| 7 | 22 | 29 | | | | | 154 | 25 | 25 | 22 | 9 | 9 |
| 8 | 22 | 29 | | | | | 154 | 25 | 25 | 22 | 9 | 9 |
| 9 | 22 | 29 | | | | | 135 | 25 | 25 | 22 | 9 | 9 |
| 10 | 29 | 22 | | | | | 117 | 25 | 25 | 22 | 7 | 9 |
| 11 | 29 | 22 | | | | | 84 | 25 | 25 | 22 | 5 | 6 |
| 12 | 29 | 22 | | | | | 29 | 25 | 29 | 22 | 5 | 9 |
| 13 | 38 | 22 | | | | | 29 | 25 | 29 | 22 | 5 | 9 |
| 14 | 38 | 22 | | | | | 29 | 25 | 29 | 22 | 5 | 9 |
| 15 | 38 | 22 | | | | | 29 | 25 | 25 | 22 | 5 | 9 |
| 16 | 38 | | 9 | 6 | 5 | 9 | 29 | 25 | 25 | 22 | 7 | 9 |
| 17 | 38 | | | | | | 25 | 25 | 25 | 22 | 7 | 9 |
| 18 | 38 | | | | | | 25 | 25 | 25 | 22 | 7 | 9 |
| 19 | 38 | | | | | | 25 | 25 | 25 | 22 | 7 | 11 |
| 20 | 38 | | | | | | 25 | 25 | 25 | 22 | 9 | 11 |
| 21 | 38 | | | | | | 25 | 25 | 25 | 19 | 9 | 11 |
| 22 | 38 | | | | | | 25 | 25 | 22 | 19 | 9 | 13 |
| 23 | 38 | 16 | | | | | 25 | 25 | 22 | 19 | 9 | 13 |
| 24 | 38 | | | | | | 25 | 25 | 22 | 19 | 9 | 16 |
| 25 | 38 | | | | | | 25 | 25 | 22 | 16 | 9 | 16 |
| 26 | 38 | | | | | | 25 | 25 | 22 | 16 | 9 | 19 |
| 27 | 38 | | | | | | 25 | 25 | 22 | 16 | 9 | 19 |
| 28 | 28 | | | | | | 25 | 25 | 22 | 16 | 9 | 22 |
| 29 | 29 | | | | | | 25 | 25 | 22 | 16 | 9 | 22 |
| 30 | 29 | | | | | | 25 | 29 | 22 | 16 | 9 | 22 |
| 31 | 29 | | | | | | ..... | 29 | ..... | 16 | 9 | ..... |

NOTE.—Discharge determined as follows: Oct. 1 to Nov. 14 and Apr. 11 to Sept. 30 from two poorly defined rating curves; Apr. 1–10, estimated from observer's notes and by indirect method; Nov. 16 to Mar. 31, estimated, because of ice, from observer's notes, weather records, and flow of adjacent streams. Braced figures show mean discharge for period included.

*Monthly discharge of Pembina River at Neche, N. Dak., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 38 | 17 | 31.7 | 1,950 | C. |
| November | 29 | ..... | 21.1 | 1,260 | D. |
| December | ..... | ..... | 9 | 553 | D. |
| January | ..... | ..... | 6 | 369 | D. |
| February | ..... | ..... | 5 | 278 | D. |
| March | ..... | ..... | 9 | 553 | D. |
| April | 154 | 25 | 45.7 | 2,720 | C. |
| May | 29 | 25 | 25.3 | 1,560 | C. |
| June | 29 | 22 | 24.6 | 1,470 | B. |
| July | 22 | 16 | 20.3 | 1,250 | B. |
| August | 16 | 5 | 8.7 | 535 | C. |
| September | 22 | 9 | 11.9 | 708 | C. |
| The year | ..... | ..... | 18.2 | 13,200 | |

MOUSE RIVER AT MINOT, N. DAK.

LOCATION.—At the Anne Street footbridge, northeast of the Great Northern Railway roundhouse, at Minot, N. Dak.

DRAINAGE AREA.—8,400 square miles.

RECORDS AVAILABLE.—May 5, 1903, to September 30, 1915.

GAGE.—Vertical staff attached to pier nearest left bank of Anne Street footbridge. From 1903 until December, 1909, the gage was a vertical staff similarly placed on a footbridge then existing, which was about 20 rods above the Anne Street bridge. Both gages had the same datum.

DISCHARGE MEASUREMENTS.—Made from the Anne Street bridge at medium and high stages. At low stages made by wading some rods below the dam at the Minneapolis, St. Paul & Sault Ste. Marie Railway water tank.

CHANNEL AND CONTROL.—Clay and silt; slightly shifting.

EXTREME OF DISCHARGE.—Maximum stage recorded during year, 4.9 feet June 26 (discharge, 41 second-feet); minimum stage recorded, 3.65 feet October 18 (discharge, 1.4 second-feet).

1903–1915: 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).

WINTER FLOW.—Discharge relation slightly affected by ice; flow eatimated from dis charge measurements, observer's notes, and records of temperature.

REGULATION.—A dam 4 feet high at the Minneapolis, St. Paul & Sault Ste. Marie Railway tank, 1 mile below, raises the water at 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 it is not absolutely tight. When the discharge is less than about 5 second-feet, the water level falls below the crest of the dam.

ACCURACY.—Results good for medium stages; for low stages errors of large percentage in the results may be due to small errors made by the gage observer or to changes in the amount of leakage through the dam, but the total error for a low-stage period is but a few second-feet.

*Discharge measurements of Mouse River at Minot, N. Dak., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Feb. 4 | E. F. Chandler | 4.20 | 2.0 | July 9 | V. H. Sprague | 4.60 | 16.8 |
| Mar. 6 | .....do | 4.26 | 2.5 | Sept. 11 | E. F. Chandler | 4.21 | 3.2 |

*Daily discharge, in second-feet, of Mouse River at Minot, N. Dak., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.8 | 1.8 | 8 | 27 | 17 | 14 | 17 | 8.0 |
| 2 | 1.8 | 2.0 | 14 | 27 | 17 | 14 | 17 | 6.5 |
| 3 | 1.8 | 2.0 | 17 | 23 | 20 | 17 | 17 | 6.5 |
| 4 | 1.8 | 2.0 | 20 | 23 | 23 | 17 | 17 | 6.5 |
| 5 | 1.6 | 2.0 | 23 | 20 | 31 | 17 | 17 | 6.5 |
| 6 | 1.6 | 2.2 | 27 | 20 | 31 | 17 | 14 | 6.5 |
| 7 | 1.6 | 2.2 | 27 | 20 | 31 | 14 | 14 | 6.5 |
| 8 | 1.6 | 2.2 | 27 | 20 | 27 | 12 | 14 | 6.5 |
| 9 | 1.6 | 2.2 | 23 | 20 | 27 | 17 | 14 | 6.5 |
| 10 | 1.6 | 2.5 | 23 | 20 | 23 | 17 | 14 | 6.5 |
| 11 | 1.6 | 2.5 | 23 | 23 | 23 | 17 | 14 | 6.5 |
| 12 | 1.6 | 2.8 | 20 | 20 | 23 | 14 | 14 | 6.5 |
| 13 | 1.6 | 2.8 | 20 | 20 | 23 | 14 | 12 | 6.5 |
| 14 | 1.4 | 2.8 | 20 | 20 | 20 | 14 | 12 | 8.0 |
| 15 | 1.4 | 2.8 | 20 | 23 | 20 | 14 | 12 | 8.0 |
| 16 | 1.4 | 2.8 | 17 | 23 | 20 | 14 | 12 | 8.0 |
| 17 | 1.4 | 2.8 | 17 | 20 | 20 | 12 | 12 | 6.5 |
| 18 | 1.4 | 3.0 | 17 | 20 | 12 | 14 | 12 | 6.5 |
| 19 | 1.4 | 3.0 | 17 | 23 | 12 | 14 | 12 | 6.5 |
| 20 | 1.4 | 3.0 | 17 | 23 | 14 | 14 | 10 | 6.5 |
| 21 | 1.4 | 3.5 | 17 | 20 | 14 | 17 | 10 | 6.5 |
| 22 | 1.6 | 3.5 | 20 | 17 | 14 | 17 | 10 | 6.5 |
| 23 | 1.6 | 3.8 | 20 | 17 | 12 | 14 | 10 | 6.5 |
| 24 | 1.6 | 3.8 | 23 | 14 | 12 | 14 | 10 | 8.0 |
| 25 | 1.6 | 3.8 | 23 | 14 | 12 | 14 | 10 | 8.0 |
| 26 | 1.6 | 3.8 | 27 | 14 | 41 | 14 | 8 | 8.0 |
| 27 | 1.6 | 3.8 | 27 | 14 | 31 | 17 | 8 | 8.0 |
| 28 | 1.8 | 3.8 | 27 | 17 | 17 | 17 | 8 | 8.0 |
| 29 | 1.8 | 3.5 | 23 | 17 | 14 | 14 | 8 | 8.0 |
| 30 | 1.8 | 3.5 | 23 | 17 | 17 | 14 | 8 | 8.0 |
| 31 | 1.8 | ..... | ..... | 17 | ..... | 14 | 8 | ..... |

NOTE.—Discharge determined from two curves well defined below 20 second-feet and poorly defined for higher stages, applicable Oct. 1 to Nov. 30, and Apr. 1 to Sept. 30.

*Monthly discharge of Mouse River at Minot, N. Dak., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in acre-feet). | Accuracy. |
|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | |
| October | 1.8 | 1.4 | 1.6 | 98 | C. |
| November | 3.8 | 1.8 | 2.87 | 171 | D. |
| December | ..... | ..... | 1.0 | 61 | D. |
| January | ..... | ..... | 1.0 | 61 | D. |
| February | ..... | ..... | 1.0 | 56 | D. |
| March | ..... | ..... | 3.0 | 184 | D. |
| April | 27 | 8 | 20.9 | 1,240 | B. |
| May | 27 | 14.5 | 19.8 | 1,220 | B. |
| June | 41 | 12 | 20.6 | 1,230 | B. |
| July | 17 | 12 | 14.9 | 916 | B. |
| August | 17 | 8 | 12.1 | 744 | B. |
| September | 8 | 6.5 | 7.05 | 420 | D. |
| The year | 41 | ..... | 8.9 | 6,400 | |

NOTE.—Discharge Dec. 1 to Mar. 31 estimated from discharge measurements and occasional gage-height observations and temperature records.

## EVAPORATION GAGE AT UNIVERSITY, N. DAK.[1]

The evaporation gage at University, N. Dak., was established April 17, 1905, on a pool in a ravine called English Coulee, which runs through the campus of the University of North Dakota, immediately west of Grand Forks, N. Dak., and 2 miles west of the Minnesota boundary.

[1] For complete description of this station and records of evaporation, rainfall, and temperature for 1905 to 1908, see U. S. Geol. Survey Water-Supply Paper 245, pp. 64-67, 1910.

The records at this station were continued during the year ending September 30, 1915, daily observations being made October 1 to November 11, 1914, and April 10 to September 30, 1915. The gage was protected from disturbance and the records of observations are reliable.

The coulee drains about 60 square miles of very level prairie. Except for brief freshets the flow in the coulee is small, varying from 1 second-foot or less to 20 second-feet. In very dry weather the water lies in pools with scarcely any perceptible flow.

A heavy galvanized-iron tank, 3 feet square and 18 inches deep, is placed in the center of an anchored raft, so that the water in the tank is at the same level as the water surface outside. The tank is filled nearly to the top, to a height precisely marked by the pointed tip of a vertical rod in the center of the tank. Once each day, after the change produced by evaporation or rainfall, the water level is restored to the original height, the precise amount of water transferred being measured with a cup of such size that one cupful of water is equivalent to 0.01 inch depth in the tank.

On the open prairie about 40 rods distant is a standard rain gage. On days of rainfall the difference (which is usually small) between the quantity measured by the rain gage and the surplus in the tank is considered the total evaporation for the day.

Observations were made usually about half an hour before sunset. The temperature of the water recorded is the observation of the water in the tank; as the tank is made of metal, it has been found that at that time of the day there is rarely a perceptible difference in temperature reading between the water within and without the tank. The temperature of the air as recorded is the mean of the readings of the standard self-recording maximum and the self-recording minimum thermometers for the preceding 24 hours.

The following table shows for each 10-day period during the year ending September 30, 1915, the gross evaporation, the total rainfall, and the mean temperatures for the 10 observations of the water and of the air.

*Evaporation observations at University, N. Dak., for year ending Sept. 30, 1915.*

| Date. | Evaporation. | Rainfall. | Mean temperature (° F.). | | Date. | Evaporation. | Rainfall. | Mean temperature (° F.). | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Water. | Air. | | | | Water. | Air. |
| | *Inches.* | *Inches.* | | | | *Inches.* | *Inches.* | | |
| Oct. 1–10 | 1.21 | 0.66 | 63 | 61 | July 1–10 | 1.52 | 0.81 | 54 | 60 |
| 11–20 | .82 | .09 | 50 | 50 | 11–20 | 1.83 | 1.15 | 55 | 66 |
| 21–31 | .86 | 1.05 | 46 | 44 | 21–31 | 1.67 | .29 | 60 | 64 |
| Nov. 1–11 | .39 | .20 | 37 | 38 | Aug. 1–10 | 1.54 | .00 | 59 | 66 |
| Apr. 10–20 | 1.66 | .02 | 53 | 51 | 11–20 | 1.58 | .00 | 61 | 68 |
| 21–30 | 1.30 | .89 | 57 | 53 | 21–31 | 1.68 | .07 | 54 | 60 |
| May 1–10 | 1.01 | .66 | 52 | 47 | Sept. 1–10 | 1.27 | .41 | 62 | 67 |
| 11–20 | 1.22 | 2.66 | 58 | 51 | 11–20 | 1.38 | .41 | 46 | 52 |
| 21–31 | 1.71 | .04 | 53 | 56 | 21–30 | 1.23 | .75 | 43 | 50 |
| June 1–10 | 1.17 | 1.46 | 53 | 56 | | | | | |
| 11–20 | 1.02 | 2.77 | 49 | 53 | | | | | |
| 21–30 | 1.49 | 3.11 | 57 | 63 | | | | | |

## RAINY LAKE AT RANIER, MINN.

LOCATION.—At foot of Rainy Lake at Ranier, Koochiching County.

RECORDS AVAILABLE.—January 1, 1910, to September 30, 1915.

GAGE.—Haskel water-stage recorder and vertical staff gage; read once daily; installed December 5, 1913, on protecting crib above Canadian Northern Railway bridge by the Canadian Department of Public Works. From August 19, 1911, to December 5, 1913, staff gage attached to foot of Ranier wharf. Prior to the latter date gage heights were read at the upper gage of the Minnesota & Ontario Power Co.,

just above the dam at International Falls, 2 miles below Ranier. Comparative readings taken on the two gages during 1911 indicate a slope of 0.50 foot between the two points, and to make the records comparable, the readings of the Minnesota & Ontario gage were reduced by 488.50. Recent studies by Mr. Adolph F. Meyer, consulting engineer of the International Joint Commission, indicate that the actual slope between the two gages varied from 0.3 to 1.2 feet during the period January 1, 1910, and August 18, 1911, so that the readings on the gage of the Minnesota & Ontario Power Co. should have been reduced by an amount ranging from 488.70 to 487.80, instead of 488.50 feet. Gage heights January 1, 1910, to August 18, 1911, published in Water-Supply Papers 285 and 305, are therefore in error as referred to the correct datum by an unknown amount varying from +0.2 to −0.7 feet. The gages at Ranier were maintained at the following elevations:

| | Feet. |
|---|---|
| Aug. 19, 1911, to Sept. 30, 1912 | 489.00 |
| Sept. 21, 1912, to Oct. 9, 1912 | 488.77 |
| Oct. 15, 1912, to Dec. 4, 1913 | 489.25 |
| Dec. 5, 1913, to Sept. 30, 1915 | 488.00 |

The records have all been reduced to the original datum, 489.00.

On June 1, 1915, a new gage was installed by the Canadian Department of Public Works at the plant of the Northern Construction Co., about 3 miles across the lake from Ranier; and from simultaneous readings it has been determined that the water surface is lower at the present Ranier gage than at the Northern Construction Co. gage by an amount varying from 0.57 of a foot at a stage of 2 feet, to 0.05 of a foot at a stage of 7 feet.

The records at this station, by indicating the change in water level, show the gain or loss in storage due to control of the flow at International Falls dam, and when used in connection with the records of flow of the Rainy at International Falls are of value in determining the natural run-off.

EXTREMES OF STAGE.—Maximum stage recorded during year, 7.65 feet October 11 and 18; minimum stage recorded, 1.15 feet, April 15.

1910–1915: Maximum stage recorded, 8.47 feet July 14, 1913; 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.—Gages are owned and maintained by the Canadian Department of Public Works.

*Daily gage height, in feet, of Rainy Lake at Ranier, Minn., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7.60 | 7.50 | 6.45 | 5.55 | 4.15 | 3.10 | 1.56 | 1.90 | 2.50 | 5.30 | 6.75 | 6.98 |
| 2 | 7.54 | 7.40 | 6.45 | 5.50 | 4.20 | 3.00 | 1.58 | 1.75 | 2.50 | 5.36 | 6.77 | 6.97 |
| 3 | 7.58 | 7.30 | 6.45 | 5.60 | 4.15 | 2.97 | 1.38 | 1.70 | 2.55 | 5.45 | 6.80 | 6.90 |
| 4 | 7.60 | 7.23 | 6.40 | 5.55 | 4.10 | 2.90 | 1.79 | 1.60 | 2.60 | 5.50 | 6.75 | 6.94 |
| 5 | 7.60 | 7.28 | 6.40 | 5.40 | 4.05 | 2.85 | 1.37 | 1.58 | 2.62 | ..... | 6.75 | 7.05 |
| 6 | 7.60 | 7.25 | 6.40 | 5.40 | 4.00 | 2.80 | 1.30 | 1.59 | 2.55 | 5.55 | 6.75 | 7.10 |
| 7 | 7.60 | 7.18 | 6.40 | 5.30 | 4.00 | 3.00 | 1.40 | 1.60 | 2.65 | 5.60 | 7.00 | 7.02 |
| 8 | 7.60 | 7.28 | 6.30 | 5.25 | 3.95 | 2.75 | 1.35 | 2.20 | 2.70 | 5.65 | 6.92 | 7.02 |
| 9 | 7.60 | 7.18 | 6.25 | 5.20 | 3.90 | 2.70 | 1.22 | 2.10 | 2.75 | 5.70 | 6.82 | 7.04 |
| 10 | 7.58 | 7.09 | 6.20 | 5.30 | 3.87 | 2.65 | 1.30 | 1.80 | 2.80 | 5.76 | 6.85 | 6.95 |
| 11 | 7.65 | 7.09 | 6.20 | 5.20 | 3.85 | 2.60 | 1.68 | 1.75 | 2.88 | 5.83 | 6.85 | 7.00 |
| 12 | 7.60 | 7.10 | 6.10 | 5.10 | 3.80 | 2.55 | 1.36 | 1.78 | 3.15 | 5.82 | 6.85 | 7.05 |
| 13 | 7.55 | 7.05 | 6.10 | 5.05 | 3.80 | 2.50 | 1.30 | 1.78 | 3.27 | 5.95 | 6.75 | 7.05 |
| 14 | 7.60 | 7.00 | 6.05 | 5.00 | 3.80 | 2.70 | 1.20 | 1.80 | 3.40 | 6.05 | 6.80 | 6.90 |
| 15 | 7.60 | 7.05 | 6.00 | 4.95 | 3.70 | 2.40 | 1.15 | 2.38 | 3.50 | 6.04 | 7.00 | 6.93 |
| 16 | 7.57 | 6.88 | 6.00 | 4.90 | 3.60 | 2.35 | 1.16 | 2.10 | 3.70 | 6.05 | 6.95 | 6.93 |
| 17 | 7.60 | 6.90 | 6.00 | 4.80 | 3.65 | 2.40 | 1.20 | 2.10 | 3.76 | 6.15 | 6.92 | 6.90 |
| 18 | 7.65 | 6.90 | 5.90 | 4.75 | 3.60 | 2.40 | 1.70 | 2.05 | 3.85 | 6.20 | 6.92 | 6.94 |
| 19 | 7.60 | 6.85 | 5.90 | 4.75 | 3.50 | 2.20 | 1.35 | 2.00 | 3.95 | 6.22 | 6.95 | 7.00 |
| 20 | 7.50 | 6.81 | 5.90 | 4.70 | 3.45 | 2.20 | 1.29 | 2.00 | 4.00 | 6.25 | 6.95 | 7.00 |
| 21 | 7.50 | 6.70 | 5.85 | 4.70 | 3.40 | 2.20 | 1.30 | 2.00 | 3.90 | 6.30 | 6.95 | 6.97 |
| 22 | 7.50 | 6.85 | 5.85 | 4.65 | 3.32 | 2.10 | 1.30 | 2.40 | 4.20 | 6.39 | 6.95 | 6.90 |
| 23 | 7.60 | 6.75 | 5.85 | 4.60 | 3.35 | 2.15 | 1.30 | 2.20 | 4.27 | 6.50 | 6.80 | 6.93 |
| 24 | 7.60 | 6.65 | 5.88 | 4.60 | 3.30 | 2.05 | 1.85 | 2.60 | 4.37 | 6.53 | 6.90 | 7.00 |
| 25 | 7.60 | 6.65 | 5.90 | 4.50 | 3.20 | 1.85 | 1.90 | 2.26 | 4.50 | 6.60 | 6.95 | 6.95 |
| 26 | 7.45 | 6.75 | 5.90 | 4.45 | 3.15 | 1.85 | 1.50 | 2.40 | 4.60 | 6.63 | 6.92 | 7.15 |
| 27 | 7.40 | 6.55 | 5.85 | 4.40 | 3.15 | 1.74 | 1.50 | 2.40 | 4.80 | 6.63 | 6.90 | 7.05 |
| 28 | 7.40 | 6.65 | 5.70 | 4.30 | 3.15 | 1.95 | 1.30 | 2.35 | 4.95 | 6.65 | 7.00 | 7.00 |
| 29 | 7.40 | 6.70 | 5.70 | 4.30 | ..... | 1.80 | 1.58 | 2.60 | 5.01 | 6.61 | 6.97 | 7.00 |
| 30 | 7.40 | 6.00 | 5.65 | 4.25 | ..... | 1.65 | 1.56 | 2.50 | 5.15 | 6.65 | 6.95 | 7.00 |
| 31 | 7.40 | ..... | 5.60 | 4.20 | ..... | 1.60 | ..... | 2.69 | ..... | 6.68 | 6.97 | ..... |

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

### RAINY RIVER AT INTERNATIONAL FALLS, MINN.

LOCATION.—At the steamboat dock half a mile below the International Falls in Koochiching County, 3 miles below the outlet of Rainy Lake.

DRAINAGE AREA.—14,600 square miles.

RECORDS AVAILABLE.—March 1, 1907, to September 30, 1915.

GAGE.—Stevens continuous water-stage recorder installed September 15, 1913, by the engineers of the Canadian Department of Public Works; the well being attached to the steam boat dock. A vertical staff gage installed April 20, 1911, by the United States Geological Survey, is attached to a piling supporting the dock, downstream side near outer corner. This gage was read twice daily from April 20, 1911, to September 15, 1913, after which date it was used as reference by which the water-stage recorder was set, thus making the datum to which records from the two gages were referred identical. From March 1, 1907, to April 20, 1911, the Minnesota & Ontario Power Co., furnished readings from a vertical staff gage located just below the dam, first on the American side but later on the Canadian side. The zero of the gage of the United States Geological Survey is 460.99 feet above that of the power company's gage, when the slope of the river between the two points, determined at gage height 2.65 feet, is considered.

DISCHARGE MEASUREMENTS.—Made from a boat in the vicinity of the gage.

CHANNEL AND CONTROL.—Channel near gage is largely solid rock; permanent. The control which is probably a long distance downstream (perhaps at Manitou Rapids 37 miles below) is subject to frequent obstructions from log jams. Backwater at gage is also caused by flood stages of Little Fork and Big Fork rivers. On

account of the above conditions no estimates of flow are made from the gage heights for the current year.

EXTREMES OF DISCHARGE.—Maximum mean daily discharge recorded during year, 11,200 second-feet, December 9; minimum mean daily discharge recorded, 1,220 second-feet, December 26.

1907–1915.—Maximum discharge recorded, 18,100 second-feet September 23 to 28, 1907; minimum discharge recorded, 431 second-feet April 21, 1909.

WINTER FLOW.—Discharge relation seriously affected by ice; estimates of flow as determined from power-house records furnished by Canadian department of public works.

REGULATION.—Since the dam and power house of the Minnesota & Ontario Power Co. have been in operation, practically no water has passed over the crest, the entire flow of the river going through the turbines and sluice gates. The plant is run on a 24-hour basis, so that with the exception of the Sunday flow the discharge 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 and a range in stage of about 7 feet.

ACCURACY.—During the past two years backwater has been so frequently indicated by discharge measurements that no attempt has been made to estimate discharge from the gage heights. The gage heights are however believed to be excellent.

COOPERATION.—Estimates of flow through the power house and results of discharge measurements are furnished by the Canadian Department of Public Works, which maintains the recording gage.

*Discharge measurements of Rainy River at International Falls, Minn., in 1913–1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| 1913. | | *Feet.* | *Sec.-ft.* | 1915. | | *Feet.* | *Sec.-ft.* |
| July 25 | B. J. Peterson | 7.17 | [a] 13,600 | Feb. 20 | B. F. Smallian | 3.96 | 8,170 |
| Aug. 8 | do | 4.78 | [a] 10,000 | Mar. 11 | do | 3.11 | 7,550 |
| 9 | do | 5.00 | [a] 10,100 | Apr. 22 | do | 3.61 | 8,080 |
| Oct. 10 | do | 3.60 | 6,260 | May 12 | do | 4.71 | 8,630 |
| 12 | do | 3.78 | 5,640 | 26 | do | 3.81 | 7,230 |
| 1914. | | | | June 25 | do | 5.16 | 8,200 |
| Oct. 7 | R. F. Smallian | 4.61 | 10,400 | 29 | do | 7.06 | 6,160 |
| 1915. | | | | 30 | do | 7.78 | 6,070 |
| Jan. 20 | do | 4.91 | 10,200 | July 3 | do | 6.06 | 6,360 |
| Feb. 10 | do | 4.31 | 7,700 | Aug. 6 | do | 4.26 | 8,890 |
| | | | | Sept. 1 | do | 3.16 | 7,630 |
| | | | | 17 | do | 3.21 | 7,690 |

[a] Discharge relation affected by backwater.

NOTE.—Discharge measurements in 1913 made by the International Joint Commission, Adolph F. Meyer, consulting engineer. Results of measurements in 1914 and 1915 were furnished by the Canadian Department of Public Works, and a correction of −460.99 feet was applied to the gage heights of these measurements to reduce them to the datum of the United States Geological Survey gage. Additional discharge measurements made in 1913 and 1914 published in Water-Supply Papers 355 and 385.

*Daily gage height, in feet, of Rainy River at International Falls, Minn., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5.0 | 4.1 | 4.9 | 5.8 | 4.1 | 3.1 | 3.2 | 3.4 | 2.5 | 7.7 | 4.4 | 3.3 |
| 2 | 5.0 | 4.0 | 5.1 | 5.8 | 4.9 | 3.7 | 3.2 | 3.2 | 2.9 | 7.1 | 3.6 | 3.3 |
| 3 | 4.8 | 5.0 | 5.0 | 4.6 | 4.7 | 4.0 | 3.2 | 3.3 | 3.0 | 6.3 | 4.4 | 3.6 |
| 4 | 3.8 | 5.2 | 4.9 | 4.3 | 4.6 | 3.9 | 2.5 | 3.5 | 3.0 | 5.7 | 4.6 | 3.9 |
| 5 | 3.6 | 5.2 | 4.8 | 5.5 | 4.6 | 3.9 | 2.6 | 3.7 | 3.0 | 4.8 | 4.7 | 2.7 |
| 6 | 3.6 | 5.1 | 4.2 | 5.5 | 4.5 | 3.8 | 3.4 | 3.6 | 3.1 | 4.8 | 4.4 | 1.2 |
| 7 | 4.6 | 5.1 | 3.3 | 5.5 | 3.8 | 2.8 | 3.4 | 3.7 | 3.3 | 5.6 | 4.4 | 2.3 |
| 8 | 4.9 | 3.1 | 4.6 | 5.5 | 3.5 | 2.4 | 3.5 | 3.1 | 3.4 | 5.5 | 4.2 | 3.4 |
| 9 | 4.8 | 3.8 | 4.8 | 5.5 | 4.5 | 3.6 | 3.5 | 2.7 | 3.6 | 5.2 | 4.3 | 3.5 |
| 10 | 4.9 | 5.0 | 5.0 | 4.5 | 4.6 | 3.2 | 3.6 | 3.5 | 3.8 | 4.9 | 4.4 | 3.5 |
| 11 | 4.0 | 5.1 | 5.1 | 4.1 | 4.6 | 3.3 | 2.6 | 4.5 | 3.9 | 4.6 | 4.4 | 3.5 |
| 12 | 3.9 | 5.0 | 5.3 | 5.2 | 4.6 | 3.4 | 2.5 | 4.8 | 4.2 | 4.5 | 4.4 | 3.3 |
| 13 | 5.0 | 4.9 | 4.5 | 5.3 | 4.3 | 3.4 | 3.3 | 4.9 | 4.9 | 4.7 | 4.5 | 2.8 |
| 14 | 5.2 | 4.7 | 4.5 | 5.3 | 4.1 | 2.5 | 3.7 | 4.8 | 6.5 | 4.6 | 4.5 | 3.3 |
| 15 | 5.0 | 3.9 | 5.4 | 5.1 | 3.8 | 2.4 | 3.8 | 4.1 | 7.6 | 4.6 | 4.3 | 3.5 |
| 16 | 5.0 | 3.8 | 5.7 | 5.1 | 4.2 | 3.2 | 3.9 | 3.7 | 7.8 | 4.5 | 3.8 | 3.5 |
| 17 | 5.0 | 4.8 | 5.6 | 5.0 | 4.2 | 3.1 | 4.0 | 4.3 | 7.9 | 3.8 | 3.9 | 3.5 |
| 18 | 3.0 | 5.1 | 5.5 | 4.7 | 4.2 | 2.9 | 2.9 | 5.1 | 8.1 | 4.2 | 4.0 | 3.7 |
| 19 | 3.8 | 5.6 | 5.5 | 5.1 | 4.3 | 3.3 | 2.4 | 5.9 | 8.0 | 3.8 | 4.0 | 2.7 |
| 20 | 5.0 | 5.9 | 4.5 | 5.1 | 4.2 | 3.4 | 3.6 | 6.2 | 7.3 | 4.3 | 3.9 | 2.9 |
| 21 | 5.1 | 6.0 | 3.8 | 5.3 | 3.6 | 2.4 | 3.8 | 6.1 | 6.6 | 4.2 | 3.9 | 3.7 |
| 22 | 5.1 | 5.3 | 5.4 | 5.4 | 2.9 | 2.4 | 3.8 | 5.1 | 6.1 | 4.2 | 3.6 | 3.6 |
| 23 | 5.2 | 5.0 | 5.6 | 5.5 | 3.8 | 3.1 | 3.8 | 4.4 | 5.5 | 3.9 | 3.8 | 3.5 |
| 24 | 5.0 | 5.8 | 5.9 | 5.2 | 3.9 | 3.1 | 3.3 | 3.9 | 5.3 | 3.8 | 3.9 | 3.8 |
| 25 | 4.0 | 5.7 | 3.8 | 5.3 | 3.8 | 3.4 | 2.2 | 3.7 | 5.2 | 4.0 | 3.9 | 4.0 |
| 26 | 4.2 | 5.6 | 1.6 | 5.6 | 3.7 | 3.8 | 2.7 | 4.0 | 5.2 | 4.2 | 3.8 | 2.8 |
| 27 | 5.1 | 5.1 | 2.4 | 5.5 | 3.8 | 3.6 | 3.6 | 3.7 | 5.4 | 4.4 | 3.8 | 2.7 |
| 28 | 5.2 | 4.6 | 4.1 | 5.5 | 3.5 | 3.0 | 4.1 | 3.8 | 6.4 | 4.5 | 3.8 | 3.4 |
| 29 | 5.3 | 3.6 | 5.2 | 5.5 | ..... | 2.2 | 4.0 | 3.0 | 7.2 | 4.5 | 3.5 | 3.6 |
| 30 | 5.2 | 3.2 | 5.9 | 5.6 | ..... | 3.3 | 4.0 | 2.6 | 7.9 | 4.7 | 3.2 | 3.8 |
| 31 | 5.2 | ..... | 5.9 | 5.0 | ..... | 3.3 | ..... | 2.4 | ..... | 4.7 | 3.4 | ..... |

NOTE.—Discharge relation affected by backwater a large part of the time; see "Accuracy" in station description. Gage heights taken from recording gage sheet.

*Daily discharge, in second-feet, of Rainy River at International Falls, Minn., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 10,500 | 7,600 | 11,000 | 10,100 | 7,150 | 6,660 | 7,780 | 8,030 | 7,200 | 6,160 | 9,180 | 7,470 |
| 2 | 10,500 | 8,940 | 10,900 | 10,300 | 8,290 | 8,350 | 7,650 | 7,410 | 6,360 | 6,170 | 7,940 | 7,440 |
| 3 | 10,000 | 10,800 | 11,100 | 6,610 | 8,180 | 8,370 | 7,440 | 7,460 | 7,260 | 7,070 | 9,920 | 8,020 |
| 4 | 7,200 | 10,800 | 10,900 | 9,030 | 8,290 | 8,300 | 6,760 | 8,260 | 7,310 | 7,810 | 10,100 | 8,780 |
| 5 | 8,650 | 10,800 | 10,400 | 10,500 | 8,080 | 8,320 | 6,810 | 8,270 | 7,280 | 6,080 | 10,200 | 6,450 |
| 6 | 10,400 | 10,800 | 7,460 | 10,100 | 8,280 | 8,310 | 8,080 | 7,970 | 7,710 | 7,630 | 9,740 | 3,490 |
| 7 | 10,600 | 10,800 | 8,270 | 10,100 | 6,790 | 5,760 | 7,760 | 8,210 | 7,360 | 8,750 | 9,590 | 6,040 |
| 8 | 10,500 | 8,270 | 10,700 | 10,300 | 7,190 | 6,620 | 8,090 | 6,940 | 7,850 | 8,290 | 9,310 | 7,840 |
| 9 | 10,500 | 9,170 | 11,200 | 10,400 | 8,240 | 7,510 | 7,870 | 5,160 | 7,780 | 8,100 | 8,950 | 7,800 |
| 10 | 10,500 | 10,800 | 10,700 | 6,980 | 8,250 | 7,360 | 7,520 | 8,140 | 7,770 | 8,250 | 9,340 | 7,740 |
| 11 | 7,640 | 10,800 | 10,700 | 8,640 | 8,360 | 7,110 | 5,400 | 8,940 | 8,340 | 7,970 | 9,720 | 7,770 |
| 12 | 8,830 | 10,800 | 10,900 | 10,400 | 8,180 | 7,560 | 6,310 | 9,580 | 7,920 | 8,550 | 9,710 | 7,370 |
| 13 | 10,500 | 10,500 | 7,220 | 10,300 | 7,750 | 7,460 | 7,540 | 9,580 | 6,850 | 8,610 | 9,690 | 6,670 |
| 14 | 10,000 | 9,950 | 8,680 | 10,100 | 6,360 | 6,000 | 8,090 | 9,600 | 7,550 | 8,910 | 9,690 | 7,520 |
| 15 | 9,270 | 7,780 | 9,310 | 9,600 | 6,860 | 6,370 | 8,110 | 7,730 | 6,470 | 9,050 | 8,910 | 7,670 |
| 16 | 9,660 | 8,960 | 10,200 | 9,560 | 6,450 | 7,340 | 8,070 | 8,020 | 6,450 | 8,470 | 8,030 | 7,750 |
| 17 | 9,680 | 10,300 | 9,290 | 9,180 | 8,210 | 7,110 | 8,150 | 8,430 | 6,800 | 7,810 | 8,440 | 7,820 |
| 18 | 7,460 | 10,800 | 9,920 | 8,220 | 8,200 | 7,380 | 5,680 | 7,560 | 7,320 | 8,720 | 8,450 | 8,210 |
| 19 | 8,370 | 11,100 | 9,990 | 9,560 | 8,400 | 7,630 | 6,610 | 8,980 | 7,060 | 7,770 | 8,480 | 6,290 |
| 20 | 10,500 | 10,700 | 6,910 | 9,540 | 7,960 | 7,440 | 8,120 | 8,710 | 8,200 | 9,050 | 8,460 | 7,090 |
| 21 | 10,500 | 11,100 | 7,830 | 9,510 | 7,160 | 6,470 | 8,180 | 8,680 | 7,930 | 8,630 | 8,440 | 8,290 |
| 22 | 10,700 | 8,190 | 9,120 | 9,450 | 6,330 | 6,330 | 8,140 | 6,740 | 7,670 | 8,610 | 8,370 | 8,070 |
| 23 | 11,000 | 9,190 | 9,310 | 8,880 | 8,440 | 7,360 | 8,180 | 7,190 | 7,570 | 7,850 | 8,010 | 8,140 |
| 24 | 10,400 | 11,100 | 9,670 | 7,940 | 8,420 | 7,290 | 6,440 | 5,360 | 8,030 | 8,830 | 8,450 | 8,860 |
| 25 | 7,000 | 10,900 | 3,450 | 8,710 | 8,260 | 7,600 | 5,420 | 7,820 | 8,090 | 8,370 | 8,230 | 8,830 |
| 26 | 9,000 | 10,900 | 1,220 | 9,420 | 8,000 | 8,060 | 7,550 | 8,310 | 7,950 | 8,730 | 8,300 | 6,020 |
| 27 | 10,600 | 10,000 | 3,710 | 8,810 | 7,790 | 8,220 | 8,280 | 7,820 | 6,690 | 8,850 | 7,930 | 6,940 |
| 28 | 10,800 | 9,420 | 8,320 | 8,560 | 7,530 | 6,830 | 8,570 | 7,960 | 6,640 | 9,530 | 7,820 | 8,040 |
| 29 | 10,800 | 8,320 | 9,950 | 9,090 | ..... | 6,730 | 8,230 | 6,910 | 6,340 | 9,600 | 7,180 | 8,300 |
| 30 | 10,800 | 8,170 | 10,400 | 9,200 | ..... | 8,230 | 8,240 | 6,310 | 6,320 | 9,990 | 7,000 | 8,550 |
| 31 | 10,700 | ..... | 10,000 | 7,530 | ..... | 7,990 | ..... | 5,800 | ..... | 9,970 | 7,540 | ..... |

NOTE.—Discharge records furnished by D. W. Jamieson, hydraulic engineer, Department of Public Works, Canada; computed from power-house records.

*Monthly discharge of Rainy River at International Falls, Minn., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Month. | Discharge in second-feet. | | |
|---|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | Maximum. | Minimum. | Mean. |
| October | 11,000 | 7,000 | 9,790 | May | 9,600 | 5,160 | 7,800 |
| November | 11,100 | 7,600 | 9,930 | June | 8,340 | 6,320 | 7,340 |
| December | 11,200 | 1,220 | 8,990 | July | 9,990 | 6,080 | 8,330 |
| January | 10,500 | 6,610 | 9,250 | August | 10,200 | 7,000 | 8,750 |
| February | 8,440 | 6,330 | 7,760 | September | 8,860 | 3,490 | 7,510 |
| March | 8,370 | 5,760 | 7,360 | | | | |
| April | 8,570 | 5,400 | 7,500 | The year | 11,200 | 1,220 | 8,370 |

NOTE.—Computed by engineers of United States Geological Survey from records furnished by Canadian Department of Public Works.

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, 1915.

GAGE.—Stevens water-stage recorder installed the last part of September, 1912, by the International Joint Commission, in cooperation with the U. S. 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 the right bank of the 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 which were bolted to the horizontal portion 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, the well, together with the float and weight, were carried away by logs. At this time a concrete well was intalled by the International Joint Commission a little 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. Both water-stage recorders refer to the same datum.

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

CHANNEL AND CONTROL.—At the gage the river consists of a small deep pool formed by a timber dam without openings which constitutes the control of the gage and is permanent unless the dam is destroyed or alterations are made in the crest. About 200 feet above the dam is a decided falls. The channel does not overflow in the vicinity of the gage. At the measuring section the bed of the stream is rock and bowlders and rather rough; the water is very swift except at low stages.

EXTREMES OF DISCHARGE.—Maximum mean daily discharge recorded during year, 3,760 second-feet June 20; minimum mean daily discharge, 51 second-feet April 29.

1905–1907 and 1912–1915: Maximum discharge recorded, 5,250 second-feet June 5, 1907; minimum discharge, zero August 24, 25, 30, 31, and September 1, 1905; August 6, 8, 1906; and April 23, 24, and 26, 1907.

WINTER FLOW.—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, during this part of the year is very constant, is computed 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 break-up 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 interval when desired to drive logs from Garden Lake to Fall Lake. At other times gates are closed so that there is only a slight flow caused by leakage through the dam. At other times some of the gates are partly opened to allow sufficient water to pass so that it will not flow over the crest of the dam.

ACCURACY.—The records for 1905–1907 were obtained by estimating the flow through the sluice ways of the logging dam at outlet of Garden Lake and are probably not better than fair. The records for the period 1912–1915 are considered good. The control is permanent; the water-stage recorder enables the accurate determination of mean daily gage heights for the portion of the year when there are violent fluctuations due to regulation of the flow in the interest of log driving. The discharge is computed from a well-defined rating table.

COOPERATION.—Records from 1905–1907 furnished by the Minnesota Canal & Power Co. For acknowledgment of cooperation with the International Joint Commission in collecting records 1912–1915, see page 14.

*Discharge measurements of Kawishiwi River near Winton, Minn., during the years ending Sept. 30, 1913–1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| 1912–13. | | *Feet.* | *Sec.-ft.* | 1913–14. | | *Feet.* | *Sec.-ft.* |
| Oct. 13 | S. B. Soulé | 2.31 | 818 | May 22 | S. B. Soulé | 4.21 | 2,120 |
| 14 | do | .72 | 109 | | | | |
| 14 | do | 3.69 | 1,770 | 1914–15. | | | |
| 15 | do | 4.98 | 2,880 | Sept. 23[a] | do | 1.23 | 186 |
| Apr. 29 | do | 3.63 | 1,700 | | | | |
| 30 | do | .62 | 81 | | | | |
| Sept. 12 | B. J. Peterson | .89 | 163 | | | | |
| 13 | do | 2.32 | 810 | | | | |

[a] Logs lodged on crest of dam which constitutes control for gage: one large log lay lengthwise of the crest and obstructed the flow almost entirely from that portion of the crest.

*Daily discharge, in second-feet, of Kawishiwi River near Winton, Minn., for the years ending Sept. 30, 1905–1907 and 1913–1915.*

| Day. | June. | July. | Aug. | Sept. | Day. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|
| 1905. | | | | | | | | | |
| 1 | ..... | 1,693 | 2,320 | 0 | 16 | ..... | 3,370 | 1,172 | 2,008 |
| 2 | ..... | 2,650 | 2,342 | 228 | 17 | ..... | 3,097 | 2,605 | 193 |
| 3 | ..... | 2,070 | 1,645 | 910 | 18 | ..... | 2,386 | 2,194 | 850 |
| 4 | ..... | 1,900 | 2,050 | 988 | 19 | ..... | 422 | 1,887 | 2,435 |
| 5 | ..... | 3,192 | 1,613 | 1,180 | 20 | ..... | 1,800 | 1,606 | 2,387 |
| 6 | ..... | 3,192 | 1,877 | 1,134 | 21 | 1,340 | 3,243 | 1,406 | 2,353 |
| 7 | ..... | 3,766 | 3,018 | 1,159 | 22 | 1,912 | 2,608 | 1,288 | 2,332 |
| 8 | ..... | 4,131 | 2,901 | 2,286 | 23 | 1,960 | 2,422 | 738 | 2,656 |
| 9 | ..... | 3,737 | 1,693 | 2,200 | 24 | 1,994 | 887 | 0 | 3,426 |
| 10 | ..... | 3,736 | 2,118 | 1,302 | 25 | 2,237 | 1,025 | 0 | 3,426 |
| 11 | ..... | 3,459 | 2,550 | 1,400 | 26 | 2,174 | 1,878 | 130 | 3,554 |
| 12 | ..... | 2,985 | 1,840 | 1,897 | 27 | 1,082 | 912 | 622 | 3,719 |
| 13 | ..... | 2,818 | 2,315 | 2,534 | 28 | 2,903 | 2,102 | 622 | 3,790 |
| 14 | ..... | 2,562 | 846 | 2,650 | 29 | 2,921 | 2,000 | 492 | 3,719 |
| 15 | ..... | 3,088 | 203 | 2,294 | 30 | 2,000 | 1,149 | 0 | 3,581 |
| | | | | | 31 | ..... | 2,300 | 0 | ..... |

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1905–6. | | | | | | | | | | | | |
| 1 | 3,426 | 1,238 | 1,083 | 856 | 506 | 360 | 276 | 1,682 | 2,585 | 2,276 | 455 | 400 |
| 2 | 3,244 | 1,210 | 1,083 | 837 | 506 | 360 | 289 | 1,840 | 2,920 | 1,152 | 1,150 | 360 |
| 3 | 2,899 | 1,210 | 1,109 | 837 | 523 | 360 | 289 | 1,836 | 2,444 | 1,095 | 214 | 400 |
| 4 | 1,458 | 1,158 | 1,109 | 837 | 506 | 360 | 289 | 1,889 | 2,353 | 1,005 | 750 | 400 |
| 5 | 1,898 | 1,134 | 1,134 | 810 | 506 | 360 | 300 | 1,930 | 2,911 | 1,860 | 524 | 400 |
| 6 | 2,659 | 1,134 | 1,158 | 783 | 506 | 360 | 300 | 2,105 | 3,146 | 830 | 0 | 380 |
| 7 | 2,123 | 1,109 | 1,158 | 760 | 491 | 345 | 315 | 2,650 | 3,146 | 880 | 795 | 380 |
| 8 | 1,350 | 1,083 | 1,158 | 731 | 491 | 345 | 315 | 2,057 | 3,096 | 920 | 0 | 416 |
| 9 | 1,361 | 1,060 | 1,158 | 731 | 474 | 345 | 330 | 2,172 | 3,074 | 930 | 848 | 435 |
| 10 | 1,768 | 1,060 | 1,158 | 731 | 474 | 345 | 330 | 2,880 | 3,020 | 950 | 1,275 | 435 |
| 11 | 2,339 | 1,039 | 1,158 | 713 | 474 | 345 | 345 | 2,706 | 3,094 | 962 | 1,070 | 435 |
| 12 | 1,711 | 972 | 1,185 | 695 | 474 | 330 | 360 | 2,150 | 3,327 | 985 | 830 | 416 |
| 13 | 1,341 | 850 | 1,158 | 695 | 458 | 330 | 416 | 2,370 | 2,764 | 1,050 | 780 | 400 |
| 14 | 1,083 | 888 | 1,158 | 676 | 458 | 330 | 474 | 1,795 | 3,144 | 1,275 | 708 | 400 |
| 15 | 934 | 908 | 1,158 | 660 | 435 | 330 | 506 | 1,836 | 2,685 | 985 | 702 | 360 |
| 16 | 843 | 928 | 1,099 | 660 | 435 | 330 | 579 | 2,057 | 2,843 | 950 | 525 | 345 |
| 17 | 775 | 928 | 1,070 | 660 | 435 | 330 | 660 | 2,913 | 3,070 | 1,546 | 550 | 330 |
| 18 | 734 | 928 | 1,070 | 642 | 416 | 320 | 760 | 3,087 | 2,846 | 830 | 600 | 315 |
| 19 | 775 | 820 | 1,070 | 642 | 416 | 315 | 856 | 3,212 | 2,940 | 810 | 560 | 300 |
| 20 | 820 | 629 | 1,050 | 621 | 400 | 315 | 931 | 3,055 | 2,378 | 830 | 523 | 289 |
| 21 | 887 | 671 | 1,024 | 621 | 400 | 315 | 1,024 | 3,008 | 2,830 | 840 | 523 | 289 |
| 22 | 964 | 700 | 1,024 | 600 | 400 | 300 | 1,158 | 2,987 | 2,062 | 840 | 523 | 276 |
| 23 | 1,083 | 903 | 1,024 | 600 | 400 | 300 | 1,265 | 3,091 | 1,344 | 830 | 523 | 276 |
| 24 | 1,109 | 1,288 | 998 | 579 | 380 | 300 | 1,491 | 3,113 | 2,259 | 800 | 523 | 263 |
| 25 | 1,158 | 1,185 | 975 | 579 | 380 | 300 | 1,730 | 3,005 | 2,387 | 745 | 523 | 300 |
| 26 | 1,210 | 1,134 | 951 | 579 | 360 | 300 | 2,389 | 2,634 | 2,251 | 740 | 506 | 289 |
| 27 | 1,265 | 1,109 | 931 | 560 | 360 | 300 | 1,654 | 2,605 | 2,623 | 710 | 491 | 300 |
| 28 | 1,288 | 1,083 | 931 | 540 | 360 | 300 | 2,307 | 2,605 | 3,232 | 1,422 | 474 | 289 |
| 29 | 1,265 | 1,060 | 910 | 540 | ..... | 289 | 2,600 | 2,565 | 1,870 | 585 | 458 | 276 |
| 30 | 1,265 | 1,060 | 880 | 540 | ..... | 289 | 2,580 | 2,446 | 2,050 | 1,181 | 435 | 276 |
| 31 | 1,238 | ..... | 880 | 523 | ..... | 289 | ..... | 2,559 | ..... | 455 | 400 | ..... |

*Daily discharge, in second-feet, of Kawishiwi River near Winton, Minn., for the years ending Sept. 30, 1905–1907 and 1913–1915*—Continued.

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. |
|---|---|---|---|---|---|---|---|---|---|
| 1906–7. | | | | | | | | | |
| 1 | 276 | 400 | 660 | 345 | 263 | 200 | 222 | 540 | 5,000 |
| 2 | 276 | 400 | 642 | 345 | 263 | 210 | 235 | 506 | 5,200 |
| 3 | 276 | 416 | 621 | 330 | 263 | 210 | 235 | 491 | 5,250 |
| 4 | 263 | 416 | 600 | 330 | 263 | 210 | 250 | 458 | 5,200 |
| 5 | 250 | 400 | 579 | 330 | 250 | 210 | 263 | 435 | 5,100 |
| 6 | 263 | 400 | 579 | 330 | 250 | 210 | 276 | 416 | 4,900 |
| 7 | 276 | 400 | 579 | 330 | 250 | 210 | 276 | 305 | 4,710 |
| 8 | 276 | 416 | 540 | 330 | 250 | 210 | 276 | 50 | 4,550 |
| 9 | 300 | 435 | 523 | 315 | 250 | 200 | 289 | 59 | 4,350 |
| 10 | 330 | 435 | 506 | 315 | 250 | 200 | 300 | 56 | 4,130 |
| 11 | 330 | 435 | 506 | 315 | 235 | 200 | 315 | 552 | 4,000 |
| 12 | 330 | 491 | 491 | 315 | 235 | 200 | 330 | 836 | 3,375 |
| 13 | 330 | 540 | 474 | 300 | 235 | 200 | 330 | 1,265 | 3,700 |
| 14 | 315 | 592 | 474 | 300 | 235 | 200 | 345 | 1,341 | 3,440 |
| 15 | 300 | 680 | 474 | 300 | 222 | 200 | 345 | 1,366 | 2,947 |
| 16 | 300 | 783 | 474 | 300 | 222 | 200 | 380 | 983 | 2,983 |
| 17 | 289 | 931 | 474 | 300 | 222 | 200 | 380 | 80 | 3,245 |
| 18 | 289 | 975 | 474 | 300 | 222 | 200 | 380 | 81 | 2,900 |
| 19 | 276 | 998 | 435 | 300 | 222 | 190 | 380 | 1,329 | 2,695 |
| 20 | 289 | 998 | 435 | 289 | 210 | 190 | 400 | 2,214 | 1,327 |
| 21 | 300 | 975 | 458 | 289 | 210 | 190 | 400 | 2,270 | 1,600 |
| 22 | 330 | 931 | 416 | 289 | 210 | 190 | 415 | 2,400 | 2,600 |
| 23 | 330 | 910 | 400 | 289 | 210 | 190 | 0 | 1,100 | 3,810 |
| 24 | 330 | 837 | 400 | 289 | 210 | 200 | 0 | 2,390 | 3,700 |
| 25 | 330 | 783 | 400 | 289 | 200 | 200 | 951 | 1,677 | 3,475 |
| 26 | 330 | 783 | 380 | 276 | 200 | 210 | 0 | 3,716 | 3,320 |
| 27 | 330 | 760 | 360 | 276 | 200 | 210 | 880 | 3,810 | 1,669 |
| 28 | 345 | 731 | 360 | 276 | 200 | 222 | 837 | 4,120 | 990 |
| 29 | 360 | 695 | 360 | 276 | ..... | 222 | 731 | 4,415 | 970 |
| 30 | 380 | 676 | 360 | 263 | ..... | 210 | 621 | 4,710 | 529 |
| 31 | 400 | ..... | 360 | 263 | ..... | 222 | ..... | 4,760 | ..... |

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1912–13. | | | | | | | | | | | | |
| 1 | ..... | ..... | 314 | 186 | 150 | 133 | 143 | 2,400 | 1,950 | 905 | 390 | 304 |
| 2 | ..... | ..... | 310 | 185 | 148 | 133 | 147 | 2,360 | 1,710 | 1,030 | 590 | 441 |
| 3 | ..... | ..... | 302 | 184 | 146 | 133 | 149 | 2,340 | 1,480 | 1,040 | 600 | 794 |
| 4 | ..... | ..... | 290 | 182 | 145 | 132 | 153 | 2,360 | 1,110 | 1,060 | 125 | 227 |
| 5 | ..... | ..... | 278 | 180 | 144 | 131 | 155 | 2,180 | 88 | 1,060 | 127 | 256 |
| 6 | ..... | ..... | 270 | 177 | 143 | 130 | 157 | 1,630 | 504 | 1,060 | 289 | 445 |
| 7 | ..... | ..... | 262 | 174 | 142 | 129 | 159 | 1,030 | 2,380 | 1,050 | 347 | 163 |
| 8 | ..... | ..... | 235 | 172 | 140 | 128 | 161 | 1,210 | 2,840 | 305 | 610 | 272 |
| 9 | ..... | ..... | 235 | 170 | 139 | 127 | 163 | 920 | 3,380 | 1,340 | 130 | 816 |
| 10 | ..... | 930 | 235 | 168 | 139 | 127 | 165 | 975 | 3,170 | 736 | 130 | 239 |
| 11 | ..... | ..... | 235 | 165 | 138 | 127 | 167 | 133 | 3,190 | 940 | 494 | 333 |
| 12 | ..... | ..... | 235 | 163 | 137 | 127 | 169 | 133 | 3,040 | 1,040 | 541 | 464 |
| 13 | ..... | ..... | 235 | 163 | 136 | 127 | 170 | 332 | 3,210 | 989 | 530 | 393 |
| 14 | 250 | 747 | 226 | 163 | 135 | 127 | 220 | 854 | 3,220 | 1,380 | 130 | 326 |
| 15 | 346 | ..... | 216 | 163 | 134 | 127 | 306 | 1,600 | 3,190 | 1,050 | 541 | 670 |
| 16 | 559 | ..... | 214 | 163 | 133 | 127 | 339 | 2,230 | 2,460 | 1,300 | 130 | 157 |
| 17 | 608 | ..... | 211 | 163 | 133 | 128 | 369 | 2,680 | 2,130 | 1,020 | 133 | 157 |
| 18 | 478 | ..... | 208 | 163 | 133 | 129 | 400 | 1,860 | 2,960 | 536 | 555 | 157 |
| 19 | 460 | 304 | 206 | 163 | 133 | 130 | 432 | 1,910 | 2,120 | 736 | 381 | 652 |
| 20 | 583 | 40 | 203 | 162 | 133 | 131 | 465 | 2,380 | 1,990 | 738 | 136 | 317 |
| 21 | 440 | 98 | 200 | 162 | 133 | 132 | 546 | 2,930 | 2,960 | 736 | 474 | 154 |
| 22 | 276 | 283 | 197 | 161 | 133 | 133 | 630 | 2,610 | 2,240 | 820 | 571 | 157 |
| 23 | 250 | 205 | 196 | 160 | 133 | 133 | 703 | 2,070 | 1,840 | 906 | 182 | 301 |
| 24 | 440 | 302 | 195 | 159 | 133 | 134 | 854 | 1,920 | 2,630 | 742 | 381 | 807 |
| 25 | 358 | 512 | 194 | 158 | 133 | 134 | 1,050 | 2,580 | 2,000 | 1,110 | 554 | 262 |
| 26 | 122 | 465 | 193 | 157 | 133 | 135 | 1,210 | 2,980 | 2,740 | 1,490 | 353 | 266 |
| 27 | 105 | 414 | 192 | 156 | 133 | 136 | 1,410 | 3,190 | 2,140 | 1,440 | 652 | 322 |
| 28 | ..... | 382 | 191 | 154 | 133 | 137 | 1,580 | 2,890 | 2,120 | 1,730 | 120 | 163 |
| 29 | ..... | 352 | 190 | 153 | ..... | 138 | 1,750 | 2,650 | 2,010 | 1,790 | 364 | 621 |
| 30 | ..... | 327 | 189 | 152 | ..... | 139 | 1,270 | 2,420 | 1,980 | 1,640 | 378 | 382 |
| 31 | ..... | ..... | 188 | 151 | ..... | 141 | ..... | 2,180 | ..... | 1,020 | 133 | ..... |

*Daily discharge, in second-feet, of Kawishiwi River near Winton, Minn., for the years ending Sept. 30, 1905–1907 and 1913–1915*—Continued.

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1913–14. | | | | | | | | | | | | |
| 1 | 382 | ..... | 747 | 423 | 314 | 235 | 190 | 996 | 2,610 | 2,000 | 1,640 | 667 |
| 2 | 387 | 930 | 742 | 418 | 311 | 70 | 190 | 1,120 | 2,520 | 1,500 | 1,720 | 924 |
| 3 | 487 | 1,050 | 736 | 409 | 308 | 15 | 190 | 1,180 | 3,800 | 1,390 | 1,100 | 918 |
| 4 | 365 | 1,040 | 730 | 400 | 306 | 15 | 190 | 1,130 | 4,480 | 2,000 | 841 | 965 |
| 5 | 625 | 908 | 720 | 396 | 303 | 15 | 187 | 1,250 | 3,870 | 2,020 | 271 | 931 |
| 6 | 448 | 817 | 714 | 391 | 300 | 15 | 187 | 1,730 | 3,870 | 2,000 | 502 | 1,020 |
| 7 | 387 | 817 | 703 | 382 | 297 | 60 | 187 | 2,430 | 3,870 | 1,320 | 868 | 976 |
| 8 | 729 | 817 | 698 | 374 | 294 | 163 | 187 | 2,830 | 2,910 | 1,360 | 337 | 977 |
| 9 | 262 | 817 | 687 | 369 | 292 | 60 | 183 | 2,900 | 2,520 | 1,710 | 176 | 792 |
| 10 | 436 | 1,360 | 682 | 365 | 289 | 15 | 183 | 3,690 | 2,520 | 2,930 | 515 | 981 |
| 11 | 655 | 1,310 | 676 | 356 | 286 | 70 | 183 | 3,970 | 2,240 | 2,950 | 696 | 743 |
| 12 | 648 | 1,270 | 671 | 356 | 283 | 247 | 180 | 3,680 | 1,150 | ..... | 805 | 770 |
| 13 | 823 | 1,220 | 661 | 356 | 280 | 243 | 180 | 3,740 | 1,540 | ..... | 823 | 776 |
| 14 | 638 | 1,190 | 650 | 356 | 277 | 239 | 141 | 3,490 | 1,130 | ..... | 829 | 898 |
| 15 | 938 | 1,140 | 645 | 356 | 274 | 235 | 48 | 3,190 | 1,520 | ..... | 836 | 1,030 |
| 16 | 1,100 | 1,130 | 640 | 356 | 272 | 231 | 49 | 2,920 | 1,200 | ..... | 805 | 1,100 |
| 17 | 1,110 | 1,110 | 630 | 356 | 269 | 231 | 51 | 2,570 | 2,140 | ..... | 784 | 737 |
| 18 | 1,010 | 1,080 | 625 | 356 | 266 | 231 | 290 | 2,630 | 2,180 | ..... | 811 | 964 |
| 19 | 1,490 | 868 | 620 | 356 | 263 | 227 | 345 | 2,460 | 2,000 | ..... | 799 | 782 |
| 20 | 1,490 | 575 | 610 | 356 | 260 | 227 | 239 | 2,290 | 1,200 | 1,120 | 272 | 675 |
| 21 | 1,470 | 585 | 580 | 356 | 257 | 227 | 247 | 2,640 | 1,130 | 860 | 170 | 805 |
| 22 | 1,340 | 590 | 561 | 356 | 254 | 227 | 258 | 2,400 | ..... | 810 | 414 | 805 |
| 23 | 1,230 | 590 | 541 | 356 | 252 | 227 | 274 | 2,080 | 1,860 | 930 | 330 | 1,110 |
| 24 | 1,260 | 347 | 522 | 356 | 250 | 224 | 178 | 2,090 | ..... | 342 | 817 | 1,330 |
| 25 | 1,570 | 145 | 503 | 356 | 247 | 216 | 73 | 1,460 | 1,130 | 1,490 | 1,050 | 785 |
| 26 | 1,490 | 148 | 484 | 350 | 245 | 216 | 71 | 2,120 | ..... | 857 | 981 | 1,340 |
| 27 | 1,680 | 148 | 470 | 344 | 242 | 212 | 75 | 1,950 | ..... | 703 | 866 | 698 |
| 28 | 1,000 | 148 | 455 | 338 | 239 | 201 | 623 | 2,020 | 2,520 | 720 | 1,130 | 1,270 |
| 29 | 1,540 | 492 | 446 | 332 | ..... | 197 | 960 | 2,250 | ..... | 759 | 854 | 656 |
| 30 | 1,520 | 747 | 437 | 326 | ..... | 197 | 879 | 2,700 | 2,020 | 1,320 | 972 | 793 |
| 31 | 1,500 | ..... | 428 | 320 | ..... | 194 | ..... | 2,930 | ..... | 1,440 | 1,440 | ..... |
| 1914–15. | | | | | | | | | | | | |
| 1 | 880 | 242 | 197 | 235 | 214 | 192 | 170 | 55 | 1,480 | 2,570 | 640 | 323 |
| 2 | 1,480 | 794 | 197 | 235 | 213 | 187 | 170 | 55 | 1,590 | 2,710 | 517 | 645 |
| 3 | 1,620 | 615 | 197 | 235 | 211 | 182 | 170 | 57 | 1,360 | 2,570 | 556 | 1,300 |
| 4 | 495 | 610 | 197 | 235 | 210 | 178 | 170 | 59 | 666 | 1,820 | 386 | 1,500 |
| 5 | 725 | 600 | 197 | 235 | 208 | 173 | 169 | 59 | 1,490 | 1,710 | 665 | 1,220 |
| 6 | 730 | 595 | 197 | 235 | 207 | 168 | 168 | 62 | 1,400 | 2,210 | 435 | 993 |
| 7 | 736 | 590 | 197 | 235 | 205 | 163 | 167 | 62 | 1,100 | 2,200 | 1,020 | 1,020 |
| 8 | 736 | 600 | 197 | 235 | 204 | 165 | 166 | 64 | 658 | 1,800 | 972 | 997 |
| 9 | 1,490 | 600 | 197 | 235 | 203 | 168 | 165 | 66 | 1,180 | 1,990 | 947 | ..... |
| 10 | 665 | 595 | 235 | 235 | 201 | 170 | 164 | 66 | 1,370 | 1,940 | 425 | ..... |
| 11 | 453 | 585 | 235 | 232 | 200 | 173 | 163 | 68 | 862 | 2,310 | 324 | ..... |
| 12 | 792 | 580 | 235 | 230 | 199 | 175 | 164 | 68 | 1,440 | 1,510 | 326 | ..... |
| 13 | 714 | 575 | 235 | 227 | 198 | 177 | 166 | 71 | 2,020 | 1,440 | 278 | 201 |
| 14 | 829 | 824 | 235 | 224 | 197 | 180 | 167 | 986 | 2,040 | 2,260 | 276 | 313 |
| 15 | 485 | 2,020 | 235 | 221 | 197 | 180 | 169 | 276 | 2,030 | 1,950 | 275 | 470 |
| 16 | 1,090 | 1,590 | 235 | 219 | 197 | 180 | 170 | 689 | 2,790 | 2,730 | 338 | 448 |
| 17 | 381 | 1,320 | 235 | 216 | 197 | 180 | 3,000 | 407 | 3,100 | 2,760 | 366 | 423 |
| 18 | 692 | 1,120 | 235 | 216 | 197 | 180 | 92 | 380 | 3,170 | 2,580 | 264 | 351 |
| 19 | 687 | 956 | 235 | 216 | 197 | 180 | 87 | 903 | 3,500 | 1,230 | 83 | 170 |
| 20 | 687 | 817 | 235 | 216 | 197 | 180 | 82 | 1,790 | 3,760 | 914 | 825 | 163 |
| 21 | 682 | 709 | 235 | 216 | 197 | 180 | 77 | 1,960 | 3,620 | 1,830 | 774 | 166 |
| 22 | 676 | 615 | 235 | 216 | 197 | 179 | 72 | 1,580 | 3,170 | 1,100 | 690 | 525 |
| 23 | 564 | 440 | 235 | 216 | 197 | 177 | 67 | 1,320 | 2,910 | 919 | 1,410 | 186 |
| 24 | 531 | 274 | 235 | 216 | 197 | 176 | 62 | 1,430 | 3,160 | 1,110 | 922 | 689 |
| 25 | 662 | 235 | 235 | 216 | 197 | 174 | 57 | 937 | 3,060 | 1,690 | 687 | 186 |
| 26 | 635 | 197 | 235 | 216 | 197 | 173 | 57 | ..... | 3,540 | 1,180 | 1,040 | 186 |
| 27 | 630 | 163 | 235 | 216 | 197 | 171 | 57 | ..... | 3,390 | 1,280 | 758 | 780 |
| 28 | 524 | 163 | 235 | 216 | 197 | 170 | 53 | ..... | 2,800 | 1,090 | 728 | 227 |
| 29 | 142 | 163 | 235 | 216 | ..... | 170 | 51 | ..... | 2,580 | 1,160 | 166 | 943 |
| 30 | 406 | 163 | 235 | 216 | ..... | 170 | 53 | ..... | 2,690 | 1,190 | 136 | 80 |
| 31 | 906 | ..... | 235 | 216 | ..... | 170 | ..... | 1,080 | ..... | 538 | 139 | ..... |

NOTE.—Records for 1905–1907 obtained by estimating the flow through the five sluiceways of the logging dam at the outlet of Garden Lake, which are closed by tainter gates. The coefficient for each sluiceway was obtained by a current meter. The estimates of daily flow for these years do not include leakage, which is estimated as follows: July, 1905, 43 second-feet; August, 1905, 62 second-feet; September, 1905, 40 second-feet; October, 1905, 7.5 second-feet; and August, 1906, 27 second-feet.

Discharge Oct. 14, 1912, to Sept. 30, 1915, computed from a rating curve well defined below 3,000 second-feet. Discharge for periods of rapid fluctuations in stage caused by logging operations determined from hourly gage heights taken from recording gage records; discharge during remainder of year determined from mean daily gage heights. Discharge partly estimated on the following days: May 28–June 2, 1913, June 14, 18, 1914, and June 12, 1915.

Record Oct. 14, 1912, to Dec. 31, 1914, is the same as that published in report of Consulting Engineers, International Joint Commission, Lake of the Woods Levels, pp. 276–277, except that only three significant figures are here used.

*Monthly discharge of Kawishiwi River near Winton, Minn., for the years ending Sept. 30, 1905–1907 and 1913–1915.*

[Drainage area, 1,200 square miles.]

| Month. | Discharge in second-feet. | | | Accuracy. |
|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | |
| 1905. | | | | |
| June 21–30 | 2,920 | 1,080 | 2,050 | ..... |
| July | 4,130 | 422 | 2,510 | ..... |
| August | 3,020 | 62 | 1,480 | ..... |
| September | 3,790 | 40 | 2,130 | ..... |
| 1905–6. | | | | |
| October | 3,430 | 734 | 1,500 | ..... |
| November | 1,290 | 629 | 1,020 | ..... |
| December | 1,180 | 880 | 1,060 | ..... |
| January | 856 | 523 | 672 | ..... |
| February | 506 | 360 | 444 | ..... |
| March | 330 | 289 | 326 | ..... |
| April | 2,580 | 276 | 902 | ..... |
| May | 3,110 | 1,680 | 2,480 | ..... |
| June | 3,330 | 1,340 | 2,670 | ..... |
| July | 2,280 | 455 | 1,010 | ..... |
| August | 1,280 | ..... | 615 | ..... |
| September | 435 | 263 | 348 | ..... |
| 1906–7. | | | | |
| October | 400 | 250 | 309 | ..... |
| November | 998 | 400 | 655 | ..... |
| December | 660 | 360 | 478 | ..... |
| January | 345 | 263 | 303 | ..... |
| February | 263 | 200 | 234 | ..... |
| March | 222 | 190 | 204 | ..... |
| April | 951 | ..... | 364 | ..... |
| May | 4,760 | 50 | 1,490 | ..... |
| June | 5,250 | 529 | 3,550 | ..... |
| 1912–13. | | | | |
| October | ..... | ..... | ..... | ..... |
| November | ..... | ..... | ..... | ..... |
| December | 314 | 188 | 227 | B. |
| 1912–13—Contd. | | | | |
| January | 186 | 151 | 166 | B. |
| February | 150 | 133 | 137 | B. |
| March | 141 | 127 | 131 | B. |
| April | 1,750 | 143 | 520 | A. |
| May | 3,190 | 133 | 1,930 | B. |
| June | 3,380 | 88 | 2,290 | A. |
| July | 1,790 | 305 | 1,060 | A. |
| August | 652 | 120 | 357 | A. |
| September | 816 | 154 | 367 | A. |
| 1913–14. | | | | |
| October | 1,680 | 262 | 968 | A. |
| November 2–30 | 1,360 | 145 | 807 | A. |
| December | 747 | 428 | 613 | B. |
| January | 423 | 320 | 364 | B. |
| February | 314 | 239 | 276 | B. |
| March | 247 | 15 | 167 | B. |
| April | 960 | 48 | 241 | B. |
| May | 3,970 | 996 | 2,410 | A. |
| August | 1,720 | 170 | 789 | A. |
| September | 1,340 | 656 | 907 | A. |
| 1914–15. | | | | |
| October | 1,620 | 142 | 733 | A. |
| November | 2,020 | 163 | 645 | A. |
| December | 235 | 197 | 224 | B. |
| January | 235 | 216 | 224 | B. |
| February | 214 | 197 | 201 | B. |
| March | 192 | 163 | 176 | A. |
| April | 3,000 | 51 | 218 | B. |
| June | 3,760 | 658 | 2,260 | A. |
| July | 2,760 | 538 | 1,750 | A. |
| August | 1,410 | 83 | 560 | A. |

NOTE.—The maximum and minimum discharge recorded in above table for the years 1905–1907 do not include leakage. Leakage during the months of July, August, September, October, 1905, and August, 1906, is included in the mean discharge given for these months. See footnote to table of daily discharge.

## VERMILION RIVER BELOW LAKE VERMILION, NEAR TOWER, MINN.

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

DRAINAGE AREA.—507 square miles.

RECORDS AVAILABLE.—May 17, 1911, to September 30, 1915.

GAGE.—Vertical staff gage attached to a tree at the left bank; read twice daily, to quarter-tenths, by Mrs. A. E. Shively.

DISCHARGE MEASUREMENTS.—All measurements except two in May, 1914, have been made from a cable just below the gage. These two measurements were made from a boat some distance below the gage.

CHANNEL AND CONTROL.—The bed of the stream is composed of solid rock and large bowlders. A heavy falls a short distance below the gage constitutes a permanent control; banks do not overflow to any considerable extent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 2.7 feet June 27 to July 9, and July 12 (discharge, 930 second-feet); minimum stage recorded, 0.38 foot March 28 to April 5 (discharge, 80 second-feet).

1911–1915: Maximum stage recorded, 3.5 feet June 6 to 11, 1913 (discharge, 1,420 second-feet); minimum stage recorded, 0.22 foot October 1 and 2, 1914 (discharge, 60 second-feet).

WINTER FLOW.—Discharge relation not affected by ice, owing to the heavy fall at the control section, and to the proximity to Vermilion Lake.

REGULATION.—At the outlet of Vermilion Lake, a few hundred feet above the 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.—Results apparently good to excellent, the accuracy probably increasing with the stage. The control is permanent; gage heights reliable, rating curve well defined, the only uncertainty being in low-water discharge measurements, owing to the very rough section at which they were made.

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

*Daily discharge, in second-feet, of Vermilion River below Lake Vermilion, Minn., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 208 | 171 | 117 | 111 | 106 | 101 | 80 | 101 | 287 | 930 | 672 | 287 |
| 2 | 208 | 171 | 117 | 111 | 106 | 98 | 80 | 106 | 287 | 930 | 672 | 287 |
| 3 | 208 | 167 | 117 | 111 | 106 | 98 | 80 | 111 | 272 | 930 | 672 | 272 |
| 4 | 208 | 167 | 117 | 111 | 106 | 95 | 80 | 114 | 272 | 930 | 672 | 257 |
| 5 | 208 | 167 | 117 | 111 | 106 | 95 | 80 | 117 | 272 | 930 | 540 | 257 |
| 6 | 208 | 163 | 117 | 111 | 106 | 90 | 83 | 122 | 287 | 930 | 540 | 231 |
| 7 | 208 | 163 | 117 | 111 | 106 | 90 | 86 | 127 | 304 | 930 | 540 | 231 |
| 8 | 208 | 163 | 117 | 111 | 106 | 86 | 86 | 130 | 321 | 930 | 540 | 208 |
| 9 | 208 | 158 | 117 | 111 | 106 | 86 | 83 | 134 | 321 | 930 | 540 | 187 |
| 10 | 208 | 158 | 117 | 111 | 106 | 86 | 83 | 139 | 358 | 870 | 540 | 187 |
| 11 | 198 | 158 | 117 | 111 | 106 | 86 | 86 | 163 | 398 | 870 | 515 | 187 |
| 12 | 198 | 152 | 114 | 111 | 106 | 86 | 86 | 171 | 398 | 930 | 515 | 187 |
| 13 | 198 | 152 | 114 | 111 | 106 | 86 | 90 | 171 | 490 | 870 | 515 | 183 |
| 14 | 198 | 148 | 114 | 111 | 106 | 86 | 90 | 163 | 590 | 870 | 515 | 183 |
| 15 | 187 | 148 | 114 | 111 | 106 | 86 | 90 | 163 | 618 | 870 | 420 | 177 |
| 16 | 187 | 144 | 114 | 111 | 106 | 86 | 90 | 208 | 728 | 870 | 420 | 171 |
| 17 | 187 | 144 | 114 | 111 | 106 | 86 | 90 | 208 | 755 | 870 | 420 | 167 |
| 18 | 187 | 139 | 114 | 111 | 106 | 86 | 90 | 231 | 755 | 870 | 420 | 163 |
| 19 | 187 | 139 | 114 | 111 | 106 | 86 | 90 | 231 | 810 | 870 | 398 | 163 |
| 20 | 187 | 134 | 114 | 111 | 106 | 86 | 90 | 257 | 810 | 870 | 398 | 163 |
| 21 | 187 | 134 | 114 | 111 | 106 | 83 | 90 | 257 | 810 | 810 | 398 | 163 |
| 22 | 183 | 130 | 114 | 106 | 106 | 83 | 90 | 272 | 870 | 755 | 378 | 158 |
| 23 | 183 | 130 | 114 | 106 | 106 | 83 | 90 | 272 | 870 | 755 | 378 | 158 |
| 24 | 183 | 127 | 114 | 106 | 106 | 83 | 90 | 272 | 870 | 782 | 358 | 152 |
| 25 | 183 | 127 | 114 | 106 | 106 | 83 | 95 | 272 | 870 | 782 | 358 | 152 |
| 26 | 177 | 122 | 114 | 106 | 106 | 83 | 95 | 272 | 870 | 755 | 358 | 148 |
| 27 | 177 | 122 | 114 | 106 | 101 | 83 | 95 | 272 | 930 | 700 | 340 | 148 |
| 28 | 177 | 117 | 111 | 106 | 101 | 80 | 98 | 272 | 930 | 700 | 321 | 148 |
| 29 | 177 | 117 | 111 | 106 | ..... | 80 | 98 | 272 | 930 | 728 | 321 | 144 |
| 30 | 171 | 117 | 111 | 106 | ..... | 80 | 101 | 272 | 930 | 728 | 321 | 144 |
| 31 | 171 | ..... | 111 | 106 | ..... | 80 | ..... | 272 | ..... | 645 | 304 | ..... |

NOTE.—Discharge computed from a rating curve well defined between 60 and 1,100 second-feet.

*Monthly discharge of Vermilion River below Lake Vermilion, near Tower, Minn., for the year ending Sept. 30, 1915.*

[Drainage area, 507 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 208 | 171 | 193 | 0.381 | 0.44 | A. |
| November | 171 | 117 | 145 | .286 | .32 | A. |
| December | 117 | 111 | 115 | .227 | .26 | A. |
| January | 111 | 106 | 109 | .215 | .25 | A. |
| February | 106 | 101 | 106 | .209 | .22 | A. |
| March | 101 | 80 | 86.6 | .171 | .20 | A. |
| April | 101 | 80 | 88.5 | .175 | .20 | A. |
| May | 272 | 101 | 198 | .391 | .45 | A. |
| June | 930 | 272 | 607 | 1.20 | 1.34 | A. |
| July | 930 | 645 | 843 | 1.66 | 1.91 | A. |
| August | 672 | 304 | 461 | .909 | 1.05 | A. |
| September | 287 | 144 | 189 | .373 | .42 | A. |
| The year | 930 | 80 | 263 | .519 | 7.06 | |

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, 1915.

GAGE.—Vertical staff gage attached to piling supporting the bridge on the downstream side, left end; read twice daily, to quarter-tenths, by T. J. La Chapelle from June 30, 1909 to September 11, 1915, and by G. H. French from September 12 to 30, 1915.

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 of stream composed of sand and gravel with some bowlders; banks high and not subject to overflow. Control permanent up to the summer of 1915, but during the high water in June there was a decided shift.

EXTREMES OF STAGE.—Maximum stage recorded during year, 22.6 feet, at 8 a. m. June 29; minimum stage recorded, 5.3 feet, September 4.

1909–1915: Maximum stage recorded, 22.6 feet, at 8 a. m. June 29, 1915; minimum stage recorded, 4.40 feet, September 5, 1910 (discharge, approximately 40 second-feet).

WINTER FLOW.—Discharge relation seriously affected by ice; discharge determined from discharge measurements, observer's notes, and weather records.

ACCURACY.—Conditions in the past have been favorable for excellent results, but during the present year an unusually high flood produced a decided shift in channel; estimates of discharge withheld until a more complete rating of the channel in its present condition can be obtained.

*Discharge measurements of Little Fork River at Little Fork, Minn., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Dec. 15[a] | S. B. Soulé | 6.02 | 118 | Mar. 27[a] | S. B. Soule | 6.65 | 112 |
| Jan. 19[a] | do | 6.16 | 85 | Sept. 13 | H. T. Critchlow | 5.66 | 159 |

[a] Made through ice; complete ice cover at gage and control.

*Daily gage height, in feet, of Little Fork River at Little Fork, Minn., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 6.2 | 6.6 | 6.5 | 5.65 | 6.2 | 6.9 | 6.7 | 8.0 | 9.2 | 19.4 | 8.4 | 5.8 |
| 2 | 6.1 | 6.6 | 6.5 | 5.65 | 6.2 | 6.9 | 6.9 | 8.1 | 9.4 | 16.6 | 8.2 | 5.6 |
| 3 | 6.0 | 6.6 | 6.5 | 5.65 | 6.2 | 6.9 | 7.1 | 8.4 | 9.5 | 14.4 | 7.9 | 5.45 |
| 4 | 6.0 | 6.7 | 6.5 | 5.7 | 6.2 | 6.9 | 7.5 | 8.6 | 9.4 | 13.4 | 7.6 | 5.3 |
| 5 | 5.9 | 6.7 | 6.5 | 5.7 | 6.2 | 7.0 | 7.8 | 9.0 | 9.6 | 10.7 | 7.3 | 5.45 |
| 6 | 5.95 | 6.8 | 6.5 | 5.75 | 6.2 | 7.0 | 8.2 | 9.2 | 9.8 | 9.4 | 7.0 | 5.7 |
| 7 | 6.2 | 6.8 | 6.4 | 5.8 | 6.2 | 7.0 | 8.4 | 9.4 | 10.0 | 8.8 | 6.8 | 5.7 |
| 8 | 6.4 | 6.8 | 6.4 | 5.85 | 6.2 | 6.9 | 8.6 | 9.7 | 10.4 | 8.5 | 6.6 | 5.7 |
| 9 | 6.4 | 6.7 | 6.4 | 5.9 | 6.2 | 6.9 | 8.9 | 10.0 | 10.9 | 8.8 | 6.4 | 5.7 |
| 10 | 6.5 | 6.7 | 6.4 | 6.0 | 6.2 | 6.8 | 9.3 | 10.5 | 12.0 | 8.9 | 6.3 | 5.6 |
| 11 | 6.6 | 6.5 | 6.3 | 6.0 | 6.2 | 6.8 | 9.5 | 10.8 | 13.4 | 9.1 | 6.2 | 5.6 |
| 12 | 6.7 | 6.4 | 6.3 | 6.0 | 6.2 | 6.7 | 9.5 | 10.8 | 17.0 | 9.3 | 6.2 | 5.8 |
| 13 | 6.8 | 6.4 | 6.2 | 6.0 | 6.2 | 6.6 | 9.2 | 10.5 | 18.6 | 9.3 | 6.2 | 5.75 |
| 14 | 6.8 | 6.4 | 6.2 | 6.0 | 6.3 | 6.6 | 8.6 | 10.2 | 19.9 | 9.2 | 6.2 | 5.7 |
| 15 | 7.0 | 6.4 | 6.1 | 6.1 | 6.4 | 6.5 | 7.9 | 10.3 | 20.5 | 9.0 | 6.2 | 5.7 |
| 16 | 6.9 | 6.3 | 6.1 | 6.1 | 6.4 | 6.5 | 7.5 | 12.0 | 21.4 | 8.9 | 6.2 | 5.65 |
| 17 | 6.8 | 6.3 | 6.0 | 6.1 | 6.5 | 6.5 | 7.2 | 14.8 | 21.4 | 8.8 | 6.3 | 5.65 |
| 18 | 6.7 | 6.3 | 6.0 | 6.1 | 6.5 | 6.4 | 7.1 | 16.2 | 21.4 | 8.6 | 6.6 | 5.8 |
| 19 | 6.6 | 6.3 | 5.95 | 6.1 | 6.5 | 6.4 | 7.0 | 16.5 | 20.2 | 8.5 | 6.6 | 5.75 |
| 20 | 6.6 | 6.4 | 5.9 | 6.1 | 6.6 | 6.4 | 7.1 | 16.7 | 18.6 | 8.4 | 6.6 | 5.7 |
| 21 | 6.5 | 6.4 | 5.9 | 6.1 | 6.6 | 6.4 | 7.2 | 15.8 | 16.7 | 8.6 | 6.4 | 5.7 |
| 22 | 6.5 | 6.4 | 5.85 | 6.2 | 6.7 | 6.4 | 7.3 | 13.0 | 15.3 | 8.8 | 6.4 | 5.7 |
| 23 | 6.5 | 6.3 | 5.8 | 6.2 | 6.7 | 6.4 | 7.5 | 11.1 | 14.2 | 8.9 | 6.5 | 5.7 |
| 24 | 6.8 | 6.3 | 5.8 | 6.2 | 6.8 | 6.5 | 7.8 | 10.3 | 14.2 | 8.9 | 6.6 | 5.7 |
| 25 | 6.9 | 6.4 | 5.75 | 6.2 | 6.8 | 6.5 | 7.9 | 10.0 | 15.2 | 8.8 | 6.4 | 5.85 |
| 26 | 7.0 | 6.4 | 5.75 | 6.2 | 6.8 | 6.5 | 8.0 | 9.8 | 16.4 | 8.6 | 6.2 | 5.9 |
| 27 | 7.0 | 6.4 | 5.7 | 6.2 | 6.8 | 6.6 | 8.1 | 9.5 | 18.8 | 8.4 | 6.2 | 5.9 |
| 28 | 6.9 | 6.4 | 5.7 | 6.2 | 6.8 | 6.6 | 8.2 | 9.2 | 22.1 | 8.1 | 6.0 | 5.8 |
| 29 | 6.9 | 6.4 | 5.7 | 6.2 | ..... | 6.6 | 8.2 | 9.0 | 22.4 | 8.0 | 6.2 | 5.9 |
| 30 | 6.8 | 6.4 | 5.7 | 6.2 | ..... | 6.6 | 8.1 | 9.0 | 21.4 | 8.4 | 6.2 | 6.0 |
| 31 | 6.7 | ..... | 5.7 | 6.2 | ..... | 6.6 | ..... | 9.1 | ..... | 8.5 | 5.95 | ..... |

NOTE.—Discharge relation affected by ice Dec. 6, 1914, to Apr. 12, 1915.

## UPPER MISSISSIPPI RIVER DRAINAGE BASIN.

### MISSISSIPPI RIVER ABOVE SANDY RIVER, NEAR LIBBY, MINN.

LOCATION.—In sec. 25, T. 50 N., R. 24 W., near Libby post office, Atkin County, a short distance above mouth of Sandy River.

DRAINAGE AREA.—4,510 square miles.

RECORDS AVAILABLE.—September 1, 1895, to September 30, 1915.

GAGE.—Vertical staff gage, just above mouth of Sandy River; gage records not used for determining discharge.

DISCHARGE MEASUREMENTS.—Made from boat, about 3,000 feet above gage, by an employee of the United States Corps of Engineers stationed at the dam.

CHANNEL AND CONTROL.—Bed of stream composed of sand and silt; no well-defined control.

EXTREMES OF DISCHARGE.—Maximum discharge recorded during year, 4,980 second-feet, June 30; minimum discharge recorded, 591 second-feet, March 31.

1895–1915: Maximum discharge recorded, 9,572 second-feet, September 20, 1900; minimum discharge recorded, 115 second-feet, February 22, 1896.

WINTER FLOW.—Determined by frequent discharge measurements; discharge interpolated for intervening days.

REGULATION.—Flow of the river is controlled by three Government reservoirs—Lake Winnibigoshish, Leach Lake, Pokegama Falls—for the purpose of increasing the low-water open-season flow in the interests of navigation.

COOPERATION.—Station maintained by United States Engineer Corps to determine flow of river above Sandy Lake Reservoir.

*Daily discharge, in second-feet, of Mississippi River above Sandy River, near Libby, Minn., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2,270 | 1,580 | 807 | 678 | 713 | 844 | 607 | 1,060 | 2,220 | 4,970 | 2,160 | 2,190 |
| 2 | 2,240 | 1,540 | 813 | 677 | 720 | 822 | 623 | 1,120 | 2,240 | 4,960 | 2,150 | 2,200 |
| 3 | 2,210 | 1,520 | 820 | 676 | 727 | 800 | 639 | 1,170 | 2,260 | 4,960 | 2,150 | 2,200 |
| 4 | 2,180 | 1,480 | 826 | 674 | 735 | 777 | 655 | 1,230 | 2,280 | 4,950 | 2,150 | 2,210 |
| 5 | 2,150 | 1,450 | 833 | 672 | 742 | 755 | 672 | 1,280 | 2,300 | 4,940 | 2,140 | 2,220 |
| 6 | 2,120 | 1,420 | 840 | 671 | 750 | 732 | 688 | 1,340 | 2,320 | 4,940 | 2,140 | 2,230 |
| 7 | 2,090 | a 1,390 | 847 | 670 | 758 | 710 | 704 | a 1,390 | 2,340 | 4,930 | 2,140 | a 2,230 |
| 8 | 2,060 | 1,360 | 854 | 668 | a 765 | 687 | 720 | 1,500 | 2,360 | 4,930 | 2,130 | 2,240 |
| 9 | 2,030 | 1,330 | a 861 | a 667 | 758 | a 665 | 736 | 1,600 | a 2,380 | a 4,920 | a 2,130 | 2,260 |
| 10 | a 2,000 | 1,300 | 850 | 672 | 750 | 664 | 752 | 1,710 | 2,540 | 4,880 | 2,120 | 2,270 |
| 11 | 2,000 | 1,260 | 838 | 678 | 742 | 663 | 768 | 1,810 | 2,700 | 4,830 | 2,120 | 2,280 |
| 12 | 1,990 | 1,230 | 827 | 683 | 734 | 662 | 784 | 1,920 | 2,860 | 4,790 | 2,120 | 2,290 |
| 13 | 1,990 | 1,200 | 815 | 689 | 726 | 661 | 800 | 2,020 | 3,020 | 4,750 | 2,110 | 2,300 |
| 14 | 1,990 | 1,170 | 804 | 696 | 718 | 660 | 817 | 2,120 | 3,190 | 4,700 | 2,110 | 2,310 |
| 15 | 1,990 | 1,140 | 793 | a 702 | a 709 | 659 | 833 | 2,230 | 3,350 | 4,660 | 2,110 | a 2,320 |
| 16 | 1,990 | 1,100 | 781 | 703 | 709 | 658 | 849 | 2,330 | a 3,520 | a 4,620 | 2,110 | 2,290 |
| 17 | a 1,980 | 1,070 | a 770 | 704 | 709 | a 657 | 865 | 2,440 | 3,640 | 4,450 | a 2,100 | 2,260 |
| 18 | 1,970 | 1,040 | 758 | 705 | 709 | 655 | 881 | a 2,540 | 3,770 | 4,280 | 2,100 | 2,230 |
| 19 | 1,950 | 1,010 | 747 | 705 | 709 | 653 | 897 | 2,490 | 3,900 | 4,110 | 2,090 | 2,200 |
| 20 | 1,930 | 973 | 736 | 706 | 709 | 651 | 913 | 2,440 | 4,030 | 3,940 | 2,080 | 2,160 |
| 21 | 1,920 | 941 | 725 | 706 | a 708 | 649 | 929 | 2,390 | 4,160 | 3,760 | 2,080 | 2,130 |
| 22 | 1,900 | 909 | 713 | 707 | 730 | 647 | 945 | 2,340 | 4,280 | 3,590 | 2,070 | 2,100 |
| 23 | 1,880 | 876 | 702 | 708 | 752 | 645 | a 961 | 2,290 | 4,360 | 3,420 | 2,060 | 2,060 |
| 24 | a 1,860 | a 844 | 691 | a 709 | 775 | a 643 | 966 | a 2,230 | a 4,490 | a 3,250 | a 2,050 | a 2,030 |
| 25 | 1,830 | 837 | a 680 | 708 | 797 | 636 | 971 | 2,230 | 4,590 | 3,100 | 2,070 | 2,050 |
| 26 | 1,790 | 830 | 680 | 708 | 819 | 628 | 976 | 2,220 | 4,690 | 2,940 | 2,090 | 2,070 |
| 27 | 1,750 | 822 | 680 | 707 | 842 | 620 | 981 | 2,220 | 4,780 | 2,780 | 2,100 | 2,080 |
| 28 | 1,720 | 814 | 680 | 707 | a 866 | 613 | 986 | 2,220 | 4,880 | 2,630 | 2,120 | 2,100 |
| 29 | 1,680 | 807 | 680 | 707 | ..... | 606 | 991 | 2,210 | 4,920 | 2,470 | 2,140 | 2,120 |
| 30 | 1,640 | 800 | 680 | 706 | ..... | 598 | a 1,010 | 2,200 | a 4,980 | 2,220 | 2,160 | a 2,130 |
| 31 | 1,610 | ..... | a 679 | a 706 | ..... | a 591 | ..... | 2,200 | ..... | a 2,160 | a 2,180 | ..... |

a Discharge measurement.

NOTE.—Discharge determined by interpolation between measurements.

*Monthly discharge of Mississippi River above Sandy River, near Libby, Minn., for the year ending Sept. 30, 1915.*

[Drainage area, 4,510 square miles.]

| Month. | Discharge in second-feet. | | | Run-off (total in millions of cubic feet). |
|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | |
| October | 2,270 | 1,610 | 1,960 | 5,250 |
| November | 1,580 | 800 | 1,130 | 2,940 |
| December | 861 | 679 | 768 | 2,060 |
| January | 709 | 667 | 693 | 1,860 |
| February | 866 | 708 | 746 | 1,800 |
| March | 844 | 591 | 675 | 1,810 |
| April | 1,010 | 607 | 831 | 2,150 |
| May | 2,540 | 1,060 | 1,950 | 5,230 |
| June | 4,980 | 2,220 | 3,440 | 8,930 |
| July | 4,970 | 2,160 | 4,090 | 11,000 |
| August | 2,180 | 2,050 | 2,120 | 5,670 |
| September | 2,320 | 2,030 | 2,190 | 5,680 |
| The year | 4,980 | 591 | 1,720 | 54,380 |

NOTE.—Computed by engineers of the United States Geological Survey from daily discharge record furnished by the United States Engineer Corps.

MISSISSIPPI RIVER AT ELK RIVER, MINN.

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

DRAINAGE AREA.—14,500 square miles.

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

GAGE.—Chain gage bolted to the handrail of the bridge, downstream side, near right bank.

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

CHANNEL AND CONTROL.—Bed of stream is sand and gravel; no well-defined control; banks high and not subject to overflow.

EXTREMES OF STAGE.—Maximum stage recorded since station was established, 6.8 feet July 22; minimum stage recorded, 3.9 feet September 1, 2, and 5.

WINTER FLOW.—Discharge relation seriously affected by ice.

REGULATION.—The nearest dam above the station on the Mississippi is at St. Cloud, 40 miles upstream. An observed systematic diurnal fluctuation at the gage of about 0.1 of a 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 for the purpose of increasing the low-water open-season flow in the interests of navigation.

Data insufficient for estimates of discharge.

*Discharge measurements of Mississippi River at Elk River, Minn., during the year ending Sept. 30, 1915.*

[Made by S. B. Soulé.]

| Date. | Gage height. | Discharge. |
|---|---|---|
| | *Feet.* | *Sec.-ft.* |
| Aug. 10 | 4.40 | 5,620 |
| Sept. 30 | 4.15 | 5,180 |

*Daily gage height, in feet, of Mississippi River at Elk River, Minn., for the year ending Sept. 30, 1915.*

| Day. | July. | Aug. | Sept. | Day. | July. | Aug. | Sept. | Day. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 5.5 | 3.9 | 11 | ..... | 4.3 | 4.0 | 21 | ..... | 4.0 | 4.3 |
| 2 | ..... | 5.4 | 3.9 | 12 | ..... | 4.4 | 4.0 | 22 | 6.8 | 4.1 | 4.1 |
| 3 | ..... | 5.4 | 4.0 | 13 | ..... | 4.4 | 4.0 | 23 | 6.6 | 4.1 | 4.0 |
| 4 | ..... | 5.1 | 4.0 | 14 | ..... | 4.4 | 4.1 | 24 | 6.5 | 4.2 | 4.1 |
| 5 | ..... | 4.9 | 3.9 | 15 | ..... | 4.4 | 4.2 | 25 | 6.2 | 4.2 | 4.0 |
| 6 | ..... | 4.8 | 4.0 | 16 | ..... | 4.2 | 4.2 | 26 | 6.0 | 4.1 | 4.1 |
| 7 | ..... | 4.7 | 4.1 | 17 | ..... | 4.2 | 4.1 | 27 | 5.9 | 4.0 | 4.0 |
| 8 | ..... | 4.7 | 4.1 | 18 | ..... | 4.2 | 4.1 | 28 | 5.8 | 4.0 | 4.1 |
| 9 | ..... | 4.5 | 4.0 | 19 | ..... | 4.1 | 4.3 | 29 | 5.8 | 4.0 | 4.3 |
| 10 | ..... | 4.4 | 4.1 | 20 | ..... | 4.1 | 4.1 | 30 | 5.7 | 4.0 | 4.2 |
| | | | | | | | | 31 | 5.6 | 4.0 | ..... |

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 the mouth of Minnesota River, in Ramsey County.

DRAINAGE AREA.—35,700 square miles.

RECORDS AVAILABLE.—March 1, 1892, to September 30, 1915. The U. S. Signal Service (later U. S. Weather Bureau) has published gage-height records since 1873; many discharge measurements made prior to 1900 by the U. S. 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 once daily to tenths, by the U. S. Weather Bureau. From 1911 to May 9, 1913, the 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, about 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 their locations.

DISCHARGE MEASUREMENTS.—Made from the Chicago, St. Paul, Minneapolis & Omaha Railway bridge 2 miles above the station.

CHANNEL AND CONTROL.—Channel somewhat shifting; no well-defined control; the banks fairly high; have not overflowed in recent years.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 10.5 feet April 5 (discharge, 31,100 second-feet); minimum stage recorded during open-water periods, 0.7 foot December 13 (discharge, 4,180 second-feet); but minimum flow during period when river was frozen over was considerably less.

1892–1915: Maximum stage recorded, 18.0 feet April 6, 1897 (discharge, 80,800 second-feet; highest known discharge occurred July 22, 1867, and amounted to 117,000 second-feet); minimum stage recorded, −0.9 foot March 22, 1896 (discharge, 1,420 second-feet).

WINTER FLOW.—Discharge relation seriously affected by ice; estimates of monthly mean flow based on the records obtained by U. S. Engineer Corps at lock and dam No. 2, below Minneapolis, allowance being made for the flow of the Minnesota River.

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

ACCURACY.—Results apparently good. The one reading a day probably does not represent the mean daily stage very accurately, although occasional additional readings have shown that it was not seriously in error. Rating curve is, however, well defined and it is believed that the possible error is but a small percentage of the total flow. Although the base data for estimating the daily flow of the river are available for years prior to 1892, the reservoir system, which has had a marked influence on the regimen of the river was then in complete operation, and it is evident that the earlier records have lost much of their value as indications of probable future flow.

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

The following discharge measurement was made by Soulé and Critchlow:
August 16, 1915: Gage height, 5.58 feet; discharge, 14,100 second-feet.

*Daily discharge, in second-feet, of Mississippi River at St. Paul, Minn., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 10,800 | 9,960 | 6,630 | | | 10,800 | 27,900 | 14,900 | 20,000 | 27,100 | 20,000 | 9,700 |
| 2 | 10,600 | 9,050 | 7,010 | | | 11,300 | 28,200 | 15,200 | 20,300 | 27,900 | 19,000 | 9,480 |
| 3 | 10,100 | 8,840 | 6,450 | | | 11,300 | 29,800 | 14,600 | 20,600 | 28,200 | 18,700 | 9,480 |
| 4 | 9,920 | 8,630 | 5,910 | | | 11,500 | 30,700 | 13,800 | 20,000 | 28,600 | 18,700 | 9,480 |
| 5 | 9,480 | 8,420 | 5,560 | | | 11,300 | 31,100 | 14,400 | 19,300 | 28,600 | 18,100 | 9,700 |
| 6 | 9,260 | 8,420 | 5,220 | | | 12,500 | 30,700 | 15,500 | 19,300 | 27,900 | 18,100 | 9,050 |
| 7 | 9,480 | 8,420 | 5,730 | | | 15,200 | 30,200 | 15,500 | 18,700 | 27,900 | 18,100 | 9,050 |
| 8 | 9,050 | 8,210 | 6,450 | | | 12,200 | 29,800 | 15,500 | 17,800 | 28,200 | 18,400 | 9,050 |
| 9 | 8,630 | 7,800 | 6,090 | | | 10,600 | 29,400 | 16,000 | 16,900 | 27,100 | 18,400 | 8,840 |
| 10 | 8,840 | 7,600 | 5,560 | | | 9,920 | 29,400 | 16,300 | 16,900 | 26,700 | 18,400 | 8,630 |
| 11 | 8,630 | 7,600 | 4,570 | | | 8,210 | 29,000 | 16,000 | 16,300 | 26,700 | 17,500 | 8,840 |
| 12 | 9,050 | 7,400 | 4,300 | | 4,350 | 7,600 | 28,200 | 15,800 | 16,300 | 26,000 | 16,900 | 8,840 |
| 13 | 9,480 | 7,600 | 4,180 | | | 7,600 | 27,900 | 15,200 | 17,200 | 25,600 | 16,300 | 8,420 |
| 14 | 10,800 | 7,800 | | | | 7,400 | 27,500 | 14,900 | 17,200 | 26,300 | 15,200 | 9,050 |
| 15 | 11,000 | 7,800 | | | | 7,010 | 27,100 | 14,400 | 18,700 | 26,300 | 14,600 | 9,260 |
| 16 | 11,500 | 7,200 | | 4,200 | | 7,200 | 26,300 | 13,800 | 20,000 | 26,300 | 13,800 | 9,700 |
| 17 | 12,000 | 5,560 | | | | 7,600 | 25,200 | 14,100 | 20,600 | 26,000 | 13,300 | 9,920 |
| 18 | 12,800 | 5,050 | | | | 8,420 | 23,700 | 14,400 | 21,000 | 25,600 | 12,800 | 9,920 |
| 19 | 13,300 | 4,720 | | | | 9,050 | 22,300 | 15,800 | 21,300 | 25,600 | 12,500 | 9,920 |
| 20 | 12,500 | 4,880 | | | | 10,100 | 21,000 | 16,600 | 21,600 | 26,300 | 12,000 | 10,600 |
| 21 | 12,500 | 4,880 | | | | 11,500 | 19,300 | 18,700 | 22,300 | 27,100 | 12,000 | 10,100 |
| 22 | 12,500 | 4,720 | 3,860 | | | 12,500 | 18,100 | 19,300 | 22,300 | 27,100 | 12,000 | 10,400 |
| 23 | 12,000 | 5,220 | | | 6,270 | 13,300 | 17,200 | 19,300 | 22,300 | 27,100 | 12,000 | 9,700 |
| 24 | 11,500 | 5,560 | | | 6,820 | 14,600 | 16,000 | 19,300 | 22,300 | 26,700 | 11,800 | 9,480 |
| 25 | 11,000 | 6,090 | | | 8,630 | 16,900 | 15,200 | 18,700 | 22,700 | 26,300 | 11,300 | 9,480 |
| 26 | 11,000 | 6,270 | | | 10,400 | 19,300 | 14,600 | 19,700 | 22,300 | 25,600 | 11,300 | 9,260 |
| 27 | 10,100 | 6,630 | | | 11,300 | 21,300 | 14,900 | 20,000 | 22,300 | 25,200 | 11,000 | 9,700 |
| 28 | 9,700 | 6,270 | | | 11,300 | 23,400 | 15,500 | 20,300 | 23,000 | 23,700 | 10,600 | 9,480 |
| 29 | 9,920 | 6,450 | | | ..... | 25,200 | 15,500 | 19,300 | 24,100 | 22,700 | 10,600 | 9,480 |
| 30 | 9,480 | 6,630 | | | ..... | 26,300 | 15,500 | 19,700 | 25,600 | 21,600 | 10,100 | 9,700 |
| 31 | 9,480 | ..... | | | ..... | 27,100 | ..... | 19,700 | ..... | 20,600 | 10,100 | ..... |

NOTE.—Discharge computed from a rating curve fairly well defined between 4,570 and 18,400 second-feet. Discharge Dec. 14 to Feb. 22, estimated, because of ice, from records of discharge at lock and dam No. 2 by U. S. Engineer Corps and the flow of the Minnesota River at Mankato; braced figures show mean discharge for period included.

*Monthly discharge of Mississippi River at St. Paul, Minn., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Accuracy. |
|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | |
| October | 13,300 | 8,630 | 10,500 | B. |
| November | 9,960 | 4,720 | 6,990 | B. |
| December | 7,010 | ..... | 4,620 | C. |
| January | ..... | ..... | 4,200 | C. |
| February | 11,300 | ..... | 5,370 | C. |
| March | 27,100 | 7,010 | 13,200 | B. |
| April | 31,100 | 14,600 | 23,900 | B. |
| May | 20,300 | 13,800 | 16,700 | B. |
| June | 25,600 | 16,300 | 20,300 | B. |
| July | 28,600 | 20,600 | 26,200 | B. |
| August | 20,000 | 10,100 | 14,600 | B. |
| September | 10,600 | 8,420 | 9,460 | B. |
| The year | 31,100 | ..... | 13,000 | |

## SANDY RIVER BELOW SANDY LAKE RESERVOIR, MINN.

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

DRAINAGE AREA.—424 square miles.

RECORDS AVAILABLE.—July 7, 1893, to Sept. 30, 1915.

GAGE.—Vertical staff.

DISCHARGE MEASUREMENTS.—No discharge measurements were made during the year.

DISCHARGE.—Computed from the flow through the openings of the dam.

EXTREMES OF DISCHARGE.—Maximum discharge recorded during year, 808 second-feet April 15; minimum discharge recorded, 5 second-feet at frequent intervals whenever the gates are closed in all about one-third of the year.

1893–1915: Maximum discharge recorded, 3,738 second-feet July 12, 1897; minimum discharge recorded, zero at frequent intervals from 1893 to 1912.

REGULATION.—The flow at the station is wholly controlled by Sandy Lake reservoir. At low stages the area of the reservoir is 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.—Results considered excellent for medium and high stages. During extreme floods the Mississippi drowns out the dam and fills Sandy Lake reservoir as much as 3 feet higher than was intended. If the Mississippi is at a fairly high stage and the dam is open, there is occasionally a slight reverse flow into the reservoir, but the amount has not been computed.

COOPERATION.—Records of discharge as published as furnished by the U. S. 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, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5 | 5 | 5 | 99 | 102 | 152 | 51 | 5 | 5 | 499 | 10 | 200 |
| 2 | 68 | 5 | 5 | 101 | 100 | 148 | 51 | 5 | 5 | 500 | 10 | 203 |
| 3 | 5 | 5 | 5 | 101 | 98 | 150 | 50 | 5 | 5 | 500 | 10 | 10 |
| 4 | 5 | 5 | 25 | 100 | 101 | 149 | 50 | 5 | 5 | 500 | 10 | 10 |
| 5 | 5 | 5 | 102 | 99 | 100 | 151 | 51 | 5 | 5 | 500 | 10 | 10 |
| 6 | 82 | 5 | 99 | 101 | 101 | 152 | 50 | 5 | 10 | 503 | 10 | 10 |
| 7 | 5 | 5 | 100 | 102 | 99 | 150 | 50 | 5 | 10 | 503 | 10 | 10 |
| 8 | 5 | 5 | 101 | 100 | 100 | 151 | 50 | 5 | 10 | 425 | 10 | 10 |
| 9 | 5 | 5 | 99 | 101 | 100 | 151 | 51 | 5 | 10 | 419 | 10 | 10 |
| 10 | 5 | 5 | 101 | 99 | 99 | 149 | 51 | 5 | 10 | 406 | 10 | 10 |
| 11 | 82 | 5 | 101 | 100 | 100 | 150 | 50 | 5 | 10 | 238 | 10 | 10 |
| 12 | 108 | 5 | 99 | 101 | 99 | 150 | 51 | 5 | 10 | 114 | 10 | 10 |
| 13 | 5 | 5 | 101 | 101 | 102 | 150 | 50 | 5 | 10 | 119 | 10 | 10 |
| 14 | 5 | 5 | 98 | 100 | 99 | 150 | 218 | 5 | 10 | 660 | 10 | 10 |
| 15 | 5 | 5 | 101 | 100 | 102 | 152 | 808 | 5 | 10 | 635 | 10 | 10 |
| 16 | 5 | 5 | 100 | 99 | 100 | 151 | 570 | 5 | 10 | 445 | 10 | 10 |
| 17 | 5 | 5 | 98 | 102 | 99 | 150 | 5 | 5 | 10 | 272 | 10 | 10 |
| 18 | 5 | 5 | 102 | 101 | 100 | 50 | 5 | 5 | 10 | 192 | 10 | 10 |
| 19 | 5 | 5 | 100 | 100 | 125 | 51 | 5 | 5 | 10 | 104 | 10 | 10 |
| 20 | 5 | 5 | 100 | 101 | 125 | 51 | 5 | 5 | 10 | 107 | 10 | 10 |
| 21 | 5 | 5 | 100 | 99 | 127 | 50 | 5 | 5 | 10 | 88 | 10 | 10 |
| 22 | 5 | 5 | 102 | 102 | 125 | 50 | 5 | 5 | 10 | 91 | 10 | 10 |
| 23 | 5 | 5 | 101 | 100 | 127 | 50 | 5 | 5 | 10 | 47 | 10 | 10 |
| 24 | 126 | 5 | 101 | 101 | 150 | 51 | 5 | 5 | 10 | 10 | 10 | 10 |
| 25 | 294 | 5 | 99 | 101 | 150 | 51 | 5 | 5 | 10 | 10 | 10 | 10 |
| 26 | 5 | 5 | 100 | 100 | 152 | 50 | 5 | 5 | 10 | 10 | 10 | 10 |
| 27 | 5 | 5 | 101 | 101 | 151 | 50 | 5 | 5 | 52 | 10 | 10 | 10 |
| 28 | 5 | 5 | 100 | 99 | 151 | 50 | 5 | 5 | 500 | 10 | 10 | 10 |
| 29 | 5 | 5 | 101 | 102 | ..... | 50 | 5 | 5 | 500 | 10 | 10 | 10 |
| 30 | 5 | 5 | 100 | 99 | ..... | 50 | 5 | 5 | 500 | 10 | 10 | 10 |
| 31 | 5 | ..... | 101 | 101 | ..... | 50 | ..... | 5 | ..... | 10 | 200 | ..... |

*Monthly discharge of Sandy River below Sandy Lake reservoir, Minn., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in millions of cubic feet.) |
|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | |
| October | 294 | 5 | 28.5 | 76.5 |
| November | 5 | 5 | 5.00 | 13.0 |
| December | 102 | 5 | 88.6 | 237 |
| January | 102 | 99 | 100 | 269 |
| February | 152 | 99 | 114 | 275 |
| March | 152 | 50 | 105 | 282 |
| April | 808 | 5 | 77.4 | 201 |
| May | 5 | 5 | 5.00 | 13.4 |
| June | 500 | 5 | 59.6 | 154 |
| July | 660 | 10 | 256 | 687 |
| August | 200 | 10 | 16.1 | 43.2 |
| September | 203 | 10 | 22.8 | 59.0 |
| The year | 808 | 5 | 73.2 | 2,310 |

NOTE.—Computed by engineers of the United States Geological Survey from daily discharge record furnished by the United States Engineer Corps.

## PINE RIVER BELOW PINE RIVER RESERVOIR, MINN.

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

DRAINAGE AREA.—452 square miles.

RECORDS AVAILABLE.—January 1, 1895, to September 30, 1915. 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 the head at the dam and from the various size openings in the dam. Discharge measurements are made about once a week to check these estimates.

EXTREMES OF DISCHARGE.—Maximum discharge during year, 520 second-feet, September 18; minimum discharge recorded, 71 second-feet, August 27 to 30.

1895–1915: Maximum discharge recorded, 1,586 second-feet, June 29, 1901; minimum discharge recorded, zero, June 8 to 15, 17, 19, and 20, 1906.

WINTER FLOW.—Estimates made as during open-water periods; see paragraph on discharge.

REGULATION.—Flow wholly controlled by Government reservoir at station. The area of the reservoir at low water is 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 raises the water in Cross, Pine, Daggett, Rush, Whitefish, Trout, and Hay lakes by varying amounts.

ACCURACY.—Results considered good.

COOPERATION.—Station maintained by United States Engineer Corps 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, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 488 | 290 | 283 | 289 | 287 | 359 | 352 | a 116 | 122 | 110 | 77 | 292 |
| 2 | 489 | 289 | 282 | a 286 | 287 | 359 | 353 | 116 | 122 | 111 | 77 | 293 |
| 3 | a 490 | 289 | 281 | 286 | 287 | 359 | a 354 | 116 | 122 | a 112 | 76 | 294 |
| 4 | 490 | 288 | 280 | 286 | 287 | 358 | 354 | 116 | 122 | 112 | 76 | a 295 |
| 5 | 490 | 288 | a 279 | 286 | 287 | 358 | 354 | 116 | a 124 | 112 | 76 | 295 |
| 6 | 491 | 287 | 279 | 286 | a 287 | a 358 | 354 | 115 | 124 | 113 | 75 | 295 |
| 7 | 491 | a 287 | 280 | 286 | 287 | 358 | 354 | 115 | 124 | 113 | a 75 | 296 |
| 8 | 492 | 287 | 281 | 286 | 287 | 359 | 355 | a 115 | 124 | 113 | 75 | 296 |
| 9 | 492 | 287 | 282 | a 287 | 287 | 359 | 355 | 115 | 123 | 113 | 75 | 296 |
| 10 | a 493 | 287 | 283 | 287 | 287 | 360 | a 355 | 115 | 123 | a 114 | 75 | 296 |
| 11 | 493 | 287 | 285 | 287 | 287 | 360 | 355 | 116 | 123 | 114 | 75 | a 297 |
| 12 | 494 | 288 | a 287 | 288 | 287 | 361 | 355 | 116 | a 123 | 114 | 75 | 508 |
| 13 | 495 | 288 | 287 | 288 | a 287 | a 361 | 356 | 118 | 122 | 75 | 75 | 510 |
| 14 | 496 | a 288 | 287 | 288 | 288 | 356 | 356 | 118 | 112 | 75 | a 75 | 512 |
| 15 | 497 | 289 | 288 | 289 | 289 | 352 | 356 | a 120 | 112 | 75 | 75 | 514 |
| 16 | 498 | 290 | 288 | a 289 | 290 | 350 | a 357 | 120 | 110 | 75 | 75 | 516 |
| 17 | a 499 | 291 | 288 | 288 | 292 | 348 | 357 | 120 | 110 | a 75 | 74 | 518 |
| 18 | 397 | 292 | 289 | 287 | 294 | 346 | 355 | 120 | 109 | 75 | 74 | a 520 |
| 19 | 395 | 293 | a 289 | 286 | 340 | 345 | 353 | 120 | a 109 | 75 | 74 | 518 |
| 20 | 392 | 294 | 289 | 285 | a 342 | a 345 | 350 | 119 | 109 | 75 | 74 | 516 |
| 21 | 250 | a 295 | 290 | 284 | 342 | 346 | 348 | 119 | 109 | 75 | a 73 | 515 |
| 22 | 248 | 294 | 290 | 283 | 343 | 347 | 347 | a 119 | 109 | 75 | 73 | 514 |
| 23 | 246 | 293 | 291 | a 283 | 344 | 348 | 346 | 119 | 109 | 75 | 73 | 513 |
| 24 | a 244 | 291 | 292 | 284 | 349 | 349 | a 344 | 119 | 109 | a 75 | 72 | 512 |
| 25 | 251 | 290 | 293 | 284 | 351 | 350 | 106 | 119 | 109 | 76 | 72 | a 511 |
| 26 | 260 | 288 | a 294 | 285 | 355 | 351 | 108 | 120 | a 108 | 76 | 72 | 511 |
| 27 | 265 | 285 | 294 | 285 | a 359 | a 353 | 110 | 120 | 108 | 76 | 71 | 508 |
| 28 | 270 | a 283 | 293 | 286 | 359 | 353 | 112 | 120 | 108 | 77 | a 71 | 505 |
| 29 | 275 | 283 | 293 | 286 | ..... | 352 | 112 | a 121 | 108 | 77 | 71 | 505 |
| 30 | 285 | 283 | 292 | a 287 | ..... | 352 | 114 | 121 | 108 | 77 | 71 | 505 |
| 31 | a 290 | ..... | 292 | 287 | ..... | 351 | ..... | 121 | ..... | a 78 | 290 | ..... |

a Discharge measurement.

*Monthly discharge of Pine River below Pine River reservoir, Minn., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Run-off (total in millions of cubic feet). |
|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | |
| October | 499 | 244 | 401 | 1,080 |
| November | 295 | 283 | 289 | 749 |
| December | 294 | 279 | 287 | 769 |
| January | 289 | 283 | 286 | 767 |
| February | 359 | 287 | 310 | 749 |
| March | 361 | 345 | 354 | 947 |
| April | 357 | 106 | 305 | 789 |
| May | 121 | 115 | 118 | 316 |
| June | 124 | 108 | 115 | 298 |
| July | 114 | 75 | 89.9 | 241 |
| August | 290 | 71 | 81.0 | 217 |
| September | 520 | 292 | 433 | 1,120 |
| The year | 520 | 71 | 255 | 8,040 |

NOTE.—Computed by engineers of the United States Geological Survey from daily discharge record furnished by the United States Engineer Corps.

CROW WING RIVER AT MOTLEY, MINN.

LOCATION.—At highway bridge at the north edge of the village of Motley, about a quarter of a mile north of the Northern Pacific Railway station and about 2 miles above the 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, 1915. The records for 1909 consist of discharge measurements and gage heights only.

GAGE.—Vertical staff in two sections; read twice daily, to quarter-tenths, by S. W. Jacobs. Lower section is attached to an old log bulkhead which constituted the abutment of a former bridge, and is about 20 feet above the upstream edge of the bridge at the left bank; upper section is attached to an old piling just back of the lower section.

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

CHANNEL AND CONTROL.—The bed of the stream is sand and gravel; fairly permanent. The banks do not overflow.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year: 8.75 feet at 6 p. m., June 29 (discharge, 4,780 second-feet); minimum open-water stage recorded, 6.25 feet, Sept. 9, 10, and 11 (discharge, 681 second-feet). A considerably lower flow occurred during December and January. Discharge measurement December 16, 1914, indicated a flow of 441 second-feet, which is probably not far from the absolute minimum for the year.

1913–1915: Maximum stage recorded, 10.3 feet at 9 a. m. June 11, 1914 (discharge, 6,940 second-feet); minimum stage recorded during open-water periods, 6.0 feet June 17 and 18, 1913 (discharge, 528 second-feet). A flow of 417 second-feet was measured by current meter on February 26, 1914; the absolute minimum was probably less than this amount.

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

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

ACCURACY.—Results considered good; channel does not shift materially. Since the establishment of the station in 1913 there has been no trouble from backwater caused by log jams.

*Discharge measurements of Crow Wing River at Motley, Minn., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Dec. 16[a] | S. B. Soulé | 6.81 | 441 | June 29 | S. B. Soulé | 8.10 | 3,420 |
| Jan. 20[a] | do | 7.28 | 520 | Sept. 16[b] | H. T. Critchlow | 6.44 | 821 |
| Mar. 28[a] | do | 8.33 | 1,340 | | | | |

[a] Made through complete ice cover.
[b] Small amount of grass in section at gage; control apparently open.

*Daily discharge, in second-feet, of Crow Wing River at Motley, Minn., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1,120 | 1,240 | | | | | | 1,240 | 1,310 | 3,830 | 1,450 | 744 |
| 2 | 1,060 | 1,240 | | | | | | 1,240 | 1,180 | 3,620 | 1,380 | 730 |
| 3 | 952 | 1,180 | | | | | | 1,450 | 1,060 | 3,420 | 1,240 | 724 |
| 4 | 905 | 1,120 | | | | | | 1,840 | 1,010 | 3,220 | 1,180 | 710 |
| 5 | 905 | 1,060 | | | | | 1,460 | 2,190 | 1,060 | 3,020 | 1,120 | 710 |
| 6 | 858 | 1,060 | | | | | | 2,460 | 1,180 | 2,920 | 1,060 | 698 |
| 7 | 858 | 1,060 | | | | | | 2,640 | 1,180 | 2,740 | 1,060 | 698 |
| 8 | 905 | 1,010 | | | | | | 2,640 | 1,180 | 2,550 | 1,010 | 687 |
| 9 | 1,060 | 1,010 | | | | | | 2,550 | 1,180 | 2,460 | 952 | 681 |
| 10 | 1,240 | 952 | | | | | 1,600 | 2,370 | 1,180 | 2,370 | 952 | 681 |
| 11 | 1,930 | 952 | | | | | 1,520 | 2,280 | 1,310 | 2,280 | 905 | 681 |
| 12 | 2,370 | 952 | | | | | 1,450 | 2,190 | 1,450 | 2,280 | 858 | 737 |
| 13 | 2,460 | 952 | | | | | 1,380 | 1,840 | 2,100 | 2,190 | 826 | 771 |
| 14 | 2,640 | 952 | | | | | 1,310 | 1,600 | 2,370 | 2,100 | 818 | 794 |
| 15 | 2,640 | 952 | | | | | 1,180 | 1,760 | 2,640 | 2,100 | 818 | 802 |
| 16 | 2,550 | | 594 | 508 | 567 | 813 | 1,180 | 2,460 | 2,830 | 2,020 | 818 | 802 |
| 17 | 2,460 | | | | | | 1,180 | 3,020 | 3,020 | 2,020 | 778 | 794 |
| 18 | 2,280 | | | | | | 1,120 | 3,620 | 3,220 | 2,020 | 751 | 786 |
| 19 | 2,190 | | | | | | 1,120 | 3,620 | 3,220 | 2,100 | 744 | 771 |
| 20 | 2,020 | | | | | | 1,060 | 3,420 | 3,220 | 2,100 | 744 | 744 |
| 21 | 1,840 | | | | | | 1,010 | 3,120 | 3,220 | 2,020 | 724 | 737 |
| 22 | 1,680 | | | | | | 1,010 | 2,920 | 3,020 | 2,020 | 724 | 710 |
| 23 | 1,600 | 869 | | | | | 952 | 2,740 | 2,830 | 1,840 | 724 | 710 |
| 24 | 1,520 | | | | | | 1,240 | 2,550 | 2,640 | 1,760 | 717 | 710 |
| 25 | 1,450 | | | | | | 1,310 | 2,370 | 2,460 | 1,600 | 710 | 710 |
| 26 | 1,450 | | | | | | 1,240 | 2,100 | 2,280 | 1,450 | 710 | 710 |
| 27 | 1,380 | | | | | | 1,240 | 1,930 | 2,460 | 1,600 | 710 | 737 |
| 28 | 1,310 | | | | | | 1,240 | 1,760 | 3,020 | 1,600 | 786 | 744 |
| 29 | 1,310 | | | | | | 1,240 | 1,600 | 4,040 | 1,520 | 794 | 751 |
| 30 | 1,310 | | | | | | 1,240 | 1,450 | 3,620 | 1,450 | 794 | 778 |
| 31 | 1,310 | ..... | | | | | ..... | 1,380 | ..... | 1,450 | 810 | ..... |

NOTE.—Discharge determined from a rating curve fairly well defined between 778 and 3,620 second-feet. Discharge, Nov. 16 to Apr. 9, estimated, because of ice, from discharge measurements, observers' notes, and weather records; braced figures show mean discharge for period included.

*Monthly discharge of Crow Wing River at Motley, Minn., for the year ending Sept. 30, 1915.*

[Drainage area, 2,140 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 2,640 | 858 | 1,600 | 0.748 | 0.86 | B. |
| November | 1,240 | ..... | 958 | .448 | .50 | C. |
| December | ..... | ..... | 594 | .278 | .32 | C. |
| January | ..... | ..... | 508 | .237 | .27 | C. |
| February | ..... | ..... | 567 | .265 | .28 | C. |
| March | ..... | ..... | 813 | .380 | .44 | C. |
| April | ..... | 952 | 1,300 | .607 | .68 | C. |
| May | 3,620 | 1,240 | 2,270 | 1.06 | 1.22 | B. |
| June | 4,040 | 1,010 | 2,220 | 1.04 | 1.16 | B. |
| July | 3,830 | 1,450 | 2,250 | 1.05 | 1.21 | B. |
| August | 1,450 | 710 | 892 | .417 | .48 | A. |
| September | 802 | 681 | 735 | .343 | .38 | A. |
| The year | 4,040 | ..... | 1,230 | .575 | 7.80 | |

LONG PRAIRIE RIVER NEAR MOTLEY, MINN.

LOCATION.—In sec. 19, T. 133 N., R. 31 W., 100 yards above the highway bridge 1 mile south of Motley, and 2 miles above the mouth of the river, in Morrison County.

DRAINAGE AREA.—973 square miles.

RECORDS AVAILABLE.—June 10, 1909, to September 30, 1915.

GAGE.—Vertical staff attached to an overhanging stump on the right bank of the river, just opposite the residence of Clem Thompson; read twice daily, morning and evening, to half-tenths, by Mrs. Clem Thompson.

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

CHANNEL AND CONTROL.—Bed of stream is light gravel and is practically permanent; left bank rather low and will overflow at extreme flood stages; right bank high and will not overflow.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 8.5 feet July 1 and 3 (discharge, 1,980 second-feet); minimum open-water stage recorded, 5.3 feet November 15, 16, and 17 (discharge, 178 second-feet). A discharge of 87 second-feet was recorded by measurement made December 17.

1909–1915: Maximum stage recorded, 9.95 feet at 6 a. m. May 6, 1912 (discharge, 2,960 second-feet); minimum stage recorded during open-water periods, 4.66 feet July 16, 17, and 19, 1911 (discharge, 47 second-feet). A flow of 39 second-feet was measured by current meter on February 27, 1914; the absolute minimum is probably about 30 second-feet.

WINTER FLOW.—Discharge relation seriously affected by ice; flow determined from discharge measurements, observer's notes, and weather records.

ACCURACY.—Rating curve well defined; results considered good; channel does not shift materially.

*Discharge measurements of Long Prairie River near Motley, Minn., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Dec. 17[a] | S. B. Soulé | 5.61 | 87 | June 30 | S. B. Soulé | 7.51 | 1,360 |
| Jan. 21[a] | do | 6.42 | 101 | Sept. 15[b] | H. T. Critchlow | 5.78 | 251 |
| Mar. 29[a] | do | 7.59 | 523 | | | | |

[a] Measurement made through ice. [b] Considerable grass in channel.

*Daily discharge, in second-feet, of Long Prairie River near Motley, Minn., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 212 | 312 | | | | | | 455 | 430 | 1,980 | 505 | |
| 2 | 172 | 312 | | | | | | 380 | 380 | 1,840 | 505 | |
| 3 | 163 | 333 | | | | | 835 | 417 | 380 | 1,980 | 505 | |
| 4 | 333 | 333 | | | | | | 455 | 380 | 1,280 | 455 | |
| 5 | 290 | 312 | | | | | | 492 | 380 | 1,220 | 455 | |
| 6 | 270 | 312 | | | | | 980 | 530 | 333 | 980 | 455 | 230 |
| 7 | 290 | 312 | | | | | 980 | 530 | 333 | 585 | 455 | |
| 8 | 333 | 290 | | | | | 920 | 530 | 333 | 380 | 455 | |
| 9 | 405 | 290 | | | | | 860 | 530 | 333 | 455 | 455 | |
| 10 | 455 | 270 | | | | | 805 | 530 | 333 | 455 | 455 | |
| 11 | 480 | 290 | | | | | 695 | 455 | 333 | 505 | 380 | |
| 12 | 480 | 290 | | | | | 640 | 380 | 333 | 505 | 380 | 240 |
| 13 | 558 | 290 | | | | | 640 | 380 | 980 | 612 | 333 | 240 |
| 14 | 585 | 290 | | | | | 585 | 380 | 980 | 668 | 333 | 240 |
| 15 | 612 | 178 | | | | | 585 | 430 | 980 | 695 | 333 | 240 |
| 16 | 640 | 178 | 75 | 100 | 100 | 280 | 585 | 980 | 980 | 722 | 333 | 240 |
| 17 | 640 | | | | | | 585 | 980 | 980 | 722 | 333 | 220 |
| 18 | 640 | | | | | | 563 | 980 | 980 | 890 | 333 | 220 |
| 19 | 612 | | | | | | 541 | 980 | 980 | 890 | 333 | 220 |
| 20 | 612 | | | | | | 519 | 980 | 980 | 890 | 290 | 220 |
| 21 | 585 | 205 | | | | | 496 | 980 | 980 | 805 | 270 | 220 |
| 22 | 558 | | | | | | 474 | 980 | 980 | 805 | 270 | 220 |
| 23 | 480 | | | | | | 452 | 920 | 980 | 805 | 270 | 220 |
| 24 | 455 | | | | | | 430 | 920 | 980 | 750 | 270 | 220 |
| 25 | 405 | 290 | | | | | 430 | 750 | 980 | 640 | 270 | 220 |
| 26 | 380 | 290 | | | | | 430 | 695 | 980 | 585 | 231 | 250 |
| 27 | 380 | 290 | | | | | 430 | 530 | 1,040 | 585 | 231 | 250 |
| 28 | 356 | 290 | | | | | 455 | 558 | 1,040 | 585 | 231 | 231 |
| 29 | 333 | 290 | | | | | 455 | 515 | 1,400 | 530 | 231 | 231 |
| 30 | 312 | 290 | | | | | 455 | 473 | 1,340 | 530 | 195 | 231 |
| 31 | 290 | ..... | | | | | ..... | 430 | ..... | 530 | 195 | ..... |

NOTE.—Discharge, except as noted below, computed from a rating curve well defined between 80 and 1,650 second-feet. Discharge estimated Nov. 17–24, Dec. 1 to Apr. 5, because of ice, from discharge measurements, gage heights, observer's notes, and weather records; Sept. 1–11 estimated on the basis of the flow of the Crow Wing River at Motley, Minn. Braced figures show mean discharge for period included. Estimates Oct. 1 to Nov. 10 and July 10 to Sept. 30 made by indirect method for shifting channel on account of backwater at the gage, caused by growth of aquatic plants in channel. Discharge interpolated Apr. 18–23, May 3–5, 11, 29, and 30.

*Monthly discharge of Long Prairie River near Motley, Minn., for the year ending Sept. 30, 1915.*

[Drainage area, 973 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 640 | 163 | 430 | 0.442 | 0.51 | B. |
| November | 333 | 178 | 266 | .273 | .30 | B. |
| December | ..... | ..... | 75 | .077 | .09 | C. |
| January | ..... | ..... | 100 | .103 | .12 | C. |
| February | ..... | ..... | 100 | .103 | .11 | C. |
| March | ..... | ..... | 280 | .288 | .33 | C. |
| April | ..... | 430 | 639 | .657 | .73 | C. |
| May | 980 | 380 | 630 | .647 | .75 | B. |
| June | 1,400 | 333 | 761 | .782 | .87 | A. |
| July | 1,980 | 380 | 819 | .842 | .97 | B. |
| August | 505 | 195 | 347 | .357 | .41 | B. |
| September | ..... | ..... | 230 | .236 | .26 | B. |
| The year | 1,980 | ..... | 391 | .402 | 5.45 | |

ELK RIVER NEAR BIG LAKE, MINN.

LOCATION.—In sec. 23, T. 33 N., R. 27 W., at the highway bridge 4 miles east of Big Lake, Sherburne County, and three-quarters of a mile north of Bailey station on the Northern Pacific and Great Northern railways, one-half 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, 1915.

GAGE.—Vertical staff gage attached to piling about 10 feet above the upstream edge of the bridge near the right bank of the river; read twice daily, to quarter-tenths, by Michael Tracy.

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

CHANNEL AND CONTROL.—Bed for the most part sand and light gravel; there is, however, a slight rapids just below the gage which constitutes the control at medium and low stages, and at which the bed is 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, increasing as the summer advances and reaching a maximum some time in September. The right bank is high and will not overflow. The left bank will 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 open-water periods, 1.96 feet at 7 a. m. July 21 (discharge, 432 second-feet); minimum discharge for open-water periods, approximately 107 second-feet September 6, at a time when the discharge relation was affected by the growth of aquatic plants obstructing the channel. It is believed that both the maximum and minimum flows occurred during the winter. A maximum stage of 2.7 feet was recorded at 8 a. m. March 27, when the river was nearly free from ice; discharge estimated at 554 second-feet; minimum flow recorded by discharge measurement made January 18, 87 second-feet, is probably not far from the minimum flow for the year.

1911–1915: Maximum stage recorded, 10.0 feet at 6.30 p. m. May 7, 1912 (discharge, 5,100 second-feet); minimum stage recorded during open-water periods, 0.22 foot July 16, 1911 (discharge, 43.4 second-feet, measured by current meter; a flow of 39 second-feet was measured by current meter on January 27, 1912.)

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

ACCURACY.—Results considered only fair, because of backwater at the gage due to growth of aquatic plants in channel.

*Discharge measurements of Elk River near Big Lake, Minn., during the year ending Sept. 30, 1915.*

[Made by S. B. Soulé.]

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Sec.-ft.* | | *Feet.* | *Sec.-ft.* |
| Oct. 14 [a] | 0.95 | 184 | June 22 [c] | 1.64 | 415 |
| Jan. 18 [b] | 1.00 | 87 | July 19 [a] | 1.84 | 403 |
| Feb. 26 [b] | 1.64 | 157 | Sept. 9 [a] | .94 | 110 |
| Apr. 24 | 1.11 | 272 | 9 [a] | .94 | 110 |

[a] Grass and weeds in section. [b] Made through complete ice cover. [c] Grass beginning to grow.

*Daily discharge, in second-feet, of Elk River near Big Lake, Minn., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 178 | 180 | | | | | 402 | 371 | 297 | 432 | 312 | 130 |
| 2 | 163 | 178 | | | | | 386 | 341 | 269 | 432 | 326 | 125 |
| 3 | 163 | 178 | | | | | 356 | 356 | 242 | 417 | 326 | 118 |
| 4 | 155 | 175 | | | | | 326 | 341 | 232 | 402 | 326 | 116 |
| 5 | 148 | 170 | | | | | 341 | 326 | 219 | 386 | 312 | 111 |
| 6 | 148 | 170 | | | | | 341 | 326 | 229 | 386 | 283 | 107 |
| 7 | 148 | 170 | | | | | 356 | 312 | 221 | 386 | 269 | 111 |
| 8 | 160 | 165 | | | | | 356 | 297 | 211 | 386 | 256 | 118 |
| 9 | 153 | 165 | | | | | 356 | 283 | 206 | 371 | 242 | 111 |
| 10 | 168 | 165 | | | | | 386 | 269 | 206 | 326 | 242 | 111 |
| 11 | 190 | 165 | | | | | 402 | 256 | 203 | 312 | 229 | 111 |
| 12 | 190 | 165 | | | | | 386 | 242 | 219 | 283 | 216 | 118 |
| 13 | 190 | 170 | | | | | 417 | 226 | 242 | 229 | 203 | 127 |
| 14 | 198 | 170 | | | | | 402 | 219 | 229 | 283 | 203 | 141 |
| 15 | 190 | 168 | | | | | 386 | 232 | 219 | 326 | 203 | 141 |
| 16 | 190 | 155 | 124 | 87 | 127 | 268 | 386 | 256 | 216 | 326 | 203 | 130 |
| 17 | 182 | | | | | | 371 | 256 | 219 | 326 | 190 | 130 |
| 18 | 182 | | | | | | 356 | 269 | 297 | 356 | 178 | 130 |
| 19 | 190 | | | | | | 356 | 269 | 356 | 402 | 178 | 127 |
| 20 | 185 | | | | | | 326 | 283 | 371 | 417 | 178 | 120 |
| 21 | 185 | | | | | | 297 | 297 | 371 | 432 | 165 | 123 |
| 22 | 178 | | | | | | 283 | 326 | 402 | 417 | 153 | 120 |
| 23 | 190 | | | | | | 283 | 326 | 432 | 402 | 153 | 116 |
| 24 | 188 | 140 | | | | | 269 | 312 | 432 | 417 | 153 | 116 |
| 25 | 182 | | | | | | 297 | 356 | 417 | 402 | 153 | 123 |
| 26 | 190 | | | | | | 326 | 371 | 402 | 402 | 153 | 118 |
| 27 | 190 | | | | | | 356 | 356 | 417 | 402 | 141 | 123 |
| 28 | 185 | | | | | | 386 | 341 | 432 | 402 | 141 | 127 |
| 29 | 185 | | | | | | 386 | 386 | 432 | 371 | 153 | 132 |
| 30 | 185 | | | | | | 371 | 371 | 432 | 341 | 153 | 136 |
| 31 | 180 | ..... | | | | | ..... | 341 | ..... | 326 | 130 | ..... |

NOTE.—Discharge determined as follows: Oct. 26 to Nov. 16, 1914, and Apr. 1 to June 30, 1915, from a fairly well defined rating curve; Oct. 1–25, 1914, and June 21 to Sept. 30, 1915, by indirect method for shifting channels as the growth of grass in channel caused backwater at the gage; Nov. 17 to Mar. 31, estimated, because of ice, from discharge measurements, observer's notes, and weather records; braced figures show mean discharge for period included.

*Monthly discharge of Elk River near Big Lake, Minn., for the year ending Sept. 30, 1915.*

[Drainage area, 615 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 198 | 148 | 178 | 0.289 | 0.33 | B. |
| November | 180 | ..... | 156 | .254 | .28 | B. |
| December | ..... | ..... | 124 | .202 | .23 | C. |
| January | ..... | ..... | 87 | .141 | .16 | C. |
| February | ..... | ..... | 127 | .207 | .22 | C. |
| March | ..... | ..... | 268 | .436 | .50 | C. |
| April | 417 | 269 | 355 | .577 | .64 | A. |
| May | 386 | 219 | 307 | .499 | .58 | A. |
| June | 432 | 203 | 302 | .491 | .55 | A. |
| July | 432 | 229 | 371 | .603 | .70 | B. |
| August | 326 | 130 | 210 | .341 | .39 | B. |
| September | 141 | 107 | 122 | .198 | .22 | B. |
| The year | 432 | ..... | 218 | .354 | 4.80 | |

CROW RIVER AT ROCKFORD, MINN.

LOCATION.—At highway bridge at Rockford, about 400 feet below the dam, not in use at present, about one-third mile below the Soo Railway bridge, and a little more than 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.

DRAINAGE AREA.—2,520 square miles.

RECORDS AVAILABLE.—June 4, 1909, to September 30, 1915.

GAGE.—Vertical staff gage attached to a piling a few feet above the right end of the bridge; read twice daily, morning and evening, to hundredths, by George W. Florida.

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

CHANNEL AND CONTROL.—Bed of stream for most part heavy gravel; practically permanent. The banks do not overflow except during extreme floods.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 10.4 feet, March 31 (discharge, 4,030 second-feet); minimum stage recorded during open-water periods, 5.4 feet November 25, September 9–11, 24, and 25 (discharge 300 second-feet). A flow of 85 second-feet was measured by current meter on January 30. The absolute minimum was probably about 30 second-feet and occurred in February.

1909–1915: Maximum stage recorded, 10.7 feet March 15, 1910 (discharge, 4,300 second-feet); minimum stage recorded during open-water periods, 4.55 feet January 29 and February 5, 1911 (discharge, 34 second-feet). The absolute minimum is probably about 30 second-feet and occurred in February, 1915.

WINTER FLOW.—Seriously affected by ice; flow estimated from discharge measurements, observer's notes, and weather records. 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, and the regulation at the various points is so slight that no appreciable effect of their operation is observed at the gage. The dam immediately above the gage was partly destroyed May 31, 1911, and has not since been repaired.

ACCURACY.—Though conditions in the channel are fairly permanent the erratic plotting of discharge measurements made below 800 second-feet do not warrant an accuracy rating of better than fair for low and medium stages. All monthly means above 800 second-feet are considered excellent.

*Discharge measurements of Crow River at Rockford, Minn., during the year ending Sept. 30, 1915.*

[Made by S. B. Soulé.]

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Sec.-ft.* | | *Feet.* | *Sec.-ft.* |
| Oct. 16 | 6.38 | 793 | July 8 [b] | 7.45 | 1,430 |
| Jan. 30 [a] | 5.30 | 85 | 8 | 7.43 | 1,420 |
| Feb. 27 [a] | 6.94 | 548 | Aug. 31 [c] | 5.72 | 593 |
| Apr. 23 | 6.79 | 1,090 | | | |

[a] Made through complete ice cover; control partly covered with ice.
[b] Small amount of grass and few snags in channel below gage.
[c] Control section clear, but accuracy of measurement low, because measuring section is unfavorable for obtaining good results at this stage.

*Daily discharge, in second-feet, of Crow River at Rockford, Minn., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 785 | 472 | 370 | | | | 3,670 | 965 | 1,640 | 1,640 | 1,160 | 420 |
| 2 | 725 | 472 | 370 | | | | 2,770 | 1,030 | 1,570 | 1,640 | 1,220 | 395 |
| 3 | 665 | 472 | 345 | | | | 2,190 | 1,100 | 1,430 | 1,640 | 1,360 | 395 |
| 4 | 665 | 445 | 345 | | | | 2,030 | 1,100 | 1,220 | 1,570 | 1,500 | 370 |
| 5 | 610 | 420 | 370 | | | | 1,950 | 1,100 | 1,160 | 1,430 | 1,640 | 345 |
| 6 | 638 | 420 | 395 | | | | 1,870 | 1,100 | 1,100 | 1,500 | 1,710 | 345 |
| 7 | 583 | 395 | 345 | | | | 1,710 | 1,100 | 965 | 1,570 | 1,710 | 332 |
| 8 | 583 | 395 | 370 | | | | 1,710 | 1,030 | 965 | 1,500 | 1,640 | 309 |
| 9 | 555 | 395 | 395 | | | | 1,950 | 1,030 | 905 | 1,430 | 1,570 | 300 |
| 10 | 583 | 370 | | | | | 2,110 | 965 | 845 | 1,430 | 1,500 | 300 |
| 11 | 610 | 345 | | | | | 2,110 | 965 | 815 | 1,360 | 1,360 | 300 |
| 12 | 638 | 345 | | | | | 2,030 | 905 | 875 | 1,360 | 1,220 | 304 |
| 13 | 725 | 345 | | | | | 1,950 | 845 | 965 | 1,290 | 1,100 | 332 |
| 14 | 785 | 327 | | | | | 1,950 | 815 | 1,030 | 1,500 | 905 | 370 |
| 15 | 845 | | | | | | 1,950 | 785 | 1,100 | 1,950 | 905 | 420 |
| 16 | 845 | | | 137 | 137 | 1,290 | 1,790 | 785 | 1,160 | 2,110 | 905 | 395 |
| 17 | 815 | | | | | | 1,500 | 845 | 1,220 | 2,190 | 965 | 395 |
| 18 | 785 | | | | | | 1,870 | 875 | 1,430 | 2,110 | 875 | 370 |
| 19 | 725 | | | | | | 1,500 | 905 | 1,430 | 2,110 | 785 | 345 |
| 20 | 695 | 300 | 246 | | | | 1,360 | 965 | 1,500 | 2,030 | 755 | 345 |
| 21 | 665 | | | | | | 1,160 | 965 | 1,570 | 1,950 | 725 | 327 |
| 22 | 665 | | | | | | 1,160 | 965 | 1,500 | 1,870 | 725 | 322 |
| 23 | 665 | | | | | | 1,100 | 905 | 1,710 | 1,790 | 665 | 314 |
| 24 | 638 | | | | | | 1,030 | 905 | 1,640 | 1,710 | 638 | 300 |
| 25 | 610 | 300 | | | | | 1,030 | 965 | 1,640 | 1,710 | 610 | 300 |
| 26 | 555 | 309 | | | | | 1,030 | 1,100 | 1,640 | 1,640 | 610 | 318 |
| 27 | 555 | 309 | | | | | 1,100 | 1,360 | 1,640 | 1,640 | 583 | 340 |
| 28 | 528 | 345 | | | | | 1,030 | 1,570 | 1,710 | 1,500 | 555 | 345 |
| 29 | 528 | 345 | | | | | 1,030 | 1,640 | 1,710 | 1,430 | 528 | 370 |
| 30 | 500 | 370 | | | | | 1,030 | 1,790 | 1,710 | 1,360 | 500 | 610 |
| 31 | 472 | ..... | | | | 4,030 | ..... | 1,790 | ..... | 1,220 | 445 | ..... |

NOTE.—Discharge computed from a rating curve poorly defined below and well defined above 800 second-feet. Discharge Nov. 15–24 and Dec. 10 to Mar. 30, estimated, because of ice, from discharge measurements, observer's notes, and weather records; braced figures show mean discharge for period included.

*Monthly discharge of Crow River at Rockford, Minn., for the year ending Sept. 30, 1915.*

[Drainage area, 2,520 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 845 | 472 | 653 | 0.259 | 0.30 | B. |
| November | 472 | ..... | 353 | .140 | .16 | C. |
| December | 395 | ..... | 281 | .112 | .13 | C. |
| January | ..... | ..... | 137 | .054 | .06 | C. |
| February | ..... | ..... | 137 | .054 | .06 | C. |
| March | 4,030 | ..... | 1,380 | .548 | .63 | C. |
| April | 3,670 | 1,030 | 1,690 | .671 | .75 | A. |
| May | 1,790 | 785 | 1,070 | .425 | .49 | A. |
| June | 1,710 | 815 | 1,330 | .528 | .59 | A. |
| July | 2,190 | 1,220 | 1,650 | .655 | .76 | A. |
| August | 1,710 | 445 | 1,010 | .401 | .46 | B. |
| September | 610 | 300 | 354 | .140 | .16 | C. |
| The year | 4,030 | ..... | 842 | .334 | 4.55 | |

MINNESOTA RIVER NEAR MONTEVIDEO, MINN.

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

DRAINAGE AREA.—6,300 square miles.

RECORDS AVAILABLE.—July 23, 1909, to September 30, 1915.

GAGE.—Chain gage attached to upstream hand rail of the bridge near the left bank; read twice daily, morning and evening, to quarter-tenths, by Ben O. Brown. Datum of gage lowered 2 feet September 16, 1909, and 1 foot additional July 29, 1910, to avoid negative readings. All gage heights referred to latest datum.

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

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

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 11.1 feet at 5.30 p. m. July 22 (discharge, 3,160 second-feet); minimum stage recorded during open-water periods, 3.5 feet, November 16 (discharge 314 second-feet). A flow of 114 second-feet was measured by current meter on January 23; the absolute minimum was probably somewhat lower.

1909–1915: Maximum stage recorded, approximately 14 feet May 7, 1912 (discharge about 6,300 second-feet based upon high-water measurements made in April, 1916); mean discharge for this date should be about 5,900 second-feet instead of 4,000 second-feet as published in Water-Supply Paper 325, page 103. The discharge for a few succeeding days as published in that report is probably somewhat too low. Minimum stage recorded during open water, 1.36 feet July 29 and August 4, 1911 (discharge, 25 second-feet). A flow of 6.8 second-feet was measured by current meter on February 9, 1912.

WINTER FLOW.—Seriously affected by ice; flow estimated from discharge measurements, observer's notes, and weather records.

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

ACCURACY.—Results are considered good; channel permanent; curve is well defined.

*Discharge measurements of Minnesota River near Montevideo, Minn., during the year ending Sept. 30, 1915.*

[Made by S. B. Soulé.]

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Sec.-ft.* | | *Feet.* | *Sec.-ft.* |
| Dec. 19[a] | 3.90 | 233 | July 22 | 11.06 | 3,240 |
| Jan. 23[a] | 3.53 | 114 | Aug. 21 | 6.38 | 1,150 |
| Mar. 31[b] | 11.09 | 2,290 | | | |

[a] Made through complete ice cover.
[b] Open at gage; control partly ice-covered.

*Daily discharge, in second-feet, of Minnesota River near Montevideo, Minn., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 568 | 648 | | | | | | 1,570 | 1,490 | 1,870 | 2,460 | 817 |
| 2 | 542 | 675 | | | | | 2,520 | 1,530 | 1,410 | 1,920 | 2,410 | 759 |
| 3 | 490 | 731 | | | | | | 1,570 | 1,380 | 1,960 | 2,320 | 731 |
| 4 | 442 | 648 | | | | | | 1,530 | 1,300 | 1,960 | 2,280 | 731 |
| 5 | 466 | 568 | | | | | 2,510 | 1,380 | 1,230 | 1,960 | 2,180 | 621 |
| 6 | 466 | 466 | | | | | 2,410 | 1,920 | 1,230 | 1,920 | 2,100 | 703 |
| 7 | 442 | 442 | | | | | 2,320 | 1,920 | 1,200 | 1,920 | 2,050 | 648 |
| 8 | 466 | 542 | | | | | 2,280 | 1,920 | 1,200 | 1,870 | 1,960 | 675 |
| 9 | 466 | 568 | | | | | 2,280 | 2,000 | 1,130 | 1,870 | 1,870 | 621 |
| 10 | 466 | 542 | | | | | 2,320 | 1,920 | 1,030 | 1,870 | 1,780 | 621 |
| 11 | 542 | 568 | | | | | 2,360 | 1,780 | 1,020 | 1,820 | 1,690 | 594 |
| 12 | 648 | 542 | | | | | 2,360 | 1,690 | 1,030 | 1,780 | 1,610 | 594 |
| 13 | 703 | 542 | | | | | 2,320 | 1,650 | 1,030 | 1,690 | 1,530 | 621 |
| 14 | 759 | 516 | | | | | 2,230 | 1,650 | 1,030 | 1,820 | 1,450 | 594 |
| 15 | 759 | 466 | | | | | 2,180 | 1,610 | 998 | 2,660 | 1,380 | 621 |
| 16 | 788 | 314 | 255 | 127 | 218 | 943 | 2,140 | 1,530 | 967 | 2,760 | 1,340 | 568 |
| 17 | 788 | | | | | | 2,100 | 1,570 | 967 | 2,910 | 1,300 | 675 |
| 18 | 817 | | | | | | 1,960 | 1,530 | 1,100 | 3,010 | 1,200 | 703 |
| 19 | 846 | | | | | | 1,960 | 1,490 | 1,200 | 3,110 | 1,160 | 648 |
| 20 | 846 | | | | | | 1,870 | 1,410 | 1,270 | 3,110 | 1,130 | 675 |
| 21 | 846 | | | | | | 1,820 | 1,490 | 1,340 | 3,110 | 1,060 | 703 |
| 22 | 817 | | | | | | 1,740 | 1,480 | 1,340 | 3,160 | 998 | 648 |
| 23 | 788 | | | | | | 1,650 | 1,470 | 1,340 | 3,110 | 998 | 648 |
| 24 | 788 | 363 | | | | | 1,570 | 1,460 | 1,380 | 3,060 | 967 | 675 |
| 25 | 788 | | | | | | 1,570 | 1,450 | 1,410 | 3,010 | 876 | 648 |
| 26 | 788 | | | | | | 1,610 | 1,490 | 1,410 | 2,910 | 876 | 621 |
| 27 | 675 | | | | | | 1,570 | 1,490 | 1,450 | 2,810 | 846 | 621 |
| 28 | 703 | | | | | | 1,690 | 1,570 | 1,570 | 2,710 | 846 | 621 |
| 29 | 731 | | | | | | 1,610 | 1,530 | 1,690 | 2,610 | 876 | 648 |
| 30 | 731 | | | | | | 1,530 | 1,530 | 1,780 | 2,510 | 906 | 648 |
| 31 | 731 | ..... | | | | | ..... | 1,490 | ..... | 2,460 | 846 | ..... |

NOTE.—Discharge computed from a rating curve well defined between 314 and 3,160 second-feet. Discharge Nov. 17 to Apr. 4 estimated, because of ice, from discharge measurements, observer's notes, and weather records; braced figures show mean discharge for period included. Discharge interpolated May 22–24.

*Monthly discharge of Minnesota River near Montevideo, Minn., for the year ending Sept. 30, 1915.*

[Drainage area, 6,300 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 846 | 442 | 668 | 0.106 | 0.12 | A. |
| November | 731 | ..... | 462 | .073 | .08 | B. |
| December | ..... | ..... | 255 | .040 | .05 | C. |
| January | ..... | ..... | 127 | .020 | .02 | C. |
| February | ..... | ..... | 218 | .035 | .04 | C. |
| March | ..... | ..... | 943 | .150 | .17 | C. |
| April | ..... | 1,530 | 2,070 | .329 | .37 | B. |
| May | 2,000 | 1,380 | 1,600 | .254 | .29 | A. |
| June | 1,780 | 967 | 1,260 | .200 | .22 | A. |
| July | 3,160 | 1,690 | 2,430 | .386 | .44 | A. |
| August | 2,460 | 846 | 1,460 | .232 | .27 | A. |
| September | 817 | 594 | 657 | .104 | .12 | A. |
| The year | 3,160 | ..... | 1,020 | .162 | 2.19 | |

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, 1915.

GAGE.—Chain gage on the right bank of the river, about 1,000 feet below mouth of Blue Earth River; read once daily, to tenths, by Clarence Staley, observer for the 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 U. S. Engineer Corps.

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

CHANNEL AND CONTROL.—Bed of stream is of sand and light gravel; fairly permanent except during high stage; banks fairly high and do not overflow except for stages above gage height of 15 feet; no well-defined control.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 14.6 feet March (discharge, 23,100 second-feet); minimum stage recorded during open-water periods, 1.4 feet December 14 and 15 (discharge, 520 second-feet). A flow of 289 second-feet which is probably very close to the actual minimum for the year, was measured by current meter January 28.

1903–1915: 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 of this river occurred in 1881, and is shown in Mankato by a well-marked line, which was approximately 27 feet above the zero of the present gage. This stage is corroborated by Mr. M. B. Haynes, city engineer of Mankato, who states that the high water occurred after the ice went out, and was not caused by backwater. The corresponding discharge would be approximately 65,000 second-feet.

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

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 the 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 over 1 foot.

ACCURACY.—Results can not be considered better than fair; channel is somewhat shifting. The gage is read only once a day, to tenths, and does not represent accurately the mean daily stage on account of the diurnal fluctuation due to the regulation of the Blue Earth.

COOPERATION.—Since 1906 gage height record has been furnished by the U. S. Weather Bureau.

*Discharge measurements of Minnesota River near Mankato, Minn., during the year ending Sept. 30, 1915.*

[Made by S. B. Soulé.]

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Sec.-ft.* | | *Feet.* | *Sec.-ft.* |
| Dec. 2 [a] | 2.01 | 877 | July 16 [a] | 7.66 | 7,540 |
| Jan. 28 [b] | 1.87 | 289 | Aug. 19 [a] | 6.64 | 5,600 |

[a] Made from highway bridge in Mankato about 2 miles below gage.
[b] Made from ice 500 feet below gage.

*Daily discharge, in second-feet, of Minnesota River at Mankato, Minn., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1,010 | 1,220 | 815 | | | 7,890 | 20,300 | 4,010 | 8,460 | 8,270 | 6,640 | 4,010 |
| 2 | 945 | 1,150 | 880 | | | 6,470 | 19,500 | 3,300 | 7,890 | 7,890 | 6,310 | 4,400 |
| 3 | 880 | 1,150 | 815 | | | 6,310 | 18,600 | 3,760 | 7,340 | 7,160 | 6,810 | 3,760 |
| 4 | 880 | 1,080 | 815 | | | 5,830 | 17,600 | 4,670 | 6,640 | 6,640 | 6,310 | 3,410 |
| 5 | 815 | 1,050 | 815 | | | 5,830 | 16,200 | 4,010 | 6,470 | 6,310 | 7,700 | 3,300 |
| 6 | 815 | 1,080 | 690 | | | 5,830 | 15,900 | 3,760 | 6,810 | 5,990 | 9,050 | 3,080 |
| 7 | 750 | 1,010 | 690 | | | 5,830 | 14,700 | 5,530 | 7,160 | 6,470 | 10,500 | 2,980 |
| 8 | 815 | 1,010 | 690 | | | 5,380 | 15,500 | 4,370 | 6,470 | 7,890 | 10,900 | 2,680 |
| 9 | 815 | 1,010 | 630 | | | 4,010 | 15,000 | 4,140 | 5,990 | 7,520 | 9,650 | 2,480 |
| 10 | 815 | 1,010 | 630 | | | 3,760 | 15,200 | 3,640 | 6,150 | 9,850 | 9,050 | 2,580 |
| 11 | 750 | 1,150 | 570 | | | 3,190 | 14,300 | 4,140 | 5,830 | 9,250 | 7,160 | 2,380 |
| 12 | 815 | 1,150 | 570 | | | 2,880 | 13,500 | 4,400 | 6,470 | 9,650 | 6,470 | 2,100 |
| 13 | 815 | 1,080 | 570 | | | 2,880 | 13,100 | 4,010 | 6,640 | 8,850 | 5,990 | 2,280 |
| 14 | 815 | 1,080 | 520 | | | 2,580 | 12,200 | 3,640 | 7,340 | 8,460 | 6,310 | 2,580 |
| 15 | 1,750 | 1,010 | 520 | | | 2,380 | 11,100 | 3,410 | 6,810 | 7,700 | 5,990 | 2,680 |
| 16 | 2,580 | 1,010 | | 310 | 2,200 | 2,100 | 10,900 | 3,520 | 6,810 | 7,700 | 6,150 | 2,580 |
| 17 | 2,780 | 750 | | | | 2,280 | 9,850 | 2,880 | 5,230 | 7,160 | 5,830 | 2,780 |
| 18 | 2,680 | 570 | | | | 4,010 | 8,850 | 3,080 | 5,090 | 8,270 | 5,530 | 2,980 |
| 19 | 2,680 | 520 | | | | 5,680 | 8,270 | 2,680 | 5,090 | 11,100 | 4,950 | 3,880 |
| 20 | 2,480 | 520 | | | | 6,980 | 7,340 | 2,660 | 4,950 | 10,700 | 5,230 | 4,140 |
| 21 | 2,100 | 690 | | | | 8,460 | 6,810 | 2,880 | 4,670 | 12,000 | 4,950 | 3,640 |
| 22 | 1,750 | 750 | | | | 9,050 | 5,230 | 2,680 | 4,950 | 12,400 | 4,950 | 3,190 |
| 23 | 1,510 | 690 | | | | 10,500 | 5,230 | 2,680 | 4,950 | 11,800 | 4,810 | 2,580 |
| 24 | 2,190 | 690 | 510 | | | 13,500 | 5,090 | 2,680 | 5,230 | 11,100 | 4,670 | 2,680 |
| 25 | 2,190 | 690 | | | | 18,600 | 4,810 | 3,640 | 4,670 | 10,700 | 4,400 | 2,880 |
| 26 | 1,750 | 690 | | | | 19,800 | 3,520 | 4,400 | 5,090 | 9,850 | 4,810 | 2,980 |
| 27 | 1,750 | 690 | | | | 20,500 | 3,880 | 4,400 | 5,530 | 10,300 | 4,670 | 2,680 |
| 28 | 1,590 | 630 | | | | 23,100 | 4,530 | 4,950 | 5,830 | 10,000 | 4,950 | 2,580 |
| 29 | 1,360 | 750 | | | | 22,700 | 4,670 | 5,530 | 8,080 | 8,850 | 4,670 | 2,680 |
| 30 | 1,430 | 815 | | | | 21,900 | 4,270 | 6,810 | 9,450 | 7,160 | 4,400 | 2,480 |
| 31 | 1,510 | ..... | | | | 21,700 | ..... | 8,650 | ..... | 7,160 | 4,140 | ..... |

NOTE.—Discharge computed from a rating curve fairly well defined between 877 and 7,540 second-feet. Indirect method for shifting channels used for Oct. 1 to Nov. 25. Discharge Dec. 16 to Feb. 28, estimated, because of ice, from discharge measurements, observer's notes, and weather records; braced figures show mean discharge for period included.

*Monthly discharge of Minnesota River at Mankato, Minn., for the year ending Sept. 30, 1915.*

[Drainage area, 14,600 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 2,780 | 750 | 1,480 | 0.101 | 0.12 | C. |
| November | 1,220 | 520 | 891 | .061 | .07 | C. |
| December | 880 | ..... | 593 | .041 | .05 | C. |
| January | ..... | ..... | 310 | .021 | .02 | C. |
| February | ..... | ..... | 2,200 | .151 | .16 | D. |
| March | 23,100 | 2,100 | 9,090 | .623 | .72 | C. |
| April | 20,300 | 3,520 | 10,900 | .747 | .83 | C. |
| May | 8,650 | 2,680 | 4,040 | .277 | .32 | C. |
| June | 9,450 | 4,670 | 6,270 | .429 | .48 | C. |
| July | 12,400 | 5,990 | 8,840 | .605 | .70 | C. |
| August | 10,900 | 4,140 | 6,260 | .429 | .49 | C. |
| September | 4,400 | 2,100 | 2,980 | .204 | .23 | C. |
| The year | 23,100 | ..... | 4,500 | .308 | 4.19 | |

## LAC QUI PARLE RIVER AT LAC QUI PARLE, MINN.

LOCATION.—In sec. 26, T. 118 N., R. 42 W., at the highway bridge at Lac Qui Parle, in Lac Qui Parle County, a short distance above mouth of Threemile Creek.

DRAINAGE AREA.—838 square miles.

RECORDS AVAILABLE.—April 27, 1910, to November 15, 1914, when station was discontinued.

GAGE.—Vertical staff gage bolted to downstream Cushing Bridge pier supporting the right end of the bridge; read daily, mornings, to quarter-tenths, by Chas. A. Gould.

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

CHANNEL AND CONTROL.—Bed of stream consists of gravel; shifts slightly during flood stages. There is a fairly well-defined low-water control a short distance below the gage. At and above the gage the banks are high and do not overflow; below the gage, in the vicinity of the control, the banks are low and overflow during high water.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 1.25 feet October 16 and 17 (discharge, 42 second-feet); minimum stage recorded, 0.55 foot October 1 (discharge, 4 second-feet).

1910–1914: Maximum stage recorded, 7.6 feet May 5 and 6, 1912; discharge, 1,550 second-feet; minimum stage recorded during open-water periods: 0.25 foot October 4, 1913 (discharge, 0.2 second-foot); a flow of 0.1 second-foot was measured February 22, 1913.

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

REGULATION.—At Dawson, about 10 miles above the station, a dam about 8 feet high, which impounds considerable water, was constructed during the late summer of 1913. Probably the extreme low stage of last part of September and the first part of October, 1913, is due to the retention of water to fill this reservoir, but no further regulation is contemplated at this dam, and no other dams control the flow.

ACCURACY.—Results considered fair, owing to shifting of channel and the fact that the rating curve is only fairly well defined.

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

*Daily discharge, in second-feet, of Lac Qui Parle River at Lac Qui Parle, Minn., for the period Oct. 1 to Nov. 15, 1914.*

| Day. | Oct. | Nov. | Day. | Oct. | Nov. | Day. | Oct. | Nov. |
|---|---|---|---|---|---|---|---|---|
| 1 | 4 | 22 | 11 | 8 | 15 | 21 | 32 | |
| 2 | 6 | 20 | 12 | 22 | 15 | 22 | 31 | |
| 4 | 6 | 20 | 13 | 34 | 15 | 23 | 30 | |
| 4 | 5 | 20 | 14 | 37 | 15 | 24 | 28 | |
| 5 | 6 | 19 | 15 | 38 | 6 | 25 | 28 | |
| 6 | 5 | 18 | 16 | 42 | | 26 | 25 | |
| 7 | 4 | 16 | 17 | 42 | | 27 | 25 | |
| 8 | 4 | 16 | 18 | 39 | | 28 | 25 | |
| 9 | 4 | 16 | 19 | 38 | | 29 | 24 | |
| 10 | 8 | 16 | 20 | 34 | | 30 | 22 | |
| | | | | | | 31 | 24 | |

NOTE.—Discharge computed from a rating curve fairly well defined between 14 and 678 second-feet and fairly well defined below 14 second-feet.

*Monthly discharge of Lac Qui Parle River at Lac Qui Parle, Minn., for the period Oct. 1 to Nov. 15, 1914.*

[Drainage area, 838 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 42 | 4 | 21.9 | 0.261 | 0.30 | B. |
| November 1–15 | 22 | 6 | 16.6 | .198 | .11 | B. |

CHIPPEWA RIVER NEAR WATSON, MINN.

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

DRAINAGE AREA.—1,940 square miles.

RECORDS AVAILABLE.—April 27, 1910, to September 30, 1915. From July 6 to September 17, 1909, four discharge measurements were made at the station.

GAGE.—Chain gage attached to downstream side of the bridge, near left bank of river; read once daily in the afternoon, to hundredths, 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. The 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, 12.9 feet July 18 (discharge, 2,260 second-feet); minimum stage recorded, 5.9 feet December 11 (discharge, 225 second-feet).

1910–1915: Maximum stage recorded, 13.5 feet July 2, 1914 (discharge, 2,660[1] second-feet); minimum stage recorded during open-water periods, 3.90 feet August 7, 8, and 9, 1910 (discharge, 11 second-feet); discharge for a stage of 3.95 feet July 30, 1911, was only 6 second-feet, due to a shift in the control. A flow of 1.7 second-feet was measured by current meter February 9, 1912.

[1] Differs from the maximum published in Water-Supply Paper 385, p. 102, because of a revision of the rating curve due to additional highwater discharge measurements obtained in 1915.

WINTER FLOW.—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 working under an 8-foot head at Hagan, but this dam is out present so that the flow is natural.

ACCURACY.—Results good.

*Discharge measurements of Chippewa River near Watson, Minn., during the year ending Sept. 30, 1915.*

[Made by S. B. Soulé.]

| Date. | Gage height. | Discharge. |
|---|---|---|
| | *Feet.* | *Sec.-ft.* |
| July 21 | 12.61 | 2,120 |
| Aug. 20 | 7.62 | 480 |

*Daily discharge, in second-feet, of Chippewa River near Watson, Minn., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 297 | 342 | 312 | ..... | 604 | 691 | 1,120 | 1,340 | 374 |
| 2 | 297 | 327 | 312 | ..... | 584 | 646 | 1,150 | 1,310 | 358 |
| 3 | 282 | 312 | 297 | ..... | 604 | 584 | 1,150 | 1,310 | 358 |
| 4 | 282 | 297 | 297 | ..... | 691 | 545 | 1,120 | 1,210 | 358 |
| 5 | 267 | 312 | 297 | 668 | 738 | 508 | 1,060 | 1,180 | 358 |
| 6 | 239 | 358 | 312 | 604 | 738 | 526 | 1,030 | 1,120 | 342 |
| 7 | 239 | 327 | 297 | 564 | 738 | 490 | 1,030 | 1,060 | 342 |
| 8 | 239 | 312 | 282 | 545 | 691 | 473 | 972 | 972 | 334 |
| 9 | 239 | 297 | 267 | 564 | 646 | 439 | 945 | 918 | 327 |
| 10 | 312 | 297 | 239 | 646 | 646 | 422 | 945 | 891 | 312 |
| 11 | 422 | 297 | 225 | 668 | 625 | 406 | 891 | 838 | 297 |
| 12 | 439 | 282 | ..... | 564 | 604 | 374 | 838 | 787 | 297 |
| 13 | 439 | 282 | ..... | 564 | 564 | 390 | 787 | 738 | 312 |
| 14 | 456 | 267 | ..... | 668 | 545 | 390 | 1,960 | 691 | 342 |
| 15 | 473 | 253 | ..... | 668 | 526 | 374 | 2,010 | 646 | 358 |
| 16 | 490 | ..... | ..... | 646 | 526 | 374 | 2,110 | 604 | 358 |
| 17 | 508 | ..... | ..... | 646 | 564 | 374 | 2,160 | 584 | 358 |
| 18 | 508 | ..... | ..... | 625 | 526 | 456 | 2,260 | 564 | 374 |
| 19 | 508 | ..... | ..... | 604 | 526 | 584 | 2,160 | 526 | 374 |
| 20 | 490 | ..... | ..... | 604 | 526 | 625 | 2,160 | 490 | 358 |
| 21 | 490 | ..... | ..... | 564 | 526 | 646 | 2,110 | 490 | 342 |
| 22 | 473 | ..... | ..... | 545 | 526 | 691 | 2,060 | 456 | 327 |
| 23 | 456 | ..... | ..... | 526 | 526 | 691 | 1,960 | 456 | 320 |
| 24 | 422 | ..... | ..... | 564 | 526 | 714 | 1,910 | 439 | 312 |
| 25 | 422 | ..... | ..... | 604 | 545 | 738 | 1,810 | 422 | 312 |
| 26 | 406 | ..... | ..... | 584 | 646 | 691 | 1,710 | 406 | 312 |
| 27 | 390 | ..... | ..... | 584 | 691 | 787 | 1,620 | 390 | 327 |
| 28 | 374 | ..... | ..... | 604 | 691 | 891 | 1,540 | 422 | 327 |
| 29 | 358 | ..... | ..... | 625 | 691 | 1,000 | 1,460 | 406 | 327 |
| 30 | 358 | 312 | ..... | 604 | 714 | 1,060 | 1,380 | 406 | 342 |
| 31 | 358 | ..... | ..... | ..... | 714 | ..... | 1,380 | 390 | ..... |

NOTE.—Discharge determined from a well-defined rating curve. Discharge relation affected by ice observations discontinued Nov. 16–29, 1914, and Dec. 12, 1914, to Apr. 4, 1915. Discharge Nov. 16–29 estimated at 280 second-feet. Discharge interpolated July 28, Sept. 8, and Sept. 23.

*Monthly discharge of Chippewa River near Watson, Minn., for the year ending Sept. 30, 1915.*

[Drainage area, 1,940 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 508 | 239 | 385 | 0.198 | 0.23 | A. |
| November | 358 | ..... | 293 | .151 | .17 | C. |
| December 1-11 | ..... | ..... | 285 | .147 | .06 | B. |
| April 5-30 | ..... | ..... | 602 | .310 | .30 | A. |
| May | 738 | 526 | 613 | .316 | .36 | A. |
| June | 1,060 | 374 | 586 | .302 | .34 | A. |
| July | 2,260 | 787 | 1,510 | .778 | .90 | A. |
| August | 1,340 | 390 | 725 | .374 | .43 | A. |
| September | 374 | 297 | 338 | .174 | .19 | A. |

ST. CROIX RIVER AT SWISS, WIS.

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

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

RECORDS AVAILABLE.—March 20, 1914, to September 30, 1915.

GAGE.—Cast-iron staff gage bolted to iron post at left end of bridge; read morning and evening, to quarter-tenths, by Capt. Richard Goldschmiedt. In August the iron post was replaced by a concrete pier, on which the gage was placed August 31.

DISCHARGE MEASUREMENTS.—Made from upstream side of bridge.

CHANNEL AND CONTROL.—Gravel, smooth; aquatic plants during summer months cause a small amount of backwater at the gage. Right bank high and not subject to overflow; left bank of medium height and may possibly overflow during extreme high water.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 4.4 feet at 6.35 p. m. June 19 (discharge, 4,500 second-feet); minimum discharge, 827 second-feet, recorded by discharge measurement made January 25.

1914–1915: Maximum stage recorded, 4.4 feet at 6.35 p. m. June 19, 1915 (discharge, 4,500 second-feet); minimum discharge, 754 second-feet, recorded by measurement made March 13, 1914. The absolute minimum occurs during the winter period and is not accurately determinable.

WINTER FLOW.—Discharge relation seriously affected by ice; flow determined from discharge measurements, observer's notes, and weather records.

ACCURACY.—Rating curve well defined over limits covered by gage readings. No diurnal fluctuation. Some uncertainty exists as to the permanency of conditions of channel and effect of plant growth, so that open-water records for part of the year are only fair.

*Discharge measurements of St. Croix River at Swiss, Wis., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Nov. 6 | S. B. Soulé | 1.05 | 1,040 | Mar 11[a] | H. C. Beckman | 2.75 | 913 |
| Jan. 25[a] | do | 2.18 | 827 | May 6 | S. B. Soulé | 2.34 | 2,050 |
| Feb. 12[a] | H. C. Beckman | 2.46 | 842 | Aug. 31 | H. T. Critchlow | .94 | 901 |

[a] Made under complete ice cover.

*Daily discharge, in second-feet, of St. Croix River at Swiss, Wis., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1,200 | 1,070 | | | | | 1,820 | 1,820 | 1,570 | 1,730 | 1,010 | 880 |
| 2 | 1,160 | 1,070 | | | | | 1,040 | 1,730 | 1,490 | 1,650 | 1,010 | 865 |
| 3 | 1,130 | 1,040 | | | | | 1,130 | 1,920 | 1,410 | 1,530 | 1,100 | 850 |
| 4 | 1,130 | 1,070 | | | | | 1,240 | 2,020 | 1,340 | 1,530 | 1,100 | 845 |
| 5 | 1,130 | 1,070 | | | | | 1,340 | 2,120 | 1,270 | 1,530 | 1,130 | 835 |
| | | | 1,500 | 875 | 850 | 930 | | | | | | |
| 6 | 1,160 | 1,040 | | | | | 1,570 | 2,120 | 1,530 | 1,530 | 1,130 | 845 |
| 7 | 1,130 | 1,040 | | | | | 1,820 | 2,120 | 1,730 | 1,530 | 1,130 | 850 |
| 8 | 1,130 | 1,010 | | | | | 2,120 | 2,120 | 2,220 | 1,490 | 1,100 | 855 |
| 9 | 1,100 | 1,040 | | | | | 2,120 | 2,120 | 2,320 | 1,410 | 1,070 | 885 |
| 10 | 1,100 | 1,040 | | | | | 2,320 | 2,120 | 2,320 | 1,380 | 1,070 | 902 |
| 11 | 1,160 | 1,040 | | | | | 2,320 | 2,120 | 2,220 | 1,340 | 1,040 | 880 |
| 12 | 1,160 | 1,070 | | | | | 2,430 | 2,120 | 2,120 | 1,300 | 1,010 | 880 |
| 13 | 1,160 | 1,070 | | | | | 2,320 | 2,120 | 2,120 | 1,270 | 1,010 | 908 |
| 14 | 1,130 | 1,100 | | | | | 2,220 | 2,020 | 2,120 | 1,270 | 1,010 | 950 |
| 15 | 1,130 | 1,100 | | | | | 2,120 | 2,120 | 2,120 | 1,410 | 980 | 1,070 |
| | | | 1,160 | 850 | 870 | 970 | | | | | | |
| 16 | 1,130 | 1,070 | | | | | 2,120 | 2,990 | 2,020 | 1,490 | 980 | 1,070 |
| 17 | 1,130 | | | | | | 2,120 | 3,840 | 1,820 | 1,450 | 980 | 1,130 |
| 18 | 1,100 | | | | | | 2,020 | 3,970 | 2,650 | 1,410 | 944 | 1,130 |
| 19 | 1,100 | 1,050 | | | | | 2,020 | 3,590 | 4,230 | 1,340 | 920 | 1,100 |
| 20 | 1,100 | | | | | | 1,920 | 3,470 | 4,230 | 1,270 | 908 | 1,040 |
| 21 | 1,070 | | | | | | 1,820 | 3,470 | 3,970 | 1,240 | 890 | 980 |
| 22 | 1,070 | | | | | | 1,820 | 3,470 | 3,710 | 1,200 | 875 | 1,010 |
| 23 | 1,070 | | | | | | 1,730 | 3,350 | 3,590 | 1,130 | 865 | 980 |
| 24 | 1,070 | | | | | | 1,730 | 3,110 | 3,470 | 1,130 | 865 | 950 |
| 25 | 1,070 | | | | | | 1,730 | 2,870 | 3,110 | 1,130 | 896 | 980 |
| | | | 1,500 | 930 | 815 | 1,030 | 1,150 | | | | | |
| 26 | 1,100 | | | | | | 1,730 | 2,650 | 2,870 | 1,130 | 908 | 1,100 |
| 27 | 1,070 | | | | | | 1,730 | 2,540 | 2,540 | 1,130 | 890 | 1,160 |
| 28 | 1,070 | | | | | | 1,820 | 2,320 | 2,220 | 1,130 | 880 | 1,160 |
| 29 | 1,070 | | | | | | 1,920 | 2,120 | 2,020 | 1,130 | 885 | 1,200 |
| 30 | 1,070 | | | | | | 1,820 | 1,920 | 1,920 | 1,100 | 896 | 1,160 |
| 31 | 1,070 | | | | | | ..... | 1,650 | ..... | 1,100 | 914 | ..... |

NOTE.—Discharge computed as follows: Oct. 1–25, by the indirect method, because of backwater from aquatic plants in channel; Oct. 26 to Nov. 16, and Apr. 1 to July 31 from a well-defined rating curve; Aug. 1 to Sept. 30, from a fairly well defined rating curve.

Discharge Nov. 17 to Mar. 31, estimated because of ice from dicharge measurements, observer's notes, and weather records; braced figures show mean discharge for period included.

*Monthly discharge of St. Croix River at Swiss, Wis., for year ending Sept. 30, 1915.*

[Drainage area, 1,550 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 1,200 | 1,070 | 1,110 | 0.716 | 0.83 | B. |
| November | ..... | 1,010 | 1,200 | .774 | .86 | C. |
| December | ..... | ..... | 1,190 | .768 | .89 | D. |
| January | ..... | ..... | 846 | .546 | .63 | C. |
| February | ..... | ..... | 909 | .586 | .61 | C. |
| March | ..... | ..... | 1,020 | .658 | .76 | D. |
| April | 2,430 | 1,040 | 1,870 | 1.21 | 1.35 | A. |
| May | 3,970 | 1,650 | 2,520 | 1.63 | 1.88 | A. |
| June | 4,230 | 1,270 | 2,410 | 1.55 | 1.73 | A. |
| July | 1,730 | 1,100 | 1,340 | .865 | 1.00 | A. |
| August | 1,130 | 865 | 981 | .633 | .73 | B. |
| September | 1,200 | 835 | 982 | .634 | .71 | B. |
| The year | 4,230 | ..... | 1,370 | .884 | 11.98 | |

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

LOCATION.—In sec. 18, T. 34 N., R. 18 W., Polk County, at the power plant of the Minneapolis General Electric Co., on the 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 the station; Snake River, draining an area in Minnesota, enters from the right, about 35 miles above the station.

DRAINAGE AREA.—5,930 square miles.

RECORDS AVAILABLE.—January 10, 1902, to June 30, 1905; January 1, 1910, to September, 30, 1915. Data for 1903 published in Water-Supply Paper No. 98, pp. 176–177, under St. Croix River near Taylors Falls, Minn.

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

EXTREMES OF DISCHARGE.—Maximum discharge recorded during year, 15,100 second-feet June 22; minimum discharge recorded, 686 second-feet, March 7, 1915.

1902–1905 and 1910–1915: Maximum discharge recorded, 33,500 second-feet May 6, 1912; minimum 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, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3,380 | 1,120 | 2,790 | 1,200 | 1,310 | 2,010 | 2,740 | 7,970 | 2,980 | 6,980 | 1,160 | 1,550 |
| 2 | 3,390 | 2,790 | 2,730 | 2,480 | 1,350 | 2,010 | 2,480 | 6,310 | 4,200 | 6,480 | 2,440 | 1,700 |
| 3 | 3,210 | 2,540 | 2,850 | 1,080 | 1,400 | 1,990 | 2,930 | 6,870 | 3,470 | 5,830 | 2,730 | 1,760 |
| 4 | 1,620 | 2,590 | 3,040 | 2,240 | 1,500 | 2,060 | 3,350 | 7,140 | 3,250 | 3,890 | 2,740 | 1,950 |
| 5 | 3,040 | 2,580 | 2,960 | 2,220 | 1,650 | 2,030 | 3,310 | 10,700 | 3,300 | 4,320 | 2,650 | 1,360 |
| 6 | 3,190 | 2,610 | 1,190 | 1,560 | 2,270 | 2,030 | 3,890 | 11,400 | 3,530 | 4,590 | 2,370 | 1,370 |
| 7 | 3,130 | 2,500 | 2,540 | 2,220 | 1,020 | 686 | 4,400 | 11,300 | 3,000 | 4,460 | 2,370 | 1,730 |
| 8 | 3,160 | 996 | 2,600 | 1,950 | 1,520 | 1,970 | 5,320 | 10,400 | 3,610 | 4,490 | 1,020 | 1,390 |
| 9 | 3,170 | 2,600 | 2,770 | 2,460 | 1,590 | 2,260 | 7,740 | 9,580 | 4,040 | 3,380 | 2,420 | 1,410 |
| 10 | 3,000 | 2,620 | 2,300 | 1,160 | 1,600 | 2,100 | 7,820 | 9,240 | 3,730 | 3,710 | 2,670 | 1,270 |
| 11 | 1,250 | 2,640 | 1,460 | 1,750 | 1,600 | 2,120 | 6,820 | 8,730 | 4,490 | 3,040 | 2,440 | 1,540 |
| 12 | 2,910 | 2,750 | 2,030 | 1,750 | 1,820 | 1,950 | 7,310 | 8,490 | 5,990 | 3,070 | 2,430 | 1,440 |
| 13 | 3,040 | 2,760 | 938 | 1,800 | 2,360 | 1,890 | 8,660 | 7,880 | 6,050 | 3,130 | 2,200 | 1,450 |
| 14 | 2,950 | 2,760 | 1,300 | 1,800 | 952 | 872 | 7,340 | 5,820 | 8,130 | 3,850 | 2,010 | 1,600 |
| 15 | 3,030 | 1,160 | 1,380 | 1,970 | 1,890 | 1,860 | 6,610 | 6,480 | 9,330 | 3,630 | 1,100 | 1,680 |
| 16 | 3,060 | 2,660 | 1,120 | 2,390 | 2,160 | 1,960 | 6,640 | 6,070 | 7,650 | 3,850 | 2,200 | 1,880 |
| 17 | 2,840 | 2,600 | 1,390 | 987 | 2,060 | 2,290 | 7,990 | 8,780 | 5,980 | 3,780 | 2,270 | 1,880 |
| 18 | 2,280 | 2,370 | 1,700 | 1,730 | 1,900 | 2,960 | 5,930 | 11,200 | 7,790 | 3,810 | 2,300 | 2,210 |
| 19 | 3,560 | 1,690 | 2,360 | 1,760 | 1,990 | 3,180 | 6,280 | 12,800 | 11,300 | 4,130 | 2,320 | 1,860 |
| 20 | 3,210 | 1,480 | 1,210 | 1,710 | 2,040 | 2,850 | 5,930 | 12,900 | 13,500 | 3,430 | 2,380 | 1,800 |
| 21 | 3,100 | 2,280 | 1,560 | 1,640 | 899 | 1,720 | 5,980 | 11,600 | 13,800 | 3,050 | 2,250 | 1,870 |
| 22 | 3,100 | 1,200 | 1,460 | 1,420 | 2,400 | 2,160 | 6,900 | 11,100 | 15,100 | 2,820 | 1,240 | 2,270 |
| 23 | 2,970 | 2,160 | 1,840 | 2,240 | 2,110 | 2,690 | 5,970 | 10,200 | 13,600 | 2,800 | 2,360 | 2,210 |
| 24 | 2,690 | 2,200 | 2,210 | 895 | 2,200 | 3,110 | 5,570 | 10,100 | 13,500 | 2,680 | 2,700 | 2,240 |
| 25 | 1,510 | 2,650 | 903 | 1,570 | 2,100 | 3,750 | 7,130 | 9,710 | 11,000 | 1,190 | 2,740 | 2,020 |
| 26 | 2,660 | 1,260 | 1,490 | 2,030 | 1,880 | 3,740 | 6,940 | 9,330 | 9,090 | 2,780 | 1,590 | 1,670 |
| 27 | 2,890 | 2,410 | 985 | 1,660 | 2,090 | 3,710 | 7,860 | 6,250 | 11,200 | 2,430 | 1,630 | 2,220 |
| 28 | 2,740 | 2,320 | 1,450 | 1,590 | 1,340 | 3,580 | 9,700 | 8,360 | 7,510 | 2,560 | 1,700 | 2,070 |
| 29 | 2,730 | 911 | 1,560 | 1,700 | ..... | 2,450 | 9,980 | 6,240 | 8,330 | 2,580 | 1,060 | 2,280 |
| 30 | 2,700 | 2,690 | 1,360 | 2,030 | ..... | 2,930 | 9,330 | 6,520 | 6,200 | 2,540 | 1,670 | 2,330 |
| 31 | 2,610 | ..... | 2,210 | 1,020 | ..... | 3,020 | ..... | 4,800 | ..... | 2,180 | 1,630 | ..... |

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, 1915.*

[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 | 3,560 | 1,250 | 2,840 | 0.479 | 0.55 |
| November | 2,790 | 911 | 2,200 | .371 | .41 |
| December | 3,040 | 903 | 1,860 | .314 | .36 |
| January | 2,480 | 895 | 1,740 | .293 | .34 |
| February | 2,400 | 899 | 1,750 | .295 | .31 |
| March | 3,750 | 686 | 2,390 | .403 | .46 |
| April | 9,980 | 2,480 | 6,300 | 1.06 | 1.18 |
| May | 12,900 | 4,800 | 8,850 | 1.49 | 1.72 |
| June | 15,100 | 2,980 | 7,490 | 1.26 | 1.41 |
| July | 6,980 | 1,190 | 3,600 | .607 | .70 |
| August | 2,740 | 1,020 | 2,090 | .352 | .41 |
| September | 2,330 | 1,270 | 1,800 | .304 | .34 |
| The year | 15,100 | 686 | 3,580 | .604 | 8.19 |

NOTE.—Computed by engineers of the United States Geological 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 & North Western Railway bridge at Trego, about 20 miles above confluence of Namakagon and Totogatic rivers.

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

RECORDS AVAILABLE.—March 11, 1914, to September 30, 1915.

GAGE.—Enameled staff fastened to retaining wall, left bank of river, just above railroad bridge; read once daily, in the morning, to quarter-tenths, 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 do not overflow. Small island downstream with rapids on either side forms the control; channel fairly permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 2.6 feet May 18 to 21 (discharge, 1,020 second-feet); minimum discharge 276 second-feet (recorded by discharge measurement made December 30).

1914–1915: Maximum stage recorded, 2.6 feet June 28, 29, and July 1 to 3, 1914, and May 18 to 21, 1915 (discharge, 1,020 second-feet). Minimum discharge, 264 second-feet (recorded by measurement made March 11, 1914).

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

ACCURACY.—Rating curve well defined over a range in stage covered by gage heights; channel permanent; records excellent.

*Discharge measurements of Namakagon River at Trego, Wis., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Dec. 30[a] | M. F. Rather | 2.28 | 276 | Mar. 16 | H. C. Beckman | 1.60 | 367 |
| Feb. 9[a] | H. C. Beckman | 2.62 | 325 | Aug. 26 | H. T. Critchlow | 1.61 | 372 |

[a] Complete ice cover.

*Daily discharge, in second-feet, of Namakagon River at Trego, Wis., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 444 | 417 | 417 | | | | 393 | 502 | 630 | 532 | 417 | 369 |
| 2 | 444 | 417 | 417 | | | | 369 | 444 | 532 | 597 | 369 | 350 |
| 3 | 444 | 417 | 417 | | | 445 | 417 | 532 | 502 | 597 | 393 | 350 |
| 4 | 417 | 417 | 417 | | | | 417 | 502 | 472 | 532 | 393 | 350 |
| 5 | 393 | 417 | 417 | | | | 332 | 502 | 472 | 564 | 444 | 350 |
| 6 | 393 | 417 | 430 | 295 | 300 | | 532 | 564 | 733 | 444 | 444 | 369 |
| 7 | 444 | 369 | 144 | | | | 597 | 532 | 873 | 444 | 417 | 350 |
| 8 | 444 | 369 | 418 | | | 530 | 597 | 564 | 838 | 532 | 417 | 350 |
| 9 | 417 | 369 | 393 | | | | 661 | 564 | 768 | 564 | 393 | 350 |
| 10 | 417 | 393 | | | | | 664 | 532 | 698 | 532 | 393 | 369 |
| 11 | 444 | 393 | | | | | 664 | 564 | 664 | 444 | 393 | 350 |
| 12 | 472 | 417 | | | | | 664 | 564 | 630 | 444 | 393 | 369 |
| 13 | 444 | 417 | | | | 380 | 597 | 597 | 698 | 417 | 393 | 369 |
| 14 | 417 | 417 | | | | | 597 | 564 | 664 | 502 | 417 | 417 |
| 15 | 472 | 369 | 395 | 325 | 330 | | 597 | 597 | 664 | 597 | 417 | 444 |
| 16 | 564 | 369 | | | | 597 | 630 | 597 | 597 | 597 | 369 | 417 |
| 17 | 532 | 393 | | | | 417 | 597 | 944 | 532 | 532 | 393 | 417 |
| 18 | 444 | 393 | | | | 350 | 532 | 1,020 | 597 | 502 | 393 | 417 |
| 19 | 444 | 393 | | | | 597 | 502 | 1,020 | 908 | 532 | 393 | 417 |
| 20 | 472 | 369 | | | | 369 | 597 | 1,020 | 908 | 444 | 369 | 444 |
| 21 | 444 | 369 | | | | 532 | 532 | 1,020 | 944 | 444 | 369 | 417 |
| 22 | 472 | 444 | | | | 532 | 502 | 1,020 | 944 | 444 | 350 | 393 |
| 23 | 472 | 417 | | | | 532 | 502 | 944 | 908 | 417 | 332 | 393 |
| 24 | 444 | 444 | | | | 417 | 444 | 944 | 733 | 417 | 350 | 393 |
| 25 | 417 | 472 | | | | 417 | 444 | 768 | 733 | 417 | 369 | 444 |
| 26 | 417 | 472 | 295 | 290 | 320 | 369 | 444 | 768 | 733 | 417 | 369 | 417 |
| 27 | 417 | 472 | | | | 369 | 564 | 768 | 597 | 444 | 350 | 417 |
| 28 | 417 | 444 | | | | 444 | 564 | 733 | 597 | 444 | 332 | 417 |
| 29 | 417 | 502 | | | | 417 | 502 | 664 | 597 | 417 | 350 | 444 |
| 30 | 417 | 532 | | | | 393 | 502 | 664 | 532 | 393 | 393 | 444 |
| 31 | 417 | ..... | | | | 393 | ..... | 630 | ..... | 417 | 369 | ..... |

NOTE.—Discharge computed as follows: Oct. 1 to Dec. 9 (except Dec. 2, 4, 6, and 8, interpolated), Mar. 16 to Sept. 30, from a rating curve well defined below 733 second-feet; discharge for Mar. 22 interpolated; gage apparently recorded in error. Discharge, Dec. 10 to Mar. 15, estimated, because of ice, from discharge measurements, observer's notes, and weather records; braced figures show mean discharge for period included.

*Monthly discharge of Namakagon River at Trego, Wis., for the year ending Sept. 30, 1915.*

[Drainage area, 420 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 564 | 393 | 442 | 1.05 | 1.21 | A. |
| November | 532 | 369 | 417 | .993 | 1.11 | A. |
| December | ..... | ..... | 366 | .871 | 1.00 | B. |
| January | ..... | ..... | 303 | .721 | .83 | C. |
| February | ..... | ..... | 316 | .752 | .78 | C. |
| March | 597 | ..... | 419 | 1.07 | 1.23 | B. |
| April | 664 | 332 | 532 | 1.27 | 1.42 | A. |
| May | 1,020 | 444 | 698 | 1.66 | 1.91 | A. |
| June | 944 | 472 | 690 | 1.64 | 1.83 | A. |
| July | 597 | 393 | 485 | 1.15 | 1.33 | A. |
| August | 444 | 332 | 385 | .917 | 1.06 | A. |
| September | 444 | 350 | 393 | .936 | 1.04 | A. |
| The year | 1,020 | ..... | 457 | 1.09 | 14.75 | |

## KETTLE RIVER NEAR SANDSTONE, MINN.

LOCATION.—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, 1915.

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 twice daily, to quarter-tenths, by F. L. Betts.

DISCHARGE MEASUREMENTS.—Made from highway bridge, about 1 mile above gage.

CHANNEL AND CONTROL.—Solid rock; permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 4.8 feet May 17 and 18 (discharge, 2,580 second-feet); minimum stage recorded during open-water periods, 1.1 feet December 22 (discharge, 70 second-feet).

1908–1915: Maximum stage recorded, 6.7 feet, June 29, 1914 (discharge, 5,770 second-feet); minimum stage recorded, 0.7 foot November 30, 1912 (discharge, approximately 12 second-feet).

WINTER FLOW.—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.—Results considered excellent. Control permanent, except from the lodging of logs or débris on the rapids, which rarely occurs; rating curve well defined.

The following discharge measurement was made by S. B. Soulé, July 31, 1915. Gage height, 1.45 feet; discharge, 116 second-feet. This measurement was made at the bridge, 2,000 feet above gage. Because of the extremely low velocity at this stage, the result is subject to considerable error. As the control is permanent, this measurement was disregarded in the preparation of estimates for 1915.

*Daily discharge in second-feet of Kettle River near Sandstone, Minn., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 370 | 269 | 124 | | | | 288 | 1,130 | 648 | 1,090 | 148 | 117 |
| 2 | 343 | 265 | 118 | | | | 309 | 1,170 | 565 | 1,010 | 141 | 117 |
| 3 | 316 | 261 | 112 | | | | 330 | 1,680 | 540 | 935 | 141 | 112 |
| 4 | 288 | 258 | 112 | | | | 375 | 2,200 | 515 | 865 | 141 | 112 |
| 5 | 288 | 254 | 112 | | | | 420 | 2,200 | 515 | 800 | 148 | 112 |
| 6 | 288 | 250 | 112 | | | | 442 | 1,990 | 735 | 735 | 148 | 112 |
| 7 | 288 | 233 | 112 | | | | 465 | 1,890 | | 675 | 141 | 112 |
| 8 | 288 | 216 | 108 | | | | 490 | 1,700 | | 620 | 141 | 108 |
| 9 | 288 | 216 | 103 | | | | 675 | 1,610 | | 592 | 141 | 108 |
| 10 | 330 | 216 | 99 | | | | 800 | 1,430 | | 565 | 136 | 108 |
| | | | | | | | | | 900 | | | |
| 11 | 420 | 216 | 94 | | | 100 | 935 | 1,260 | | 515 | 136 | 101 |
| 12 | 420 | 216 | 90 | | | | 935 | 1,170 | | 515 | 136 | 101 |
| 13 | 398 | 210 | 90 | | | | 900 | 1,010 | | 465 | 136 | 112 |
| 14 | 375 | 204 | 90 | | | | 865 | 1,010 | | 442 | 136 | 160 |
| 15 | 375 | 198 | 90 | | | | 865 | 1,610 | 1,170 | 515 | 136 | 216 |
| 16 | 330 | 192 | 90 | 80 | 63 | | 800 | 2,320 | 1,090 | 865 | 136 | 216 |
| 17 | 309 | 186 | 90 | | | | 768 | 2,580 | 1,090 | 420 | 136 | 216 |
| 18 | 288 | 181 | 90 | | | | 675 | 2,580 | 1,090 | 330 | 136 | 186 |
| 19 | 288 | 176 | 90 | | | | 648 | 2,440 | 1,010 | 330 | 131 | 186 |
| 20 | 288 | 170 | 90 | | | | 620 | 2,090 | 1,010 | 288 | 131 | 186 |
| 21 | 288 | 165 | 90 | | | | 620 | 1,990 | 935 | 269 | 131 | 173 |
| 22 | 288 | 160 | 70 | | | | 620 | 1,890 | 935 | 250 | 124 | 160 |
| 23 | 291 | 160 | | | | 288 | 675 | 1,610 | 865 | 233 | 124 | 141 |
| 24 | 294 | 160 | | | | 309 | 1,340 | 1,430 | 935 | 216 | 124 | 131 |
| 25 | 297 | 160 | | | | 309 | 1,520 | 1,170 | 865 | 216 | 124 | 90 |
| 26 | 300 | 160 | 84 | | | 288 | 1,520 | 1,090 | 832 | 216 | 124 | 90 |
| 27 | 303 | 160 | | | | 269 | 1,520 | 1,010 | 800 | 201 | 117 | 90 |
| 28 | 306 | 148 | | | | 269 | 1,520 | 905 | 1,090 | 188 | 117 | 101 |
| 29 | 309 | 136 | | | | 269 | 1,430 | 800 | 1,260 | 174 | 117 | 108 |
| 30 | 296 | 130 | | | | 269 | 1,260 | 705 | 1,770 | 161 | 117 | 112 |
| 31 | 282 | ..... | | | | 250 | ..... | 675 | ..... | 148 | 117 | ..... |

NOTE.—Discharge Oct. 1 to Dec. 22 and Mar. 23 to Sept. 30, except as noted below, computed from a well-defined rating curve. Discharge interpolated as follows: Oct. 1–3, 23–28, 30–31; Nov. 2–5, 7, 9–11, 13–16, 18–21, 23–26, 28, 30, Dec. 1, 2, 4, 5, 8–11, Mar. 28, Apr. 4, May 3, and July 28–30. Discharge Dec. 23 to Mar. 22, estimated, because of ice, from discharge measurements, observer's notes, and weather records. Discharge June 7–14, estimated because no gage height record was available. Braced figures show mean discharge for period included.

*Monthly discharge of Kettle River near Sandstone, Minn., for the year ending Sept. 30, 1915.*

[Drainage area, 825 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 420 | 282 | 317 | 0.384 | 0.44 | B. |
| November | 269 | 130 | 198 | .240 | .27 | B. |
| December | 124 | ..... | 94.6 | .115 | .13 | B. |
| January | ..... | ..... | 80 | .097 | .11 | C. |
| February | ..... | ..... | 63 | .076 | .08 | C. |
| March | 309 | ..... | 152 | .184 | .21 | C. |
| April | 1,520 | 288 | 821 | .995 | 1.11 | A. |
| May | 2,580 | 675 | 1,560 | 1.89 | 2.18 | A. |
| June | ..... | 515 | 916 | 1.11 | 1.24 | B. |
| July | 1,090 | 148 | 479 | .581 | .67 | A. |
| August | 148 | 117 | 133 | .161 | .19 | A. |
| September | 216 | 90 | 133 | .161 | .18 | A. |
| The year | 2,580 | ..... | 414 | .502 | 6.81 | |

SNAKE RIVER NEAR PINE CITY, MINN.

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

DRAINAGE AREA.—915 square miles.

RECORDS AVAILABLE.—June 26, 1913, to September 30, 1915.

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

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

CHANNEL AND CONTROL.—Bed of stream rock and heavy gravel; both banks in the vicinity of the gage are high and are not likely 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 of the dam as obtained from readings of the staff gage. The flow through the turbines is computed from hourly records of the gate openings and head.

EXTREMES OF DISCHARGE.—Maximum mean daily discharge during year, 1,890 second-feet May 22; minimum mean daily discharge, 49 second-feet, January 10.

1913–1915: Maximum mean daily discharge, 4,140 second-feet July 2, 1914; minimum mean daily discharge, 33 second-feet February 11, 1914.

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

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

ACCURACY.—Results at medium and high stages considered excellent; at low stages fair to good. Conditions favorable for estimating the waste by means of the river gage; estimates of flow through the wheels probably less accurate, but as they are based on 24 readings of the gate opening daily, the accuracy should range from fair to good.

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

The following discharge measurement was made by S. B. Soulé from the highway bridge a short distance above the dam:

May 19, 1915: Gage height (river gage), 2.65 feet; discharge, 1,560 second-feet. Of this amount 208 second-feet passed through the turbines of the power plant and 1,352 second-feet were wasted over the dam and represents the flow past the river gage.

*Daily discharge, in second-feet, of Snake River near Pine City, Minn., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 406 | 111 | 130 | 57 | 73 | 104 | 404 | 1,290 | 757 | 1,100 | 179 | 119 |
| 2 | 368 | 197 | 128 | 56 | 66 | 210 | 358 | 1,160 | 653 | 1,120 | 219 | 116 |
| 3 | 341 | 200 | 130 | 51 | 68 | 108 | 333 | 1,170 | 538 | 1,070 | 197 | 112 |
| 4 | 241 | 249 | 134 | 68 | 68 | 111 | 311 | 1,170 | 458 | 975 | 221 | 121 |
| 5 | 308 | 185 | 130 | 77 | 72 | 98 | 397 | 1,140 | 454 | 914 | 224 | 80 |
| 6 | 288 | 161 | 69 | 72 | 70 | 81 | 407 | 1,180 | 411 | 843 | 209 | 108 |
| 7 | 252 | 223 | 129 | 67 | 51 | 50 | 447 | 1,180 | 556 | 762 | 200 | 110 |
| 8 | 245 | 96 | 131 | 65 | 61 | 97 | 584 | 1,280 | 424 | 707 | 142 | 113 |
| 9 | 232 | 170 | 134 | 76 | 62 | 124 | 523 | 1,280 | 390 | 611 | 192 | 114 |
| 10 | 219 | 220 | 126 | 49 | 65 | 121 | 591 | 1,280 | 356 | 580 | 190 | 71 |
| 11 | 109 | 227 | 126 | 73 | 67 | 114 | 547 | 1,270 | 411 | 509 | 181 | 103 |
| 12 | 197 | 221 | 128 | 70 | 66 | 119 | 592 | 1,190 | 407 | 506 | 179 | 110 |
| 13 | 236 | 211 | 68 | 82 | 66 | 123 | 601 | 1,040 | 448 | 469 | 166 | 95 |
| 14 | 258 | 185 | 105 | 68 | 57 | 65 | 603 | 896 | 532 | 487 | 139 | 103 |
| 15 | 263 | 98 | 109 | 74 | 66 | 150 | 583 | 789 | 667 | 534 | 98 | 102 |
| 16 | 269 | 176 | 113 | 82 | 69 | 222 | 553 | 845 | 658 | 628 | 151 | 100 |
| 17 | 270 | 184 | 93 | 65 | 66 | 282 | 522 | 1,020 | 621 | 791 | 161 | 100 |
| 18 | 173 | 204 | 101 | 69 | 80 | 363 | 463 | 1,270 | 807 | 815 | 117 | 105 |
| 19 | 252 | 95 | 122 | 68 | 80 | 416 | 514 | 1,500 | 965 | 852 | 107 | 63 |
| 20 | 258 | 95 | 74 | 68 | 91 | 460 | 493 | 1,680 | 1,240 | 786 | 119 | 107 |
| 21 | 248 | 131 | 100 | 69 | 61 | 456 | 498 | 1,820 | 1,470 | 703 | 134 | 108 |
| 22 | 240 | 65 | 98 | 85 | 93 | 466 | 512 | 1,890 | 1,510 | 632 | 76 | 109 |
| 23 | 242 | 129 | 90 | 73 | 98 | 465 | 534 | 1,840 | 1,450 | 572 | 124 | 99 |
| 24 | 233 | 146 | 70 | 68 | 97 | 522 | 565 | 1,800 | 1,330 | 514 | 120 | 102 |
| 25 | 182 | 170 | 64 | 70 | 97 | 547 | 568 | 1,580 | 1,180 | 432 | 110 | 103 |
| 26 | 259 | 90 | 76 | 83 | 102 | 574 | 767 | 1,420 | 1,010 | 421 | 96 | 60 |
| 27 | 261 | 114 | 59 | 79 | 103 | 579 | 1,000 | 1,300 | 897 | 389 | 119 | 97 |
| 28 | 250 | 129 | 73 | 79 | 67 | 569 | 1,160 | 1,140 | 896 | 360 | 141 | 98 |
| 29 | 206 | 77 | 71 | 76 | ..... | 553 | 1,220 | 984 | 955 | 342 | 75 | 97 |
| 30 | 182 | 116 | 67 | 69 | ..... | 458 | 1,260 | 875 | 1,020 | 318 | 119 | 100 |
| 31 | 220 | ..... | 67 | 62 | ..... | 450 | ..... | 812 | ..... | 265 | 118 | ..... |

NOTE.—Discharge determined by adding the flow of the river opposite the power house, determined from a well-defined rating curve, to the flow through the power house. See "Determination of discharge" in station description.

*Monthly discharge of Snake River near Pine City, Minn., for the year ending Sept. 30, 1915.*

[Drainage area, 915 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 406 | 109 | 249 | 0.272 | 0.31 | B. |
| November | 249 | 65 | 156 | .170 | .19 | B. |
| December | 134 | 59 | 100 | .109 | .13 | B. |
| January | 85 | 49 | 70.0 | .077 | .09 | B. |
| February | 103 | 51 | 74.4 | .081 | .08 | B. |
| March | 579 | 50 | 292 | .319 | .37 | B. |
| April | 1,260 | 311 | 597 | .652 | .73 | A. |
| May | 1,890 | 789 | 1,260 | 1.38 | 1.59 | A. |
| June | 1,510 | 356 | 782 | .855 | .95 | A. |
| July | 1,120 | 265 | 645 | .705 | .81 | A. |
| August | 224 | 75 | 149 | .163 | .19 | B. |
| September | 121 | 60 | 101 | .110 | .12 | B. |
| The year | 1,890 | 49 | 375 | .410 | 5.56 | |

APPLE RIVER NEAR SOMERSET, WIS.

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

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

RECORDS AVAILABLE.—January, 1901, to September 30, 1915.

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

DISCHARGE.—The 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 computing the published records.

EXTREMES OF DISCHARGE.—Maximum mean daily discharge during year, 824 second feet April 7; minimum mean daily discharge, 104 second-feet August 29.

1904–1915: Maximum mean daily discharge, 2,280 second-feet June, 1905, minimum mean daily discharge, 38 second-feet May, 1910. No maximum and minimum records available for 1901–1903.

REGULATION.—There are a number of power plants on the Apple River above the 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 at tests on one of the turbines made at the flume of the Holyoke Water Power Co., Holyoke, Mass. In 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, located 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 date. In June, 1914, a series of current meter measurements were made by the Wisconsin Railroad Commission and the 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 computed by the company agreed very closely, the percentage difference for the twelve tests ranging from —6.4 per cent 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.

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

*Daily discharge, in second-feet, of Apple River near Somerset, Wis., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 219 | 248 | 279 | 199 | 242 | 283 | 345 | 346 | 375 | 414 | 299 | 214 |
| 2 | 294 | 208 | 194 | 252 | 190 | 221 | 335 | 318 | 265 | 315 | 320 | 183 |
| 3 | 244 | 275 | 257 | 174 | 242 | 256 | 434 | 307 | 255 | 413 | 358 | 199 |
| 4 | 307 | 200 | 204 | 256 | 183 | 212 | 485 | 373 | 261 | 325 | 245 | 204 |
| 5 | 216 | 236 | 265 | 207 | 265 | 283 | 539 | 272 | 451 | 381 | 302 | 174 |
| 6 | 284 | 231 | 200 | 231 | 153 | 190 | 643 | 278 | 420 | 363 | 245 | 138 |
| 7 | 273 | 260 | 269 | 193 | 205 | 276 | 824 | 235 | 448 | 346 | 288 | 224 |
| 8 | 321 | 195 | 216 | 262 | 182 | 263 | 769 | 332 | 629 | 363 | 316 | 235 |
| 9 | 262 | 272 | 247 | 177 | 255 | 284 | 726 | 269 | 660 | 357 | 305 | 212 |
| 10 | 305 | 246 | 203 | 234 | 166 | 254 | 707 | 383 | 646 | 372 | 294 | 236 |
| 11 | 283 | 228 | 232 | 185 | 245 | 338 | 777 | 323 | 495 | 360 | 289 | 233 |
| 12 | 349 | 254 | 206 | 263 | 159 | 242 | 614 | 346 | 499 | 267 | 306 | 157 |
| 13 | 269 | 260 | 144 | 172 | 241 | 299 | 616 | 290 | 458 | 374 | 259 | 231 |
| 14 | 339 | 242 | 194 | 259 | 210 | 229 | 441 | 343 | 498 | 401 | 310 | 252 |
| 15 | 240 | 212 | 199 | 194 | 259 | 315 | 476 | 271 | 345 | 523 | 205 | 218 |
| 16 | 317 | 257 | 159 | 239 | 194 | 345 | 479 | 289 | 411 | 631 | 336 | 187 |
| 17 | 294 | 205 | 206 | 161 | 230 | 373 | 536 | 318 | 428 | 591 | 276 | 272 |
| 18 | 294 | 198 | 211 | 232 | 198 | 426 | 503 | 323 | 497 | 459 | 244 | 249 |
| 19 | 231 | 191 | 252 | 200 | 232 | 384 | 483 | 338 | 554 | 542 | 274 | 195 |
| 20 | 306 | 188 | 163 | 231 | 216 | 336 | 418 | 456 | 658 | 578 | 175 | 312 |
| 21 | 224 | 234 | 245 | 220 | 284 | 337 | 348 | 423 | 726 | 525 | 248 | 282 |
| 22 | 326 | 244 | 177 | 231 | 257 | 271 | 376 | 570 | 683 | 423 | 148 | 233 |
| 23 | 265 | 269 | 238 | 171 | 286 | 340 | 353 | 612 | 671 | 434 | 238 | 181 |
| 24 | 319 | 233 | 186 | 214 | 214 | 432 | 394 | 544 | 627 | 327 | 174 | 268 |
| 25 | 228 | 248 | 224 | 215 | 278 | 525 | 349 | 589 | 569 | 332 | 258 | 224 |
| 26 | 312 | 175 | 168 | 251 | 229 | 409 | 337 | 567 | 447 | 273 | 244 | 169 |
| 27 | 186 | 284 | 226 | 191 | 260 | 449 | 359 | 360 | 486 | 358 | 256 | 248 |
| 28 | 344 | 206 | 186 | 232 | 227 | 460 | 409 | 380 | 360 | 304 | 184 | 227 |
| 29 | 210 | 250 | 245 | 195 | ..... | 457 | 351 | 274 | 431 | 302 | 104 | 225 |
| 30 | 310 | 241 | 180 | 227 | ..... | 410 | 365 | 440 | 425 | 277 | 243 | 247 |
| 31 | 248 | ..... | 230 | 165 | ..... | 367 | ..... | 393 | ..... | 304 | 238 | ..... |

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, 1915.*

[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 | 349 | 186 | 278 | 0.505 | 0.58 |
| November | 284 | 175 | 233 | .424 | .47 |
| December | 279 | 144 | 213 | .387 | .45 |
| January | 263 | 161 | 214 | .389 | .45 |
| February | 286 | 153 | 225 | .409 | .43 |
| March | 525 | 190 | 331 | .602 | .69 |
| April | 824 | 335 | 493 | .896 | 1.00 |
| May | 612 | 235 | 373 | .678 | .78 |
| June | 726 | 255 | 489 | .889 | .99 |
| July | 631 | 267 | 395 | .718 | .83 |
| August | 358 | 104 | 257 | .467 | .54 |
| September | 312 | 138 | 221 | .402 | .45 |
| The year | 824 | 104 | 310 | .564 | 7.66 |

CHIPPEWA RIVER AT BISHOPS BRIDGE, NEAR WINTER, WIS.

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

DRAINAGE AREA.—775 square miles (measured on map published by the Wisconsin Geological and Natural History Survey, edition of 1911; scale, 1 inch=6 miles).

RECORDS AVAILABLE.—February 23, 1912, to September 30, 1915.

GAGE.—Metal staff fastened to a wooden pier on right bank immediately above bridge January 27, 1914. Zero of this gage is 3.44 feet below the zero of the original wooden staff gage attached to the same pier and read prior to January 27, 1914. Gage read twice daily, morning and evening, to quarter-tenths by John Edberg.

DISCHARGE MEASUREMENTS.—Made from upstream side of highway bridge immediately below gage.

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

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 7.65 feet 9 a. m. June 9 (discharge, 3,610 second-feet); minimum stage recorded, 4.35 feet at 12.05 p. m. November 16 (discharge, 287 second-feet).

1913–1915: Maximum stage recorded, 7.8 feet April 21 and 22, 1913 (discharge, 3,820 [1] second-feet); minimum discharge, 200 second-feet, recorded by discharge measurement made February 23, 1912.

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

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

ACCURACY.—Rating curve well defined; no diurnal fluctuation; channel and control permanent; observer reliable; open-water records believed excellent.

[1] Discharge published as 4,570 second-feet in United States Geol. Survey Water-Supply Paper 385 and Railroad Commission of Wisconsin water-power report to the Legislature, 1914, based on an erroneous extension of the rating curve.

*Discharge measurements of Chippewa River at Bishops Bridge, near Winter, Wis., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Dec. 11[a] | H. C. Beckman | 4.90 | 464 | Apr. 16 | S. B. Soulé | 6.10 | 1,530 |
| Jan. 8[b] | M. F. Rather | 5.65 | 334 | June 10 | do | 7.55 | 3,460 |
| Feb. 8[b] | H. C. Beckman | 5.74 | 320 | July 15 | H. C. Beckman | 5.45 | 936 |
| Mar. 15[b] | do | 6.11 | 416 | Aug. 24 | H. T. Critchlow | 4.44 | 312 |

[a] Partial ice cover on river. [b] Made through complete ice cover.

*Daily discharge, in second-feet, of Chippewa River at Bishops Bridge, near Winter, Wis., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1,170 | 402 | 380 | | | | | 1,440 | 1,280 | 1,120 | 425 | 304 |
| 2 | 1,070 | 380 | 402 | | | | | 1,380 | 1,120 | 1,070 | 380 | 322 |
| 3 | 975 | 380 | 402 | | | | 535 | 1,380 | 930 | 1,020 | 450 | 304 |
| 4 | 885 | 402 | 380 | | | | | 1,440 | 840 | 975 | 525 | 322 |
| 5 | 800 | 402 | 380 | 340 | 320 | 410 | | 1,380 | 800 | 930 | 690 | 322 |
| 6 | 760 | 380 | 380 | | | | 575 | 1,380 | 1,740 | 840 | 690 | 304 |
| 7 | 725 | 380 | | | | | 630 | 1,500 | 2,700 | 800 | 575 | 304 |
| 8 | 725 | 380 | 435 | | | | 725 | 1,680 | 3,400 | 760 | 575 | 304 |
| 9 | 660 | 380 | | | | | 930 | 1,740 | 3,540 | 725 | 575 | 304 |
| 10 | 630 | 380 | | | | | 1,120 | 1,680 | 3,400 | 690 | 575 | 304 |
| 11 | 725 | 380 | | | | | 1,330 | 1,680 | 3,540 | 690 | 525 | 304 |
| 12 | 760 | 380 | | | | | 1,560 | 1,680 | 3,540 | 660 | 500 | 304 |
| 13 | 725 | 380 | | | | | 1,740 | 1,680 | 3,400 | 660 | 475 | 322 |
| 14 | 725 | 380 | | | | | 1,500 | 1,620 | 3,120 | 760 | 450 | 380 |
| 15 | 690 | 402 | | | | | 1,560 | 1,680 | 2,700 | 840 | 425 | 475 |
| 16 | 660 | 287 | 450 | 330 | 340 | 465 | 1,560 | 2,050 | 2,570 | 930 | 402 | 525 |
| 17 | 630 | | | | | | 1,620 | 2,310 | 2,310 | 930 | 360 | 575 |
| 18 | 630 | | | | | | 1,620 | 2,310 | 2,180 | 840 | 360 | 630 |
| 19 | 602 | | | | | | 1,680 | 2,310 | 2,310 | 800 | 340 | 690 |
| 20 | 575 | | | | | | 1,800 | 2,180 | 2,180 | 760 | 340 | 760 |
| 21 | 575 | 435 | | | | | 1,920 | 2,440 | 2,180 | 725 | 340 | 725 |
| 22 | 550 | | | | | | 2,180 | 2,570 | 2,180 | 760 | 322 | 725 |
| 23 | 575 | | | | | | 1,560 | 2,570 | 2,050 | 840 | 322 | 630 |
| 24 | 575 | | | | | | 1,620 | 2,440 | 1,920 | 660 | 304 | 575 |
| 25 | 550 | 475 | | | | | 1,560 | 2,440 | 1,860 | 630 | 304 | 550 |
| 26 | 525 | 450 | 375 | 320 | 370 | 515 | 1,500 | 2,310 | 1,800 | 602 | 304 | 660 |
| 27 | 500 | 425 | | | | | 1,500 | 2,180 | 1,680 | 575 | 304 | 690 |
| 28 | 475 | 402 | | | | | 1,560 | 1,990 | 1,560 | 550 | 304 | 630 |
| 29 | 475 | 380 | | | | | 1,560 | 1,800 | 1,440 | 525 | 304 | 630 |
| 30 | 450 | 360 | | | | | 1,500 | 1,680 | 1,330 | 500 | 322 | 630 |
| 31 | 425 | ..... | | | | | ..... | 1,560 | ..... | 475 | 304 | ..... |

NOTE.—Discharge computed as follows: Oct. 1 to Nov. 16, Nov. 25 to Dec. 6, Apr. 6 to Sept. 30, from a rating curve fairly well defined below 930 and above 2,050 second-feet, and well defined between these limits. Low water on Nov. 16 was caused by ice gorge which held back the water above the gage. Discharge Nov. 17–24 and Dec. 7 to Apr. 5 estimated, because of ice, from discharge measurements observer's notes, and weather records; braced figures show mean discharge for period indicated.

*Monthly discharge of Chippewa River at Bishops Bridge near Winter, Wis., for the year ending Sept. 30, 1915.*

[Drainage area, 775 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 1,170 | 425 | 671 | 0.866 | 1.00 | B. |
| November | 475 | ..... | 402 | .519 | .58 | B. |
| December | ..... | ..... | 409 | .528 | .61 | C. |
| January | ..... | ..... | 330 | .426 | .49 | C. |
| February | ..... | ..... | 341 | .440 | .46 | C. |
| March | ..... | ..... | 465 | .600 | .69 | C. |
| April | 2,180 | ..... | 1,300 | 1.68 | 1.87 | B. |
| May | 2,570 | 1,380 | 1,890 | 2.44 | 2.81 | A. |
| June | 3,540 | 800 | 2,190 | 2.83 | 3.16 | A. |
| July | 1,120 | 475 | 763 | .985 | 1.14 | A. |
| August | 690 | 304 | 422 | .545 | .63 | B. |
| September | 760 | 304 | 483 | .623 | .70 | B. |
| The year | 3,540 | ..... | 806 | 1.04 | 14.14 | |

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 the station, and Flambeau River from the right about 21 miles below.

DRAINAGE AREA.—1,380 square miles (measured on Wisconsin Geological and Natural History Survey map, edition of 1911; scale, 1 inch=6 miles).

RECORDS AVAILABLE.—December 31, 1913, to September 30, 1915.

GAGE.—Chain gage, attached to downstream side of bridge; read twice daily, morning and evening, to quarter-tenths by H. C. Gardner.

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

CHANNEL AND CONTROL.—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 is at all times within the banks.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 7.05 feet at 6.45 a. m. May 18 (discharge, 5,940 second-feet); minimum discharge, 501 second-feet, recorded by measurement made February 3.

1914–1915: Maximum stage recorded, 9.32 feet at 6.45 a. m. April 30, 1914 (discharge, 8,620 second-feet); minimum discharge, 405 second-feet, recorded by measurement March 5, 1914. The absolute minimum was probably about 350 second-feet during the last part of February, 1914.

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

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 million cubic feet and is used in connection with reservoirs on Upper Flambeau River, for the purpose of regulating the flow of Chippewa River. No diurnal fluctuation observed.

ACCURACY.—Estimates of flow above 2,500 second-feet believed excellent; below 2,500 second-feet estimates may be somewhat in error, owing to the filling of the channel during periods of low flow.

*Discharge measurements of Chippewa River near Bruce, Wis., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Nov. 5 | H. C. Beckman..... | 1.88 | 745 | Mar. 17[b] | H. C. Beckman..... | 3.49 | 708 |
| Jan. 5[a] | M. F. Rather..... | 2.88 | 564 | Apr. 7 | M. F. Rather..... | 3.68 | 2,400 |
| Feb. 3[a] | H. C. Beckman..... | 3.05 | 501 | Aug. 27[c] | H. T. Critchlow..... | 1.70 | 552 |

[a] Made through complete ice cover.
[b] Made through partial ice cover.
[c] One channel filling with sand brought down by Thornapple River.

*Daily discharge, in second-feet, of Chippewa River near Bruce, Wis., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1,870 | 790 | | | | | | 2,860 | 2,160 | 1,870 | 877 | 595 |
| 2 | 1,780 | 755 | | | | | | 2,660 | 1,960 | 1,670 | 893 | 595 |
| 3 | 1,680 | 755 | | | | | 945 | 2,560 | 1,780 | 1,580 | 965 | 588 |
| 4 | 1,500 | 755 | | | | | | 2,860 | 1,500 | 1,520 | 1,190 | 574 |
| 5 | 1,410 | 755 | 865 | 560 | 510 | 510 | | 2,860 | 1,500 | 1,480 | 2,040 | 574 |
| 6 | 1,320 | 755 | | | | | 2,060 | 2,660 | 2,460 | 1,430 | 1,990 | 560 |
| 7 | 1,320 | 720 | | | | | 2,460 | 3,160 | 4,090 | 1,360 | 1,740 | 560 |
| 8 | 1,320 | 720 | | | | | 3,260 | 3,870 | 4,530 | 1,300 | 1,530 | 560 |
| 9 | 1,320 | 720 | | | | | 3,560 | 3,870 | 4,860 | 1,240 | 1,300 | 548 |
| 10 | 1,320 | 685 | | | | | 4,310 | 3,460 | 4,970 | 1,190 | 1,150 | 548 |
| 11 | 1,500 | 685 | | | | | 4,640 | 3,160 | 4,860 | 1,300 | 1,130 | 530 |
| 12 | 1,590 | 685 | | | | | 4,310 | 3,060 | 4,860 | 1,420 | 1,020 | 530 |
| 13 | 1,590 | 665 | | | | | 3,870 | 3,060 | 4,860 | 1,390 | 933 | 548 |
| 14 | 1,500 | 755 | | | | | 3,460 | 2,860 | 4,530 | 1,230 | 997 | 756 |
| 15 | 1,410 | 755 | 795 | 650 | 650 | 720 | 3,260 | 2,660 | 4,090 | 1,820 | 925 | 877 |
| 16 | 1,320 | | | | | | 3,260 | 3,760 | 3,660 | 3,160 | 830 | 1,010 |
| 17 | 1,230 | | | | | | 3,260 | 5,540 | 3,260 | 3,260 | 778 | 957 |
| 18 | 1,100 | 820 | | | | | 3,160 | 5,880 | 3,060 | 2,520 | 742 | 965 |
| 19 | 1,060 | | | | | | 3,160 | 5,190 | 4,090 | 1,780 | 707 | 1,020 |
| 20 | 1,060 | | | | | | 3,260 | 4,640 | 4,420 | 1,510 | 693 | 1,130 |
| 21 | 1,020 | | | | | | 3,060 | 4,530 | 3,870 | 1,460 | 644 | 1,140 |
| 22 | 977 | | | | | | 2,960 | 5,650 | 3,660 | 1,410 | 630 | 1,100 |
| 23 | 938 | | | | | | 2,960 | 5,880 | 3,360 | 1,280 | 630 | 1,020 |
| 24 | 938 | | | | | | 3,060 | 5,190 | 3,060 | 1,200 | 623 | 965 |
| 25 | 938 | | | | | | 3,060 | 4,530 | 2,860 | 1,180 | 595 | 925 |
| 26 | 977 | 800 | 605 | 550 | 680 | 950 | 2,860 | 4,530 | 2,660 | 1,150 | 574 | 1,180 |
| 27 | 938 | | | | | | 3,160 | 3,980 | 2,460 | 1,110 | 560 | 1,480 |
| 28 | 862 | | | | | | 3,870 | 3,460 | 2,260 | 1,090 | 554 | 1,400 |
| 29 | 862 | | | | | | 3,870 | 3,060 | 2,160 | 1,050 | 560 | 1,190 |
| 30 | 825 | | | | | | 3,360 | 2,660 | 2,060 | 1,020 | 616 | 1,170 |
| 31 | 825 | | | | | | ..... | 2,460 | ..... | 985 | 536 | ..... |

NOTE.—Discharge determined as follows: Oct. 1 to Nov. 15, and Apr. 6 to July 31, from a rating curve fairly well defined below 2,500 second-feet, and well defined between 2,500 and 6,000 second-feet; Aug. 1 to Sept. 30, from a rating curve fairly well defined between 550 and 1,000 second-feet, and poorly defined above 1,000 second-feet; Nov. 16 to Apr. 5 estimated, because of ice, from discharge measurements, observer's notes, and weather records. Braced figures show mean flow for period included.

*Monthly discharge of Chippewa River near Bruce, Wis., for the year ending Sept. 30, 1915.*

[Drainage area, 1,380 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 1,870 | 825 | 1,240 | 0.898 | 1.04 | B. |
| November | ..... | ..... | 769 | .557 | .62 | C. |
| December | ..... | ..... | 750 | .543 | .63 | D. |
| January | ..... | ..... | 585 | .424 | .49 | C. |
| February | ..... | ..... | 609 | .441 | .46 | C. |
| March | ..... | ..... | 734 | .532 | .61 | C. |
| April | 4,640 | ..... | 2,940 | 2.13 | 2.38 | A. |
| May | 5,880 | 2,460 | 3,760 | 2.72 | 3.14 | A. |
| June | 4,970 | 1,500 | 3,330 | 2.41 | 2.69 | A. |
| July | 3,260 | 985 | 1,510 | 1.09 | 1.26 | B. |
| August | 2,040 | 536 | 934 | .677 | .78 | C. |
| September | 1,480 | 530 | 853 | .618 | .69 | C. |
| The year | 5,880 | ..... | 1,500 | 1.09 | 14.79 | |

CHIPPEWA RIVER AT CHIPPEWA FALLS, WIS.

LOCATION.—In sec. 7, T. 28 N., R. 8 W., at the highway bridge at Chippewa Falls, Chippewa County, 2,500 feet below the mouth of Duncan Creek coming in from the right.

DRAINAGE AREA.—5,600 square miles.

RECORDS AVAILABLE.—June 22, 1888, to September 30, 1915. 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 obtained gage readings when no record was obtained by the Weather Bureau.

GAGE.—Friez water-stage recorder installed January, 1914, on web between the two piers supporting first right-hand span and about 10 feet upstream from gage formerly used by United States Weather Bureau; gage referred to the original datum. Prior to installation of this recording gage readings were taken from a painted staff gage on the cylindrical pier at the right end of bridge. See Water-Supply Paper 355, page 118, for reported error in this gage, found August 19, 1913.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge.

CHANNEL AND CONTROL.—Heavy gravel; fairly permanent; both banks high and will rarely overflow.

EXTREMES OF STAGE.—Maximum stage recorded during year, 8.12 feet at 6 a. m. May 23 (discharge, 24,100 second-feet); minimum discharge, 959 second-feet, recorded by discharge measurement made March 8; absolute winter minimum probably somewhat lower owing to regulation.

1888–1915: Maximum stage recorded, 26.03 feet December 6, 1896. September 10, 1884, a stage of 26.03 feet was reached; discharge not estimated; minimum stage recorded, —0.8 foot July 24, 1910 (discharge, approximately, 460 second-feet).

WINTER FLOW.—Discharge relation seriously affected by ice; flow determined from discharge measurements, recording gage graph, observer's notes, and weather records.

REGULATION.—Some fluctuation is caused by the operation of power plant about half a mile above gage. The greatest fluctuation is, however, caused by the operation of larger plants above, notably the plant of the Brunet Falls Manufac-

turing 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.—Rating curve well defined; recording graph accurate; open-water records excellent.

*Discharge measurements of Chippewa River at Chippewa Falls, Wis., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Nov. 9 | H. C. Beckman | 1.10 | 2,680 | Feb. 1[a] | H. C. Beckman | .92 | 1,060 |
| Dec. 23[a] | do | 1.52 | 1,760 | Mar. 8[a] | do | .72 | 1,210 |
| Jan. 4[a] | M. F. Rather | .74 | 1,000 | 8[a] | do | .49 | 959 |
| 26[a] | H. C. Beckman | 1.30 | 1,440 | 9[a] | do | 1.26 | 1,860 |
| 27[a] | do | 1.67 | 1,730 | Aug. 23 | H. T. Critchlow | 1.04 | 2,600 |

[a] Made through complete ice cover.

*Daily discharge, in second-feet, of Chippewa River at Chippewa Falls, Wis., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5,490 | 2,960 | 2,160 | | | | 2,910 | 9,140 | 6,700 | 4,740 | 2,870 | 2,640 |
| 2 | 5,120 | 3,040 | 3,090 | | | | 3,020 | 7,980 | 5,620 | 4,620 | 3,900 | 2,500 |
| 3 | 4,490 | 2,850 | 3,110 | | | | 3,220 | 7,980 | 5,490 | 4,250 | 7,400 | 2,540 |
| 4 | 4,130 | 2,780 | 3,330 | | | | 3,660 | 7,980 | 5,180 | 4,130 | 15,300 | 2,520 |
| 5 | 4,010 | 2,810 | 3,200 | | | | 4,620 | 8,850 | 4,860 | 3,780 | 21,500 | 2,420 |
| | | | | 1,450 | 1,450 | 1,830 | | | | | | |
| 6 | 3,660 | 2,720 | 3,070 | | | | 7,400 | 8,850 | 5,620 | 3,510 | 21,500 | 2,330 |
| 7 | 4,130 | 2,780 | 3,330 | | | | 10,900 | 9,430 | 7,690 | 3,660 | 19,500 | 2,040 |
| 8 | 4,130 | 2,760 | 2,560 | | | | 14,000 | 11,500 | 10,900 | 3,260 | 17,200 | 2,500 |
| 9 | 3,530 | 2,600 | 2,620 | | | | 16,600 | 13,400 | 12,500 | 3,400 | 15,000 | 2,440 |
| 10 | 4,860 | 2,740 | 2,560 | | | | 17,600 | 12,800 | 13,400 | 3,240 | 12,800 | 2,250 |
| 11 | 4,740 | 2,600 | 2,310 | | | | 19,400 | 11,200 | 13,100 | 3,900 | 10,600 | 1,810 |
| 12 | 4,990 | 2,720 | 2,330 | | | | 20,400 | 10,300 | 13,400 | 8,850 | 8,400 | 2,020 |
| 13 | 6,840 | 2,850 | 2,350 | | | | 19,400 | 9,140 | 12,800 | 8,850 | 6,200 | 1,880 |
| 14 | 6,420 | 2,830 | 1,990 | | | | 16,600 | 8,850 | 12,500 | 6,420 | 4,250 | 2,580 |
| 15 | 6,010 | 2,830 | | | | | 14,700 | 8,270 | 11,500 | 6,280 | 4,010 | 3,330 |
| | | | | 1,300 | 1,520 | 2,090 | | | | | | |
| 16 | 5,620 | 2,850 | | | | | 13,100 | 9,140 | 10,300 | 7,690 | 3,660 | 6,700 |
| 17 | 5,240 | 2,560 | 2,350 | | | | 12,500 | 12,200 | 9,430 | 9,720 | 3,550 | 7,260 |
| 18 | 4,620 | 2,160 | | | | | 12,500 | 16,600 | 8,560 | 10,600 | 3,550 | 6,840 |
| 19 | 4,490 | 1,970 | | | | | 11,500 | 16,600 | 9,430 | 8,560 | 3,130 | 7,400 |
| 20 | 4,250 | 2,270 | | | | | 11,200 | 16,000 | 12,500 | 6,280 | 3,000 | 5,880 |
| 21 | 4,010 | 2,200 | | | | | 10,600 | 15,600 | 13,700 | 5,120 | 2,850 | 4,990 |
| 22 | 3,780 | 2,160 | | | | | 10,000 | 21,100 | 12,500 | 4,860 | 2,440 | 4,620 |
| 23 | 3,900 | 1,940 | | | | | 9,430 | 23,700 | 11,200 | 4,130 | 2,560 | 4,250 |
| 24 | 3,660 | 2,200 | | | | | 10,000 | 22,200 | 10,000 | 3,900 | 2,740 | 4,250 |
| 25 | 3,290 | 1,960 | | | | | 10,300 | 19,000 | 8,560 | 3,660 | 2,270 | 4,130 |
| 26 | 3,440 | 2,580 | 1,700 | 1,350 | 1,820 | 2,830 | 10,300 | 15,300 | 7,980 | 3,900 | 2,380 | 4,010 |
| 27 | 3,220 | 2,620 | | | | | 9,720 | 14,000 | 6,580 | 3,530 | 2,310 | 6,840 |
| 28 | 3,240 | 2,540 | | | | | 10,000 | 11,500 | 5,180 | 4,010 | 2,480 | 8,270 |
| 29 | 3,150 | 3,400 | | | | | 10,900 | 10,300 | 3,780 | 3,550 | 2,400 | 7,400 |
| 30 | 2,960 | 2,830 | | | | | 10,600 | 8,560 | 4,860 | 3,480 | 2,310 | 7,120 |
| 31 | 3,020 | ..... | | | | | ..... | 7,690 | ..... | 3,150 | 2,600 | ..... |

NOTE.—Discharge determined as follows: Nov. 7, May 15–16, June 3–5, and 26–30, and Aug. 6–14, partly estimated; Oct. 1 to Dec. 14, and Apr. 1 to Sept. 30, with the exception of the above days, from a rating curve well defined between 2,390 and 23,700 second-feet. Discharge, Dec. 15 to Mar. 31, estimated, because of ice from discharge measurements, recording graph, observer's notes, and weather records. Braced figures show mean discharge for period indicated.

*Monthly discharge of Chippewa River at Chippewa Falls, Wis., for the year ending Sept. 30, 1915.*

[Drainage area, 5,600 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 6,840 | 2,960 | 4,340 | 0.775 | 0.89 | A. |
| November | 3,400 | 1,940 | 2,600 | .464 | .52 | A. |
| December | 3,330 | ..... | 2,280 | .407 | .47 | C. |
| January | ..... | ..... | 1,370 | .245 | .28 | B. |
| February | ..... | ..... | 1,580 | .282 | .29 | B. |
| March | ..... | ..... | 2,270 | .405 | .47 | C. |
| April | 20,400 | 2,910 | 11,200 | 2.00 | 2.23 | A. |
| May | 23,700 | 7,690 | 12,400 | 2.21 | 2.55 | A. |
| June | 13,700 | 3,780 | 9,190 | 1.64 | 1.83 | B. |
| July | 10,600 | 3,150 | 5,130 | .916 | 1.06 | A. |
| August | 21,500 | 2,270 | 6,920 | 1.24 | 1.43 | C. |
| September | 8,270 | 1,810 | 4,190 | .748 | .83 | A. |
| The year | 23,700 | ..... | 5,310 | .948 | 12.85 | |

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

LOCATION.—In sec. 34, T. 40 N., R. 6 W., in Sawyer County, at Lessards, about 1 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.

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

RECORDS AVAILABLE.—December 22, 1911, to September 30, 1915.

GAGE.—July 18 to Sept. 30, 1915, a sloping gage on the right bank, about 100 feet below old staff gage; datum set so that it would read the same at medium stage of water; Dec. 22, 1911, to July 17, 1914, vertical staff and metal gage fastened to log booms on right side of river. Gage read during 1915 twice daily, morning and evening, to half-tenths by Miss Ulda Lessard.

DISCHARGE MEASUREMENTS.—Made from a boat at a section near old staff gage.

CHANNEL AND CONTROL.—Banks medium high; seldom overflow; channel heavy gravel and not liable to shift. Control, head of rapids a short distance below gage. During certain periods logs lodge on this control and cause backwater.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 7.25 feet at 8 a. m., June 10 (discharge, 1,790 second-feet); minimum stage recorded, 5.0 feet, August and September (discharge, 170 second-feet).

1911–1915: Maximum stage recorded, 6.8 feet, April 22 to 26, 1913 (discharge, 1,960 second-feet); minimum discharge, 127 second-feet, recorded by measurement February 23, 1912.

WINTER FLOW.—Discharge relation seriously affected by ice; flow determined from discharge measurements, observer's notes, and weather records.

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

ACCURACY.—Owing to the presence of logs on the control during a large part of the year, possible error in gage datum prior to July 17, and possible errors in gage readings, the published records are only fair.

*Discharge measurements of West Fork of Chippewa River at Lessards, near Winter, Wis., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Dec. 11[a] | H. C. Beckman | 5.20 | 235 | June 10 | S. B. Soulé | 7.18 | 1,720 |
| Jan. 8[b] | M. F. Rather | 5.85 | 246 | July 16 | H. C. Beckman | [d] 5.85 | 646 |
| Feb. 8[b] | H. C. Beckman | 6.10 | 202 | 17 | do | [d] 5.81 | 579 |
| Mar. 15[b] | do | 6.25 | 304 | Aug. 25[e] | H. T. Critchlow | [d] 5.03 | 176 |
| Apr. 16[c] | S. B. Soulé | 6.54 | 850 | 25[e] | do | [d] 5.03 | 186 |

[a] Partial ice cover on river.
[b] Made through complete ice cover.
[c] Logs jammed on control section.
[d] Gage height refers to new slope gage.
[e] Small amount of grass in control section.

*Daily discharge, in second-feet, of West Fork of Chippewa River at Lessards, near Winter, Wis., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 770 | 262 | 215 | | | | | 715 | | 800 | 465 | 170 |
| 2 | 770 | 262 | 245 | | | | | 715 | | 758 | 212 | 170 |
| 3 | | 262 | 245 | | | | 385 | 715 | | 715 | 258 | 170 |
| 4 | | 245 | 245 | | | | | 758 | | 630 | 282 | 170 |
| 5 | | 245 | 245 | | | | | 800 | 800 | 630 | 306 | 170 |
| | | | | 240 | 195 | 280 | | | | | | |
| 6 | | 245 | 245 | | | | | 800 | | 592 | 306 | 170 |
| 7 | | 245 | | | | | | 800 | | 555 | 306 | 170 |
| 8 | | 190 | 245 | | | | | 842 | 1,440 | 555 | 258 | 170 |
| 9 | | 190 | | | | | | 885 | 1,540 | 630 | 258 | 170 |
| 10 | | 190 | | | | | | 928 | 1,740 | 800 | 258 | 170 |
| 11 | | 190 | | | | | | 970 | 1,640 | 460 | 258 | 170 |
| 12 | | 190 | | | | | 545 | 970 | 1,540 | 460 | 258 | 235 |
| 13 | | 190 | | | | | | 1,020 | 1,340 | 490 | 235 | 235 |
| 14 | | 190 | | | | | | 1,060 | 1,160 | 555 | 235 | 258 |
| 15 | | 190 | | | | | | 1,110 | 1,160 | 630 | 212 | 258 |
| | 445 | | 225 | 235 | 235 | 315 | | | | | | |
| 16 | | 245 | | | | | | 800 | 1,160 | 630 | 212 | 282 |
| 17 | | 245 | | | | | 1,250 | 800 | 1,060 | 555 | 212 | 282 |
| 18 | | 245 | | | | | 1,060 | 885 | 970 | 600 | 212 | 282 |
| 19 | | 215 | | | | | 1,020 | 928 | 928 | | 212 | 410 |
| 20 | | 215 | | | | | 1,020 | 928 | 970 | | 212 | 410 |
| 21 | | 215 | | | | | 970 | 970 | 970 | | 170 | 410 |
| 22 | | 245 | | | | | 885 | 970 | 1,020 | | 170 | 465 |
| 23 | | 245 | | | | | 885 | 1,020 | 1,060 | | 170 | 465 |
| 24 | | 245 | | | | | 800 | 1,020 | 1,020 | | 170 | 465 |
| 25 | | 245 | | | | | 715 | 1,060 | 970 | 400 | 170 | 465 |
| | | | 215 | 200 | 270 | 330 | | | | | | |
| 26 | | 245 | | | | | 715 | 1,060 | 970 | | 170 | 410 |
| 27 | | 245 | | | | | 758 | 1,160 | 1,020 | | 170 | 383 |
| 28 | | 245 | | | | | 715 | 1,060 | 1,020 | | 191 | 356 |
| 29 | 300 | 245 | | | | | 715 | 928 | 928 | | 191 | 383 |
| 30 | 280 | 215 | | | | | 715 | 800 | 842 | | 170 | 383 |
| 31 | 262 | ..... | | | | | ..... | 750 | ..... | | 170 | ..... |

NOTE.—Discharge determined as follows: Oct. 1 and 2, Apr. 17 to May 29, June 8 to July 16, from curves based on discharge measurements made when logs were present on the control; Oct. 29 to Dec. 6, July 17, 18, and Aug. 1 to Sept. 30, from curves representing open-channel conditions; Oct. 3–28, Apr. 6–16, June 1–8, and July 19–31, when control was obstructed by logs or gage readings were unreliable, estimated from flow of Chippewa River at Bishop's Bridge. Dec. 7 to Apr. 5, estimated, because of ice, from discharge measurements, observer's notes, and weather records. Braced figures show mean discharge for period indicated.

*Monthly discharge of West Fork of Chippewa River at Lessards, near Winter, Wis., for the year ending Sept. 30, 1915.*

[Drainage area, 485 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | ..... | 262 | 450 | 0.928 | 1.07 | C. |
| November | 262 | 190 | 230 | .474 | .53 | B. |
| December | ..... | ..... | 227 | .468 | .54 | C. |
| January | ..... | ..... | 224 | .462 | .53 | C. |
| February | ..... | ..... | 231 | .476 | .50 | C. |
| March | ..... | ..... | 309 | .637 | .73 | C. |
| April | 1,250 | ..... | 671 | 1.38 | 1.54 | C. |
| May | 1,160 | 715 | 911 | 1.88 | 2.17 | B. |
| June | 1,740 | ..... | 1,070 | 2.21 | 2.47 | C. |
| July | 800 | ..... | 524 | 1.08 | 1.24 | C. |
| August | 465 | 170 | 228 | .470 | .54 | B. |
| September | 465 | 170 | 290 | .598 | .67 | A. |
| The year | 1,740 | ..... | 448 | .924 | 12.53 | |

FLAMBEAU RIVER NEAR BUTTERNUT, WIS.

LOCATION.—In the NW. ¼ sec. 28, T. 40 N., R. 1 E., in Ashland County, about 6 miles northeast of Butternut and 7 miles upstream from Park Falls.

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

RECORDS AVAILABLE.—July 30, 1914, to September 30, 1915.

GAGE.—Vertical cast-iron staff gage attached to posts driven into the right bank of river; read twice daily, morning and evening, to quarter-tenths, by Miss Mathilda Schultz.

DISCHARGE MEASUREMENTS.—Made from a cable about 1,500 feet downstream from the gage.

CHANNEL AND CONTROL.—Channel at the gage composed of mud and rock; left bank is low and likely to overflow; right bank slopes back gradually to high-water mark; at the cable site, 1,500 feet below the gage, the channel is rocky and the banks high. Control is head of Schultz Rapids, 1,700 feet below the gage.

EXTREMES OF DISCHARGE.—1914–1915: Maximum stage recorded, 6.2 feet at 1 p. m. June 10, 1915 (discharge, 2,840 second-feet); minimum discharge, 365 second-feet, recorded by measurement November 19, 1914.

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

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

ACCURACY.—Rating curve well defined over range in stage covered by gage heights; no diurnal fluctuation; channel permanent; open-water records excellent.

*Discharge measurements of Flambeau River near Butternut, Wis., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Nov. 19[a] | G. H. Canfield | 1.62 | 365 | Apr. 8[b] | M. F. Rather | 2.00 | 512 |
| Jan. 7[b] | M. F. Rather | 1.65 | 466 | Apr. 15 | S. B. Soulé | 3.85 | 1,310 |
| Feb. 4[b] | H. C. Beckman | 1.68 | 385 | June 9 | do | 5.94 | 2,640 |
| Mar. 12[b] | G. H. Canfield | 1.94 | 408 | Aug. 12 | H. T. Chritchlow | 2.55 | 702 |

[a] Partial ice cover, control practically open. [b] Measurement made through complete ice cover.

*Daily discharge, in second-feet, of Flambeau River near Butternut, Wis., for the years ending Sept. 30, 1914–1915.*

| Day. | July. | Aug. | Sept. | Day. | July. | Aug. | Sept. | Day. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1914. | | | | 1914. | | | | 1914. | | | |
| 1 | ..... | 725 | 962 | 11 | ..... | 940 | 805 | 21 | ..... | 985 | 1,120 |
| 2 | ..... | 673 | 962 | 12 | ..... | 940 | 814 | 22 | ..... | 940 | 1,300 |
| 3 | ..... | 624 | 940 | 13 | ..... | 1,010 | 810 | 23 | ..... | 1,010 | 1,220 |
| 4 | ..... | 616 | 940 | 14 | ..... | 1,010 | 895 | 24 | ..... | 1,050 | 1,220 |
| 5 | ..... | 616 | 940 | 15 | ..... | 962 | 1,100 | 25 | ..... | 1,030 | 1,170 |
| 6 | ..... | 577 | 918 | 16 | ..... | 1,030 | 1,120 | 26 | ..... | 1,030 | 1,140 |
| 7 | ..... | 577 | 918 | 17 | ..... | 1,080 | 1,220 | 27 | ..... | 1,050 | 1,100 |
| 8 | ..... | 547 | 859 | 18 | ..... | 1,100 | 1,220 | 28 | ..... | 985 | 1,050 |
| 9 | ..... | 518 | 832 | 19 | ..... | 1,050 | 1,220 | 29 | ..... | 962 | 1,030 |
| 10 | ..... | 841 | 760 | 20 | ..... | 985 | 1,170 | 30 | 764 | 890 | 940 |
| | | | | | | | | 31 | 774 | 859 | ..... |

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1914–15. | | | | | | | | | | | | |
| 1 | 940 | 682 | | | | | | 872 | 1,010 | 1,220 | 554 | 805 |
| 2 | 886 | 682 | | | | | | 850 | 940 | 1,170 | 592 | 805 |
| 3 | 841 | 682 | | | | | | 850 | 886 | 1,080 | 673 | 760 |
| 4 | 796 | 699 | | | | | | 940 | 841 | 1,030 | 805 | 716 |
| 5 | 787 | 707 | | | | | 430 | 985 | 805 | 940 | 850 | 716 |
| 6 | 751 | 699 | 495 | 430 | 380 | 385 | | 940 | 2,070 | 850 | 895 | 673 |
| 7 | 734 | 694 | | | | | | 1,080 | 2,210 | 716 | 940 | 673 |
| 8 | 742 | 751 | | | | | | 1,200 | 2,560 | 673 | 895 | 632 |
| 9 | 738 | 814 | | | | | 449 | 1,280 | 2,700 | 632 | 850 | 632 |
| 10 | 738 | 823 | | | | | 914 | 1,250 | 2,840 | 592 | 805 | 592 |
| 11 | 782 | 796 | | | | | 1,380 | 1,080 | 2,700 | 632 | 805 | 592 |
| 12 | 769 | 782 | | | | | 1,410 | 1,080 | 2,490 | 673 | 716 | 554 |
| 13 | 738 | 734 | | | | | 1,440 | 1,010 | 2,350 | 716 | 673 | 592 |
| 14 | 751 | 751 | | | | | 1,370 | 940 | 2,210 | 760 | 673 | 716 |
| 15 | 751 | 764 | | | | | 1,300 | 940 | 2,000 | 805 | 716 | 805 |
| 16 | 738 | 716 | 445 | 430 | 380 | 395 | 1,330 | 1,170 | 1,940 | 850 | 716 | 850 |
| 17 | 738 | | | | | | 1,330 | 1,380 | 1,870 | 850 | 760 | 895 |
| 18 | 699 | | | | | | 1,330 | 1,440 | 1,680 | 760 | 760 | 940 |
| 19 | 707 | 400 | | | | | 1,300 | 1,300 | 1,870 | 805 | 760 | 940 |
| 20 | 694 | | | | | | 1,280 | 1,200 | 1,940 | 805 | 760 | 940 |
| 21 | 694 | | | | | | 1,220 | 1,200 | 1,800 | 760 | 760 | 895 |
| 22 | 657 | | | | | | 1,120 | 1,500 | 1,800 | 716 | 760 | 850 |
| 23 | 632 | | | | | | 1,120 | 1,620 | 1,740 | 716 | 716 | 850 |
| 24 | 632 | | | | | | 1,100 | 1,620 | 1,620 | 716 | 760 | 940 |
| 25 | 665 | | | | | | 1,080 | 1,560 | 1,500 | 716 | 805 | 940 |
| 26 | 648 | 460 | 395 | 420 | 390 | 375 | 1,030 | 1,380 | 1,380 | 760 | 805 | 1,120 |
| 27 | 632 | | | | | | 1,010 | 1,330 | 1,330 | 716 | 850 | 1,120 |
| 28 | 632 | | | | | | 1,030 | 1,220 | 1,280 | 632 | 805 | 1,120 |
| 29 | 657 | | | | | | 1,030 | 1,220 | 1,280 | 632 | 850 | 1,120 |
| 30 | 682 | | | | | | 985 | 1,120 | 1,280 | 592 | 850 | 1,120 |
| 31 | 682 | | | | | | ..... | 1,050 | ..... | 592 | 850 | ..... |

NOTE.—Discharge July 30 to Nov. 16, 1914, and Apr. 9 to Sept. 30, 1915, except Apr. 10, 12, 14, and 17, determined from a well-defined rating curve; discharge Apr. 10, 12, and 14 interpolated. Discharge Nov. 17 to Apr. 8 estimated, because of ice, from discharge measurements and weather records, the observer's notes not being used on account of unstability of gage during winter period; braced figures show mean discharge for period indicated.

*Monthly discharge of Flambeau River near Butternut, Wis., for the years ending Sept. 30, 1914–1915.*

[Drainage area 660 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| 1914. | | | | | | |
| August | 1,100 | 518 | 878 | 1.33 | 1.53 | A. |
| September | 1,300 | 760 | 1,020 | 1.55 | 1.73 | A. |
| 1914–15. | | | | | | |
| October | 940 | 632 | 727 | 1.10 | 1.27 | A. |
| November | 823 | ..... | 599 | .908 | 1.01 | B. |
| December | ..... | ..... | 443 | .671 | .77 | C. |
| January | ..... | ..... | 426 | .645 | .74 | C. |
| February | ..... | ..... | 383 | .580 | .60 | C. |
| March | ..... | ..... | 385 | .583 | .67 | C. |
| April | 1,440 | ..... | 967 | 1.47 | 1.64 | C. |
| May | 1,620 | 850 | 1,180 | 1.79 | 2.06 | A. |
| June | 2,840 | 805 | 1,760 | 2.67 | 2.98 | A. |
| July | 1,220 | 592 | 778 | 1.18 | 1.36 | A. |
| August | 940 | 554 | 774 | 1.18 | 1.36 | A. |
| September | 1,120 | 554 | 830 | 1.26 | 1.41 | A. |
| The year | 2,840 | ..... | 772 | 1.17 | 15.87 | |

FLAMBEAU RIVER NEAR LADYSMITH, WIS.

LOCATION.—In sec. 20, T. 35 N., R. 5. W., Rusk County, at H. J. Cornelissen's farm, about 6 miles by road northeast of Ladysmith, 20 miles above mouth of river, and 19 miles below mouth of South Fork of Flambeau River,[1] coming in from the right.

DRAINAGE AREA.—1,940 square miles (measured on Wisconsin Geological and Natural History Survey map, edition of 1911; scale, 1 inch=6 miles).

RECORDS AVAILABLE.—January 2, 1914, to September 30, 1915. 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 the dam of the Menasha Pulp Co. and about 6 miles below the present station.

GAGE.—Chain, fastened to a cantilever arm, supported by two trees on the left bank of the river, on the farm of H. J. Cornelissen; read twice daily, morning and afternoon, to quarter-tenths by H. J. Cornelissen.

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

CHANNEL AND CONTROL.—Channel, 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 are medium high, wooded, and do not overflow; control not well defined, formed by the channel below the gage.

EXTREMES OF DISCHARGE.—Maximum stage when channel was clear of ice and logs recorded during year, 7.2 feet at 7 p. m. May 17 (discharge, 9,520 second-feet); minimum discharge 552 second-feet, recorded by discharge neasurements made February 2. The absolute minimum discharge during the winter period probably is somewhat lower.

1903–1906 and 1914–1915: Maximum discharge recorded, 12,800 second-feet May 28 and 29, 1903; minimum discharge, 390 second-feet December 4, 1904.

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

WINTER FLOW.—Discharge relation seriously affected by surface and slush ice; flow estimated from discharge measurements, observer's notes, and weather records.

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

ACCURACY.—Rating curve fairly well developed over a range in stage covered by 95 per cent of the gage heights. Control permanent; no marked diurnal fluctuation; open-water records good; winter records only fair owing to presence of surface and slush ice, which makes it extremely difficult to measure the discharge accurately and which causes more than a usual amount of backwater at the gage.

*Discharge measurements of Flambeau River near Ladysmith, Wis., during the yeer ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Nov. 6 | H. C. Beckman | 2.65 | 1,290 | Apr. 6[a] | M. F. Rather | 4.20 | 1,330 |
| Jan. 6[a] | M. F. Rather | 3.88 | 646 | 14 | S. B. Soulé | 4.95 | 4,240 |
| Feb. 2[a] | H. C. Beckman | 3.70 | 552 | June 11 | ....do | 5.23 | 5,030 |
| Mar. 18[a] | ....do | 3.75 | 599 | Aug. 20 | H. C. Beckman | 3.38 | 2,160 |

[a] Made through complete ice cover; ice on control.

*Daily discharge, in second-feet, of Flambeau River near Ladysmith, Wis., for the years ending Sept. 30, 1914-1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1913-14. | | | | | | | | | | | | |
| 1 | | | | | | | | 7,840 | 2,770 | 5,440 | 1,450 | 2,050 |
| 2 | | | | | | | | 6,500 | 2,370 | 4,760 | 1,240 | 2,280 |
| 3 | | | | | | | | 6,320 | 2,090 | 4,600 | 1,240 | 2,510 |
| 4 | | | | | | | | 5,440 | 3,180 | 4,200 | 1,220 | 2,490 |
| 5 | | | | | | | | 4,760 | 3,110 | 3,480 | 1,020 | 2,330 |
| 6 | | | | | | | 1,000 | 4,760 | 3,400 | 3,330 | 944 | 2,220 |
| 7 | | | | | | | | 4,120 | 2,900 | 3,260 | 972 | 2,130 |
| 8 | | | | | 860 | 640 | | 4,200 | 2,770 | 2,200 | 1,030 | 2,020 |
| 9 | | | | | | | | 4,200 | 2,410 | 1,930 | 916 | 1,890 |
| 10 | | | | | | | | 4,280 | 2,150 | 1,800 | 963 | 1,730 |
| 11 | | | | | | | | 3,960 | 1,860 | 1,660 | 1,010 | 1,860 |
| 12 | | | | | | | | 3,880 | 1,560 | 1,630 | 1,360 | 2,030 |
| 13 | | | | | | | | 3,880 | 1,430 | 2,170 | 1,620 | 2,170 |
| 14 | | | | | | | 2,000 | 3,640 | 1,320 | 2,450 | 1,670 | 2,280 |
| 15 | | | | | | | | 3,480 | 1,230 | 2,590 | 1,780 | 2,770 |
| 16 | | | | 1,100 | | | | 3,640 | 1,340 | 2,560 | 1,890 | 3,480 |
| 17 | | | | | | | | 3,640 | 1,080 | 2,430 | 1,930 | 3,560 |
| 18 | | | | | | | 2,700 | 3,640 | 1,120 | 2,130 | 2,030 | 3,960 |
| 19 | | | | | | | 3,640 | 3,180 | 1,190 | 2,010 | 1,860 | 3,880 |
| 20 | | | | | | | 3,330 | 3,960 | 1,340 | 1,850 | 2,540 | 3,260 |
| 21 | | | | | | | 3,480 | 3,400 | 1,230 | 1,720 | 2,510 | 3,110 |
| 22 | | | | | | | 2,900 | 3,480 | 1,060 | 1,600 | 2,270 | 2,970 |
| 23 | | | | | 750 | 630 | 2,900 | 2,330 | 1,160 | 1,520 | 2,340 | 3,480 |
| 24 | | | | | | | 2,840 | 2,220 | 2,200 | 1,460 | 2,720 | 3,480 |
| 25 | | | | | | | 3,960 | 2,250 | 4,440 | 2,020 | 2,970 | 3,330 |
| 26 | | | | | | | 4,200 | 2,130 | 5,100 | 1,620 | 2,760 | 2,970 |
| 27 | | | | | | | 4,930 | 1,930 | 5,610 | 1,930 | 2,610 | 2,760 |
| 28 | | | | | | | 6,680 | 1,910 | 6,140 | 1,770 | 2,500 | 2,540 |
| 29 | | | | | | | 9,640 | 3,960 | 5,960 | 1,600 | 2,320 | 2,440 |
| 30 | | | | | | | 9,240 | 3,480 | 5,710 | 1,470 | 2,250 | 2,150 |
| 31 | | | | | | | ..... | 2,970 | ..... | 1,460 | 2,080 | ..... |

*Daily discharge, in second-feet, of Flambeau River near Ladysmith, Wis., for the years ending Sept. 30, 1914–1915*—Continued.

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1914–15. | | | | | | | | | | | | |
| 1 | 1,970 | 1,280 | | | | | | 2,800 | 2,400 | 2,090 | 1,190 | 1,430 |
| 2 | 1,960 | 1,230 | | | | | | 2,500 | 2,140 | 2,040 | 1,100 | 1,410 |
| 3 | 1,790 | 1,230 | | | | | | 2,640 | 2,050 | 1,900 | 1,400 | 1,410 |
| 4 | 1,650 | 1,230 | | | | | | 2,840 | 1,860 | 1,740 | 1,930 | 1,250 |
| 5 | 1,580 | 1,320 | | | | | | 3,040 | 1,810 | 1,620 | 2,770 | 1,220 |
| 6 | 1,460 | 1,250 | 880 | 480 | 690 | 855 | 1,770 | 2,870 | 1,910 | 1,730 | 3,180 | 1,250 |
| 7 | 1,600 | 1,320 | | | | | | 3,110 | 3,110 | 1,540 | 3,180 | 963 |
| 8 | 1,690 | 1,340 | | | | | | 3,720 | 3,960 | 1,470 | 2,840 | 889 |
| 9 | 1,720 | 1,320 | | | | | | 4,120 | 4,440 | 1,360 | 2,540 | 1,030 |
| 10 | 1,730 | 1,210 | | | | | | 4,200 | 4,440 | 1,360 | 2,210 | 944 |
| 11 | 1,930 | 1,350 | | | | | | 3,960 | 4,930 | 1,620 | 2,040 | 853 |
| 12 | 2,080 | 1,340 | | | | | | 3,960 | 4,600 | 1,660 | 1,840 | 889 |
| 13 | 2,200 | 1,440 | | | | | 5,100 | 3,960 | 4,440 | 1,380 | 1,650 | 1,010 |
| 14 | 2,030 | 1,350 | | | | | 4,760 | 4,120 | 4,280 | 1,580 | 1,470 | 1,220 |
| 15 | 1,980 | 1,350 | 635 | 480 | 1,030 | 910 | 4,200 | 4,200 | 3,960 | 1,970 | 1,330 | 1,650 |
| 16 | 1,810 | | | | | | 4,120 | 6,140 | 3,560 | 2,450 | 1,400 | 1,910 |
| 17 | 1,720 | | | | | | 3,720 | 9,240 | 3,330 | 2,580 | 1,440 | 2,210 |
| 18 | 1,580 | | | | | | 3,640 | 5,440 | 3,040 | 2,440 | 1,500 | 2,330 |
| 19 | 1,560 | | | | | | 3,800 | 5,100 | 3,800 | 2,270 | 1,350 | 2,270 |
| 20 | 1,460 | | | | | | 3,960 | 4,120 | 4,200 | 2,090 | 1,360 | 2,170 |
| 21 | 1,540 | | | | | | 3,800 | 4,280 | 4,200 | 1,780 | 1,250 | 1,980 |
| 22 | 1,450 | | | | | | 3,800 | 5,610 | 4,120 | 1,840 | 1,180 | 1,890 |
| 23 | 1,380 | | | | | | 3,610 | 6,140 | 3,800 | 1,500 | 1,130 | 1,810 |
| 24 | 1,430 | 1,050 | | | | | 3,420 | 5,440 | 3,480 | 1,460 | 1,330 | 1,690 |
| 25 | 1,460 | | | | | | 3,230 | 5,440 | 3,330 | 1,490 | 1,230 | 1,850 |
| 26 | 1,450 | | 665 | 615 | 875 | 755 | 3,040 | 5,100 | 2,870 | 1,470 | 1,320 | 2,490 |
| 27 | 1,470 | | | | | | 2,900 | 4,280 | 2,540 | 1,490 | 1,140 | 3,260 |
| 28 | 1,350 | | | | | | 3,260 | 3,560 | 2,340 | 1,470 | 1,210 | 3,330 |
| 29 | 1,400 | | | | | | 3,180 | 3,180 | 2,200 | 1,560 | 1,350 | 3,180 |
| 30 | 1,360 | | | | | | 3,040 | 3,040 | 2,150 | 1,250 | 1,440 | 3,180 |
| 31 | 1,300 | | | | | | ..... | 2,630 | ..... | 1,180 | 1,360 | ..... |

NOTE.—Discharge, except as noted below, determined from a rating curve well defined between 1,020 and 6,140 second-feet above 6,140 second-feet curve is based on an extension of the area and mean velocity curves and is approximate only. Discharge Jan. 1 to Apr. 17, 1914, and Nov. 16, 1914, to Apr. 12, 1915, estimated, because of ice, from discharge measurements, observer's notes, and weather records. Braced figures show mean discharge for period indicated. Discharge Apr. 23–25, 1915, interpolated because of backwater from logs.

*Monthly discharge of Flambeau River near Ladysmith, Wis., for the years ending Sept. 30, 1914–1915.*

[Drainage area, 1,940 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| 1914. | | | | | | |
| January | ..... | ..... | 1,100 | 0.567 | 0.65 | D. |
| February | ..... | ..... | 809 | .417 | .43 | D. |
| March | ..... | ..... | 635 | .327 | .38 | D. |
| April | 9,640 | ..... | 2,810 | 1.45 | 1.62 | C. |
| May | 7,840 | 1,910 | 3,850 | 1.98 | 2.28 | B. |
| June | 6,140 | 1,060 | 2,640 | 1.36 | 1.52 | A. |
| July | 5,440 | 1,460 | 2,410 | 1.24 | 1.43 | A. |
| August | 2,970 | 916 | 1,810 | .933 | 1.08 | A. |
| September | 3,960 | 1,730 | 2,670 | 1.38 | 1.54 | A. |
| 1914–15. | | | | | | |
| October | 2,200 | 1,300 | 1,650 | 0.851 | 0.98 | A. |
| November | 1,440 | ..... | 1,180 | .608 | .68 | B. |
| December | ..... | ..... | 725 | .374 | .43 | D. |
| January | ..... | ..... | 528 | .272 | .31 | C. |
| February | ..... | ..... | 864 | .445 | .46 | C. |
| March | ..... | ..... | 837 | .431 | .50 | C. |
| April | 5,100 | ..... | 2,930 | 1.51 | 1.68 | C. |
| May | 9,240 | 2,500 | 4,220 | 2.51 | 2.51 | A. |
| June | 4,930 | 1,810 | 3,310 | 2.18 | 1.91 | A. |
| July | 2,580 | 1,180 | 1,720 | .887 | 1.02 | A. |
| August | 3,180 | 1,100 | 1,670 | .861 | .99 | A. |
| September | 3,330 | 853 | 1,770 | .912 | 1.02 | A. |
| The year | 9,240 | ..... | 1,780 | .918 | 12.49 | |

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 the confluence of Jump and Chippewa rivers.

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

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

GAGE.—Chain gage bolted to downstream side of hand rail of bridge.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge.

CHANNEL AND CONTROL.—Heavy gravel, clean, and free from vegetation; right bank high and will not overflow; left bank may overflow occasionally.

EXTREMES OF STAGE.—Maximum stage recorded during part of year ending September 30, 1915, 7.82 feet at 7 a. m. August 5; minimum stage recorded, 3.10 feet, Sept. 6, 7, 8, and 9.

WINTER FLOW.—Discharge relation seriously affected by ice; flow to be determined from discharge measurements, observer's notes, and weather records.

ACCURACY.—Channel conditions permanent; gage records reliable.

The following discharge measurement was made by H. C. Beckman.

July 22, 1915: Gage height, 3.90 feet; discharge, 483 second-feet.

Data insufficient for estimates of daily discharge.

*Daily gage height, in feet, of Jump River at Sheldon, Wis., for the year ending Sept. 30, 1915.*

| Day. | July. | Aug. | Sept. | Day. | July. | Aug. | Sept. | Day. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 3.41 | 3.28 | 11 | | 4.4 | 3.12 | 21 | | 3.24 | 4.3 |
| 2 | | 4.0 | 3.21 | 12 | | 4.05 | 3.12 | 22 | 3.92 | 3.21 | 4.15 |
| 3 | | 6.1 | 3.18 | 13 | | 3.82 | 3.15 | 23 | 3.76 | 3.21 | 3.99 |
| 4 | | 7.2 | 3.15 | 14 | | 3.69 | 3.36 | 24 | 3.74 | 3.20 | 3.88 |
| 5 | | 7.8 | 3.15 | 15 | | 3.56 | 5.8 | 25 | 4.3 | 3.18 | 3.79 |
| 6 | | 7.4 | 3.11 | 16 | | 3.51 | 6.1 | 26 | 4.4 | 3.15 | 5.15 |
| 7 | | 6.7 | 3.10 | 17 | | 3.42 | 5.65 | 27 | 4.15 | 3.14 | 5.7 |
| 8 | | 6.1 | 3.11 | 18 | | 3.35 | 5.15 | 28 | 3.89 | 3.12 | 5.35 |
| 9 | | 5.5 | 3.14 | 19 | | 3.30 | 4.7 | 29 | 3.76 | 3.22 | 4.95 |
| 10 | | 4.85 | 3.15 | 20 | | 3.28 | 4.4 | 30 | 3.65 | 3.28 | 4.6 |
| | | | | | | | | 31 | 3.51 | 3.28 | ..... |

EAU CLAIRE RIVER NEAR AUGUSTA, WIS.

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

DRAINAGE AREA.—500 square miles.

RECORDS AVAILABLE.—July 16, 1914, to September 30, 1915.

GAGE.—Chain gage on downstream side of bridge; read once daily in the morning to quarter-tenths 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.—The channel at the bridge and above is sandy and very shifting; a short distance below the gage the channel narrows and a rock outcrop overlain with large bowlders forms the control. Banks high and not subject to overflow.

EXTREMES OF DISCHARGE.—1914–1915: Maximum stage recorded, 7.7 feet at 9 a. m. May 23, 1915 (discharge, 4,370 second-feet); minimum discharge 55 second-feet; recorded by measurement made December 30, 1914, and Janunary 28, 1915.

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

REGULATION.—No dams are at present in operation above the station; flow natural.
ACCURACY.—Excellent rating curve developed over range covered by gage heights; control apparently permanent; no diurnal fluctuation; records good.

*Discharge measurements of Eau Claire River near Augusta, Wis., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Nov. 10 | H. C. Beckman | 0.83 | 174 | Apr. 8 | H. C. Beckman | 5.59 | 2,480 |
| Dec. 30[a] | G. H. Canfield | 1.25 | 55 | 8 | do | 5.52 | 2,400 |
| Jan. 28[a] | H. C. Beckman | 1.14 | 55 | July 1 | W. G. Hoyt | .81 | 167 |
| Mar. 4[a] | do | 1.87 | 137 | Sept. 10 | H. T. Critchlow | .46 | 86.1 |
| Apr. 3 | M. F. Rather | 2.25 | 613 | 10 | do | .46 | 84.4 |

[a] Made through complete ice cover.

*Daily discharge, in second-feet, of Eau Claire River near Augusta, Wis., for the years ending Sept. 30, 1914–1915.*

| Day. | July. | Aug. | Sept. | Day. | July. | Aug. | Sept. | Day. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1914. | | | | 1914. | | | | 1914. | | | |
| 1 | ..... | 119 | 138 | 12 | ..... | 91 | 523 | 22 | 167 | 191 | 530 |
| 2 | ..... | 119 | 179 | 13 | ..... | 85 | 463 | 23 | 179 | 239 | 866 |
| 3 | ..... | 119 | 179 | 14 | ..... | 85 | 634 | 24 | 191 | 269 | 710 |
| 4 | ..... | 114 | 155 | 15 | ..... | 75 | 1,890 | 25 | 172 | 239 | 634 |
| 5 | ..... | 107 | 162 | 16 | 446 | 85 | 2,840 | 26 | 155 | 191 | 513 |
| 6 | ..... | 95 | 1,040 | 17 | 365 | 179 | 1,690 | 27 | 143 | 167 | 397 |
| 7 | ..... | 95 | 947 | 18 | 275 | 191 | 1,510 | 28 | 143 | 155 | 333 |
| 8 | ..... | 95 | 530 | 19 | 234 | 239 | 990 | 29 | 131 | 138 | 295 |
| 9 | ..... | 95 | 365 | 20 | 179 | 227 | 710 | 30 | 131 | 119 | 254 |
| 10 | ..... | 95 | 301 | 21 | 179 | 191 | 496 | 31 | 131 | 107 | ..... |
| 11 | ..... | 95 | 414 | | | | | | | | |

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1914–15. | | | | | | | | | | | | |
| 1 | 227 | 215 | | | | | 430 | 349 | 269 | 179 | 381 | 105 |
| 2 | 210 | 210 | | | | | 496 | 301 | 239 | 160 | 365 | 100 |
| 3 | 196 | 203 | | | | | 598 | 365 | 227 | 136 | 886 | 93 |
| 4 | 186 | 203 | | | | | 990 | 748 | 215 | 136 | 1,630 | 93 |
| 5 | 179 | 203 | | | | | 1,460 | 748 | 215 | 136 | 2,310 | 93 |
| 6 | 167 | 203 | 190 | 59 | 75 | 155 | 2,520 | 672 | 381 | 148 | 2,380 | 87 |
| 7 | 191 | 186 | | | | | 3,320 | 786 | 1,760 | 160 | 1,400 | 87 |
| 8 | 710 | 179 | | | | | 2,450 | 1,180 | 1,080 | 136 | 1,040 | 87 |
| 9 | 826 | 179 | | | | | 1,890 | 1,080 | 826 | 179 | 767 | 87 |
| 10 | 634 | 172 | | | | | 1,820 | 826 | 826 | 148 | 520 | 87 |
| 11 | 710 | 167 | | | | | 1,760 | 634 | 1,820 | 141 | 407 | 87 |
| 12 | 886 | 172 | | | | | 1,510 | 513 | 1,760 | 136 | 317 | 87 |
| 13 | 1,180 | 179 | | | | | 1,290 | 414 | 990 | 124 | 349 | 117 |
| 14 | 2,030 | 191 | | | | | 1,080 | 397 | 826 | 112 | 349 | 282 |
| 15 | 1,510 | 215 | | | | | 990 | 381 | 634 | 131 | 317 | 493 |
| 16 | 990 | 285 | 140 | 62 | 175 | 260 | 947 | 672 | 530 | 368 | 248 | 417 |
| 17 | 748 | 191 | | | | | 1,040 | 1,290 | 463 | 257 | 215 | 339 |
| 18 | 598 | | | | | | 906 | 1,290 | 463 | 229 | 191 | 251 |
| 19 | 513 | | | | | | 748 | 1,180 | 1,080 | 210 | 167 | 220 |
| 20 | 463 | | | | | | 672 | 1,040 | 1,290 | 181 | 160 | 189 |
| 21 | 397 | | | | | | 598 | 1,890 | 906 | 157 | 143 | 165 |
| 22 | 365 | | | | | | 530 | 4,250 | 672 | 157 | 131 | 148 |
| 23 | 333 | | | | | | 480 | 4,370 | 564 | 157 | 131 | 141 |
| 24 | 317 | 200 | | | | | 463 | 2,030 | 430 | 169 | 150 | 124 |
| 25 | 317 | | | | | 755 | 430 | 1,400 | 349 | 162 | 126 | 117 |
| 26 | 333 | | 75 | 56 | 420 | | 430 | 826 | 285 | 193 | 119 | 124 |
| 27 | 285 | | | | | | 414 | 634 | 239 | 169 | 112 | 129 |
| 28 | 269 | | | | | 826 | 496 | 496 | 203 | 295 | 107 | 141 |
| 29 | 239 | | | | | 598 | 496 | 463 | 191 | 314 | 107 | 141 |
| 30 | 227 | | | | | 496 | 414 | 381 | 227 | 229 | 112 | 29 |
| 31 | 215 | | | | | 463 | ..... | 301 | ..... | 225 | 107 | ..... |

NOTE.—Discharge computed as follows: July 16 to Nov. 17, 1914, and Mar. 28 to Sept. 30, 1915, except Apr. 10, from a rating curve well defined between 57 and 2,760 second-feet; rating curve above 2,760 second-feet approximate, being based on extension of curve and mean velocity curves. Discharge for Apr. 10 interpolated. Discharge Nov. 18 to Mar. 27 estimated, because of ice, from discharge measurements, observer's notes and weather records. Braced figures show mean discharge for period included.

*Monthly discharge of Eau Claire River near Augusta, Wis., for the years ending Sept. 30, 1914–1915.*

[Drainage area, 500 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| July 16–31 | 446 | 131 | 201 | 0.402 | 0.24 | A. |
| August | 269 | 75 | 142 | .284 | .33 | A. |
| September | 2,840 | 138 | 690 | 1.38 | 1.54 | A. |
| October | 2,030 | 167 | 531 | 1.06 | 1.22 | A. |
| November | 285 | ..... | 198 | .396 | .44 | B. |
| December | ..... | ..... | 133 | .266 | .31 | C. |
| January | ..... | ..... | 58.9 | .118 | .14 | C. |
| February | ..... | ..... | 209 | .418 | .44 | C. |
| March | ..... | ..... | 381 | .762 | .88 | C. |
| April | 3,320 | 414 | 1,060 | 2.12 | 2.36 | B. |
| May | 4,370 | 301 | 1,030 | 2.06 | 2.38 | A. |
| June | 1,820 | 191 | 665 | 1.33 | 1.48 | A. |
| July | 368 | 112 | 182 | .364 | .42 | A. |
| August | 2,380 | 107 | 508 | 1.02 | 1.18 | B. |
| September | 493 | 87 | 159 | .318 | .35 | B. |
| The year | 4,370 | ..... | 427 | .854 | 11.60 | |

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 the station.

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

RECORDS AVAILABLE.—March 10, 1914, to September 30, 1915.

GAGE.—Chain gage attached to the downstream side of the bridge; read twice daily, morning and evening, to quarter-tenths by Andrew Lundeguam.

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

CHANNEL AND CONTROL.—Rock and gravel; small amount of grass growth during summer months; left bank high and will not overflow; right bank medium high and may overflow during extremely high water; control not well defined.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 4.15 feet at 7 a. m. April 7 (discharge, 3,320 second-feet); minimum stage recorded, 0.80 foot at 5 p. m. November 19 (discharge, approximately 385 second-feet).

1914–1915: Maximum stage recorded, 4.95 feet at 6.10 p. m. June 28, 1914 (discharge, 4,380 second-feet); minimum stage recorded, 0.80 foot November 19, 1914 (discharge, approximately 385 second-feet, apparently caused by the temporary holding back of the water by ice).

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

REGULATION.[1]—Flow regulated by the operation of reservoirs at the following dams: Long Lake, sec. 24, T. 37 N., R. 11 W., capacity 1,000,000,000 cubic feet; Cedar Lake, sec. 21, T. 36 N., R. 10 W., capacity 965,000,000 cubic feet; Birch Lake, sec. 25, T. 37 N., R. 10 W., capacity 1,174,000,000 cubic feet; Bear Lake, sec. 7, T. 36 N., R. 11 W., capacity 280,000,000 cubic feet; and Chetac Lake, sec. 20, T. 33 N., R. 10 W., capacity 998,000,000 cubic feet.

ACCURACY.—Rating curve very well defined above 560 second-feet; channel fairly permanent; no diurnal fluctuation; records good.

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

*Discharge measurements of Red Cedar River near Colfax, Wis., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Nov. 7 | H. C. Beckman | 1.42 | 619 | Mar. 6[b] | H. C. Beckman | 2.80 | 758 |
| Dec. 29[a] | G. H. Canfield | 2.70 | 534 | May 14 | S. B. Soulé | 1.62 | 757 |
| Jan. 27[a] | H. C. Beckman | 2.94 | 618 | Aug. 24 | do | 1.39 | 604 |

[a] Made through complete ice cover. [b] Made through partial ice cover.

*Daily discharge, in second-feet, of Red Cedar River near Colfax, Wis., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 670 | 510 | 790 | | | | 1,010 | 730 | 610 | 730 | 790 | 560 |
| 2 | 670 | 470 | 670 | | | | 1,560 | 790 | 610 | 670 | 850 | 560 |
| 3 | 670 | 470 | 730 | | | | 1,980 | 850 | 610 | 730 | 1,460 | 560 |
| 4 | 730 | 730 | 730 | | | | 2,640 | 790 | 610 | 670 | 1,870 | 560 |
| 5 | 670 | 610 | 670 | | | | 2,880 | 730 | 610 | 610 | 1,760 | 560 |
| 6 | 730 | 610 | 610 | 535 | 775 | 1,080 | 3,000 | 760 | 730 | 610 | 1,190 | 510 |
| 7 | 730 | 610 | 610 | | | | 3,120 | 850 | 930 | 670 | 930 | 510 |
| 8 | 730 | 560 | 670 | | | | 2,640 | 790 | 1,370 | 610 | 1,010 | 560 |
| 9 | 610 | 435 | 730 | | | | 2,200 | 730 | 1,280 | 610 | 930 | 560 |
| 10 | 730 | 470 | 730 | | | | 2,090 | 610 | 850 | 610 | 730 | 510 |
| 11 | 930 | 435 | 670 | | | | 2,200 | 670 | 1,190 | 1,190 | 670 | 510 |
| 12 | 730 | 510 | 670 | | | | 1,980 | 730 | 850 | 1,280 | 670 | 510 |
| 13 | 790 | 560 | | | | | 1,370 | 790 | 930 | 790 | 670 | 510 |
| 14 | 790 | 510 | | | | | 1,370 | 730 | 790 | 730 | 610 | 670 |
| 15 | 730 | 670 | | | | 1,550 | 1,280 | 670 | 730 | 1,280 | 610 | 670 |
| 16 | 670 | 435 | 595 | 460 | 1,190 | | 1,190 | 1,100 | 730 | 1,010 | 610 | 610 |
| 17 | 610 | 395 | | | | | 1,190 | 1,370 | 670 | 790 | 610 | 610 |
| 18 | 670 | 435 | | | | | 1,100 | 1,760 | 930 | 730 | 610 | 560 |
| 19 | 610 | 385 | | | | 1,010 | 1,100 | 1,370 | 1,760 | 670 | 610 | 510 |
| 20 | 670 | 610 | | | | 870 | 930 | 1,460 | 1,980 | 730 | 560 | 510 |
| 21 | 610 | 730 | | | | 730 | 850 | 1,980 | 1,560 | 670 | 610 | 510 |
| 22 | 610 | 670 | | | | 670 | 790 | 1,760 | 1,560 | 670 | 560 | 510 |
| 23 | 670 | 510 | | | | 730 | 850 | 2,090 | 1,460 | 610 | 560 | 510 |
| 24 | 610 | 510 | | | | 670 | 790 | 1,660 | 1,100 | 670 | 610 | 510 |
| 25 | 670 | 610 | | | | 2,200 | 790 | 1,190 | 790 | 610 | 610 | 560 |
| 26 | 560 | 610 | 525 | 595 | 1,440 | 1,760 | 730 | 1,460 | 730 | 610 | 560 | 560 |
| 27 | 560 | 610 | | | | 1,370 | 930 | 610 | 730 | 610 | 560 | 510 |
| 28 | 610 | 730 | | | | 1,010 | 850 | 850 | 790 | 610 | 560 | 560 |
| 29 | 470 | 610 | | | | 850 | 790 | 850 | 930 | 610 | 670 | 510 |
| 30 | 560 | 670 | | | | 790 | 790 | 730 | 790 | 560 | 560 | 510 |
| 31 | 510 | ..... | | | | 930 | ..... | 610 | ..... | 560 | 610 | ..... |

NOTE.—Discharge computed as follows: Oct. 1 to Dec. 12, and Mar. 19 to Sept. 30, from a rating curve very well defined above 560 second-feet. Discharge Mar. 20 interpolated. Discharge Dec. 13 to Mar. 18 estimated, because of ice, from discharge measurements, observer's notes, and weather records. Braced figures show mean discharge for period included.

*Monthly discharge of Red Cedar River near Colfax, Wis., for the year ending Sept. 30, 1915.*

[Drainage area, 1,100 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 930 | 470 | 664 | 0.604 | 0.70 | A. |
| November | 730 | 385 | 556 | .505 | .56 | A. |
| December | 790 | ..... | 607 | .552 | .64 | B. |
| January | ..... | ..... | 532 | .484 | .56 | C. |
| February | ..... | ..... | 1,110 | 1.01 | 1.05 | C. |
| March | 2,200 | ..... | 1,190 | 1.08 | 1.24 | C. |
| April | 3,120 | 730 | 1,500 | 1.36 | 1.52 | A. |
| May | 2,090 | 610 | 1,030 | .936 | 1.08 | A. |
| June | 1,980 | 610 | 974 | .885 | .99 | A. |
| July | 1,280 | 560 | 726 | .660 | .76 | B. |
| August | 1,870 | 560 | 781 | .710 | .82 | B. |
| September | 670 | 510 | 546 | .496 | .55 | B. |
| The year | 3,120 | 385 | 849 | .772 | 10.47 | |

## 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, morning and evening, to tenths by Albert Malhus.

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 do not overflow.

EXTREMES OF STAGE.—Maximum stage recorded during year, 5.2 feet April 7; minimum stage, 1.0 foot August 22, 29, and September 5.

1909–1915: Maximum stage recorded, 5.8 feet April 4, 1913; minimum stage recorded, 0.6 foot December 15, 1912. Minimum stages are caused by operation of gates in dam above station.

WINTER FLOW.—Winters are severe in this locality, but discharge relation is apparently not greatly affected by ice, probably because of the rapids a short distance below the station, which ordinarily do not entirely freeze over.

REGULATION.—The operation of storage reservoirs in the headwaters of the river (see "Regulation" in station description for Red Cedar River at Colfax, Wis.), together with storage at the power plant above the gaging station, modifies the flow.

COOPERATION.—Gage-height record furnished by Wisconsin & Minnesota Light & Power Co.

*Daily gage height, in feet, of Red Cedar River at Cedar Falls, Wis., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.8 | 2.8 | 2.8 | 2.6 | 2.8 | 3.1 | 3.2 | 2.9 | 2.8 | 3.0 | 2.4 | 2.7 |
| 2 | 2.7 | 2.7 | 2.7 | 2.6 | 2.8 | 3.0 | 3.4 | 1.6 | 2.8 | 3.0 | 3.0 | 2.7 |
| 3 | 2.8 | 2.7 | 2.8 | 2.4 | 2.8 | 3.0 | 3.9 | 2.9 | 2.8 | 2.9 | 3.5 | 2.6 |
| 4 | 2.8 | 2.7 | 2.8 | 2.7 | 2.9 | 2.9 | 4.2 | 2.9 | 2.8 | 2.6 | 4.0 | 2.6 |
| 5 | 2.9 | 2.7 | 2.7 | 2.7 | 2.9 | 2.9 | 4.9 | 2.8 | 2.8 | 2.6 | 4.2 | 1.0 |
| 6 | 2.9 | 2.7 | 2.4 | 2.7 | 2.9 | 2.9 | 5.0 | 2.8 | 2.7 | 3.0 | 4.1 | 1.4 |
| 7 | 2.9 | 2.8 | 2.7 | 2.7 | 2.4 | 2.4 | 5.2 | 2.9 | 3.2 | 3.0 | 4.0 | 2.7 |
| 8 | 3.0 | 2.0 | 2.7 | 2.7 | 2.8 | 2.9 | 5.0 | 3.0 | 3.6 | 2.9 | 2.6 | 2.6 |
| 9 | 2.9 | 2.7 | 2.8 | 2.7 | 2.9 | 2.9 | 4.7 | 1.8 | 3.5 | 2.9 | 3.0 | 2.6 |
| 10 | 2.6 | 2.7 | 2.7 | 2.3 | 2.8 | 2.9 | 4.5 | 3.0 | 3.5 | 2.9 | 3.0 | 2.5 |
| 11 | 3.0 | 2.8 | 2.7 | 2.7 | 2.9 | 2.9 | 4.3 | 3.0 | 3.4 | 2.2 | 3.0 | 2.5 |
| 12 | 3.1 | 2.8 | 2.6 | 2.7 | 2.9 | 2.9 | 4.2 | 3.0 | 3.4 | 3.6 | 3.0 | 2.0 |
| 13 | 3.2 | 2.7 | 2.4 | 2.7 | 2.9 | 2.8 | 4.2 | 2.9 | 3.1 | 3.5 | 2.9 | 2.6 |
| 14 | 3.0 | 2.7 | 2.6 | 2.7 | 2.7 | 2.6 | 4.0 | 2.8 | 3.2 | 3.5 | 2.9 | 2.6 |
| 15 | 3.0 | 2.0 | 2.6 | 2.7 | 2.9 | 2.8 | 3.7 | 2.8 | 3.0 | 3.5 | 2.4 | 2.5 |
| 16 | 3.0 | 2.6 | 2.6 | 2.6 | 2.9 | 2.8 | 3.6 | 1.8 | 3.0 | 3.7 | 2.6 | 2.5 |
| 17 | 2.9 | 2.6 | 2.6 | 2.4 | 3.0 | 3.0 | 3.4 | 3.0 | 3.0 | 3.7 | 2.6 | 2.6 |
| 18 | 2.8 | 2.7 | 2.6 | 2.8 | 3.0 | 3.2 | 3.3 | 3.4 | 2.9 | 2.6 | 2.7 | 2.5 |
| 19 | 2.7 | 2.7 | 2.6 | 2.8 | 3.0 | 3.3 | 3.3 | 3.6 | 3.0 | 3.5 | 2.7 | 2.2 |
| 20 | 2.7 | 2.8 | 2.4 | 2.8 | 3.2 | 3.2 | 3.2 | 3.6 | 3.7 | 3.3 | 2.6 | 2.6 |
| 21 | 2.7 | 2.8 | 2.5 | 2.8 | 3.2 | 2.6 | 3.0 | 3.7 | 4.2 | 3.0 | 2.6 | 2.6 |
| 22 | 2.7 | 1.2 | 2.6 | 2.8 | 3.4 | 2.9 | 2.9 | 3.7 | 4.0 | 2.8 | 1.0 | 2.6 |
| 23 | 2.8 | 2.7 | 2.6 | 2.8 | 3.5 | 3.0 | 3.2 | 3.7 | 2.8 | 2.8 | 2.6 | 2.6 |
| 24 | 2.7 | 2.7 | 2.6 | 2.4 | 3.6 | 3.7 | 2.9 | 4.6 | 2.6 | 2.8 | 2.6 | 2.6 |
| 25 | 2.6 | 2.7 | 2.4 | 2.8 | 3.5 | 4.2 | 1.6 | 3.9 | 2.4 | 2.4 | 2.7 | 2.6 |
| 26 | 2.6 | 2.7 | 2.7 | 2.8 | 3.4 | 4.2 | 2.9 | 3.9 | 2.6 | 2.8 | 2.7 | 2.0 |
| 27 | 2.7 | 2.8 | 2.2 | 2.8 | 3.3 | 4.0 | 2.9 | 3.7 | 2.3 | 2.8 | 2.6 | 2.6 |
| 28 | 2.7 | 2.8 | 2.6 | 2.8 | 3.0 | 3.2 | 3.0 | 3.6 | 3.0 | 2.8 | 2.7 | 2.6 |
| 29 | 2.8 | 2.0 | 2.7 | 2.8 | ..... | 3.5 | 2.9 | 3.6 | 3.0 | 2.7 | 1.0 | 2.6 |
| 30 | 2.8 | 2.8 | 2.6 | 2.8 | ..... | 3.3 | 2.9 | 2.7 | 3.0 | 2.7 | 2.7 | 2.6 |
| 31 | 2.8 | ..... | 2.4 | 2.4 | ..... | 3.5 | ..... | 2.7 | ..... | 2.6 | 2.7 | ..... |

NOTE.—Low stage of 1.0 foot on Sunday, Aug. 22 and Sept. 5, caused by closing down of power plant; no water passing over spillway.

RED CEDAR RIVER AT MENOMONIE, WIS.

LOCATION.—Sec. 27, T. 28 N., R. 13 W., Dunn County, about 900 feet below the power house of the Wisconsin & Minnesota Light & Power Co., Menomonie, about 13 miles above the confluence of Red Cedar and Chippewa rivers. Wilson Creek discharges from the right into the service reservoir just above the station.

DRAINAGE AREA.—1,810 square miles (measured on Wisconsin Geological and Natural History Survey map, edition of 1911; scale, 1 inch=6 miles).

RECORDS AVAILABLE.—June 16, 1907, to September 5, 1908; May 9, 1913, to September 30, 1915.

GAGE.—Barrett & Lawrence water-stage recorder installed May 9, 1913, over a wooden intake and well on the right bank of the river about 1 mile above the 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.

DISCHARGE MEASUREMENTS.—Made from the highway bridge about 1 mile below the gage.

CHANNEL AND CONTROL.—Bed at gage composed of heavy gravel; left bank high and will not overflow; right bank of medium height and will overflow at flood stages; channel at measuring section sandy and liable to shift; both banks high at measuring section and will not overflow.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 5.13 feet from 7 to 10 p. m. April 7 (discharge, 6,140 second-feet); minimum stage recorded, 1.75 feet December 13 (discharge approximately 160 second-feet).

1907–8 and 1913–1915: Maximum discharge, 6,700 second-feet June 6, 1914; minimum discharge, 100 second-feet November 8, 1907.

WINTER FLOW.—Discharge relation not affected by ice, as the control is kept open by the flow of relatively warm water from the service reservoir immediately above the gage.

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 above Menomonie. (See "Regulation" in station description for Red Cedar River at Colfax, Wis.)

ACCURACY.—Rating curve well defined; mean stage accurately determined from recording gage; records excellent.

*Discharge measurements of Red Cedar River at Menomonie, Wis., during the year ending Sept. 30, 1915.*

[Made by W. G. Hoyt.]

| Date. | Gage height. | Discharge. |
|---|---|---|
| | *Feet.* | *Sec.-ft.* |
| July 12 | 2.87 | 1,490 |
| 12 | 2.88 | 1,520 |

*Daily discharge, in second-feet, of Red Cedar River at Menomonie, Wis., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1,250 | 519 | 1,080 | 830 | 734 | 1,610 | 1,700 | 1,150 | 1,330 | 1,540 | 890 | 1,060 |
| 2 | 1,180 | 854 | 1,030 | 929 | 955 | 1,610 | 2,520 | 1,250 | 1,290 | 1,430 | 1,490 | 1,070 |
| 3 | 1,160 | 916 | 1,100 | 830 | 955 | 1,370 | 2,880 | 1,230 | 1,180 | 1,160 | 2,160 | 1,080 |
| 4 | 686 | 878 | 1,060 | 806 | 955 | 1,360 | 4,180 | 1,320 | 1,160 | 968 | 2,330 | 1,050 |
| 5 | 1,370 | 890 | 1,120 | 1,010 | 1,080 | 1,390 | 4,860 | 1,370 | 890 | 698 | 3,220 | 806 |
| 6 | 1,150 | 890 | 794 | 1,080 | 1,080 | 1,350 | 5,600 | 1,320 | 758 | 1,480 | 3,320 | 674 |
| 7 | 1,220 | 794 | 1,060 | 942 | 1,050 | 1,100 | 5,600 | 1,260 | 1,100 | 1,520 | 2,520 | 734 |
| 8 | 1,180 | 614 | 1,070 | 981 | 1,020 | 1,490 | 5,340 | 1,250 | 2,060 | 1,290 | 1,880 | 806 |
| 9 | 1,260 | 942 | 1,060 | 955 | 929 | 1,390 | 4,520 | 1,370 | 1,730 | 1,260 | 2,110 | 890 |
| 10 | 1,330 | 1,050 | 1,080 | 770 | 854 | 1,400 | 3,960 | 1,370 | 2,130 | 1,220 | 1,610 | 890 |
| 11 | 890 | 866 | 916 | 746 | 968 | 1,300 | 3,360 | 1,320 | 1,610 | 686 | 1,390 | 866 |
| 12 | 1,580 | 878 | 722 | 942 | 942 | 1,150 | 3,460 | 1,250 | 1,860 | 1,290 | 1,180 | 854 |
| 13 | 1,680 | 866 | 398 | 968 | 968 | 1,180 | 2,790 | 1,120 | 1,400 | 2,330 | 1,150 | 758 |
| 14 | 1,420 | 782 | 590 | 929 | 942 | 1,060 | 2,470 | 1,370 | 1,440 | 1,780 | 1,120 | 981 |
| 15 | 1,220 | 578 | 686 | 866 | 1,110 | 1,440 | 2,520 | 1,290 | 1,370 | 2,060 | 746 | 1,010 |
| 16 | 1,400 | 830 | 770 | 929 | 1,290 | 1,430 | 2,160 | 981 | 1,280 | 2,420 | 994 | 916 |
| 17 | 1,010 | 903 | 698 | 878 | 1,230 | 1,360 | 2,080 | 1,290 | 1,140 | 2,290 | 1,230 | 1,150 |
| 18 | 1,030 | 916 | 830 | 710 | 1,370 | 1,540 | 1,640 | 2,190 | 1,290 | 1,800 | 1,080 | 1,080 |
| 19 | 981 | 782 | 818 | 942 | 1,500 | 1,760 | 1,910 | 2,330 | 1,550 | 1,640 | 782 | 818 |
| 20 | 1,260 | 968 | 554 | 929 | 1,490 | 1,840 | 1,800 | 2,370 | 2,350 | 1,400 | 1,020 | 981 |
| 21 | 1,110 | 942 | 770 | 1,020 | 1,620 | 1,790 | 1,490 | 2,290 | 2,980 | 1,360 | 854 | 916 |
| 22 | 1,030 | 566 | 878 | 890 | 2,050 | 1,670 | 1,460 | 3,160 | 2,450 | 1,250 | 614 | 916 |
| 23 | 1,030 | 722 | 854 | 806 | 2,630 | 1,550 | 1,250 | 2,700 | 2,090 | 1,150 | 994 | 968 |
| 24 | 1,030 | 890 | 842 | 770 | 2,300 | 1,740 | 1,350 | 3,360 | 1,910 | 1,110 | 1,430 | 968 |
| 25 | 806 | 818 | 626 | 842 | 2,000 | 3,070 | 1,080 | 2,700 | 1,540 | 1,020 | 1,070 | 929 |
| 26 | 1,100 | 614 | 674 | 1,070 | 2,110 | 3,740 | 1,370 | 2,240 | 1,400 | 1,070 | 662 | 903 |
| 27 | 1,150 | 686 | 626 | 1,020 | 1,850 | 3,260 | 1,540 | 2,000 | 854 | 1,260 | 710 | 770 |
| 28 | 1,070 | 806 | 818 | 1,100 | 1,440 | 2,660 | 1,400 | 2,160 | 994 | 1,260 | 794 | 994 |
| 29 | 916 | 542 | 968 | 966 | ..... | 2,140 | 1,500 | 1,520 | 1,520 | 1,050 | 530 | 1,030 |
| 30 | 1,010 | 968 | 981 | 832 | ..... | 1,840 | 1,400 | 1,150 | 1,550 | 929 | 955 | 830 |
| 31 | 854 | ..... | 903 | 698 | ..... | 1,730 | ..... | 1,190 | ..... | 890 | 1,030 | ..... |

NOTE.—Discharge determined from a rating curve well defined above 530 second-feet. The record of the water-stage recorder for Nov. 13–19 was lost and water-stage recorder was not working properly Feb. 5–11, Sept. 28–30; discharge for these periods determined from the gage reading at noon corrected by the relation that existed between the noon gage height and the mean daily gage height determined for the period when gage was working satisfactorily.

*Monthly discharge of Red Cedar River at Menomonie, Wis., for the year ending Sept. 30, 1915.*

[Drainage area, 1,810 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 1,680 | 686 | 1,140 | 0.630 | 0.73 | A. |
| November | 1,050 | 519 | 809 | .447 | .50 | A. |
| December | 1,120 | 398 | 851 | .470 | .54 | B. |
| January | 1,100 | 698 | 903 | .499 | .58 | B. |
| February | 2,630 | 734 | 1,340 | .740 | .77 | B. |
| March | 3,740 | 1,060 | 1,720 | .950 | 1.10 | B. |
| April | 5,600 | 1,080 | 2,640 | 1.46 | 1.63 | A. |
| May | 3,360 | 981 | 1,700 | .939 | 1.08 | A. |
| June | 2,980 | 758 | 1,540 | .851 | .95 | A. |
| July | 2,420 | 686 | 1,370 | .757 | .87 | A. |
| August | 3,320 | 530 | 1,350 | .746 | .86 | A. |
| September | 1,150 | 674 | 922 | .509 | .57 | A. |
| The year | 5,600 | 398 | 1,360 | .751 | 10.18 | |

## ZUMBRO RIVER AT ZUMBRO FALLS, MINN.

LOCATION.—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, 1915.

GAGE.—Chain attached to the upstream handrail of bridge near left end; read twice daily, to hundredths, 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 is fine sand; shifts considerably; a slight riffle a few hundred feet below gage acts as a rather indefinite control during low stages; right bank is fairly low and overflows during high flood stages; the left bank does not overflow.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 16.4 feet at 6 p. m. March 25 (discharge, 8,570 second-feet); minimum stage recorded during open-water periods, 4.68 feet at 8 a. m. January 18 and 22 (discharge, 148 second-feet). A flow of 106 second-feet, which is probably not far from the minimum flow for the year, was measured by current meter January 27.

1909–1915: Maximum stage recorded, 16.65 feet at 5.30 p. m. October 11, 1911 (discharge, 9,200 second-feet); 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; minimum stage recorded during open-water periods, 4.50 feet at 8 a. m. January 10 and 21, 1914 (discharge, approximately 128 second-feet; 106 second-feet was measured by current meter January 27, 1915).

WINTER FLOW.—Discharge relation not seriously affected by ice, except during and following 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. Mean flow for periods in which open-water rating curve is not applicable, estimated from discharge measurements, observer's notes, and weather records.

REGULATION.—The slight artificial regulation at the power plants above Zumbro Falls is not observable at the gage.

ACCURACY.—Results considered good; gage heights are reliable and represent the true mean stage for the day; rating curve is well defined; except for an occasional shift in control, results would be excellent.

*Discharge measurements of Zumbro River at Zumbro Falls, Minn., during the year ending Sept. 30, 1915.*

[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.* |
| Dec. 24[a] | 4.87 | 128 | May 27 | 6.86 | 864 | Aug. 21 | 5.67 | 385 |
| Jan. 27[b] | 4.80 | 106 | Aug. 5 | 9.66 | 2,460 | | | |

[a] Control partly ice covered; measurement made from bridge.
[b] Measurement made through complete ice cover 3,000 feet above gage; control partly ice covered.

*Daily discharge, in second-feet, of Zumbro River at Zumbro Falls, Minn., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 185 | 185 | 191 | | | 520 | 920 | 282 | 1,220 | 620 | 1,220 | 322 |
| 2 | 179 | 179 | 181 | | 120 | 500 | 920 | 282 | 920 | 520 | 2,100 | 322 |
| 3 | 179 | 185 | 177 | | | 449 | 870 | 282 | 540 | 483 | 3,020 | 322 |
| 4 | 169 | 185 | 187 | | | 398 | 1,430 | 308 | 620 | 466 | 3,260 | 308 |
| 5 | 169 | 185 | 187 | | 169 | 382 | 1,430 | 336 | 700 | 432 | 2,290 | 295 |
| 6 | 185 | 187 | 181 | | 145 | 336 | 1,270 | 366 | 1,550 | 432 | 1,610 | 295 |
| 7 | 187 | 187 | 181 | 140 | | 336 | 1,020 | 366 | 1,730 | 640 | 1,270 | 308 |
| 8 | 189 | 185 | 185 | | | 308 | 870 | 366 | 1,320 | 2,780 | 1,070 | 336 |
| 9 | 187 | 185 | 185 | | 150 | 322 | 780 | 336 | 970 | 1,430 | 870 | 351 |
| 10 | 210 | 179 | 169 | | | 483 | 700 | 322 | 920 | 1,270 | 780 | 466 |
| 11 | 233 | 177 | 169 | | | 740 | 700 | 308 | 1,790 | 970 | 700 | 500 |
| 12 | 245 | 187 | 167 | | 167 | 1,120 | 620 | 295 | 1,550 | 870 | 660 | 466 |
| 13 | 257 | 179 | | 165 | 187 | 1,220 | 580 | 282 | 1,790 | 740 | 620 | 540 |
| 14 | 270 | 177 | | 169 | 540 | 1,430 | 540 | 270 | 1,320 | 640 | 640 | 820 |
| 15 | 270 | 177 | | 167 | 398 | 1,320 | 500 | 282 | 920 | 580 | 600 | 820 |
| 16 | 257 | 165 | | 162 | 322 | 1,320 | 466 | 308 | 780 | 520 | 540 | 660 |
| 17 | 233 | | | 151 | 308 | 2,030 | 449 | 282 | 700 | 520 | 500 | 540 |
| 18 | 233 | | | 149 | 366 | 3,020 | 432 | 282 | 1,370 | 920 | 466 | 483 |
| 19 | 210 | | | 160 | 382 | 2,860 | 398 | 257 | 3,660 | 2,290 | 432 | 432 |
| 20 | 210 | 170 | | 162 | 500 | 1,910 | 382 | 282 | 2,100 | 1,670 | 432 | 432 |
| 21 | 210 | | | 151 | 870 | 1,320 | 366 | 366 | 1,370 | 1,120 | 398 | 415 |
| 22 | 210 | | 140 | 149 | 3,020 | 1,220 | 336 | 740 | 1,070 | 920 | 382 | 398 |
| 23 | 206 | 153 | | 151 | 3,180 | 1,020 | 336 | 820 | 820 | 740 | 398 | 382 |
| 24 | 198 | 179 | | | 1,730 | 3,340 | 322 | 620 | 820 | 660 | 398 | 351 |
| 25 | 173 | 187 | | | 1,070 | 7,570 | 322 | 660 | 820 | 660 | 366 | 336 |
| 26 | 187 | 181 | | 110 | 780 | 3,260 | 308 | 920 | 820 | 640 | 366 | 351 |
| 27 | 189 | 171 | | | 660 | 1,970 | 308 | 820 | 740 | 700 | 336 | 336 |
| 28 | 187 | 185 | | | 580 | 1,910 | 308 | 680 | 700 | 1,120 | 336 | 336 |
| 29 | 187 | 173 | | | ..... | 1,550 | 295 | 1,220 | 660 | 920 | 336 | 336 |
| 30 | 189 | 185 | | | ..... | 1,220 | 282 | 2,570 | 660 | 740 | 351 | 322 |
| 31 | 185 | ..... | | | ..... | 1,070 | ..... | 1,790 | ..... | 920 | 336 | ..... |

NOTE.—Discharge computed from a rating curve well defined between 169 and 2,710 second-feet. Discharge, Nov. 17–22, Dec. 13 to Jan. 12, Jan. 24 to Feb. 4 and Feb. 7–11, estimated, because of ice, from discharge measurements, observer's notes and weather records. Braced figures show mean discharge for periods included.

*Monthly discharge of Zumbro River at Zumbro Falls, Minn., for the year ending Sept. 30, 1915.*

[Drainage area, 1,120 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 270 | 169 | 206 | 0.184 | 0.21 | B. |
| November | ..... | 153 | 178 | .159 | .18 | B. |
| December | 191 | ..... | 155 | .138 | .16 | C. |
| January | ..... | ..... | 139 | .124 | .14 | C. |
| February | 3,180 | ..... | 593 | .529 | .55 | C. |
| March | 7,570 | 308 | 1,500 | 1.34 | 1.54 | A. |
| April | 1,430 | 282 | 615 | .549 | .61 | A. |
| May | 2,570 | 257 | 558 | .498 | .57 | B. |
| June | 3,660 | 540 | 1,160 | 1.04 | 1.16 | A. |
| July | 2,780 | 432 | 901 | .804 | .93 | A. |
| August | 3,260 | 336 | 874 | .780 | .90 | B. |
| September | 820 | 295 | 419 | .374 | .42 | B. |
| The year | 7,570 | ..... | 609 | .544 | 7.37 | |

SOUTH BRANCH OF ZUMBRO RIVER NEAR ZUMBRO FALLS, MINN.

LOCATION.—In sec. 22, T. 109 N., R. 14 W., at the Woodville Bridge, 1½ miles above the mouth of the 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, 1915.

GAGE.—Chain gage attached to the downstream hand rail of bridge near center of river, read by W. M. Whipple.

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

CHANNEL AND CONTROL.—Bed of stream is for the most part 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, 11.8 feet at 3.30 p. m., March 25 (discharge, 8,360 second-feet); minimum stage recorded, 1.99 feet November 12; discharge, 135 second-feet.

1911–1915: Maximum stage recorded, 11.8 feet at 3.30 p. m. March 25, 1915 (discharge, 8,360 second-feet); minimum stage recorded, 1.80 feet December 26, 1914 (discharge, 62 second-feet).

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

REGULATION.—Effect of operation of small power plants above the station not noticeable at gage.

ACCURACY.—On account of the slight shifting of control records can not be considered better than fair.

*Discharge measurements of South Branch of Zumbro River near Zumbro Falls, Minn., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Dec. 23[a] | S. B. Soulé | 2.06 | 92 | Aug. 4 | S. B. Soulé | 6.24 | 2,840 |
| Jan. 26[a] | do | 2.10 | 91 | 20 | H. T. Crichlow | 2.42 | 295 |
| May 26 | do | 3.40 | 837 | | | | |

[a] Made through complete ice cover; control partly ice covered.

*Daily discharge, in second-feet, of South Branch of Zumbro River near Zumbro Falls, Minn., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 128 | 122 | | | | 410 | 778 | 188 | 1,100 | 385 | 1,350 | 244 |
| 2 | 128 | 122 | | | | 362 | 696 | 188 | 723 | 326 | 1,350 | 236 |
| 3 | 128 | 122 | | | | 318 | 696 | 196 | 564 | 322 | 1,770 | 232 |
| 4 | 128 | 122 | | | | 274 | 980 | 240 | 485 | 322 | 2,630 | 232 |
| 5 | 128 | 122 | | | | 256 | 1,220 | 274 | 460 | 313 | 1,840 | 232 |
| 6 | 155 | 122 | | | | 211 | 1,040 | 286 | 485 | 295 | 1,280 | 227 |
| 7 | 162 | 115 | | | | 192 | 805 | 286 | 1,420 | 980 | 805 | 227 |
| 8 | 148 | 115 | | | | 188 | 643 | 278 | 832 | 1,560 | 778 | 219 |
| 9 | 148 | 115 | | | | 196 | 537 | 244 | 590 | 1,700 | 696 | 227 |
| 10 | 183 | 115 | | | | 750 | 537 | 227 | 643 | 778 | 564 | 256 |
| 11 | 183 | 115 | | | | 805 | 511 | 227 | 1,100 | 670 | 485 | 385 |
| 12 | 198 | 112 | | | 430 | 920 | 460 | 211 | 1,160 | 590 | 485 | 336 |
| 13 | 194 | 115 | | | | 750 | 435 | 211 | 832 | 485 | 460 | 340 |
| 14 | 194 | 115 | | | | 920 | 385 | 196 | 860 | 435 | 435 | 696 |
| 15 | 202 | 115 | | | | 537 | 340 | 203 | 590 | 362 | 410 | 696 |
| 16 | 202 | | 100 | 90 | | 274 | 331 | 203 | 485 | 362 | 362 | 643 |
| 17 | 194 | | | | | 1,420 | 318 | 196 | 410 | 340 | 362 | 410 |
| 18 | 190 | | | | | 2,470 | 295 | 192 | 1,100 | 564 | 340 | 318 |
| 19 | 180 | | | | | 2,310 | 278 | 188 | 3,760 | 1,770 | 313 | 313 |
| 20 | 162 | | | | | 1,220 | 265 | 196 | 2,070 | 1,490 | 300 | 300 |
| 21 | 148 | | | | | 920 | 248 | 236 | 1,220 | 778 | 282 | 269 |
| 22 | 145 | | | | | 860 | 236 | 410 | 778 | 643 | 269 | 252 |
| 23 | 145 | 110 | | | | 750 | 236 | 211 | 564 | 564 | 269 | 248 |
| 24 | 141 | | | | 2,150 | 3,170 | 227 | 778 | 537 | 485 | 252 | 227 |
| 25 | 135 | | | | 980 | 7,460 | 219 | 980 | 643 | 460 | 248 | 244 |
| 26 | 132 | | | | 616 | 2,990 | 207 | 750 | 805 | 410 | 248 | 248 |
| 27 | 122 | | | | 564 | 1,840 | 211 | 723 | 537 | 410 | 244 | 244 |
| 28 | 122 | | | | 485 | 1,840 | 219 | 590 | 511 | 670 | 236 | 227 |
| 29 | 122 | | | | ..... | 1,560 | 211 | 1,350 | 485 | 778 | 210 | 223 |
| 30 | 115 | | | | ..... | 1,100 | 200 | 1,990 | 435 | 564 | 232 | 219 |
| 31 | 122 | ..... | | | ..... | 920 | ..... | 1,700 | ..... | 805 | 236 | ..... |

NOTE.—Discharge Oct. 1 to Nov. 15 determined from a well-defined rating curve; Feb. 24 to Sept. 30, from a rating curve fairly well defined between 120 and 3,600 second-feet. Discharge, Nov. 16 to Feb. 23, estimated, because of ice, from discharge measurements, observer's notes, and weather records. Braced figures show mean discharge for period included.

*Monthly discharge of South Branch of Zumbro River near Zumbro Falls, Minn., for the year ending Sept. 30, 1915.*

[Drainage area, 821 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 202 | 115 | 154 | 0.188 | 0.22 | B. |
| November | 122 | ..... | 114 | .139 | .16 | C. |
| December | ..... | ..... | 100 | .122 | .14 | C. |
| January | ..... | ..... | 90 | .110 | .13 | C. |
| February | ..... | ..... | 524 | .638 | .66 | D. |
| March | 7,460 | 188 | 1,230 | 1.50 | 1.73 | B. |
| April | 1,220 | 200 | 459 | .559 | .62 | B. |
| May | 1,990 | 188 | 456 | .555 | .64 | B. |
| June | 3,760 | 410 | 873 | 1.06 | 1.18 | B. |
| July | 1,770 | 295 | 665 | .810 | .93 | B. |
| August | 2,630 | 232 | 638 | .777 | .90 | B. |
| September | 696 | 219 | 306 | .373 | .42 | B. |
| The year | 7,460 | ..... | 467 | .569 | 7.73 | |

## 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 Wisconsin Geological and Natural History Survey map, edition of 1911; scale, 1 inch=6 miles).

RECORDS AVAILABLE.—December 13, 1913, to September 30, 1915.

GAGE.—Chain gage attached to downstream side of bridge; read twice daily, morning and evening, to half-tenths, 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 overflow during extreme floods.

EXTREMES OF DISCHARGE.—Maximum stage during year, 6.52 feet at 6 p. m. March 26 (discharge, 1,660 second-feet); minimum discharge, 163 second-feet, recorded by measurement January 29.

1914–15: 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.

WINTER FLOW.—Discharge relation seriously affected by ice; flow determined from discharge measurements, observer's notes, and weather records.

REGULATION.—No power plant above station has sufficient storage to affect the natural flow of the river.

ACCURACY.—Rating curve fairly well defined; no diurnal fluctuation; records good.

*Discharge measurements of Trempealeau River at Dodge, Wis., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Nov. 12 | H. C. Beckman | 1.83 | 259 | Apr. 2 | M. F. Rather | 3.09 | 613 |
| Jan. 9[a] | do | 2.67 | 246 | May 28 | S. B. Soulé | 2.85 | 539 |
| 29[a] | do | 2.32 | 163 | Aug. 7 | do | 2.89 | 553 |
| Mar. 12[b] | M. F. Rather | 3.80 | 442 | | | | |

[a] Made through complete ice cover. [b] Made through partical ice cover.

*Daily discharge, in second-feet, of Trempealeau River at Dodge, Wis., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 260 | 260 | | | | | 564 | 308 | 408 | 358 | 383 | 236 |
| 2 | 248 | 260 | | | | | 564 | 308 | 358 | 308 | 642 | 236 |
| 3 | 236 | 272 | | | | | 616 | 333 | 333 | 260 | 851 | 224 |
| 4 | 236 | 260 | | | | | 669 | 383 | 308 | 272 | 929 | 224 |
| 5 | 224 | 260 | | | | | 721 | 383 | 296 | 272 | 825 | 224 |
| | | | 265 | 235 | 240 | 410 | | | | | | |
| 6 | 236 | 260 | | | | | 747 | 358 | 358 | 284 | 642 | 191 |
| 7 | 260 | 272 | | | | | 734 | 383 | 511 | 358 | 485 | 213 |
| 8 | 284 | 260 | | | | | 721 | 383 | 537 | 590 | 642 | 236 |
| 9 | 308 | 260 | | | | | 616 | 358 | 383 | 590 | 485 | 260 |
| 10 | 296 | 260 | | | | | 616 | 333 | 433 | 459 | 408 | 383 |
| 11 | 333 | 272 | | | | | 590 | 333 | 616 | 669 | 358 | 333 |
| 12 | 358 | 272 | | | | | 564 | 459 | 616 | 616 | 333 | 358 |
| 13 | 485 | 272 | | | | | 511 | 358 | 485 | 408 | 383 | 408 |
| 14 | 564 | 260 | | | | | 485 | 308 | 408 | 358 | 511 | 669 |
| 15 | 459 | 260 | | | | | 459 | 308 | 358 | 308 | 408 | 669 |
| | | | 230 | 240 | 495 | | | | | | | |
| 16 | 408 | 260 | | | | 785 | 433 | 308 | 333 | 308 | 333 | 564 |
| 17 | 358 | 248 | | | | | 433 | 408 | 333 | 284 | 308 | 459 |
| 18 | 333 | | | | | | 433 | 433 | 383 | 590 | 296 | 383 |
| 19 | 308 | | | | | | 408 | 459 | 511 | 485 | 284 | 333 |
| 20 | 308 | | | | | | 383 | 564 | 511 | 383 | 272 | 459 |
| 21 | 308 | | | | | | 358 | 877 | 485 | 308 | 272 | 511 |
| 22 | 284 | | | | | 877 | 333 | 1,010 | 459 | 284 | 260 | 459 |
| 23 | 284 | | | | | 903 | 308 | 1,060 | 459 | 260 | 260 | 383 |
| 24 | 284 | | | | | 1,040 | 308 | 1,060 | 358 | 260 | 272 | 358 |
| 25 | 284 | | | | | 1,240 | 308 | 982 | 333 | 260 | 260 | 331 |
| | | 245 | 220 | 195 | 1,080 | | | | | | | |
| 26 | 284 | | | | | 1,520 | 308 | 799 | 260 | 236 | 260 | 331 |
| 27 | 284 | | | | | 1,560 | 333 | 642 | 260 | 272 | 236 | 331 |
| 28 | 260 | | | | | 1,090 | 333 | 511 | 333 | 358 | 236 | 331 |
| 29 | 272 | | | | | 851 | 358 | 459 | 408 | 333 | 248 | 308 |
| 30 | 260 | | | | | 642 | 308 | 433 | 459 | 333 | 224 | 308 |
| 31 | 272 | | | | | 590 | ..... | 408 | ..... | 358 | 236 | ..... |

NOTE.—Discharge, except as noted below, determined from a rating curve fairly well defined above 286 second-feet. Discharge Apr. 1 interpolated on account of probable error in gage reading. Nov. 18 to Mar. 21 estimated, because of ice, from discharge measurements, observer's notes, and weather records. Braced figures show mean discharges for period included.

*Monthly discharge of Trempealeau River at Dodge, Wis., for the year ending Sept. 30, 1915.*

[Drainage area, 633 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 564 | 224 | 309 | 0.488 | 0.56 | B. |
| November | | | 255 | .403 | .45 | C. |
| December | | | 238 | .376 | .43 | C. |
| January | | | 222 | .351 | .40 | C. |
| February | | | 571 | .902 | .94 | D. |
| March | 1,560 | | 743 | 1.17 | 1.35 | D. |
| April | 747 | 308 | 484 | .765 | .85 | A. |
| May | 1,060 | 308 | 507 | .801 | .92 | A. |
| June | 616 | 260 | 410 | .648 | .72 | B. |
| July | 669 | 236 | 368 | .581 | .67 | B. |
| August | 929 | 224 | 405 | .640 | .74 | B. |
| September | 669 | 191 | 357 | .564 | .63 | B. |
| The year | 1,560 | | 405 | .640 | 8.66 | |

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'Neal Creek enters from the left about a mile above the gage, and Cunningham Creek, also from the left, about 1½ miles below.

DRAINAGE AREA.—774 square miles (measured on Wisconsin Geological and Natural History Survey map, edition of 1911; scale, 1 inch=6 miles).

RECORDS AVAILABLE.—April 7, 1905, to March 31, 1909; December 11, 1913, to September 30, 1915.

GAGE.—Chain gage fastened to downstream side of highway bridge; read twice daily, morning and evening, to quarter-tenths, by A. Bissell.

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

CHANNEL AND CONTROL.—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 the gage section.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 9.62 feet at 6 a. m. April 8 (discharge, 5,990 second-feet); minimum stage recorded by measurement made January 30 (discharge, 28 second-feet); owing to diurnal fluctuations at such low stages it is likely that the absolute minimum was less than 28 second-feet.

1905–1909 and 1913–1915: Maximum stage recorded, 19.8 feet June 6, 1905 (discharge approximately, 29,400 second-feet).[1] 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 approximately 20 second-feet).

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

REGULATION.—Several dams on Back 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.—Control is permanent; rating curve well defined over the range in stage covered by gage heights; medium and high-stage records excellent; low-stage records, especially during the winter only fair, owing to diurnal fluctuations.

[1] Previously determined as 23,000 second-feet from a curve, the highest measurement of which was made at a stage of only 7.7 feet.

*Discharge measurements of Black River at Neillsville, Wis., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Dec. 30[a] | G. H. Canfield | 3.00 | 41 | Mar. 3[a] | H. C. Beckman | 4.56 | 181 |
| Jan. 30[a] | H. C. Beckman | 3.40 | 28 | Apr. 1[b] | M. F. Rather | 4.69 | 511 |

[a] Made through complete ice cover. [b] Open water at gage; ice jam below.

*Daily discharge, in second-feet, of Black River at Neillsville, Wis., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 184 | 118 | 127 | | | | | 468 | 245 | 245 | 181 | 85 |
| 2 | 156 | 112 | 114 | | | | 585 | 380 | 200 | 164 | 210 | 91 |
| 3 | 132 | 118 | 300 | | | | | 468 | 167 | 116 | 468 | 67 |
| 4 | 119 | 112 | 280 | | | | 1,360 | 820 | 121 | 100 | 1,360 | 72 |
| 5 | 105 | 110 | 238 | | | | 2,760 | 945 | 123 | 89 | 2,360 | 56 |
| | | | | 72 | 33 | 135 | | | | | | |
| 6 | 105 | 110 | 204 | | | | 4,160 | 820 | 1,150 | 85 | 2,070 | 51 |
| 7 | 121 | 105 | 114 | | | | 4,700 | 1,220 | 3,680 | 110 | 1,570 | 57 |
| 8 | 280 | 102 | 98 | | | | 5,480 | 1,890 | 3,160 | 102 | 1,220 | 71 |
| 9 | 618 | 121 | | | | | 4,420 | 1,800 | 2,070 | 71 | 880 | 60 |
| 10 | 540 | 102 | | | | | 4,030 | 1,430 | 1,570 | 61 | 590 | 49 |
| 11 | 700 | 94 | 110 | | | | 3,910 | 1,010 | 2,660 | 66 | 422 | 43 |
| 12 | 820 | 92 | | | | | 3,680 | 700 | 2,160 | 58 | 245 | 43 |
| 13 | 1,720 | 98 | | | | | 2,960 | 565 | 1,570 | 55 | 217 | 65 |
| 14 | 1,890 | 100 | | | | | 2,160 | 490 | 1,150 | 52 | 217 | 129 |
| 15 | 1,500 | 119 | | | | | 1,800 | 490 | 820 | 92 | 340 | 320 |
| | | | | 75 | 100 | 195 | | | | | | |
| 16 | 1,010 | 161 | | | | | 1,800 | 820 | 672 | 760 | 245 | 645 |
| 17 | 760 | | | | | | 1,500 | 820 | 468 | 880 | 214 | 590 |
| 18 | 565 | | | | | | 1,290 | 2,160 | 618 | 540 | 445 | 238 |
| 19 | 445 | | | | | | 1,150 | 1,800 | 1,430 | 380 | 360 | 320 |
| 20 | 360 | | | | | | 1,010 | 1,640 | 1,890 | 300 | 231 | 242 |
| | | 100 | 31 | | | | | | | | | |
| 21 | 300 | | | | | | 945 | 4,160 | 1,890 | 242 | 156 | 178 |
| 22 | 262 | | | | | | 820 | 5,640 | 1,500 | 156 | 112 | 148 |
| 23 | 231 | | | | | | 700 | 4,030 | 1,010 | 127 | 95 | 123 |
| 24 | 217 | | | | | | 700 | 2,760 | 645 | 127 | 81 | 116 |
| 25 | 191 | 112 | | | | | 700 | 1,890 | 445 | 178 | 73 | 84 |
| | | | | 36 | 380 | 1,030 | | | | | | |
| 26 | 200 | 119 | | | | | 645 | 1,290 | 320 | 153 | 60 | 95 |
| 27 | 178 | 123 | | | | | 590 | 945 | 242 | 145 | 52 | 95 |
| 28 | 158 | 116 | 36 | | | | 645 | 760 | 445 | 300 | 54 | 106 |
| 29 | 143 | 110 | | | | | 700 | 565 | 360 | 280 | 71 | 110 |
| 30 | 127 | 119 | | | | | 618 | 422 | 320 | 207 | 48 | 110 |
| 31 | 127 | ..... | | | | | ..... | 320 | ..... | 245 | 50 | ..... |

NOTE.—Discharge except as noted below, determined from a rating curve fairly well defined below and well defined above 14,300 second-feet. Discharge Nov. 17–24, and Dec. 9 to Apr. 3, estimated, because of ice, from discharge measurements, observer's notes, and weather records. Braced figures show mean discharge for period included.

*Monthly discharge of Black River at Neillsville, Wis., for the year ending Sept. 30, 1915.*

[Drainage area, 774 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 1,890 | 105 | 460 | 0.594 | 0.68 | A. |
| November | 161 | ..... | 109 | .141 | .16 | C. |
| December | 300 | ..... | 89.4 | .116 | .13 | D. |
| January | ..... | ..... | 60.2 | .078 | .09 | C. |
| February | ..... | ..... | 156 | .202 | .21 | C. |
| March | ..... | ..... | 472 | .610 | .70 | D. |
| April | 5,480 | ..... | 1,900 | 2.45 | 2.73 | A. |
| May | 5,640 | 320 | 1,400 | 1.81 | 2.09 | A. |
| June | 3,680 | 121 | 1,100 | 1.42 | 1.58 | A. |
| July | 880 | 52 | 209 | .270 | .31 | B. |
| August | 2,360 | 48 | 474 | .612 | .71 | B. |
| September | 645 | 43 | 149 | .193 | .22 | B. |
| The year | 5,640 | ..... | 549 | .709 | 9.61 | |

LA CROSSE RIVER NEAR WEST SALEM, WIS.

LOCATION.—In sec. 22, T. 17 N., R. 6 W., La Crosse County, at highway bridge 2 miles west of West Salem, and 10 miles above the mouth of the river. Dutch Creek enters from the right 6 miles above station.

DRAINAGE AREA.—412 square miles (measured on Wisconsin Geological and Natural History Survey map, edition of 1911; scale, 1 inch=6 miles).

RECORDS AVAILABLE.—December 22, 1913, to September 30, 1915.

GAGE.—Chain gage fastened to concrete guard rail on the upstream side of bridge; read twice daily, morning and evening, to quarter-tenths, 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.—Heavy gravel and rock; right bank high and will not overflow; left bank above the gage low, and overflows at flood stages. Channel free from vegetation; control for low stages a rocky riffle with a fall of about 6 inches. Control is apparently 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.—1913–1915: Maximum stage recorded, 7.3 feet at 7 a. m. February 23, 1915 (discharge estimated, because of backwater from ice at approximately 1,800 second-feet); minimum stage recorded, 1.05 feet at 7 a. m. November 17, 1914 (discharge approximately 130 second-feet).

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

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 the station.

ACCURACY.—Rating curve well defined; control permanent; records for medium and high water stage believed excellent; accuracy of low-water records impaired by diurnal fluctuation.

*Discharge measurements of La Crosse River near West Salem, Wis., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Nov. 13 | H. C. Beckman | 1.28 | 175 | Feb. 16[b] | M. F. Rather | 3.15 | 423 |
| Jan. 11[a] | .....do | 1.59 | 183 | Mar. 16 | .....do | 2.03 | 487 |

[a] Made through complete ice cover.
[b] River open at gage; control partly ice covered.

*Daily discharge, in second-feet, of La Crosse River near West Salem, Wis., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 239 | 222 | 239 | | | | 326 | 222 | 239 | 281 | 348 | 239 |
| 2 | 260 | 222 | 239 | | | | 326 | 222 | 239 | 260 | 551 | 239 |
| 3 | 204 | 222 | 239 | | | | 326 | 239 | 239 | 222 | 638 | 239 |
| 4 | 222 | 239 | 222 | | | | 326 | 281 | 222 | 204 | 779 | 239 |
| 5 | 204 | 192 | 204 | | | | 394 | 281 | 222 | 222 | 715 | 222 |
| 6 | 239 | 239 | 222 | 180 | 200 | | 461 | 281 | 222 | 239 | 595 | 239 |
| 7 | 304 | 204 | 204 | | | | 506 | 326 | 222 | 239 | 461 | 239 |
| 8 | 326 | 192 | 204 | | | 1,420 | 461 | 326 | 222 | 348 | 371 | 239 |
| 9 | 304 | 222 | 239 | | | | 416 | 326 | 222 | 348 | 348 | 239 |
| 10 | 260 | 180 | 204 | | | | 371 | 281 | 239 | 304 | 326 | 326 |
| 11 | 304 | 222 | | | | | 371 | 281 | 260 | 239 | 304 | 416 |
| 12 | 304 | 222 | | | | | 394 | 239 | 260 | 260 | 281 | 506 |
| 13 | 348 | 222 | | | | | 371 | 239 | 239 | 239 | 281 | 595 |
| 14 | 394 | 204 | | | | | 348 | 222 | 239 | 239 | 281 | 715 |
| 15 | 326 | 204 | | | | | 326 | 222 | 239 | 239 | 260 | 862 |
| 16 | 326 | 204 | 160 | 195 | 455 | 438 | 326 | 222 | 239 | 239 | 326 | 779 |
| 17 | 304 | 170 | | | | 551 | 304 | 239 | 239 | 204 | 304 | 638 |
| 18 | 281 | | | | | 595 | 304 | 260 | 281 | 222 | 281 | 595 |
| 19 | 281 | | | | | 551 | 281 | 260 | 326 | 281 | 281 | 506 |
| 20 | 222 | | | | | 461 | 281 | 281 | 304 | 281 | 281 | 506 |
| 21 | 239 | 195 | | | | 371 | 260 | 371 | 281 | 281 | 260 | 506 |
| 22 | 239 | | | | | 348 | 239 | 461 | 260 | 260 | 222 | 506 |
| 23 | 239 | | | | | 438 | 260 | 416 | 260 | 239 | 260 | 438 |
| 24 | 239 | | | | | 638 | 239 | 348 | 260 | 239 | 239 | 371 |
| 25 | 204 | | | | | 715 | 192 | 371 | 239 | 204 | 239 | 348 |
| 26 | 239 | 222 | 155 | 170 | 1,000 | 595 | 192 | 371 | 222 | 239 | 239 | 348 |
| 27 | 239 | 239 | | | | 551 | 239 | 326 | 204 | 348 | 239 | 371 |
| 28 | 239 | 180 | | | | 416 | 239 | 304 | 239 | 461 | 239 | 371 |
| 29 | 239 | 180 | | | | 394 | 239 | 281 | 281 | 595 | 204 | 371 |
| 30 | 204 | 192 | | | | 326 | 239 | 260 | 394 | 436 | 239 | 348 |
| 31 | 239 | ..... | | | | 326 | ..... | 239 | ..... | 326 | 239 | ..... |

NOTE.—Discharge, except as noted below, determined from a well-defined rating curve. Flow Nov. 18–25 and Dec. 11 to Mar. 15 estimated from discharge measurements, observer's notes, and weather records. Braced figures show mean flow for period included.

*Monthly discharge of La Crosse River near West Salem, Wis., for the year ending Sept. 30, 1915.*

(Drainage area, 412 square miles.)

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 394 | 204 | 265 | 0.643 | 0.74 | B. |
| November | 239 | 170 | 205 | .498 | .56 | B. |
| December | ..... | ..... | 178 | .432 | .50 | C. |
| January | ..... | ..... | 181 | .439 | .51 | C. |
| February | ..... | ..... | 520 | 1.26 | 1.31 | D. |
| March | 715 | 326 | 452 | 1.10 | 1.27 | C. |
| April | 506 | 192 | 319 | .774 | .86 | A. |
| May | 461 | 222 | 290 | .704 | .81 | B. |
| June | 394 | 204 | 252 | .612 | .68 | B. |
| July | 595 | 204 | 282 | .684 | .79 | B. |
| August | 779 | 204 | 343 | .833 | .96 | A. |
| September | 862 | 222 | 419 | 1.02 | 1.14 | A. |
| The year | 862 | ..... | 307 | .745 | 10.13 | |

ROOT RIVER AT 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 square miles.

RECORDS AVAILABLE.—May 28, 1909, to September 30, 1915.

GAGE.—Vertical staff bolted to the downstream side of the stone abutment, right end of bridge, read twice daily by Olaf Larson. Prior to June 28, 1913, gage was attached to piling just above the right abutment. The datum of the present gage was changed slightly on the date of installation to allow for the slight slope in the river between the two points.

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

CHANNEL AND CONTROL.—No well-defined control. The bed of the stream is silt and fine sand, shifting out during floods and gradually filling in afterwards. Both banks overflow at a stage of about 8.5 feet, the overflow at the gage section attaining at times a width of about 5,000 feet. Floods on the south Root, which enters the main Root about a mile below the station, are such, at times, as to produce considerable backwater at the gage.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 9.35 feet at 7.30 a. m. March 26 (discharge, 7,330 second-feet); minimum stage recorded during open-water periods, 1.39 feet at 6.30 a. m. November 17 (discharge, 327 second-feet). A flow of 232 second-feet, which was probably not far from the minimum for the year, was measured by current meter January 29.

1909–1915: Maximum stage recorded, 10.8 feet late at night August 14, 1911 (discharge determined from rating curve based on highwater measurement made in 1915, 15,200 second-feet); minimum stage recorded during open-water periods: 0.80 foot July 17, 1911 (discharge 267 second-feet). A flow of 231 second-feet was measured by current meter on January 23, 1914.

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

REGULATION.—Nearest dam above station is at Rushford. As the flow is ample at all times for the power generated at that point, it is not held back during certain parts of the day, and the dam has no influence on the flow at Houston.

ACCURACY.—Results considered fair. Gage readings are reliable; high-water portion of curve well defined. Low-water estimates may be affected by slight shifts in channel. Estimates of discharge for flood stages above 8.9 feet in 1911, as published in Water-Supply Paper 305, are too low on account of an erroneous extension of the 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, give 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 the rating curve for 1911.

*Discharge measurements of Root River at Houston, Minn., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Dec. 22[a] | S. B. Soulé | 2.04 | 252 | May 29 | S. B. Soulé | 2.95 | 889 |
| Jan. 29[a] | do | 2.25 | 232 | Aug. 6 | do | 5.34 | 2,110 |

[a] Made through complete ice cover.

*Daily discharge, in second-feet, of Root River at Houston, Minn., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 352 | 352 | 379 | | | | 1,640 | 567 | 1,640 | 757 | 1,480 | 602 |
| 2 | 352 | 352 | 352 | | | | 1,530 | 533 | 1,270 | 716 | 2,560 | 567 |
| 3 | 352 | 352 | 352 | | | | 1,530 | 567 | 1,070 | 638 | 3,000 | 567 |
| 4 | 352 | 352 | 352 | | | | 1,860 | 567 | 933 | 638 | 3,830 | 567 |
| 5 | 352 | 352 | 352 | | | | 2,920 | 638 | 888 | 602 | 3,160 | 567 |
| | | | | | | 935 | | | | | | |
| 6 | 379 | 352 | 340 | | | | 2,840 | 676 | 843 | 567 | 2,230 | 567 |
| 7 | 379 | 352 | 352 | | | | 2,360 | 716 | 716 | 638 | 1,800 | 533 |
| 8 | 379 | 352 | 352 | | | | 1,800 | 716 | 799 | 1,750 | 1,580 | 567 |
| 9 | 379 | 352 | 352 | | | | 1,530 | 676 | 757 | 2,230 | 1,420 | 567 |
| 10 | 379 | 352 | 352 | | | | 1,370 | 638 | 757 | 1,980 | 1,270 | 567 |
| 11 | 407 | 352 | 340 | | | 676 | 1,320 | 602 | 757 | 1,320 | 1,170 | 602 |
| 12 | 434 | 352 | 352 | | | 716 | 1,220 | 567 | 716 | 1,120 | 1,070 | 757 |
| 13 | 468 | 352 | 340 | | | 888 | 1,120 | 567 | 799 | 978 | 1,020 | 1,370 |
| 14 | 468 | 352 | | | | 1,420 | 1,020 | 533 | 716 | 888 | 978 | 1,320 |
| 15 | 468 | 379 | | | | 1,320 | 978 | 500 | 676 | 843 | 1,020 | 1,070 |
| 16 | 468 | 352 | | 235 | 990 | 1,220 | 933 | 500 | 638 | 799 | 978 | 888 |
| 17 | 468 | 327 | | | | 1,580 | 888 | 533 | 602 | 799 | 933 | 757 |
| 18 | 468 | 340 | | | | 2,700 | 799 | 500 | 638 | 888 | 978 | 716 |
| 19 | 434 | | | | | 2,360 | 757 | 500 | 978 | 2,760 | 933 | 676 |
| 20 | 434 | | | | | 1,920 | 757 | 500 | 1,120 | 3,340 | 888 | 888 |
| 21 | 407 | | | | | 1,480 | 716 | 602 | 1,120 | 1,800 | 799 | 1,220 |
| 22 | 407 | 340 | 250 | | | 1,320 | 676 | 676 | 888 | 1,370 | 757 | 933 |
| 23 | 379 | | | | | 1,480 | 638 | 799 | 757 | 1,120 | 757 | 843 |
| 24 | 379 | | | | | 3,830 | 638 | 1,020 | 676 | 1,860 | 757 | 799 |
| 25 | 379 | | | | | 5,990 | 602 | 888 | 638 | 1,370 | 716 | 716 |
| 26 | 379 | | | | | 6,220 | 602 | 888 | 638 | 1,070 | 676 | 676 |
| 27 | 379 | 379 | | | | 3,250 | 638 | 1,020 | 716 | 1,120 | 638 | 676 |
| 28 | 379 | 352 | | | | 2,700 | 638 | 933 | 716 | 1,170 | 638 | 638 |
| 29 | 379 | 352 | | | | 2,490 | 602 | 933 | 1,270 | 1,020 | 638 | 638 |
| 30 | 352 | 352 | | | | 2,100 | 567 | 1,640 | 1,120 | 1,070 | 602 | 638 |
| 31 | 352 | ..... | | | | 1,800 | ..... | 2,420 | ..... | 1,170 | 602 | ..... |

NOTE.—Discharge computed from a rating curve well defined between 900 and 10,600 second-feet and fairly well defined below 900 second-feet. Discharge Nov. 19–26, and Dec. 14 to Mar. 10, estimated, because of ice, from gage heights, observer's notes, discharge measurements, and climatic records; braced figures show mean discharge for period included.

*Monthly discharge of Root River at Houston, Minn., for the year ending Sept. 30, 1915.*

[Drainage area, 1,560 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 468 | 352 | 398 | 0.255 | 0.29 | B. |
| November | ..... | ..... | 349 | .224 | .25 | B. |
| December | 379 | ..... | 292 | .187 | .22 | C. |
| January | ..... | ..... | 235 | .151 | .17 | C. |
| February | ..... | ..... | 990 | .635 | .66 | C. |
| March | 6,220 | ..... | 1,830 | 1.17 | 1.35 | B. |
| April | 2,920 | 567 | 1,180 | .756 | .84 | A. |
| May | 2,420 | 500 | 755 | .484 | .56 | B. |
| June | 1,640 | 602 | 862 | .553 | .62 | A. |
| July | 3,340 | 567 | 1,240 | .795 | .92 | A. |
| August | 3,830 | 602 | 1,290 | .827. | .95 | A. |
| September | 1,370 | 533 | 750 | .481 | .54 | B. |
| The year | 6,220 | ..... | 847 | .543 | 7.37 | |

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 in Filmore County, and about 5 miles below the 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 to September 30, 1915.

GAGE.—Chain gage on floor of bridge, downstream side, near right bank; read twice daily, to quarter-tenths, by Olaf Waage.

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

CHANNEL AND CONTROL.—Bed of stream is sand and light gravel. A few hundred feet below the gage the channel is narrowed by a low island and there is a slight riffle which constitutes a 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 former channel 1,000 feet back from the right bank. At extreme flood stages the right bank is overflowed to a width of a quarter of a mile.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 6.42 feet at 2.30 p. m. July 19 (discharge, 3,920 second-feet), minimum stage recorded, 2.2 feet at 9 a. m. September 4 to 9 (discharge, 194 second-feet).

1910–1915: Maximum stage recorded, 10.3 feet August 13, 1911 (discharge, 9,380 second-feet); minimum stage recorded 1.71 feet July 4, 1911 (discharge, 38 second-feet).

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

REGULATION.—Several miles above the station is a power plant working under a varying load for light and power, but inspection of the morning and evening gage heights indicates that the diurnal fluctuation at the gage is slight.

ACCURACY.—Results apparently fair; the rating curve is fairly well defined; channel fairly permanent.

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

August 6, 1915: Gage height, 3.70 feet; discharge, 979 second-feet.

*Daily discharge, in second-feet, of North Branch of Root River near Lanesboro, Minn., for the year ending Sept. 30, 1915.*

| Day. | July. | Aug. | Sept. | Day. | July. | Aug. | Sept. | Day. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 1,190 | 222 | 11 | ..... | 414 | 297 | 21 | 715 | 305 | 391 |
| 2 | ..... | 2,040 | 222 | 12 | ..... | 391 | 322 | 22 | 514 | 296 | 347 |
| 3 | ..... | 2,260 | 222 | 13 | ..... | 347 | 347 | 23 | 391 | 286 | 274 |
| 4 | ..... | 2,480 | 201 | 14 | ..... | 438 | 438 | 24 | 347 | 259 | 259 |
| 5 | ..... | 1,530 | 201 | 15 | ..... | 372 | 347 | 25 | 326 | 259 | 236 |
| 6 | ..... | 956 | 201 | 16 | 274 | 305 | 305 | 26 | 305 | 236 | 248 |
| 7 | ..... | 747 | 201 | 17 | 274 | 347 | 286 | 27 | 305 | 236 | 259 |
| 8 | ..... | 630 | 212 | 18 | ..... | 369 | 259 | 28 | 391 | 236 | 236 |
| 9 | ..... | 514 | 212 | 19 | 3,160 | 347 | 292 | 29 | 305 | 229 | 222 |
| 10 | ..... | 438 | 222 | 20 | 1,720 | 305 | 326 | 30 | 488 | 222 | 236 |
| | | | | | | | | 31 | 347 | 222 | ..... |

NOTE.—Discharge computed from a well-defined rating curve. Discharge interpolated July 18, 25, Aug. 1, 8, 15, 22, 29, Sept. 5, 12, 19, and 26, as gage was not read.

*Monthly discharge of North Branch of Root River near Lanesboro, Minn., for the year ending Sept. 30, 1915.*

[Drainage area, 647 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| August | 2,480 | 222 | 620 | 0.958 | 1.10 | B. |
| September | 438 | 201 | 268 | .414 | .46 | B. |

UPPER IOWA RIVER NEAR DECORAH, IOWA.

LOCATION.—At the highway bridge in the village of Freeport, Winneshick County, 3 miles below Decorah and about 4 miles above the upper power plant of the Upper Iowa Power Co.; nearest tributary, Trout Creek, enters from the right about a mile above station.

DRAINAGE AREA.—560 square miles (measured on United States Geological Survey map of scale 1 to 500,000; revised since last published).

RECORDS AVAILABLE.—August 28, 1913, to November 21, 1914, when station was discontinued.

GAGE.—Chain gage attached to bridge; read twice daily by Chas. Savoy.

DISCHARGE MEASUREMENTS.—Made from bridge.

CHANNEL AND CONTROL.—Sand and gravel; may shift during high water.

EXTREMES OF DISCHARGE.—Maximum stage recorded during maintenance of station, 11.6 feet at 4 p. m. May 24, 1914 (discharge roughly 6,000 second-feet); minimum stage recorded, 2.15 feet September 14, 1913 (discharge, 38 second-feet).

WINTER FLOW.—Discharge relation affected by ice.

DIVERSIONS.—None.

REGULATION.—The operation of a number of small gristmills above the station produce a slight fluctuation.

ACCURACY.—Results at low stage good; at high stage very approximate and should be used with caution.

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

*Daily discharge, in second-feet, of Upper Iowa River near Decorah, Iowa, for the period Aug. 27, 1913, to Nov. 21, 1914.*

| Day. | Aug. | Sept. | Day. | Aug. | Sept. | Day. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|
| 1913. | | | 1913. | | | 1913. | | |
| 1 | | 44 | 11 | | 44 | 21 | | 59 |
| 2 | | 51 | 12 | | 44 | 22 | | 59 |
| 3 | | 51 | 13 | | 37 | 23 | | 59 |
| 4 | | 47 | 14 | | 37 | 24 | | 50 |
| 5 | | 47 | 15 | | 37 | 25 | | 66 |
| 6 | | 44 | 16 | | 37 | 26 | | 67 |
| 7 | | 44 | 17 | | 51 | 27 | 51 | 59 |
| 8 | | 44 | 18 | | 44 | 28 | 47 | 51 |
| 9 | | 44 | 19 | | 44 | 29 | 47 | 56 |
| 10 | | 37 | 20 | | 85 | 30 | 47 | 59 |
| | | | | | | 31 | 44 | |

*Daily discharge, in second-feet, of Upper Iowa River near Decorah, Iowa, for the period Aug. 27, 1913, to Nov. 21, 1914*—Continued.

| Day. | Oct. | Nov. | Dec. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1913–14. | | | | | | | | | | |
| 1 | 97 | 76 | 95 | ..... | 153 | 346 | 278 | 670 | 127 | 166 |
| 2 | 62 | 76 | 95 | ..... | 144 | 278 | 247 | 602 | 116 | 134 |
| 3 | 73 | 76 | 91 | ..... | 127 | 247 | 278 | 692 | 108 | 91 |
| 4 | 59 | 76 | 85 | ..... | 112 | 232 | 419 | 419 | 112 | 74 |
| 5 | 73 | 76 | 76 | ..... | 95 | 195 | 765 | 328 | 95 | 66 |
| 6 | 76 | 76 | 76 | ..... | 95 | 176 | 1,470 | 294 | 103 | 56 |
| 7 | 151 | 76 | 59 | ..... | 95 | 211 | 1,130 | 328 | 85 | 56 |
| 8 | 76 | 76 | 44 | ..... | 80 | 163 | 1,300 | 247 | 84 | 51 |
| 9 | 217 | 76 | 76 | ..... | 74 | 166 | 765 | 328 | 76 | 54 |
| 10 | 262 | 76 | 85 | ..... | 76 | 151 | 497 | 311 | 84 | 61 |
| 11 | 477 | 76 | 85 | ..... | 76 | 915 | 1,130 | 184 | 80 | 53 |
| 12 | 163 | 76 | 80 | ..... | 69 | 538 | 1,080 | 195 | 76 | 47 |
| 13 | 128 | 76 | 76 | ..... | 67 | 311 | 1,530 | 184 | 69 | 74 |
| 14 | 95 | 73 | ..... | ..... | 61 | 278 | 1,960 | 173 | 67 | 865 |
| 15 | 95 | 67 | ..... | ..... | 59 | 217 | 1,840 | 168 | 67 | 517 |
| 16 | 95 | 67 | ..... | ..... | 59 | 184 | 1,130 | 168 | 80 | 262 |
| 17 | 95 | 67 | ..... | ..... | 59 | 163 | 765 | 195 | 84 | 278 |
| 18 | 95 | 67 | ..... | ..... | 59 | 149 | 602 | 151 | 76 | 211 |
| 19 | 95 | 76 | ..... | ..... | 76 | 137 | 890 | 144 | 76 | 168 |
| 20 | 99 | 76 | ..... | ..... | 73 | 130 | 477 | 130 | 134 | 149 |
| 21 | 85 | 91 | ..... | ..... | 69 | 134 | 865 | 125 | 85 | 130 |
| 22 | 80 | 112 | ..... | ..... | 59 | 189 | 497 | 116 | 74 | 189 |
| 23 | 76 | 76 | ..... | ..... | 59 | 176 | 477 | 116 | 103 | 171 |
| 24 | 76 | 76 | ..... | ..... | 85 | 3,150 | 364 | 189 | 91 | 144 |
| 25 | 85 | 76 | ..... | 112 | 127 | 1,410 | 311 | 151 | 76 | 130 |
| 26 | 80 | 76 | ..... | 97 | 114 | 1,130 | 625 | 144 | 61 | 118 |
| 27 | 76 | 76 | ..... | 91 | 311 | 715 | 3,080 | 127 | 62 | 149 |
| 28 | 76 | 76 | ..... | 87 | 1,300 | 559 | 2,500 | 538 | 69 | 114 |
| 29 | 76 | 76 | ..... | 151 | 580 | 497 | 1,590 | 189 | 66 | 103 |
| 30 | 76 | 95 | ..... | 195 | 382 | 419 | 865 | 144 | 61 | 95 |
| 31 | 76 | ..... | ..... | 144 | ..... | 311 | ..... | 127 | 59 | ..... |

| Day. | Oct. | Nov. | Day. | Oct. | Nov. | Day. | Oct. | Nov. |
|---|---|---|---|---|---|---|---|---|
| 1914. | | | 1914. | | | 1914. | | |
| 1 | 95 | 149 | 11 | 189 | 116 | 21 | 232 | 76 |
| 2 | 80 | 144 | 12 | 195 | 116 | 22 | 217 | ..... |
| 3 | 99 | 144 | 13 | 328 | 116 | 23 | 206 | ..... |
| 4 | 76 | 134 | 14 | 497 | 116 | 24 | 184 | ..... |
| 5 | 80 | 134 | 15 | 457 | 116 | 25 | 179 | ..... |
| 6 | 477 | 125 | 16 | 419 | 99 | 26 | 173 | ..... |
| 7 | 346 | 125 | 17 | 364 | 95 | 27 | 168 | ..... |
| 8 | 382 | 121 | 18 | 311 | 112 | 28 | 161 | ..... |
| 9 | 247 | 121 | 19 | 278 | 87 | 29 | 156 | ..... |
| 10 | 203 | 125 | 20 | 247 | 80 | 30 | 156 | ..... |
| | | | | | | 31 | 151 | ..... |

NOTE.—Daily discharge computed from a rating curve fairly well defined between 50 and 200 second-feet. Above 500 second-feet the estimates should be used with great caution. They may be as much as 25 per cent in error.

*Monthly discharge of Upper Iowa River near Decorah, Iowa, for the period Aug. 27, 1913, to Nov. 21, 1914.*

[Drainage area, 560 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| 1913. | | | | | | |
| August 27–31 | 51 | 44 | 47.2 | 0.084 | 0.02 | C. |
| September | 85 | 37 | 49.9 | .089 | .10 | B. |
| 1913–14. | | | | | | |
| October | 477 | 59 | 111 | .198 | .23 | B. |
| November | 112 | 67 | 77.0 | .138 | .15 | A. |
| December 1–13 | 95 | 44 | 78.7 | .140 | .07 | A. |
| March 25–31 | 195 | 87 | 125 | .223 | .06 | B. |
| April | 1,300 | 59 | 160 | .286 | .32 | B. |
| May | 3,150 | 130 | 448 | .800 | .92 | C. |
| June | 3,080 | 247 | 991 | 1.77 | 1.98 | C. |
| July | 692 | 116 | 254 | .454 | .52 | B. |
| August | 134 | 59 | 84.1 | .150 | .17 | A. |
| September | 865 | 51 | 159 | .284 | .32 | A. |
| 1914. | | | | | | |
| October | 477 | 76 | 237 | 0.423 | 0.49 | A. |
| November 1–21 | 149 | 76 | 117 | .209 | .16 | A. |

## WISCONSIN RIVER NEAR RHINELANDER, WIS.

LOCATION.—On the line between secs. 26 and 27, T. 36 N., R. 8 E., Oneida County, at highway bridge immediately below power station of the Rhinelander Power Co., 8 miles southwest of Rhinelander and 8 miles below the mouth of Pelican River.

DRAINAGE AREA.—1,110 square miles.

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

GAGE.—Standard chain gage fastened to upstream side of bridge, read twice daily, morning and evening, by G. N. Kramer.

DISCHARGE MEASUREMENTS.—Made from highway bridge to which gage is attached.

CHANNEL AND CONTROL.—Gravel; during the greater part of the open-water period aquatic plants grow in the channel, destroying the open-water discharge relation. Both banks are high and will not overflow.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 4.8 feet at 7 a. m. July 18 (discharge approximately 2,920 second-feet); minimum stage recorded, 1.9 feet at 7 a. m. September 6 (discharge approximately 245 second-feet).

1905–1915: Maximum discharge recorded, 3,850 second-feet October 9, 1911; minimum discharge recorded, zero during August–September, 1907, and June–July, 1908. The minimum flow is due to regulation and it is doubtful if the flow during these periods was absolutely zero. It is possible, however, so to control the flow that the absolute minimum for short periods will be small.

WINTER FLOW.—Relatively warm water from service reservoir above the station prevents the formation of much ice on the control. Flow when ice is present is determined from discharge measurements, observer's notes, and weather records.

REGULATION.—Above the gaging station the following reservoirs are operated by the Wisconsin Valley Improvement Co. for the purpose of regulating the flow: South Pelican, North Pelican, Big St. Germain, Little St. Germain, Sugar Camp, Seven Mile, Upper Nine Mile, Lower Nine Mile, Burnt Rollways, Long on Deerskin, Little Deerskin, Buckatahpon, Twin, and Vieux Desert. The flow is also regulated at the dam immediately above the station by the Rhinelander Paper Co. dam and the Otto Rapids dam of the Eagle River Electric Co. For more detailed information in regard to these reservoirs and power plants see page 127.

ACCURACY.—Records only fair, owing to presence of aquatic plants in the channel during the greater part of the year and to diurnal fluctuation. In September, 1915, a Stevens water-stage recorder was installed at the head of Whirlpool Rapids, Lincoln County, sec. 3, T. 35 N., R. 8 E., about 2 miles below the present gage, and a cable installed from which discharge measurements may be made. The control at the new site will not be affected by vegetation and records will probably be more accurate.

*Discharge measurements of Wisconsin River near Rhinelander, Wis., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Nov. 14[a] | G. H. Canfield | 2.68 | 1,000 | Mar. 15 | G. H. Canfield | 2.80 | 1,180 |
| Jan. 7[b] | do | 2.75 | 934 | May 20 | H. C. Beckman | 2.81 | 1,250 |
| Feb. 11[b] | do | 2.34 | 642 | Aug. 16[c] | do | 3.90 | 1,430 |
| Mar. 15 | do | 2.80 | 1,180 | | | | |

[a] Aquatic plants along shore but none in main channel.
[b] No ice at gage section; complete in cover half a mile downstream.
[c] Heavy growth of aquatic plants in gage section.

*Daily discharge, in second-feet, of Wisconsin River near Rhinelander, Wis., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1,220 | 488 | 1,180 | | | | 930 | 1,460 | 1,220 | 700 | 625 | 1,180 |
| 2 | 1,180 | 1,090 | 1,270 | | | | 1,090 | 1,140 | 1,140 | 700 | 738 | 1,140 |
| 3 | 1,010 | 1,270 | 1,220 | | | | 1,010 | 1,220 | 1,050 | 521 | 700 | 1,090 |
| 4 | 850 | 1,180 | 1,270 | | | | 662 | 1,270 | 1,010 | 325 | 1,090 | 1,090 |
| 5 | 970 | 1,220 | 1,270 | | | | 970 | 1,180 | 1,050 | 325 | 1,790 | 355 |
| 6 | 850 | 1,220 | 930 | 790 | 840 | 1,150 | 1,090 | 1,180 | 850 | 355 | 1,680 | 270 |
| 7 | 890 | 1,360 | 1,180 | | | | 1,180 | 1,320 | 1,180 | 625 | 1,460 | 590 |
| 8 | 890 | 738 | 1,270 | | | | 1,320 | 1,320 | 1,050 | 738 | 890 | 970 |
| 9 | 970 | 1,050 | 1,090 | | | | 1,740 | 1,050 | 1,010 | 738 | 1,900 | 1,140 |
| 10 | 890 | 1,320 | 890 | | | | 1,570 | 1,180 | 1,140 | 738 | 2,020 | 850 |
| 11 | 930 | 1,520 | | | | | 1,360 | 1,140 | 1,140 | 554 | 1,570 | 1,180 |
| 12 | 1,320 | 1,320 | | | | | 1,410 | 1,180 | 1,010 | 625 | 1,570 | 292 |
| 13 | 1,050 | 1,620 | | | | | 1,790 | 1,140 | 850 | 662 | 1,570 | 418 |
| 14 | 1,050 | 1,570 | | | | | 2,020 | 1,180 | 1,140 | 850 | 1,270 | 930 |
| 15 | 1,180 | 775 | | | | | 1,840 | 1,140 | 1,220 | 554 | 1,460 | 1,090 |
| 16 | 1,220 | 1,270 | 685 | 800 | 840 | 1,160 | 1,900 | 890 | 1,140 | 890 | 1,360 | 775 |
| 17 | 1,270 | 1,140 | | | | | 1,790 | 1,270 | 1,050 | 812 | 1,360 | 1,180 |
| 18 | 890 | 1,220 | | | | | 1,180 | 1,180 | 1,270 | 2,780 | 970 | 1,140 |
| 19 | 1,220 | 1,140 | | | | | 1,520 | 1,180 | 1,180 | 2,020 | 890 | 812 |
| 20 | 1,410 | 1,180 | | | | | 1,570 | 1,180 | 700 | 1,900 | 890 | 1,050 |
| 21 | 1,360 | 1,090 | | | | | 1,570 | 1,360 | 775 | 1,790 | 850 | 1,320 |
| 22 | 1,270 | 1,010 | | | | | 1,840 | 1,570 | 1,180 | 1,570 | 295 | 1,180 |
| 23 | 1,320 | 1,090 | | | | | 1,460 | 1,090 | 1,140 | 1,460 | 340 | 1,140 |
| 24 | 1,220 | 1,180 | | | | | 1,410 | 1,410 | 1,140 | 1,570 | 775 | 1,140 |
| 25 | 970 | 1,090 | | | | | 1,050 | 1,360 | 1,050 | 464 | 700 | 1,050 |
| 26 | 1,140 | 1,180 | 775 | 840 | 915 | 930 | 1,520 | 1,360 | 930 | 1,010 | 700 | 1,010 |
| 27 | 1,220 | 1,320 | | | | | 1,360 | 1,180 | 738 | 930 | 488 | 1,010 |
| 28 | 1,180 | 1,270 | | | | | 1,270 | 1,140 | 890 | 890 | 464 | 1,180 |
| 29 | 1,140 | 1,320 | | | | | 1,270 | 1,050 | 930 | 1,010 | 270 | 1,050 |
| 30 | 1,050 | 1,140 | | | | | 1,460 | 1,180 | 812 | 970 | 440 | 662 |
| 31 | 1,010 | ..... | | | | | ..... | 1,140 | ..... | 890 | 1,050 | ..... |

NOTE.—Discharge determined as follows: Oct. 1 to Nov. 10 and June 1 to Sept. 30, by indirect method; Nov. 11 to Dec. 10 and Apr. 1 to May 31, from a rating curve fairly well defined between 554 and 3,200 second-feet; Dec. 11 to Mar. 31 estimated, because of ice, from discharge measurements, observer's notes, and weather records. Braced figures show mean discharge for period included.

*Monthly discharge of Wisconsin River near Rhinelander, Wis., for the year ending Sept. 30, 1915.*

[Drainage area, 1,110 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 1,410 | 850 | 1,100 | 0.991 | 1.14 | |
| November | 1,620 | 488 | 1,180 | 1.06 | 1.18 | |
| December | 1,270 | ..... | 869 | .783 | .90 | C. |
| January | ..... | ..... | 811 | .731 | .84 | C. |
| February | ..... | ..... | 861 | .776 | .81 | C. |
| March | ..... | ..... | 1,080 | .973 | 1.12 | C. |
| April | 2,020 | 662 | 1,400 | 1.26 | 1.41 | |
| May | 1,570 | 890 | 1,210 | 1.09 | 1.26 | |
| June | 1,270 | 700 | 1,030 | .928 | 1.04 | |
| July | 2,780 | 325 | 967 | .871 | 1.00 | |
| August | 2,020 | 270 | 1,040 | .937 | 1.08 | |
| September | 1,320 | 270 | 943 | .850 | .95 | |
| The year | 2,780 | 270 | 1,040 | .937 | 12.73 | |

WISCONSIN RIVER AT MERRILL, WIS.

LOCATION.—At highway bridge at east end of the city of Merrill, Lincoln County, 1,000 feet below the power house of the Merrill Electric Railway & Power Co., and half a mile below the mouth of Prairie River, coming in from the left. (See Pl. IV, *B*.

DRAINAGE AREA.—2,630 square miles.

RECORDS AVAILABLE.—November 17, 1902, to September 30, 1915.

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 above the recording gage.

CHANNEL AND CONTROL.—Heavy gravel and rock; nearly permanent; small island below gage and small rapids on either side probably constitute control. Both banks fairly high and rarely overflow.

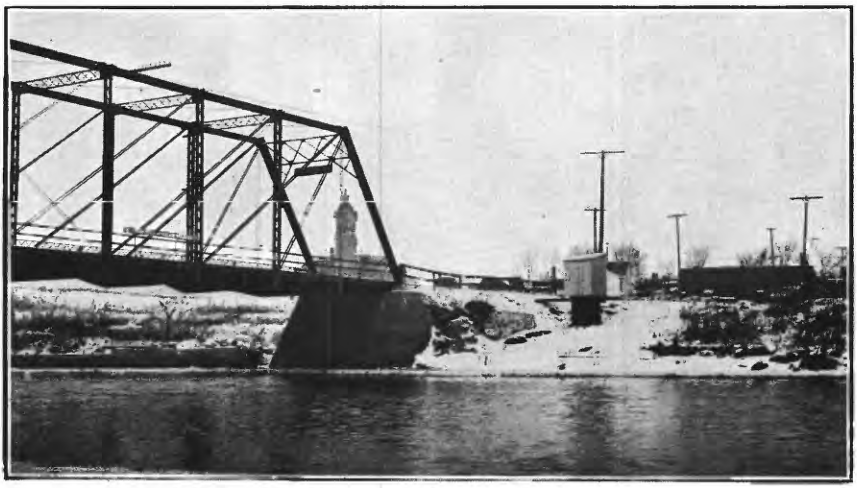
EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 7.30 feet at 1 a. m. August 7 (discharge, 6,760 second-feet); minimum stage recorded, 2.95 feet at 7 a. m. July 6 (discharge, approximately 450 second-feet).

1912–1915: 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 approximately 390 second-feet).

WINTER FLOW.—Discharge relation affected somewhat by ice; flow determined from discharge measurements, observer's notes, gage record, and weather records.

REGULATION.—Above the gaging station are 17 reservoirs, 3 in the Tomahawk River basin and 14 in the headwaters of Wisconsin River above the gaging station near Rhinelander, which are operated by the Wisconsin Valley Improvement Co. for the purpose of regulating the flow in the Wisconsin River. In addition to the above reservoirs the following eight dams on Wisconsin and Tomahawk rivers are

*A*. MEASURING FLOW OF AN ICE-COVERED STREAM, WISCONSIN RIVER AT NECEDAH, WIS.



*B*. GAGING STATION ON WISCONSIN RIVER AT MERRILL, WIS.

Looking upstream. Shows chain gage on bridge and shelter for water-stage recorder.

operated for power: Merrill, Merrill Electric Light & Railway Co.; Grandfather, Father Falls, Grandfather Falls Co.; Tomahawk, Tomahawk Pulp & Paper Co.; Kings, Tomahawk Power Co.; Hat Rapids, Rhinelander Power Co.; Rhinelander, Rhinelander Power Co.; Otter Rapids, Eagle River Electric Co.; Tomahawk, Tomahawk Light, Telephone & Improvement Co. For more detailed information in regard to these reservoirs and power plants see table on page 127.

ACCURACY.—Rating curve well defined; mean daily discharge determined by integrating the discharge direct from recording gage records; channel practically permanent throughout the year; records believed excellent.

*Discharge measurements of Wisconsin River at Merrill, Wis., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 5 | G. H. Canfield | [a]4.79 | 1,930 | Feb. 8[c] | G. H. Canfield | 4.62 | 1,380 |
| 6 | do | 4.74 | 1,720 | 9[c] | do | 5.14 | 1,880 |
| Nov. 20[b] | do | 4.40 | 1,370 | Mar. 8 | do | 4.52 | 1,370 |
| Jan. 4[c] | do | 5.03 | 1,760 | June 9 | Hoyt and Bennett | 6.23 | 4,240 |

[a] During measurement stage fell 0.6 foot in 20 minutes.
[b] One channel partly frozen; control clear of ice.
[c] Ice on control.

*Daily discharge, in second-feet, of Wisconsin River at Merrill, Wis., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2,050 | 2,040 | 2,280 | | 1,160 | 1,120 | 1,800 | 3,460 | 2,620 | 2,180 | 2,780 | 2,020 |
| 2 | 2,050 | 1,400 | 2,290 | {1,330 | 1,500 | 1,570 | 1,720 | 3,280 | 2,580 | 1,970 | 2,680 | 2,140 |
| 3 | 2,050 | 1,860 | 2,290 | | 1,580 | 1,660 | 1,760 | 3,020 | 2,430 | 1,790 | 4,070 | 2,160 |
| 4 | 2,050 | 1,870 | 2,350 | 1,330 | 1,260 | 1,360 | 1,900 | 3,920 | 2,320 | 1,350 | 6,080 | 2,240 |
| 5 | 2,250 | 1,910 | 2,110 | 1,540 | 1,600 | 1,390 | 2,140 | 3,360 | 2,180 | 1,280 | 7,020 | 1,980 |
| 6 | 3,380 | 1,840 | 2,060 | 1,640 | 1,210 | 1,560 | 3,030 | 3,280 | 3,360 | 845 | 7,520 | 1,640 |
| 7 | 2,160 | 1,870 | 1,880 | 1,640 | 1,480 | 1,500 | 3,650 | 3,810 | 3,040 | 1,700 | 7,420 | 1,460 |
| 8 | 2,630 | 1,900 | 2,290 | 1,600 | 1,340 | 1,300 | 4,490 | 4,570 | 4,060 | 1,480 | 6,180 | 1,280 |
| 9 | 2,560 | 1,190 | 1,720 | 1,230 | 1,540 | 1,260 | 5,240 | 5,020 | 3,880 | 1,890 | 5,010 | 1,890 |
| 10 | 2,740 | 1,420 | 1,800 | 1,420 | 1,320 | 1,640 | 6,380 | 4,410 | 3,720 | 1,700 | 4,950 | 1,660 |
| 11 | 3,220 | 1,760 | 1,380 | 1,280 | 1,480 | 1,660 | 7,140 | 3,860 | 3,420 | 2,160 | 4,120 | 1,610 |
| 12 | 2,800 | 1,820 | 1,410 | 1,430 | 1,220 | 1,530 | 6,620 | 3,720 | 3,320 | 2,320 | 3,920 | 1,510 |
| 13 | 2,870 | 1,710 | 1,730 | 1,400 | 1,520 | 1,900 | 7,150 | 3,150 | 2,940 | 2,620 | 3,350 | 1,640 |
| 14 | 2,960 | 1,790 | 1,460 | 1,140 | 1,420 | 1,920 | 6,400 | 3,280 | 2,680 | 2,430 | 3,460 | 1,580 |
| 15 | 2,980 | 1,960 | 1,630 | 1,400 | 1,340 | 1,710 | 5,640 | 3,120 | 2,970 | 2,680 | 3,000 | 2,620 |
| 16 | 2,980 | 1,490 | 1,480 | 1,540 | 1,700 | 1,680 | 5,560 | 3,760 | 2,840 | 3,560 | 2,880 | 2,500 |
| 17 | 2,800 | 1,680 | 1,260 | 1,640 | 1,410 | 2,020 | 5,520 | 4,140 | 2,610 | 4,400 | 2,980 | 2,680 |
| 18 | 2,900 | 1,980 | 1,540 | 1,250 | 1,340 | 1,740 | 5,310 | 4,420 | 2,600 | 5,380 | 2,740 | 2,560 |
| 19 | 2,400 | 1,600 | 1,640 | 1,630 | 1,610 | 1,870 | 4,780 | 4,370 | 3,340 | 4,250 | 2,400 | 2,560 |
| 20 | 2,620 | 1,520 | 1,540 | 1,440 | 1,440 | 1,910 | 5,080 | 3,860 | 3,680 | 3,780 | 2,380 | 2,520 |
| 21 | 2,740 | 1,840 | 1,360 | 1,360 | 1,420 | 1,960 | 4,430 | 5,450 | 3,440 | 3,350 | 2,320 | 2,500 |
| 22 | 2,400 | 1,770 | 1,660 | 1,380 | 1,310 | 1,590 | 4,280 | 6,540 | 3,490 | 3,040 | 2,380 | 2,640 |
| 23 | 2,660 | 1,430 | 1,620 | 1,470 | 1,420 | 1,550 | 4,070 | 6,740 | 3,100 | 2,580 | 1,330 | 2,160 |
| 24 | 2,390 | 1,780 | 1,480 | 1,570 | 1,720 | 2,100 | 5,010 | 5,840 | 2,590 | 3,180 | 1,880 | 2,220 |
| 25 | 2,540 | 1,770 | | 1,140 | 1,400 | 2,040 | 4,780 | 5,240 | 2,120 | 3,660 | 1,720 | 2,020 |
| 26 | 1,860 | 1,920 | | 1,430 | 1,560 | 1,820 | 3,000 | 5,300 | 2,420 | 3,220 | 1,840 | 2,580 |
| 27 | 2,300 | 1,650 | {1,400 | 1,480 | 1,220 | 1,830 | 4,060 | 4,770 | 2,850 | 2,750 | 1,820 | 1,900 |
| 28 | 2,420 | 1,840 | | 1,250 | 1,560 | 2,070 | 4,170 | 3,940 | 1,870 | 2,660 | 1,800 | 2,390 |
| 29 | 2,100 | 1,920 | | 1,380 | ..... | 1,540 | 4,020 | 3,450 | 3,020 | 2,400 | 2,000 | 2,740 |
| 30 | 1,940 | 1,960 | | 1,470 | ..... | 1,520 | 3,880 | 3,270 | 2,520 | 2,100 | 1,120 | 2,550 |
| 31 | 1,890 | ..... | | 1,280 | ..... | 1,700 | ..... | 2,610 | ..... | 2,070 | 1,770 | ..... |

NOTE.—Discharge determined from a rating curve well defined between 1,210 and 8,430 second-feet, poorly defined below 1,210 second-feet, and fairly well defined above 8,430 second-feet.
Discharge relation affected by ice Dec. 10 to Mar. 30; discharge during this period determined by standard methods used during periods when river is frozen over. Necessary corrections to gage heights determined from discharge measurements, gage records, observer's notes, and weather records. Instead of applying rating curve to mean daily gage height the discharge was determined by the "Fuller" integrator, which determines directly the mean daily discharge. Braced figures show mean discharge for period included.

*Monthly discharge of Wisconsin River at Merrill, Wis., for the year ending Sept. 30, 1915.*

| Month. | Discharge in second-feet. | | | Accuracy. | Month | Discharge in second-feet. | | | Accuracy. |
|---|---|---|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | | | Maximum. | Minimum. | Mean. | |
| October | 3,380 | 1,860 | 2,510 | B. | April | 7,150 | 1,720 | 4,430 | A. |
| November | 2,040 | 1,190 | 1,750 | A. | May | 6,740 | 2,610 | 4,140 | A. |
| December | 2,350 | ..... | 1,680 | B. | June | 4,060 | 1,870 | 2,930 | A. |
| January | ..... | ..... | 1,410 | C. | July | 5,380 | 845 | 2,610 | B. |
| February | ..... | ..... | 1,430 | C. | August | 7,520 | 1,120 | 3,380 | A. |
| March | ..... | ..... | 1,680 | C. | September | 2,740 | 1,280 | 2,130 | A. |
| | | | | | The year | 7,520 | ..... | 2,510 | |

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 2 miles below the station, and Big Roche a Cri Creek, also from the left, about 28 miles below the station.

DRAINAGE AREA.—5,500 square miles (measured on Wisconsin Geological and Natural History Survey map, edition of 1911; scale, 1 inch=6 miles).

RECORDS AVAILABLE.—May 21, 1914, to September 30, 1915.

GAGE.—Gurley graph water-stage recorder, in wooden shelter on right bank of river, installed October 23, 1914; prior to this date a staff gage about 300 feet upstream from recording gage. The recording gage was set so as to give the same readings as the staff gage at medium stages; there is probably but slight difference in readings at other stages.

DISCHARGE MEASUREMENTS.—Made from cable a short distance above the gage house.

CHANNEL AND CONTROL.—Gravel; clean; probably nearly permanent; both banks high and will rarely overflow.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 8.68 feet at 7 a. m. May 24 (discharge, 19,800 second-feet); minimum stage recorded, 0.80 foot 10 p. m. August 31 to 2 a. m. September 1 (discharge, 1,030 second-feet).

May 21, 1914, to September 30, 1915: Maximum stage recorded, approximately 15.3 feet during the flood of June 6 to 9, 1914, as determined by levels run to high-water marks after water had receded (discharge, approximately 54,000 second-feet); minimum discharge recorded, 0.80 foot 10 p. m. August 31 to 2 a. m. September 1, 1915; discharge, 1,030 second-feet. The absolute minimum was probably below this figure and was due to regulation.

WINTER FLOW.—Discharge relation seriously affected by ice; flow determined from discharge measurements, observer's notes, and weather records.

REGULATION.—No storage reservoirs discharge into the Wisconsin River between Nekoosa and Merrill. For detailed information in regard to the 17 storage reservoirs above Merrill on the Wisconsin River and its tributaries, see the table on page 127.

Between Nekoosa and Merrill the following 12 dams are operated for power: Edwards Paper Co.: Nekoosa dam and Port Edwards dam at Nekoosa; Centralia Pulp & Water Power Co. dam; Consolidated Water Power & Paper Co.; Grand Rapids dam and Biron dam; Plover Paper Co. dam at Whiting; Wisconsin River Paper & Pulp Co. dam; Jackson Milling Co. dam; Wausau Sulphate Fibre Co. dam; Marathon Paper Mills Co. dam; Wausau Street Railway Co. dam; Wausau Paper Mills Co. dam.

For more detailed information in regard to these power plants see table on page 127.

ACCURACY.—Rating curve well defined; mean daily gage height accurately determined; channel permanent; open-water records excellent.

*Reservoirs maintained by the Wisconsin Valley Improvement Co. in 1915.*[a]

| Name. | Location of reservoir. | Location of dam. | Area of reservoir. | Drainage area. | Capacity (millions of cubic feet). | |
|---|---|---|---|---|---|---|
| | | | | | Summer. | Winter. |
| *Tomahawk River.* | | | *Square miles.* | *Square miles.* | | |
| Rice Storage | Tps. 35-36 N., Rs. 5-7 E. | Secs. 4 and 9, T. 35 N., R. 6 E. | 6.85 | 558.25 | 1,788 | 1,788 |
| 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 |
| *Wisconsin River.* | | | | | | |
| South Pelican | T. 35 N., Rs. 10-11 E. | Sec. 11, T. 35 N., R. 10 E. | 5.49 | 22.50 | 0 | 305 |
| North Pelican | Tps. 36-38 N., Rs. 9-11 E. | Sec. 4, T. 36 N., R. 10 E. | 2.33 | 93.00 | 83 | 205 |
| Big St. Germain | Tps. 40-41 N., Rs. 7-8 E. | Sec. 30, T. 40 N., R. 8 E. | 2.51 | 68.76 | 243 | 243 |
| Little St. Germain | T. 40 N., Rs. 8-9 E. | Sec. 35, T. 40 N., R. 8 E. | 1.57 | 19.34 | 142 | 142 |
| Sugar Camp | Tps. 38-39 N., Rs. 8-10 E. | Sec. 17, T. 39 N., R. 9 E. | 3.34 | 59.00 | 380 | 380 |
| Seven Mile | T. 39 N., Rs. 11-12 E. | Sec. 11, T. 39 N., R. 11 E. | .87 | 14.00 | 117 | 117 |
| Upper Nine Mile | T. 40 N., Rs. 11-12 E. | Sec. 36, T. 40 N., R. 11 E. | .24 | 3.00 | 14 | 14 |
| Lower Nine Mile | Tps. 39-40 N., R. 11 E. | Sec. 4, T. 39 N., R. 11 E. | 1.14 | 28.00 | 93 | 93 |
| Burnt Rollways | Tps. 37-40 N., Rs. 11-12 E. | Sec. 5, T. 39 N., R. 11 E. | 10.91 | 133.00 | 386 | 609 |
| Long on Deerskin | Tps. 41-42 N., R. 12 E. | Sec. 7, T. 41 N., R. 12 E. | 3.96 | 28.80 | 316 | 384 |
| Little Deerskin | Tps. 40-41 N., Rs. 10-11 E. | Sec. 33, T. 41 N., R. 11 E. | .49 | 4.90 | 22 | 22 |
| Buckatahpon | T. 41 N., R. 9 E. | Sec. 24, T. 41 N., R. 9 E. | 1.88 | 14.10 | 142 | 142 |
| Twin | Tps. 41-42 N., R. 11 E. | Sec. 19, T. 41 N., R. 11 E. | 5.41 | 25.70 | 330 | 380 |
| Vieux Desert | T. 42 N., R. 11 E. | Sec. 17, T. 42 N., R. 11 E. | 7.47 | 27.50 | 600 | 600 |
| | | | 68.77 | 1,198.52 | 5,099 | 6,227 |

*Power plants on Wisconsin and Tomahawk rivers above Nekoosa, Wis.*[a]

| Name of power. | Location. | Head developed. | Area of pond in acres. |
|---|---|---|---|
| *Wisconsin River.* | | | |
| Nekoosa—Edwards Paper Co.: | | *Feet.* | |
| Nekoosa dam | T. 21 N., R. 5 E. | 19 | 150 |
| Port Edwards dam | T. 22 N., R. 5 E. | 18 | 50 |
| Centralia Pulp & Water Power Co. dam | T. 22 N., R. 5 E. | 13 | 150 |
| Consolidated Water Power & Paper Co.: | | | |
| Grand Rapids dam | T. 22 N., R. 6 E. | 28 | 320 |
| Biron dam | T. 23 N., R. 6 E. | 16 | 160 |
| Whiting—Plover Paper Co. dam | T. 23 N., R. 8 E. | 6.5 | 49 |
| Wisconsin River Paper & Pulp Co. dam | T. 23 N., R. 8 E. | 18 | 76 |
| Jackson Milling Co. dam | T. 23 N., R. 8 E. | 8 | ..... |
| Wausau Sulphate Fibre Co. dam | Sec. 29, T. 27 N., R. 7 E. | 17 | 674 |
| Marathon Paper Mills Co. dam | Sec. 24, T. 28 N., R. 7 E. | 20 | 1,774 |
| Wausau Street Railway Co. dam | Sec. 35, T. 29 N., R. 7 E. | 22 | 304 |
| Wausau Paper Mills Co. dam | Sec. 3, T. 29 N., R. 7 E. | 16 | 596 |
| Merrill—Merrill Electric Light & Railway Co. | Sec. 13, T. 31 N., R. 6 E. | 14 | ..... |
| Grandfather Falls—Grandfather Falls Co. | Sec. 30, T. 33 N., R. 6 E. | 33 | ..... |
| Tomahawk—Tomahawk Pulp & Paper Co. | Sec. 10, T. 34 N., R. 6 E. | 16 | 2,733 |
| Kings—Tomahawk Power Co. | Sec. 25, T. 35 N., R. 6 E. | 23 | 1,810 |
| Hat Rapids—Rhinelander Power Co. | Sec. 27, T. 36 N., R. 8 E. | 20 | 650 |
| Rhinelander—Rhinelander Paper Co. | Sec. 6, T. 36 N., R. 9 E. | 32 | 3,576 |
| Otter Rapids—Eagle River Electric Co. | Sec. 36, T. 40 N., R. 9 E. | 12 | 3,250 |
| *Tomahawk River.* | | | |
| Tomahawk—Tomahawk Light, Telephone & Improvement Co. | Sec. 28, T. 35 N., R. 6 E. | 13.5 | 709 |

[a] From information furnished by Wisconsin Valley Improvement Co.

*Discharge measurements of Wisconsin River near Nekoosa, Wis., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height.[a] | Discharge. | Date. | Made by— | Gage height.[a] | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 2 | G. H. Canfield | 2.21 | 3,310 | Feb. 4[e] | G. H. Canfield | 3.73 | 2,570 |
| Nov. 21[bc] | do | 1.07 | 1,410 | Mar. 4[f] | do | 3.51 | 2,940 |
| 22[d] | do | 1.73 | 2,210 | Apr. 10 | H. C. Beckman | 7.92 | 17,700 |
| Jan. 1[e] | do | 3.80 | 2,110 | 12 | do | 8.44 | 19,200 |
| Feb. 3[e] | do | 3.31 | 2,130 | 16 | do | 5.97 | 11,800 |
| 4[e] | do | 3.02 | 1,530 | 17 | do | 5.71 | 11,200 |

[a] Refers to hook gage installed Oct. 23.
[b] Some ice near shore, control nearly open.
[c] Made by wading under cable.
[d] Made through complete ice cover 2 miles down stream; frazil under ice at gage section.
[e] Made through complete ice cover; no frazil in section.
[f] Made at cable section; two-thirds ice cover.

*Daily discharge in second-feet of Wisconsin River near Nekoosa, Wis., for the years ending Sept. 30, 1914–1915.*

| Day. | May. | June. | July. | Aug. | Sept. | Day. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1914. | | | | | | 1914. | | | | | |
| 1 | | 6,200 | 17,800 | 3,980 | 5,220 | 16 | | 6,770 | 6,880 | 1,720 | 7,940 |
| 2 | | 6,660 | 17,800 | 3,920 | 7,460 | 17 | | 4,400 | 5,540 | 2,480 | 8,900 |
| 3 | | 6,660 | 18,400 | 3,190 | 6,090 | 18 | | 3,790 | 5,540 | 3,190 | 9,900 |
| 4 | | 13,500 | 17,200 | 3,010 | 6,200 | 19 | | 4,020 | 5,430 | 4,360 | 8,180 |
| 5 | | 24,000 | 12,800 | 3,920 | 5,870 | 20 | | 5,320 | 5,320 | 6,770 | 7,940 |
| 6 | | | 11,200 | 3,680 | 6,090 | 21 | | 4,800 | 5,870 | 4,700 | 6,540 | 7,700 |
| 7 | | | 8,420 | 2,740 | 5,220 | 22 | | 5,540 | 6,310 | 3,830 | 5,760 | 6,090 |
| 8 | | 34,300 | 7,230 | 2,570 | 5,320 | 23 | | 13,900 | 5,650 | 3,830 | 4,700 | 4,900 |
| 9 | | | 5,980 | 2,830 | 4,300 | 24 | | 19,000 | 5,120 | 3,870 | 5,650 | 5,650 |
| 10 | | 21,400 | 5,760 | 3,370 | 3,740 | 25 | | 16,900 | 6,090 | 3,830 | 6,880 | 5,010 |
| 11 | | 15,400 | 5,980 | 3,370 | 4,120 | 26 | | 12,300 | 6,660 | 3,740 | 7,940 | 4,600 |
| 12 | | 9,400 | 6,660 | 3,140 | 4,120 | 27 | | 10,700 | 7,700 | 5,540 | 7,000 | 4,640 |
| 13 | | 8,180 | 6,770 | 2,920 | 4,400 | 28 | | 9,150 | 12,000 | 5,010 | 6,420 | 4,300 |
| 14 | | 6,770 | 6,660 | 2,660 | 6,420 | 29 | | 8,420 | 16,600 | 3,920 | 6,880 | 3,680 |
| 15 | | 6,540 | 6,770 | 2,150 | 5,650 | 30 | | 7,460 | 17,800 | 3,280 | 6,200 | 3,740 |
| | | | | | | 31 | | 6,090 | | 3,500 | 5,870 | |

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1914–15. | | | | | | | | | | | | |
| 1 | 3,920 | 2,480 | | | | | 4,600 | 6,310 | 5,220 | 3,920 | 3,740 | 2,480 |
| 2 | 4,020 | 3,190 | | | | | 4,300 | 6,310 | 4,800 | 4,300 | 4,400 | 2,740 |
| 3 | 3,280 | 3,460 | | | | | 4,600 | 6,090 | 4,120 | 3,920 | 4,400 | 2,480 |
| 4 | 2,660 | 2,920 | | | | | 4,500 | 5,430 | 3,830 | 3,010 | 4,300 | 2,020 |
| 5 | 4,020 | 2,920 | | | | | 5,120 | 6,090 | 4,020 | 2,660 | 7,230 | 2,320 |
| 6 | 4,020 | 2,660 | 2,840 | 1,800 | 2,020 | 2,600 | 7,940 | 6,540 | 3,830 | 4,020 | 9,900 | 3,010 |
| 7 | 2,150 | 2,920 | | | | | 12,300 | 6,540 | 4,020 | 2,920 | 10,900 | 2,400 |
| 8 | 3,100 | 2,740 | | | | | 15,400 | 7,230 | 5,540 | 2,570 | 11,500 | 3,100 |
| 9 | 4,210 | 3,010 | | | | | 17,200 | 9,150 | 6,310 | 2,660 | 10,400 | 2,480 |
| 10 | | 3,010 | | | | | 18,400 | 10,200 | 5,760 | 2,400 | 8,660 | 2,400 |
| 11 | | 2,320 | | | | | 18,400 | 8,900 | 6,540 | 1,850 | 7,460 | 2,480 |
| 12 | | 2,570 | | | | | 19,300 | 7,940 | 6,770 | 2,660 | 6,770 | 2,070 |
| 13 | | 2,660 | | | | | 19,000 | 6,540 | 6,770 | 1,520 | 5,760 | 2,920 |
| 14 | | 2,660 | | | | | 16,000 | 6,090 | 6,540 | 3,640 | 5,650 | 2,660 |
| 15 | | 2,230 | 1,860 | 1,620 | 2,350 | | 13,900 | 6,310 | 5,320 | 3,830 | 4,400 | 3,190 |
| 16 | 3,800 | 2,740 | | | | 2,900 | 12,300 | 5,870 | 4,800 | 3,640 | 4,800 | 3,740 |
| 17 | | 2,660 | | | | | 10,900 | 7,000 | 5,010 | 3,640 | 4,210 | 3,460 |
| 18 | | 2,230 | | | | | 10,700 | 8,180 | 4,800 | 5,540 | 4,600 | 4,300 |
| 19 | | 2,740 | | | | | 9,900 | 9,400 | 4,600 | 5,220 | 4,500 | 4,210 |
| 20 | | 2,150 | | | | | 8,180 | 9,400 | 4,600 | 6,770 | 4,500 | 3,830 |
| 21 | | | | | | | 7,940 | 10,200 | 7,000 | 5,220 | 4,020 | 3,820 |
| 22 | | | | | | | 8,180 | 13,100 | 6,770 | 4,700 | 2,920 | 4,210 |
| 23 | 4,020 | | | | | 2,920 | 7,940 | 18,400 | 6,540 | 4,500 | 3,280 | 3,550 |
| 24 | 4,020 | | | | | 3,920 | 7,700 | 19,900 | 5,540 | 4,500 | 2,920 | 3,740 |
| 25 | 3,830 | | | | | 4,900 | 7,460 | 16,900 | 5,120 | 4,210 | 3,100 | 3,550 |
| 26 | 3,830 | 2,300 | 1,790 | 2,010 | 3,240 | 5,540 | 8,180 | 12,500 | 4,400 | 4,600 | 3,280 | 3,550 |
| 27 | 3,740 | | | | | 7,000 | 7,460 | 10,900 | 4,600 | 5,430 | 2,480 | 3,100 |
| 28 | 3,640 | | | | | 6,540 | 6,540 | 10,400 | 3,640 | 5,120 | 2,740 | 2,920 |
| 29 | 3,640 | | | | | 6,090 | 7,000 | 8,660 | 3,370 | 4,600 | 3,550 | 3,460 |
| 30 | 4,020 | | | | | 4,800 | 7,230 | 7,230 | 4,120 | 4,500 | 2,010 | 3,100 |
| 31 | 3,280 | | | | | 4,800 | | 6,310 | | 4,020 | 1,330 | |

NOTE.—Discharge, except as noted below, determined from a well-defined rating curve. June 6–9, 1914, estimated because water was over gage, from maximum gage height of 15.3 feet, determined by levels to high-water mark; Oct. 10–22, 1914, estimated, because gage was not read, from flow preceding and following this period, and general conditions of flow; June 26, 27, and 28, 1915, partly estimated; Nov. 21 to Mar. 22, estimated because of ice from discharge measurements, observer's notes, and weather records. Braced figures show mean discharge for period included.

*Monthly discharge of Wisconsin River near Nekoosa, Wis., for the years ending Sept. 30, 1914–1915.*

[Drainage area, 5,500 square miles.[a]]

| Month. | Discharge in second-feet. | | | Accuracy. |
|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | |
| 1914. | | | | |
| May 21–31 | 19,000 | 4,800 | 10,400 | A. |
| June | [b] 54,000 | 3,790 | 12,500 | B. |
| July | 18,400 | 3,280 | 7,390 | A. |
| August | 7,940 | 1,720 | 4,380 | A. |
| September | 9,900 | 3,680 | 5,780 | A. |
| 1914–15. | | | | |
| October | ..... | 2,150 | 3,700 | C. |
| November | 3,460 | ..... | 2,580 | B. |
| December | ..... | ..... | 2,150 | C. |
| January | ..... | ..... | 1,820 | C. |
| February | ..... | ..... | 2,490 | C. |
| March | 7,000 | ..... | 3,460 | C. |
| April | 19,300 | 4,300 | 10,300 | A. |
| May | 19,900 | 5,430 | 9,030 | A. |
| June | 7,000 | 3,370 | 5,140 | B. |
| July | 6,770 | 1,520 | 3,940 | A. |
| August | 11,500 | 1,330 | 5,150 | A. |
| September | 4,300 | 2,020 | 3,110 | A. |
| The year | 19,900 | ..... | 4,410 | |

[a] Estimates of "Second-feet per square mile" and "Run-off (depth in inches)" omitted, as distribution of flow at station is due to regulation. See description of station on Wisconsin River at Merrill, Wis.
[b] Estimated crest of flood, June 6–9, 1914.

## WISCONSIN RIVER AT MUSCODA, WIS.

LOCATION.—In sec. 1, T. 8 N., R. 1 W., Grant County, at highway bridge 1 mile north of the village of Muscoda. Eagle Mill Creek enters from the right about half a mile below, Underwood Creek from the left 4½ miles above the station.

DRAINAGE AREA.—10,300 square miles (measured on Wisconsin Geological and Natural History Survey map, edition of 1911; scale, 1 inch=6 miles).

RECORDS AVAILABLE.—December 21, 1902, to December 31, 1903, and December 4, 1913, to September 30, 1915. 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 plate girder on downstream side of bridge; read twice daily, morning and evening, to half-tenths; by William Hessler. Elevation of zero of present gage approximately 12.62 feet above that of gage maintained December 20, 1902, to December 31, 1903; elevation of gage November, 1908, to December 3, 1913, as read and published by United States Weather Bureau was approximately the same as that of present gage, sea-level elevation of which is approximately 666.2 feet.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge.

CHANNEL AND CONTROL.—No well-defined control at this station; rock outcrops for about 100 feet under right-hand end of the bridge; rest of the channel is sand and shifts during medium and high stages. The left bank is high and will not overflow; right bank low and will overflow above the bridge. The road leading to the bridge is high and all the water will pass under the bridge.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 6.0 feet April 17 (discharge, 23,600 second-feet); minimum stage recorded, 0.70 feet December 2, 1914 (discharge, approximately, 3,390 second-feet).

1903 and 1914–1915: Maximum stage recorded, 22.70 feet September 23, 1903, corresponding to 10.1 feet for present gage datum (discharge, approximately, 60,500 second-feet); minimum stage recorded, 0.7 foot December 2, 1914, and 5 p. m., July 24, 1915 (discharge, approximately, 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, 0.0; corresponding discharge not computed owing to possible changes in channel and datum of gage.

WINTER FLOW.—Discharge relation seriously affected by ice; flow determined from discharge measurements, observer's notes, and weather records.

REGULATION.—Nearest power plant above the station is at Prairie du Sac, about 40 miles distant; during the last part of 1915 considerable diurnal fluctuation was observed at the gage. Owing to regulation by storage in the headwaters, the flow at this station is not natural. For detailed information in regard to the reservoirs and power plants above Nekoosa, see page 127.

ACCURACY.—Rating curve only fairly well defined; channel not permanent; some diurnal fluctuation; records fair.

*Discharge measurements of Wisconsin River at Muscoda, Wis., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Jan. 26[a] | G. H. Canfield | 3.32 | 4,190 | Apr. 28 | Hoyt and Beckman | 3.55 | 11,800 |
| 26[a] | M. F. Rather | 3.32 | 3,920 | July 14 | M. F. Rather | 1.57 | 4,970 |

[a] Made through complete ice cover.

*Daily discharge, in second-feet, of Wisconsin River at Muscoda, Wis., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7,620 | 6,160 | 4,350 | | | | 12,900 | 10,600 | 15,400 | 6,310 | 10,600 | 6,980 |
| 2 | 7,240 | 6,160 | 3,570 | | | | 11,300 | 9,800 | 15,000 | 6,310 | 10,900 | 5,330 |
| 3 | 6,870 | 6,510 | 5,530 | | | | 10,200 | 9,060 | 9,800 | 5,980 | 8,700 | 5,330 |
| 4 | 6,870 | 6,160 | 5,830 | | | | 9,800 | 11,300 | 11,300 | 6,980 | 9,060 | 4,490 |
| 5 | 6,160 | 5,530 | 5,250 | | | | 9,800 | 10,200 | 10,900 | 6,310 | 10,900 | 4,490 |
| | | | | 4,020 | 4,200 | | | | | | | |
| 6 | 5,830 | 5,830 | 5,530 | | | | 10,600 | 9,800 | 9,430 | 5,980 | 10,200 | 4,490 |
| 7 | 5,530 | 5,530 | 5,250 | | | | 9,430 | 8,350 | 6,980 | 6,310 | 9,430 | 4,490 |
| 8 | 6,160 | 5,250 | 5,530 | | | | 8,350 | 7,660 | 7,320 | 6,310 | 9,430 | 4,750 |
| 9 | 6,510 | 5,250 | 5,830 | | | | 10,600 | 10,900 | 7,320 | 5,980 | 9,060 | 5,030 |
| 10 | 6,870 | 5,250 | 5,250 | | | 8,520 | 12,900 | 10,900 | 6,980 | 5,650 | 15,000 | 5,330 |
| 11 | 6,510 | 5,000 | 5,530 | | | | 14,600 | 8,000 | 7,660 | 5,650 | 15,000 | 5,650 |
| 12 | 6,160 | 5,000 | 5,830 | | | | 18,200 | 9,430 | 8,700 | 6,310 | 13,700 | 7,320 |
| 13 | 6,510 | 5,830 | 4,780 | | | | 21,300 | 12,100 | 10,200 | 5,030 | 12,900 | 6,310 |
| 14 | 6,510 | 5,830 | 4,350 | | | | 21,300 | 13,300 | 9,800 | 5,030 | 11,300 | 8,700 |
| 15 | 6,870 | 5,250 | | | | | 21,900 | 11,700 | 9,060 | 4,750 | 9,800 | 10,900 |
| | | | | 4,100 | 7,400 | | | | | | | |
| 16 | 8,010 | 5,000 | | | | | 22,400 | 9,800 | 8,350 | 4,750 | 10,200 | 12,100 |
| 17 | 8,400 | 5,250 | 4,570 | | | 9,430 | 23,600 | 9,430 | 9,060 | 4,490 | 9,430 | 12,900 |
| 18 | 8,400 | 5,250 | | | | 8,350 | 21,900 | 9,800 | 9,060 | 4,020 | 10,900 | 12,100 |
| 19 | 9,180 | 5,000 | | | | 8,350 | 19,200 | 9,800 | 9,060 | 3,290 | 10,200 | 9,430 |
| 20 | 9,570 | 5,530 | | | | 8,350 | 15,900 | 10,200 | 8,700 | 3,620 | 8,700 | 8,350 |
| 21 | 8,790 | 5,830 | | | | 8,350 | 15,400 | 10,200 | 8,000 | 3,620 | 8,350 | 11,300 |
| 22 | 8,790 | 4,780 | | | | 7,660 | 15,000 | 12,100 | 8,350 | 5,650 | 8,000 | 11,700 |
| 23 | 8,010 | 4,350 | | | | 8,000 | 14,100 | 14,100 | 5,330 | 8,350 | 7,660 | 12,100 |
| 24 | 8,010 | 4,350 | | | | 10,200 | 12,100 | 15,400 | 8,000 | 6,980 | 7,660 | 11,700 |
| 25 | 7,620 | 4,150 | | | | 10,600 | 11,700 | 15,400 | 9,800 | 6,980 | 7,320 | 10,200 |
| 26 | 6,870 | 4,560 | 4,170 | 4,050 | 11,500 | 9,800 | 11,300 | 16,300 | 9,800 | 7,660 | 7,320 | 9,430 |
| 27 | 7,240 | 5,000 | | | | 9,800 | 11,300 | 18,200 | 8,000 | 6,310 | 5,330 | 9,430 |
| 28 | 6,870 | 5,530 | | | | 10,600 | 11,300 | 20,200 | 7,660 | 6,310 | 4,750 | 10,900 |
| 29 | 6,510 | 5,530 | | | | 10,600 | 11,300 | 21,900 | 6,980 | 10,600 | 4,250 | 8,000 |
| 30 | 6,160 | 5,530 | | | | 12,100 | 10,600 | 20,200 | 5,650 | 9,430 | 4,750 | 7,320 |
| 31 | 6,510 | ..... | | | | 13,300 | ..... | 16,300 | ..... | 7,660 | 8,350 | ..... |

[1] Daily river stages, pt. 10, p. 98.

NOTE.—Discharge determined as follows: Oct. 1 to Dec. 14, from a rating curve well defined between 3,570 and 16,500 second-feet; Mar. 17 to Sept. 30, from a rating curve fairly well defined between 4,490 and 13,700 second-feet; Dec. 15 to Mar. 16, estimated, because of ice, from discharge measurements, observer's notes and weather records. Braced figures show mean discharge for period included.

*Monthly discharge of Wisconsin River at Muscoda, Wis., for the year ending Sept. 30, 1915.*

[Drainage area, 10,300 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 9,570 | 5,530 | 7,200 | 0.699 | 0.81 | A. |
| November | 6,510 | 4,150 | 5,340 | .518 | .58 | A. |
| December | 5,830 | 3,570 | 4,700 | .456 | .53 | C. |
| January | ..... | ..... | 4,060 | .394 | .45 | D. |
| February | ..... | ..... | 7,430 | .721 | .75 | D. |
| March | 13,300 | ..... | 9,090 | .883 | 1.02 | C. |
| April | 23,600 | 8,350 | 14,300 | 1.39 | 1.55 | B. |
| May | 21,900 | 7,660 | 12,300 | 1,19 | 1.37 | B. |
| June | 15,400 | 5,330 | 8,920 | .866 | .97 | B. |
| July | 10,600 | 3,290 | 6,080 | .590 | .68 | B. |
| August | 15,000 | 4,250 | 9,330 | .906 | 1.04 | B. |
| September | 12,900 | 4,490 | 8,220 | .798 | .89 | B. |
| The year | 23,600 | ..... | 8,080 | .784 | 10.64 | |

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, 1915.

GAGE.—Chain gage fastened to cantilever arm on the right bank; read twice daily, morning and evening, to quarter-tenths, by Frank Sutherland.

DISCHARGE MEASUREMENTS.—Made from cable about half a mile below gage.

CHANNEL AND CONTROL.—Channel at gage and a short distance below sandy and likely to shift. Control is formed by rapids about 2,000 feet below gage. Channel at cable section heavy gravel and 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 halfway up the rapids which are below the gage, and probably affect the discharge relation. During 1914 and 1915 the maximum head maintained at the reservoir was 11 feet 3 inches, which probably did not affect the control for the gage.

EXTREMES OF STAGE.—1914–1915: Maximum recorded stage during year, 4.7 feet April 14 and 15, 1915; minimum stage recorded, 1.95 feet September 10 to 13, 1914.

WINTER FLOW.—Discharge relation seriously affected by ice; flow determined from discharge measurements, observer's notes, and weather records.

REGULATION.—Squirrel and Minocqua reservoirs, above the station, are operated for the purpose of regulating flow in Wisconsin River.[1]

ACCURACY.—Gage-height record reliable; data insufficient to warrant publication of estimates of daily discharge.

[1] See U. S. Geol. Survey Water-Supply Paper 417, p. 13.

*Discharge measurements of Tomahawk River near Bradley, Wis., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Nov. 17[a] | G. H. Canfield | 2.59 | 144 | May 21 | H. C. Beckman | 3.55 | 665 |
| Jan. 6[b] | do | 2.77 | 304 | Aug. 14 | do | 2.73 | 429 |
| Feb. 10[b] | do | 3.07 | 326 | Sept. 13 | W. G. Hoyt | 1.97 | 264 |
| Mar. 17[b] | do | 3.28 | 383 | 13 | do | 1.98 | 270 |
| Apr. 9[c] | M. F. Rather | 4.45 | 734 | | | | |

[a] Made from cable; partial ice cover.
[b] Made through complete ice cover near gage.
[c] Probably ice on control.

*Daily gage height in feet, of Tomahawk River near Bradley, Wis., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.65 | 2.45 | 3.0 | 2.6 | ..... | ..... | 2.9 | 2.9 | 2.65 | 2.28 | 2.25 | 2.49 |
| 2 | 2.65 | 2.45 | 3.0 | ..... | 3.05 | 3.25 | ..... | 2.8 | 2.5 | 2.2 | 2.6 | 2.36 |
| 3 | 2.6 | 2.44 | 3.65 | 2.7 | ..... | ..... | 2.6 | 2.8 | 2.44 | 2.16 | 3.05 | 2.22 |
| 4 | 2.55 | 2.46 | 3.25 | ..... | 3.05 | 3.3 | 2.9 | 2.9 | 2.35 | 2.19 | 3.55 | 2.2 |
| 5 | 2.5 | 2.48 | 3.2 | 2.7 | ..... | ..... | 3.15 | 3.0 | 2.3 | 2.24 | 3.8 | 2.15 |
| 6 | 2.5 | 2.44 | 3.25 | ..... | 3.05 | 3.25 | 3.6 | 3.0 | 2.9 | 2.25 | 3.9 | 2.06 |
| 7 | 2.65 | 2.4 | ..... | 2.8 | ..... | ..... | 3.95 | 3.2 | 3.6 | 2.19 | 3.95 | 2.02 |
| 8 | 2.7 | 2.39 | 2.6 | ..... | 3.1 | 3.2 | 4.4 | 3.4 | 3.7 | 2.15 | 3.95 | 2.0 |
| 9 | 2.75 | 2.38 | ..... | 2.8 | ..... | ..... | 4.5 | 3.45 | 3.7 | 2.08 | 3.85 | 2.0 |
| 10 | 2.75 | 2.38 | 2.9 | ..... | 3.1 | 3.25 | 4.5 | 3.45 | 3.55 | 2.0 | 3.7 | 1.95 |
| 11 | 2.85 | 2.36 | ..... | 2.8 | ..... | ..... | 4.7 | 3.35 | 3.4 | 2.2 | 3.45 | 1.95 |
| 12 | 3.0 | 2.35 | 2.95 | ..... | 3.1 | 3.3 | 4.7 | 3.3 | 3.3 | 2.7 | 3.15 | 1.95 |
| 13 | 3.0 | 2.34 | ..... | 2.85 | ..... | ..... | 4.7 | 3.3 | 3.3 | 2.9 | 2.9 | 1.96 |
| 14 | 3.0 | 2.38 | 3.0 | ..... | 3.15 | 3.35 | 4.7 | 3.25 | 3.35 | 2.9 | 2.7 | 2.36 |
| 15 | 3.0 | 2.49 | ..... | 2.85 | ..... | ..... | 4.7 | 3.2 | 3.3 | 3.6 | 2.7 | 3.3 |
| 16 | 2.95 | 2.5 | 3.0 | ..... | 3.15 | 3.35 | 4.6 | 3.4 | 3.2 | 4.0 | 2.8 | 3.6 |
| 17 | 2.9 | 2.44 | ..... | 2.9 | ..... | ..... | 4.5 | 3.5 | 3.1 | 4.2 | 2.75 | 3.9 |
| 18 | 2.85 | 2.85 | 2.95 | ..... | 3.15 | 3.4 | 4.4 | 3.55 | 3.0 | 4.2 | 2.65 | 4.1 |
| 19 | 2.8 | 3.05 | ..... | 2.95 | ..... | ..... | 4.3 | 3.5 | 3.1 | 4.2 | 2.55 | 4.2 |
| 20 | 2.8 | 2.85 | 2.9 | ..... | 3.2 | 3.4 | 4.2 | 3.4 | 3.2 | 4.1 | 2.46 | 4.1 |
| 21 | 2.75 | 2.6 | ..... | 2.95 | ..... | ..... | 4.2 | 3.55 | 3.35 | 3.9 | 2.38 | 3.95 |
| 22 | 2.7 | 2.45 | 2.85 | ..... | 3.2 | 3.45 | 4.1 | 3.75 | 3.3 | 3.7 | 2.3 | 3.75 |
| 23 | 2.65 | 2.35 | ..... | 3.0 | ..... | ..... | 3.9 | 3.8 | 3.2 | 3.4 | 2.21 | 3.5 |
| 24 | 2.6 | 2.41 | 2.7 | ..... | 3.2 | 3.5 | 4 2 | 3.9 | 3.05 | 3.25 | 2.28 | 3.3 |
| 25 | 2.55 | 2.5 | ..... | 3.0 | ..... | ..... | 4.6 | 3.95 | 2.85 | 3.15 | 2.38 | 3.15 |
| 26 | 2.55 | 2.7 | 2.6 | ..... | 3.2 | 2.8 | 4.2 | 3.85 | 2.65 | 3.05 | 2.39 | 3.35 |
| 27 | 2.55 | 2.75 | ..... | 3.05 | ..... | ..... | 3.2 | 3.65 | 2.5 | 2.9 | 2.4 | 3.5 |
| 28 | 2.5 | 2.7 | 2.55 | ..... | 3.25 | 3.15 | 3.15 | 3.4 | 2.5 | 2.8 | 2.38 | 3.6 |
| 29 | 2.5 | 2.75 | ....., | 3.05 | ..... | ..... | 3.15 | 3.25 | 2.49 | 2.7 | 2.48 | 3.7 |
| 30 | 2.5 | 2.9 | 2.6 | ..... | ..... | 3.4 | 3.05 | 2.95 | 2.38 | 2.6 | 2.6 | 3.7 |
| 31 | 2.48 | ..... | ..... | 3.0 | ..... | ..... | ..... | 2.8 | ..... | 2.6 | 2.55 | ..... |

NOTE.—Discharge relation affected by ice and other causes from about Nov. 11 to Apr. 30.

### PRAIRIE RIVER NEAR MERRILL, WIS.

LOCATION.—On line between secs. 20 and 29, T. 32 N., R. 7 E., Lincoln County, at highway bridge 4½ miles northeast of Merrill, and about 5½ miles above the mouth of the river. Haymeadow Creek enters from the left about 5 miles above the station.

DRAINAGE AREA.—164 square miles (measured on Wisconsin Geological and Natural History Survey map, edition of 1911; scale, 1 inch=6 miles).

RECORDS AVAILABLE.—January 18, 1914, to September 30, 1915.

GAGE.—Chain gage attached to upstream side of bridge; read twice daily, morning and evening, to quarter-tenths, by G. H. Bell.

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

CHANNEL AND CONTROL.—Gravel; clean and free from vegetation. Left bank is only of medium height and may overflow at high stages; right bank is high and will not overflow; both banks wooded. No well-defined control.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.7 feet at 4 p. m. May 22 (discharge, 738 second-feet); minimum discharge, 72 second-feet, recorded by discharge measurement made January 4.

1914–1915: Maximum stage recorded, 4.6 feet; April 30, 1914 (discharge, 1,160 second-feet); minimum, 72 second-feet, recorded by measurement made January 4, 1915. Absolute minimum occurred during the winter period 1914–1915 and was probably somewhat less than 72 second-feet.

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

ACCURACY.—Rating curve well defined over a range in stage covered by gage heights; no diurnal fluctuation; control permanent; records excellent.

*Discharge measurements of Prairie River near Merrill, Wis., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 7 | G. H. Canfield | 1.84 | 109 | Mar. 7[b] | G. H. Canfield | 1.77 | 102 |
| Jan. 4[a] | do | 1.90 | 72 | June 9 | W. G. Hoyt | 2.79 | 370 |
| Feb. 8[a] | do | 1.78 | 85 | | | | |

[a] Made through partial ice cover. [b] Ice along shores but control clear.

*Daily discharge, in second-feet, of Prairie River near Merrill, Wis., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 118 | 118 | 186 | | | 111 | 103 | 261 | 212 | 137 | 244 | 103 |
| 2 | 120 | 118 | 159 | | | 122 | 101 | 244 | 172 | 133 | 313 | 97 |
| 3 | 118 | 122 | 154 | | | 116 | 114 | 261 | 159 | 118 | 348 | 101 |
| 4 | 118 | 122 | 148 | | | 110 | 110 | 278 | 137 | 118 | 535 | 97 |
| 5 | 115 | 122 | 135 | 70 | 85 | 110 | 137 | 278 | 137 | 133 | 655 | 97 |
| 6 | 115 | 120 | 122 | | | 110 | 330 | 278 | 313 | 137 | 655 | 93 |
| 7 | 120 | 118 | 120 | | | 52 | 313 | 330 | 458 | 128 | 574 | 97 |
| 8 | 148 | 118 | 118 | | | 73 | 384 | 440 | 535 | 133 | 458 | 101 |
| 9 | 159 | 115 | 110 | | | 90 | 458 | 440 | 402 | 106 | 366 | 103 |
| 10 | 172 | 115 | 103 | | | 106 | 535 | 421 | 348 | 103 | 296 | 101 |
| 11 | 184 | 116 | 102 | | | 108 | 614 | 313 | 330 | 133 | 244 | 101 |
| 12 | 184 | 115 | 101 | | | 110 | 614 | 296 | 278 | 212 | 184 | 103 |
| 13 | 184 | 96 | | | | 108 | 574 | 278 | 261 | 212 | 159 | 118 |
| 14 | 184 | 120 | | | | 106 | 535 | 244 | 244 | 184 | 133 | 133 |
| 15 | 172 | 148 | | 75 | 95 | 102 | 366 | 244 | 198 | 159 | 128 | 148 |
| 16 | 159 | 172 | 85 | | | 97 | 348 | 313 | 184 | 212 | 137 | 137 |
| 17 | 148 | 148 | | | | 99 | 330 | 440 | 184 | 384 | 133 | 137 |
| 18 | 137 | | | | | 101 | 313 | 421 | 172 | 348 | 137 | 133 |
| 19 | 133 | | | | | 101 | 313 | 440 | 184 | 278 | 128 | 137 |
| 20 | 128 | | | | | 101 | 313 | 458 | 212 | 212 | 110 | 128 |
| 21 | 126 | 120 | | | | 99 | 296 | 458 | 184 | 172 | 103 | 115 |
| 22 | 122 | | | | | 97 | 278 | 738 | 172 | 159 | 97 | 103 |
| 23 | 118 | | | | | 102 | 278 | 696 | 159 | 137 | 103 | 115 |
| 24 | 126 | | | | | 106 | 348 | 655 | 137 | 228 | 106 | 103 |
| 25 | 128 | | | | | 112 | 421 | 614 | 128 | 278 | 103 | 101 |
| 26 | 137 | 159 | 75 | 80 | 100 | 118 | 384 | 496 | 118 | 348 | 101 | 97 |
| 27 | 137 | 159 | | | | 110 | 366 | 421 | 110 | 261 | 97 | 103 |
| 28 | 128 | 159 | | | | 103 | 384 | 421 | 110 | 228 | 101 | 110 |
| 29 | 126 | 186 | | | | 97 | 348 | 348 | 184 | 184 | 110 | 106 |
| 30 | 122 | 212 | | | | 91 | 313 | 256 | 159 | 184 | 110 | 106 |
| 31 | 122 | ..... | | | | 97 | ..... | 212 | ..... | 159 | 106 | ..... |

NOTE.—Discharge, except as noted below, determined from a rating curve well defined between 103 and 870 second-feet, Nov. 27, 29, Dec. 1, 3, 5, 7, 9, 11, and Mar. 1, 3, 5, and every other day throughout the month, interpolated. Discharge Nov. 18–25 and Dec. 13 to Feb. 28, estimated, because of ice, from discharge measurements, observer's notes, and weather records. Braced figures show mean discharge for period included.

*Monthly discharge of Prairie River near Merrill, Wis., for the year ending Sept. 30, 1915.*

[Drainage area, 164 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 184 | 115 | 139 | 0.848 | 0.98 | A. |
| November | 212 | 96 | 131 | .799 | .89 | B. |
| December | 186 | ..... | 98.8 | .602 | .69 | C. |
| January | ..... | ..... | 75.2 | .459 | .53 | C. |
| February | ..... | ..... | 92.9 | .566 | .59 | C. |
| March | 122 | 73 | 103 | .628 | .72 | B. |
| April | 614 | 101 | 344 | 2.10 | 2.34 | A. |
| May | 738 | 212 | 388 | 2.37 | 2.73 | A. |
| June | 535 | 110 | 219 | 1.34 | 1.50 | A. |
| July | 384 | 103 | 191 | 1.16 | 1.34 | A. |
| August | 655 | 97 | 228 | 1.39 | 1.60 | A. |
| September | 148 | 93 | 111 | .677 | .76 | A. |
| The year | 738 | ..... | 177 | 1.08 | 14.67 | |

## LITTLE RIB RIVER NEAR WAUSAU, WIS.

LOCATION.—In sec. 29, T. 29 N., R. 7 E., Marathon County, at second highway bridge above mouth, about 3½ miles west of Wausau and 1 mile above junction with Big Rib River.

DRAINAGE AREA.—76 square miles (measured on Wisconsin Geological and Natural History Survey map, edition of 1911; scale, 1 inch=6 miles).

RECORDS AVAILABLE.—January 10, 1914, to September 30, 1915.

GAGE.—Chain gage fastened to downstream side of highway bridge; read twice daily morning and evening, to quarter-tenths, by Harry Hartwig.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge during high water; at low and medium stages by wading.

CHANNEL AND CONTROL.—Gravel and sand; control small rapids on each side of small island about 20 feet below gage; left bank high and will not overflow; right bank low above gage and during exceptional high floods will overflow around right end of bridge; both banks brush covered.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 5.75 feet at 6.15 a. m. April 6 (discharge, 695 second-feet); minimum discharge, 6.4 second-feet recorded by measurement made January 5; absolute minimum for the winter period probably less than 6.4 second-feet.

1914–1915: Maximum stage recorded, 9.85 feet at 6 p. m. June 4, 1914 (discharge, approximately 1,880 second-feet); minimum stage recorded during open water, 1.18 feet August 6 to 9, 1914 (discharge, approximately 6 second-feet); mean of 4 second-feet was estimated for the period February 21 to 28, 1914.

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

ACCURACY.—Rating curve fairly well defined over a range in stage covered by gage heights; no diurnal fluctuation; results subject to errors due to changes in channel and to collection of débris on the control in spring; records only fair.

*Discharge measurements of Little Rib River near Wausau, Wis., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Jan. 5[a] | G. H. Canfield | 1.22 | 6.4 | June 29 | W. G. Hoyt | 1.74 | 64. |
| Feb. 6[a] | do | 1.24 | 8.6 | Sept. 9 | H. T. Critchlow | 1.15 | 12.0 |
| Mar. 9[b] | do | 1.21 | 9.6 | 9 | do | 1.15 | 11.3 |

[a] Complete ice cover at gage; nearly open at control.
[b] Made by wading; complete ice cover at gage; nearly open at control.

*Daily discharge, in second-feet, of Little Rib River near Wausau, Wis., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 13 | 12 | a 18 | | | a 26 | 56 | 26 | 31 | 20 | 15 | 15 |
| 2 | 13 | 12 | 24 | | | 22 | 58 | 23 | 28 | 16 | 23 | 14 |
| 3 | 12 | 13 | a 22 | | | a 21 | 132 | 39 | 25 | 15 | 74 | 13 |
| 4 | 12 | 15 | 19 | | | 20 | 150 | 75 | 23 | 15 | 110 | 12 |
| 5 | 12 | 17 | a 16 | 6 | 9 | a 19 | 200 | 50 | 22 | 16 | 170 | 12 |
| 6 | 12 | 14 | 12 | | | 18 | 652 | 39 | 125 | 15 | 82 | 12 |
| 7 | 13 | 13 | a 10 | | | a 17 | 368 | 125 | 125 | 15 | 61 | 13 |
| 8 | 72 | 13 | 8 | | | 16 | 384 | 162 | 46 | 15 | 46 | 14 |
| 9 | 34 | 12 | a 10 | | | a 16 | 305 | 89 | 38 | 14 | 33 | 13 |
| 10 | 25 | 12 | 12 | | | 16 | 400 | 57 | 40 | 13 | 30 | 12 |
| 11 | 34 | 11 | a 11 | | a 16 | a 16 | 320 | 45 | 140 | 13 | 25 | 11 |
| 12 | 43 | 12 | 10 | | 16 | 16 | 208 | 42 | 68 | 15 | 21 | 12 |
| 13 | 72 | 12 | 9 | | a 20 | a 22 | 140 | 34 | 46 | 15 | 19 | 20 |
| 14 | 78 | 13 | | | 24 | 28 | 125 | 30 | 35 | 13 | 18 | 67 |
| 15 | 46 | 25 | | 7 | a 57 | 28 | 110 | 28 | 27 | 15 | 16 | 26 |
| 16 | 32 | 42 | | | 90 | 30 | 110 | 140 | 24 | 17 | 28 | 20 |
| 17 | 27 | 43 | | | a 70 | a 30 | 103 | 155 | 22 | 16 | 74 | 16 |
| 18 | 23 | 14 | | | 50 | 30 | 85 | 132 | 22 | 13 | 27 | 15 |
| 19 | 21 | a 12 | 8 | | a 39 | a 29 | 88 | 93 | 170 | 13 | 20 | 13 |
| 20 | 19 | 11 | | | 28 | 28 | 75 | 89 | 85 | 12 | 17 | 13 |
| 21 | 18 | a 10 | | | a 40 | a 26 | 63 | 384 | 51 | 13 | 16 | 12 |
| 22 | 17 | 10 | | | 51 | 23 | 54 | 567 | 40 | 13 | 14 | 12 |
| 23 | 17 | a 9 | | | 57 | a 60 | 54 | 215 | 30 | 21 | 14 | 12 |
| 24 | 17 | 8 | | | a 63 | 96 | 50 | 148 | 26 | 33 | 15 | 12 |
| 25 | 17 | a 10 | | | 54 | | 44 | 110 | 22 | 68 | 14 | 12 |
| 26 | 16 | 11 | | 8 | 46 | | 40 | 140 | 20 | 28 | 13 | 12 |
| 27 | 14 | a 12 | | | a 38 | | 34 | 83 | 19 | 22 | 13 | 13 |
| 28 | 13 | 12 | 7 | | 30 | 100 | 44 | 58 | 16 | 30 | 12 | 12 |
| 29 | 13 | a 12 | | | ..... | | 34 | 50 | 39 | 24 | 15 | 12 |
| 30 | 13 | 13 | | | ..... | | 28 | 43 | 30 | 20 | 27 | 12 |
| 31 | 13 | ..... | | | ..... | | ..... | 35 | ..... | 16 | 19 | ..... |

[a] Interpolated.

NOTE.—Discharge determined as follows: Oct. 1 to Dec. 14, from a rating curve well defined between 7 and 830 second-feet; Feb. 12 to Sept. 30, except Mar. 25–31 and Apr. 4 and 5, from a rating curve fairly well defined between 11 and 830 second-feet. Discharge Mar. 25–31 and Apr. 4 and 5 estimated because of log jam. Discharge Dec. 13 to Feb. 10 estimated, because of ice, from discharge measurements, observer's notes, and weather records. Braced figures show mean discharge for period included.

*Monthly discharge of Little Rib River near Wausau, Wis., for the year ending Sept. 30, 1915.*

[Drainage area, 76 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 78 | 12 | 25.2 | 0.332 | 0.38 | B. |
| November | 43 | 8 | 14.5 | .191 | .21 | C. |
| December | 24 | ..... | 10.3 | .136 | .16 | D. |
| January | ..... | ..... | 7.0 | .092 | .11 | D. |
| February | 90 | ..... | 31.4 | .413 | .43 | C. |
| March | ..... | 16 | 43.6 | .574 | .66 | C. |
| April | 652 | 28 | 150 | 1.97 | 2.20 | B. |
| May | 567 | 23 | 107 | 1.41 | 1.63 | B. |
| June | 170 | 16 | 47.8 | .629 | .70 | B. |
| July | 68 | 12 | 18.8 | .247 | .28 | B. |
| August | 170 | 12 | 34.9 | .459 | .53 | B. |
| September | 67 | 11 | 15.5 | .204 | .23 | B. |
| The year | 652 | ..... | 42.1 | .554 | 7.52 | |

## EAU CLAIRE RIVER AT KELLY, WIS.

LOCATION.—In sec. 13, T. 23 N., R. 8 E., Marathon County, at highway bridge three-fourths mile below Kelly, 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 Wisconsin Geological and Natural History Survey map, edition of 1911; scale, 1 inch=6 miles).

RECORDS AVAILABLE.—January 1, 1914, to September 30, 1915.

GAGE.—Chain gage fastened to downstream side of highway bridge; read twice daily, morning and evening, to quarter-tenths, by J. J. Duginski.

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 will not overflow.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.0 feet May 22 (discharge, 1,120 second-feet); minimum stage recorded, 0.45 foot, October 2 and 3 (discharge, approximately 40 second-feet).

1914–1915: Maximum stage recorded, 4.7 feet at 5 p. m. June 4, 1914; (discharge, approximately 2,360 second-feet); minimum stage recorded, 0.45 foot August 13, 14, and 15, 1914, and October 2 and 3, 1915 (discharge, approximately 40 second-feet).

WINTER FLOW.—Discharge relation affected somewhat by ice, though not to such an extent as other streams in this region; flow estimated from discharge measurements, observer's notes, and weather records.

REGULATION.—Immediately above the gage is a dam which was formerly used to create a pond at a mill but is now used for floating logs; during a few days in the spring the manipulation of the gates in this dam causes sudden fluctuations at the gage; at other times the flow is natural.

ACCURACY.—Curve well developed; control and channel permanent; no diurnal fluctuation; records excellent.

*Discharge measurements of Eau Claire River at Kelly, Wis., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 15 | G. H. Canfield | 1.35 | 225 | Mar. 9[b] | G. H. Canfield | .80 | 86 |
| Jan. 5[a] | do | .90 | 68 | June 29 | W. G. Hoyt | 1.04 | 141 |
| Feb. 7[a] | do | 1.11 | 70 | | | | |

[a] Made through complete ice cover below gage.
[b] Made by wading, control practically clear of ice.

*Daily discharge, in second-feet, of Eau Claire River at Kelly, Wis., for the year ending Sept. 30, 1915.*

| Day. | Oct | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 44 | 60 | 210 | | | | 129 | 182 | 267 | 224 | a137 | 85 |
| 2 | 43 | 58 | a 196 | | | | 155 | 210 | 224 | 204 | 145 | 82 |
| 3 | 41 | 63 | 182 | | | | 182 | 300 | 210 | 182 | 177 | 74 |
| 4 | a 67 | 68 | a 156 | | | | a 201 | 390 | 182 | 160 | 216 | 71 |
| 5 | 93 | 64 | 129 | | | 90 | 320 | 300 | 155 | 155 | 238 | a 71 |
| 6 | 84 | 60 | a 126 | | | | 738 | 300 | a 211 | 155 | 499 | 71 |
| 7 | 93 | 63 | 124 | | | | 800 | 443 | 267 | 134 | 443 | 71 |
| 8 | 106 | 60 | a 114 | 65 | 70 | 71 | 925 | 738 | 267 | 129 | 416 | 70 |
| 9 | 129 | 63 | 104 | | | 85 | 990 | 617 | 238 | 109 | 365 | 65 |
| 10 | 168 | 63 | 100 | | | 82 | 990 | 557 | 129 | 104 | 284 | 64 |
| 11 | 182 | 58 | a 89 | | | 85 | a 990 | 390 | 300 | 116 | 196 | 64 |
| 12 | 210 | 64 | 78 | | | 89 | 990 | 390 | 340 | 109 | 168 | a 85 |
| 13 | 196 | 70 | a 74 | | | 94 | 862 | 340 | 365 | 104 | 116 | 106 |
| 14 | 196 | 93 | 71 | | | a 102 | 677 | 390 | 320 | 96 | 94 | 134 |
| 15 | 224 | | 72 | | | 109 | 617 | 267 | 267 | 104 | a 90 | 134 |
| 16 | 210 | | 72 | | | 104 | 557 | 300 | 238 | 129 | 85 | 158 |
| 17 | 182 | | a 70 | | | 100 | 557 | 499 | 210 | 142 | 134 | 155 |
| 18 | 182 | 90 | 68 | | | 100 | a 557 | 557 | 238 | 155 | 116 | 155 |
| 19 | 155 | | a 66 | | | 100 | 557 | 528 | 238 | 155 | 89 | a 144 |
| 20 | 129 | | | | | 100 | 617 | 499 | 284 | 145 | 85 | 134 |
| 21 | 124 | | | | | a 100 | 557 | 800 | 267 | 155 | 85 | 129 |
| 22 | 109 | a 90 | | | | 100 | 340 | 1,120 | 182 | 155 | a 85 | 109 |
| 23 | 100 | 89 | | | | 100 | 390 | 1,060 | 196 | 155 | 85 | 87 |
| 24 | 84 | a 91 | | 60 | 110 | 100 | 471 | 925 | 182 | 155 | 85 | 85 |
| 25 | a 78 | 93 | 65 | | | 300 | 738 | 677 | 155 | a 158 | 85 | 85 |
| 26 | 71 | a 100 | | | | 300 | 677 | 499 | 129 | 160 | 85 | a 86 |
| 27 | 65 | 106 | | | | 267 | 499 | 443 | a 129 | 171 | 85 | 87 |
| 28 | 64 | a 112 | | | | a 218 | 471 | 267 | 129 | 182 | 85 | 85 |
| 29 | 60 | 119 | | | | 168 | 443 | 267 | 155 | 196 | a 85 | 82 |
| 30 | 60 | a 164 | | | | 168 | 182 | 267 | 182 | 160 | 85 | 78 |
| 31 | 58 | ..... | | | | 155 | ..... | 267 | ..... | 129 | 85 | ..... |

[a] Interpolated.

NOTE.—Discharge, except as noted below, determined from a rating curve well defined between 71 and 1,460 second-feet.
Nov. 15–21 and Dec. 20 to Mar. 7, estimated because of ice from discharge measurements, observer's notes, and weather records. Braced figures show mean discharge for periods included.

*Monthly discharge of Eau Claire River at Kelly, Wis., for the year ending Sept. 30, 1915.*

[Drainage area, 326 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 224 | 41 | 116 | 0.356 | 0.41 | A. |
| November | ..... | 58 | 83.4 | .256 | .29 | B. |
| December | 210 | ..... | 92.9 | .285 | .33 | C. |
| January | ..... | ..... | 62.4 | .191 | .22 | D. |
| February | ..... | ..... | 88.6 | .272 | .28 | D. |
| March | 300 | 71 | 123 | .377 | .43 | C. |
| April | 990 | 129 | 573 | 1.76 | 1.96 | A. |
| May | 1,120 | 182 | 477 | 1.46 | 1.68 | A. |
| June | 365 | 129 | 222 | .681 | .76 | A. |
| July | 224 | 96 | 148 | .454 | .52 | B. |
| August | 499 | 85 | 162 | .497 | .57 | B. |
| September | 155 | 64 | 96.9 | .297 | .33 | B. |
| The year | 1,120 | ..... | 187 | .574 | 7.78 | |

BIG EAU PLEINE RIVER NEAR STRATFORD, WIS.

LOCATION.—In sec. 13, T. 27 N., R. 3 E., Marathon County, at highway bridge at a place locally known as Weber Farm, about 2 miles north of Stratford, about 1 mile above the Chicago & North Western Railway bridge. Dill Creek enters from the right about 5 miles above the station.

DRAINAGE AREA.—223 square miles (measured on Wisconsin Geological and Natural History Survey map, edition of 1911; scale, 1 inch=6 miles).

RECORDS AVAILABLE.—July 24, 1914, to September 30, 1915.

GAGE.—Sloping gage reading from 1.0 to 15.6 feet, on right bank of the river and vertical staff gage, reading from 15 to 18 feet at upper end of sloping gage; gage read twice daily, morning and evening, to quarter-tenths, by Christian Weber.

DISCHARGE MEASUREMENTS.—At low stages made by wading about 1,000 feet below gage; at medium and high stages made either from a highway bridge or from the Chicago & North Western Railway bridge, both below the gage.

CHANNEL AND CONTROL.—Very heavy gravel and rock; control at head of rapids 400 feet below gage. Both banks at gage are high and will overflow only at stage about 15 feet and above.

EXTREMES OF DISCHARGE.—July 29, 1914, to September 30, 1915: Maximum stage recorded, when control was unobstructed, 6.9 feet at 6 p. m. May 21, 1914 (discharge approximately 3,250 second-feet); minimum discharge, 3.0 second-feet, recorded by measurement made February 5, 1915. The June flood of 1914 reached a maximum stage of 20.7 feet, as determined by levels run to high-water marks, July 23, 1914.

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

REGULATION.—No dams are now in operation above the station.

ACCURACY.—Rating curve well defined over range covered by gage heights; control permanent; open-water records apparently excellent.

*Discharge measurements of Big Eau Pleine River near Stratford, Wis., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Nov. 11 | H. C. Beckman | 1.88 | 26 | Apr. 9[c] | H. C. Beckman | 5.22 | 1,490 |
| Dec. 29[a] | G. H. Canfield | 1.50 | 3.4 | 13 | do | 3.93 | 677 |
| Feb. 5[a] | do | 1.90 | 3.0 | June 30 | W. G. Hoyt | 2.65 | 186 |
| Mar. 8[a] | do | 2.15 | 19 | Sept. 8 | H. T. Critchlow | 1.66 | 11.0 |
| Apr. 1[b] | M. F. Rather | 2.95 | 127 | 8 | do | 1.66 | 9.4 |

[a] Made through complete ice cover.
[b] Made through complete ice cover; channel nearly open at control.
[c] Logs on control; estimated backwater, 0.10 foot.

*Daily discharge, in second-feet, of Big Eau Pleine River near Stratford, Wis., for the years ending Sept. 30, 1914–1915.*

| Day. | July. | Aug. | Sept. | Day. | July. | Aug. | Sept. | Day. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1914. | | | | 1914. | | | | 1914. | | | |
| 1 | ..... | 20 | 146 | 11 | ..... | 13 | 76 | 21 | ..... | 56 | 122 |
| 2 | ..... | 20 | 87 | 12 | ..... | 12 | 110 | 22 | ..... | 36 | 134 |
| 3 | ..... | 16 | 98 | 13 | ..... | 12 | 76 | 23 | ..... | 36 | 197 |
| 4 | ..... | 14 | 66 | 14 | ..... | 13 | 382 | 24 | 20 | 171 | 158 |
| 5 | ..... | 13 | 56 | 15 | ..... | 10 | 720 | 25 | 20 | 87 | 122 |
| 6 | ..... | 10 | 56 | 16 | ..... | 10 | 518 | 26 | 19 | 56 | 98 |
| 7 | ..... | 10 | 47 | 17 | ..... | 10 | 566 | 27 | 22 | 30 | 76 |
| 8 | ..... | 10 | 36 | 18 | ..... | 76 | 616 | 28 | 30 | 24 | 56 |
| 9 | ..... | 9 | 30 | 19 | ..... | 146 | 280 | 29 | 36 | 24 | 47 |
| 10 | ..... | 12 | 30 | 20 | ..... | 87 | 171 | 30 | 30 | 22 | 38 |
| | | | | | | | | 31 | 26 | 28 | ..... |

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1914–15. | | | | | | | | | | | | |
| 1 | 33 | 33 | | | | | | 80 | 45 | 80 | 28 | 16 |
| 2 | 30 | 30 | | | | | | 72 | 38 | 56 | 72 | 16 |
| 3 | 28 | 33 | | | | | | 146 | 32 | 32 | 83 | 16 |
| 4 | 24 | 38 | | | | | | 230 | 28 | 28 | 447 | 16 |
| 5 | 24 | 38 | | | | | | 197 | 26 | 26 | 970 | 13 |
| | | | 22 | 3 | 3 | 31 | 1,360 | | | | | |
| 6 | 22 | 33 | | | | | | 151 | 117 | 22 | 668 | 13 |
| 7 | 14 | 33 | | | | | | 424 | 238 | 26 | 470 | 12 |
| 8 | 470 | 28 | | | | | | 591 | 184 | 22 | 344 | 10 |
| 9 | 238 | 28 | | | | | | 382 | 127 | 22 | 213 | 10 |
| 10 | 176 | 28 | | | | | | 280 | 127 | 20 | 141 | 10 |
| 11 | 382 | 28 | | | | | 1,570 | 252 | 591 | 20 | 94 | 10 |
| 12 | 295 | 28 | | | | | 970 | 171 | 363 | 18 | 68 | 10 |
| 13 | 970 | 33 | | | | | 694 | 141 | 266 | 14 | 42 | 19 |
| 14 | 720 | 33 | | | | | 518 | 127 | 184 | 14 | 36 | 28 |
| 15 | 403 | 42 | | | | | 424 | 117 | 127 | 45 | 28 | 52 |
| | | | 9 | 3 | 10 | 24 | | | | | | |
| 16 | 280 | | | | | | 403 | 424 | 94 | 127 | 205 | 112 |
| 17 | 210 | | | | | | 344 | 720 | 60 | 94 | 94 | 83 |
| 18 | 166 | 28 | | | | | 310 | 566 | 103 | 66 | 38 | 62 |
| 19 | 146 | | | | | | 280 | 382 | 382 | 45 | 28 | 52 |
| 20 | 110 | | | | | | 266 | 447 | 518 | 42 | 22 | 38 |
| 21 | 94 | | | | | | 230 | 2,240 | 344 | 38 | 20 | 30 |
| 22 | 76 | | | | | | 184 | 2,060 | 230 | 51 | 19 | 28 |
| 23 | 66 | | | | | | 184 | 1,040 | 166 | 51 | 16 | 24 |
| 24 | 60 | | | | | | 210 | 542 | 94 | 42 | 16 | 22 |
| 25 | 56 | | | | | | 192 | 403 | 66 | 38 | 13 | 20 |
| 26 | 56 | 26 | 4 | 3 | 52 | 220 | 166 | 266 | 51 | 30 | 13 | 20 |
| 27 | 47 | | | | | | 141 | 151 | 38 | 42 | 13 | 16 |
| 28 | 42 | | | | | | 134 | 117 | 32 | 60 | 12 | 16 |
| 29 | 38 | | | | | | 127 | 94 | 171 | 72 | 16 | 16 |
| 30 | 38 | | | | | | 103 | 72 | 171 | 45 | 16 | 16 |
| 31 | 36 | | | | | | ..... | 60 | ..... | 30 | 16 | ..... |

NOTE.—Discharge, except as noted below, determined from a rating curve well defined between 9 and and 1,500 second-feet; above 1,500 second-feet the rating curve is only an extension. 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 included.

*Monthly discharge of Big Eau Pleine River near Stratford, Wis., for the years ending Sept. 30, 1914–1915.*

[Drainage area, 223 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| 1914. | | | | | | |
| July 24–31 | 36 | 19 | 25.4 | 0.114 | 0.03 | A. |
| August | 171 | 9 | 35.3 | .158 | .18 | A. |
| September | 720 | 30 | 174 | .780 | .87 | A. |
| 1914–15. | | | | | | |
| October | 970 | 14 | 173 | .776 | .89 | A. |
| November | | | 29.5 | .132 | .15 | B. |
| December | | | 11.4 | .051 | .06 | C. |
| January | | | 3.00 | .013 | .01 | D. |
| February | | | 19.5 | .087 | .09 | C. |
| March | | | 95.8 | .430 | .50 | C. |
| April | | 103 | 702 | 3.15 | 3.51 | C. |
| May | 2,240 | 60 | 418 | 1.87 | 2.16 | B. |
| June | 591 | 26 | 167 | .749 | .84 | A. |
| July | 127 | 14 | 42.5 | .191 | .22 | A. |
| August | 970 | 12 | 137 | .614 | .71 | A. |
| September | 112 | 10 | 26.9 | .121 | .14 | A. |
| The year | 2,240 | | 152 | .682 | 9.28 | |

PLOVER RIVER NEAR STEVENS POINT, WIS.

LOCATION.—In sec. 30, T. 25 N., R. 9 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, 1915.

GAGE.—Metal vertical staff gage bolted to the left abutment, downstream side of bridge; read twice daily, morning and evening, to quarter-tenths by C. A. Van Order.

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

CHANNEL AND CONTROL.—Heavy gravel and small rock; permanent and free from vegetation. At high stages both banks will overflow around the bridge. Control not well defined, but is probably small rapids below gage.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 2.65 feet at 7.30 p. m. April 10 (discharge, 480 second-feet), minimum recorded discharge, 84 second feet, by measurement made February 5; absolute minimum for the winter period probably was somewhat less.

1914–1915: Maximum stage recorded, 4.75 feet, June 5, 1914 (discharge, approximately 1,570 second-feet); minimum recorded discharge 84 second-feet (measurement made February 5, 1915).

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

REGULATION.—Two dams are used in connection with grist mills above the station, but the plants have little pondage so that the flow at the gage, except for brief periods, is nearly natural.

ACCURACY.—Rating curve well defined over range in stage covered by gage heights; channel permanent; little diurnal fluctuation; open-water records excellent.

*Discharge measurements of Plover River near Stevens Point, Wis., during the yeari endng Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Jan. 2[a] | G. H. Canfield | 2.18 | 127 | Mar. 6[b] | G. H. Canfield | 1.35 | 91 |
| 2[a] | do | 1.72 | 94 | June 28 | W. G. Hoyt | 1.17 | 130 |
| Feb. 5[a] | do | 2.20 | 84 | | | | |

[a] Made through complete ice cover. [b] Ice arched over water surface at gage section.

*Daily discharge, in second feet, of Plover River near Stevens Point, Wis., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 153 | 144 | 163 | | | | 173 | 173 | 144 | 134 | 125 | 100 |
| 2 | 153 | 153 | 163 | | | | 153 | 163 | 144 | 134 | 144 | 100 |
| 3 | 153 | 153 | 173 | | | | 173 | 184 | 134 | 116 | 144 | 100 |
| 4 | 153 | 153 | 163 | | | | 194 | 184 | 134 | 116 | 144 | 108 |
| 5 | 153 | 144 | 153 | | | | 262 | 184 | 134 | 125 | 153 | 108 |
| | | | | 80 | 80 | | | | | | | |
| 6 | 163 | 134 | 144 | | | | 332 | 184 | 153 | 125 | 153 | 92 |
| 7 | 153 | 134 | 153 | | | | 357 | 194 | 163 | 125 | 144 | 89 |
| 8 | 173 | 144 | 134 | | | | 357 | 228 | 153 | 125 | 144 | 89 |
| 9 | 173 | 153 | 153 | | | 115 | 410 | 216 | 144 | 125 | 134 | 89 |
| 10 | 173 | 144 | 134 | | | | 466 | 205 | 153 | 116 | 108 | 93 |
| 11 | 173 | 144 | 116 | | | | 466 | 194 | 173 | 125 | 100 | 97 |
| 12 | 184 | 144 | 116 | | | | 410 | 205 | 173 | 125 | 100 | 108 |
| 13 | 239 | 144 | | | | | 383 | 173 | 173 | 89 | 108 | 153 |
| 14 | 194 | 153 | | | | | 357 | 173 | 163 | 89 | 100 | 144 |
| 15 | 194 | 163 | | | | | 332 | 163 | 144 | 108 | 134 | 144 |
| | | | | 70 | 100 | | | | | | | |
| 16 | 194 | 173 | 115 | | | | 332 | 205 | 153 | 144 | 134 | 144 |
| 17 | 163 | 153 | | | | | 308 | 239 | 134 | 125 | 134 | 144 |
| 18 | 173 | | | | | | 274 | 228 | 153 | 134 | 125 | 144 |
| 19 | 184 | | | | | | 239 | 228 | 163 | 134 | 116 | 144 |
| 20 | 163 | | | | | | 228 | 262 | 173 | 116 | 100 | 134 |
| 21 | 144 | 130 | | | | 140 | 239 | 308 | 163 | 125 | 108 | 116 |
| 22 | 153 | | | | | | 216 | 308 | 173 | 116 | 93 | 108 |
| 23 | 144 | | | | | | 216 | 308 | 153 | 116 | 100 | 100 |
| 24 | 153 | | | | | | 216 | 296 | 144 | 116 | 116 | 97 |
| 25 | 144 | 100 | | | | | 216 | 285 | 125 | 116 | 100 | 93 |
| 26 | 153 | 134 | 100 | 60 | 95 | | 216 | 239 | 134 | 134 | 86 | 116 |
| 27 | 153 | 134 | | | | 184 | 216 | 184 | 125 | 125 | 100 | 108 |
| 28 | 153 | 134 | | | | 194 | 216 | 184 | 134 | 125 | 108 | 99 |
| 29 | 144 | 144 | | | | 189 | 194 | 173 | 134 | 134 | 100 | 108 |
| 30 | 144 | 144 | | | | 184 | 173 | 173 | 134 | 116 | 116 | 93 |
| 31 | 144 | ..... | | | | 178 | ..... | 163 | ..... | 134 | 100 | ..... |

NOTE.—Discharge, except as noted below, determined from a rating curve well defined between 116 and 1,370 second-feet. Discharge Mar. 29 and 31 interpolated; Nov. 18–24 and Dec. 13 to Mar. 26 estimated, because of ice, from discharge measurements, observer's notes, and weather records. Braced figures show mean discharge for period included.

*Monthly discharge of Plover River near Stevens Point, Wis., for the year ending Sept. 30, 1915.*

[Drainage area, 136 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 239 | 144 | 164 | 1.21 | 1.40 | A. |
| November | 173 | ..... | 141 | 1.04 | 1.16 | A. |
| December | 173 | ..... | 122 | .897 | 1.03 | C. |
| January | ..... | ..... | 69.7 | .512 | .59 | D. |
| February | ..... | ..... | 91.4 | .672 | .70 | D. |
| March | 194 | ..... | 135 | .993 | 1.14 | C. |
| April | 466 | 153 | 277 | 2.04 | 2.28 | A. |
| May | 308 | 163 | 213 | 1.57 | 1.81 | A. |
| June | 173 | 125 | 149 | 1.10 | 1.23 | A. |
| July | 144 | 89 | 122 | .897 | 1.03 | A. |
| August | 153 | 86 | 118 | .868 | 1.00 | A. |
| September | 153 | 89 | 112 | .824 | .92 | A. |
| The year | 466 | ..... | 143 | 1.05 | 14.29 | |

BARABOO RIVER NEAR BARABOO, WIS.

LOCATION.—In sec. 33, T. 12 N., R. 7 E., Sauk County, at highway bridge 4 miles downstream from Baraboo, about 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 Wisconsin Geological and Natural History Survey map, edition of 1911; scale, 1 inch=6 miles).

RECORDS AVAILABLE.—December 18, 1913, to September 30, 1915.

GAGE.—Chain gage, attached to upstream side of bridge; read twice daily, morning and evening, to hundredths, by G. C. Johnson.

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

CHANNEL AND CONTROL.—Channel composed of sand and mud; no well-defined control, water is confined to one channel at all stages and does not overflow the banks except at extreme flood stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 10.2 feet at 5.30 p. m. September 17, 1915 (discharge, 2,180 second-feet); minimum discharge, 122 second-feet, recorded by measurement made January 12. Absolute minimum for year occurred last part of December and was probably somewhat less.

1914–1915: Maximum stage recorded 10.2 feet at 5.30 p. m. September 17, 1915 (discharge, 2,180 second-feet). Minimum stage recorded, 0.95 foot at 6.15 a. m. August 18, 1914 (discharge, 108 second-feet).

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

REGULATION.—In the vicinity of Baraboo, 4 miles above the station, there are four dams, and one at Reedsburg, 18 miles above the 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 feet at low-water stages. Estimates of mean monthly discharge probably represent nearly the natural flow.

ACCURACY.—Rating curve fairly well developed between stages of 1.5 and 6.0 feet; estimates of daily discharge based on gage heights outside these limits may be in error from 10 to 20 per cent, and the diurnal fluctuation at low stages may introduce considerable error in the estimates of daily discharge for such period.

*Discharge measurements of Baraboo River near Baraboo, Wis., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec. ft.* | | | *Feet.* | *Sec. ft.* |
| Nov. 5 | M. F. Rather | 1.60 | 166 | Feb. 18[b] | H. C. Beckman | 8.62 | 890 |
| 5 | do | 1.65 | 175 | Mar. 1[c] | G. H. Canfield | 7.21 | 732 |
| Jan. 12[a] | H. C. Beckman | 2.10 | 122 | Apr. 30 | W. G. Hoyt | 1.92 | 219 |

[a] Made through complete ice cover.
[b] Open water at gage; partial ice cover and brush on banks, and ice below gage.
[c] Open water at gage; ice jam one-fourth mile below gage.

*Daily discharge, in second-feet, of Baraboo River near Baraboo, Wis., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 178 | 188 | 178 | | | | 551 | 190 | 274 | 159 | 449 | 198 |
| 2 | 186 | 179 | 174 | | | | 535 | 187 | 246 | 162 | 449 | 179 |
| 3 | 162 | 196 | 200 | | | | 551 | 226 | 232 | 155 | 710 | 175 |
| 4 | 163 | 192 | 196 | | | | 625 | 246 | 220 | 149 | 625 | 165 |
| 5 | 136 | 190 | 184 | | | | 732 | 232 | 204 | 146 | 646 | 153 |
| | | | | 115 | 225 | 360 | | | | | | |
| 6 | 164 | 182 | 167 | | | | 1,010 | 232 | 194 | 141 | 551 | 155 |
| 7 | 179 | 186 | 189 | | | | 1,220 | 253 | 188 | 142 | 477 | 169 |
| 8 | 193 | 171 | 177 | | | | 1,370 | 267 | 206 | 203 | 625 | 170 |
| 9 | 274 | 173 | 182 | | | | 1,460 | 295 | 213 | 195 | 365 | 221 |
| 10 | 667 | 161 | 174 | | | | 1,520 | 309 | 203 | 192 | 288 | 226 |
| 11 | 407 | 179 | 184 | | | 323 | 1,310 | 267 | 208 | 200 | 253 | 351 |
| 12 | 288 | 175 | 177 | | | 421 | 1,100 | 226 | 195 | 181 | 239 | 875 |
| 13 | 365 | 175 | 160 | | | 520 | 950 | 200 | 226 | 192 | 239 | 1,640 |
| 14 | 477 | 163 | | | | 802 | 755 | 198 | 213 | 200 | 288 | 1,550 |
| 15 | 463 | 173 | | | | 900 | 605 | 195 | 260 | 186 | 274 | 1,850 |
| | | | | 250 | 565 | | | | | | | |
| 16 | 477 | 226 | | | | 925 | 463 | 198 | 232 | 165 | 551 | 2,000 |
| 17 | 463 | 232 | 140 | | | 1,010 | 393 | 203 | 195 | 156 | 1,040 | 2,140 |
| 18 | 421 | | | | | 1,040 | 365 | 220 | 198 | 165 | 1,160 | 1,940 |
| 19 | 288 | | | | | 1,070 | 344 | 212 | 200 | 159 | 925 | 1,610 |
| 20 | 260 | | | | | 1,010 | 309 | 393 | 195 | 177 | 535 | 1,460 |
| 21 | 246 | 140 | | | | 1,130 | 288 | 850 | 195 | 187 | 309 | 1,400 |
| 22 | 232 | | | | | 1,130 | 274 | 1,010 | 213 | 167 | 220 | 1,130 |
| 23 | 226 | | | | | 1,250 | 260 | 1,010 | 200 | 184 | 190 | 875 |
| 24 | 213 | | | | | 1,430 | 239 | 900 | 203 | 167 | 220 | 520 |
| 25 | 173 | | | | | 1,790 | 220 | 710 | 208 | 152 | 226 | 407 |
| 26 | 198 | 136 | 110 | 190 | 1,340 | 2,060 | 220 | 477 | 195 | 144 | 209 | 463 |
| 27 | 205 | 153 | | | | 1,940 | 226 | 421 | 176 | 196 | 195 | 568 |
| 28 | 226 | 188 | | | | 1,880 | 203 | 393 | 155 | 535 | 167 | 568 |
| 29 | 190 | 172 | | | | 1,400 | 210 | 379 | 170 | 778 | 163 | 520 |
| 30 | 190 | 172 | | | | 1,040 | 198 | 337 | 170 | 875 | 153 | 435 |
| 31 | 190 | ..... | | | | 802 | ..... | 302 | ..... | 802 | 175 | ..... |

NOTE.—Discharge, except as noted below, determined from a rating curve fairly well defined between 188 and 826 second-feet; above 826 second-feet approximate only, based on extension of the area and mean velocity curves. Discharge Nov. 18–25, and Dec. 14 to Mar. 10, estimated, because of ice, from discharge measurements, observer's notes, and weather records. Braced figures show mean discharge for period indicated.

*Monthly discharge of Baraboo River near Baraboo, Wis., for the year ending Sept 30, 1915.*

[Drainage area, 572 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 667 | 136 | 274 | 0.479 | 0.55 | A. |
| November | 232 | ..... | 169 | .295 | .33 | B. |
| December | 200 | ..... | 146 | .255 | .29 | C. |
| January | ..... | ..... | 185 | .323 | .37 | D. |
| February | ..... | ..... | 665 | 1.16 | 1.21 | D. |
| March | 2,060 | ..... | 886 | 1.55 | 1.79 | C. |
| April | 1,520 | 198 | 617 | 1.08 | 1.20 | B. |
| May | 1,010 | 187 | 372 | .650 | .75 | B. |
| June | 274 | 155 | 206 | .360 | .40 | B. |
| July | 875 | 141 | 246 | .430 | .50 | B. |
| August | 1,160 | 153 | 417 | .729 | .84 | B. |
| September | 2,140 | 153 | 804 | 1.41 | 1.57 | B. |
| The year | 2,140 | ..... | 413 | .722 | 9.80 | |

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 Kickapoo, Crawford County, about 25 miles above mouth of the river and 2 miles below the mouth of Tainter Creek, which enters from the right.

DRAINAGE AREA.—629 square miles (measured on Wisconsin Geological and Natural History Survey map, edition of 1911; scale, 1 inch=6 miles).

RECORDS AVAILABLE.—December 25, 1913, to September 30, 1915.

GAGE.—Chain gage fastened to downstream side of bridge; read twice daily, morning and evening, to quarter-tenths 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.—Channel composed of rock covered by a deposit of sand; banks at gage section fairly high and do not overflow at ordinary high-water stages. Control at the 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 rating curve.

EXTREMES OF DISCHARGE.—1914–1915: Maximum stage recorded, 6.85 feet at 5.20 a. m. July 30, 1915 (discharge, 1,880 second-feet); minimum open-water stage recorded, 0.86 foot at 8 a. m. November 29 (discharge, 201 second-feet). Absolute minimum was approximately 100 second-feet and occurred during the last part of January, 1915.[1]

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

REGULATION.—Mills at Gays Mills immediately above the 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 the gage.

ACCURACY.—Rating curve fairly well defined; little fluctuation; records believed good. See footnote to table of daily discharge.

[1] The flow of 154 second-feet for August 15, 1914, as published in Water-Supply Paper 385, is in error. See footnote to table of daily discharge.

*Discharge measurements of Kickapoo River at Gays Mills, Wis., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Jan. 14[a] | H. C. Beckman | 1.65 | 241 | Apr. 27 | W. G. Hoyt | 1.21 | 309 |
| Feb. 17[b] | M. F. Rather | 4.10 | 584 | July 15 | M. F. Rather | 1.02 | 234 |
| Mar. 17[a] | do | 2.24 | 513 | | | | |

[a] Made through complete ice cover; partial ice cover at control.
[b] Complete ice cover at control.

*Daily discharge, in second-feet, of Kickapoo River at Gays Mills, Wis., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 251 | 251 | 251 | | | | 450 | 265 | 295 | 237 | 670 | 251 |
| 2 | 251 | 251 | 251 | | | | 460 | 251 | 265 | 265 | 1,060 | 265 |
| 3 | 232 | 251 | 251 | | | | 500 | 295 | 280 | 251 | 1,100 | 265 |
| 4 | 251 | 237 | 251 | | | | 470 | 325 | 265 | 251 | 670 | 265 |
| 5 | 237 | 251 | 251 | | | | 575 | 340 | 251 | 251 | 527 | 237 |
| 6 | 265 | 232 | 251 | 300 | 300 | 290 | 670 | 295 | 251 | 265 | 527 | 265 |
| 7 | 355 | 251 | 232 | | | | 1,000 | 325 | 295 | 295 | 500 | 265 |
| 8 | 355 | 237 | 251 | | | | 1,030 | 368 | 265 | 450 | 450 | 265 |
| 9 | 430 | 237 | 251 | | | | 620 | 368 | 237 | 460 | 450 | 545 |
| 10 | 368 | 237 | 237 | | | 325 | 575 | 310 | 251 | 310 | 380 | 522 |
| 11 | 325 | 251 | 251 | | | 380 | 560 | 310 | 295 | 280 | 325 | 510 |
| 12 | 325 | 251 | 280 | | | 418 | 527 | 265 | 295 | 265 | 325 | 368 |
| 13 | 355 | 251 | 203 | | | 518 | 525 | 265 | 380 | 265 | 325 | 545 |
| 14 | 450 | 265 | 380 | | | 545 | 510 | 251 | 380 | 265 | 325 | 971 |
| 15 | 485 | 237 | | 325 | 585 | 522 | 470 | 251 | 295 | 251 | 325 | 1,100 |
| 16 | 405 | 237 | | | | 470 | 430 | 265 | 251 | 251 | 325 | 850 |
| 17 | 355 | 237 | 205 | | | 518 | 405 | 251 | 251 | 251 | 522 | 1,030 |
| 18 | 325 | 224 | | | | 532 | 405 | 280 | 265 | 340 | 527 | 1,160 |
| 19 | 310 | 216 | | | | 522 | 368 | 280 | 310 | 295 | 380 | 850 |
| 20 | 295 | 221 | | | | 522 | 355 | 325 | 355 | 295 | 295 | 1,030 |
| 21 | 295 | 206 | | | | 500 | 325 | 478 | 325 | 295 | 295 | 1,100 |
| 22 | 280 | 221 | | | | 485 | 325 | 525 | 295 | 265 | 280 | 910 |
| 23 | 280 | 237 | | | | 500 | 325 | 500 | 280 | 251 | 280 | 510 |
| 24 | 280 | 237 | | | | 730 | 325 | 380 | 265 | 251 | 295 | 478 |
| 25 | 265 | 237 | | | | 1,060 | 310 | 355 | 265 | 237 | 280 | 470 |
| 26 | 265 | 237 | 230 | 155 | 960 | 1,160 | 295 | 355 | 265 | 237 | 295 | 485 |
| 27 | 265 | 265 | | | | 575 | 295 | 368 | 251 | 237 | 265 | 522 |
| 28 | 265 | 251 | | | | 522 | 310 | 325 | 265 | 790 | 265 | 518 |
| 29 | 280 | 201 | | | | 522 | 295 | 355 | 251 | 1,510 | 265 | 470 |
| 30 | 265 | 280 | | | | 478 | 295 | 355 | 237 | 1,760 | 265 | 460 |
| 31 | 251 | ..... | | | | 450 | ..... | 325 | ..... | 545 | 265 | ..... |

NOTE.—Discharge, except as noted below, determined from a rating curve fairly well defined between 211 and 1,340 second-feet. Nov. 1, interpolated. Dec. 15 to Mar. 9, estimated, because of ice, from discharge measurements, observer's notes, and weather records. Braced figures show mean discharge for period included.

Estimates of discharge for August and September, 1914, as published in Water-Supply Paper 385 and Report by Railroad Commission of Wisconsin to the legislature, 1914, were based on measurement made Aug. 21, 1914, which indicated a change in the discharge relation as expressed by the rating curve used before and after this period. Measurements made during 1915 indicate that the control is fairly permanent and that the measurement made in August, 1914, was in error. Revised estimates for August and September, 1914, are given in the table of monthly discharge.

*Monthly discharge of Kickapoo River at Gays Mills, Wis., for the period Aug. 1, 1914, to Sept. 30, 1915.*

[Drainage area, 629 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| 1914. | | | | | | |
| August | 470 | 206 | 258 | 0.410 | 0.47 | C. |
| September | 730 | 237 | 348 | .553 | .62 | B. |
| 1914–15. | | | | | | |
| October | 485 | 232 | 310 | .493 | .57 | B. |
| November | 280 | 201 | 240 | .382 | .43 | B. |
| December | 380 | ..... | 237 | .377 | .43 | C. |
| January | ..... | ..... | 257 | .409 | .47 | D. |
| February | ..... | ..... | 590 | .938 | .98 | D. |
| March | 1,160 | ..... | 479 | .762 | .88 | C. |
| April | 1,030 | 295 | 467 | .742 | .83 | B. |
| May | 525 | 251 | 329 | .523 | .60 | B. |
| June | 380 | 237 | 281 | .447 | .50 | B. |
| July | 1,760 | 237 | 393 | .625 | .72 | B. |
| August | 1,100 | 265 | 421 | .669 | .77 | B. |
| September | 1,160 | 237 | 583 | .927 | 1.03 | B. |
| The year | 1,760 | ..... | 380 | .604 | 8.21 | |

NOTE.—Estimates for August and September, 1914, superseded the figures published in Water-Supply Paper 385 and Report by Railroad Commission of Wisconsin to the legislature, 1914. See footnote to table of daily discharge.

## TURKEY RIVER AT GARBER, IOWA.

LOCATION.—At single span highway bridge at Garber, Clayton County, about 800 feet above mouth of Wayne Creek, which enters from the right.

DRAINAGE AREA.—1,530 square miles (revised by measurement on United States Geological Survey map of scale 1 to 500,000.

RECORDS AVAILABLE.—August 29, 1913, to September 30, 1915, except October 1, 1914, to March 30, 1915, when the 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 the bridge, and at low water by wading.

CHANNEL AND CONTROL.—Control consists of sand and mud; channel shifting. The right bank is high and will not overflow. The left bank will overflow only at extreme high stage or at gage height approximately 21 feet.

EXTREMES OF STAGE.—Maximum stage recorded during year, 14.3 feet at 6 p. m. Aug. 4; minimum stage recorded, 3.8 feet April 27. The highest stage within the last 20 years probably occurred May 18, 1902, when a stage representing about 23.7 feet referred to gage datum was reached, as indicated by the high-water marks on A. F. Grafe's residence in Garber.

WINTER FLOW.—Discharge relation affected by ice; observations discontinued.

REGULATION.—An electric light plant and gristmill at Elkader probably cause a slight daily fluctuation.

Data insufficient for estimates of discharge.

*Discharge measurements of Turkey River at Garber, Iowa, during the year ending Sept. 30, 1915.*

[Made by C. Herlofson.]

| Date. | Gage height. | Discharge. |
|---|---|---|
| | *Feet.* | *Sec.-ft.* |
| Mar. 31 | 5.89 | 1,890 |
| Sept. 8 | 3.96 | 506 |

*Daily gage height, in feet, of Turkey River at Garber, Iowa, for the year ending Sept. 30, 1915.*

| Day. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Day. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 5.6 | 4.1 | 7.5 | 5.0 | 9.2 | 4.0 | 16 | ..... | 4.6 | 4.1 | 5.0 | 4.6 | 5.0 | 5.9 |
| 2 | ..... | 5.4 | 4.3 | 6.5 | 4.6 | 12.9 | 4.0 | 17 | ..... | 4.5 | 3.95 | 4.7 | 4.8 | 4.8 | 5.6 |
| 3 | ..... | 5.4 | 5.0 | 5.8 | 7.4 | 12.9 | 3.95 | 18 | ..... | 4.4 | 3.95 | 5.7 | 6.2 | 4.8 | 4.8 |
| 4 | ..... | 5.2 | 7.0 | 5.4 | 4.6 | 14.3 | 3.95 | 19 | ..... | 4.4 | 4.0 | 5.2 | 6.2 | 4.6 | 4.4 |
| 5 | ..... | 5.7 | 5.9 | 5.1 | 4.8 | 12.4 | 3.95 | 20 | ..... | 4.3 | 4.2 | 5.0 | 6.0 | 4.5 | 5.1 |
| 6 | ..... | 6.1 | 5.8 | 5.0 | 4.6 | 8.2 | 3.95 | 21 | ..... | 4.1 | 4.9 | 5.2 | 5.4 | 4.4 | 4.7 |
| 7 | ..... | 6.2 | 5.6 | 4.9 | 4.4 | 7.0 | 3.95 | 22 | ..... | 4.1 | 5.2 | 5.1 | 5.3 | 4.4 | 4.4 |
| 8 | ..... | 6.0 | 5.9 | 4.6 | 5.0 | 6.3 | 4.0 | 23 | ..... | 4.0 | 5.4 | 4.1 | 6.4 | 4.4 | 4.3 |
| 9 | ..... | 5.6 | 5.2 | 4.6 | 5.6 | 5.7 | 4.1 | 24 | ..... | 4.0 | 5.4 | 4.4 | 6.5 | 4.3 | 4.2 |
| 10 | ..... | 5.6 | 4.9 | 4.6 | 5.0 | 5.5 | 4.0 | 25 | ..... | 3.9 | 7.9 | 4.4 | 8.6 | 4.3 | 4.1 |
| 11 | ..... | 5.6 | 4.6 | 4.5 | 5.0 | 5.3 | 4.0 | 26 | ..... | 3.85 | 7.8 | 4.2 | 7.7 | 4.2 | 8.8 |
| 12 | ..... | 5.4 | 4.5 | 4.4 | 4.8 | 5.0 | 4.0 | 27 | ..... | 3.8 | 5.8 | 4.6 | 6.4 | 4.2 | 6.7 |
| 13 | ..... | 5.1 | 4.3 | 5.4 | 4.4 | 4.8 | 5.8 | 28 | ..... | 3.95 | 5.8 | 4.8 | 5.0 | 4.1 | 6.1 |
| 14 | ..... | 4.9 | 4.2 | 5.2 | 4.6 | 5.4 | 5.0 | 29 | ..... | 4.2 | 9.6 | 4.8 | 4.8 | 4.1 | 5.1 |
| 15 | ..... | 4.7 | 4.2 | 4.8 | 4.6 | 5.3 | 4.8 | 30 | ..... | 4.2 | 10.8 | 4.8 | 5.2 | 4.1 | 4.8 |
| | | | | | | | | 31 | 5.9 | ..... | 9.1 | ..... | 9.2 | 4.0 | ..... |

MAQUOKETA RIVER BELOW 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 the Bridgeport bridge, about 3 miles northeast of Maquoketa, Jackson County; about 1,200 feet above mouth of Mill Creek, which enters from the right, and about 2 miles below the mouth of North Fork of Maquoketa River.

DRAINAGE AREA.—1,600 square miles, revised by measurement on United States Geological Survey map of scale, 1 to 500,000. Drainage area at mouth, 1,960 square miles.

RECORDS AVAILABLE.—September 1, 1913, to September 30, 1915, 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 sandy and 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, 19.4 feet at 7 a. m. September 28 (discharge, 16,200 second-feet); minimum stage recorded, 2.0 feet June 8 (discharge, 325 second-feet.)

Prior to 1915: Maximum stage about 23.5 feet, probably in 1905 (discharge, approximately 25,000 second-feet).

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

DIVERSIONS.—None.

REGULATION.—None.

ACCURACY.—Results considered good.

*Discharge measurements of Maquoketa River below North Fork of Maquoketa River, near Maquoketa, Iowa, during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| une 15 | W. G. Hoyt | 4.42 | 1,430 | Sept. 28 | C. Herlofson | 18.50 | 14,500 |
| 15 | ....do | 4.42 | 1,410 | 29 | ....do | 11.93 | 6,510 |
| Sept. 9 | C. Herlofson | 2.51 | 494 | | | | |

*Daily discharge, in second-feet, of Maquoketa River below North Fork of Maquoketa River, near Maquoketa, Iowa, for the periods Mar. 12 to Sept. 30, 1914, and Mar. 21 to Sept. 30, 1915.*

| Day. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|
| **1914.** | | | | | | | |
| 1 | ..... | 764 | 407 | 477 | 561 | 327 | 1,540 |
| 2 | ..... | 764 | 407 | 440 | 477 | 327 | 1,310 |
| 3 | ..... | 712 | 407 | 477 | 477 | 320 | 764 |
| 4 | ..... | 660 | 1,770 | 440 | 440 | 320 | 517 |
| 5 | ..... | 561 | 1,140 | 7,530 | 407 | 320 | 440 |
| 6 | ..... | 561 | 660 | 3,370 | 407 | 334 | 6,280 |
| 7 | ..... | 517 | 609 | 2,700 | 366 | 320 | 764 |
| 8 | ..... | 517 | 517 | 1,260 | 378 | 320 | 561 |
| 9 | ..... | 477 | 477 | 1,090 | 366 | 314 | 440 |
| 10 | ..... | 477 | 440 | 980 | 366 | a 311 | 407 |
| 11 | ..... | 477 | 1,090 | 817 | a 366 | 308 | 407 |
| 12 | 980 | 477 | 1,310 | 817 | 366 | 308 | 407 |
| 13 | 517 | 440 | 1,090 | 660 | 353 | 308 | 392 |
| 14 | 517 | 440 | 817 | 817 | 353 | 308 | 3,160 |
| 15 | 517 | 440 | 660 | 764 | 353 | 308 | 11,200 |
| 16 | 517 | 440 | 561 | 660 | 334 | 320 | 9,580 |
| 17 | 477 | 424 | 477 | 609 | 477 | 334 | 2,570 |
| 18 | 440 | 407 | a 458 | 609 | 407 | 314 | 1,770 |
| 19 | 424 | 407 | 440 | 561 | 366 | 2,900 | 1,370 |
| 20 | 407 | 407 | 407 | 517 | 344 | 609 | 1,200 |
| 21 | 407 | 407 | 407 | 517 | 334 | 407 | 980 |
| 22 | a 400 | 407 | 440 | 660 | 334 | 353 | a 952 |
| 23 | 392 | 378 | 407 | 712 | 334 | 344 | 925 |
| 24 | 392 | 378 | 407 | 660 | 344 | 334 | 764 |
| 25 | 407 | 392 | 407 | 1,040 | 353 | 327 | 712 |
| 26 | 817 | 378 | 609 | 1,040 | 334 | 320 | 609 |
| 27 | 660 | 392 | 609 | 871 | 320 | 314 | 561 |
| 28 | 477 | 392 | 2,260 | 925 | 440 | 314 | 517 |
| 29 | 561 | 407 | 980 | 817 | 353 | 314 | 517 |
| 30 | 660 | 407 | 609 | 609 | 334 | 308 | 477 |
| 31 | 817 | ..... | 517 | ..... | 330 | 314 | ..... |
| **1915.** | | | | | | | |
| 1 | ..... | 602 | 402 | 2,070 | 582 | 783 | 435 |
| 2 | ..... | 602 | 418 | 1,480 | 561 | 2,830 | 435 |
| 3 | ..... | 602 | 602 | 1,200 | 487 | 2,900 | 418 |
| 4 | ..... | 602 | 602 | a 1,040 | 452 | 1,830 | 418 |
| 5 | ..... | 602 | 523 | 880 | 487 | 1,770 | a 432 |
| 6 | ..... | 602 | 561 | 370 | 487 | 1,830 | a 446 |
| 7 | ..... | 602 | 602 | 385 | 1,040 | 1,480 | a 460 |
| 8 | ..... | 602 | 561 | 325 | 1,420 | 1,200 | a 473 |
| 9 | ..... | 602 | 602 | 645 | 1,310 | 1,040 | 487 |
| 10 | ..... | 602 | 561 | 645 | 1,040 | 880 | 1,000 |
| 11 | ..... | 561 | 523 | 831 | 1,040 | 783 | 880 |
| 12 | ..... | 561 | 487 | 4,000 | 783 | 690 | 645 |
| 13 | ..... | 561 | 470 | 7,260 | 690 | 690 | 561 |
| 14 | ..... | 561 | 385 | 2,380 | 645 | 690 | 930 |
| 15 | ..... | 523 | a 410 | 1,480 | 1,090 | 1,090 | 831 |
| 16 | ..... | 523 | 435 | 1,260 | 831 | 831 | 690 |
| 17 | ..... | 523 | 418 | 1,040 | 1,710 | 1,710 | 1,830 |
| 18 | ..... | a 505 | 402 | 982 | 1,600 | 690 | 2,010 |
| 19 | ..... | 487 | 402 | 1,650 | 1,830 | a 646 | 982 |
| 20 | ..... | 487 | 435 | 1,140 | 1,260 | 602 | 783 |
| 21 | 1,140 | 470 | 690 | 1,040 | 982 | 561 | 783 |
| 22 | 1,040 | 470 | 831 | 930 | 831 | 561 | 736 |
| 23 | 880 | 470 | 736 | 831 | 783 | 523 | 690 |
| 24 | 880 | 452 | 690 | 783 | 690 | 523 | 645 |
| 25 | 880 | 435 | 1,480 | 736 | 645 | 523 | 602 |
| 26 | a 856 | 435 | 1,950 | 690 | 602 | 487 | 5,530 |
| 27 | 831 | 435 | 1,480 | 645 | 602 | 487 | 9,130 |
| 28 | a 807 | 435 | 1,600 | 690 | 645 | 470 | 13,800 |
| 29 | 783 | 418 | 1,890 | 602 | 1,420 | 487 | 7,720 |
| 30 | 690 | 402 | 1,950 | 602 | 1,040 | 452 | 3,230 |
| 31 | 690 | ..... | 2,190 | ..... | 880 | 418 | ..... |

a Interpolated.

NOTE.—Discharge computed from a well-defined rating curve. Discharge June 12 and Sept. 10, 1915, estimated from discharge at near-by gaging stations. Estimates of discharge in the above table for Mar. 12 to Sept. 30, 1914, differ above 660 second-feet from those published in Water-Supply Paper 385 because of a revision of the rating curve based upon high-water discharge measurements made in 1915.

*Monthly discharge of Maquoketa River below North Fork of Maquoketa River, near Maquoketa, Iowa, for the periods Mar. 12 to Sept. 30, 1914, and Mar. 21 to Sept. 30, 1915.*

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

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| 1914. | | | | | | |
| March 12-31 | 980 | 392 | 539 | 0.337 | 0.25 | B. |
| April | 764 | 378 | 477 | .298 | .33 | B. |
| May | 2,260 | 407 | 703 | .439 | .51 | A. |
| June | 7,530 | 440 | 1,110 | .694 | .77 | A. |
| July | 561 | 320 | 380 | .238 | .27 | B. |
| August | 2,900 | 308 | 415 | .259 | .30 | B. |
| September | 11,200 | 392 | 1,740 | 1.09 | 1.22 | B. |
| 1915. | | | | | | |
| March 21-31 | 1,140 | 690 | 862 | .539 | .22 | A. |
| April | 602 | 402 | 524 | .328 | .37 | A. |
| May | 2,190 | 385 | 816 | .510 | .59 | A. |
| June | 7,260 | 325 | 1,290 | .806 | .90 | B. |
| July | 1,830 | 452 | 918 | .574 | .66 | A. |
| August | 2,900 | 418 | 982 | .614 | .71 | A. |
| September | 13,800 | 418 | 1,930 | 1.21 | 1.35 | B. |

a Revised measurement.

NOTE.—Estimates of monthly discharge, March to September, 1914, supersede those published in Water-Supply Paper 385. See footnote to table of daily discharge.

ROCK RIVER AT AFTON, WIS.

LOCATION.—On the line between secs. 22 and 27, T. 2 N., R. 12 E., at highway bridge in the town of Afton, Rock County, about 9 miles above Illinois State line. Bass Creek enters from the right about three-fourths mile below station.

DRAINAGE AREA.—3,190 square miles (measured on Wisconsin Geological and Natural History Survey map, edition of 1911; scale, 1 inch=6 miles).

RECORDS AVAILABLE.—February 5, 1914, to September 30, 1915.

GAGE.—Chain gage fastened to the downstream side of bridge; read twice daily, morning and evening, to quarter-tenths by Albert Engelke.

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

CHANNEL AND CONTROL.—Both banks medium high and will not overflow to any extent at flood stages; channel, gravel and clean silt, practically permanent: no well defined control section.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 9.88 feet at 4 p. m., September 13 (discharge, 10,300 second-feet); minimum stage recorded during open-water periods 1.41 feet July 29 and 30 (discharge 828 second-feet). A flow of 746 second-feet was measured by current meter on January 8; the absolute minimum was probably about 620 second-feet.

1914–1915: 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, approximately 459 second-feet).

WINTER FLOW.—Discharge relation seriously affected by ice; flow determined from discharge measurements, observer's notes, and weather records.

REGULATION.—Operation of power plants at Janesville and above causes fluctuations at the gage during low stages.

ACCURACY.—Rating curve well defined; channel permanent; gage-height record good; results good.

*Discharge measurements of Rock River at Afton, Wis., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec. ft.* | | | *Feet.* | *Sec. ft.* |
| Jan. 8[a] | W. G. Hoyt | 2.36 | 746 | July 21 | M. F. Rather | 1.86 | 1,030 |
| Feb. 18 | G. H. Canfield | 4.80 | 3,450 | Sept. 13 | C. P. Gross | 9.83 | 10,300 |
| Feb. 28 | W. G. Hoyt | 7.23 | 6,610 | 15 | W. G. Hoyt | 7.24 | 6,540 |
| Apr. 23 | do | 3.40 | 2,080 | | | | |

[a] Made through complete ice cover.

*Daily discharge, in second-feet, of Rock River at Afton, Wis., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2,310 | 2,060 | 911 | | | 6,630 | 3,920 | 1,430 | 3,240 | 1,270 | 921 | 1,300 |
| 2 | 2,060 | 2,060 | 948 | | | 6,770 | 3,800 | 1,270 | 3,240 | 1,210 | 2,400 | 1,180 |
| 3 | 1,980 | 2,140 | 1,100 | | | 6,910 | 3,560 | 1,460 | 3,140 | 942 | 3,140 | 1,240 |
| 4 | 1,670 | 2,060 | 1,180 | | | 7,050 | 3,340 | 1,360 | 3,140 | 921 | 2,850 | 1,150 |
| 5 | 1,670 | 1,900 | 1,060 | | | 7,190 | 3,450 | 1,270 | 2,940 | 871 | 2,850 | 1,140 |
| | | | | 705 | 1,090 | | | | | | | |
| 6 | 1,740 | 1,740 | 1,060 | | | 6,910 | 3,240 | 1,270 | 2,760 | 942 | 3,240 | 1,120 |
| 7 | 1,460 | 1,670 | 1,140 | | | 6,630 | 3,140 | 1,270 | 2,760 | 953 | 3,560 | 1,150 |
| 8 | 1,430 | 1,460 | | | | 6,490 | 3,040 | 1,040 | 2,400 | 1,160 | 3,800 | 1,130 |
| 9 | 1,360 | 1,430 | | | | 6,210 | 2,850 | 1,100 | 2,310 | 1,120 | 4,040 | 1,560 |
| 10 | 1,140 | 1,530 | | | | 6,070 | 2,760 | 1,330 | 2,220 | 871 | 4,040 | 1,460 |
| 11 | 969 | 1,500 | 910 | | | 5,810 | 2,580 | 1,300 | 2,140 | 866 | 4,040 | 1,330 |
| 12 | 1,040 | 1,430 | | | | 5,810 | 2,850 | 1,140 | 2,060 | 953 | 4,040 | 1,300 |
| 13 | 1,270 | 1,400 | | | | 5,810 | 2,760 | 1,210 | 1,980 | 969 | 3,680 | 8,910 |
| 14 | 1,670 | 1,300 | | | 1,930 | 5,680 | 2,670 | 1,270 | 2,060 | 948 | 3,450 | 7,620 |
| 15 | 1,640 | 1,210 | | | | 5,940 | 2,670 | 1,300 | 1,980 | 996 | 3,240 | 6,490 |
| | | | | 790 | | | | | | | | |
| 16 | 1,740 | 1,100 | | | | 5,940 | 2,580 | 1,150 | 1,820 | 1,020 | 3,240 | 6,630 |
| 17 | 1,900 | 1,040 | | | 3,240 | 5,940 | 2,580 | 1,210 | 1,820 | 942 | 3,040 | 6,910 |
| 18 | 1,980 | 1,020 | | | 3,450 | 5,940 | 2,400 | 1,270 | 1,900 | 942 | 2,670 | 6,910 |
| 19 | 2,220 | | | | 3,680 | 5,810 | 2,400 | 1,330 | 1,740 | 1,120 | 2,490 | 7,050 |
| 20 | 2,140 | | | | 3,800 | 5,680 | 2,490 | 1,460 | 1,820 | 1,050 | 2,310 | 7,050 |
| | | | 750 | | | | | | | | | |
| 21 | 2,310 | 860 | | | 3,920 | 5,550 | 2,490 | 1,460 | 1,980 | 1,010 | 2,140 | 6,910 |
| 22 | 2,400 | | | | 4,520 | 5,680 | 2,220 | 1,140 | 1,780 | 1,030 | 1,980 | 6,910 |
| 23 | 2,850 | | | | 5,160 | 5,420 | 2,060 | 1,460 | 1,820 | 1,020 | 1,900 | 6,630 |
| 24 | 2,670 | | | | 6,350 | 5,290 | 1,980 | 1,820 | 1,740 | 847 | 1,900 | 6,490 |
| 25 | 2,670 | | | | 5,940 | 5,160 | 1,780 | 1,980 | 1,740 | 871 | 1,740 | 6,210 |
| | | | | 875 | | | | | | | | |
| 26 | 2,760 | 896 | | | 5,940 | 5,030 | 1,820 | 2,490 | 1,640 | 996 | 1,670 | 8,040 |
| 27 | 2,670 | 1,060 | | | 6,210 | 4,770 | 1,600 | 2,670 | 1,460 | 1,050 | 1,670 | 7,620 |
| 28 | 2,400 | 1,150 | 723 | | 6,490 | 4,520 | 1,460 | 2,760 | 1,560 | 980 | 1,400 | 6,630 |
| 29 | 2,400 | 1,140 | | | ..... | 4,520 | 1,530 | 3,240 | 1,360 | 828 | 1,360 | 6,210 |
| 30 | 2,310 | 1,060 | | | ..... | 4,280 | 1,430 | 3,140 | 1,060 | 828 | 1,460 | 5,940 |
| 31 | 2,310 | ..... | | | ..... | 4,160 | ..... | 3,040 | ..... | 932 | 1,270 | ..... |

NOTE.—Discharge, except as noted below, determined from a well-defined rating curve; Nov. 19–25 and Dec. 8 to Feb. 16, estimated, because of ice, from discharge measurements, observer's notes, and weather records. Braced figures show mean discharge for period included.

*Monthly discharge of Rock River at Afton, Wis., for the year ending Sept. 30, 1915.*

[Drainage area, 3,190 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 2,850 | 969 | 1,970 | 0.618 | 0.71 | B. |
| November | 2,140 | ..... | 1,310 | .411 | .46 | B. |
| December | ..... | ..... | 855 | .268 | .31 | D. |
| January | ..... | ..... | 793 | .249 | .29 | C. |
| February | 6,350 | ..... | 2,900 | .909 | .95 | D. |
| March | 7,190 | 4,160 | 5,790 | 1.82 | 2.10 | A. |
| April | 3,920 | 1,430 | 2,580 | .809 | .90 | A. |
| May | 3,240 | 1,040 | 1,630 | .511 | .59 | B. |
| June | 3,240 | 1,060 | 2,120 | .665 | .74 | B. |
| July | 1,270 | 828 | 983 | .308 | .36 | B. |
| August | 4,040 | 921 | 2,630 | .824 | .95 | A. |
| September | 8,910 | 1,120 | 4,670 | 1.46 | 1.63 | A. |
| The year | 8,910 | ..... | 2,350 | .737 | 9.99 | |

ROCK RIVER AT ROCKFORD, ILL.

LOCATION.—In the southern part of T. 44 N., R. 1 E., at highway bridge at Nelson Avenue, Rockford, Winnebago County, about 2 miles below mouth of Kent Creek.

DRAINAGE AREA.—6,520 square miles.

RECORDS AVAILABLE.—July 30, 1914, to September 30, 1915.

GAGE.—Chain gage attached to bridge; read daily, morning and afternoon, to quarter-tenths prior to March 4, 1915, and to hundredths after that date, by Winston Burrows.

DISCHARGE MEASUREMENTS.—Made from upstream side of bridge.

CHANNEL AND CONTROL.—Probably permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 9.3 feet at 9 a. m. September 17 (discharge, 17,000 second-feet); minimum stage recorded, 2.3 feet at 8 a. m. November 21 (discharge, 1,770 second-feet).

WINTER FLOW.—Discharge relation affected by ice during parts of December, January, and February.

REGULATION.—The operation of the power plant at dam 2 miles upstream, in the city of Rockford, causes fluctuation at the gage.

ACCURACY.—Gage readings reliable; regulation of stream may affect mean daily gage height as obtained from two readings per day.

*Discharge measurements of Rock River at Rockford, Ill., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Mar. 5 | William Kessler | 7.75 | 12,800 | Sept. 17 | G. J. Trinkaus | 9.13 | 16,300 |
| May 6 | .....do | 3.26 | 2,880 | 23 | William Kessler | 8.20 | 14,200 |
| Aug. 6 | J. B. Fountain | 6.23 | 8,840 | | | | |

*Daily discharge, in second-feet, of Rock River at Rockford, Ill., for the years ending Sept. 30, 1914–15.*

| Day. | July. | Aug. | Sept. | Day. | July. | Aug. | Sept. | Day. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1914. | | | | 1914. | | | | 1914. | | | |
| 1 | | 1,880 | 2,460 | 11 | | 1,660 | 1,660 | 21 | | 1,880 | 13,200 |
| 2 | | 1,660 | 2,100 | 12 | | 1,550 | 1,660 | 22 | | 1,880 | 11,400 |
| 3 | | 1,770 | 3,200 | 13 | | 1,880 | 1,000 | 23 | | 1,990 | 10,600 |
| 4 | | 1,880 | 2,820 | 14 | | 1,660 | 1,880 | 24 | | 2,100 | 7,620 |
| 5 | | 2,100 | 1,990 | 15 | | 1,660 | 6,920 | 25 | | 2,100 | 5,590 |
| 6 | | 2,100 | 1,440 | 16 | | 1,140 | 12,900 | 26 | | 1,770 | 5,170 |
| 7 | | 2,100 | 1,880 | 17 | | 1,660 | 14,000 | 27 | | 1,660 | 4,770 |
| 8 | | 1,550 | 1,990 | 18 | | 1,550 | 13,400 | 28 | | 1,770 | 4,570 |
| 9 | | 502 | 1,880 | 19 | | 1,660 | 12,900 | 29 | | 1,380 | 4,380 |
| 10 | | 1,380 | 1,880 | 20 | | 1,770 | 13,200 | 30 | 2,100 | 698 | 4,190 |
| | | | | | | | | 31 | 1,990 | 1,880 | |

| Day. | Oct. | Nov. | Dec. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1914–15. | | | | | | | | | | | |
| 1 | 3,820 | 3,200 | 2,700 | | 14,500 | 5,800 | 2,340 | 7,620 | 3,070 | 2,580 | 2,460 |
| 2 | 3,490 | 3,340 | 2,340 | | 14,800 | 5,800 | 2,220 | 6,920 | 2,820 | 2,700 | 2,460 |
| 3 | 3,200 | 3,070 | 2,100 | | 14,800 | 5,590 | 2,580 | 6,240 | 2,580 | 5,170 | 2,580 |
| 4 | 2,940 | 3,340 | 2,340 | | 13,400 | 5,170 | 2,700 | 5,590 | 2,340 | 7,150 | 2,580 |
| 5 | 2,820 | 3,070 | 2,460 | | 12,900 | 4,970 | 2,700 | 5,170 | 2,220 | 8,850 | 2,580 |
| 6 | 2,700 | 3,070 | 2,700 | | 12,700 | 4,770 | 2,700 | | 2,460 | 8,850 | 2,580 |
| 7 | 2,820 | 2,940 | 2,940 | | 10,600 | 4,570 | 2,580 | | 2,340 | 8,850 | 2,460 |
| 8 | 2,820 | 2,340 | 2,700 | | 9,100 | 4,380 | 2,580 | | 2,820 | 8,600 | 2,700 |
| 9 | 2,700 | 2,700 | 2,580 | | 8,850 | 4,190 | | | 3,820 | 8,100 | 2,820 |
| 10 | 2,340 | 2,580 | 2,580 | | 9,100 | 4,000 | | | 4,380 | 7,620 | 3,070 |
| 11 | 2,100 | 2,700 | 2,580 | | 9,100 | 4,000 | | | 3,650 | 6,920 | 3,490 |
| 12 | 2,220 | 2,460 | 2,460 | | 8,850 | 4,000 | | | 3,490 | 6,460 | 4,000 |
| 13 | 2,580 | 2,580 | 1,880 | | 8,350 | 4,190 | | | 3,200 | 6,020 | 5,380 |
| 14 | 2,700 | 2,580 | 2,220 | | 9,350 | 4,190 | | | 2,940 | 5,800 | 12,900 |
| 15 | 2,940 | 2,340 | 2,580 | | 9,350 | 4,380 | | | 3,200 | 5,380 | 15,300 |
| 16 | 3,070 | 2,820 | | | 9,350 | 4,380 | | | 3,820 | 4,970 | 12,400 |
| 17 | 3,340 | 2,820 | | | 9,350 | 4,380 | | | 4,190 | 4,570 | 16,700 |
| 18 | 3,820 | 1,990 | | | 9,350 | 4,190 | | | 4,000 | 4,380 | 15,300 |
| 19 | 4,000 | 1,990 | | | 9,100 | 4,000 | | | 4,000 | 4,190 | 14,000 |
| 20 | 4,380 | 2,100 | | | 8,850 | 4,190 | | | 3,820 | 3,490 | 14,000 |
| 21 | 4,380 | 1,770 | | | 8,600 | 4,000 | | | 3,340 | 3,200 | 14,300 |
| 22 | 4,380 | 1,770 | | 14,000 | 8,600 | 3,820 | | | 3,070 | 3,070 | 14,300 |
| 23 | 4,380 | 1,880 | | 14,300 | 8,350 | 3,340 | | | 2,940 | 2,940 | 14,300 |
| 24 | 4,190 | 2,460 | | 14,300 | 8,100 | 2,940 | | | 2,700 | 3,070 | 14,300 |
| 25 | 4,380 | 2,220 | | 13,700 | 7,860 | 2,820 | | | 2,460 | 3,340 | 14,300 |
| 26 | 4,380 | 2,100 | | 14,500 | 7,380 | 2,700 | | | 2,580 | 3,490 | 14,500 |
| 27 | 4,190 | 1,990 | | 14,500 | 6,920 | 2,580 | | 3,340 | 2,700 | 3,200 | 15,100 |
| 28 | 4,000 | 1,990 | | 14,500 | 6,690 | 2,820 | | 3,340 | 2,580 | 2,940 | 15,300 |
| 29 | 3,820 | 2,100 | | | 6,240 | 2,460 | | 3,200 | 2,580 | 2,700 | 15,100 |
| 30 | 3,490 | 2,340 | | | 6,020 | 2,340 | | 3,070 | 2,580 | 2,580 | 14,300 |
| 31 | 3,340 | | | | 5,800 | | | | 2,580 | 2,460 | |

NOTE.—Discharge, except as noted, determined from a rating curve well defined above and fairly well defined below 960 second-feet. Discharge estimated, because of ice, as follows: Dec. 16–31, 2,700 second-feet; Jan. 1–31, 2,700 second-feet; Feb. 1–10, 3,000 second-feet; Feb. 11–21, 8,500 second-feet. Discharge estimated when gage was not read by comparison with records at Lyndon, as follows: May 9–31, 3,500 second-feet; June 6–26, 2,300 second-feet.

*Monthly discharge of Rock River at Rockford, Ill., for the years ending Sept. 30, 1914–15.*

[Drainage area, 6,520 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| 1914. | | | | | | |
| August | 2,100 | 502 | 1,680 | 0.258 | 0.30 | B. |
| September | 14,000 | 1,000 | 5,750 | .882 | .98 | B. |
| 1914–15. | | | | | | |
| October | 4,380 | 2,100 | 3,410 | .523 | .60 | A. |
| November | 3,340 | 1,770 | 2,490 | .382 | .43 | B. |
| December | ..... | 1,880 | 2,590 | .397 | .46 | C. |
| January | ..... | ..... | 2,700 | .414 | .48 | D. |
| February | 14,500 | ..... | 7,970 | 1.22 | 1.27 | D. |
| March | 14,800 | 5,800 | 9,430 | 1.45 | 1.67 | A. |
| April | 5,800 | 2,340 | 4,030 | .618 | .69 | A. |
| May | ..... | ..... | 3,250 | .499 | .58 | D. |
| June | ..... | ..... | 3,090 | .474 | .53 | D. |
| July | 4,380 | 2,220 | 3,070 | .471 | .54 | A. |
| August | 8,850 | 2,460 | 4,960 | .761 | .88 | A. |
| September | 16,700 | 2,460 | 9,520 | 1.46 | 1.63 | A. |
| The year | 16,700 | ..... | 4,680 | .718 | 9.76 | |

ROCK RIVER AT LYNDON, ILL.

LOCATION.—In center of T. 20 N., R. 5 E., at highway bridge known as Lyndon Bridge, in eastern part of village of Lyndon, Whiteside County; about 10 miles above Rock Creek and 20 miles below dam at Sterling.

DRAINAGE AREA.—9,010 square miles.

RECORDS AVAILABLE.—November 24, 1914, to September 30, 1915.

GAGE.—Chain gage attached to bridge; read daily, morning and afternoon, to hundredths 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, 15.5 feet at 5 p. m. February 15 (discharge not determined because of backwater from ice). Maximum stage recorded during open-water periods, 12.9 feet at 5.40 p. m. February 25 (discharge, 23,200 second-feet); minimum stage recorded, 5.0 feet at 12 m. November 24 (discharge, 1,850 second-feet).

WINTER FLOW.—Discharge relation affected by ice during parts of December, January, and February.

REGULATION.—Operation of the power plants in the city of Sterling, about 20 miles upstream, may cause a slight fluctuation at the gage.

ACCURACY.—Gage readings reliable; records good except during winter.

*Discharge measurements of Rock River at Lyndon, Ill., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Nov. 23 | B. J. Peterson | 5.08 | 1,970 | May 8 | William Kessler | 5.93 | 3,190 |
| 25 | do | 5.18 | 2,110 | Sept. 21 | do | 10.87 | 15,700 |
| Mar. 2 | William Kessler | 11.08 | 16,300 | 24 | do | 10.83 | 14,900 |
| May 8 | do | 6.12 | 3,520 | | | | |

*Daily discharge, in second-feet, of Rock River at Lyndon, Ill., for the year ending Sept. 30, 1915.*

| Day. | Nov. | Dec. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 2,250 | | 16,600 | a 6,630 | 2,250 | 10,600 | 3,800 | 6,630 | 2,830 |
| 2 | | 2,390 | | 16,600 | 6,400 | 2,390 | 9,710 | 4,160 | a 7,900 | 3,140 |
| 3 | | 2,390 | | a 16,400 | 6,170 | 3,300 | 7,840 | 2,530 | 9,160 | 3,630 |
| 4 | | 2,390 | | 16,200 | 5,520 | 3,300 | 6,400 | 2,530 | 15,800 | 3,300 |
| 5 | | 2,110 | | 15,800 | 5,730 | 3,300 | 6,170 | 3,300 | 14,800 | 2,680 |
| 6 | | 2,110 | | 14,200 | 5,520 | 3,300 | 5,520 | a 3,220 | 13,200 | 2,530 |
| 7 | | 2,250 | | 12,600 | a 5,520 | a 3,300 | 5,730 | 3,140 | 12,300 | a 2,890 |
| 8 | | 2,390 | | 11,100 | 5,520 | 3,140 | 5,950 | 5,950 | 12,300 | a 3,250 |
| 9 | | 2,680 | | 10,600 | 4,720 | 3,630 | 5,950 | 4,530 | 13,200 | a 3,620 |
| 10 | | 2,680 | | a 9,880 | 5,110 | 3,630 | 5,730 | 4,530 | 11,400 | a 3,980 |
| 11 | | 2,530 | | 9,160 | 4,720 | 3,460 | 5,110 | 9,990 | 8,890 | 4,340 |
| 12 | | 2,680 | | 9,430 | 4,910 | 2,530 | 11,100 | 10,600 | 9,430 | 4,340 |
| 13 | | 2,250 | | 9,990 | 4,910 | 3,140 | 11,700 | 6,170 | 9,430 | 4,720 |
| 14 | | 3,630 | | 9,710 | 4,530 | 2,530 | 15,200 | 6,170 | 7,840 | 7,340 |
| 15 | | 5,110 | | 10,600 | 4,720 | 2,530 | 12,000 | 10,800 | 7,100 | 12,900 |
| 16 | | | | 10,800 | 4,530 | 2,390 | 10,800 | 6,860 | a 6,980 | 14,800 |
| 17 | | | | 10,600 | 4,340 | 4,340 | 10,800 | 7,340 | 6,860 | 19,400 |
| 18 | | | | a 10,400 | 3,980 | 4,340 | 10,300 | 6,400 | 7,100 | 19,800 |
| 19 | | | | 10,300 | 4,340 | 4,160 | 9,160 | 7,100 | 5,520 | 17,600 |
| 20 | | | | 9,990 | a 4,220 | 2,980 | 8,890 | 5,110 | 4,530 | 15,800 |
| 21 | | | | 9,160 | a 4,100 | 2,680 | 9,160 | 5,730 | 5,110 | 15,800 |
| 22 | | | 14,500 | 8,890 | 3,980 | 3,630 | 7,590 | 4,530 | 5,310 | 15,800 |
| 23 | | | a 18,300 | 9,430 | 3,980 | 4,160 | 7,100 | 4,530 | 4,720 | 15,800 |
| 24 | 1,980 | | 22,100 | 8,620 | 3,800 | 4,160 | 5,950 | 4,720 | 4,340 | 15,500 |
| 25 | 2,390 | | 23,200 | a 8,360 | 3,460 | 3,800 | 5,730 | 4,530 | 4,530 | 14,200 |
| 26 | 3,300 | | 21,300 | 8,100 | 3,140 | 7,340 | 5,110 | 4,340 | 4,530 | 13,800 |
| 27 | 2,390 | | 19,100 | 7,840 | 3,630 | 5,110 | 5,110 | 4,340 | 3,980 | 14,800 |
| 28 | 2,110 | | 18,300 | 7,340 | a 3,540 | 6,170 | 4,160 | 3,300 | 3,460 | 17,600 |
| 29 | 2,110 | | | 7,590 | 3,460 | a 7,660 | 4,720 | 5,950 | 2,680 | 18,300 |
| 30 | 2,110 | | | 7,100 | 3,140 | 9,160 | 3,800 | 9,990 | 2,830 | 18,300 |
| 31 | | | | 6,860 | | 12,000 | | 7,340 | 2,680 | |

a Interpolated.

NOTE.—Discharge determined from a rating curve well defined between 1,850 and 19,800 second-feet. Discharge estimated, because of ice, from gage heights, observer's notes, and climatic records, as follows: Dec. 16–31, 2,900 second-feet; Jan. 1–31, 2,900 second-feet; Feb. 1–10, 3,400 second-feet; Feb. 11–21, 9,800 second-feet.

*Monthly discharge of Rock River at Lyndon, Ill., for the year ending Sept. 30, 1915.*

[Drainage area, 9,010 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| November 24-30 | 3,300 | 1,980 | 2,340 | 0.260 | 0.07 | B. |
| December | ..... | 2,110 | 2,780 | .309 | .36 | C. |
| January | ..... | ..... | 2,900 | .322 | .37 | D. |
| February | 23,200 | ..... | 9,950 | 1.10 | 1.15 | D. |
| March | 16,600 | 6,860 | 10,700 | 1.19 | 1.37 | A. |
| April | 6,630 | 3,140 | 4,610 | .512 | .57 | A. |
| May | 12,000 | 2,250 | 4,190 | .465 | .54 | A. |
| June | 15,200 | 3,800 | 7,770 | .862 | .96 | A. |
| July | 10,800 | 2,530 | 5,600 | .622 | .72 | A. |
| August | 15,800 | 2,680 | 7,570 | .840 | .97 | A. |
| September | 19,800 | 2,530 | 10,400 | 1.15 | 1.28 | A. |

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, 9 miles above the Illinois State line, about a mile below the junction of the east and west branches of Pecatonica River. Skinner Creek enters from the left about a mile below the station.

DRAINAGE AREA.—959 square miles (measured on Wisconsin Geological and Natural History Survey map, edition of 1911; scale, 1 inch=6 miles).

RECORDS AVAILABLE.—February 9, 1914, to September 30, 1915.

GAGE.—Vertical staff fastened to downstream side of the left abutment; read twice daily, morning and evening, to quarter-tenths, by W. C. Shadewaldt.

DISCHARGE MEASUREMENTS.—At low and medium stages made from upstream side of highway bridge about 400 feet above the gage; at extremely high stages considerable water overflows to the left of this highway bridge and measurements are made from the railroad bridge to which the gage is attached.

CHANNEL AND CONTROL.—Channel, sand and mud; undoubtedly shifting; banks only medium high and overflow at flood stages. All the water passes beneath the railroad bridge to which the gage is fastened. There is little fall in the river below the gage, and no regular control.

EXTREMES OF DISCHARGE.—1914–1915: Maximum stage recorded, 14.6 feet a. m. and p. m., September 14, 1915 (discharge, approximately 6,590 second-feet), minimum discharge 286 second-feet, recorded by discharge measurement made January 7, 1915. An estimated mean discharge of 245 second-feet was made for period January 21 to 31.

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

REGULATION.—Operation of dams at Argyle, on the East Branch of Pecatonica River, and the Darlington dam, on the West Branch of Pecatonica River, cause little, if any, diurnal fluctuation at the gage.

ACCURACY.—Rating curve well defined over a range in stage covered by low and medium-stage gage heights; upper section of the curve poorly defined. Channel may be shifting; open-water records good at medium stages.

*Discharge measurements of Pecatonica River at Dill, Wis., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Nov. 28[a] | G. H. Canfield | 1.35 | 327 | Mar. 1 | W. G. Hoyt | 3.92 | 1,280 |
| Jan. 7[b] | W. G. Hoyt | 1.71 | 286 | Apr. 22 | do | 1.59 | 455 |
| Feb. 5[b] | do | 2.36 | 430 | 22 | do | 1.59 | 449 |
| 26 | H. C. Beckman | 12.25 | 5,240 | July 19 | M. F. Rather | 2.25 | 629 |

[a] Brush in section which may cause backwater.
[b] Made through complete ice cover.

*Daily discharge, in second-feet, of Pecatonica River at Dill, Wis., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 400 | 425 | | | | 1,320 | 556 | 400 | 772 | 476 | 556 | 400 |
| 2 | 400 | 425 | | | | 1,080 | 556 | 425 | 625 | 476 | 1,400 | 400 |
| 3 | 388 | 425 | | | | 1,000 | 556 | 556 | 625 | 463 | 1,680 | 400 |
| 4 | 376 | 425 | | | | 960 | 556 | 590 | 590 | 450 | 1,560 | 425 |
| 5 | 376 | 425 | | | | 920 | 528 | 502 | 590 | 450 | 1,320 | 425 |
| 6 | 376 | 412 | 325 | 290 | 475 | 772 | 556 | 450 | 556 | 476 | 920 | 425 |
| 7 | 376 | 400 | | | | 809 | 528 | 450 | 556 | 846 | 735 | 438 |
| 8 | 425 | 400 | | | | 772 | 528 | 450 | 528 | 1,320 | 625 | 502 |
| 9 | 425 | 400 | | | | 772 | 528 | 450 | 528 | 920 | 625 | 772 |
| 10 | 388 | 400 | | | | 735 | 528 | 438 | 556 | 590 | 625 | 846 |
| 11 | 376 | 400 | | | | 846 | 556 | 425 | 1,640 | 556 | 590 | 625 |
| 12 | 376 | 400 | | | | 1,040 | 528 | 400 | 1,640 | 515 | 542 | 556 |
| 13 | 425 | 400 | | | | 1,360 | 528 | 400 | 2,060 | 489 | 502 | 2,100 |
| 14 | 625 | 400 | | | | 1,240 | 528 | 400 | 1,760 | 515 | 502 | 6,590 |
| 15 | 625 | 425 | | | | 1,040 | 502 | 400 | 1,000 | 625 | 502 | 5,900 |
| 16 | 556 | 412 | 320 | 265 | 905 | 920 | 476 | 400 | 772 | 920 | 502 | 5,020 |
| 17 | 735 | 388 | | | | 846 | 476 | 400 | 698 | 625 | 476 | 4,180 |
| 18 | 698 | 364 | | | | 846 | 476 | 400 | 698 | 515 | 450 | 4,080 |
| 19 | 556 | 364 | | | | 809 | 476 | 400 | 735 | 625 | 450 | 3,230 |
| 20 | 528 | 364 | | | | 772 | 463 | 489 | 772 | 556 | 450 | 1,800 |
| 21 | 476 | | | | 2,980 | 735 | 463 | 625 | 698 | 625 | 425 | 1,240 |
| 22 | 463 | | | | 3,380 | 698 | 463 | 735 | 661 | 542 | 425 | 1,200 |
| 23 | 450 | | | | 3,880 | 698 | 450 | 528 | 625 | 528 | 425 | 1,000 |
| 24 | 450 | | | | 4,860 | 698 | 450 | 528 | 556 | 476 | 425 | 846 |
| 25 | 450 | | | | 5,460 | 698 | 438 | 625 | 556 | 515 | 425 | 772 |
| 26 | 438 | 335 | 300 | 245 | 5,240 | 661 | 425 | 1,040 | 528 | 489 | 412 | 3,480 |
| 27 | 438 | | | | 3,880 | 625 | 425 | 1,040 | 528 | 542 | 400 | 4,430 |
| 28 | 425 | | | | 2,060 | 625 | 425 | 698 | 502 | 528 | 400 | 4,280 |
| 29 | 412 | | | | ..... | 625 | 425 | 960 | 489 | 502 | 400 | 3,180 |
| 30 | 425 | | | | ..... | 556 | 400 | 1,240 | 476 | 489 | 400 | 2,060 |
| 31 | 425 | | | | ..... | 556 | ..... | 1,000 | ..... | 489 | 400 | ..... |

NOTE.—Discharge, except as noted below, determined from a rating curve well defined below and fairly well defined above 1,320 second-feet. Discharge Nov. 21 to Feb. 20, estimated because of ice, from discharge measurements, observer's notes, and weather records. Braced figures show mean discharge for period included.

*Monthly discharge of Pecatonica River at Dill, Wis., for the year ending Sept. 30, 1915.*

[Drainage area, 959 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 735 | 376 | 461 | 0.481 | 0.55 | A. |
| November | 425 | ..... | 380 | .396 | .44 | C. |
| December | ..... | ..... | 315 | .328 | .38 | D. |
| January | ..... | ..... | 266 | .277 | .32 | D. |
| February | 5,460 | ..... | 1,630 | 1.70 | 1.77 | D. |
| March | 1,360 | 556 | 840 | .876 | 1.01 | B. |
| April | 556 | 400 | 493 | .514 | .57 | A. |
| May | 1,240 | 400 | 576 | .601 | .69 | A. |
| June | 2,060 | 476 | 777 | .810 | .90 | A. |
| July | 1,320 | 450 | 585 | .610 | .70 | A. |
| August | 1,680 | 400 | 631 | .658 | .76 | A. |
| September | 6,590 | 400 | 2,050 | 2.14 | 2.39 | B. |
| The year | 6,590 | ..... | 741 | .773 | 10.48 | |

PECATONICA RIVER AT FREEPORT, ILL.

LOCATION.—In T. 27 N., R. 8 E., at highway bridge at Hancock Avenue, Freeport, Stephenson County; about half a mile east of the Illinois Central Railroad station, and about 2 miles above mouth of Yellow Creek.

DRAINAGE AREA.—1,330 square miles.

RECORDS AVAILABLE.—September 11, 1914, to September 30, 1915.

GAGE.—Chain gage attached to bridge; read daily, morning and afternoon, to quarter-tenths to March 3 and to hundredths after March 3, by William Stout and Mrs. M. H. Stout.

DISCHARGE MEASUREMENTS.—Made from upstream side of bridge.

CHANNEL AND CONTROL.—Bed of channel at gage consists of soft mud; character of control not known.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 17.2 feet at 5 p. m. February 16, and 7 a. m. February 28 (discharge, 7,780 second-feet); minimum stage recorded, 3.1 feet at 4.30 p. m. December 12 (discharge, 278 second-feet).

WINTER FLOW.—Discharge relation affected by ice during parts of December, January, and February. Warm water from a roundhouse above gage keeps river partly open at gage, but ice forms at points below.

REGULATION.—Operation of the powerhouse at a dam about a mile above the gage in the city of Freeport causes slight fluctuation at the gage.

ACCURACY.—Gage readings reliable; records good except during winter.

*Discharge measurements of Pecatonica River at Freeport, Ill., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Mar. 3 | William Kessler | 9.79 | 1,780 | Aug. 7 | J. B. Fountain | 8.45 | 1,430 |
| 3 | do | 9.64 | 1,690 | Sept. 22 | William Kessler | 11.44 | 2,310 |
| May 7 | do | 5.40 | 641 | 22 | do | 11.25 | 2,200 |
| 7 | do | 5.40 | 634 | 28 | G. J. Trinkaus | 15.79 | 5,690 |
| July 10 | do | 7.48 | 1,100 | 29 | do | 15.72 | 5,780 |
| 10 | do | 7.14 | 1,010 | | | | |

*Daily discharge, in second-feet, of Pecatonica River at Freeport, Ill., for the period Sept. 11, 1914, to Sept. 30, 1915.*

| Day. | Sept. | Oct. | Nov. | Dec. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 502 | 519 | 469 | ..... | 6,310 | 801 | 537 | 1,320 | 672 | 779 | 612 |
| 2 | ..... | 502 | 519 | 485 | ..... | 3,910 | 779 | 502 | 1,090 | 672 | 990 | 574 |
| 3 | ..... | 485 | 555 | 469 | ..... | 1,980 | 757 | 652 | 1,090 | 672 | 2,340 | 593 |
| 4 | ..... | 485 | 537 | 469 | ..... | 1,390 | 735 | 735 | 918 | 652 | 2,880 | 593 |
| 5 | ..... | 469 | 519 | 423 | ..... | 1,240 | 735 | 735 | 847 | 632 | 2,300 | 574 |
| 6 | ..... | 502 | 519 | 381 | ..... | 1,140 | 735 | 574 | 801 | 652 | 1,710 | 555 |
| 7 | ..... | 485 | 555 | 453 | ..... | 1,020 | 757 | 632 | 824 | 1,020 | 1,290 | 574 |
| 8 | ..... | 469 | 555 | 469 | ..... | 1,090 | 735 | 612 | 801 | 1,710 | 1,140 | 632 |
| 9 | ..... | 519 | 519 | 453 | ..... | 1,120 | 735 | 593 | 757 | 1,440 | 1,020 | 672 |
| 10 | ..... | 519 | 469 | 485 | ..... | 1,060 | 735 | 593 | 735 | 1,190 | 966 | 870 |
| 11 | 395 | 519 | 453 | 469 | ..... | 1,060 | 735 | 593 | 1,770 | 990 | 918 | 1,160 |
| 12 | 409 | 485 | 469 | 322 | ..... | 1,160 | 714 | 593 | 2,100 | 847 | 1,060 | 870 |
| 13 | 409 | 502 | 469 | 341 | ..... | 1,440 | 714 | 612 | 2,570 | 757 | 918 | 1,320 |
| 14 | 612 | 555 | 485 | 438 | ..... | 1,710 | 693 | 593 | 2,670 | 779 | 847 | 2,520 |
| 15 | 5,660 | 735 | 469 | 438 | ..... | 1,620 | 693 | 574 | 1,980 | 1,360 | 801 | 3,590 |
| 16 | 13,000 | 779 | 485 | 438 | 5,520 | 1,390 | 672 | 652 | 1,360 | 1,650 | 779 | 5,120 |
| 17 | 10,700 | 870 | 485 | 469 | 5,250 | 1,260 | 652 | 632 | 1,140 | 1,420 | 847 | 6,310 |
| 18 | 8,790 | 942 | 469 | 453 | 5,250 | 1,190 | 652 | 593 | 1,060 | 1,020 | 779 | 6,310 |
| 19 | 6,140 | 870 | 381 | 453 | 5,520 | 1,140 | 632 | 593 | 1,160 | 966 | 735 | 5,810 |
| 20 | 2,940 | 779 | 341 | 453 | 5,000 | 1,090 | 632 | 612 | 1,140 | 966 | 714 | 5,120 |
| 21 | 1,140 | 672 | 409 | 409 | 4,360 | 1,040 | 632 | 672 | 1,040 | 990 | 693 | 4,000 |
| 22 | 847 | 593 | 453 | 453 | 4,270 | 1,020 | 593 | 672 | 942 | 942 | 672 | 2,470 |
| 23 | 714 | 593 | 453 | 485 | 4,360 | 990 | 574 | 847 | 870 | 847 | 672 | 1,560 |
| 24 | 652 | 574 | 438 | 469 | 4,880 | 966 | 593 | 757 | 801 | 801 | 672 | 1,240 |
| 25 | 632 | 593 | 438 | 453 | 5,520 | 990 | 574 | 942 | 801 | 735 | 652 | 1,140 |
| 26 | 593 | 574 | 485 | ..... | 6,310 | 942 | 574 | 1,160 | 757 | 757 | 632 | 2,380 |
| 27 | 555 | 574 | 502 | ..... | 8,010 | 894 | 555 | 1,240 | 735 | 801 | 632 | 5,000 |
| 28 | 519 | 537 | 469 | ..... | 8,520 | 894 | 555 | 1,140 | 714 | 1,020 | 612 | 5,810 |
| 29 | 519 | 537 | 453 | ..... | ..... | 870 | 555 | 1,440 | 693 | 1,020 | 612 | 5,660 |
| 30 | 519 | 519 | 453 | ..... | ..... | 824 | 519 | 2,100 | 672 | 918 | 612 | 5,380 |
| 31 | ..... | 537 | ..... | ..... | ..... | 824 | ..... | 1,650 | ..... | 942 | 612 | ..... |

NOTE.—Discharge determined from rating curve well defined between 395 and 8,000 second-feet and fairly well defined above 8,000 second-feet. Discharge estimated, because of ice, from gage heights, observer's notes, and climatic records, as follows: Dec. 26-31, 440 second-feet; Jan. 1-31, 450 second-feet; Feb. 1-5, 450 second-feet; and Feb. 6-15, 1,800 second-feet. Estimates for the period when the discharge relation was believed to have been affected by ice are based on insufficient data and should be used with caution.

*Monthly discharge of Pecatonica River at Freeport, Ill., for the period Sept. 11, 1914, to Sept. 30, 1915.*

[Drainage area, 1,330 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| 1914. | | | | | | |
| September 11–30 | 13,000 | 395 | 2,790 | 2.10 | 1.56 | A. |
| 1914–15. | | | | | | |
| October | 942 | 469 | 590 | .444 | .51 | A. |
| November | 555 | 341 | 477 | .359 | .40 | A. |
| December | ..... | 322 | 443 | .333 | .38 | B. |
| January | ..... | ..... | 450 | .338 | .39 | D. |
| February | 8,520 | ..... | 3,320 | 2.50 | 2.60 | D. |
| March | 6,310 | 824 | 1,410 | 1.06 | 1.22 | B. |
| April | 801 | 519 | 667 | .502 | .56 | A. |
| May | 2,100 | 502 | 801 | .602 | .69 | A. |
| June | 2,670 | 672 | 1,140 | .857 | .96 | A. |
| July | 1,710 | 632 | 963 | .724 | .83 | A. |
| August | 2,880 | 612 | 996 | .749 | .86 | A. |
| September | 6,310 | 555 | 2,630 | 1.98 | 2.21 | B. |
| The year | 8,520 | 322 | 1,140 | .857 | 11.61 | |

SUGAR RIVER NEAR BRODHEAD, WIS.

LOCATION.—In sec. 26, T. 2 N., R. 9 E., Green County, at highway bridge 2 miles southwest of the village of Brodhead, about 12 miles above the Illinois State line. Jordan Creek enters from the right about 2 miles below, and Little Jordan Creek, also from the right, about 4 miles above the station.

DRAINAGE AREA.—529 square miles (measured on Wisconsin Geological and Natural History Survey map, edition of 1911; scale, 1 inch=6 miles).

RECORDS AVAILABLE.—February 7, 1914, to September 30, 1915.

GAGE.—Chain gage attached to downstream side of bridge; read daily, morning and evening, to quarter-tenths by Arthur Christensen.

DISCHARGE MEASUREMENTS.—Made from upstream side of bridge at medium and high stages; at low stages by wading.

CHANNEL AND CONTROL.—Sand and gravel with no well-defined control; right bank of medium height; rarely overflows; left bank at the gage and above overflows at stage of approximately 7 feet on the gage.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 11.25 feet at 6 p. m. September 13 (discharge, approximately 12,500 second-feet); levels run to the high-water marks made during the night of September 13 showed a maximum stage of 11.4 feet (discharge approximately 13,000 second-feet); minimum stage recorded, 0.78 foot November 29, 1915; discharge, approximately 108 second-feet.

1914–1915: Maximum stage recorded, 11.4 feet, September 13, 1915; discharge, approximately 13,000 second-feet; minimum stage recorded, 0.4 foot at 10 a. m. Sunday, August 30, 1914 (water was undoubtedly being held at the dam); discharge determined from extension of the rating curve, approximately 74 second-feet.

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

REGULATION.—At extremely low stages there may be some diurnal fluctuation caused by the operation of power plants above the gage, especially the plant at Brodhead.

ACCURACY.—Channel shifting; rating curves only fairly well defined; at exceptionally low stages some diurnal fluctuation; records fair.

*Discharge measurements of Sugar River near Brodhead, Wis., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Jan. 6[a] | W. G. Hoyt | 2 10 | 127 | Apr. 21 | W. G. Hoyt | 1.54 | 274 |
| Feb. 4[a] | do | 2.37 | 134 | 21 | do | 1.59 | 280 |
| 24 | H. C. Beckman | 6.82 | 3,140 | July 21 | M. F. Rather | 1.82 | 376 |
| 25 | do | 6.45 | 2,500 | Sept. 16 | H. C. Beckman | 5.91 | 2,200 |

[a] Made under complete ice cover.

*Daily discharge, in second-feet, of Sugar River near Brodhead, Wis., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 250 | 250 | 176 | | | 690 | 338 | 244 | 426 | 283 | 296 | 283 |
| 2 | 250 | 188 | 278 | | | 653 | 324 | 220 | 352 | 270 | 580 | 296 |
| 3 | 292 | 224 | 237 | | | 616 | 324 | 283 | 324 | 283 | 1,590 | 283 |
| 4 | 166 | 250 | 224 | | | 527 | 270 | 296 | 310 | 257 | 1,920 | 270 |
| 5 | 250 | 237 | 224 | | | 410 | 338 | 310 | 283 | 270 | 1,810 | 220 |
| | | | | 150 | 230 | | | | | | | |
| 6 | 224 | 250 | 188 | | | 380 | 338 | 296 | 270 | 270 | 1,290 | 310 |
| 7 | 250 | 278 | 224 | | | 324 | 338 | 296 | 283 | 352 | 887 | 310 |
| 8 | 224 | 166 | 250 | | | 459 | 338 | 283 | 283 | 510 | 580 | 310 |
| 9 | 224 | 250 | 278 | | | 410 | 324 | 244 | 296 | 476 | 476 | 510 |
| 10 | 292 | 199 | 278 | | | 410 | 310 | 270 | 296 | 410 | 410 | 728 |
| 11 | 224 | 224 | 292 | | | 380 | 296 | 257 | 846 | 310 | 410 | 634 |
| 12 | 250 | 224 | 278 | | | 442 | 352 | 257 | 616 | 324 | 366 | 527 |
| 13 | 278 | 337 | 224 | | | 544 | 296 | 257 | 846 | 352 | 366 | 4,990 |
| 14 | 292 | 224 | | | | 846 | 296 | 244 | 766 | 296 | 366 | 8,600 |
| 15 | 307 | 224 | | | | 887 | 310 | 244 | 580 | 527 | 352 | 3,450 |
| | | | | 195 | 775 | | | | | | | |
| 16 | 384 | 224 | | | | 846 | 296 | 220 | 442 | 380 | 366 | 2,260 |
| 17 | 467 | 237 | 205 | | | 616 | 296 | 270 | 380 | 296 | 352 | 1,830 |
| 18 | 520 | 224 | | | | 510 | 244 | 257 | 380 | 270 | 380 | 2,550 |
| 19 | 538 | 156 | | | | 527 | 283 | 283 | 410 | 324 | 380 | 1,710 |
| 20 | 416 | | | | | 510 | 283 | 270 | 442 | 352 | 324 | 1,200 |
| 21 | 322 | 160 | | | 1,100 | 442 | 283 | 310 | 410 | 352 | 324 | 878 |
| 22 | 307 | | | | 1,240 | 459 | 270 | 410 | 352 | 366 | 310 | 668 |
| 23 | 307 | | | | 1,810 | 459 | 296 | 310 | 338 | 352 | 324 | 626 |
| 24 | 264 | | | | 2,970 | 442 | 283 | 380 | 296 | 324 | 310 | 544 |
| 25 | 278 | 212 | | | 2,630 | 442 | 220 | 690 | 283 | 270 | 310 | 469 |
| 26 | 250 | 224 | 155 | 230 | 1,860 | 442 | 283 | 616 | 283 | 296 | 296 | 2,010 |
| 27 | 237 | 212 | | | 1,390 | 410 | 270 | 653 | 244 | 338 | 296 | 2,790 |
| 28 | 250 | 199 | | | 887 | 366 | 244 | 616 | 270 | 324 | 283 | 1,770 |
| 29 | 224 | 108 | | | ..... | 366 | 244 | 544 | 262 | 338 | 270 | 1,350 |
| 30 | 250 | 250 | | | ..... | 352 | 257 | 527 | 310 | 324 | 296 | 965 |
| 31 | 278 | ..... | | | ..... | 338 | ..... | 544 | ..... | 310 | 296 | ..... |

NOTE.—Discharge determined as follows: Oct. 1 to Nov. 19 and Nov. 25 to Dec. 13 from a rating curve well defined between 199 and 4,580 second-feet; Feb. 21 to Sept. 15 from a rating curve fairly well defined between 244 and 4,500 second-feet; Sept. 16–30 from a rating curve fairly well defined between 335 and 2,260 second-feet; Nov. 20–24, and Dec. 14 to Feb. 20 estimated because of ice from discharge measurements, observer's notes, and weather records. Braced figures show mean discharge for period included.

*Monthly discharge of Sugar River near Brodhead, Wis., for the year ending Sept. 30, 1915.*

[Drainage area, 529 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 538 | 166 | 292 | 0.552 | 0.64 | A. |
| November | 337 | 108 | 212 | .401 | .45 | C. |
| December | 292 | ..... | 203 | .384 | .44 | C. |
| January | ..... | ..... | 193 | .365 | .42 | C. |
| February | 2,970 | ..... | 855 | 1.62 | 1.69 | C. |
| March | 887 | 324 | 500 | .945 | 1.09 | B. |
| April | 352 | 220 | 295 | .558 | .62 | B. |
| May | 690 | 220 | 352 | .665 | .77 | B. |
| June | 846 | 244 | 396 | .749 | .84 | B. |
| July | 527 | 257 | 336 | .635 | .73 | B. |
| August | 1,920 | 270 | 542 | 1.02 | 1.18 | B. |
| September | 8,600 | 220 | 1,440 | 2.72 | 3.04 | B. |
| The year | 8,600 | 108 | 464 | .877 | 11.91 | |

### IOWA RIVER AT MARSHALLTOWN, IOWA.

LOCATION.—At the Third Avenue highway bridge, 1 mile south of Marshalltown, Marshall County, and about a mile below site of old gaging station.

DRAINAGE AREA.—1,380 square miles, revised by measurement on United States Geological Survey map of scale 1 to 500,000.

RECORDS AVAILABLE.—May 21 to September 30, 1915; February 23, 1903, to August 8, 1903, at old location 1 mile above present station.

GAGE.—Chain gage attached to downstream handrail of bridge, 60 feet from right pier; read once daily 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 will not overflow; left bank will overflow at a stage between 13 and 14 feet.

EXTREMES OF DISCHARGE.—Maximum stage recorded during part of year, 13.6 feet, June 1 (discharge, 8,420 second-feet); minimum stage recorded, 3.2 feet, September 4 to 7 (discharge, 455 second-feet).

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

ACCURACY.—Results fairly good.

*Discharge measurements of Iowa River at Marshalltown, Iowa, during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* |
| May 22 | C. Herlofson | 5.12 | 1,010 |
| 29 | do | 13.21 | 7,850 |
| June 6 | A. Davis | 9.62 | 3,620 |

*Daily discharge, in second-feet, of Iowa River at Marshalltown, Iowa, for the year ending Sept. 30, 1915.*

| Day. | May. | June. | July. | Aug. | Sept. | Day. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 8,420 | 1,860 | 1,080 | 503 | 16 | | 1,280 | 975 | 840 | 579 |
| 2 | | 6,500 | 1,440 | 1,530 | 479 | 17 | | 1,440 | 1,160 | 873 | 632 |
| 3 | | 5,860 | 1,240 | 1,320 | 479 | 18 | | 2,080 | 1,360 | 906 | 906 |
| 4 | | 5,140 | 1,080 | 1,320 | 455 | 19 | | 2,260 | 2,200 | 840 | 1,200 |
| 5 | | 5,380 | 1,010 | 1,400 | 455 | 20 | | 1,580 | 2,260 | 777 | 3,980 |
| 6 | | 3,790 | 1,010 | 1,530 | 455 | 21 | 808 | 1,530 | 2,200 | 873 | 6,500 |
| 7 | | 3,020 | 1,320 | 2,140 | 455 | 22 | 1,010 | 1,440 | 1,980 | 840 | 840 |
| 8 | | 2,460 | 2,460 | 1,980 | 479 | 23 | 1,080 | 1,360 | 1,660 | 808 | 1,120 |
| 9 | | 2,080 | 1,620 | 1,660 | 479 | 24 | 1,240 | 1,280 | 1,580 | 717 | 940 |
| 10 | | 1,860 | 1,400 | 1,400 | 553 | 25 | 1,530 | 1,920 | 1,240 | 660 | 873 |
| 11 | | 1,760 | 1,280 | 1,160 | 1,010 | 26 | 3,880 | 2,080 | 1,160 | 632 | 4,600 |
| 12 | | 1,580 | 1,160 | 1,010 | 688 | 27 | 7,560 | 1,920 | 1,080 | 579 | 6,360 |
| 13 | | 1,480 | 1,040 | 906 | 579 | 28 | 7,300 | 2,950 | 1,720 | 553 | 7,700 |
| 14 | | 1,400 | 940 | 873 | 553 | 29 | 7,560 | 3,020 | 1,920 | 503 | 6,110 |
| 15 | | 1,280 | 906 | 873 | 553 | 30 | 8,120 | 2,520 | 1,280 | 528 | 4,810 |
| | | | | | | 31 | 7,840 | | 1,120 | 528 | |

NOTE.—Discharge computed from a rating curve fairly well defined between 700 and 9,000 second-feet.

*Monthly discharge of Iowa River at Marshalltown, Iowa, for the year ending Sept. 30, 1915.*

[Drainage area, 1,380 square miles.] [a]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| May 21-31 | 8,120 | 808 | 4,360 | 3.16 | 1.29 | A. |
| June | 8,420 | 1,280 | 2,690 | 1.95 | 2.18 | A. |
| July | 2,460 | 906 | 1,440 | 1.04 | 1.20 | B. |
| August | 2,140 | 503 | 1,020 | .739 | .85 | B. |
| September | 7,700 | 455 | 1,840 | 1.33 | 1.48 | B. |

[a] This drainage area supersedes that published in previous reports.

IOWA RIVER AT IOWA CITY, IOWA.

LOCATION.—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 the dam.

DRAINAGE AREA.—3,140 square miles (revised by measurement on United States Geological Survey map of scale, 1 to 500,000).

RECORDS AVAILABLE.—October 30, 1913, to September 30, 1915, 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 once daily 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 of stream sandy and subject to change; right bank is high and will not overflow; left bank will overflow 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 discharge during year, approximately 20,000 second-feet, February 18, 24, and 25. Minimum stage recorded: 1.2 feet November 19; (discharge, 492 second-feet); maximum stage recorded prior to 1915, about 15 feet (old gage) night of June 2–3, 1903 (discharge, approximately 20,000 second; feet); minimum stage recorded, −1.7 feet (old gage) several days in November and December, 1904 (discharge, 160 second-feet).

WINTER FLOW.—Discharge relation affected by ice; discharge determined from head on the crest of the dam.

REGULATION.—Slight diurnal fluctuation due to operation of power plant above station.

ACCURACY.—Results fair.

*Discharge measurements of Iowa River at Iowa City, Iowa, during 1914–1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| 1914. | | *Feet.* | *Sec.-ft.* | 1915. | | *Feet.* | *Sec.-ft.* |
| May 23 | Hutchins and Urick | 1.42 | 532 | Mar. 20 | ..... | ..... | 4,630 |
| Oct. 24 | Hutchins and Holt | 3.74 | 1,920 | Apr. 23 | R. E. Hutchins | 3.10 | 1,390 |
| | | | | 23 | Dunlap and Repass | 3.10 | 1,460 |
| 1915. | | | | May 10 | Hutchins and Repass | ..... | 1,640 |
| Feb. 22 | ..... | ..... | 15,200 | Jnue 2 | C. Herlofson | 9.45 | 7,600 |
| 27 | ..... | ..... | 17,500 | | | | |

NOTE.—Measurements May 23, 1914, to May 10, 1915, made by Engineering Department, University of Iowa.

*Daily discharge, in second-feet, of Iowa River at Iowa City, Iowa, for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1,300 | 1,130 | 560 | 350 | 400 | 9,340 | 5,580 | 1,130 | 5,920 | 2,690 | 8,320 | 915 |
| 2 | 1,450 | 1,130 | 800 | 350 | 400 | 7,950 | 5,580 | 1,300 | 7,100 | 2,780 | 9,210 | 815 |
| 3 | 1,610 | 1,130 | 700 | 350 | 400 | 6,740 | 5,350 | 1,370 | 8,820 | 2,690 | 8,580 | 815 |
| 4 | 1,760 | 1,080 | 700 | 350 | 400 | 5,820 | 5,460 | 1,440 | 9,340 | 2,860 | 6,740 | 770 |
| 5 | 1,910 | 1,020 | 660 | 350 | 400 | 4,910 | 3,860 | 1,080 | 9,340 | 2,780 | 4,910 | 725 |
| 6 | 2,070 | 965 | 440 | 350 | 400 | 3,860 | 3,660 | 1,240 | 8,950 | 2,610 | 5,130 | 725 |
| 7 | 2,220 | 915 | 660 | 350 | 400 | 3,200 | 3,140 | 1,560 | 8,320 | 2,290 | 5,240 | 1,130 |
| 8 | 2,380 | 815 | 600 | 350 | 400 | 2,690 | 2,610 | 1,640 | 7,820 | 2,060 | 4,060 | 1,130 |
| 9 | 2,540 | 770 | 600 | 350 | 400 | 2,690 | 2,490 | 1,500 | 7,340 | 2,140 | 4,260 | 2,450 |
| 10 | 2,690 | 815 | 560 | 350 | 600 | 2,530 | 2,370 | 1,560 | 6,740 | 2,220 | 3,200 | 1,500 |
| 11 | 3,120 | 815 | 440 | 400 | 800 | 2,370 | 2,290 | 1,560 | 6,980 | 4,580 | 2,940 | 2,370 |
| 12 | 3,570 | 815 | 400 | 500 | 1,000 | 2,060 | 2,290 | 1,440 | 5,240 | 4,480 | 3,380 | 2,450 |
| 13 | 3,860 | 725 | 320 | 400 | 1,500 | 1,990 | 2,370 | 1,370 | 5,460 | 4,260 | 3,030 | 2,610 |
| 14 | 3,660 | 635 | 600 | 300 | 4,000 | 1,840 | 2,290 | 1,300 | 3,960 | 3,760 | 2,940 | 2,690 |
| 15 | 3,380 | 595 | 440 | 400 | 6,000 | 1,990 | 2,370 | 1,440 | 3,200 | 3,860 | 2,140 | 3,480 |
| 16 | 2,690 | 595 | 360 | 1,000 | 10,000 | 2,140 | 2,290 | 1,370 | 2,780 | 3,570 | 1,640 | 3,660 |
| 17 | 2,450 | 555 | 440 | 2,200 | 15,000 | 2,530 | 2,220 | 1,130 | 2,530 | 3,570 | 1,500 | 3,030 |
| 18 | 2,450 | 515 | 480 | 1,400 | 20,000 | 2,780 | 2,220 | 1,080 | 2,370 | 3,120 | 1,300 | 2,530 |
| 19 | 2,450 | 475 | 400 | 1,400 | 15,000 | 3,080 | 2,140 | 1,370 | 3,380 | 3,030 | 1,130 | 2,530 |
| 20 | 2,530 | 515 | 300 | 1,400 | 12,000 | 3,380 | 1,840 | 1,640 | 3,480 | 3,030 | 1,370 | 2,450 |
| 21 | 2,450 | 515 | 520 | 1,800 | 12,000 | 3,660 | 1,560 | 1,640 | 3,480 | 2,860 | 1,500 | 2,450 |
| 22 | 2,450 | 475 | 400 | 1,400 | 15,200 | 3,660 | 1,560 | 1,500 | 3,660 | 2,780 | 1,370 | 2,450 |
| 23 | 2,290 | 595 | 380 | 1,000 | 18,000 | 3,760 | 1,560 | 1,560 | 3,380 | 2,780 | 1,440 | 3,200 |
| 24 | 2,290 | 635 | 520 | 600 | 20,000 | 3,860 | 1,500 | 1,640 | 3,300 | 3,030 | 1,370 | 3,660 |
| 25 | 1,640 | 680 | 400 | 500 | 20,000 | 4,160 | 1,500 | 2,690 | 2,860 | 3,660 | 1,300 | 3,860 |
| 26 | 1,560 | 635 | 360 | 500 | 19,000 | 4,480 | 1,300 | 4,160 | 2,780 | 4,260 | 1,300 | 8,700 |
| 27 | 1,500 | 680 | 320 | 500 | 17,500 | 4,320 | 1,180 | 4,160 | 2,690 | 5,460 | 1,240 | 10,800 |
| 28 | 1,370 | 635 | 350 | 500 | 12,000 | 4,160 | 1,130 | 4,480 | 2,530 | 8,700 | 1,130 | 9,990 |
| 29 | 1,300 | 635 | 350 | 400 | ..... | 4,690 | 1,130 | 6,620 | 2,610 | 8,580 | 1,080 | 10,200 |
| 30 | 1,300 | 680 | 350 | 400 | ..... | 4,690 | 1,080 | 6,160 | 2,610 | 6,270 | 1,080 | 11,500 |
| 31 | 1,240 | ..... | 350 | 400 | ..... | 5,140 | ..... | 5,810 | ..... | 5,580 | 1,020 | ..... |

NOTE.—Discharge computed from a rating curve well defined between 400 and 12,000 second-feet. Discharge Oct. 2–9, Mar. 4, 15, 19, 27, and 31, Apr. 7 and 9, interpolated. Discharge Dec. 1–27 and Jan. 1–25 estimated by Prof. R. E. Hutchins from discharge relation curves for the State university power plant. Discharge relation curves for the plant, affected by backwater from ice below the dam Dec. 28–31 and Jan. 26 to Feb. 15, and discharge estimated from consideration of probable flow at Cedar Rapids and records of temperature. Discharge Feb. 16–28 estimated from three discharge measurements and flow at Cedar Rapids.

*Monthly discharge of Iowa River at Iowa City, Iowa, for the year ending Sept. 30, 1915.*

[Drainage area, 3,140 square miles.[a]]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 3,860 | ..... | 2,240 | 0.713 | 0.82 | B. |
| November | 1,130 | 475 | 739 | .235 | .26 | B. |
| December | 800 | 300 | 476 | .152 | .18 | C. |
| January | 2,200 | 300 | 674 | .215 | .25 | C. |
| February | 20,000 | 400 | 7,970 | 2.54 | 2.64 | C. |
| March | 9,340 | 1,840 | 3,890 | 1.24 | 1.43 | A. |
| April | 5,580 | 1,080 | 2,530 | .807 | .90 | A. |
| May | 6,620 | 1,080 | 2,190 | .697 | .80 | A. |
| June | 9,340 | 2,370 | 4,970 | 1.58 | 1.76 | A. |
| July | 8,700 | 2,060 | 3,750 | 1.19 | 1.37 | A. |
| August | 9,210 | 1,020 | 3,060 | .975 | 1.12 | A. |
| September | 11,500 | 725 | 3,520 | 1.12 | 1.25 | A. |
| The year | 20,000 | 300 | 2,960 | .943 | 12.78 | |

[a] Supersedes that published in previous reports.

## IOWA RIVER AT WAPELLO, IOWA.

LOCATION.—At highway bridge, about one-half mile from railroad station, at Wapello, Louisa County, and about 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 United States Geological Survey map of scale 1 to 500,000).

RECORDS AVAILABLE.—February 26 to September 30, 1915.

GAGE.—Chain gage attached to vertical near center of first span from right abutment; read once daily by C. W. Warren.

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

CHANNEL AND CONTROL.—Bed of stream sand and gravel and subject to shift, right bank high and will not overflow; it is possible that levee along left bank might break or be overtopped at extremely high stages.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year: 11.5 feet, February 26 and 27 (discharge, 41,800 second-feet); minimum stage recorded, 1.70 feet, September 6 to 8 (discharge, 3,120 second-feet); maximum known stage prior to 1915, approximately 14.3 feet about April 3, 1912 (discharge, approximately 58,000 second-feet). The flood of June, 1892, was much higher.

WINTER FLOW.—Discharge relation seriously affected by ice.

ACCURACY.—Results considered good.

*Discharge measurements of Iowa River at Wapello, Iowa, during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* |
| Feb. 26 | Bolster and Egbert | 11.36 | 41,000 |
| Aug. 7 | C. Herlofson | 6.40 | 17,100 |

*Daily discharge, in second-feet, of Iowa River at Wapello, Iowa, for the year ending Sept. 30, 1915.*

| Day. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 35,800 | 33,700 | 4,990 | 25,300 | 9,290 | 22,100 | 3,700 |
| 2 | ..... | 30,100 | 28,600 | 4,990 | 25,300 | 8,990 | 20,400 | 3,700 |
| 3 | ..... | 24,400 | 23,900 | 5,460 | 25,800 | 9,290 | 20,400 | 3,500 |
| 4 | ..... | 24,400 | 21,300 | 5,950 | 30,600 | 8,990 | 20,400 | 3,500 |
| 5 | ..... | 17,900 | 18,300 | 5,700 | 36,300 | 7,540 | 18,700 | 3,310 |
| 6 | ..... | 15,500 | 15,900 | 5,220 | 36,300 | 7,260 | 17,100 | 3,120 |
| 7 | ..... | 13,200 | 14,400 | 6,200 | 33,700 | 7,540 | 17,100 | 3,120 |
| 8 | ..... | 12,200 | 13,200 | 7,260 | 28,600 | 7,540 | 17,500 | 3,120 |
| 9 | ..... | 11,200 | 12,500 | 7,820 | 23,000 | 7,260 | 15,500 | 10,800 |
| 10 | ..... | 10,200 | 12,200 | 7,540 | 20,000 | 7,540 | 14,000 | 10,500 |
| 11 | ..... | 9,590 | 12,200 | 7,260 | 18,300 | 10,200 | 12,500 | 16,300 |
| 12 | ..... | 8,690 | 11,800 | 6,990 | 17,500 | 14,000 | 11,800 | 15,500 |
| 13 | ..... | 8,400 | 11,500 | 6,460 | 16,300 | 12,200 | 10,800 | 11,200 |
| 14 | ..... | 8,110 | 11,800 | 6,200 | 15,900 | 11,500 | 9,290 | 10,200 |
| 15 | ..... | 8,110 | 11,800 | 6,720 | 13,200 | 11,800 | 8,400 | 9,900 |
| 16 | ..... | 8,110 | 11,500 | 5,700 | 12,200 | 10,800 | 7,540 | 9,590 |
| 17 | ..... | 8,690 | 10,800 | 4,990 | 11,200 | 10,500 | 6,720 | 9,590 |
| 18 | ..... | 9,290 | 9,900 | 4,760 | 10,800 | 9,290 | 6,460 | 9,900 |
| 19 | ..... | 10,200 | 9,290 | 4,760 | 11,800 | 9,900 | 6,200 | 8,990 |
| 20 | ..... | 10,800 | 8,690 | 4,990 | 11,800 | 10,500 | 6,200 | 8,110 |
| 21 | ..... | 12,200 | 8,110 | 5,700 | 11,800 | 10,200 | 6,460 | 6,990 |
| 22 | ..... | 12,900 | 7,540 | 5,700 | 11,800 | 9,900 | 6,200 | 6,720 |
| 23 | ..... | 14,000 | 7,260 | 5,950 | 12,200 | 9,900 | 5,950 | 8,400 |
| 24 | ..... | 15,500 | 6,460 | 5,460 | 12,200 | 11,200 | 5,700 | 9,290 |
| 25 | ..... | 17,100 | 6,200 | 6,720 | 11,500 | 12,500 | 5,220 | 9,590 |
| 26 | 41,800 | 18,300 | 5,950 | 14,000 | 11,200 | 14,400 | 4,990 | 13,600 |
| 27 | 41,800 | 18,300 | 5,460 | 14,400 | 10,200 | 15,500 | 4,760 | 17,900 |
| 28 | 41,300 | 19,000 | 5,460 | 16,300 | 9,290 | 16,300 | 4,540 | 24,800 |
| 29 | ..... | 19,600 | 5,220 | 19,100 | 9,590 | 17,500 | 4,320 | 29,600 |
| 30 | ..... | 24,800 | 4,990 | 21,300 | 9,290 | 21,700 | 4,110 | 33,200 |
| 31 | ..... | 33,200 | ..... | 23,900 | ..... | 22,600 | 3,900 | ..... |

NOTE.—Daily discharge computed from a rating curve well defined between 3,000 and 60,000 second-feet. Discharge Mar. 28 interpolated.

*Monthly discharge of Iowa River at Wapello, Iowa, for the year ending Sept. 30, 1915.*

[Drainage area, 12,480 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| March | 35,800 | 8,110 | 15,800 | 1.27 | 1.46 | A. |
| April | 33,700 | 4,990 | 12,200 | .978 | 1.09 | A. |
| May | 23,900 | 4,760 | 8,340 | .668 | .77 | B. |
| June | 36,300 | 9,290 | 17,800 | 1.43 | 1.60 | A. |
| July | 22,600 | 7,260 | 11,400 | .913 | 1.05 | A. |
| August | 22,100 | 3,900 | 10,500 | .841 | .97 | B. |
| September | 33,200 | 3,120 | 10,600 | .849 | .95 | B. |

## CEDAR RIVER[1] AT JANESVILLE, IOWA.

LOCATION.—At the Illinois Central Railroad bridge about one-fourth mile below the highway bridge and about 3 miles above junction with Shellrock River.

DRAINAGE AREA.—1,660 square miles (revised by measurement on United States Geological Survey map of scale 1 to 500,000).

RECORDS AVAILABLE.—April 26, 1905, to September 30, 1906, and May 28 to September 30, 1915.

GAGE.—Chain gage attached to upstream guard rail of bridge about the middle of left span; read once daily by James Townsend.

DISCHARGE MEASUREMENTS.—Made from upstream side of railroad bridge.

CHANNEL AND CONTROL.—Bed of stream, gravel; fairly permanent; both banks high and not subject to overflow.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 8.8 feet at 7 a. m. May 31 (discharge, 6,890 second-feet); minimum stage recorded, 1.39 feet September 12 (discharge, 329 second-feet).

1905–1906: Maximum stage recorded 13.3 feet March 28, 1906 (discharge, about 22,600 second-feet); minimum stage recorded, 0.90 foot at various times in 1905 (discharge, 330 second-feet).

WINTER FLOW.—Discharge relation seriously affected by ice.

REGULATION.—May be slight diurnal fluctuation of water level due to operation of power plant at Waverly, about 9 miles above station.

ACCURACY.—Results considered excellent.

*Discharge measurements of Cedar River at Janesville, Iowa, during the year ending Sept. 30, 1915.*

[Made by C. Herlofson.]

| Date. | Gage height. | Discharge. |
|---|---|---|
| | *Feet.* | *Sec.-ft.* |
| May 23 | 2.03 | 721 |
| June 1 | 8.29 | 6,260 |
| Sept. 11 | 1.52 | 399 |

[1] Called Red Cedar River in Water-Supply Papers 171 and 207.

*Daily discharge, in second-feet, of Cedar River at Janesville, Iowa, for the year ending Sept. 30, 1915.*

| Day. | May. | June. | July. | Aug. | Sept. | Day. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 6,530 | 1,300 | 1,160 | 458 | 16 | | 1,300 | 2,020 | 905 | 1,040 |
| 2 | | 5,050 | 1,100 | 2,020 | 458 | 17 | | 1,230 | 2,180 | 1,580 | 905 |
| 3 | | 3,630 | 775 | 1,950 | 396 | 18 | | 1,580 | 1,440 | 905 | 742 |
| 4 | | 2,340 | 840 | 1,650 | 396 | 19 | | 1,720 | 2,580 | 1,040 | 614 |
| 5 | | 2,180 | 905 | 3,000 | 427 | 20 | | 1,720 | 3,260 | 1,230 | 1,000 |
| 6 | | 1,720 | 710 | 2,580 | 427 | 21 | | 2,580 | 5,050 | 1,100 | 938 |
| 7 | | 1,650 | 1,100 | 2,260 | 372 | 22 | | 2,660 | 3,720 | 840 | 646 |
| 8 | | 1,580 | 1,510 | 1,720 | 427 | 23 | | 1,950 | 2,500 | 775 | 646 |
| 9 | | 1,880 | 2,420 | 1,300 | 396 | 24 | | 1,650 | 2,180 | 710 | 552 |
| 10 | | 1,800 | 3,260 | 1,100 | 366 | 25 | | 1,650 | 1,950 | 646 | 500 |
| 11 | | 1,650 | 3,920 | 1,040 | 427 | 26 | 2,020 | 1,440 | 1,440 | 646 | 1,510 |
| 12 | | 1,510 | 2,420 | 970 | 329 | 27 | 2,260 | 905 | 1,300 | 583 | 1,200 |
| 13 | | 1,810 | 1,720 | 840 | 583 | 28 | 4,410 | 1,800 | 1,230 | 520 | 938 |
| 14 | | 1,720 | 1,650 | 775 | 489 | 29 | 4,830 | 1,650 | 1,040 | 520 | 710 |
| 15 | | 1,510 | 1,440 | 775 | 872 | 30 | 5,950 | 1,580 | 1,720 | 458 | 614 |
| | | | | | | 31 | 6,890 | | 1,440 | 520 | |

NOTE.—Discharge computed from a rating curve well defined between 300 and 8,000 second-feet. Discharge September 25, estimated from discharge of Shellrock River near Clarksville.

*Monthly discharge of Cedar River at Janesville, Iowa, for the year ending Sept. 30, 1915.*

[Drainage area, 1,660 square miles.][1]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| May 26–31 | 6,890 | 2,020 | 4,390 | 2.64 | 0.59 | A. |
| June | 6,530 | 905 | 2,070 | 1.25 | 1.40 | A. |
| July | 5,050 | 710 | 1,940 | 1.17 | 1.35 | A. |
| August | 3,000 | 458 | 1,170 | .705 | .81 | A. |
| September | 1,510 | 329 | 646 | .389 | .43 | A. |

[1] Supersedes drainage area previously published.

CEDAR RIVER AT CEDAR RAPIDS, IOWA.

LOCATION.—In the central part of Cedar Rapids, Linn County, about one-half mile below the dam and between the electric railroad bridge and the Seventh Avenue combination railroad and foot bridge.

DRAINAGE AREA.—At gaging station 6,640 square miles; at junction with Iowa River, 7,930 square miles (revised measurements on United States Geological Survey map of scale 1 to 500,000).

RECORDS AVAILABLE.—October 26, 1902, to September 30, 1915.

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 daily in the morning, to tenths, by R. S. Toogood. Elevation of zero of gage from Northwestern R. R. 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 of river consists of rock and gravel; free from vegetation and practically permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 11.7 feet at 7 a. m. March 29; (discharge, 32,400 second-feet); minimum stage recorded, 3.1 feet October 6 (discharge, 1,100 second-feet). 1902–1915: Maximum stage recorded 17.2 feet April 1, 1912 (discharge, 54,000 second-feet), minimum stage recorded, 2.5 feet, July 24 to 28, 1911 (discharge, 410 second-feet.)

WINTER FLOW.—Discharge relation affected by ice, except in 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 the dam above the gaging station during this year. The construction of a new dam to replace the old one has been begun and the regimen of flow has been slightly affected as an incident to construction work. There is no dam for a long distance below Cedar Rapids and no backwater at the gaging station.

ACCURACY.—Records excellent; open-water estimates based on a well-defined rating curve.

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

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

*Daily discharge, in second-feet, of Cedar River at Cedar Rapids, Iowa, for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1,630 | 1,840 | 1,260 | | | 10,800 | 13,500 | 3,480 | 22,100 | 5,770 | 5,770 | 2,320 |
| 2 | 1,260 | 2,070 | 1,440 | | | 9,710 | 12,300 | 3,480 | 29,600 | 6,120 | 6,120 | 2,070 |
| 3 | 1,440 | 1,840 | 1,260 | | | 8,250 | 12,300 | 3,170 | 29,600 | 5,770 | 5,770 | 2,070 |
| 4 | 1,260 | 2,070 | 1,440 | | | 7,890 | 10,800 | 3,790 | 22,900 | 5,090 | 8,970 | 1,840 |
| 5 | 1,260 | 1,840 | 1,260 | | | 6,120 | 9,340 | 3,170 | 20,600 | 4,430 | 10,400 | 2,070 |
| 6 | 1,100 | 2,070 | 1,440 | | | 5,770 | 8,610 | 4,760 | 13,500 | 4,760 | 10,800 | 1,840 |
| 7 | 1,260 | 1,840 | 1,260 | | 1,200 | 5,090 | 7,890 | 6,120 | 11,200 | 4,110 | 10,100 | 2,070 |
| 8 | 2,320 | 2,070 | 1,440 | 800 | | 4,760 | 8,250 | 6,120 | 9,710 | 4,430 | 9,340 | 1,840 |
| 9 | 4,760 | 1,840 | 1,440 | | | 4,110 | 8,250 | 5,770 | 8,970 | 4,110 | 8,610 | 2,320 |
| 10 | 4,110 | 1,840 | 1,630 | | | 4,110 | 8,250 | 5,430 | 8,610 | 5,090 | 7,890 | 2,870 |
| 11 | 4,110 | 1,630 | 1,440 | | | 3,480 | 7,890 | 5,090 | 8,250 | 5,770 | 6,470 | 2,870 |
| 12 | 3,480 | 1,630 | 1,630 | | | 3,480 | 8,250 | 4,760 | 7,530 | 6,470 | 6,120 | 2,320 |
| 13 | 3,480 | 1,440 | 1,440 | | | 3,170 | 8,610 | 4,430 | 7,530 | 7,170 | 5,430 | 2,320 |
| 14 | 2,870 | 1,630 | | | 10,000 | 3,480 | 8,610 | 4,110 | 7,170 | 6,820 | 4,760 | 1,840 |
| 15 | 4,110 | 1,440 | | | 14,300 | 3,450 | 7,890 | 3,480 | 6,820 | 5,770 | 4,110 | 2,590 |
| 16 | 4,430 | 1,630 | | | 13,500 | 3,790 | 7,170 | 3,480 | 6,470 | 5,430 | 4,110 | 2,590 |
| 17 | 5,770 | 1,260 | | | 14,600 | 4,430 | 7,170 | 2,870 | 6,120 | 5,090 | 3,480 | 4,430 |
| 18 | 5,090 | 1,440 | | | 12,300 | 4,430 | 6,120 | 3,170 | 6,120 | 5,770 | 3,790 | 3,790 |
| 19 | 5,090 | 1,260 | | | 9,710 | 6,820 | 5,430 | 2,590 | 6,470 | 6,820 | 4,110 | 4,110 |
| 20 | 4,430 | 1,630 | | | 9,340 | 8,250 | 5,090 | 3,170 | 6,470 | 6,120 | 4,430 | 3,480 |
| 21 | 4,430 | 1,440 | | | 9,710 | 8,970 | 4,430 | 2,870 | 7,170 | 6,820 | 3,790 | 5,430 |
| 22 | 3,480 | 1,440 | 1,000 | | 12,700 | 11,200 | 4,430 | 3,170 | 7,530 | 7,890 | 3,790 | 5,770 |
| 23 | 3,480 | 1,260 | | 2,000 | 22,500 | 13,900 | 3,790 | 2,870 | 7,890 | 8,610 | 3,480 | 5,090 |
| 24 | 2,870 | 1,630 | | | 22,900 | 13,100 | 3,790 | 3,480 | 7,890 | 9,710 | 3,480 | 4,110 |
| 25 | 2,870 | 1,440 | | | 26,500 | 13,100 | 3,480 | 4,430 | 7,530 | 9,710 | 2,870 | 4,110 |
| 26 | 2,320 | 1,630 | | | 21,800 | 12,700 | 3,480 | 8,250 | 6,470 | 8,250 | 2,870 | 8,970 |
| 27 | 2,590 | 1,440 | | | 17,400 | 17,800 | 3,170 | 9,710 | 6,470 | 8,250 | 2,590 | 17,000 |
| 28 | 2,320 | 1,630 | | | 13,100 | 30,400 | 3,170 | 12,000 | 6,470 | 9,340 | 2,590 | 22,900 |
| 29 | 2,320 | 1,440 | | | ..... | 32,400 | 2,870 | 17,800 | 6,120 | 9,340 | 2,320 | 17,000 |
| 30 | 2,070 | 1,630 | | | ..... | 24,500 | 3,480 | 18,200 | 6,120 | 7,530 | 2,590 | 13,900 |
| 31 | 2,070 | ..... | | | ..... | 17,800 | ..... | 16,600 | ..... | 6,120 | 2,320 | ..... |

NOTE.—Daily discharge computed from a rating curve well defined between 600 and 36,000 second-feet. Discharge Dec. 14 to Feb. 14 estimated, because of ice, from climatic records and probable discharge at Iowa City. Braced figures show mean discharge for period included.

*Monthly discharge of Cedar River at Cedar Rapids, Iowa, for the year ending Sept. 30, 1915.*

[Drainage area, 6,640 square miles.] [a]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 5,770 | 1,100 | 3,030 | 0.456 | 0.53 | A. |
| November | 2,070 | 1,260 | 1,640 | .247 | .28 | A. |
| December | ..... | ..... | 1,170 | .176 | .20 | C. |
| January | ..... | ..... | 1,420 | .214 | .25 | D. |
| February | 26,500 | ..... | 8,780 | 1.32 | 1.38 | B. |
| March | 32,400 | 3,170 | 9,910 | 1.49 | 1.72 | A. |
| April | 13,500 | 2,870 | 6,930 | 1.04 | 1.16 | A. |
| May | 18,200 | 2,590 | 5,870 | .884 | 1.02 | A. |
| June | 29,600 | 6,120 | 10,500 | 1.58 | 1.76 | A. |
| July | 9,710 | 4,110 | 6,530 | .983 | 1.13 | A. |
| August | 10,800 | 2,320 | 5,270 | .794 | .92 | A. |
| September | 22,900 | 1,840 | 5,200 | .783 | .87 | A. |
| The year | 32,400 | ..... | 5,490 | .827 | 11.24 | |

[a] Supersedes drainage area previously published.

## SHELLROCK RIVER NEAR CLARKSVILLE, IOWA.

LOCATION.—At the highway bridge, 1¼ miles northwest of Clarksville, Butler County, and approximately 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 the station and 2,680 square miles at the junction with Cedar River (measured on United States Geological Survey map of scale 1 to 500,000).

RECORDS AVAILABLE.—May 28 to September 30, 1915.

GAGE.—Chain gage attached to hand rail on upstream side of bridge 75 feet from right abutment; read once daily by Mrs. H. H. Sherburne.

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

CHANNEL AND CONTROL.—Rock and sand; probably permanent. The right bank is high and will not overflow; left bank will probably overflow during extreme high stage.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year: 11.0 feet at 7.30 a. m. May 30 (discharge, 10,200 second-feet). Minimum stage recorded since station was established, 1.6 feet several days during September (discharge, 185 second-feet); in April, 1907, a stage of approximately 16.5 feet was reached (discharge, approximately 19,000 second-feet),

WINTER FLOW.—Discharge relation affected by ice.

ACCURACY.—Results considered good.

*Discharge measurements of Shellrock River near Clarksville, Iowa, during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* |
| May 31 | C. Herlofson | 9.07 | 7,490 |
| June 7 | A. Davis | 5.21 | 2,740 |
| Sept. 11 | C. Herlofson | 1.92 | 330 |

*Daily discharge, in second-feet, of Shellrock River near Clarksville, Iowa, for the year ending Sept. 30, 1915.*

| Day. | May. | June. | July. | Aug. | Sept. | Day. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 5,380 | 1,200 | 935 | 298 | 16 | ..... | 1,340 | 1,200 | 690 | 840 |
| 2 | ..... | 4,640 | 1,000 | 1,340 | 275 | 17 | ..... | 1 200 | 1,340 | 1 140 | 690 |
| 3 | ..... | 3,700 | 902 | 3,700 | 252 | 18 | ..... | 1,280 | 1,060 | 662 | 608 |
| 4 | ..... | 3,140 | 902 | 4,760 | 230 | 19 | ..... | 1,980 | 2,160 | 662 | 552 |
| 5 | ..... | 2,940 | 902 | 3,580 | 230 | 20 | ..... | 1,980 | 2,160 | 662 | 525 |
| 6 | ..... | 2,630 | 810 | 2,530 | 208 | 21 | ..... | 1,980 | 1,900 | 552 | 498 |
| 7 | ..... | 2,630 | 810 | 1,980 | 208 | 22 | ..... | 1,730 | 1,570 | 552 | 470 |
| 8 | ..... | 2,530 | 1,500 | 1,730 | 185 | 23 | ..... | 1,420 | 1.340 | 498 | 420 |
| 9 | ..... | 2,340 | 1,570 | 1,340 | 185 | 24 | ..... | 1,420 | 1,200 | 470 | 395 |
| 10 | ..... | 2,060 | 1,200 | 1,140 | 185 | 25 | ..... | 2,340 | 1.000 | 445 | 345 |
| 11 | ..... | 1,980 | 1,060 | 935 | 208 | 26 | ..... | 2,160 | 902 | 420 | 420 |
| 12 | ..... | 1,810 | 1,000 | 870 | 275 | 27 | ..... | 1,900 | 902 | 395 | 608 |
| 13 | ..... | 1,980 | 935 | 902 | 320 | 28 | ..... | 3,140 | 1,570 | 840 | 370 | 662 |
| 14 | ..... | 1,810 | 902 | 810 | 1,900 | 29 | ..... | 8,940 | 1,810 | 840 | 345 | 608 |
| 15 | ..... | 1,500 | 810 | 750 | 1,200 | 30 | ..... | 10,200 | 1,420 | 810 | 320 | 552 |
| | | | | | | 31 | ..... | 7,110 | ..... | 1,060 | 320 | ..... |

NOTE.—Discharge computed from a rating curve fairly well defined between 200 and 10,000 second-feet.

*Monthly discharge of Shellrock River near Clarksville, Iowa, for the year ending Sept. 30, 1915.*

[Drainage area, 1,660 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| May 28–31 | 10,200 | 3,140 | 7,350 | 4.43 | 0.66 | B. |
| June | 5,380 | 1,200 | 2,200 | 1.33 | 1.48 | A. |
| July | 2,160 | 810 | 1,150 | .693 | .80 | B. |
| August | 4,760 | 320 | 1,160 | .699 | .81 | B. |
| September | 1,900 | 185 | 478 | .288 | .32 | A. |

SKUNK RIVER AT COPPOCK, IOWA.

LOCATION.—At highway bridge about one-eighth mile above railroad bridge and about one-fourth mile above junction with Crooked Creek.

DRAINAGE AREA.—2,890 square miles (measured on United States Geological Survey map of scale 1 to 500,000).

RECORDS AVAILABLE.—October 21, 1913, to September 30, 1915.

GAGE.—Chain gage attached to downstream side of bridge; read once daily by J. W. Ricks.

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

CHANNEL AND CONTROL.—Gravel and sand; channel likely to shift.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 16.3 feet at 9.30 a. m. August 4 (discharge, 13,700 second-feet); minimum stage recorded during open-water periods, 3.5 feet December 10 (discharge, 34 second-feet); the minimum flow during the winter period was much lower.

Maximum stage recorded prior to 1915, approximately 24 feet about May 31, 1903 (discharge, approximately 30,000 second-feet).

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

ACCURACY.—Conditions of flow fairly good, current not normal to bridge at medium or high stages. Two railroad bridges below gage catch drift at high stages, thus affecting the discharge relation.

*Discharge measurements of Skunk River at Coppock, Iowa, during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* |
| Oct. 27 | C. Herlofson | 5.23 | 1,130 |
| 27 | ....do | 5.21 | 1,130 |
| Feb. 25 | D. V. Egbert | 14.12 | 10,300 |

*Daily discharge, in second-feet, of Skunk River at Coppock, Iowa, for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1,180 | 835 | 370 | | | 8,500 | 3,200 | | 3,920 | 1,300 | 8,950 | 1,270 |
| 2 | 1,060 | 785 | 370 | | | 8,000 | 2,720 | | 3,560 | 1,180 | 9,090 | 1,390 |
| 3 | 940 | 785 | 370 | | | 7,000 | 2,330 | | 3,290 | 1,120 | 12,200 | 1,390 |
| 4 | 835 | 735 | 370 | | | 6,000 | 1,760 | 800 | 3,290 | 995 | 13,700 | 1,090 |
| 5 | 785 | 690 | 370 | | | 5,500 | 1,620 | | 4,210 | 885 | 12,100 | 979 |
| 6 | 735 | 690 | 370 | | 400 | 5,000 | 1,490 | | 4,400 | 835 | 10,100 | 979 |
| 7 | 645 | 645 | 370 | 250 | | 4,500 | 1,360 | 885 | 5,910 | 885 | 8,400 | 924 |
| 8 | 690 | 600 | 370 | | | 4,000 | 1,300 | 995 | 6,260 | 1,360 | 6,860 | 924 |
| 9 | 785 | 600 | 355 | | | 3,500 | 1,300 | 940 | 6,140 | 885 | 6,140 | 4,540 |
| 10 | 2,330 | 600 | 340 | | | 3,500 | 1,240 | 835 | 5,910 | 995 | 5,800 | 2,490 |
| 11 | 2,960 | 560 | 340 | | | 3,000 | 1,300 | 835 | 5,470 | 9,090 | 5,580 | 6,020 |
| 12 | 3,120 | 520 | 330 | | 1,000 | 2,500 | 1,300 | 785 | 5,470 | 8,130 | 5,360 | 5,690 |
| 13 | 3,040 | 520 | 320 | | 1,200 | 2,500 | 1,240 | 735 | 6,020 | 4,120 | 4,540 | 5,150 |
| 14 | 2,640 | 520 | 310 | | 1,200 | 2,000 | | 690 | 5,470 | 3,040 | 4,060 | 5,470 |
| 15 | 2,560 | 520 | | 400 | 1,500 | 2,000 | | 835 | 3,740 | 2,330 | 3,620 | 5,690 |
| 16 | 2,640 | 480 | | 800 | 3,000 | 1,500 | | 785 | 2,330 | 2,880 | 2,560 | 6,500 |
| 17 | 2,640 | 440 | | 1,500 | 6,000 | 1,500 | | 690 | 2,040 | 2,260 | 2,190 | 6,380 |
| 18 | 2,560 | 440 | | 1,000 | 9,000 | 1,500 | | 690 | 2,040 | 2,330 | 2,260 | 6,380 |
| 19 | 2,330 | 430 | | 1,000 | 9,380 | 2,000 | | 600 | 4,300 | 3,830 | 2,340 | 4,240 |
| 20 | 2,100 | 420 | | 1,000 | 9,700 | 2,000 | | 645 | 3,560 | 3,460 | 1,910 | 3,620 |
| 21 | 1,960 | 410 | | 1,000 | 10,100 | 2,000 | 1,000 | 1,240 | 3,640 | 3,290 | 1,840 | 2,880 |
| 22 | 1,820 | 400 | 250 | 1,000 | 10,400 | 2,000 | | 1,420 | 3,740 | 3,040 | 1,770 | 2,260 |
| 23 | 1,620 | 400 | | 800 | 10,600 | 2,500 | | 995 | 3,380 | 2,800 | 1,700 | 2,050 |
| 24 | 1,420 | 400 | | 600 | 10,700 | 2,500 | | 885 | 2,960 | 3,640 | 1,580 | 2,490 |
| 25 | 1,300 | 370 | | | 10,300 | 2,500 | | 1,360 | 2,560 | 6,740 | 1,450 | 2,960 |
| 26 | 1,240 | 370 | | | 10,100 | 3,000 | | 6,020 | 3,460 | 6,500 | 1,330 | 4,840 |
| 27 | 1,120 | 370 | | 400 | 9,500 | 3,000 | | 6,260 | 1,960 | 5,260 | 1,270 | 7,360 |
| 28 | 1,060 | 370 | | | 9,000 | 3,500 | | 5,000 | 1,820 | 6,260 | 1,210 | 8,400 |
| 29 | 995 | 370 | | | ..... | 3,500 | | 5,360 | 1,560 | 8,130 | 1,090 | 8,540 |
| 30 | 940 | 370 | | | ..... | 3,500 | | 5,470 | 1,420 | 9,090 | 1,090 | 8,400 |
| 31 | 885 | ..... | | | ..... | 3,500 | | 4,600 | ..... | 9,230 | 1,040 | ..... |

NOTE.—Daily discharge computed from two rating curves, well defined throughout. Discharge Nov. 19–24 and Dec. 11 to Feb. 18 estimated, because of ice, from climatic records and probable discharge at Iowa City. Discharge Feb. 20 to May 6, except Feb. 22, 24–26, Mar. 2, and Apr. 2–13, interpolated, or estimated from known discharge at Iowa City. Braced figures show mean discharge for period included.

*Monthly discharge of Skunk River at Coppock, Iowa, for the years ending Sept. 30, 1914–1915.*

[Drainage area, 2,890 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximun. | Minimum. | Mean. | Per square mile. | | |
| 1913–14. | | | | | | |
| October 21–31 | 157 | 106 | 126 | 0.044 | 0.02 | B. |
| November | 95 | 67 | 80.4 | .028 | .03 | B. |
| December | 168 | 83 | 114 | .039 | .04 | C. |
| April | 560 | 179 | 305 | .106 | .12 | A. |
| May | 1,560 | 190 | 457 | .158 | .18 | B. |
| June | 1,560 | 157 | 602 | .208 | .23 | B. |
| July | 1,300 | 86 | 242 | .084 | .10 | A. |
| August | 168 | 33 | 59.5 | .021 | .02 | B. |
| September | 6,430 | 70 | 2,230 | .772 | .86 | A. |
| 1914–15. | | | | | | |
| October | 3,120 | 645 | 1,640 | .567 | .65 | A. |
| November | 835 | 370 | 522 | .181 | .20 | A. |
| December | 370 | ..... | 297 | .103 | .12 | B. |
| January | 1,500 | ..... | 497 | .172 | .20 | C. |
| February | 10,700 | ..... | 4,550 | 1.57 | 1.64 | A. |
| March | 8,500 | 1,500 | 3,470 | 1.20 | 1.38 | A. |
| April | 3,200 | ..... | 1,310 | .453 | .51 | B. |
| May | 6,260 | 600 | 1,750 | .606 | .70 | A. |
| June | 6,260 | 1,420 | 3,790 | 1.31 | 1.46 | A. |
| July | 9,230 | 835 | 3,740 | 1.29 | 1.49 | A. |
| August | 13,700 | 1,040 | 4,620 | 1.60 | 1.84 | A. |
| September | 8,540 | 924 | 4,040 | 1.40 | 1.56 | A. |
| The year | 13,700 | ..... | 2,520 | .872 | 11.75 | |

## SKUNK RIVER AT AUGUSTA, IOWA.

LOCATION.—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 United States Geological Survey map of scale 1 to 500,000).

RECORDS AVAILABLE.—September 30 to November 15, 1913; May 27 to September 30, 1915.

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 the downstream left side of the 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 overflow; left bank will only overflow at extreme high stage; remains of old mill dam 600 feet below gage will probably make discharge relation permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 15.6 feet at 6 p. m. July 11 (discharge, 25,800 second-feet); minimum stage recorded, 3.2 feet, August 31, September 1 and 6 (discharge, 1,100 second-feet).

Maximum stage prior to 1915, 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.

WINTER FLOW.—Discharge relation affected by ice.

ACCURACY.—Results considered good.

COOPERATION.—Station maintained by and measurements made by Hydraulic Engineering Co. of Maine during the fall of 1913.

*Discharge measurements of Skunk River at Augusta, Iowa, during 1913–1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| 1913. | | *Feet.* | *Sec.-ft.* | 1913. | | *Feet.* | *Sec.-ft.* |
| Oct. 1 | McDaniel and Logson.. | [a]1.28 | 148 | Oct. 23 | McDaniel and Logson.. | 1.45 | 229 |
| 6 | .....do..... | 1.44 | 184 | 25 | .....do..... | 1.30 | 162 |
| 7 | .....do..... | 1.19 | 118 | 27 | .....do..... | 1.38 | 188 |
| 9 | .....do..... | 1.02 | 83 | 28 | .....do..... | 1.36 | 180 |
| 13 | .....do..... | 1.52 | 249 | 30 | .....do..... | 1.28 | 157 |
| 13 | .....do..... | 1.76 | 384 | Nov. 1 | .....do..... | 1.23 | 126 |
| 14 | .....do..... | 1.53 | 241 | 4 | .....do..... | 1.17 | 120 |
| 15 | .....do..... | 1.40 | 196 | 5 | .....do..... | 1.17 | 112 |
| 16 | .....do..... | 1.22 | 145 | 6 | .....do..... | 1.16 | 101 |
| 17 | .....do..... | 1.59 | 309 | 14 | .....do..... | 1.08 | 89 |
| 18 | .....do..... | 2.01 | 534 | 15 | .....do..... | [a]1.08 | 70 |
| 20 | .....do..... | 1.77 | 396 | | | | |
| 21 | .....do..... | 1.53 | 259 | 1915. | | | |
| 22 | .....do..... | 1.44 | 229 | Feb. 24[b] | R. H. Bolster..... | [c]11.11 | 12,100 |
| 23 | .....do..... | 1.40 | 224 | June 15 | C. Herlofson..... | [c]6.24 | 5,720 |

[a] Measurements Oct. 1 to Nov. 15, 1913, made by engineers, Hydraulic Engineering Co. of Maine. See "Gage" in station description.
[b] Discharge relation affected by ice jam below station.
[c] Gage height refers to chain gage.

*Daily discharge, in second-feet, of Skunk River at Augusta, Iowa, for the periods Oct. 1 to Nov. 15, 1913, and May 27 to Sept. 30, 1915.*

| Day. | Oct. | Nov. | Day. | Oct. | Nov. | Day. | Oct. | Nov. |
|---|---|---|---|---|---|---|---|---|
| 1913. | | | 1913. | | | 1913. | | |
| 1 | 154 | 135 | 11 | 87 | 69 | 21 | 261 | ..... |
| 2 | 146 | 131 | 12 | 271 | 75 | 22 | 220 | ..... |
| 3 | 90 | 124 | 13 | 302 | 84 | 23 | 215 | ..... |
| 4 | 117 | 114 | 14 | 251 | 84 | 24 | 165 | ..... |
| 5 | 302 | 114 | 15 | 224 | 84 | 25 | 150 | ..... |
| 6 | 206 | 110 | 16 | 161 | ..... | 26 | 161 | ..... |
| 7 | 121 | 110 | 17 | 286 | ..... | 27 | 194 | ..... |
| 8 | 75 | 110 | 18 | 527 | ..... | 28 | 186 | ..... |
| 9 | 66 | 114 | 19 | 480 | ..... | 29 | 173 | ..... |
| 10 | 87 | 63 | 20 | 387 | ..... | 30 | 154 | ..... |
| | | | | | | 31 | 139 | ..... |

| Day. | May. | June. | July. | Aug. | Sept. | Day. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1915. | | | | | | 1915. | | | | | |
| 1 | ..... | 7,380 | 4,940 | 19,600 | 1,100 | 16 | ..... | 4,060 | 4,230 | 3,880 | 6,610 |
| 2 | ..... | 6,040 | 3,550 | 17,600 | 1,160 | 17 | ..... | 2,620 | 3,880 | 2,920 | 9,360 |
| 3 | ..... | 5,300 | 2,060 | 22,800 | 1,560 | 18 | ..... | 2,340 | 2,770 | 2,340 | 10,600 |
| 4 | ..... | 4,940 | 1,680 | 23,400 | 1,260 | 19 | ..... | 2,340 | 5,120 | 2,340 | 17,000 |
| 5 | ..... | 5,480 | 1,440 | 23,000 | 1,210 | 20 | ..... | 4,580 | 5,860 | 2,340 | 9,970 |
| 6 | ..... | 6,040 | 1,210 | 23,200 | 1,100 | 21 | ..... | 4,060 | 4,940 | 2,060 | 7,380 |
| 7 | ..... | 7,180 | 2,620 | 19,600 | 1,160 | 22 | ..... | 3,880 | 4,060 | 1,930 | 3,880 |
| 8 | ..... | 8,550 | 2,200 | 13,900 | 1,160 | 23 | ..... | 3,880 | 3,390 | 1,800 | 3,080 |
| 9 | ..... | 8,950 | 1,680 | 8,950 | 2,770 | 24 | ..... | 3,550 | 6,610 | 1,800 | 2,340 |
| 10 | ..... | 8,350 | 1,440 | 7,380 | 4,400 | 25 | ..... | 2,920 | 14,600 | 1,680 | 2,620 |
| 11 | ..... | 7,960 | 25,300 | 7,180 | 6,800 | 26 | ..... | 2,620 | 13,700 | 1,560 | 3,230 |
| 12 | ..... | 7,570 | 23,700 | 6,800 | 6,610 | 27 | 13,500 | 3,550 | 13,500 | 1,320 | 6,040 |
| 13 | ..... | 10,400 | 14,200 | 6,420 | 6,230 | 28 | 12,900 | 2,920 | 13,100 | 1,320 | 9,970 |
| 14 | ..... | 9,970 | 7,570 | 4,760 | 5,860 | 29 | 11,200 | 2,620 | 21,900 | 1,260 | 11,800 |
| 15 | ..... | 8,350 | 6,610 | 4,230 | 6,230 | 30 | 10,400 | 2,060 | 19,600 | 1,160 | 12,200 |
| | | | | | | 31 | 9,150 | ..... | 22,500 | 1,100 | ..... |

NOTE.—Discharge determined as follows: Oct. 1 to Nov. 15, 1913, from a rating curve well defined between 80 and 600 second-feet; May 27 to Sept. 30, 1915, from a rating curve well defined between 1,100 and 40,000 second-feet.

*Monthly discharge of Skunk River at Augusta, Iowa, for the periods Oct. 1 to Nov. 15, 1913, and May 27 to Sept. 30, 1915.*

[Drainage area, 4,290 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| 1913. | | | | | | |
| October | 527 | 66 | 205 | 0.048 | 0.06 | A. |
| November 1–15 | 135 | 63 | 101 | .024 | .01 | B. |
| 1915. | | | | | | |
| May 27–31 | 13,500 | 9,150 | 11,400 | 2.66 | .49 | B. |
| June | 10,400 | 2,060 | 5,350 | 1.25 | 1.40 | A. |
| July | 25,300 | 1,210 | 8,390 | 1.96 | 2.26 | A. |
| August | 23,400 | 1,100 | 7,730 | 1.80 | 2.08 | A. |
| September | 17,000 | 1,100 | 5,490 | 1.28 | 1.43 | A. |

## DES MOINES RIVER AT KALO, IOWA.

LOCATION.—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 United States Geological Survey map of scale 1 to 500,000).

RECORDS AVAILABLE.—October 18, 1913, to September 30, 1915, 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 once daily 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 $-1.0 \pm 0.2$ foot.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year and since station was established, 14.0 feet at 8 a. m. May 30 (discharge, 18,500 second-feet); minimum stage recorded, 2.3 feet at 8.10 a. m. May 20 (discharge 1,000 second-feet); minimum stage recorded 1913–1915, 0.6 foot November 17, 1913 (discharge, 190 second-feet).

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

ACCURACY.—Results considered excellent.

*Discharge measurements of Des Moines River at Kalo, Iowa, during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* |
| Apr. 22 | C. Herlofson | 4.16 | 2,640 |
| May 31 | A. Davis | 12.72 | 16,100 |

*Daily discharge, in second-feet, of Des Moines River at Kalo, Iowa, for the year ending Sept. 30, 1915.*

| Day. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|
| 1 | ..... | 7,200 | 1,800 | 14,600 | 3,590 | 3,100 | 1,910 |
| 2 | ..... | 6,450 | 1,800 | 12,300 | 3,460 | 4,930 | 1,820 |
| 3 | ..... | 6,300 | 1,980 | 11,000 | 2,980 | 5,500 | 1,730 |
| 4 | ..... | 6,150 | 2,270 | 9,990 | 3,100 | 5,500 | 1,560 |
| 5 | ..... | 5,870 | 2.270 | 9,480 | 2,860 | 5,350 | 1,560 |
| 6 | ..... | 5,590 | 2,270 | 8,130 | 1,910 | 5,500 | 1,480 |
| 7 | ..... | 5,310 | 2,270 | 7,330 | 1,820 | 5,950 | 1,400 |
| 8 | ..... | 5,040 | 2,070 | 6,400 | 1,910 | 6,100 | 1,560 |
| 9 | ..... | 5,040 | 1,980 | 5,800 | 1,820 | 6,250 | 1,480 |
| 10 | ..... | 4,910 | 1,890 | 5,500 | 1,820 | 5,950 | 1,400 |
| 11 | ..... | 4,780 | 1,620 | 5,210 | 3,100 | 5,500 | 1,320 |
| 12 | ..... | 4,650 | 1,450 | 5,070 | 2,100 | 5,350 | 1,320 |
| 13 | ..... | 4,390 | 1,370 | 5,070 | 2,000 | 5,210 | 1,480 |
| 14 | ..... | 4,150 | 1,290 | 5,070 | 1,910 | 4,650 | 2,740 |
| 15 | ..... | 4,150 | 1,290 | 4,510 | 1,820 | 4,120 | 3,100 |
| 16 | ..... | 3,910 | 1,210 | 3,980 | 2,100 | 3,590 | 2,520 |
| 17 | ..... | 3,670 | 1,140 | 3,340 | 1,820 | 3,460 | 2,520 |
| 18 | ..... | 3,430 | 1,070 | 3,220 | 2,520 | 3,340 | 2,520 |
| 19 | ..... | 3,210 | 1,000 | 2,860 | 4,370 | 3,100 | 2,410 |
| 20 | ..... | 2,990 | 1,000 | 2,860 | 4,650 | 2,980 | 3,340 |
| 21 | 5,310 | 2,880 | 1,210 | 2,860 | 4,240 | 2,860 | 2,860 |
| 22 | 8,500 | 2,670 | 1,530 | 2,740 | 3,850 | 2,860 | 2,630 |
| 23 | 6,450 | 2,470 | 2,070 | 2,520 | 3,720 | 2,860 | 2,410 |
| 24 | 7,680 | 2,370 | 2,880 | 2,740 | 3,590 | 2,860 | 2,300 |
| 25 | 8,840 | 2,170 | 5,730 | 3,590 | 3,460 | 2,520 | 2,200 |
| 26 | 9,350 | 2,070 | 7,200 | 4,110 | 3,460 | 2,200 | 5,210 |
| 27 | 8,670 | 2,070 | 8,670 | 4,110 | 3,220 | 2,000 | 5,210 |
| 28 | 7,680 | 1,980 | 11,600 | 3,980 | 3,220 | 2,000 | 5,350 |
| 29 | 8,840 | 1,890 | 15,800 | 3,980 | 3,220 | 2,100 | 4,510 |
| 30 | 8,670 | 1,890 | 18,500 | 3,860 | 3,100 | 2,200 | 3,980 |
| 31 | 8,160 | ..... | 16,300 | ..... | 3,100 | 2,100 | ..... |

NOTE.—Discharge computed from two well-defined rating curves. Aug. 15, interpolated.

*Monthly discharge of Des Moines River at Kalo, Iowa, for the years ending Sept. 30, 1914–1915.*

[Drainage area, 4,170 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| 1913–14. | | | | | | |
| November 5–30 | 303 | 190 | 239 | 0.057 | 0.06 | C. |
| December 1–18 | 303 | 110 | 216 | .052 | .03 | D. |
| March 22–31 | 380 | 213 | 285 | .068 | .03 | C. |
| April | 679 | 254 | 360 | .086 | .10 | B. |
| May | 3,340 | 303 | 914 | .219 | .25 | B. |
| June | 6,530 | 790 | 4,180 | .100 | .11 | B. |
| July | 4,580 | 762 | 2,180 | .523 | .60 | C. |
| August | 706 | 254 | 411 | .098 | .11 | B. |
| September | 734 | 286 | 489 | .117 | .13 | B. |
| 1915. | | | | | | |
| March 21–31 | 9,350 | 5,310 | 8,010 | 1.92 | .79 | A. |
| April | 7,200 | 1,890 | 3,990 | .956 | 1.07 | A. |
| May | 18,500 | 1,000 | 4,020 | .964 | 1.11 | A. |
| June | 14,600 | 2,520 | 5,540 | 1.33 | 1.48 | B. |
| July | 4,650 | 1,820 | 2,900 | .695 | .80 | B. |
| August | 6,250 | 2,000 | 3,940 | .944 | 1.09 | B. |
| September | 5,350 | 1,320 | 2,530 | .606 | .68 | B. |

DES MOINES RIVER AT DES MOINES, IOWA.

LOCATION.—At the Walnut Street Bridge at Des Moines, Polk County, about one-third mile above mouth of Raccoon River and about 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 United States Geological Survey map of scale 1 to 500,000.

RECORDS AVAILABLE.—October 2, 1902, to August 3, 1903; October 1, 1914, to September 30, 1915 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 the 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, 1915.

GAGE.—The original Weather Bureau gage is a staff 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 AND CONTROL.—Channel satisfactory for accurate measurements. 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: 16.0 feet June 1; minimum stage recorded, 1.7 feet December 13 and 31.

1897–1915: Maximum stage recorded, 22.6 feet May 31, 1903; minimum stage recorded, 0.8 foot at various times.

WINTER FLOW.—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 discharge relation.

REGULATION.—The Edison Power & Light Co.'s dam, about one-fourth mile above the 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 heights are furnished by the United States Weather Bureau.

Estimates of discharge withheld until additional data are collected.

*Discharge measurements of Des Moines River at Des Moines, Iowa, during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | | Discharge. |
|---|---|---|---|---|
| | | Locust street gage. | Walnut street gage. | |
| | | *Feet.* | *Feet.* | *Sec-ft.* |
| Apr. 23[a] | Bolster and Herlofson | 4.99 | 4.87 | 3,520 |
| May 29[b] | A. Davis | 15.10 | 15.21 | 23,300 |
| June 6[b] | ....do | 10.80 | 10.78 | 15,100 |

[a] Made from Grand Avenue Bridge. [b] Made from Court Avenue Bridge.

*Daily gage height, in feet, of Des Moines River at Des Moines, Iowa, for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.7 | 4.1 | 3.4 | 1.8 | 2.0 | 8.2 | 7.8 | 4.5 | 16.0 | 6.3 | 7.2 | 4.8 |
| 2 | 3.6 | 4.0 | 3.4 | 1.9 | 1.9 | 7.7 | 7.4 | 4.4 | 15.6 | 6.1 | 7.5 | 4.7 |
| 3 | 3.6 | 3.9 | 3.4 | 2.0 | 2.0 | 7.3 | 7.0 | 4.5 | 14.4 | 5.8 | 8.2 | 4.6 |
| 4 | 3.6 | 3.9 | 3.4 | 1.9 | 1.8 | 7.0 | 6.6 | 4.6 | 13.0 | 5.6 | 8.0 | 4.6 |
| 5 | 3.6 | 3.9 | 3.4 | 1.9 | 1.9 | 6.5 | 6.5 | 4.7 | 12.0 | 5.3 | 7.9 | 4.4 |
| 6 | 3.6 | 3.8 | 3.4 | 2.8 | 3.0 | 5.9 | 6.4 | 4.8 | 10.8 | 5.3 | 7.8 | 4.3 |
| 7 | 4.0 | 3.8 | 3.4 | 2.8 | 2.6 | 5.5 | 6.3 | 4.9 | 10.2 | 5.2 | 8.1 | 4.2 |
| 8 | 4.4 | 3.8 | 3.4 | 3.0 | 2.3 | 5.4 | 6.2 | 4.8 | 9.7 | 5.2 | 7.6 | 4.2 |
| 9 | 4.7 | 3.8 | 3.4 | 3.0 | 2.3 | 5.4 | 6.1 | 4.8 | 8.9 | 5.1 | 7.4 | 4.3 |
| 10 | 4.9 | 3.8 | 3.3 | 3.5 | 2.4 | 5.3 | 6.0 | 4.7 | 8.1 | 5.0 | 7.2 | 4.2 |
| 11 | 5.2 | 3.7 | 2.8 | 3.5 | 2.8 | 5.3 | 6.0 | 4.6 | 7.4 | 5.2 | 7.0 | 4.4 |
| 12 | 5.2 | 3.7 | 2.3 | 3.5 | 3.8 | 5.3 | 6.0 | 4.5 | 6.8 | 5.2 | 6.8 | 4.3 |
| 13 | 5.0 | 3.6 | 1.7 | 3.5 | 4.4 | 5.3 | 5.9 | 4.3 | 6.5 | 5.2 | 6.6 | 4.2 |
| 14 | 4.8 | 3.6 | 1.8 | 3.5 | 8.8 | 5.1 | 5.8 | 4.2 | 6.2 | 5.1 | 6.5 | 4.1 |
| 15 | 4.9 | 3.6 | 1.8 | 3.5 | 6.3 | 5.2 | 5.7 | 4.1 | 6.1 | 5.0 | 6.4 | 4.2 |
| 16 | 5.2 | 3.6 | 2.5 | 3.5 | 5.3 | 5.5 | 5.6 | 4.0 | 6.2 | 5.5 | 6.1 | 5.0 |
| 17 | 5.2 | 3.5 | 2.8 | 3.2 | 6.1 | 6.0 | 5.5 | 3.9 | 5.9 | 5.7 | 6.0 | 5.4 |
| 18 | 5.0 | 3.5 | 2.6 | 3.2 | 6.8 | 6.9 | 5.3 | 3 9 | 5.6 | 6.0 | 5.9 | 5.4 |
| 19 | 4.9 | 2.4 | 2.6 | 2.8 | 9.4 | 7.8 | 5.2 | 3.8 | 5.4 | 8.1 | 5.9 | 5.3 |
| 20 | 4.7 | 1.8 | 2.4 | 2.7 | 10.3 | 8.6 | 5.1 | 3.8 | 5.4 | 9.6 | 5.6 | 5.2 |
| 21 | 4.6 | 2.0 | 2.5 | 2.5 | 11.3 | 8.5 | 5.0 | 3.8 | 5.5 | 9.5 | 5.4 | 5.6 |
| 22 | 4.5 | 3.3 | 2.3 | 2.7 | 12.1 | 8.0 | 5.0 | 4.0 | 5.5 | 9.2 | 5.4 | 6.1 |
| 23 | 4.4 | 3.0 | 2.3 | 2.1 | 13.0 | 7.6 | 4.9 | 4.3 | 5.4 | 7.7 | 5.8 | 5.6 |
| 24 | 4.4 | 3.5 | 2.5 | 2.0 | 13.3 | 7.7 | 4.8 | 4.6 | 5.2 | 7.8 | 5.7 | 5.4 |
| 25 | 4.4 | 3.5 | 2.6 | 2.0 | 13.4 | 8.4 | 4.7 | 4.9 | 5.1 | 8.2 | 5.4 | 5.2 |
| 26 | 4.4 | 3.5 | 2.1 | 2.1 | 12.4 | 8.9 | 4.6 | 7.0 | 6.4 | 7.3 | 5.2 | 5.5 |
| 27 | 4.3 | 3.5 | 2.0 | 2.0 | 10.3 | 9.1 | 4.6 | 9.0 | 7.0 | 7.0 | 5.0 | 8.1 |
| 28 | 4.2 | 3.4 | 1.8 | 1.9 | 9.1 | 9.0 | 4.6 | 12.7 | 7.6 | 7.5 | 4.9 | 10.1 |
| 29 | 4.2 | 3.5 | 1.9 | 1.9 | ..... | 8.6 | 4.6 | 14.7 | 7.4 | 10.6 | 4.9 | 10.7 |
| 30 | 4.2 | 3.4 | 1.8 | 1.8 | ..... | 8.2 | 4.5 | 15.5 | 6.7 | 9.3 | 4.8 | 10.9 |
| 31 | 4.1 | ..... | 1.7 | 1.9 | ..... | 8.0 | ..... | 15.7 | ..... | 8.1 | 4.8 | ..... |

## DES MOINES RIVER AT KEOSAUQUA, IOWA.

LOCATION.—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 from United States Geological Survey map of 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, 1915.

GAGE.—Chain gage attached to an upstream vertical of bridge; read once daily 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 about 18.5 feet, early in the morning of August 3 (discharge, about 63,000 second-feet); minimum stage recorded, 0.70 foot November 24 and 28 (discharge, 1,190 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 about June 1, 1851, about 24 feet (discharge, about 80,000 second-feet); minimum stage recorded, 1903–1915; zero August 28 to September 6, 1911 (discharge, 160 second-feet).

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

ACCURACY.—Results considered fair.

The following discharge measurement was made by Egbert and Davis:
June 4, 1915: Gage height, 15.30 feet; discharge, 51,900 second-feet.

*Daily discharge, in second-feet, of Des Moines River at Keosauqua, Iowa, for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Feb. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 3,200 | 2,770 | ..... | ..... | 5,310 | 45,000 | 16,900 | 53,000 | 6,340 |
| 2 | 3,000 | 2,570 | ..... | ..... | 4,570 | 53,000 | 14,300 | 56,000 | 5,800 |
| 3 | 2,800 | 2,470 | ..... | ..... | 4,570 | 56,000 | 12,400 | 62,000 | 5,530 |
| 4 | 2,600 | 2,370 | ..... | ..... | 4,570 | 53,000 | 13,700 | 38,000 | 5,000 |
| 5 | 2,500 | 2,280 | ..... | ..... | 4,810 | 49,500 | 11,800 | 25,000 | 5,000 |
| 6 | 2,500 | 2,090 | ..... | 12,000 | 5,570 | 46,000 | 8,850 | 20,500 | 4,740 |
| 7 | 2,600 | 2,090 | ..... | 11,500 | 5,570 | 42,000 | 11,200 | 18,500 | 4,480 |
| 8 | 3,000 | 2,090 | ..... | 11,000 | 5,310 | 36,000 | 12,400 | 17,000 | 4,220 |
| 9 | 4,000 | 2,000 | ..... | 11,000 | 5,570 | 30,000 | 12,400 | 18,000 | 6,880 |
| 10 | 8,000 | 2,000 | ..... | 10,700 | 5,570 | 26,000 | 13,000 | 15,500 | 7,160 |
| 11 | 9,870 | 2,000 | ..... | 10,100 | 5,060 | 25,000 | 17,500 | 13,700 | 10,600 |
| 12 | 11,000 | 1,910 | ..... | 9,870 | 5,060 | 23,000 | 12,700 | 12,700 | 11,200 |
| 13 | 9,870 | 1,910 | ..... | 9,870 | 4,570 | 24,000 | 12,400 | 11,800 | 8,280 |
| 14 | 8,790 | 1,820 | ..... | 9,870 | 4,090 | 20,000 | 13,700 | 11,200 | 5,800 |
| 15 | 7,710 | 1,740 | ..... | 9,600 | 4,090 | 16,000 | 19,500 | 11,200 | 5,260 |
| 16 | 7,170 | 1,570 | 26,200 | 9,060 | 3,860 | 14,000 | 15,200 | 11,200 | 5,530 |
| 17 | 7,170 | 1,570 | 25,900 | 8,790 | 3,410 | 12,400 | 18,200 | 11,800 | 5,800 |
| 18 | 7,980 | 1,570 | 20,000 | 7,980 | 3,190 | 12,100 | 20,800 | 14,300 | 20,200 |
| 19 | 7,710 | 1,490 | 17,600 | 7,710 | 3,080 | 17,500 | 28,100 | 14,600 | 17,200 |
| 20 | 7,170 | 1,490 | 16,000 | 7,170 | 3,190 | 17,200 | 31,000 | 14,000 | 12,400 |
| 21 | 5,570 | 1,420 | 20,000 | 6,630 | 5,060 | 14,900 | 32,000 | 14,900 | 8,280 |
| 22 | 5,060 | 1,340 | 25,000 | 6,360 | 4,570 | 12,700 | 33,000 | 14,300 | 9,140 |
| 23 | 4,810 | 1,260 | 29,300 | 6,090 | 3,520 | 11,200 | 36,000 | 10,600 | 7,720 |
| 24 | 4,570 | 1,190 | 32,500 | 5,570 | 3,630 | 10,600 | 59,000 | 8,280 | 7,720 |
| 25 | 4,090 | 1,260 | 33,100 | 5,570 | 5,570 | 9,430 | 46,000 | 8,280 | 6,610 |
| 26 | 3,630 | 1,260 | 32,200 | 5,310 | 12,600 | 11,200 | 31,000 | 8,000 | 7,720 |
| 27 | 3,520 | 1,260 | ..... | 5,060 | 18,800 | 8,850 | 22,000 | 7,160 | 26,400 |
| 28 | 3,410 | 1,190 | ..... | 4,570 | 25,000 | 11,800 | 32,000 | 6,610 | 28,800 |
| 29 | 3,080 | 1,260 | ..... | 4,570 | 27,000 | 11,800 | 45,000 | 6,070 | 27,800 |
| 30 | 2,980 | 1,260 | ..... | 6,090 | 32,000 | 12,400 | 50,000 | 5,800 | 27,000 |
| 31 | 2,980 | ..... | ..... | ..... | 36,000 | ..... | 52,000 | 5,800 | ..... |

NOTE.—Discharge determined as follows: Oct. 1–10, estimated from discharge of Des Moines River at Des Moines; Oct. 11 to Nov. 30, Feb. 16–26 (except Feb. 20 and 21, which was estimated), and Apr. 6 to May 27, from a rating curve well defined between 1,000 and 35,000 second-feet; May 28 to Sept. 30, except May 30 to June 16 and July 20 to Aug. 10, which was determined by indirect method for shifting channel, from a rating curve well defined between 1,500 and 15,000 second-feet. The gage was not read Dec. 1 to Feb. 15 and Feb. 27 to Apr. 5. The mean flow for December was less than 1,000 second-feet.

*Monthly discharge of Des Moines River at Keosauqua, Iowa, for the year ending Sept. 30, 1915.*

[Drainage area, 13,900 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| October | 11,000 | 2,500 | 5,240 | 0.377 | 0.43 | A. |
| November | 2,770 | 1,190 | 1,750 | .126 | .14 | A. |
| February 16–26 | 33,100 | 16,000 | 25,300 | 1.82 | .74 | A. |
| April 6–30 | 12,000 | 4,570 | 8,080 | .582 | .54 | A. |
| May | 36,000 | 3,080 | 8,540 | .615 | .71 | A. |
| June | 56,000 | 8,850 | 24,400 | 1.76 | 1.96 | A. |
| July | 59,000 | 8,850 | 24,300 | 1.75 | 2.02 | A. |
| August | 62,000 | 5,800 | 17,600 | 1.27 | 1.46 | A. |
| September | 28,800 | 4,220 | 10,500 | .755 | .84 | A. |

RACCOON RIVER AT VAN METER, IOWA.

LOCATION.—At highway bridge about one-third mile from railroad station, about 1 mile below South Raccoon River, and about 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 United States Geological Survey map of scale 1 to 500,000).

RECORDS AVAILABLE.—April 25 to September 30, 1915.

GAGE.—Chain gage attached to downstream handrail of bridge about 25 feet from right end of bridge; read once daily by E. C. Trindle.

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

CHANNEL AND CONTROL.—Bed of stream sandy and 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 will not overflow; left bank overflows at a stage of about 11 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, 13.8 feet at 7 a. m. May 29; discharge, 22,900 second-feet; minimum stage recorded, 1.0 foot May 19 (discharge, 540 second-feet).

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

ACCURACY.—Results considered good.

*Discharge measurements of Raccoon River at Van Meter, Iowa, during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* |
| Apr. 24 | C. Herlofson | 3.71 | 1,010 |
| May 29 | A. Davis | 15.61 | 21,900 |
| June 5 | .....do | 9.75 | 7,770 |

*Daily discharge, in second-feet, of Raccoon River at Van Meter, Iowa, for the year ending Sept. 30, 1915.*

| Day. | Apr. | May. | June. | July. | Aug. | Sept. | Day. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 762 | 12,800 | 1,760 | 5,580 | 1,140 | 16 | ..... | 632 | 2,110 | 4,080 | 1,520 | 860 |
| 2 | ..... | 860 | 11,000 | 2,020 | 5,320 | 1,070 | 17 | ..... | 600 | 1,930 | 5,320 | 2,980 | 1,070 |
| 3 | ..... | 2,290 | 9,690 | 1,360 | 4,200 | 1,000 | 18 | ..... | 570 | 2,110 | 6,820 | 2,980 | 1,520 |
| 4 | ..... | 1,210 | 8,760 | 1,360 | 3,620 | 930 | 19 | ..... | 540 | 1,930 | 13,900 | 2,880 | 1,680 |
| 5 | ..... | 1,140 | 7,850 | 1,210 | 3,300 | 930 | 20 | ..... | 570 | 2,020 | 10,800 | 2,480 | 1,600 |
| 6 | ..... | 1,140 | 6,400 | 1,070 | 2,980 | 860 | 21 | ..... | 1,070 | 2,020 | 11,700 | 2,020 | 1,360 |
| 7 | ..... | 1,210 | 6,120 | 2,020 | 2,580 | 795 | 22 | ..... | 1,520 | 2,110 | 7,550 | 1,840 | 1,210 |
| 8 | ..... | 1,210 | 6,260 | 1,840 | 2,290 | 860 | 23 | ..... | 1,360 | 2,020 | 6,540 | 1,680 | 2,110 |
| 9 | ..... | 1,140 | 5,840 | 1,680 | 2,020 | 1,280 | 24 | ..... | 1,760 | 1,930 | 5,980 | 1,440 | 2,780 |
| 10 | ..... | 1,000 | 6,400 | 2,110 | 1,840 | 1,070 | 25 | 1,000 | 2,380 | 1,840 | 5,580 | 1,280 | 2,380 |
| 11 | ..... | 930 | 3,960 | 3,400 | 1,680 | 1,000 | 26 | 930 | 4,560 | 1,600 | 4,560 | 1,210 | 2,380 |
| 12 | ..... | 860 | 3,190 | 4,320 | 1,600 | 860 | 27 | 1,600 | 7,700 | 1,360 | 3,740 | 1,210 | 4,810 |
| 13 | ..... | 795 | 2,880 | 5,320 | 2,380 | 930 | 28 | 1,140 | 16,200 | 1,280 | 8,450 | 1,140 | 8,300 |
| 14 | ..... | 762 | 2,480 | 3,190 | 2,020 | 930 | 29 | 1,000 | 22,900 | 1,210 | 11,000 | 1,360 | 14,600 |
| 15 | ..... | 762 | 2,200 | 2,380 | 1,760 | 860 | 30 | 930 | 15,900 | 1,140 | 8,450 | 1,210 | 18,700 |
| | | | | | | | 31 | ..... | 15,600 | ..... | 6,540 | 1,210 | ..... |

NOTE.—Discharge computed from a rating curve well defined between 500 and 25,000 second-feet.

*Monthly discharge of Raccoon River at Van Meter, Iowa, for the year ending Sept. 30, 1915.*

[Drainage area, 3,410 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| April 25-30 | 1,600 | 930 | 1,100 | 0.323 | 0.07 | B. |
| May | 22,900 | 540 | 3,550 | 1.04 | 1.20 | A. |
| June | 12,800 | 1,140 | 4,080 | 1.20 | 1.34 | A. |
| July | 13,900 | 1,070 | 5,030 | 1.48 | 1.71 | A. |
| August | 5,580 | 1,140 | 2,310 | .677 | .78 | A. |
| September | 18,700 | 795 | 2,660 | .780 | .87 | A. |

## KANKAKEE RIVER AT MOMENCE, ILL.

LOCATION.—At the highway bridge in Momence, about one-half mile below the Chicago & Eastern Illinois Railroad bridge.

DRAINAGE AREA.—2,340 square miles.

RECORDS AVAILABLE.—February 22, 1905, to July 20, 1906; December 3, 1914, to September 30, 1915.

GAGE.—Chain gage attached to the bridge over left channel; read daily, morning and evening, to hundredths, by Oscar Conrad.

DISCHARGE MEASUREMENTS.—Made from upstream side of the bridge across the two channels.

CHANNEL AND CONTROL.—Solid rock; practically permanent; river at gage divided into two channels by an island. Aquatic growth covers bed of river during summer. Recent measurements show that there has been a change in the discharge relation as expressed by the rating curve used prior to July 20, 1906.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 3.90 feet at 8 a. m. July 11 (discharge, 4,640 second-feet); minimum stage recorded, 1.62 feet at 4 p. m. December 3 (discharge, 474 second-feet).

WINTER FLOW.—Discharge relation seriously affected by ice during parts of November, December, and January.

ACCURACY.—Results good for periods when discharge was unaffected by ice or aquatic growth. Results fair for periods when grass was growing in channel.

*Discharge measurements of Kankakee River at Momence, Ill., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Dec. 3 | Peterson and Freund | 1.62 | 458 | Apr. 30 | William Kesler | 2.00 | 972 |
| Feb. 18 | William Kesler | 2.90 | 2,880 | June 17 | do | 2.47 | [a] 1,610 |
| Mar. 16 | do | 2.25 | 1,490 | July 14 | do | 3.47 | [a] 3,690 |
| Apr. 30 | do | 2.00 | 1,010 | | | | |

[a] Aquatic growth in bed of river.

*Daily discharge, in second-feet, of Kankakee River at Momence, Ill., for the year ending Sept. 30, 1915.*

| Day. | Dec. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | ..... | 2,280 | 975 | 990 | 2,620 | 990 | 1,420 | 990 |
| 2 | ..... | ..... | 2,160 | 945 | 1,070 | 2,620 | 990 | 1,420 | 990 |
| 3 | 474 | ..... | 2,050 | 915 | 1,070 | 2,500 | 990 | 2,160 | 930 |
| 4 | 498 | ..... | 2,050 | 714 | 1,070 | 2,390 | 990 | 2,500 | 930 |
| 5 | 510 | ..... | 2,050 | 635 | 1,070 | 2,280 | 1,150 | 2,390 | 930 |
| 6 | 510 | ..... | 2,050 | 596 | 1,150 | 2,160 | 1,070 | 2,160 | 930 |
| 7 | 522 | ..... | 1,940 | 510 | 1,150 | 2,160 | 1,150 | 1,830 | 990 |
| 8 | 534 | ..... | 1,940 | 462 | 1,150 | 2,050 | 1,240 | 1,420 | 945 |
| 9 | 546 | ..... | 1,940 | 414 | 1,240 | 2,050 | 1,240 | 1,240 | 945 |
| 10 | 546 | ..... | 1,940 | 390 | 1,240 | 2,050 | 1,420 | 1,150 | 870 |
| 11 | 570 | ..... | 1,830 | 402 | 1,240 | 2,050 | 4,640 | 1,070 | 870 |
| 12 | 596 | ..... | 1,720 | 450 | 1,330 | 2,050 | 4,110 | 1,070 | 870 |
| 13 | ..... | ..... | 1,620 | 570 | 1,520 | 2,050 | 4,110 | 1,150 | 870 |
| 14 | ..... | ..... | 1,520 | 635 | 1,620 | 2,050 | 4,110 | 990 | 812 |
| 15 | ..... | ..... | 1,520 | 742 | 2,390 | 1,830 | 4,640 | 1,070 | 742 |
| 16 | ..... | ..... | 1,420 | 840 | 2,390 | 1,720 | 4,110 | 1,240 | 674 |
| 17 | ..... | ..... | 1,420 | 915 | 2,280 | 1,720 | 4,110 | 1,330 | 812 |
| 18 | ..... | 2,860 | 1,420 | 915 | 2,160 | 1,520 | 3,600 | 1,240 | 885 |
| 19 | ..... | 2,860 | 1,330 | 945 | 2,050 | 1,520 | 2,980 | 1,150 | 885 |
| 20 | ..... | 2,860 | 1,330 | 990 | 1,720 | 1,420 | 2,740 | 1,070 | 960 |
| 21 | ..... | 2,980 | 1,330 | 1,150 | 1,420 | 1,240 | 2,160 | 1,070 | 1,070 |
| 22 | ..... | 2,860 | 1,330 | 1,240 | 1,330 | 1,150 | 1,940 | 1,240 | 1,150 |
| 23 | ..... | 2,860 | 1,240 | 1,330 | 1,330 | 1,150 | 1,720 | 1,150 | 1,150 |
| 24 | ..... | 2,740 | 1,240 | 1,330 | 1,420 | 1,150 | 1,620 | 1,150 | 1,150 |
| 25 | ..... | 3,850 | 1,150 | 1,240 | 1,420 | 1,070 | 1,420 | 1,620 | 1,150 |
| 26 | ..... | 5,180 | 1,070 | 1,240 | 1,330 | 990 | 1,330 | 1,620 | 1,150 |
| 27 | ..... | 2,500 | 1,070 | 1,150 | 1,330 | 915 | 1,240 | 1,420 | 1,150 |
| 28 | ..... | 2,390 | 1,070 | 1,150 | 1,720 | 840 | 1,240 | 1,330 | 1,150 |
| 29 | ..... | ..... | 1,070 | 1,070 | 2,390 | 840 | 1,420 | 1,240 | 1,150 |
| 30 | ..... | ..... | 1,070 | 990 | 2,740 | 770 | 1,520 | 1,150 | 1,150 |
| 31 | ..... | ..... | 990 | ..... | 2,740 | ..... | 1,420 | 1,070 | ..... |

NOTE.—Discharge determined from a well-defined rating curve. Because of backwater caused by grass in channel, indirect method for shifting channels was used for computing discharge May 26 to Sept. 30. Discharge estimated, because of ice, from gage heights, observer's notes, and climatic records as follows: Dec. 13–31, 550 second-feet; Jan. 1–15, 550 second-feet; Jan. 5–31, 700 second-feet; and Feb. 1–17, 2,500 second-feet. These estimates for the period, when the discharge relation is believed to have been affected by backwater from ice, are based upon insufficient data and should be used with caution.

*Monthly discharge of Kankakee River at Momence, Ill., for the year ending Sept. 30, 1915.*

[Drainage area, 2,340 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| December | | | 543 | 0.232 | 0.25 | D. |
| January | | | 627 | .268 | .31 | D. |
| February | | | 2,730 | 1.17 | 1.22 | D. |
| March | 2,280 | 990 | 1,550 | .662 | .76 | A |
| April | 1,330 | 390 | 862 | .368 | .41 | A. |
| May | 2,740 | 990 | 1,580 | .675 | .78 | B. |
| June | 2,620 | 770 | 1,700 | .727 | .81 | B. |
| July | 4,640 | 990 | 2,170 | .927 | 1.07 | B. |
| August | 2,500 | 990 | 1,390 | .594 | .68 | C. |
| September | 1,150 | 674 | 975 | .417 | .47 | C. |

KANKAKEE RIVER AT CUSTER PARK, ILL.

LOCATION.—At Wabash Railroad bridge at Custer Park; about one-half mile above Horse Creek and about 15 miles below the power dam at Kankakee.

DRAINAGE AREA.—4,870 square miles.

RECORDS AVAILABLE.—November 6, 1914, to September 30, 1915.

GAGE.—Chain gage attached to bridge; read daily, morning and afternoon, to hundredths, 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.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year: 12.60 feet at 5.30 p. m. July 11 (discharge, 21,300 second-feet); minimum stage recorded, 4.09 feet at 8.20 a. m. November 15 (discharge not determined).

WINTER FLOW.—Discharge relation seriously affected by ice during part of December, January, and February.

REGULATION.—Operation of power plants at Kankakee cause fluctuation at the gage.

ACCURACY.—Gage readings reliable; records good except during winter.

*Discharge measurements of Kankakee River at Custer Park, Ill., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Nov. 21 | Peterson and Kessler | 4.87 | [a] 333 | May 11 | William Kessler | 5.74 | 1,350 |
| Feb. 24 | William Kessler | 7.22 | 4,150 | July 13 | do | 11.11 | 15,800 |
| Apr. 10 | do | 5.59 | 1,380 | 13 | do | 10.93 | 15,600 |
| May 1 | do | 5.57 | 1,220 | | | | |

[a] Thin ice cover on river.

*Daily discharge, in second-feet, of Kankakee River at Custer Park, Ill., for the year ending Sept. 30, 1915.*

| Day. | Nov. | Dec. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 611 | ..... | 3,470 | 1,340 | 1,340 | 5,130 | 1,480 | 7,580 | 2,130 |
| 2 | ..... | 611 | ..... | 3,070 | 1,280 | 1,280 | 4,880 | 1,640 | 8,790 | 1,880 |
| 3 | ..... | 611 | ..... | 2,880 | 1,340 | 1,480 | 4,880 | 1,640 | 14,000 | 2,130 |
| 4 | ..... | 611 | ..... | 2,690 | 1,210 | 1,340 | 5,380 | 1,640 | 12,600 | 1,960 |
| 5 | ..... | 611 | ..... | 2,500 | 1,140 | 1,340 | 5,130 | 2,040 | 10,000 | 1,800 |
| 6 | 567 | 611 | ..... | 2,500 | 1,080 | 1,340 | 4,880 | 1,960 | 7,880 | 1,800 |
| 7 | 535 | 655 | ..... | 2,500 | 1,210 | 1,480 | 4,390 | 1,800 | 6,170 | 1,960 |
| 8 | 551 | 655 | ..... | 2,600 | 1,080 | 1,640 | 3,680 | 2,500 | 5,130 | 1,800 |
| 9 | 526 | 655 | ..... | 2,310 | 1,140 | 1,480 | 4,390 | 2,400 | 4,390 | 2,220 |
| 10 | 502 | 655 | ..... | 2,600 | 1,140 | 1,560 | 3,070 | 2,880 | 3,680 | 1,880 |
| 11 | 611 | 655 | ..... | 2,500 | 1,280 | 1,480 | 2,880 | 19,500 | 3,070 | 2,220 |
| 12 | 551 | 611 | ..... | 2,400 | 1,480 | 2,310 | 2,690 | 19,200 | 2,880 | 1,880 |
| 13 | 551 | 655 | ..... | 2,310 | 1,480 | 1,410 | 2,500 | 16,000 | 2,880 | 1,880 |
| 14 | 559 | ..... | ..... | 1,880 | 1,720 | 1,210 | 2,500 | 14,000 | 2,690 | 2,880 |
| 15 | 250 | ..... | ..... | 1,960 | 1,560 | 1,280 | 2,310 | 16,000 | 2,880 | 2,600 |
| 16 | 535 | ..... | 6,170 | 1,800 | 1,480 | 1,410 | 2,500 | 16,400 | 3,070 | 2,130 |
| 17 | 410 | ..... | 5,130 | 1,960 | 1,480 | 2,130 | 2,130 | 15,300 | 4,630 | 1,720 |
| 18 | 250 | ..... | 4,150 | 1,640 | 1,410 | 2,880 | 2,040 | 16,700 | 3,910 | 2,130 |
| 19 | 567 | ..... | 3,910 | 1,640 | 1,280 | 1,800 | 2,220 | 11,600 | 3,270 | 3,910 |
| 20 | 350 | ..... | 3,470 | 1,340 | 1,340 | 1,720 | 1,880 | 10,000 | 3,270 | 4,630 |
| 21 | 330 | ..... | 3,070 | 1,340 | 1,280 | 1,560 | 1,800 | 8,480 | 3,910 | 6,170 |
| 22 | 410 | ..... | 3,270 | 1,640 | 1,340 | 1,640 | 1,720 | 7,290 | 6,720 | 5,900 |
| 23 | 478 | ..... | 3,270 | 1,410 | 1,960 | 1,640 | 1,640 | 6,440 | 6,170 | 5,130 |
| 24 | 502 | ..... | 4,150 | 1,560 | 2,220 | 2,130 | 1,560 | 5,640 | 6,440 | 4,390 |
| 25 | 551 | ..... | 4,880 | 1,720 | 2,310 | 2,040 | 1,560 | 4,880 | 8,480 | 3,680 |
| 26 | 518 | ..... | 4,880 | 1,560 | 2,400 | 2,040 | 1,560 | 5,640 | 7,290 | [a] 3,920 |
| 27 | 567 | ..... | 4,390 | 1,410 | 2,040 | 1,800 | 1,410 | 5,900 | 5,900 | [a] 4,160 |
| 28 | 567 | ..... | 3,680 | 1,340 | 1,880 | 1,880 | 1,410 | 5,640 | 4,880 | [a] 4,400 |
| 29 | 611 | ..... | ..... | 1,340 | 1,720 | 2,500 | 1,340 | 5,900 | 3,910 | 4,630 |
| 30 | 611 | ..... | ..... | 1,480 | 1,480 | 3,680 | 1,280 | 7,290 | 2,690 | 4,630 |
| 31 | ..... | ..... | ..... | 1,280 | ..... | 4,630 | ..... | 7,580 | 2,400 | ..... |

[a] Interpolated.

NOTE.—Discharge, except as noted below, determined from a fairly well-defined rating curve. Discharge estimated, because of ice, from gage heights, observer's notes, and climatic records, as follows: Nov. 17 and 19–22, daily estimates; Dec. 14–31, 600 second-feet; Jan. 1–15, 600 second-feet; Jan. 16–31, 800 second-feet; and Feb. 1–15, 3,000 second-feet. These estimates for the period when the discharge relation is believed to have been affected by ice are based upon insufficient data and should be used with caution.

*Monthly discharge of Kankakee River at Custer Park, Ill., for the year ending Sept. 30, 1915.*

[Drainage area, 4,870 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| November 6–30 | 611 | 250 | 498 | 0.102 | 0.09 | C. |
| December | ..... | ..... | 613 | .126 | .15 | D. |
| January | ..... | ..... | 703 | .144 | .17 | D. |
| February | ..... | ..... | 3,550 | .729 | .76 | D. |
| March | 3,470 | 1,280 | 2,020 | .415 | .48 | B. |
| April | 2,400 | 1,080 | 1,500 | .308 | .34 | B. |
| May | 4,630 | 1,210 | 1,850 | .380 | .44 | B. |
| June | 5,380 | 1,280 | 2,820 | .579 | .65 | B. |
| July | 19,500 | 1,480 | 7,920 | 1.63 | 1.88 | B. |
| August | 14,000 | 2,400 | 5,530 | 1.14 | 1.31 | B. |
| September | 6,170 | 1,720 | 3,080 | .632 | .71 | B. |

## DES PLAINES RIVER AT LEMONT, ILL.

LOCATION.—At concrete highway bridge at Stephens Street, about one-fourth mile north of main section of Lemont; about 8 miles above the junction of Des Plaines River and the Chicago Drainage Canal

DRAINAGE AREA.—705 square miles.

RECORDS AVAILABLE.—November 4, 1914, to September 30, 1915.

GAGE.—Enamel staff gage attached to bridge; read daily, morning and evening, to hundredths, by T. Foley.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge.

CHANNEL AND CONTROL.—Solid rock; aquatic plants cover the bed of the river during July, August, and September.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 5.1 feet at 6.15 p. m, May 31, 7 a. m. and 5.30 p. m. June 1, and 7 a. m. June 2 (discharge, 2,490 second-feet); minimum stage recorded, 0.60 foot November 26 (discharge, 3.9 second-feet; measured by current meter).

WINTER FLOW.—Discharge relation affected by ice during parts of December, January. and February.

ACCURACY.—Aquatic plants in channel affect discharge relation; gage readings reliable; records good except during winter.

*Discharge measurements of Des Plaines River at Lemont, Ill., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Nov. 3 | William Kessler | 1.30 | [a] 135 | Mar. 3 | William Kessler | 1.37 | 158 |
| 4 | do | 1.13 | [a] 94 | Apr. 24 | do | 1.24 | [a] 82.2 |
| 26 | B. J. Peterson | .60 | 3.9 | June 1 | C. U. Freund | 5.10 | 2,490 |
| Feb. 22 | William Kessler | 3.85 | 1,320 | July 31 | William Kessler | 3.25 | [a] 562 |
| 23 | do | 3.90 | 1,440 | Aug. 5 | J. B. Fountain | 5.05 | [a] 1,730 |

[a] Backwater from aquatic plants.

*Daily discharge, in second-feet, of Des Plaines River at Lemont, Ill., for the year ending Sept. 30, 1915.*

| Day. | Nov. | Dec. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 9 | ..... | 1,250 | 174 | 44 | 2,490 | 348 | 752 | 61 |
| 2 | ..... | 8 | ..... | 1,120 | 160 | 43 | 2,490 | 300 | 752 | 58 |
| 3 | ..... | 14 | ..... | 1,000 | 158 | 50 | 2,380 | 250 | 972 | 52 |
| 4 | 88 | 15 | ..... | 832 | 138 | 63 | 2,180 | 204 | 1,520 | 44 |
| 5 | 61 | 12 | ..... | 673 | 138 | 75 | 1,900 | 234 | 1,680 | 43 |
| 6 | 60 | 11 | ..... | 548 | 129 | 75 | 1,480 | 190 | 1,520 | 48 |
| 7 | 84 | 9 | ..... | 478 | 113 | 88 | 1,250 | 190 | 1,220 | 60 |
| 8 | 52 | 8 | ..... | 414 | 102 | 92 | 1,120 | 204 | 972 | 126 |
| 9 | 39 | 12 | ..... | 374 | 100 | 90 | 1,060 | 234 | 805 | 84 |
| 10 | 30 | 15 | ..... | 336 | 113 | 88 | 943 | 266 | 597 | 80 |
| 11 | 29 | 14 | ..... | 355 | 111 | 94 | 832 | 478 | 478 | 138 |
| 12 | 28 | 16 | ..... | 478 | 117 | 83 | 887 | 414 | 394 | 138 |
| 13 | 27 | 15 | ..... | 524 | 113 | 73 | 1,560 | 355 | 355 | 115 |
| 14 | 29 | 15 | ..... | 524 | 153 | 72 | 1,900 | 283 | 355 | 104 |
| 15 | 28 | 18 | ..... | 524 | 156 | 58 | 1,990 | 300 | 414 | 94 |
| 16 | 24 | 14 | ..... | 572 | 153 | 66 | 1,900 | 355 | 456 | 126 |
| 17 | 23 | 15 | ..... | 572 | 126 | 300 | 1,810 | 414 | 374 | 176 |
| 18 | 22 | 14 | ..... | 597 | 117 | 597 | 1,720 | 355 | 300 | 219 |
| 19 | 20 | 14 | ..... | 597 | 124 | 501 | 1,640 | 300 | 266 | 336 |
| 20 | 18 | 15 | ..... | 572 | 120 | 355 | 1,480 | 250 | 234 | 394 |
| 21 | 18 | ..... | 1,480 | 548 | 104 | 318 | 1,480 | 219 | 234 | 435 |
| 22 | 17 | ..... | 1,320 | 478 | 94 | 394 | 1,400 | 190 | 219 | 435 |
| 23 | 14 | ..... | 1,480 | 435 | 92 | 943 | 1,180 | 176 | 190 | 394 |
| 24 | 11 | ..... | 1,640 | 374 | 84 | 943 | 1,000 | 150 | 163 | 374 |
| 25 | 10 | ..... | 1,720 | 374 | 75 | 778 | 832 | 150 | 150 | 300 |
| 26 | 9 | ..... | 1,720 | 336 | 72 | 648 | 699 | 126 | 150 | 300 |
| 27 | 9 | ..... | 1,480 | 300 | 68 | 887 | 622 | 115 | 126 | 318 |
| 28 | 9 | ..... | 1,320 | 266 | 72 | 1,180 | 524 | 115 | 104 | 414 |
| 29 | 7 | ..... | ..... | 283 | 66 | 1,320 | 456 | 283 | 84 | 524 |
| 30 | 7 | ..... | ..... | 219 | 56 | 1,900 | 394 | 394 | 75 | 524 |
| 31 | ..... | ..... | ..... | 219 | ..... | 2,380 | ..... | 597 | 63 | ..... |

NOTE.—Discharge, except as noted below, determined from a fairly well-defined rating curve. Indirect method for shifting channel used for determining discharge Nov. 4 to Dec. 20, Apr. 6 to May 29, and July 1 to Sept. 30. Discharge estimated, because of ice, from gage heights, observer's notes, and climatic records, as follows: Dec. 21–31, 20 second-feet; Jan. 1–31, 40 second-feet; Feb. 1–20, 1,000 second-feet. Estimates for the period when the discharge relation is believed to have been affected by ice are based upon insufficient data and should be used with caution.

*Monthly discharge of Des Plaines River at Lemont, Ill., for the year ending Sept. 30, 1915.*

[Drainage area, 705 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| November 4-30 | 88 | 7 | 28.6 | 0.041 | 0.04 | C. |
| December | | 8 | 15.6 | .022 | .03 | D. |
| January | | | 40.0 | .057 | .07 | D. |
| February | | | 1,150 | 1.63 | 1.70 | D. |
| March | 1,250 | 219 | 522 | .740 | .85 | B. |
| April | 174 | 56 | 113 | .160 | .18 | B. |
| May | 2,380 | 43 | 471 | .668 | .77 | C. |
| June | 2,490 | 394 | 1,390 | 1.97 | 2.20 | B. |
| July | 597 | 115 | 272 | .386 | .45 | C. |
| August | 1,680 | 63 | 515 | .730 | .84 | B. |
| September | 524 | 43 | 217 | .308 | .34 | C. |

DES PLAINES RIVER AT ROMEO, ILL.

LOCATION.—In T. 36 N., R. 10 E., third principal meridian; at highway bridge about three-fourths mile west of Romeo, Will County; about 3 miles above the junction of Des Plaines River and the Chicago drainage canal.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—September 7 to October 31, 1914, when station was discontinued; re-established November 4, 1914, at Lemont, about 5 miles upstream.

GAGE.—Chain gage attached to downstream side of the second of four bridges from Romeo; read daily, morning and afternoon, to quarter-tenths, by Fred Boehme.

DISCHARGE MEASUREMENTS.—Made from downstream side of four bridges.

CHANNEL AND CONTROL.—Four channels; rock bottom; control probably permanent.

EXTREMES OF STAGE.—Maximum stage recorded during year, 1.8 feet at 7 a. m. October 21; minimum stage recorded, 1.35 feet, October 5 to 9.

ACCURACY.—Gage readings reliable. Conditions at this station are not favorable, and it was therefore discontinued and a new station established at Lemont. (*See* Des Plaines River at Lemont.)

No discharge measurements made during 1915.

Data insufficient for estimates of discharge.

*Daily gage height, in feet, of Des Plaines River at Romeo, Ill., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Day. | Oct. | Day. | Oct. |
|---|---|---|---|---|---|
| 1 | 1.40 | 11 | 1.45 | 21 | 1.75 |
| 2 | 1.40 | 12 | 1.45 | 22 | 1.75 |
| 3 | 1.40 | 13 | 1.45 | 23 | 1.70 |
| 4 | 1.40 | 14 | 1.46 | 24 | 1.62 |
| 5 | 1.35 | 15 | 1.42 | 25 | 1.55 |
| 6 | 1.35 | 16 | 1.40 | 26 | 1.50 |
| 7 | 1.35 | 17 | 1.40 | 27 | 1.50 |
| 8 | 1.35 | 18 | 1.41 | 28 | 1.50 |
| 9 | 1.35 | 19 | 1.48 | 29 | 1.50 |
| 10 | 1.42 | 20 | 1.62 | 30 | |
| | | | | 31 | 1.52 |

DES PLAINES RIVER AT JOLIET, ILL.

LOCATION.—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, 1915; on original chain gage September 5 to December 19, 1914.

GAGE.—Gurley seven-day water-stage recorder installed December 3. Chain gage attached to downstream side of bridge at Cass Street was 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 year, 10,980 second-feet, August 3; minimum mean daily discharge, 5,420 second-feet, April 25.

WINTER FLOW.—Discharge relation not affected by ice on account of swift current and rapidly fluctuating stage.

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 sanitary district of Chicago 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 the gage.

ACCURACY.—Chain-gage readings reliable, but daily discharge obtained from two readings per day is in error owing to rapid fluctuations of stage. Estimates of discharge obtained by means of water-stage recorder good.

*Discharge measurements of Des Plaines River at Joliet, Ill., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 29 | Horton and Kessler | [a] 4.27 | 5,970 | Feb. 27 | William Kessler | 5.46 | 10,300 |
| Nov. 1 | William Kessler | [a] 2.48 | 2,590 | 28 | do | 2.47 | 3,970 |
| 4 | do | [a] 4.63 | 6,660 | 28 | do | 2.52 | 4,390 |
| Feb. 20 | do | 3.15 | 5,640 | Mar. 14 | do | 5.34 | 9,690 |
| 20 | do | 3.53 | 6,120 | 14 | do | 1.87 | 3,190 |
| 20 | do | 5.64 | 11,000 | 14 | do | 1.87 | 3,200 |
| 21 | do | 3.49 | 5,310 | 15 | do | 5.29 | 9,740 |
| 22 | do | 4.07 | 7,310 | June 19 | Kessler and Freund | 5.84 | 11,400 |
| 22 | do | 3.86 | 6,800 | Aug. 8 | William Kessler | 6.00 | 12,000 |

[a] Referred to chain gage datum at Cass Street.

*Discharge measurements of Illinois & Michigan Canal [a] at Joliet, Ill., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height.[b] | Discharge. | Date. | Made by— | Gage height.[b] | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Oct. 29 | William Kessler | 7.92 | 444 | Apr. 24 | William Kessler | 7.58 | 320 |
| Nov. 1 | do | 7.68 | 358 | May 21 | do | 7.55 | 386 |
| 22 | B. J. Peterson | 7.75 | [c] 337 | | | | |

[a] See "Diversions" in station description.
[b] Referred to same datum as chain gage on Des Plaines River at Joliet at Cass Street. See "gage" in station description.
[c] Mill drawing water from the canal below station not in operation.

*Daily gage height, in feet, of Des Plaines River at Joliet, Ill., for the period Oct. 1 to Dec. 19, 1914.*

[J. S. Staunton, observer.]

| Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. | Day. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.8 | 3.4 | 4.6 | 11 | ..... | 4.4 | 4.5 | 21 | 4.0 | 3.4 | ..... |
| 2 | 4.8 | 4.2 | 4.4 | 12 | 4.8 | 4.0 | 3.4 | 22 | 4.2 | 3.6 | ..... |
| 3 | 3.9 | 3.8 | 4.5 | 13 | 4.6 | 4.6 | 3.4 | 23 | 4.3 | 4.3 | ..... |
| 4 | 4.5 | 4.2 | 4.3 | 14 | 5.4 | 4.2 | 4.6 | 24 | 4.4 | 4.4 | ..... |
| 5 | 5.2 | 4.2 | 3.4 | 15 | 4.6 | 4.3 | 4.7 | 25 | ..... | 4.4 | ..... |
| 6 | 4.9 | 4.2 | 3.5 | 16 | 5.0 | 4.4 | 4.6 | 26 | 4.6 | 3.2 | ..... |
| 7 | 3.8 | 3.7 | 4.6 | 17 | 4.7 | 4.2 | 4.4 | 27 | 4.4 | 4.0 | ..... |
| 8 | 4.8 | 3.7 | 4.4 | 18 | ..... | 4.3 | 4.8 | 28 | 4.6 | 3.4 | ..... |
| 9 | 4.6 | 4.2 | 4.3 | 19 | 5.0 | 4.2 | 4.0 | 29 | 4.2 | 3.3 | ..... |
| 10 | 4.4 | 4.4 | 4.3 | 20 | 4.1 | 4.3 | ..... | 30 | 4.2 | 4.2 | ..... |
| | | | | | | | | 31 | 3.8 | ..... | ..... |

NOTE.—Gage heights represent mean of two readings a day of the chain gage at Cass Street Bridge. Because of the fluctuations in stage, noted under "Regulation," they do not represent the true mean gage height.

*Daily discharge, in second-feet, of Des Plaines River at Joliet, Ill., for the year ending Sept. 30, 1915.*

| Day. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 6,550 | 7,370 | 8,460 | a 7,560 | 6,600 | 10,220 | a 8,230 | 7,930 | 7,940 |
| 2 | ..... | 7,120 | a 7,970 | 8,140 | a 7,760 | 6,780 | 10,000 | a 8,150 | 8,480 | 7,960 |
| 3 | ..... | 6,510 | a 8,020 | 8,140 | 6,500 | 7,110 | 9,950 | a 7,550 | 10,980 | 7,910 |
| 4 | 7,640 | 7,560 | 7,960 | 7,770 | 6,220 | 7,000 | 9,680 | 7,300 | 10,080 | 7,710 |
| 5 | 7,080 | 7,090 | a 8,000 | 7,670 | 6,760 | 7,150 | 8,870 | 6,980 | 10,110 | 7,590 |
| 6 | 6,600 | 7,290 | a 7,250 | a 6,950 | 6,500 | 7,130 | 8,520 | 7,240 | 9,730 | 7,850 |
| 7 | 7,770 | 7,280 | a 6,630 | a 6,780 | 6,800 | 6,960 | 8,180 | 7,530 | 9,400 | 8,120 |
| 8 | 7,750 | 7,030 | a 8,000 | a 7,360 | 6,810 | 6,850 | 8,000 | (b) | 8,920 | 8,000 |
| 9 | 7,440 | 6,500 | 8,340 | a 7,940 | 6,580 | 6,640 | 8,580 | a 7,570 | 8,830 | 8,190 |
| 10 | 7,710 | 6,050 | 8,330 | 7,720 | 6,100 | 7,310 | a 8,130 | 7,690 | 8,980 | 8,050 |
| 11 | 8,170 | 7,640 | 8,240 | 7,490 | 5,830 | 7,330 | 8,200 | 8,220 | 8,650 | 8,040 |
| 12 | 7,220 | 7,310 | 8,700 | 7,880 | 6,640 | 7,090 | 7,960 | 8,270 | 8,860 | 7,960 |
| 13 | 7,320 | 7,110 | 8,030 | 7,000 | 7,230 | 7,080 | 8,920 | 7,470 | 8,750 | 8,530 |
| 14 | (b) | 7,200 | a 7,880 | a 6,380 | 7,000 | 7,180 | 9,390 | 8,200 | 8,060 | 8,500 |
| 15 | (b) | 7,400 | 9,050 | 7,780 | 6,700 | 6,590 | 9,580 | 8,180 | 8,210 | 8,440 |
| 16 | (b) | 6,870 | 9,480 | 8,300 | 6,900 | 6,710 | 9,450 | 8,240 | 8,280 | 8,390 |
| 17 | (b) | 6,740 | 10,100 | 8,680 | 6,450 | 6,940 | 9,320 | 7,340 | 8,500 | 8,200 |
| 18 | (b) | 7,670 | 9,210 | 8,320 | 5,530 | 7,410 | 8,820 | 7,600 | 8,220 | 7,450 |
| 19 | (b) | 7,870 | 8,970 | 8,150 | 6,600 | 7,800 | 9,210 | 7,670 | 8,360 | (b) |
| 20 | (b) | 7,760 | 8,200 | a 8,030 | 6,910 | 7,530 | 8,820 | 7,920 | 8,770 | (b) |
| 21 | (b) | 7,550 | 8,480 | a 6,560 | 6,790 | 6,960 | 8,600 | 7,770 | 8,290 | 8,080 |
| 22 | 7,550 | 7,630 | 8,700 | a 8,300 | 6,740 | a 7,140 | 8,500 | 7,450 | 8,070 | 7,720 |
| 23 | 7,580 | a 7,240 | 9,100 | a 8,050 | 6,750 | 7,310 | 8,640 | 7,000 | 8,700 | (b) |
| 24 | 7,430 | (b) | 9,220 | 7,700 | 6,000 | 7,590 | 8,250 | 7,520 | 8,540 | (b) |
| 25 | (b) | (b) | 9,400 | 7,580 | 5,420 | 8,040 | 8,240 | 6,110 | 8,630 | (b) |
| 26 | (b) | (b) | 9,680 | a 7,860 | 6,700 | 7,990 | a 8,310 | 6,730 | 8,700 | 7,840 |
| 27 | 6,130 | (b) | 8,340 | 6,810 | 6,940 | 7,820 | 7,820 | 6,820 | 8,510 | 8,180 |
| 28 | 6,970 | (b) | a 7,300 | a 6,640 | 7,140 | 8,180 | 7,730 | 7,200 | 7,950 | 8,500 |
| 29 | 7,050 | (b) | ..... | a 7,400 | 7,050 | 9,050 | 7,580 | 7,640 | 7,580 | 8,210 |
| 30 | 7,840 | (b) | ..... | 7,250 | 6,940 | 8,930 | 7,620 | 8,100 | 8,260 | 8,210 |
| 31 | 7,370 | 6,300 | ..... | 7,400 | ..... | 9,660 | ..... | 8,310 | 8,580 | ..... |

a Discharge partly estimated because of incomplete gage height record. b No record.

NOTE.—Daily discharge determined from a well-defined rating curve by means of the Fuller discharge integrator. These estimates do 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, 1915.*

| Month. | Discharge in second-feet. | | | Accuracy. |
|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | |
| February | 10,100 | 7,250 | 8,430 | A. |
| March | 8,680 | 6,380 | 7,630 | A. |
| April | 7,760 | 5,420 | 6,660 | A. |
| May | 9,660 | 6,590 | 7,420 | A. |
| June | 10,220 | 7,580 | 8,700 | A. |
| August | 10,980 | 7,580 | 8,710 | A. |

NOTE.—Table does not include flow of the Illinois and Michigan canal, which diverts water around the gage. See "Diversions" in station description and measurements of flow in the canal made during the year.

FOX RIVER AT SOUTH ELGIN, ILL.

LOCATION.—In sec. 35, T. 41 N., R. 8 E., at highway bridge at South Elgin, Kane County; about 400 feet below the power dam of the Murray & Nickell Manufacturing Co., and about 3 miles below the power dam in the city of Elgin.

DRAINAGE AREA.—1,500 square miles.

RECORDS AVAILABLE.—July 29, 1914, to September 30, 1915.

GAGE.—Chain gage attached to bridge; read daily, morning and afternoon, to quarter-tenths to March 6, 1915, and to hundredths after that date, by C. H. Molitor.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge.

CHANNEL AND CONTROL.—Solid rock, permanent; aquatic plants cover bed of river during summer.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 4.2 feet at 4.30 p. m. February 28 (discharge, 4,520 second-feet); minimum open-water stage recorded, 1.28 feet at 6.55 a. m. January 6 (discharge, 121 second-feet). The minimum during periods when ice was present may have been slightly less.

WINTER FLOW.—Discharge relation affected by ice during parts of December, January, and February.

REGULATION.—Operation of the power plants at Elgin and South Elgin cause considerable fluctuation at the gage.

ACCURACY.—Gage readings reliable; estimates only fair because the mean gage height obtained from two readings of the gage per day may be considerably in error owing to fluctuation of stage. Aquatic plants in the channel during periods of the summer affect the discharge relation.

*Discharge measurements of Fox River at South Elgin, Ill., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Mar. 6 | William Kessler | 3.70 | 3,370 | May 21 | William Kessler | 2.32 | 1,090 |
| May 5 | do | 1.96 | 648 | June 19 | do | 3.11 | 2,160 |
| 15 | do | 1.87 | 583 | 22 | do | 3.17 | 2,290 |
| 20 | do | 2.09 | 824 | 26 | do | 2.79 | 1,640 |
| 21 | do | 2.01 | 765 | Aug. 13 | Kessler and Fountain | 2.65 | [a] 918 |

[a] Aquatic plants in channel.

*Daily discharge, in second-feet, of Fox River at South Elgin, Ill., for the years ending Sept. 30, 1914–1915.*

| Day. | July. | Aug. | Sept | Day. | July. | Aug. | Sept. | Day. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1914. | | | | 1914. | | | | 1914. | | | |
| 1 | ..... | 160 | 64 | 11 | ..... | 357 | 218 | 21 | ..... | 61 | 510 |
| 2 | ..... | 276 | 76 | 12 | ..... | 154 | 190 | 22 | ..... | 47 | 616 |
| 3 | ..... | 324 | 108 | 13 | ..... | 103 | 211 | 23 | ..... | 45 | 427 |
| 4 | ..... | 366 | 121 | 14 | ..... | 37 | 232 | 24 | ..... | 79 | 464 |
| 5 | ..... | 166 | 130 | 15 | ..... | 37 | 239 | 25 | ..... | 82 | 698 |
| 6 | ..... | 70 | 218 | 16 | ..... | 35 | 218 | 26 | ..... | 73 | 709 |
| 7 | ..... | 136 | 308 | 17 | ..... | 41 | 253 | 27 | ..... | 121 | 719 |
| 8 | ..... | 178 | 246 | 18 | ..... | 73 | 292 | 28 | ..... | 108 | 678 |
| 9 | ..... | 53 | 225 | 19 | ..... | 45 | 276 | 29 | 375 | 90 | 688 |
| 10 | ..... | 90 | 211 | 20 | ..... | 35 | 357 | 30 | 260 | 94 | 688 |
| | | | | | | | | 31 | 178 | 76 | ..... |

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1914–15. | | | | | | | | | | | | |
| 1 | 657 | 935 | 268 | ..... | 1,040 | 3,810 | 1,340 | 349 | 1,910 | 1,100 | 567 | 473 |
| 2 | 626 | 935 | 276 | ..... | 990 | 3,810 | 1,280 | 392 | 1,990 | 880 | 567 | 366 |
| 3 | 626 | 880 | 276 | ..... | 597 | 3,580 | 1,220 | 436 | 1,990 | 880 | 668 | 473 |
| 4 | 616 | 935 | 232 | ..... | 548 | 3,580 | 1,280 | 427 | 1,990 | 772 | 567 | 300 |
| 5 | 606 | 880 | 253 | ..... | 606 | 3,810 | 1,280 | 284 | 1,990 | 772 | 616 | 410 |
| 6 | 510 | 825 | 276 | 130 | 825 | 3,360 | 1,410 | 260 | 1,910 | 719 | 567 | 519 |
| 7 | 510 | 678 | 276 | 178 | 538 | 3,140 | 1,220 | 340 | 1,910 | 719 | 519 | 519 |
| 8 | 519 | 647 | 253 | 184 | 410 | 2,830 | 1,160 | 268 | 1,910 | 772 | 616 | 473 |
| 9 | 384 | 657 | 260 | 178 | 772 | 2,830 | 1,100 | 284 | 1,830 | 772 | 616 | 519 |
| 10 | 410 | 558 | 308 | 136 | 880 | 2,730 | 1,040 | 349 | 1,830 | 719 | 519 | 473 |
| 11 | 375 | 538 | 268 | 166 | 1,220 | 2,530 | 880 | 292 | 2,160 | 772 | 519 | 410 |
| 12 | 375 | 482 | 253 | 178 | 2,340 | 2,250 | 825 | 197 | 1,990 | 668 | 567 | 519 |
| 13 | 375 | 501 | 204 | 190 | 2,080 | 2,160 | 825 | 253 | 1,990 | 616 | 567 | 668 |
| 14 | 384 | 340 | 184 | 184 | 2,340 | 2,250 | 880 | 284 | 1,990 | 668 | 519 | 410 |
| 15 | 375 | 292 | ..... | 246 | 1,760 | 2,080 | 880 | 308 | 1,990 | 668 | 668 | 519 |
| 16 | 375 | 276 | ..... | 375 | 1,830 | 1,990 | 935 | 349 | 1,990 | 567 | 719 | 825 |
| 17 | 392 | 253 | ..... | 284 | 1,680 | 1,990 | 825 | 482 | 1,910 | 445 | 772 | 1,040 |
| 18 | 357 | 225 | ..... | 324 | 1,760 | 2,160 | 880 | 401 | 1,910 | 410 | 668 | 1,160 |
| 19 | 445 | 232 | ..... | 308 | 1,830 | 2,080 | 825 | 357 | 1,830 | 510 | 668 | 1,540 |
| 20 | 538 | 276 | ..... | 340 | 1,990 | 1,910 | 719 | 418 | 1,910 | 482 | 616 | 1,610 |
| 21 | 668 | 246 | ..... | 375 | 2,250 | 1,680 | 825 | 657 | 1,990 | 436 | 616 | 1,680 |
| 22 | 678 | 225 | ..... | 340 | 2,340 | 1,760 | 772 | 626 | 1,830 | 410 | 616 | 1,760 |
| 23 | 772 | 232 | ..... | 324 | 2,730 | 1,760 | 772 | 825 | 1,760 | 384 | 616 | 1,990 |
| 24 | 825 | 253 | ..... | 292 | 3,580 | 1,760 | 678 | 825 | 1,610 | 284 | 567 | 1,990 |
| 25 | 880 | 225 | ..... | ..... | 3,810 | 1,760 | 647 | 1,040 | 1,540 | 332 | 616 | 1,990 |
| 26 | 935 | 260 | ..... | ..... | 4,040 | 1,680 | 597 | 1,100 | 1,480 | 418 | 567 | 2,250 |
| 27 | 772 | 246 | ..... | ..... | 3,810 | 1,610 | 501 | 1,220 | 1,340 | 375 | 427 | 2,160 |
| 28 | 825 | 246 | ..... | ..... | 4,280 | 1,540 | 384 | 1,410 | 1,340 | 427 | 384 | 2,250 |
| 29 | 935 | 246 | ..... | ..... | ..... | 1,480 | 436 | 1,680 | 1,220 | 519 | 519 | 2,340 |
| 30 | 935 | 276 | ..... | ..... | ..... | 1,340 | 392 | 1,910 | 1,160 | 418 | 616 | 2,340 |
| 31 | 935 | ..... | ..... | ..... | ..... | 1,480 | ..... | 1,910 | ..... | 473 | 668 | ..... |

NOTE.—Discharge, except as noted, determined from rating curve well defined above and poorly defined below 519 second-feet. Indirect method for shifting channel used because of backwater from aquatic plants, July 29 to Sept. 30, 1914, and July 1 to Sept. 30, 1915. Discharge estimated, because of ice, from gage heights, observer notes, and climatic records, as follows: Dec. 15–31, 230 second-feet; Jan. 1–5, 300 second-feet; Jan. 25–31, 350 second-feet. Daily discharge for January and February in the above table may be somewhat high on account of using open-water rating.

*Monthly discharge of Fox River, at South Elgin, Ill., for the years ending Sept. 30, 1914–15.*

[Drainage area, 1,500 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| 1914. | | | | | | |
| August | 366 | 35 | 117 | 0.078 | 0.09 | C. |
| September | 719 | 64 | 346 | .231 | .26 | C. |
| 1914–15. | | | | | | |
| October | 935 | 357 | 601 | .401 | .46 | C. |
| November | 935 | 225 | 460 | .307 | .34 | C. |
| December | ..... | ..... | 242 | .161 | .19 | D |
| January | ..... | 130 | 280 | .187 | .22 | D |
| February | 4,280 | 410 | 1,890 | 1.26 | 1.31 | C. |
| March | 3,810 | 1,340 | 2,350 | 1.57 | 1.81 | C. |
| April | 1,410 | 384 | 894 | .596 | .67 | C. |
| May | 1,910 | 197 | 643 | .429 | .49 | C. |
| June | 2,160 | 1,160 | 1,810 | 1.21 | 1.35 | C. |
| July | 1,100 | 284 | 593 | .395 | .46 | C. |
| August | 772 | 384 | 591 | .394 | .45 | C. |
| September | 2,340 | 300 | 1,130 | .753 | .84 | C. |
| The year | 4,280 | 130 | 948 | .632 | 8.59 | |

FOX RIVER AT AURORA, ILL.

LOCATION.—In T. 38 N., R. 8 E., at the Elgin, Joliet & Eastern Railway bridge in the southern part of Aurora, Kane County, about 1½ miles below the power dam in Aurora.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—July 29 to October 30, 1914, when station was discontinued.

GAGE.—Chain gage attached to bridge; read daily, morning and afternoon, to quarter-tenths by Ralph Williams.

DISCHARGE MEASUREMENTS.—Made from foot-walk on downstream side of bridge.

CHANNEL AND CONTROL.—Probably permanent; measuring section rough.

REGULATION.—Operation of the power plants in Aurora causes fluctuations at the gage.

ACCURACY.—Gage readings reliable. Mean gage height obtained from two readings a day may be in error owing to fluctuation of the stage.

Data insufficient for estimates of discharge.

*Daily gage height, in feet of Fox River at Aurora, Ill., for the period Oct. 1 to 30, 1914.*

| Day. | Oct. | Day. | Oct. | Day. | Oct. |
|---|---|---|---|---|---|
| 1 | 1.86 | 11 | 1.60 | 21 | 1.91 |
| 2 | 1.82 | 12 | 1.75 | 22 | 1.92 |
| 3 | 1.82 | 13 | 1.65 | 23 | 1.96 |
| 4 | 1.72 | 14 | 1.68 | 24 | 2.02 |
| 5 | 1.79 | 15 | 1.62 | 25 | 2.09 |
| 6 | 1.82 | 16 | 1.71 | 26 | 2.24 |
| 7 | 1.78 | 17 | 1.78 | 27 | 2.12 |
| 8 | 1.74 | 18 | 1.79 | 28 | 2.05 |
| 9 | 1.70 | 19 | 1.80 | 29 | 2.14 |
| 10 | 1.68 | 20 | 1.84 | 30 | 2.11 |
| | | | | 31 | ..... |

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, 1915.

GAGE.—Chain gage attached to bridge; read daily, morning and afternoon, to hundredths, by Nelson Mathias.

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, is of coarse gravel and large boulders and is practically permanent.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 10.00 feet at 4 p. m. February 5 and 6 a. m. June 13 (discharge, 6,450 second-feet); minimum stage recorded, 5.62 feet in afternoon of November 20 (discharge, 105 second-feet; by current meter measurement).

WINTER FLOW.—Discharge relation seriously affected by ice during parts of December, January, and February.

REGULATION.—Fluctuations in stage during low water caused by power plant at Montgomery.

ACCURACY.—Gage readings reliable; estimates good except during winter.

*Discharge measurements of Fox River at Wedron, Ill., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Nov. 5 | William Kessler | 6.81 | 1,030 | May 22 | William Kessler | 7.64 | 1,890 |
| 20 | Peterson and Kessler | 5.62 | [a]105 | June 21 | do | 8.57 | 3,100 |
| Feb. 17 | William Kessler | 8.46 | 2,960 | 21 | do | 8.55 | 3,100 |
| Mar. 1 | do | 9.07 | 4,140 | July 2 | do | 7.16 | 1,310 |
| May 10 | do | 6.15 | 476 | 2 | do | 7.20 | 1,320 |

[a] Partial ice cover at gage and at control.

*Daily discharge, in second-feet, of Fox River at Wedron, Ill., for the year ending Sept. 30, 1915.*

| Day. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 577 | ..... | 4,190 | 4,190 | 1,490 | 577 | 2,870 | 1,440 | 3,770 | 820 |
| 2 | ..... | 654 | ..... | 3,380 | 4,190 | 1,390 | 472 | 2,720 | 1,340 | 2,430 | 820 |
| 3 | ..... | 616 | ..... | 2,570 | 4,190 | 1,390 | 577 | 2,570 | 1,240 | 5,370 | 820 |
| 4 | ..... | 616 | ..... | 2,570 | 3,980 | 1,390 | 694 | 2,570 | 1,190 | 5,630 | 778 |
| 5 | 1,000 | 438 | ..... | 6,450 | 3,770 | 1,090 | 778 | 2,430 | 1,140 | 4,190 | 735 |
| 6 | 910 | 541 | ..... | 5,120 | 3,380 | 1,240 | 694 | 2,170 | 1,000 | 3,200 | 735 |
| 7 | 865 | 541 | ..... | 3,380 | 3,380 | 1,140 | 654 | 2,300 | 1,240 | 2,720 | 820 |
| 8 | 910 | 654 | ..... | 3,030 | 3,200 | 1,140 | 616 | 2,300 | 1,290 | 2,300 | 865 |
| 9 | 778 | 654 | ..... | 2,870 | 2,870 | 1,090 | 472 | 2,170 | 1,340 | 1,930 | 1,040 |
| 10 | 955 | 616 | 654 | 2,430 | 2,870 | 1,090 | 438 | 2,050 | 1,190 | 1,930 | 1,090 |
| 11 | 820 | 577 | 654 | 3,380 | 2,720 | 1,140 | 472 | 2,300 | 2,300 | 1,640 | 1,040 |
| 12 | 778 | 577 | 694 | 4,410 | 2,720 | 1,040 | 438 | 3,380 | 3,380 | 1,540 | 1,190 |
| 13 | 694 | ..... | 694 | 4,880 | 2,570 | 1,190 | 505 | 6,450 | 2,170 | 1,490 | 955 |
| 14 | 778 | ..... | 694 | 6,170 | 2,570 | 1,140 | 472 | 5,370 | 1,640 | 1,540 | 1,040 |
| 15 | 616 | ..... | 778 | 6,170 | 2,430 | 1,040 | 505 | 4,640 | 1,930 | 1,700 | 1,240 |
| 16 | 577 | ..... | 865 | 3,380 | 2,430 | 955 | 616 | 3,980 | 1,930 | 1,700 | 1,240 |
| 17 | 694 | ..... | 1,140 | 2,870 | 2,430 | 910 | 865 | 3,770 | 1,490 | 2,570 | 1,390 |
| 18 | 694 | ..... | 955 | 2,720 | 2,430 | 865 | 865 | 3,380 | 1,290 | 2,300 | 1,590 |
| 19 | 650 | ..... | 694 | 2,570 | 2,300 | 865 | 755 | 3,570 | 1,090 | 1,810 | 1,810 |
| 20 | 300 | ..... | ..... | 2,570 | 2,300 | 1,090 | 735 | 3,380 | 1,140 | 1,540 | 1,930 |
| 21 | 550 | ..... | ..... | 2,430 | 2,170 | 955 | 1,440 | 3,200 | 1,040 | 1,490 | 2,050 |
| 22 | 438 | ..... | ..... | 2,570 | 2,050 | 1,000 | 1,810 | 2,870 | 955 | 1,340 | 2,050 |
| 23 | 505 | ..... | ..... | 3,980 | 2,170 | 910 | 1,390 | 2,570 | 910 | 1,240 | 2,170 |
| 24 | 472 | ..... | ..... | 5,120 | 2,050 | 865 | 1,190 | 2,430 | 865 | 1,240 | 2,170 |
| 25 | 654 | ..... | ..... | 4,640 | 1,930 | 735 | 1,390 | 2,170 | 910 | 1,140 | 2,300 |
| 26 | 541 | ..... | ..... | 3,980 | 1,930 | 654 | 1,810 | 2,050 | 1,190 | 1,040 | 2,430 |
| 27 | 406 | ..... | ..... | 3,770 | 1,810 | 694 | 1,810 | 1,930 | 1,090 | 1,000 | 3,570 |
| 28 | 363 | ..... | ..... | 3,770 | 1,810 | 654 | 1,640 | 1,700 | 1,140 | 955 | 3,570 |
| 29 | 541 | ..... | ..... | ..... | 1,640 | 616 | 2,720 | 1,700 | 2,170 | 865 | 3,380 |
| 30 | 505 | ..... | ..... | ..... | 1,640 | 438 | 4,190 | 1,540 | 5,120 | 820 | 3,380 |
| 31 | ..... | ..... | ..... | ..... | 1,540 | ..... | 3,380 | ..... | 3,570 | 955 | ..... |

NOTE.—Discharge, except as noted, determined from a rating curve well defined above and poorly defined below 375 second-feet. Discharge estimated, because of ice, from gage heights, observer's notes, and climatic records, as follows: Nov. 19–21, daily estimates; Dec. 13–31, 400 second-feet; Jan. 1–9, 550 second-feet; Jan. 20–31, 650 second-feet.

*Monthly discharge of Fox River at Wedron, Ill., for the year ending Sept. 30, 1915.*

[Drainage area, 2,500 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| November 5-30 | 1,000 | ..... | 654 | 0.262 | 0.25 | B. |
| December | ..... | ..... | 473 | .189 | .22 | D. |
| January | 1,140 | ..... | 664 | .266 | .31 | D. |
| February | 6,450 | 2,430 | 3,760 | 1.50 | 1.56 | B. |
| March | 4,190 | 1,540 | 2,630 | 1.05 | 1.21 | B. |
| April | 1,490 | 438 | 1,010 | .404 | .45 | B. |
| May | 4,190 | 438 | 1,130 | .452 | .52 | B. |
| June | 6,450 | 1,540 | 2,880 | 1.15 | 1.28 | B. |
| July | 5,120 | 865 | 1,600 | .640 | .74 | B. |
| August | 5,630 | 820 | 2,040 | .816 | .94 | B. |
| September | 3,570 | 735 | 1,630 | .652 | .73 | B. |

## 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, about 100 feet below the Santa Fe Railway bridge.

DRAINAGE AREA.—1,080 square miles.

RECORDS AVAILABLE.—July 27, 1914, to September 30, 1915.

GAGE.—Chain gage attached to highway bridge; read daily, morning and afternoon, by Michael Cipola.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge.

CHANNEL AND CONTROL.—Channel consists of gravel and rocks. Control consists of coarse gravel.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 18.35 feet at 3.30 p. m. August 3 (discharge, 12,000 second-feet); minimum stage recorded, 0.52 foot October 1 to 7; discharge, 1.3 second-feet.

1914–1915: Maximum stage recorded, 18.35 feet at 3.30 p. m. August 3, 1915 (discharge, 12,000 second-feet); minimum stage recorded, 0.45 foot, August 16 and 17, 1914; discharge, 0.7 second-foot).

WINTER FLOW.—Ice may affect the discharge relation during parts of December, January, and February.

ACCURACY.—Records fair, except for periods in which discharge relation was affected by ice.

*Discharge measurements of Vermilion River near Streator, Ill., during the year ending Sept. 30, 1915.*

| Date. | Made by— | Gage height. | Discharge. | Date. | Made by— | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|
| | | *Feet.* | *Sec.-ft.* | | | *Feet.* | *Sec.-ft.* |
| Feb. 17 | William Kessler | 2.57 | 310 | May 22 | William Kessler | 1.39 | 58.5 |
| May 10 | do | .90 | 15.4 | Aug. 7 | do | 6.47 | 1,870 |
| 10 | do | .90 | 15.4 | Sept. 25 | do | 5.12 | 1,210 |
| 22 | do | 1.39 | 58.2 | | | | |

*Daily discharge, in second-feet, of Vermilion River near Streator, Ill., for the years ending September 30, 1914 and 1915.*

| Day. | July. | Aug. | Sept. | Day. | July. | Aug. | Sept. | Day. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1914. | | | | 1914. | | | | 1914. | | | |
| 1 | ..... | 1.0 | 1.0 | 11 | ..... | 1.0 | 1.3 | 21 | ..... | .9 | 1.3 |
| 2 | ..... | 1.0 | 3.8 | 12 | ..... | .9 | 1.3 | 22 | ..... | 1.0 | 1.8 |
| 3 | ..... | 1.0 | 1.8 | 13 | ..... | .9 | 1.3 | 23 | ..... | 2.5 | 1.3 |
| 4 | ..... | 1.0 | 1.3 | 14 | ..... | 1.0 | 1.3 | 24 | ..... | 1.0 | 1.3 |
| 5 | ..... | 1.0 | 1.0 | 15 | ..... | .8 | 28 | 25 | ..... | 1.0 | 1.3 |
| 6 | ..... | 1.0 | 1.8 | 16 | ..... | .7 | 3.6 | 26 | ..... | 1.0 | 1.3 |
| 7 | ..... | 1.0 | 1.6 | 17 | ..... | .7 | 1.3 | 27 | ..... | 1.0 | 1.3 |
| 8 | ..... | 1.0 | 1.3 | 18 | ..... | .9 | 1.3 | 28 | ..... | 1.0 | 2.2 |
| 9 | ..... | .9 | 1.3 | 19 | ..... | .9 | 1.3 | 29 | ..... | .9 | 1.0 |
| 10 | ..... | 1.0 | 1.3 | 20 | ..... | .9 | 1.3 | 30 | ..... | .9 | 1.0 |
| | | | | | | | | 31 | ..... | .9 | 1.0 |

| Day. | Oct. | Nov. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1914-15. | | | | | | | | | | |
| 1 | 1.3 | 4.7 | 1,350 | 204 | 21 | 29 | 526 | 26 | 3,410 | 464 |
| 2 | 1.3 | 4.7 | 2,510 | 171 | 20 | 27 | 434 | 21 | 2,640 | 375 |
| 3 | 1.3 | 4.7 | 1,210 | 133 | 18 | 39 | 526 | 16 | 9,340 | 318 |
| 4 | 1.3 | 4.9 | 930 | 105 | 17 | 28 | 1,500 | 26 | 8,400 | 252 |
| 5 | 1.3 | 5.2 | 3,720 | 86 | 17 | 26 | 1,300 | 54 | 3,560 | 252 |
| 6 | 1.3 | 4.9 | 1,910 | 100 | 15 | 24 | 1,050 | 193 | 2,450 | 419 |
| 7 | 1.3 | 5.2 | 1,350 | 80 | 14 | 23 | 818 | 216 | 1,800 | 375 |
| 8 | 2.5 | 3.8 | 1,130 | 64 | 14 | 23 | 620 | 252 | 1,450 | 318 |
| 9 | 2.5 | 4.1 | 930 | 85 | 18 | 23 | 495 | 216 | 1,170 | 390 |
| 10 | 3.8 | 4.9 | 891 | 88 | 16 | 17 | 375 | 216 | 930 | 495 |
| 11 | 3.0 | 5.6 | 783 | 86 | 17 | 14 | 291 | 495 | 749 | 854 |
| 12 | 3.0 | 5.2 | 818 | 83 | 30 | 16 | 228 | 749 | 652 | 1,850 |
| 13 | 2.5 | 5.2 | 588 | 85 | 68 | 20 | 193 | 716 | 557 | 2,330 |
| 14 | 4.1 | 5.2 | 620 | 85 | 150 | 21 | 150 | 620 | 464 | 1,750 |
| 15 | 3.0 | 5.2 | 495 | 80 | 127 | 22 | 121 | 557 | 291 | 1,350 |
| 16 | 4.1 | 5.2 | 434 | 72 | 129 | 30 | 98 | 684 | 419 | 1,700 |
| 17 | 3.0 | 5.2 | 360 | 64 | 72 | 11 | 86 | 684 | 360 | 1,650 |
| 18 | 2.5 | ..... | 278 | 59 | 55 | 6.5 | 77 | 557 | 620 | 1,550 |
| 19 | 2.5 | ..... | 216 | 60 | 64 | 88 | 62 | 419 | 930 | 3,340 |
| 20 | 2.5 | ..... | 182 | 54 | 60 | 80 | 59 | 304 | 930 | 3,060 |
| 21 | 2.5 | ..... | 156 | 50 | 51 | 119 | 47 | 216 | 1,050 | 2,710 |
| 22 | 2.8 | ..... | 133 | 46 | 46 | 62 | 59 | 171 | 1,130 | 2,210 |
| 23 | 3.0 | ..... | 193 | 50 | 41 | 45 | 18 | 150 | 1,450 | 1,800 |
| 24 | 3.8 | ..... | 332 | 35 | 41 | 47 | 2.2 | 140 | 2,390 | 1,450 |
| 25 | 3.8 | ..... | 419 | 35 | 40 | 47 | 1.9 | 119 | 1,910 | 1,210 |
| 26 | 3.6 | ..... | 434 | 25 | 38 | 65 | 1.9 | 96 | 1,600 | 1,050 |
| 27 | 4.1 | 6.0 | 360 | 23 | 40 | 83 | 3.0 | 105 | 1,250 | 1,300 |
| 28 | 4.1 | 5.2 | 265 | 24 | 41 | 526 | 20 | 137 | 930 | 1,700 |
| 29 | 3.8 | 5.2 | ..... | 26 | 43 | 749 | 20 | 304 | 818 | 1,700 |
| 30 | 3.8 | 5.2 | ..... | 24 | 34 | 716 | 18 | 684 | 684 | 1,550 |
| 31 | 3.8 | ..... | ..... | 23 | ..... | 652 | ..... | 1,500 | 557 | ..... |

NOTE.—Discharge, except as noted below, determined from fairly well defined rating curve. Discharge estimated, because of ice, from gage heights, observer's notes, and climatic records as follows: Nov. 18–26, 5 second-feet; Dec. 16–31, 2 second-feet; and Jan. 1–31, 4 second-feet. Gage not read Dec. 1–15, 1914; discharge estimated, by comparison with records of stream flow in adjacent drainage basins, at 6 second-feet.

*Monthly discharge of Vermilion River near Streator, Ill., for the years ending Sept. 30, 1914 and 1915.*

[Drainage area, 1,080 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| 1914. | | | | | | |
| August | 2.5 | 0.7 | 1.04 | 0.0010 | 0.001 | C. |
| September | 28 | 1.0 | 2.39 | .0022 | .002 | C. |
| 1914–15. | | | | | | |
| October | 4.1 | 1.3 | 2.81 | .0026 | .003 | B. |
| November | 6.0 | 3.8 | 5.02 | .0046 | .005 | C. |
| December | ..... | ..... | 4 | .0037 | .004 | |
| January | ..... | ..... | 4 | .0037 | .004 | |
| February | 3,720 | 133 | 821 | .760 | .79 | B. |
| March | 204 | 23 | 71.1 | .066 | .08 | A. |
| April | 150 | 14 | 45.2 | .042 | .05 | B. |
| May | 749 | 6.5 | 118 | .109 | .13 | B. |
| June | 1,500 | 1.9 | 307 | .284 | .32 | B. |
| July | 1,500 | 16 | 343 | .318 | .37 | A. |
| August | 9,340 | 291 | 1,770 | 1.64 | 1.89 | B. |
| September | 3,340 | 252 | 1,330 | 1.23 | 1.37 | B. |
| The year | 9,340 | 1.3 | 398 | .369 | 5.02 | |

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 at Seville, Fulton County, about a quarter of a mile east of the railway station at Seville.

DRAINAGE AREA.—1,600 square miles.

RECORDS AVAILABLE.—July 24, 1914, to September 30, 1915.

GAGE.—Standard chain gage attached to bridge; read daily, in the morning, by Raymond Hooper prior to May 1, and by A. E. Meyers beginning May 1.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge; low-water measurements are made by wading below the dam at the 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 year, 23.1 feet at 7.15 a. m. February 3 (ice gorged at control); minimum stage recorded, 2.02 feet at 6.45 a. m. November 19.

1914–1915: Maximum stage recorded, 23.1 feet at 7.15 a. m. February 3, 1915 (ice gorged at control); minimum stage recorded, 1.35 feet July 31, August 28 and 29, 1914.

WINTER FLOW.—Ice may affect discharge relation during parts of December, January, and February.

DIVERSIONS.—Water pumped from reservoir at the pumping station of the Toledo, Peoria & Western Railway; amount not known.

ACCURACY.—Gage readings reliable.

Data insufficient for estimates of discharge.

*Discharge measurements of Spoon River at Seville, Ill., during the year ending Sept. 30, 1915.*

[Made by William Kessler.]

| Date. | Gage height. | Discharge. |
|---|---|---|
| | *Feet.* | *Sec.-ft.* |
| Mar. 20 | 3.40 | 210 |
| June 3 | 5.72 | 1,150 |
| 3 | 5.69 | 1,130 |
| Sept. 20 | 8.39 | 2,650 |

*Daily gage height, in feet, of Spoon River at Seville, Ill., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.28 | 2.18 | 2.25 | 2.32 | 16.1 | 4.25 | 3.0 | 2.58 | 12.8 | 3.6 | 12.6 | 3.0 |
| 2 | 2.22 | 2.15 | 2.25 | 2.32 | 20.5 | 4.0 | 3.0 | 2.58 | 5.7 | 6.8 | 12.6 | 3.0 |
| 3 | 2.20 | 2.15 | 2.28 | 2.30 | 23.1 | 3.9 | 3.0 | 2.73 | 5.6 | 4.7 | 16.0 | 3.0 |
| 4 | 2.12 | 2.15 | 2.28 | 2.32 | 21.2 | 3.8 | 3.0 | 2.68 | 5.1 | 3.7 | 14.0 | 3.0 |
| 5 | 2.10 | 2.12 | 2.28 | 2.32 | 20.9 | 3.9 | 3.0 | 2.72 | 4.7 | 3.55 | 12.0 | 3.1 |
| 6 | 2.10 | 2.12 | 2.28 | 2.32 | 20.4 | 3.7 | 3.0 | 2.84 | 4.5 | 3.4 | 9.9 | 3.0 |
| 7 | 2.10 | 2.12 | 2.28 | ..... | 19.3 | 3.7 | 3.0 | 2.57 | 4.4 | 3.6 | 9.2 | 3.0 |
| 8 | 2.09 | 2.10 | 2.30 | 2.60 | 17.0 | 3.7 | 3.05 | 3.2 | 4.1 | 5.8 | 7.8 | 3.0 |
| 9 | 2.20 | 2.08 | 2.30 | 2.80 | 16.6 | 3.7 | 3.05 | 2.64 | 3.15 | 5.4 | 7.0 | 3.5 |
| 10 | 2.88 | 2.08 | 2.30 | 2.80 | 11.7 | 3.7 | 3.1 | 2.67 | 3.9 | 5.9 | 6.5 | 3.1 |
| 11 | 2.85 | 2.05 | 2.28 | 2.90 | 8.9 | 3.7 | 3.1 | 2.67 | 3.9 | 9.4 | 6.8 | 9.9 |
| 12 | 3.8 | 2.05 | 2.20 | 2.90 | 8.9 | 3.65 | 3.1 | 2.58 | 3.8 | 8.4 | 5.2 | ..... |
| 13 | 3.2 | 2.05 | 2.25 | 2.88 | 9.2 | 3.6 | 3.05 | 2.77 | 3.7 | 5.4 | 4.9 | ..... |
| 14 | 2.92 | 2.05 | 2.02 | 2.78 | 9.3 | 3.6 | 3.05 | 2.67 | 3.6 | 4.3 | 4.5 | ..... |
| 15 | 2.92 | 2.05 | 2.22 | 2.78 | 7.2 | 3.55 | 3.0 | 2.55 | 3.65 | 8.0 | 4.2 | ..... |
| 16 | 2.82 | 2.05 | 2.15 | 2.82 | 5.7 | 3.5 | 3.0 | 2.42 | 3.9 | 10.8 | 6.6 | ..... |
| 17 | 3.1 | 2.05 | 2.12 | 16.5 | 5.1 | 3.5 | 3.0 | 2.62 | 3.7 | 5.7 | 5.6 | ..... |
| 18 | 2.88 | 2.05 | 2.15 | 17.6 | 4.8 | 3.5 | 2.90 | 2.55 | 3.85 | 5.3 | 4.7 | ..... |
| 19 | 2.9 | 2.02 | 2.15 | 14.8 | 4.6 | 3.5 | 2.90 | 2.82 | 3.9 | 5.7 | 4.3 | ..... |
| 20 | 2.85 | 2.05 | 2.15 | 12.3 | 4.5 | 3.5 | 2.90 | 2.37 | 3.15 | 5.4 | 3.9 | ..... |
| 21 | 2.80 | 2.08 | 2.22 | 9.1 | 4.4 | 3.4 | 2.88 | 3.4 | 3.9 | 5.4 | 4.2 | ..... |
| 22 | 2.65 | 2.08 | 2.20 | 7.4 | 4.4 | 3.3 | 2.93 | 3.45 | 3.75 | 5.0 | 4.0 | ..... |
| 23 | 2.60 | 2.08 | 2.18 | 4.8 | 5.3 | 3.3 | 2.98 | 2.72 | 3.55 | 4.2 | 3.9 | ..... |
| 24 | 2.55 | 2.08 | 2.18 | 5.6 | 6.6 | 3.3 | 3.05 | 2.96 | 3.5 | 4.4 | 3.7 | ..... |
| 25 | 2.45 | 2.08 | 2.20 | 6.6 | 5.6 | 3.3 | 3.05 | 3.65 | 3.3 | 4.2 | 3.7 | ..... |
| 26 | 2.38 | 2.15 | 2.20 | 6.4 | 5.2 | 3.3 | 2.98 | 5.5 | 9.2 | 3.9 | 3.5 | ..... |
| 27 | 2.30 | 2.15 | 2.22 | 6.1 | 4.1 | 3.25 | 2.63 | 6.0 | 3.45 | 3.8 | 3.5 | ..... |
| 28 | 2.30 | 2.15 | 2.22 | 5.9 | 4.4 | 3.2 | 2.73 | 5.3 | 3.7 | 3.4 | 3.35 | 4.8 |
| 29 | 2.22 | 2.15 | 2.28 | 5.7 | ..... | 3.15 | 2.68 | 8.6 | 3.5 | 5.6 | 3.3 | 4.8 |
| 30 | 2.20 | 2.20 | 2.25 | 5.4 | ..... | 3.1 | 2.68 | 13.0 | 3.4 | 10.0 | 3.0 | 4.3 |
| 31 | 2.18 | ..... | 2.28 | 6.8 | ..... | 3.0 | ..... | 12.0 | ..... | 12.8 | 3.0 | ..... |

NOTE.—Discharge relation probably affected by ice about Dec. 15 to Feb. 9.

## SANGAMON RIVER AT MONTICELLO, ILL.

LOCATION.—In the northeastern part of T. 18 N., R. 5 E. third principal meridian, at the Illinois Central Railroad bridge, about half a mile west of Monticello, Platt County.

DRAINAGE AREA.—550 square miles.

RECORDS AVAILABLE.—February 4, 1908, to October 1, 1912; October 31 to December 31, 1912; June 23, 1914, to September 30, 1915.

GAGE.—Standard chain gage attached to bridge; read daily, in the morning, 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; shifts during extreme high water. Soundings taken August 4, 1914, indicate that there would be no flow if the water surface at the gage were to fall to a stage of 1.4 feet.

EXTREMES OF DISCHARGE—Maximum stage recorded during year, 13.65 feet at 9 a. m. August 1 (discharge, 4,940 second-feet); minimum stage recorded, 1.6 feet October 1 to 3 and 5 to 9 (discharge, 2 second-feet.

Maximum stage recorded during periods covered by records, 15.2 feet May 14 1908 (discharge, 9,280 second-feet); maximum stage during flood of March–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).

WINTER FLOW.—Discharge relation may be affected by ice during parts of December, January, and February.

ACCURACY.—Results fair except for periods in which discharge relation was affected by ice.

*Discharge measurements of Sangamon River at Monticello, Ill., during the year ending Sept. 30, 1915.*

[Made by William Kessler.]

| Date. | Gage height. | Discharge. |
|---|---|---|
| | *Feet.* | *Sec.-ft.* |
| Mar. 18 | 3.07 | 74.1 |
| 18 | 3.07 | [a]66.3 |
| Aug. 3 | 12.26 | 3,060 |
| 3 | 12.21 | 3,060 |

[a] Measurement made at highway bridge above station.

*Daily discharge, in second-feet, of Sangamon River at Monticello, Ill., for the years ending Sept. 30, 1914 and 1915.*

| Day. | June. | July. | Aug. | Sept. | Day. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|
| 1914. | | | | | 1914. | | | | |
| 1 | | 18 | 1.0 | 6.0 | 16 | | 7.0 | 2.0 | 6.0 |
| 2 | | 17 | 1.0 | 7.0 | 17 | | 6.3 | 2.0 | 6.0 |
| 3 | | 16 | 1.0 | 6.0 | 18 | | 5.5 | 2.0 | 5.0 |
| 4 | | 15 | 2.4 | 6.0 | 19 | | 4.8 | 2.0 | 5.0 |
| 5 | | 14 | 3.0 | 6.0 | 20 | | 4.0 | 2.0 | 4.0 |
| 6 | | 14 | 2.0 | 8.5 | 21 | | 4.0 | 14 | 3.0 |
| 7 | | 13 | 2.0 | 11 | 22 | | 4.0 | 6.0 | 2.0 |
| 8 | | 12 | 2.0 | 21 | 23 | 25 | 4.0 | 6.0 | 2.0 |
| 9 | | 12 | 2.0 | 17 | 24 | 25 | 4.0 | 6.0 | 2.0 |
| 10 | | 11 | 2.0 | 17 | 25 | 22 | 2.0 | 8.0 | 2.0 |
| 11 | | 8.0 | 2.0 | 14 | 26 | 22 | 4.0 | 6.0 | 2.0 |
| 12 | | 8.0 | 2.0 | 9.5 | 27 | 22 | 6.0 | 5.0 | 2.0 |
| 13 | | 8.0 | 1.5 | 7.8 | 28 | 20 | 4.0 | 4.0 | 2.0 |
| 14 | | 8.0 | 2.0 | 6.0 | 29 | 17 | 2.0 | 6.0 | 2.0 |
| 15 | | 7.8 | 2.0 | 6.0 | 30 | 17 | 2.0 | 6.0 | 2.0 |
| | | | | | 31 | | 1.0 | 6.0 | |

*Daily discharge, in second-feet, of Sangamon River at Monticello, Ill., for the years ending Sept. 30, 1914 and 1915*—Continued.

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1914–15. | | | | | | | | | | | | |
| 1 | 2 | 4 | 8 | ..... | 807 | 194 | 41 | 65 | 508 | 60 | 4,860 | 338 |
| 2 | 2 | 4 | 8 | ..... | 1,100 | 165 | 39 | 65 | 258 | 129 | 4,030 | 290 |
| 3 | 2 | 4 | 11 | ..... | 862 | 140 | 38 | 65 | 290 | 73 | 3,200 | 242 |
| 4 | 2 | 4 | 11 | ..... | 1,040 | 119 | 36 | 55 | 258 | 98 | 2,720 | 210 |
| 5 | 2 | 4 | 11 | ..... | 1,220 | 119 | 34 | 55 | 210 | 124 | 1,860 | 179 |
| 6 | 2 | 4 | 11 | 8 | 980 | 119 | 33 | 53 | 175 | 82 | 1,220 | 210 |
| 7 | 2 | 4 | 11 | 8 | 936 | 119 | 33 | 57 | 140 | 134 | 807 | 422 |
| 8 | 2 | 4 | 11 | 8 | 891 | 119 | 33 | 53 | 120 | 371 | 580 | 405 |
| 9 | 2 | 5 | 11 | 7 | 473 | 109 | 33 | 53 | 100 | 242 | 526 | 290 |
| 10 | 3 | 5 | 11 | 8 | 422 | 100 | 36 | 53 | 82 | 134 | 526 | 226 |
| 11 | 3 | 6 | 11 | 8 | 322 | 100 | 78 | 43 | 82 | 366 | 456 | 226 |
| 12 | 3 | 6 | 11 | 8 | 258 | 100 | 119 | 38 | 65 | 599 | 354 | 194 |
| 13 | 3 | 6 | 10 | 8 | 226 | 91 | 226 | 33 | 64 | 371 | 290 | 456 |
| 14 | 7 | 6 | 10 | 8 | 218 | 86 | 152 | 30 | 63 | 258 | 258 | 405 |
| 15 | 6 | 6 | ..... | 8 | 210 | 82 | 119 | 28 | 53 | 165 | 210 | 290 |
| 16 | 6 | 6 | ..... | ..... | 210 | 82 | 100 | 26 | 50 | 165 | 165 | 210 |
| 17 | 6 | 6 | ..... | ..... | 165 | 73 | 86 | 23 | 38 | 508 | 2,640 | 338 |
| 18 | 8 | 6 | ..... | ..... | 140 | 73 | 76 | 22 | 36 | 333 | 1,260 | 814 |
| 19 | 10 | 6 | ..... | ..... | 119 | 73 | 65 | 21 | 30 | 158 | 526 | 1,290 |
| 20 | 8 | 6 | ..... | ..... | 100 | 65 | 63 | 20 | 50 | 109 | 562 | 1,810 |
| 21 | 7 | 6 | ..... | ..... | 96 | 67 | 61 | 20 | 69 | 86 | 3,200 | 1,810 |
| 22 | 6 | 6 | ..... | ..... | 91 | 69 | 146 | 20 | 49 | 82 | 2,900 | 1,520 |
| 23 | 6 | 6 | ..... | ..... | 129 | 65 | 140 | 38 | 38 | 49 | 2,200 | 1,160 |
| 24 | 6 | 6 | ..... | ..... | 388 | 65 | 152 | 55 | 30 | 42 | 2,020 | 807 |
| 25 | 5 | 6 | ..... | ..... | 562 | 59 | 152 | 55 | 24 | 91 | 1,960 | 618 |
| 26 | 4 | 6 | ..... | ..... | 422 | 59 | 152 | 42 | 22 | 140 | 1,220 | 490 |
| 27 | 4 | 6 | ..... | ..... | 322 | 54 | 134 | 55 | 116 | 100 | 1,010 | 473 |
| 28 | 4 | 6 | ..... | ..... | 258 | 51 | 119 | 194 | 210 | 129 | 715 | 456 |
| 29 | 4 | 7 | ..... | ..... | ..... | 48 | 91 | 322 | 140 | 104 | 602 | 422 |
| 30 | 4 | 8 | ..... | ..... | ..... | 45 | 78 | 442 | 86 | 758 | 490 | 388 |
| 31 | 4 | ..... | ..... | ..... | ..... | 43 | ..... | 562 | ..... | 1,040 | 405 | ..... |

NOTE.—Discharge determined from a fairly well defined rating curve. Discharge interpolated for Sundays from June 23, 1914, to July 31, 1915, and July 16–18, 1914, Apr. 8, June 8, Aug. 2, 29, and Sept. 18, 1915, because gage was not read. Discharge estimated, because of ice, from gage heights, observer's notes, and climatic records, as follows: Dece. 15–31, 1914, and Jan. 1–6, 1915, 6 second-feet; Jan. 16–31, 8 second-feet.

*Monthly discharge of Sangamon River at Monticello, Ill., for the years ending Sept. 30, 1914 and 1915.*

[Drainage area, 550 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| 1914. | | | | | | |
| July | 18 | 1.0 | 7.95 | 0.014 | 0.02 | C. |
| August | 14 | 1.0 | 3.58 | .0065 | .007 | C. |
| September | 21 | 2.0 | 6.53 | .012 | .01 | C. |
| 1914–15. | | | | | | |
| October | 10 | 2 | 4.4 | .0080 | .009 | C. |
| November | 8 | 4 | 5.5 | .010 | .01 | C. |
| December | 11 | ..... | 8.0 | .015 | .02 | D. |
| January | ..... | ..... | 7.6 | .014 | .02 | D. |
| February | 1,220 | 91 | 463 | .842 | .88 | B. |
| March | 194 | 43 | 88.8 | .161 | .19 | B. |
| April | 226 | 33 | 88.8 | .161 | .18 | B. |
| May | 562 | 20 | 85.9 | .156 | .18 | B. |
| June | 508 | 22 | 115 | .209 | .23 | B. |
| July | 1,040 | 42 | 229 | .416 | .48 | B. |
| August | 4,860 | 165 | 1,410 | 2.56 | 2.95 | B. |
| September | 1,810 | 179 | 566 | 1.03 | 1.15 | B. |
| The year | 4,860 | 2 | 255 | .464 | 6.30 | |

## 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 Wabash Railroad bridge about a quarter of a mile west of Riverton, Sangamon County, and about 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, 1915.

GAGE.—Standard chain gage attached to bridge; read daily, in the morning, by J. H. Steele.

DISCHARGE MEASUREMENTS.—Made from downstream side of three-span bridge.

CHANNEL AND CONTROL.—Measuring section is at a pool; shifts slightly; discharge measurements indicate that the control, which consists of compact gravel, is permanent. Point of zero flow was determined by leveling August 5, 1914, to be at gage height 6.6 feet.

EXTREMES OF DISCHARGE.—Maximun stage recorded during year, 26.85 feet at 7.30 a. m. August 24 (discharge, 18,600 second-feet); minimum stage recorded, 6.9 feet October 3 to 15 (discharge, 3 second-feet).

1908–1912, 1914–15: Maximun stage recorded, 27.1 feet October 1, 1911 (discharge, 19,200 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 to 15, 1915 (discharge, 3 second-feet).

WINTER FLOW.—Ice may affect the discharge relation during short periods of extremely cold weather.

ACCURACY.—Records good except for extreme low stages and for periods during December and January, when the discharge relation may have been affected by ice.

*Discharge measurements of Sangamon River at Riverton, Ill., during the year ending Sept. 30, 1915.*

[Made by William Kessler.]

| Date. | Gage height. | Discharge. |
|---|---|---|
| | *Feet.* | *Sec.-feet.* |
| Mar. 22 | 8.66 | 252 |
| July 24 | 10.53 | 754 |
| Aug. 3 | 16.09 | 3,210 |
| Aug. 4 | 15.95 | 3,130 |

*Daily discharge, in second-feet, of Sangamon River at Riverton, Ill., for the years ending Sept. 30, 1914 and 1915.*

| Day. | Aug. | Sept. | Day. | Aug. | Sept. | Day. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|
| 1914. | | | 1914. | | | 1914. | | |
| 1 | ..... | 51 | 11 | 20 | 112 | 21 | 29 | 39 |
| 2 | ..... | 51 | 12 | 20 | 112 | 22 | 29 | 39 |
| 3 | ..... | 112 | 13 | 13 | 78 | 23 | 29 | 39 |
| 4 | ..... | 151 | 14 | 29 | 51 | 24 | 29 | 29 |
| 5 | ..... | 151 | 15 | 24 | 39 | 25 | 24 | 29 |
| 6 | ..... | 112 | 16 | 20 | 29 | 26 | 20 | 13 |
| 7 | 16 | 240 | 17 | 20 | 29 | 27 | 20 | 8 |
| 8 | 16 | 359 | 18 | 20 | 29 | 28 | 20 | 5 |
| 9 | 13 | 240 | 19 | 39 | 39 | 29 | 39 | 5 |
| 10 | 13 | 112 | 20 | 39 | 39 | 30 | 78 | 5 |
| | | | | | | 31 | 51 | ..... |

*Daily discharge, in second-feet, of Sangamon River at Riverton, Ill., for the years ending Sept. 30, 1914 and 1915*—Continued.

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1914-15. | | | | | | | | | | | | |
| 1 | 5 | 8 | 20 | 45 | 2,160 | 1,060 | 151 | 335 | 9,100 | 1,280 | 1,620 | 4,990 |
| 2 | 5 | 8 | 20 | 131 | 4,490 | 888 | 131 | 335 | 8,010 | 1,240 | 2,320 | 2,980 |
| 3 | 3 | 8 | 20 | 172 | 6,340 | 696 | 131 | 335 | 6,340 | 1,130 | 3,040 | 2,050 |
| 4 | 3 | 8 | 13 | 194 | 6,010 | 603 | 131 | 311 | 4,760 | 824 | 3,200 | 1,660 |
| 5 | 3 | 8 | 20 | 172 | 6,340 | 603 | 112 | 287 | 3,490 | 760 | 2,920 | 2,000 |
| 6 | 3 | 8 | 29 | 172 | 7,180 | 542 | 112 | 240 | 2,380 | 760 | 2,870 | 1,920 |
| 7 | 3 | 8 | 34 | 172 | 6,560 | 542 | 112 | 1,200 | 1,960 | 955 | 3,040 | 1,240 |
| 8 | 3 | 8 | 39 | 434 | 5,160 | 513 | 112 | 1,390 | 1,580 | 1,540 | 3,200 | 1,310 |
| 9 | 3 | 10 | 29 | 486 | 3,840 | 434 | 112 | 728 | 1,280 | 2,100 | 3,320 | 1,280 |
| 10 | 3 | 6 | 51 | 460 | 2,650 | 359 | 172 | 460 | 1,100 | 1,960 | 3,490 | 1,170 |
| 11 | 3 | 8 | 51 | 434 | 2,050 | 384 | 263 | 409 | 1,020 | 4,010 | 3,260 | 1,200 |
| 12 | 3 | 8 | 51 | 542 | 1,620 | 409 | 311 | 359 | 4,620 | 5,900 | 1,830 | 1,420 |
| 13 | 3 | 8 | 51 | 384 | 1,200 | 384 | 287 | 287 | 5,420 | 6,930 | 1,390 | 1,390 |
| 14 | 3 | 20 | 34 | 359 | 1,020 | 384 | 217 | 287 | 5,070 | 7,450 | 955 | 1,280 |
| 15 | 3 | 20 | 39 | 335 | 920 | 335 | 194 | 240 | 3,900 | 7,180 | 824 | 1,130 |
| 16 | 8 | 13 | 29 | 311 | 856 | 311 | 263 | 217 | 2,920 | 6,120 | 696 | 1,200 |
| 17 | 29 | 13 | 29 | 287 | 760 | 323 | 287 | 194 | 1,870 | 4,990 | 1,020 | 1,170 |
| 18 | 13 | 13 | 29 | 287 | 634 | 311 | 240 | 172 | 1,540 | 3,950 | 728 | 1,280 |
| 19 | 10 | 13 | 20 | 299 | 634 | 263 | 240 | 151 | 1,240 | 3,090 | 728 | 1,540 |
| 20 | 8 | 13 | 29 | 287 | 572 | 263 | 217 | 217 | 1,620 | 2,210 | 1,020 | 1,710 |
| 21 | 5 | 13 | 29 | 240 | 460 | 263 | 194 | 240 | 1,710 | 1,580 | 6,220 | 1,790 |
| 22 | 8 | 13 | 29 | 194 | 460 | 240 | 172 | 263 | 3,840 | 1,170 | 12,300 | 2,100 |
| 23 | 20 | 13 | 29 | 131 | 665 | 240 | 603 | 359 | 4,130 | 955 | 16,700 | 2,260 |
| 24 | 20 | 16 | 20 | 94 | 920 | 240 | 542 | 287 | 3,490 | 824 | 18,500 | 2,260 |
| 25 | 8 | 20 | 20 | 94 | 1,350 | 240 | 513 | 335 | 2,540 | 665 | 18,100 | 2,210 |
| 26 | 8 | 20 | 13 | 112 | 1,280 | 217 | 728 | 5,330 | 1,750 | 665 | 16,000 | 2,210 |
| 27 | 8 | 20 | 5 | 39 | 1,280 | 194 | 824 | 8,940 | 1,130 | 359 | 13,500 | 1,920 |
| 28 | 8 | 20 | 8 | 58 | 1,200 | 172 | 792 | 10,300 | 888 | 990 | 11,700 | 1,540 |
| 29 | 8 | 13 | 5 | 78 | ..... | 172 | 760 | 10,500 | 792 | 792 | 12,300 | 1,310 |
| 30 | 8 | 20 | 20 | 64 | ..... | 151 | 460 | 10,700 | 955 | 696 | 9,100 | 1,170 |
| 31 | 8 | ..... | 39 | 112 | ..... | 151 | ..... | 10,200 | ..... | 1,500 | 7,450 | ..... |

NOTE.—Discharge determined from a rating curve well defined between 10 and 4,400 second-feet. Discharge Jan. 28, May 16, and Aug. 13 interpolated. Observer reported "Gage read to top of ice" on Jan. 23, 24, 26, and 27. Estimates for the last half of December and for January may be somewhat too large because of the assumption that the open-water rating was applicable.

*Monthly discharge of Sangamon River at Riverton, Ill., for the years ending Sept. 30, 1914 and 1915.*

[Drainage area, 2,560 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| 1914. | | | | | | |
| August 7-31 | 78 | 13 | 26.8 | 0.010 | 0.009 | B. |
| September | 359 | 5 | 78.2 | .031 | .03 | B. |
| 1914-15. | | | | | | |
| October | 29 | 3 | 7.29 | .0029 | .003 | C. |
| November | 20 | 6 | 12.6 | .0049 | .005 | C. |
| December | 51 | 5 | 27.5 | .011 | .01 | C. |
| January | 542 | 39 | 232 | .091 | .10 | D. |
| February | 7,180 | 460 | 2,450 | .957 | 1.00 | B. |
| March | 1,060 | 151 | 383 | .150 | .17 | A. |
| April | 824 | 112 | 313 | .122 | .14 | A. |
| May | 10,700 | 151 | 2,120 | .828 | .95 | B. |
| June | 9,100 | 792 | 3,010 | 1.18 | 1.32 | A. |
| July | 7,450 | 359 | 2,410 | .941 | 1.08 | A. |
| August | 18,500 | 696 | 5,910 | 2.31 | 2.66 | B. |
| September | 4,990 | 1,130 | 1,760 | .688 | .77 | A. |
| The year | 18,500 | 3 | 1,550 | .605 | 8.21 | |

## 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, 1915.

GAGE.—Standard chain gage attached to bridge; read daily in the morning by J. M. Weaver to December 31, and daily in the morning and afternoon by Andrew Peterson after March 19.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge.

CHANNEL AND CONTROL.—Probably shifting; the river for some distance above and below the station has been dredged and straightened, thus increasing the slope considerably and disturbing the regimen of the river. Conditions along the improved section are probably reverting to their former state.

EXTREMES OF STAGE.—Maximum stage recorded during year, 17.8 feet at 6 a. m. and 7 p. m. August 27; minimum stage recorded, 0.1 foot December 21, 22, 24, 25, and 31.

Maximum stage recorded during period 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).

WINTER FLOW.—Discharge relation may be affected by ice during parts of December, January, and February.

ACCURACY—Backwater caused by ice jams or drift lodging at railroad bridge 2½ miles below gage may at times affect discharge relation.

Data insufficient for estimates of discharge.

*Discharge measurements of Sangamon River near Oakford, Ill., during the year ending Sept. 30, 1915.*

[Made by William Kessler.]

| Date. | Gage height. | Discharge. |
|---|---|---|
| | *Feet.* | *Sec.-ft.* |
| Mar. 19 | 2.35 | 673 |
| 19 | 2.35 | 663 |
| June 2 | 14.87 | 14,400 |

*Daily gage height, in feet, of Sangamon River near Oakford, Ill., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.2 | 0.8 | 0.8 | ..... | 1.85 | 2.4 | 15.6 | 4.0 | 9.6 | 13.8 |
| 2 | 1.0 | ..... | .7 | ..... | 1.85 | 2.2 | 14.9 | 4.3 | 10.0 | 12.2 |
| 3 | 1.0 | .8 | ..... | ..... | 1.8 | 2.1 | 13.8 | 4.2 | 11.4 | 9.5 |
| 4 | ..... | ..... | .8 | ..... | 1.8 | 2.4 | 11.8 | 4.0 | 12.4 | 7.2 |
| 5 | ..... | .8 | ..... | ..... | 1.8 | 2.2 | 10.8 | 3.8 | 12.2 | 6.6 |
| 6 | .9 | ..... | ..... | ..... | 1.75 | 2.0 | 9.0 | 3.5 | 11.5 | 5.8 |
| 7 | .8 | .8 | ..... | ..... | 1.75 | 2.1 | 7.6 | 3.6 | 10.0 | 5.6 |
| 8 | 1.0 | ..... | .8 | ..... | 1.7 | 2.8 | 7.0 | 4.2 | 8.6 | 5.4 |
| 9 | ..... | .8 | .9 | ..... | 1.65 | 3.7 | 6.2 | 5.1 | 8.4 | 5.6 |
| 10 | .9 | .8 | ..... | ..... | 1.8 | 3.0 | 5.4 | 5.6 | 8.5 | 5.7 |
| 11 | ..... | .8 | .9 | ..... | 2.3 | 2.6 | 5.4 | 8.9 | 8.1 | 6.6 |
| 12 | .9 | .8 | ..... | ..... | 2.6 | 2.3 | 5.9 | 10.9 | 7.8 | 7.4 |
| 13 | ..... | .8 | ..... | ..... | 2.6 | 2.2 | 8.0 | 11.0 | 6.7 | 8.0 |
| 14 | .9 | ..... | .9 | ..... | 2.5 | 2.2 | 8.4 | 10.9 | 5.4 | 6.8 |
| 15 | .9 | ..... | .8 | ..... | 2.5 | 2.1 | 8.1 | 10.8 | 4.9 | 9.4 |
| 16 | .9 | .8 | ..... | ..... | 2.4 | 1.9 | 7.6 | 11.2 | 4.5 | 12.5 |
| 17 | ..... | .8 | .9 | ..... | 2.3 | 1.75 | 6.8 | 11.3 | 5.4 | 11.6 |
| 18 | .9 | ..... | ..... | ..... | 2.2 | 1.65 | 5.8 | 10.2 | 5.6 | 11.8 |
| 19 | .9 | .8 | 1.0 | 2.4 | 2.1 | 1.55 | 5.2 | 9.0 | 4.3 | 11.3 |
| 20 | .9 | ..... | ..... | 2.3 | 2.6 | 1.5 | 5.4 | 7.4 | 4.2 | 10.6 |
| 21 | .9 | .8 | .1 | 2.2 | 2.0 | 1.75 | 5.7 | 6.2 | 9.8 | 11.0 |
| 22 | .9 | ..... | .1 | 2.2 | 2.0 | 1.85 | 6.2 | 5.3 | 12.8 | 10.7 |
| 23 | .9 | .8 | ..... | 2.2 | 2.3 | 1.8 | 7.2 | 4.7 | 13.7 | 10.2 |
| 24 | ..... | .8 | .1 | 2.2 | 2.4 | 1.8 | 7.6 | 4.1 | 15.0 | 9.3 |
| 25 | .8 | .8 | .1 | 2.1 | 2.5 | 1.9 | 7.4 | 3.8 | 16.4 | 8.2 |
| 26 | .8 | ..... | ..... | 2.0 | 2.6 | 8.9 | 5.8 | 4.2 | 17.4 | 7.8 |
| 27 | ..... | .7 | ..... | 1.95 | 2.7 | 11.3 | 5.0 | 4.9 | 17.8 | 7.6 |
| 28 | .8 | ..... | ..... | 1.95 | 2.8 | 12.7 | 4.4 | 4.7 | 17.6 | 7.2 |
| 29 | .8 | .8 | .2 | 1.9 | 2.8 | 14.4 | 4.1 | 4.6 | 17.3 | 6.7 |
| 30 | ..... | ..... | ..... | 1.9 | 2.7 | 15.8 | 3.9 | 4.8 | 16.1 | 6.4 |
| 31 | .8 | ..... | .1 | 1.85 | ..... | 15.9 | ..... | 7.7 | 15.0 | ..... |

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, Ill.; about one-fourth mile upstream from the highway bridge known as the Half Acre Bridge.

DRAINAGE AREA.—427 square miles.

RECORDS AVAILABLE—February 11, 1908, to September 30, 1912; November 1 to December 31, 1912; August 8, 1914, to September 30, 1915.

GAGE.—Standard chain gage attached to bridge; read daily, in the morning, 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 and 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.

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 discharge relation was considerably affected by the change in slope. Subsequent to 1912 a new bridge was built, and since then the discharge relation has again changed. The change is probably permanent; section is in a pool; control probably shifts slightly during floods. A determination by soundings August 8, 1914, indicates that there would be no flow past the gage if the river were to fall to 0.35 foot±0.1 foot by the present gage.

EXTREMES OF STAGE.—Maximum stage recorded during year, 14.82 feet, at 6 a. m. August 22; minimum stage recorded, 0.56 foot, at 7 a. m. October 6.

WINTER FLOW.—Ice may affect the discharge relation during parts of December, January, and February.

ACCURACY.—Gage-height record reliable. During the summer of 1915 a new highway bridge about one-fourth mile below gage was in course of construction, and the discharge relation may have been affected by backwater.

Data insufficient for estimating discharge.

*Discharge measurements of South Fork of Sangamon River near Taylorville, Ill., during the year ending Sept. 30, 1915.*

[Made by William Kessler.]

| Date. | Gage height. | Discharge. |
|---|---|---|
| | *Feet.* | *Sec.-ft.* |
| Mar. 23 | 1.93 | 29.0 |
| June 1 | 9.30 | 1,500 |

*Daily gage height, in feet, of South Fork of Sangamon River near Taylorville, Ill., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.58 | 0.68 | 0.90 | 3.8 | 9.0 | 3.4 | 1.55 | 1.62 | 9.6 | 6.6 | 4.3 | 6.2 |
| 2 | .59 | .68 | .91 | 2.8 | 11.0 | 3.2 | 1.52 | 1.44 | 8.9 | 5.7 | 4.5 | 5.4 |
| 3 | .59 | .69 | .95 | 2.35 | 11.2 | 2.9 | 1.50 | 1.90 | 8.1 | 5.0 | 6.5 | 4.9 |
| 4 | .59 | .70 | .95 | 1.67 | 10.4 | 2.8 | 1.48 | 2.3 | 6.7 | 4.5 | 6.6 | 4.4 |
| 5 | .58 | .71 | .99 | 1.36 | 9.7 | 2.7 | 1.47 | 2.2 | 5.8 | 5.3 | 6.8 | 4.1 |
| 6 | .56 | .72 | .97 | 1.35 | 9.4 | 2.8 | 1.48 | 2.15 | 5.0 | 5.8 | 5.8 | 4.1 |
| 7 | .57 | .73 | .96 | 3.9 | 8.8 | 2.9 | 1.52 | 2.25 | 4.5 | 5.3 | 4.5 | 3.8 |
| 8 | .58 | ..... | 1.01 | 5.0 | 7.5 | 2.8 | 1.52 | 4.0 | 4.3 | 6.3 | 3.8 | 3.8 |
| 9 | .73 | ..... | 1.07 | 5.2 | 5.5 | 2.8 | 1.54 | 3.5 | 4.0 | 7.7 | 3.3 | 4.1 |
| 10 | .73 | .85 | 1.04 | 4.4 | 4.0 | 2.6 | 1.66 | 3.2 | 3.7 | 7.5 | 3.2 | 3.9 |
| 11 | .70 | .84 | 1.04 | 3.4 | 3.9 | 2.45 | 2.2 | 2.45 | 8.6 | 9.2 | 2.9 | 3.6 |
| 12 | .70 | .84 | 1.03 | 2.8 | 3.4 | 2.4 | 2.5 | 2.25 | 9.4 | 10.3 | 2.8 | 3.5 |
| 13 | .69 | .86 | 1.03 | 2.3 | 3.2 | 2.35 | 2.7 | 1.96 | 9.7 | 11.0 | 2.7 | 3.5 |
| 14 | .68 | .90 | .98 | 2.1 | 3.2 | 2.3 | 2.3 | 1.78 | 8.8 | 10.8 | 2.6 | 3.4 |
| 15 | .67 | .92 | .90 | 1.92 | 3.2 | 2.25 | 2.1 | 1.88 | 7.4 | 10.2 | 2.6 | 3.3 |
| 16 | .81 | .92 | .88 | 1.92 | 3.0 | 2.2 | 1.93 | 1.91 | 5.8 | 9.5 | 2.9 | 3.4 |
| 17 | .80 | .90 | .86 | 2.4 | 2.9 | 2.1 | 1.71 | 1.95 | 4.7 | 9.0 | 3.5 | 3.1 |
| 18 | .80 | .86 | .87 | 2.9 | 2.6 | 2.05 | 1.58 | 1.76 | 4.3 | 7.7 | 3.2 | 3.8 |
| 19 | .88 | .85 | .88 | 3.0 | 2.5 | 2.0 | 1.52 | 1.52 | 4.0 | 6.2 | 4.1 | 5.5 |
| 20 | .75 | .85 | .90 | 2.5 | 2.3 | 2.05 | 1.51 | 1.66 | 5.3 | 5.3 | 4.3 | 5.5 |
| 21 | .75 | .85 | .90 | 2.15 | 2.15 | 2.05 | 1.52 | 2.15 | 8.8 | 4.7 | 11.8 | 5.0 |
| 22 | .74 | .85 | .88 | 1.74 | 2.1 | 1.99 | 1.60 | 4.2 | 9.0 | 4.4 | 14.8 | 5.7 |
| 23 | .71 | .87 | .86 | 1.55 | 3.2 | 1.96 | 4.5 | 3.5 | 9.2 | 4.0 | 14.1 | 5.0 |
| 24 | .68 | .87 | .87 | 1.49 | 5.3 | 1.90 | 5.0 | 3.1 | 8.0 | 3.7 | 12.8 | 4.3 |
| 25 | .65 | .88 | .85 | 1.29 | 6.2 | 1.85 | 6.1 | 3.0 | 6.8 | 3.4 | 11.5 | 4.2 |
| 26 | .64 | .90 | .78 | 1.28 | 5.4 | 1.82 | 5.6 | 7.0 | 4.9 | 3.4 | 10.7 | 3.6 |
| 37 | .64 | .90 | .76 | 1.31 | 4.4 | 1.79 | 4.6 | 11.6 | 4.0 | 4.3 | 9.9 | 3.5 |
| 28 | .64 | .90 | .78 | 1.25 | 3.7 | 1.68 | 3.6 | 12.0 | 4.2 | 4.2 | 9.0 | 3.5 |
| 29 | .64 | .89 | 1.32 | 1.25 | ..... | 1.66 | 2.9 | 11.3 | 5.3 | 4.0 | 8.0 | 3.7 |
| 30 | .65 | .89 | 2.6 | 1.21 | ..... | 1.64 | 1.84 | 10.8 | 7.1 | 3.7 | 7.1 | 3.5 |
| 31 | .66 | ..... | 2.7 | 2.2 | ..... | 1.60 | ..... | 10.2 | ..... | 4.0 | 6.8 | ..... |

NOTE.—See "Accuracy" in station description.

## KASKASKIA RIVER AT SHELBYVILLE, ILL.

LOCATION.—Between secs. 8 and 17, T. 11 N., R. 4 E. third principal meridian, at highway bridge at the eastern edge of Shelbyville, Shelby County, a short distance above the Chicago & Eastern Illinois and Big Four railroad bridge.

DRAINAGE AREA.—1,030 square miles.

RECORDS AVAILABLE.—February 25, 1908, to September 30, 1912; November 1 to December 31, 1912; and August 11 to December 5, 1914, when station was discontinued.

GAGE.—Standard chain gage attached to bridge; read daily, in the afternoon, to tenths.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge.

CHANNEL AND CONTROL.—Measuring section at a pool; bed shifts. Discharge measurements indicate that control shifts slightly during extreme floods.

EXTREMES OF DISCHARGE.—Maximum stage recorded during periods of records, 25.8 feet May 8, 1908 (discharge, 10,600 second-feet); minimum stage recorded, 4.7 feet, October 4 to 7, 1914 (discharge, approximately 0.2 second-foot).

WINTER FLOW.—Ice may affect the discharge relation during parts of December, January, and February.

ACCURACY.—Results for 1914 not considered better than fair, because sufficient discharge measurements have not been made to determine the rating curve definitely.

*Daily discharge, in second-feet, of Kaskaskia River at Shelbyville, Ill., for the period Aug. 10 to Dec. 5, 1914.*

| Day. | Aug. | Sept. | Oct. | Nov. | Dec. | Day. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 35 | 0.5 | 12 | 22 | 16 | 1.5 | 12 | 1.5 | 12 | ..... |
| 2 | ..... | 35 | .5 | 12 | 22 | 17 | 1.5 | 12 | 1.5 | 12 | ..... |
| 3 | ..... | 35 | .5 | 12 | 22 | 18 | 1.5 | 4.5 | 1.5 | 12 | ..... |
| 4 | ..... | 35 | .2 | 12 | 22 | 19 | .5 | 4.5 | 4.5 | 12 | ..... |
| 5 | ..... | 68 | .2 | 12 | 22 | 20 | .5 | 4.5 | 4.5 | 12 | ..... |
| 6 | ..... | 774 | .2 | 12 | ..... | 21 | .5 | 1.5 | 4.5 | 12 | ..... |
| 7 | ..... | 462 | .2 | 12 | ..... | 22 | .5 | 1.5 | 4.5 | 12 | ..... |
| 8 | ..... | 110 | .5 | 12 | ..... | 23 | .5 | .5 | 4.5 | 12 | ..... |
| 9 | ..... | 68 | 1.5 | 12 | ..... | 24 | .5 | .5 | 4.5 | 12 | ..... |
| 10 | 0.5 | 50 | 4.5 | 12 | ..... | 25 | .5 | .5 | 4.5 | 12 | ..... |
| 11 | 50 | 35 | 4.5 | 12 | ..... | 26 | .5 | .5 | 4.5 | 22 | ..... |
| 12 | 35 | 22 | 1.5 | 12 | ..... | 27 | 1.5 | .5 | 4.5 | 22 | ..... |
| 13 | 22 | 22 | 1.5 | 12 | ..... | 28 | 50 | .5 | 4.5 | 22 | ..... |
| 14 | 12 | 22 | 1.5 | 12 | ..... | 29 | 50 | .5 | 12 | 22 | ..... |
| 15 | 4.5 | 12 | 1.5 | 12 | ..... | 30 | 50 | .5 | 12 | 22 | ..... |
| | | | | | | 31 | 50 | ..... | 12 | ..... | ..... |

NOTE.—Discharge determined from a rating curve which is not well defined.

*Monthly discharge of Kaskaskia River at Shelbyville, Ill., for the period Aug. 10 to Nov. 30, 1914.*

[Drainage area, 1,030 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| August 10–31 | 50 | 0.5 | 15.2 | 0.015 | 0.01 | C. |
| September | 774 | .5 | 61.0 | .059 | .07 | C. |
| October | 12 | .2 | 3.38 | .0033 | .004 | C. |
| November | 22 | 12 | 13.7 | .013 | .01 | C. |

KASKASKIA RIVER AT VANDALIA, ILL.

LOCATION.—In sec. 16, T. 6 N., R. 1 E. third principal meridian, at highway bridge at the east end of Main street, Vandalia, Fayette County.

DRAINAGE AREA.—1,980 square miles.

RECORDS AVAILABLE.—February 26, 1908, to October 4, 1912; November 1 to December 31, 1912; August 11, 1914, to September 30, 1915.

GAGE.—Standard chain gage attached to bridge; read daily, in the afternoon, to tenths.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge.

CHANNEL AND CONTROL.—Measuring section is at a pool; bed is somewhat shifting.

EXTREMES OF STAGE.—Maximum stage recorded during year, 22.2 feet at 1 p. m. May 27; minimum stage recorded, 0.70 foot October 5, 7, and 8.

Maximum stage recorded during periods of records, 22.2 feet at 1 p. m. May 27, 1915; the flood of 1875 is said to have reached a stage of 22.8 feet; minimum stage recorded, 0.38 foot August 12, 1914.

WINTER FLOW.—Ice may affect the discharge relation during parts of December, January, and February.

ACCURACY.—Gage-height record is reliable. On May 27, 1915, the levee which prevents the river from overflowing the adjoining low lands broke above and below the gage. Sufficient data have not been obtained to determine the effect of these breaks upon the discharge relation during flood stages.

*Discharge measurements of Kaskaskia River at Vandalia, Ill., during the year ending Sept. 30, 1915.*

[Made by William Kessler.]

| Date. | Gage height. | Discharge. |
|---|---|---|
| | *Feet.* | *Sec.-ft.* |
| May 26 | 15.56 | 5,400 |
| 31 | 19.24 | 9,910 |

*Daily gage height, in feet, of Kaskaskia River at Vandalia, Ill., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.75 | 1.00 | 1.20 | 2.55 | 14.0 | 6.1 | 2.7 | 2.7 | 18.2 | 10.8 | 4.9 | 12.0 |
| 2 | .75 | 1.02 | 1.22 | 2.5 | 16.3 | 5.6 | 2.6 | 2.5 | 16.9 | 6.0 | 7.9 | 9.5 |
| 3 | .72 | 1.02 | 1.25 | 2.05 | 18.6 | 5.2 | 2.6 | 5.0 | 15.6 | 4.9 | 14.9 | 8.6 |
| 4 | .70 | 1.07 | 1.30 | 1.95 | 17.3 | 5.0 | 2.55 | 5.1 | 14.9 | 4.5 | 15.5 | 7.4 |
| 5 | .72 | 1.05 | 1.52 | 1.72 | 16.8 | 5.2 | 2.5 | 4.1 | 13.1 | 4.8 | 15.1 | 6.6 |
| 6 | .72 | 1.02 | 1.55 | 1.70 | 16.4 | 5.3 | 2.55 | 3.4 | 11.0 | 4.5 | 11.4 | 6.0 |
| 7 | .70 | 1.00 | 1.62 | 2.85 | 15.5 | 5.2 | 2.55 | 3.55 | 9.4 | 3.7 | 9.3 | 6.0 |
| 8 | .70 | 1.25 | 1.62 | 3.8 | 7.8 | 4.8 | 2.55 | 4.7 | 8.1 | 11.9 | ..... | 6.2 |
| 9 | 4.2 | 1.45 | 1.60 | 4.0 | 6.9 | 4.6 | 2.5 | 3.8 | 7.2 | 14.7 | 8.4 | 6.0 |
| 10 | 4.8 | 1.48 | 1.72 | ..... | 6.6 | 4.6 | 2.6 | 3.6 | 6.5 | 10.9 | 8.6 | 6.0 |
| 11 | 4.2 | 1.50 | 1.65 | 2.8 | 6.2 | 4.4 | 2.65 | ..... | .4 | 14.6 | 9.8 | 5.9 |
| 12 | 3.1 | 1.45 | 1.58 | 2.55 | 6.0 | 4.4 | 2.8 | ..... | 10.2 | 16.6 | 8.5 | 5.2 |
| 13 | 2.48 | 1.42 | 1.60 | 2.30 | 6.0 | 4.2 | 2.7 | ..... | 8.6 | 17.6 | 6.8 | 4.9 |
| 14 | 1.62 | 1.38 | 1.52 | 2.15 | 5.8 | 4.1 | 2.65 | ..... | 13.3 | 17.4 | 5.9 | 4.5 |
| 15 | 1.45 | 1.35 | 1.40 | 2.10 | 5.6 | 4.0 | 2.6 | 3.05 | 9.4 | 15.2 | 6.3 | 4.3 |
| 16 | 1.52 | 1.32 | 1.32 | 2.05 | 5.2 | 3.9 | 2.55 | 2.95 | 6.1 | 10.3 | 6.0 | 4.2 |
| 17 | 2.6 | 1.25 | 1.25 | ..... | 4.4 | 3.8 | 2.48 | 2.7 | 5.4 | 8.7 | 10.5 | 4.3 |
| 18 | 2.2 | 1.22 | 1.28 | 4.2 | ..... | 3.6 | 2.32 | 2.42 | 5.1 | 8.7 | 13.7 | 4.1 |
| 19 | 1.78 | 1.18 | 1.30 | 4.2 | 4.2 | 3.7 | 2.28 | 2.20 | 4.6 | 7.6 | 13.4 | 4.7 |
| 20 | 1.52 | 1.15 | 1.30 | 3.35 | 4.0 | 3.6 | 2.20 | 10.4 | 4.4 | 7.5 | 13.2 | 6.8 |
| 21 | 1.42 | 1.12 | 1.28 | 3.6 | 4.0 | 3.5 | 2.12 | 12.0 | 14.5 | 6.5 | 22.1 | 6.6 |
| 22 | 1.32 | 1.12 | 1.25 | 2.30 | 3.8 | 3.45 | 2.5 | 7.0 | 16.1 | 5.6 | 21.0 | 6.4 |
| 23 | 1.25 | 1.15 | 1.18 | 2.10 | 12.8 | 3.4 | 7.2 | 5.0 | 14.1 | 5.1 | 19.3 | 6.2 |
| 24 | 1.20 | 1.18 | 1.15 | ..... | 15.4 | 3.3 | 6.5 | 4.6 | 7.1 | 4.7 | 18.4 | 6.0 |
| 25 | 1.18 | 1.15 | 1.10 | 2.35 | 11.6 | 3.2 | 5.2 | 4.2 | 5.2 | 4.4 | 17.7 | 5.5 |
| 26 | 1.08 | 1.18 | 1.08 | 2.10 | 8.2 | 3.5 | 4.1 | 14.7 | 4.8 | 4.4 | 17.2 | 5.6 |
| 27 | 1.00 | 1.18 | 1.02 | 2.02 | 7.4 | 3.0 | 3.5 | 22.2 | 4.5 | 3.9 | 16.7 | 5.4 |
| 28 | 1.00 | 1.12 | 1.05 | 1.95 | 6.7 | 2.9 | 3.1 | 21.2 | 5.4 | 4.1 | 16.0 | 5.2 |
| 29 | 1.00 | 1.12 | 1.55 | 1.72 | ..... | 2.7 | 2.9 | 20.1 | 12.7 | 4.9 | 15.9 | 5.0 |
| 30 | 1.02 | 1.15 | 2.85 | 1.95 | ..... | 2.7 | 2.8 | 20.3 | 13.9 | 5.5 | 15.2 | 4.8 |
| 31 | .98 | ..... | 2.6 | 3.5 | ..... | 2.7 | ..... | 19.3 | ..... | 4.8 | 13.5 | ..... |

NOTE.—Gage read to top of ice Jan. 8, 9, and 23–28. Ice gorge below gage Feb. 1. Discharge relation affected by ice about Dec. 16 to Feb. 1.

KASKASKIA RIVER AT CARLYLE, ILL.

LOCATION.—In sec. 19, T. 2 N., R. 2 W. third principal meridian, at the Baltimore & Ohio Southwestern Railroad bridge about one-fourth mile east of Carlyle, Clinton County.

DRAINAGE AREA.—2,680 square miles.

RECORDS AVAILABLE.—March 2, 1908, to September 30, 1912; November 1 to December 31, 1912; August 13, 1914, to September 30, 1915, when station was discontinued.

GAGE.—Standard chain gage attached to upstream side of bridge; read daily, in the morning, by A. J. Marcham.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge.

CHANNEL AND CONTROL.—May shift slightly during extreme floods. A determination by soundings on August 13, 1914, indicates that there would be no flow past the gage if the river were to fall to 3.7 feet ±0.3 foot, referred to gage datum.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 30.75 feet at 2.30 p. m. August 24 (discharge, approximately 20,000 second-feet); minimum stage recorded, 5.32 feet at 7.30 a. m. October 8 (discharge, 55 second-feet).

Maximum stage recorded during periods of records, 30.75 feet at 2.30 p. m. August 24, 1915 (discharge, approximately 20,000 second-feet). The flood of 1882, which is the highest known, is said to have reached a height of about 32.5 feet referred to the present gage (discharge not estimated). Minimum stage recorded, 5.4 feet, October 14 to 16, 1909 (discharge, 23 second-feet).

WINTER FLOW.—Ice may affect the discharge relation during parts of December, January, and February.

DIVERSIONS.—A dam 3½ feet high, about 700 feet above the gaging section, is used to store water for the city of Carlyle. The average amount pumped is about 3,500,000 gallons every 30 days, and during June, July, and August about 4,500,000 gallons every 30 days. The outfalls of one section of the city sewerage system and some private sewers are above the section, so that the diversion is negligible.

ACCURACY.—Results good.

*Discharge measurements of Kaskaskia River at Carlyle, Ill., during the year ending Sept. 30, 1915.*

[Made by William Kessler.]

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | *Feet.* | *Sec.-ft.* | | *Feet.* | *Sec.-ft.* |
| May 25 | 11.96 | 1,610 | June 8 | 22.00 | 6,830 |
| 25 | 12.70 | 4,900 | Sept. 17 | 8.76 | 690 |

*Daily discharge, in second-feet, of Kaskaskia River at Carlyle, Ill., for the years ending Sept. 30, 1914–1915.*

| Day. | Aug. | Sept. | Day. | Aug. | Sept. | Day. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|
| 1914. | | | 1914. | | | 1914. | | |
| 1 | ..... | 121 | 11 | ..... | 1,680 | 21 | 53 | 121 |
| 2 | ..... | 112 | 12 | ..... | 855 | 22 | 55 | 105 |
| 3 | ..... | 93 | 13 | 88 | 491 | 23 | 62 | 99 |
| 4 | ..... | 147 | 14 | 80 | 331 | 24 | 67 | 95 |
| 5 | ..... | 147 | 15 | 180 | 280 | 25 | 82 | 91 |
| 6 | ..... | 132 | 16 | 206 | 270 | 26 | 147 | 91 |
| 7 | ..... | 125 | 17 | 99 | 188 | 27 | 780 | 88 |
| 8 | ..... | 1,890 | 18 | 91 | 172 | 28 | 855 | 84 |
| 9 | ..... | 3,200 | 19 | 80 | 147 | 29 | 399 | 80 |
| 10 | ..... | 2,850 | 20 | 67 | 132 | 30 | 197 | 74 |
| | | | | | | 31 | 155 | ..... |

*Daily discharge, in second-feet, of Kaskaskia River at Carlyle, Ill., for the years ending Sept. 30, 1914–1915*—Continued.

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1914–15. | | | | | | | | | | | | |
| 1 | 70 | 77 | 62 | 755 | 3,480 | 3,480 | 353 | 310 | 12,100 | 4,500 | 2,160 | 8,950 |
| 2 | 67 | 74 | 64 | 680 | 4,730 | 2,430 | 353 | 270 | 11,500 | 4,650 | 2,580 | 8,210 |
| 3 | 64 | 72 | 70 | 514 | 5,490 | 1,710 | 331 | 537 | 10,600 | 3,160 | 3,720 | 7,650 |
| 4 | 62 | 70 | 74 | 353 | 7,930 | 1,560 | 331 | 830 | 9,550 | 2,340 | 3,960 | 6,950 |
| 5 | 60 | 67 | 80 | 260 | 8,650 | 1,290 | 310 | 960 | 8,650 | 1,890 | 4,180 | 4,910 |
| 6 | 58 | 64 | 84 | 197 | 8,650 | 1,170 | 310 | 730 | 7,930 | 1,530 | 4,240 | 3,840 |
| 7 | 56 | 62 | 91 | 251 | 9,400 | 1,170 | 310 | 680 | 7,230 | 1,470 | 4,300 | 2,670 |
| 8 | 55 | 74 | 99 | 830 | 8,350 | 1,230 | 300 | 855 | 6,670 | 1,440 | 4,000 | 1,770 |
| 9 | 80 | 140 | 108 | 1,170 | 7,650 | 1,140 | 290 | 880 | 5,750 | 2,670 | 3,560 | 1,500 |
| 10 | 755 | 197 | 115 | 930 | 6,810 | 1,080 | 310 | 805 | 2,880 | 3,520 | 2,640 | 1,380 |
| 11 | 2,400 | 242 | 112 | 755 | 6,010 | 990 | 300 | 630 | 2,340 | 3,800 | 2,550 | 1,290 |
| 12 | 2,820 | 180 | 108 | 655 | 5,120 | 880 | 290 | 514 | 1,860 | 4,000 | 2,490 | 1,170 |
| 13 | 1,950 | 125 | 118 | 491 | 3,160 | 830 | 310 | 445 | 2,130 | 4,240 | 2,490 | 1,140 |
| 14 | 780 | 108 | 115 | 399 | 2,460 | 780 | 353 | 422 | 2,400 | 4,650 | 2,100 | 1,020 |
| 15 | 353 | 99 | 95 | 353 | 1,740 | 730 | 353 | 399 | 2,700 | 4,820 | 2,550 | 880 |
| 16 | 310 | 91 | 88 | 331 | 1,530 | 705 | 353 | 606 | 3,100 | 5,240 | 2,820 | 805 |
| 17 | 583 | 84 | 80 | 930 | 1,350 | 680 | 331 | 399 | 2,160 | 5,620 | 2,760 | 705 |
| 18 | 537 | 82 | 74 | 1,590 | 1,200 | 606 | 331 | 468 | 1,410 | 5,750 | 3,800 | 630 |
| 19 | 514 | 80 | 72 | 1,350 | 990 | 606 | 310 | 290 | 1,050 | 6,010 | 4,360 | 583 |
| 20 | 353 | 77 | 72 | 855 | 880 | 583 | 310 | 880 | 930 | 5,240 | 5,360 | 583 |
| 21 | 242 | 72 | 72 | 705 | 830 | 560 | 300 | 2,790 | 1,920 | 4,500 | 9,250 | 990 |
| 22 | 180 | 70 | 74 | 606 | 1,020 | 537 | 290 | 3,720 | 4,040 | 3,640 | 15,100 | 1,350 |
| 23 | 147 | 67 | 77 | 468 | 2,160 | 537 | 270 | 3,640 | 4,500 | 2,700 | 19,100 | 1,290 |
| 24 | 118 | 64 | 74 | 399 | 3,410 | 514 | 990 | 2,640 | 5,360 | 1,890 | 19,900 | 1,230 |
| 25 | 105 | 62 | 74 | 353 | 4,820 | 491 | 1,440 | 1,590 | 5,880 | 1,110 | 18,500 | 1,140 |
| 26 | 99 | 60 | 74 | 353 | 6,140 | 468 | 1,470 | 1,920 | 5,240 | 930 | 16,400 | 1,110 |
| 27 | 91 | 58 | 72 | 270 | 7,230 | 445 | 1,410 | 3,920 | 3,720 | 830 | 14,600 | 1,050 |
| 28 | 84 | 58 | 112 | 290 | 4,570 | 422 | 1,230 | 4,430 | 2,550 | 880 | 13,200 | 960 |
| 29 | 84 | 58 | 251 | 270 | ..... | 399 | 830 | 5,750 | 3,600 | 1,110 | 11,800 | 905 |
| 30 | 82 | 60 | 118 | 353 | ..... | 399 | 399 | 10,900 | 4,130 | 1,380 | 10,800 | 855 |
| 31 | 80 | ..... | 280 | 1,290 | ..... | 376 | ..... | 12,100 | ..... | 1,800 | 9,700 | ..... |

NOTE.—Discharge determined from a rating curve fairly well defined below 8,000 second-feet; open-water curve applied throughout the year. Discharge Jan. 25 to Feb. 1 may, therefore, be somewhat large owing to presence of ice on river.

*Monthly discharge of Kaskaskia River at Carlyle, Ill., for the years ending Sept. 30, 1914 and 1915.*

[Drainage area, 2,680 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| 1914. | | | | | | |
| August 13–31 | 855 | 53 | 197 | 0.074 | 0.05 | B. |
| September | 3,200 | 74 | 476 | .178 | .20 | B. |
| 1914–15. | | | | | | |
| October | 2,820 | 55 | 427 | .159 | .18 | B. |
| November | 242 | 58 | 89.8 | .034 | .04 | B. |
| December | 280 | 62 | 98.7 | .037 | .04 | B. |
| January | 1,590 | 197 | 613 | .229 | .26 | C. |
| February | 9,400 | 830 | 4,490 | 1.68 | 1.75 | C. |
| March | 3,840 | 376 | 941 | .351 | .40 | B. |
| April | 1,470 | 270 | 502 | .187 | .21 | B. |
| May | 12,100 | 270 | 2,110 | .787 | .91 | B. |
| June | 12,100 | 930 | 4,800 | 1.79 | 2.00 | A. |
| July | 6,010 | 830 | 3,140 | 1.17 | 1.35 | A. |
| August | 19,900 | 2,100 | 7,260 | 2.71 | 3.12 | B. |
| September | 8,950 | 583 | 2,250 | .840 | .94 | A. |
| The year | 19,900 | 55 | 2,210 | .825 | 11.20 | |

KASKASKIA RIVER AT NEW ATHENS, ILL.

LOCATION.—In the W. ½ NE. ¼ sec. T. 2 S., R. 7 W. third principal meridian, at the Illinois Central Railroad Bridge, about 600 feet north of the railroad station at New Athens, St. Clair County, about 1 mile below the mouth of Silver Creek and 3 miles above the mouth of Lively Creek.

DRAINAGE AREA.—5,220 square miles.

RECORDS AVAILABLE.—January 23, 1907, to September 30, 1912; October 30 to December 31, 1912; June 22, 1914, to September 30, 1915. A record of river heights from January 23, 1907, to October 28, 1909, was kept by C. J. von Roth Roffy for the New Athens Journal. The river height was taken on Wednesday and Thursday mornings of each week, that for Thursday being published Friday with the change in 24 hours as obtained from the river height of Wednesday. This record was kept up for the information of farmers living on the west side of the river who were cut off from reaching town when the river reached a height of 30 feet. The record is authentic. The gage heights have been reduced to the present datum, the maximum error probably not being over 0.4 foot and decreasing as the stage increases.

GAGE.—Standard chain gage attached to the bridge, installed November 1, 1909; read daily at noon by Henry Hoffmann.

DISCHARGE MEASUREMENTS.—Made from downstream lower chord of bridge and from concrete trestle approach.

CHANNEL AND CONTROL.—Probably permanent.

EXTREMES OF STAGE.—Maximum stage recorded during year, 35.7 feet at noon August 26 (discharge, 63,100 second-feet); minimum stage recorded, 2.35 feet October 7 and 8 (discharge, 133 second-feet).

Maximum stage recorded during periods of records, 35.7 feet at noon August 26, 1915 (discharge, 63,100 second-feet); minimum stage recorded, 2.08 feet August 10, 1914 (discharge, 102 second-feet).

WINTER FLOW.—Discharge relation may be slightly affected by ice during parts of December, January, and February.

ACCURACY.—Results fair. Discharge relation is affected by backwater from Mississippi River when the stage at Chester reaches a gage height of approximately 19 feet. Prior to 1915 no discharge measurements had been made at New Athens when the stage on the Mississippi River as indicated by the United States Weather Bureau gage readings at Chester, Ill., was high enough to cause backwater at New Athens. In 1915 ten measurements were made during May, June, and September when there was considerable backwater at New Athens due to high water in the Mississippi River. From these measurements and the gage readings at New Athens and Chester estimates of daily discharge for periods when the Mississippi River caused backwater at New Athens have been computed by the slope method described in Water-Supply Paper 345, page 53.

Published estimates of discharge for the following periods may be considerably too large, depending on the amount of the backwater effect produced at New Athens: 1907, January 21–28; June 14–18; July 19 to August 3. 1908, May 17 to July 23. 1909, March 14; April 21 to May 1; May 11–17; June 12 to July 27. 1910, May 10–13; June 12–15. 1912, March 22 to May 11; June 19–22.

*Discharge measurements of Kaskaskia River at New Athens, Ill., during the year ending Sept. 30, 1915.*

[Made by William Kessler.]

| Day. | Gage height. | Discharge. | Day. | Gage height. | Discharge. | Day. | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|---|
| | *Feet.* | *Sec.-ft.* | | *Feet.* | *Sec.-ft.* | | *Feet.* | *Sec.-ft.* |
| Mar. 30 | 4.78 | 673 | June 5 | 25.00 | a20,400 | June 9 | 22.52 | a13,400 |
| May 24 | 18.34 | 8,890 | 6 | 24.71 | a20,200 | 11 | 21.57 | a10,900 |
| 24 | 18.41 | 8,110 | 7 | 24.55 | a18,900 | Sept. 18 | 8.40 | a1,100 |
| 30 | 21.81 | a12,500 | 7 | 23.95 | a17,200 | | | |
| 30 | 21.91 | a12,900 | 7 | 23.82 | a17,100 | | | |

a Backwater from Mississippi River when this measurement was made. (See "Accuracy," in station description.)

*Daily discharge, in second-feet, of Kaskaskia River at New Athens, Ill., for the years ending Sept. 30, 1914 and 1915.*

| Day. | June. | July. | Aug. | Sept. | Day. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|
| 1914. | | | | | 1914. | | | | |
| 1 | | 204 | 120 | 600 | 16 | | 140 | a 161 | 1,800 |
| 2 | | 196 | 120 | 521 | 17 | | 140 | a 183 | 1,440 |
| 3 | | 187 | 113 | 521 | 18 | | 133 | 204 | 1,360 |
| 4 | | 187 | 113 | 627 | 19 | | 126 | 196 | 990 |
| 5 | | 179 | 113 | 627 | 20 | | 120 | 171 | 683 |
| 6 | | 187 | 108 | 1,400 | 21 | | 120 | 155 | 573 |
| 7 | | 187 | 102 | 1,520 | 22 | 683 | 120 | 148 | 495 |
| 8 | | 171 | 102 | 2,160 | 23 | 600 | 120 | 140 | 350 |
| 9 | | 171 | 102 | 2,400 | 24 | 547 | 120 | 196 | 282 |
| 10 | | 171 | 102 | 3,900 | 25 | 470 | 126 | 171 | 251 |
| 11 | | 163 | 232 | 4,430 | 26 | 470 | 140 | 1,200 | 222 |
| 12 | | 171 | 155 | 3,410 | 27 | 445 | 133 | 683 | 213 |
| 13 | | 163 | 140 | 2,030 | 28 | 373 | 126 | 990 | 204 |
| 14 | | 155 | 187 | 1,200 | 29 | 293 | 126 | 1,680 | 196 |
| 15 | | 140 | 140 | 990 | 30 | 232 | 120 | 1,280 | 179 |
| | | | | | 31 | | 120 | 800 | |

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1914–15. | | | | | | | | | | | | |
| 1 | 171 | 204 | 155 | 3,200 | 10,800 | 9,800 | 627 | 740 | 15,000 | 23,100 | 3,900 | 35,800 |
| 2 | 155 | 204 | 155 | 3,100 | 13,500 | 8,760 | 600 | 683 | 16,800 | 19,600 | 4,490 | 29,600 |
| 3 | 155 | 187 | 171 | 3,000 | 15,700 | 6,670 | 573 | 683 | 19,300 | 17,000 | 6,140 | 24,400 |
| 4 | 148 | 171 | 222 | 2,300 | 22,000 | 3,620 | 573 | 573 | 20,800 | 14,900 | 6,690 | 20,600 |
| 5 | 140 | 171 | 421 | 1,600 | 24,100 | 2,290 | 573 | 1,360 | 20,500 | 13,100 | 7,100 | 17,500 |
| 6 | 140 | 171 | 470 | 1,280 | 24,100 | 1,890 | 547 | 1,800 | 19,500 | 10,300 | 7,310 | 15,100 |
| 7 | 133 | 171 | 373 | 2,500 | 24,100 | 2,300 | 521 | 1,640 | 17,300 | 7,250 | 6,510 | 12,700 |
| 8 | 133 | 282 | 282 | 3,580 | 23,400 | 2,160 | 521 | 1,680 | 15,400 | 7,050 | 5,590 | 10,600 |
| 9 | 470 | 683 | 261 | 3,580 | 24,400 | 2,120 | 521 | 2,300 | 13,400 | 8,020 | 5,040 | 7,260 |
| 10 | 4,430 | 683 | 241 | 3,630 | 22,000 | 2,030 | 521 | 2,450 | 12,100 | 8,100 | 4,730 | 3,960 |
| 11 | 7,260 | 740 | 241 | 3,300 | 20,300 | 1,800 | 573 | 1,720 | 11,000 | 8,500 | 4,060 | 2,700 |
| 12 | 7,600 | 573 | 241 | 2,500 | 17,900 | 1,640 | 573 | 1,240 | 9,980 | 8,930 | 3,740 | 2,210 |
| 13 | 6,780 | 521 | 241 | 1,900 | ..... | 1,560 | 655 | 920 | 8,150 | 8,670 | 3,560 | 1,360 |
| 14 | 5,230 | 445 | 241 | 1,600 | ..... | 1,440 | 740 | 860 | 5,850 | 8,500 | 3,720 | 1,270 |
| 15 | 2,950 | 373 | 241 | 1,360 | ..... | 1,280 | 920 | 711 | 4,760 | 8,520 | 3,880 | 1,120 |
| 16 | 2,900 | 304 | 241 | 1,320 | ..... | 1,160 | 990 | a 656 | 4,810 | 8,430 | 3,410 | 965 |
| 17 | 4,610 | 261 | 241 | 2,030 | ..... | 1,100 | 920 | 600 | 5,080 | 8,330 | 3,930 | 1,000 |
| 18 | 3,460 | 241 | 222 | 2,650 | ..... | 1,060 | 860 | 627 | 5,300 | 7,740 | 6,940 | 1,100 |
| 19 | 2,700 | 204 | 222 | 3,000 | ..... | 1,020 | 830 | 573 | 3,830 | 7,190 | 9,020 | 1,090 |
| 20 | 1,940 | 204 | ..... | 2,850 | ..... | 1,020 | 683 | 1,680 | 3,140 | 7,330 | 14,500 | 1,010 |
| 21 | 1,200 | 187 | ..... | 1,980 | ..... | 955 | 521 | 3,850 | 5,860 | 7,400 | 31,700 | 968 |
| 22 | 800 | 171 | ..... | 1,240 | ..... | 920 | 470 | 5,720 | 7,800 | 6,990 | 47,200 | 1,120 |
| 23 | 627 | 171 | ..... | ..... | ..... | 890 | 521 | 7,100 | 8,410 | 5,990 | 53,100 | 1,410 |
| 24 | 521 | 171 | ..... | ..... | ..... | 860 | 683 | 8,510 | 9,350 | 4,140 | 58,600 | 1,420 |
| 25 | 421 | 171 | ..... | ..... | 10,100 | 830 | 2,030 | 7,680 | 10,400 | 3,290 | 62,400 | 1,280 |
| 26 | 350 | 171 | ..... | ..... | 10,200 | 800 | 2,800 | 6,620 | 11,100 | 2,990 | 63,100 | 1,080 |
| 27 | 304 | 155 | ..... | ..... | 10,600 | 770 | 2,210 | 8,610 | 11,200 | 2,920 | 60,600 | 979 |
| 28 | 282 | 155 | ..... | ..... | 10,700 | 740 | 1,600 | 10,600 | 14,000 | 2,820 | 56,900 | 1,280 |
| 29 | 241 | 155 | ..... | ..... | ..... | 711 | 1,130 | 11,900 | 24,300 | 2,760 | 52,000 | 1,400 |
| 30 | 222 | 155 | ..... | ..... | ..... | 683 | 860 | 12,600 | 26,100 | 2,480 | 47,500 | 1,150 |
| 31 | 222 | ..... | ..... | ..... | ..... | 655 | ..... | 13,800 | ..... | 3,300 | 42,000 | ..... |

a Interpolated.

NOTE.—Discharge, except as noted below, determined from a rating curve fairly well defined below 12,400 second-feet. Discharge Feb. 26 to Mar. 6, May 29 to Aug. 22, and Sept. 13–30, computed by the slope method because of backwater from the Mississippi River (see "Accuracy," in station description). Discharge estimated, because of ice, from gage heights, observer's notes, and climatic records as follows: Dec. 20–31, 640 second-feet; Jan. 23–31, 1,100 second-feet. Discharge Feb. 13–24, when gage was not read estimated by comparison with flow at Carlyle, at 4,300 second-feet.

*Monthly discharge of Kaskaskia River at New Athens, Ill., for the years ending Sept. 30, 1914 and 1915.*

[Drainage area, 5,220 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| 1914. | | | | | | |
| July | 204 | 120 | 150 | 0.029 | 0.03 | A. |
| August | 1,680 | 102 | 332 | .064 | .07 | A. |
| September | 4,430 | 179 | 1,190 | .228 | .25 | B. |
| 1914-15. | | | | | | |
| October | 7,600 | 133 | 1,830 | .351 | .40 | B. |
| November | 740 | 155 | 282 | .054 | .06 | B. |
| December | ..... | 155 | 405 | .078 | .09 | C. |
| January | ..... | ..... | 2,050 | .393 | .45 | C. |
| February | 24,400 | ..... | 12,000 | 2.30 | 2.40 | C. |
| March | 9,800 | 655 | 2,050 | .393 | .45 | B. |
| April | 2,800 | 470 | 872 | .167 | .19 | B. |
| May | 13,800 | 573 | 3,890 | .745 | .86 | B. |
| June | 26,100 | 3,140 | 12,000 | 2.30 | 2.57 | B. |
| July | 23,100 | 2,480 | 8,250 | 1.58 | 1.82 | B. |
| August | 63,100 | 3,410 | 22,200 | 4.25 | 4.90 | B. |
| September | 35,800 | 965 | 6,780 | 1.30 | 1.45 | B. |
| The year | 63,100 | 133 | 6,020 | 1.15 | 15.64 | |

SHOAL CREEK NEAR BREESE, ILL.

LOCATION.—In the southwest corner of the NW. ¼ sec. 24, T. 2 N., R. 4 W. third principal meridian, at the Baltimore & Ohio Southwestern Railroad bridge about 1½ miles east of Breese, Clinton County, Ill.; about 3 miles above the mouth of Beaver Creek.

DRAINAGE AREA.—760 square miles.

RECORDS AVAILABLE.—November 5, 1909, to September 30, 1912; October 30 to December 31, 1912; August 14 to December 7, 1914, when station was discontinued.

GAGE.—Standard chain gage attached to bridge; read daily, in the afternoon, by John Nordman.

DISCHARGE MEASUREMENTS.—Made from upstream side of bridge; during floods made also from downstream side of wooden trestle over overflow channel.

CHANNEL AND CONTROL.—Practically permanent; channel rough, as rock has been placed in bed of stream, under bridge, to prevent scour. A determination by leveling on August 13, 1914, indicates that there would be no flow past the gage if the river were to fall to 0.4 foot ±0.1 foot by the gage.

EXTREMES OF DISCHARGE.—Maximum stage recorded during periods of records, 19.6 feet October 5, 1911 (discharge, 6,880 second-feet); maximum stage recorded during flood of March–April, 1913; 23.2 feet at 6.30 a. m. March 29 (discharge approximately 11,600 second-feet, determined from extension of rating curve); minimum stage recorded, 0.9 foot during periods of August, September, October, and November, 1914 (discharge, 23 second-feet).

WINTER FLOW.—Ice may affect the discharge relation during parts of December, January, and February.

DIVERSIONS.—The intake pipe of the Breese municipal pumping system is about one-fourth mile above the section, but the quantity of water diverted is negligible.

ACCURACY.—Gage readings reliable; results fair.

No discharge measurements were made during the year ending September 30, 1915.

*Daily discharge, in second-feet, of Shoal Creek near Breese, Ill., for the period Aug. 14 to Dec. 7, 1914.*

| Day. | Aug. | Sept. | Oct. | Nov. | Dec. | Day. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 88 | 23 | 23 | 29 | 16 | 29 | 235 | 133 | 41 | ..... |
| 2 | ..... | 78 | 23 | 23 | 29 | 17 | 29 | 220 | 213 | 35 | ..... |
| 3 | ..... | 83 | 23 | 23 | 29 | 18 | 23 | 193 | 299 | 32 | ..... |
| 4 | ..... | 56 | 23 | 23 | 35 | 19 | 23 | 133 | 112 | 29 | ..... |
| 5 | ..... | 88 | 23 | 23 | 38 | 20 | 23 | 92 | 74 | 29 | ..... |
| 6 | ..... | 536 | 23 | 23 | 41 | 21 | 23 | 65 | 56 | 23 | ..... |
| 7 | ..... | 156 | 23 | 23 | 41 | 22 | 23 | 60 | 52 | 23 | ..... |
| 8 | ..... | 624 | 23 | 83 | ..... | 23 | 23 | 29 | 41 | 23 | ..... |
| 9 | ..... | 468 | 112 | 92 | ..... | 24 | 35 | 26 | 41 | 38 | ..... |
| 10 | ..... | 349 | 1,260 | 83 | ..... | 25 | 349 | 23 | 38 | 41 | ..... |
| 11 | ..... | 150 | 1,070 | 74 | ..... | 26 | 400 | 23 | 35 | 41 | ..... |
| 12 | ..... | 48 | 768 | 56 | ..... | 27 | 133 | 23 | 35 | 38 | ..... |
| 13 | ..... | 41 | 122 | 48 | ..... | 28 | 65 | 23 | 35 | 35 | ..... |
| 14 | 23 | 41 | 56 | 44 | ..... | 29 | 41 | 23 | 29 | 29 | ..... |
| 15 | 32 | 38 | 65 | 41 | ..... | 30 | 41 | 23 | 26 | 29 | ..... |
| | | | | | | 31 | 56 | ..... | 26 | ..... | ..... |

NOTE.—Discharge determined from a fairly well-defined rating curve.

*Monthly discharge of Shoal Creek near Breese, Ill., for the period Aug. 14 to Nov. 30, 1914.*

[Drainage area, 760 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| August 14–31 | 400 | 23 | 76.2 | 0.100 | 0.07 | D. |
| September | 624 | 23 | 134 | .176 | .20 | B. |
| October | 1,260 | 23 | 157 | .207 | .24 | C. |
| November | 92 | 23 | 38.9 | .051 | .06 | B. |

## SILVER CREEK NEAR LEBANON, ILL.

LOCATION.—In the northwest corner of sec. 5, T. 2 N., R. 7 W. third principal meridian, at highway bridge at Wrights Crossing, about 2 miles west of Lebanon, St. Clair County.

DRAINAGE AREA.—335 square miles.

RECORDS AVAILABLE.—March 3, 1908, to September 30, 1912; November 3 to December 31, 1912; August 14 to December 5, 1914, when station was discontinued.

GAGE.—Chain gage attached to bridge; read daily, in the morning, by W. D. McKoin.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge and small approach spans; and also at high stages from downstream side of three steel viaducts on road west of bridge.

CHANNEL AND CONTROL.—Control is formed by an accumulation of drift a short distance below gage; may shift during high water. A determination by leveling, August 14, 1914, indicates that there would be no flow past the gage if the river stage were to fall to 0.4 foot ±0.1 foot referred to the gage datum.

EXTREMES OF DISCHARGE.—Maximum stage recorded during periods of records, 15.9 feet May 7, 1908 (discharge, 5,240 second-feet); a stage of 18.5 feet (discharge approximately 8,100 second-feet) was recorded March 27 during the flood of March-April, 1913; the observer was unable to reach gage to obtain the crest stage of this flood. Minimum stage about a week in 1908 and on October 14, 1909, when there was no flow past the gage.

WINTER FLOW.—Ice may affect the discharge relation during parts of December, January, and February.

ACCURACY.—Results fair.

No discharge measurements were made at this station during the year ending September 30, 1915.

*Daily discharge, in second-feet, of Silver Creek near Lebanon, Ill., for the period Aug. 14 to Dec. 5, 1914.*

| Day. | Aug. | Sept. | Oct. | Nov. | Dec. | Day. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 17 | 0.6 | 7.2 | 7.0 | 16 | 2.0 | 516 | 253 | 22 | ..... |
| 2 | ..... | 187 | .4 | 7.0 | 8.0 | 17 | 1.9 | 355 | 679 | 14 | ..... |
| 3 | ..... | 157 | .2 | 6.8 | 8.4 | 18 | 1.0 | 136 | 540 | 12 | ..... |
| 4 | ..... | 104 | .3 | 6.2 | 8.4 | 19 | .6 | 18 | 244 | 9.0 | ..... |
| 5 | ..... | 80 | .2 | 6.0 | 9.6 | 20 | .6 | 16 | 104 | 8.0 | ..... |
| 6 | ..... | 271 | .2 | 5.8 | ..... | 21 | 49 | 8.0 | 49 | 8.0 | ..... |
| 7 | ..... | 425 | .2 | 5.5 | ..... | 22 | 104 | 7.5 | 31 | 8.0 | ..... |
| 8 | ..... | 665 | .2 | 6.2 | ..... | 23 | 41 | 5.3 | 24 | 8.4 | ..... |
| 9 | ..... | 639 | 41 | 316 | ..... | 24 | 17 | 3.0 | 19 | 8.0 | ..... |
| 10 | ..... | 298 | 730 | 298 | ..... | 25 | 69 | 2.6 | 16 | 8.0 | ..... |
| 11 | ..... | 122 | 679 | 129 | ..... | 26 | 195 | 2.5 | 13 | 8.0 | ..... |
| 12 | ..... | 47 | 665 | 64 | ..... | 27 | 307 | 2.2 | 9.6 | 8.4 | ..... |
| 13 | ..... | 21 | 405 | 41 | ..... | 28 | 92 | 1.6 | 9.0 | 8.4 | ..... |
| 14 | 0.1 | 16 | 104 | 29 | ..... | 29 | 37 | 1.0 | 8.6 | 8.4 | ..... |
| 15 | .1 | 98 | 33 | 26 | ..... | 30 | 16 | .8 | 7.8 | 8.4 | ..... |
| | | | | | | 31 | 13 | ..... | 7.3 | ..... | ..... |

NOTE.—Discharge determined from a poorly defined rating curve.

*Monthly discharge of Silver Creek near Lebanon, Ill., for the period Aug. 14 to Nov. 30, 1914.*

[Drainage area, 335 square miles.]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area). | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| August 14-31 | 307 | 0.1 | 52.6 | 0.157 | 0.11 | C. |
| September | 665 | .8 | 141 | .421 | .47 | C. |
| October | 730 | .2 | 151 | .451 | .52 | C. |
| November | 316 | 5.5 | 36.7 | .110 | .12 | C. |

## 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, and about 6 miles west of West Frankfort; about 1½ miles below the mouth of Middle Fork and about 2 miles downstream from station formerly maintained at the Chicago, Burlington & Quincy Railroad bridge.

DRAINAGE AREA.—753 square miles.

RECORDS AVAILABLE.—August 18, 1914, to September 30, 1915. June 16, 1908, to September 30, 1912, and November 1 to December 31, 1912, maintained at the Chicago, Burlington & Quincy Railroad bridge.

GAGE.—Standard chain gage attached to bridge; read daily, morning and afternoon, by Louis Robertson.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge and steel approach, and in high water also made from downstream side of two culverts under road on right side; at extreme high stages the lowland between the bridge and the culverts is covered with water.

CHANNEL AND CONTROL.—Probably permanent; control is about one-fourth mile below the gage. A determination by leveling August 18, 1914, indicates that there would be no flow past the gage if the river were to fall to about 0.6 foot ± 0.05 foot by the gage.

EXTREMES OF STAGE.—Maximum stage recorded during period of records, 23.8 feet at 7 a. m. and 5 p. m. February 4, 1915; minimum stage, August 18 to 26, 1914, when there was no flow past the gage.

WINTER FLOW.—Ice may affect the discharge relation during parts of December, January, and February.

ACCURACY.—Gage-height record reliable.

Data insufficient for estimates of discharge.

*Discharge measurements of Big Muddy River at Plumfield, Ill., during the year ending Sept. 30, 1915.*

[Made by William Kessler.]

| Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. | Date. | Gage height. | Discharge. |
|---|---|---|---|---|---|---|---|---|
| | *Feet.* | *Sec.-ft.* | | *Feet.* | *Sec.-ft.* | | *Feet.* | *Sec.-ft.* |
| Mar. 29 | 1.68 | 27.2 | June 12 | 2.44 | 82.8 | Sept. 17 | 1.33 | 13.1 |
| May 29 | 17.60 | 3,660 | July 24 | 2.48 | 87.1 | 17 | 1.33 | 13.7 |
| 29 | 17.74 | 3,750 | 24 | 2.47 | 88.7 | | | |
| June 12 | 2.44 | 75.3 | Sept. 17 | 1.33 | 13.3 | | | |

*Daily gage height, in feet, of Big Muddy River at Plumfield, Ill., for the year ending Sept. 30, 1915.*

| Day. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.38 | 1.22 | 1.05 | 6.5 | 16.0 | 12.9 | 1.53 | 1.10 | 18.2 | 14.6 | 2.02 | 16.6 |
| 2 | 1.30 | 1.19 | 1.05 | 6.1 | 20.4 | 9.1 | 1.49 | 1.06 | 17.5 | 15.2 | 2.9 | 14.8 |
| 3 | 1.24 | 1.15 | 1.05 | 4.6 | 23.2 | 5.5 | 1.44 | 1.01 | 16.5 | 15.4 | 4.6 | 12.5 |
| 4 | 1.18 | 1.15 | 1.29 | 3.4 | 23.8 | 3.8 | 1.41 | .96 | 14.7 | 15.7 | 4.2 | 8.8 |
| 5 | 1.12 | 1.12 | 1.44 | 2.7 | 23.5 | 5.3 | 1.39 | .91 | 12.6 | 15.8 | 3.0 | 4.8 |
| 6 | 1.09 | 1.10 | 1.59 | 2.45 | 22.8 | 8.0 | 1.38 | .98 | 8.7 | 15.4 | 2.49 | 2.5 |
| 7 | 1.04 | 1.06 | 1.86 | 4.2 | 22.0 | 8.7 | 1.36 | 1.22 | 7.2 | 14.4 | 2.03 | 2.08 |
| 8 | 1.00 | 1.05 | 2.9 | 8.0 | 21.2 | 7.6 | 1.34 | 3.7 | 4.8 | 14.2 | 1.74 | 1.85 |
| 9 | 2.75 | 1.04 | 2.75 | 9.2 | 19.7 | 5.8 | 1.30 | 3.0 | 3.7 | 14.1 | 1.56 | 1.72 |
| 10 | 6.6 | 1.00 | 2.42 | 8.7 | 18.3 | 4.6 | 1.33 | 2.9 | 2.9 | 14.6 | 1.53 | 1.82 |
| 11 | 9.4 | .98 | 2.14 | 6.7 | 16.5 | 3.9 | 1.40 | 2.31 | 2.48 | 14.8 | 1.89 | 1.74 |
| 12 | 10.1 | .95 | 1.95 | 5.2 | 14.1 | 3.4 | 1.36 | 2.08 | 2.47 | 14.7 | 4.1 | 1.62 |
| 13 | 10.2 | .95 | 1.88 | 4.9 | 11.3 | 3.0 | 1.34 | 1.99 | 3.7 | 14.0 | 5.3 | 1.55 |
| 14 | 10.6 | 1.92 | 1.81 | 4.8 | 8.9 | 2.75 | 1.30 | 1.82 | 2.42 | 11.9 | 4.8 | 1.46 |
| 15 | 11.2 | 1.72 | 1.72 | 4.5 | 7.6 | 2.65 | 1.28 | 1.61 | 2.28 | 9.1 | 6.9 | 1.38 |
| 16 | 11.4 | 1.52 | 1.61 | 4.6 | 6.6 | 2.42 | 1.28 | 1.51 | 2.24 | 8.0 | 9.5 | 1.36 |
| 17 | 11.0 | 1.40 | 1.51 | 6.8 | 5.2 | 2.32 | 1.28 | 1.41 | 1.97 | 7.0 | 9.9 | 1.32 |
| 18 | 10.3 | 1.34 | 1.48 | 9.4 | 4.0 | 2.26 | 1.24 | 1.34 | 1.94 | 6.0 | 8.2 | 3.2 |
| 19 | 8.8 | 1.18 | 1.86 | 9.7 | 3.35 | 2.18 | 1.20 | 1.27 | 2.9 | 5.0 | 8.2 | 3.35 |
| 20 | 6.1 | 1.14 | 3.25 | 4.3 | 3.0 | 2.15 | 1.26 | 1.38 | 2.8 | 3.8 | 11.3 | 2.8 |
| 21 | 4.0 | 1.15 | 4.2 | 4.9 | 2.8 | 2.09 | 1.24 | 1.46 | 6.4 | 2.95 | 14.4 | 2.02 |
| 22 | 3.05 | 1.15 | 4.5 | 4.1 | 3.0 | 2.07 | 1.24 | 2.00 | 10.4 | 2.6 | 16.7 | 1.84 |
| 23 | 2.6 | 1.12 | 5.2 | 4.6 | 10.5 | 2.05 | 1.24 | 8.2 | 12.3 | 2.46 | 20.5 | 1.58 |
| 24 | 2.22 | 1.12 | 5.2 | 5.8 | 12.7 | 1.99 | 1.20 | 13.7 | 13.4 | 2.13 | 22.8 | 1.44 |
| 25 | 1.95 | 1.10 | 4.7 | 5.3 | 14.6 | 1.93 | 1.18 | 15.6 | 14.0 | 1.83 | 23.4 | 1.31 |
| 26 | 1.75 | 1.10 | 4.0 | ..... | 15.6 | 1.87 | 1.11 | 15.9 | 13.8 | 1.66 | 23.0 | 1.21 |
| 27 | 1.68 | 1.10 | 3.2 | 3.3 | 15.5 | 1.79 | 1.10 | 16.2 | 11.7 | 1.52 | 22.3 | 1.17 |
| 28 | 1.48 | 1.08 | 2.6 | ..... | 14.7 | 1.75 | 1.12 | 16.8 | 9.6 | 1.36 | 21.3 | 1.44 |
| 29 | 1.38 | 1.10 | 2.6 | 2.28 | ..... | 1.72 | 1.10 | 17.5 | 12.2 | 2.06 | 20.1 | 2.36 |
| 30 | 1.32 | 1.09 | 4.2 | 2.38 | ..... | 1.63 | 1.08 | 18.3 | 13.6 | 2.85 | 18.9 | 2.9 |
| 31 | 1.24 | ..... | 6.0 | 11.5 | ..... | 1.59 | ..... | 18.5 | ..... | 2.40 | 17.6 | ..... |

NOTE.—Discharge relation probably affected by ice Dec. 16 to Jan. 10, and Jan. 22-31.

### BEAUCOUP CREEK NEAR PINCKNEYVILLE, ILL.

LOCATION.—In sec. 30, T. 5 S., R. 2 E. third principal meridian; at Illinois Central Railroad bridge about 1½ miles east of Pinckneyville, Perry County, about 10 miles above the mouth of Galum Creek.

DRAINAGE AREA.—227 square miles.

RECORDS AVAILABLE.—June 17, 1908, to September 30, 1912; November 30 to December 31, 1912; and June 24 to November 2, 1914, when station was discontinued.

GAGE.—Standard chain gage attached to bridge; read daily, in the morning, by R. C. Huggins.

DISCHARGE MEASUREMENTS.—Made from downstream side of wooden trestle; low-water measurements made at wading section about 1,000 feet below gage.

CHANNEL AND CONTROL.—May shift slightly during extreme floods. The creek goes dry at times, the water then standing in pools near the gage. A determination by leveling, August 17, 1914, indicates that there would be no flow past the gage if the river were to fall to about 1.8 feet ±0.1 foot by the gage.

EXTREMES OF DISCHARGE.—Maximum stage recorded during periods of records, 21.1 feet, February 28, 1910 (discharge, 2,170 second-feet); the flood of 1902 reached a height of about 27.5 feet on the present gage. Minimum stage July 3, 4, and July 7 to August 21, 1914, when there was no flow past the gage.

WINTER FLOW.—Discharge relation may be affected by ice during parts of December, January, and February.

ACCURACY.—Gage readings erroneous at times; records not very good.

*Daily discharge, in second-feet, of Beaucoup Creek near Pinckneyville, Ill., for the period June 24 to Nov. 2, 1914.*

| Day. | June. | July. | Aug. | Sept. | Oct. | Nov. | Day. | June. | July. | Aug. | Sept. | Oct. | Nov. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ..... | 0.2 | 0.0 | 133 | 4.2 | 5.8 | 16 | ..... | .0 | .0 | 179 | 171 | ..... |
| 2 | ..... | .2 | .0 | 6.9 | 2.9 | 5.8 | 17 | ..... | .0 | .0 | 126 | 1,140 | ..... |
| 3 | ..... | .0 | .0 | 8.0 | 1.8 | ..... | 18 | ..... | .0 | .0 | 40 | 403 | ..... |
| 4 | ..... | .0 | .0 | 8.8 | 1.8 | ..... | 19 | ..... | .0 | .0 | 8.0 | 236 | ..... |
| 5 | ..... | .1 | .0 | 9.6 | 4.9 | ..... | 20 | ..... | .0 | .0 | 6.9 | 70 | ..... |
| 6 | ..... | .1 | .0 | 653 | 8.0 | ..... | 21 | ..... | .0 | .0 | 5.8 | 45 | ..... |
| 7 | ..... | .0 | .0 | 928 | 8.0 | ..... | 22 | ..... | .0 | 1.1 | 5.8 | 35 | ..... |
| 8 | ..... | .0 | .0 | 1,590 | 1.8 | ..... | 23 | ..... | .0 | 1.0 | 2.9 | 26 | ..... |
| 9 | ..... | .0 | .0 | 1,570 | 200 | ..... | 24 | 0.9 | .0 | 1.0 | 14 | 21 | ..... |
| 10 | ..... | .0 | .0 | 914 | 1,890 | ..... | 25 | .6 | .0 | 1.1 | 26 | 16 | ..... |
| 11 | ..... | .0 | .0 | 86 | 2,100 | ..... | 26 | .6 | .0 | 65 | 26 | 12 | ..... |
| 12 | ..... | .0 | .0 | 60 | 1,920 | ..... | 27 | .6 | .0 | 68 | 12 | 5.8 | ..... |
| 13 | ..... | .0 | .0 | 38 | 1,350 | ..... | 28 | .5 | .0 | 1,180 | 8.0 | 5.8 | ..... |
| 14 | ..... | .0 | .0 | 16 | 1,360 | ..... | 29 | .4 | .0 | 1,890 | 5.8 | 5.8 | ..... |
| 15 | ..... | .0 | .0 | 12 | 766 | ..... | 30 | .2 | .0 | 1,570 | 4.2 | 5.8 | ..... |
| | | | | | | | 31 | ..... | .0 | 852 | ..... | 5.8 | ..... |

NOTE.—Discharge determined from a fairly well defined rating curve.

*Monthly discharge of Beaucoup Creek near Pinckneyville, Ill., for the period July 1 to Oct. 31, 1914.*

[Drainage area, 227 square miles]

| Month. | Discharge in second-feet. | | | | Run-off (depth in inches on drainage area.) | Accuracy. |
|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Per square mile. | | |
| July | 0.2 | 0.0 | 0.02 | 0.0001 | 0.0001 | C. |
| August | 1,890 | .0 | 182 | .802 | .92 | C. |
| September | 1,590 | 2.9 | 217 | .956 | 1.07 | C. |
| October | 2,100 | 1.8 | 381 | 1.68 | 1.94 | C. |

## MISCELLANEOUS MEASUREMENTS.

*Miscellaneous measurements in upper Mississippi River drainage basin during the year ending Sept. 30, 1915.*

| Date. | Stream. | Tributary to— | Locality. | Gage height. | Discharge. |
|---|---|---|---|---|---|
| | | | | *Feet.* | *Sec.-ft.* |
| July 17 | Pecatonica River | Rock River | Freeport, Ill. | ..... | 510 |
| Nov. 4 | Des Plaines River | Illinois River | 1,000 feet above Bear Trap dam at Lockport, Ill. | ..... | 113 |
| 26 | ....do | ....do | ....do | ..... | 22.2 |
| July 15 | Fox River | ....do | Dundee, Ill. | ..... | 735 |
| 15 | ....do | ....do | Elgin, Ill. | ..... | 835 |
| 14 | Vermilion River | ....do | Above intake of city gas plant, Streator, Ill. | ..... | 2.1 |
| Apr. 3 | Wapsipinicon River | Mississippi River | Massillon, Iowa | ..... | 2,770 |
| May 30 | Des Moines River | ....do | Boone, Iowa | *a* 21.61 | 27,500 |
| June 5 | ....do | ....do | ....do | *a* 14.7 | 13,200 |
| 1 | ....do | ....do | Ottumwa, Iowa | *a* 16.96 | 56,300 |

*a* United States Weather Bureau gage.

# INDEX.

# STREAM-GAGING STATIONS

AND

# PUBLICATIONS RELATING TO WATER RESOURCES

## PART V. HUDSON BAY AND UPPER MISSISSIPPI RIVER DRAINAGE BASINS

# STREAM-GAGING STATIONS AND PUBLICATIONS RELATING TO WATER RESOURCES.

## INTRODUCTION.

Investigation of water resources by the United States Geological Survey has consisted in large part of measurements of the volume of flow of streams and studies of the conditions affecting that flow, but it has comprised also investigation of such closely allied subjects as irrigation, water storage, water powers, underground waters, and quality of waters. Most of the results of these investigations have been published in the series of water-supply papers, but some have appeared in the bulletins, professional papers, 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 basins.
II. South Atlantic and eastern Gulf of Mexico basins.
III. Ohio River basin.
IV. St. Lawrence River basin.
V. Upper Mississippi River and Hudson Bay basins.
VI. Missouri River basin.
VII. Lower Mississippi River basin.
VIII. Western Gulf of Mexico basins.
IX. Colorado River basin.
X. Great Basin.
XI. Pacific basins in California.
XII. North Pacific basins (published in three volumes).

## 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., Customhouse.
St. Paul, Minn., Old Capitol Building.
Madison, Wis., Capitol Building.
Helena, Mont., Montana National Bank Building.
Denver, Colo., 403 New Post Office Building.
Salt Lake City, Utah, Federal Building.
Boise, Idaho, 615 Idaho Building.
Portland, Oreg., 416 Couch Building.
Tacoma, Wash., Federal Building.
San Francisco, Cal., 328 Customhouse.
Los Angeles, Cal., Federal Building.
Phoenix, Ariz., 417 Fleming Building.
Austin, Tex., Old Post Office Building.
Honolulu, Hawaii, Kapiolani 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 3,800 points in the United States, and the data obtained have been published in the reports tabulated below:

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

[A=Annual Report; B=Bulletin; WS=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. |
| WS 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. |
| WS 15 | Descriptions, measurements, and gage heights, eastern United States, eastern Mississippi River, and Missouri River above junction with Kansas. | 1897. |
| WS 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. |
| WS 27 | Measurements, ratings, and gage heights, eastern United States, eastern Mississippi River, and Missouri River. | 1898. |
| WS 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. |
| WS 35 to 39 | Descriptions, measurements, gage heights, and ratings | 1899. |
| 21st A, pt. 4 | Monthly discharge | 1899. |
| WS 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. |
| WS 65, 66 | Descriptions, measurements, gage heights, and ratings | 1901. |
| WS 75 | Monthly discharge | 1901. |
| WS 82 to 85 | Complete data | 1902. |
| WS 97 to 100 | do | 1903. |
| WS 124 to 135 | do | 1904. |
| WS 165 to 178 | do | 1905. |
| WS 201 to 214 | do | 1906. |
| WS 241 to 252 | do | 1907–8. |
| WS 261 to 272 | do | 1909. |
| WS 281 to 292 | do | 1910. |
| WS 301 to 312 | do | 1911. |
| WS 321 to 332[a] | do | 1912. |
| WS 351 to 362[a] | do | 1913. |
| WS 381 to 394 | do | 1914. |
| WS 401 to 414 | do | 1915. |

[a] In preparation.

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 1915. The data for any particular station will in general be found in the reports covering the years during which the station was maintained. For example, data for Machias River at Whitneyville, Me., 1903 to 1915, are published in Water-Supply Papers 97, 124, 165, 201, 241, 261, 281, 301, 321, 351, 381, and 401, which contain records for the New England streams from 1903 to 1915. Results of miscellaneous measurements are published by drainage basins.

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 stream of the river are presented first, and the tributaries in regular order from source to mouth follow, the streams in each tributary basin being listed before those of the next basin below.

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

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

| Year. | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | North Pacific drainage basins. | | |
| | North Atlantic slope (St. John River to York River). | South Atlantic and eastern Gulf of Mexico (James River to the Mississippi). | Ohio River. | St. Lawrence River and Great Lakes. | Hudson Bay and upper Mississippi River. | Missouri River. | Lower Mississippi River. | Western Gulf of Mexico. | Colorado River. | Great Basin. | Pacific slope in California. | Pacific basins in Washington and upper Columbia River. | Snake River basin. | Lower Columbia River and Pacific basins in Oregon. |
| 1899[a] | 35 | [b] 35, 36 | 36 | 36 | 36 | [c] 36, 37 | 37 | 37 | [d] 37, 38 | 38, [e] 39 | 38, [f] 39 | 38 | 38 | 38 |
| 1900[g] | 47, [h] 48 | 48 | 48, [i] 49 | 49 | 49 | 49, [j] 50 | 50 | 50 | 50 | 51 | 51 | 51 | 51 | 51 |
| 1901 | 65, 75 | 65, 75 | 65, 75 | 65, 75 | [k] 65, 66, 75 | 66, 75 | [k] 65, 66, 75 | 66, 75 | 66, 75 | 66, 75 | 66, 75 | 66, 75 | 66, 75 | 66, 75 |
| 1902 | 82 | [b] 82, 83 | 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 | 332A | 332B | 332C |
| 1913 | 351 | 352 | 353 | 354 | 355 | 356 | 357 | 358 | 359 | 360 | 361 | 362A | 362B | 362C |
| 1914 | 381 | 382 | 383 | 384 | 385 | 386 | 387 | 388 | 389 | 390 | 391 | 392 | 393 | 394 |
| 1915 | 401 | 402 | 403 | 404 | 405 | 406 | 407 | 408 | 409 | 410 | 411 | 412 | 413 | 414 |

[a] Rating tables and index to Water-Supply Papers 35–39 contained in Water-Supply Paper 39. Estimates for 1899 in Twenty-first Annual Report, Part IV.
[b] James River only.
[c] Gallatin River.
[d] Green and Gunnison rivers and Grand River above junction with Gunnison.
[e] Mohave River only.
[f] Kings and Kern rivers and south Pacific slope basins.
[g] Rating tables and index to Water-Supply Papers 47–52 and data on precipitation, wells, and irrigation in California and Utah contained in Water-Supply Paper 52. Estimates or 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 pp. XV–XVI.)

## GAGING STATIONS.

NOTE.—Dash after a date indicates that station was being maintained September 30, 1915. 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–
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.
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–

Red River tributaries—Continued.
Red Lake River at Crookston, Minn., 1901–
Thief River near Thief River Falls, Minn., 1909–
Clearwater River at Red Lake Falls, Minn., 1909–
South Branch of Two Rivers at Hallock, Minn., 1911–1914.
Pembina River at Neche, N. Dak., 1903–1915.
Roseau River at Dominion City, Canada, 1912.
West Branch of Roseau River near Malung, Minn., 1911–1914.
Mouse River near Foxholm, N. Dak., 1904–1906.
Mouse River at Minot, N. Dak., 1903–
Des Lacs River at Foxholm, N. Dak., 1904–1906.
Rainy Lake at Rainier, Minn., 1910–
Rainy River at International Falls, Minn., 1907–
Kawishiwi River near Winton, Minn., 1905–1907; 1912–
Vermilion River below Lake Vermilion, near Tower, Minn., 1911–
Little Fork at Little Fork, Minn., 1909–
Big Fork at Big Falls, Minn., 1909–1912.
Big Fork at Laurel, Minn., 1909.
Black River near Loman, Minn., 1909.

UPPER MISSISSIPPI RIVER BASIN.

Mississippi River above Sandy River, Minn., 1895–
Mississippi River near Fort Ripley, Minn., 1909–10.
Mississippi River near Sauk Rapids, Minn., 1903–1906.
Mississippi River at Elk River, Minn., 1915–
Mississippi River at Anoka, Minn., 1905–1914.
Mississippi River at St. Paul, Minn., 1873–
Sandy River below Sandy Lake reservoir, Minn., 1893–
Pine River below Pine River reservoir, Minn., 1886–
Prairie River near Grand Rapids, Minn., 1909.
Crow Wing River at Nimrod, Minn., 1910–1914.
Crow Wing River at Motley, Minn., 1909; 1913–
Crow Wing River at Pillager, Minn., 1903; 1909–1913.
Long Prairie River near Motley, Minn., 1909–
Sauk River near St. Cloud, Minn., 1909–1913.
Elk River near Big Lake, Minn., 1911–
Crow River at Rockford, Minn., 1909–
Crow River near Dayton, Minn., 1906.
North Fork of Crow River near Rockford, Minn., 1909–10.
South Fork of Crow River near Rockford, Minn., 1909–1912.
Rum River at Onamia, Minn., 1909–1912.
Rum River at Cambridge, Minn., 1909–1914.
Rum River at St. Francis, Minn., 1903.
Rum River near Anoka, Minn., 1905–6; 1909.
Minnesota River near Odessa, Minn., 1909–1913.
Minnesota River near Montevideo, Minn., 1909–
Minnesota River near Mankato, Minn., 1903–
Whetstone River near Big Stone, S. Dak., 1910–1912.
Lac qui Parle River at Lac qui Parle, Minn., 1910–1914.
Chippewa River near Watson, Minn., 1909–
Redwood River near Redwood Falls, Minn., 1909–1914.
Cottonwood River near New Ulm, Minn., 1909–1913.
Blue Earth River at Rapidan Mills, Minn., 1909–10.

Mississippi River tributaries—Continued.
St. Croix River at Swiss, Wis., 1914–
St. Croix River near St. Croix Falls, Wis., 1902–1905; 1910–
Namakagon River at Trego, Wis., 1914–
Yellow River at Webster, Wis., 1914.
Kettle River near Sandstone, Minn., 1908–
Snake River at Mora, Minn., 1909–1913.
Snake River near Pine City, Minn., 1913–
Apple River near Somerset, Wis., 1901–
Cannon River at Welch, Minn., 1909–1914.
Chippewa River at Bishops Bridge, near Winter, Wis., 1912–
Chippewa River near Bruce, Wis., 1913–
Chippewa River at Chippewa Falls, Wis., 1888–
Chippewa River near Eau Claire, Wis., 1902–1909.
West Fork of Chippewa River near Winter, Wis., 1911–
Flambeau River near Butternut, Wis., 1914–
Flambeau River near Ladysmith, Wis., 1914–
Flambeau River at Ladysmith, Wis., 1903–1906.
Jump River at Sheldon, Wis., 1915–
Eau Claire River near Augusta, Wis., 1914–
Eau Claire River near Eau Claire, Wis., 1913–14.
Red Cedar River near Colfax, Wis., 1914–
Red Cedar River at Cedar Falls, Wis., 1909–
Red Cedar River at Menominee, Wis., 1907–8; 1913–
Zumbro River at Zumbro Falls, Minn., 1909–
South Branch of Zumbro River near Zumbro Falls, Minn., 1911–
Trempealeau River at Dodge, Wis., 1913–
Black River at Neillsville, Wis., 1905–1909; 1913–
Black River at Melrose, Wis., 1902–3.
La Crosse River near West Salem, Wis., 1913–
Root River near Houston, Minn., 1909–
North Branch of Root River near Lanesboro, Minn., 1910–
Upper Iowa River near Decorah, Iowa, 1913–14.
Wisconsin River near Rhinelander, Wis., 1905–
Wisconsin River at Merrill, Wis., 1902–
Wisconsin River near Nekoosa, Wis., 1914–
Wisconsin River near Necedah, Wis., 1902–1914.
Wisconsin River at Muscoda, Wis., 1902–3; 1913–
Tomahawk River near Bradley, Wis., 1914–
Prairie River near Merrill, Wis., 1914–
Little Rib River near Wausau, Wis., 1914–
Eau Claire River at Kelley, Wis., 1914–
Big Eau Pleine River near Stratford, Wis., 1914–
Plover River near Stevens Point, Wis., 1914–
Baraboo River near Baraboo, Wis., 1913–
Kickapoo River at Gays Mills, Wis., 1913–
Turkey River at Garber, Iowa, 1913–
Maquoketa River above mouth of North Fork, near Maquoketa, Iowa, 1913–
Maquoketa River at Manchester, Iowa, 1903.
Maquoketa River below mouth of North Fork, near Maquoketa, Iowa, 1913–
Wapsipinicon River at Stone City, Iowa, 1903–1914.
Rock River at Watertown, Wis., 1914.
Rock River at Afton, Wis., 1914–

Mississippi River tributaries—Continued.
Rock River above mouth of Pecatonica River, at Rockton, Ill., 1903.
Rock River below mouth of Pecatonica River, at Rockton, Ill., 1903–1909.
Rock River at Rockford, Ill., 1914–
Rock River near Nelson, Ill., 1906.
Rock River at Sterling, Ill., 1905–6.
Catfish River at Madison, Wis., 1902–3.
Lake Mendota at Madison, Wis., 1902–3.
Pecatonica River at Dill, Wis., 1914–
Pecatonica River at Freeport, Ill., 1914–
Sugar River near Brodhead, Wis., 1914–
Iowa River near Iowa Falls, Iowa, 1911–1914.
Iowa River at Marshalltown, Iowa, 1903; 1915–
Iowa River at Iowa City, Iowa, 1903–1906; 1913–
Iowa River at Wapello, Iowa, 1915–
Cedar River near Austin, Minn., 1909–1914.
Cedar River at Janesville, Iowa, 1905–6; 1915–
Cedar River at Cedar Rapids, Iowa, 1902–
Shellrock River near Clarksville, Iowa, 1915–
Skunk River at Coppock, Iowa, 1913–
Skunk River at Augusta, Iowa, 1913; 1915–
Des Moines River at Jackson, Minn., 1909–1913.
Des Moines River at Fort Dodge, Iowa, 1905–6; 1911–1913.
Des Moines River at Kalo, Iowa, 1913–
Des Moines River at Des Moines, Iowa, 1902–3; 1905–6.
Des Moines River at Keosauqua, Iowa, 1903–1906; 1911–
Raccoon River near Des Moines, Iowa, 1902–3.
Raccoon River at Van Meter, Iowa, 1915–
Illinois River near Minooka, Ill., 1902–1904.
Illinois River near Seneca, Ill., 1902–3.
Illinois River near Ottawa, Ill., 1902–1904.
Illinois River near La Salle, Ill., 1902–3.
Illinois River near Peoria, Ill., 1903–1906.
Kankakee River at Davis, Ind., 1905–6.
Kankakee River at Momence, Ill., 1905–6; 1914–
Kankakee River at Custer Park, Ill., 1914–
Yellow River at Knox, Ind., 1905–6.
Des Plaines River at Riverside, Ill., 1896–1898.
Des Plaines River above mouth of Jackson Creek, near Channahon, Ill., 1903–1906.
Des Plaines River above Kankakee River, near Channahon, Ill., 1902–3.
Des Plaines River at Lemont, Ill., 1914–
Des Plaines River at Romeo, Ill., 1914.
Des Plaines River at Joliet, Ill., 1914–
Fox River at South Elgin, Ill., 1914–15.
Fox River at Aurora, Ill., 1914.
Fox River at Sheridan, Ill., 1905–6.
Fox River at Wedron, Ill., 1914–
Fox River at Ottawa, Ill., 1903.
Vermilion River near Streator, Ill., 1914–
Spoon River at Seville, Ill., 1914–
Sangamon River at Monticello, Ill., 1908–1912; 1914–
Sangamon River at Decatur, Ill., 1905.

Mississippi River tributaries—Continued.
Illinois River tributaries—Continued.
Sangamon River at Riverton, Ill., 1908–1912; 1914–
Sangamon River at Springfield, Ill., 1903.
Sangamon River near Oakford, Ill., 1909–1912; 1914–
Sangamon River near Chandlerville, Ill., 1908–9.
South Fork of Sangamon River near Taylorville, Ill., 1908–1912; 1914–
Salt Creek near Kenny, Ill., 1908–1912.
Cahokia Creek at Poag, Ill., 1909–1912.
Kaskaskia River near Arcola, Ill., 1908–1912.
Kaskaskia River at Shelbyville, Ill., 1908–1912; 1914.
Kaskaskia River at Vandalia, Ill., 1908–1912; 1914–
Kaskaskia River at Carlyle, Ill., 1908–1912; 1914–15.
Kaskaskia River at New Athens, Ill., 1907–1912; 1914–
Shoal Creek near Breese, Ill., 1909–1912; 1914.
Silver Creek near Lebanon, Ill., 1908–1912; 1914.
Big Muddy River near Cambon, Ill., 1908–1912.
Big Muddy River at Plumfield, Ill., 1914–
Beaucoup Creek near Pinckneyville, Ill., 1908–1912; 1914.

## 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. (Continued in No. 26.)
Discusses, by counties, glacial deposits and sources of well waters; many well sections.

57. Preliminary list of deep borings in the United States, Part I (Alabama-Montana), by N. H. Darton. 1902. 60 pp. (See No. 149.) 5c.

61. Preliminary list of deep borings in the United States, Part II (Nebraska-Wyoming), by N. H. Darton. 1902. 67 pp. 5c.
Nos. 57 and 61 contain information as to depth, diameter, yield, and head of water in borings more than 400 feet deep. A revised edition 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, tempera ture, use, and quality; many miscellaneous analyses.

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.

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.

*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; gives also index to literature on floods on American streams.

*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. 40c.

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 underground waters, artesian phenomena and yield of artesian wells, the chemical composition of underground waters, municipal, domestic, and industrial water supplies, and mineral waters; gives details concerning topography, geology, underground 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.

## 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, streams 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 waterworks, 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.

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.

[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.

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 brief discussions of the underground waters in connection with the economic resources of the areas and more or less information concerning the utilization of the water resources.

An asterisk (*) indicates that the stock of the folio is exhausted.

117. Casselton-Fargo, North Dakota-Minnesota.

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]

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 map showing areas in which flowing wells may probably be obtained.

185. Murphysboro-Herrin, Illinois.

188. Tallula-Springfield, Illinois.

Discusses wells and the wholesomeness of the water; gives analyses of water from wells in the city of Springfield.

195. Belleville-Breese, Illinois.

Discusses wells and gives analyses of water from springs and wells.

## 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 navi-

[1] Issued in two editions (see first paragraph, this page). Specify which edition is wanted.

gation 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 Bartow, 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.

## 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. 10c. (See Water-Supply Paper 22.)

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

*14. New tests of certain pumps and water lifts used in irrigation, by O. P. Hood. 1898. 91 pp., 1 pl. 10c.

Discusses efficiency of pumps and water lifts of various types.

*20. Experiments with windmills, by T. O. Perry. 1899. 97 pp., 12 pls. 15c.

Includes tables and descriptions of wind wheels, makes comparisons of wheels of several types and discusses results.

*22. Sewage irrigation, Part II, by G. W. Rafter. 1899. 100 pp., 7 pls. 15c.

Gives résumé of Water-Supply Paper No. 3; discusses pollution of certain streams, experiments on purification of factory wastes in Massachusetts, value of commercial fertilizers, and describes American sewage-disposal plants by States; contains bibliography of publications relating to sewage, ntilization, and disposal.

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

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

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

*42. The windmill; its efficiency and economic use, Part II, by E. C. Murphy. 1901. 75 pp., 2 pls. 10c.

Nos. 41 and 42 give details of results of experimental tests with windmills of various types.

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

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

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

*56. Methods of stream measurement. 1901. 51 pp., 12 pls. 15c.

Describes the methods used by the survey in 1901–2. (See also Nos. 64, 94, and 95.)

64. Accuracy of stream measurements, by E. C. Murphy. 1902. 99 pp., 4 pls. (See No. 95.) 10c.

Describes methods of measuring velocity of water and of measuring and computing stream flow and compares results obtained with the different instruments and methods; describes also experiments and results at the Cornell University hydraulic laboratory. A second, enlarged edition published as Water-Supply Paper 95.

*67. The motions of underground waters, by C. S. Slichter. 1902. 106 pp., 8 pls. 15c.

Discusses origin, depth, and amount of 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 well.

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

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

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

Describes topography and geology of the island, the springs, running streams, and wells; discusses utilization of the surface and underground waters.

79. Normal and polluted waters in northeastern United States, by M. O. Leighton. 1903. 192 pp. 10c.

Defines essential qualities of water for various uses, the impurities in rain, surface, and ground waters, meaning and importance of sanitary analyses, and principal sources of 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 rainfall, run-off, and evaporation formulas; discusses effect of forests on rainfall and run-off.

87. Irrigation in India (second edition), by H. M. Wilson. 1903. 238 pp., 27 pls. 25c.

First edition was published in Part II of the Twelfth Annual Report.

93. Proceedings of first conference of engineers of the Reclamation Service, with accompanying papers, compiled by F. H. Newell, chief engineer. 1904. 361 pp. 25c.

Contains the following papers of more or less general interest:
Limits of an irrigation project, by D. W. Ross.
Relation of Federal and State laws to irrigation, by Morris Bien.
Electrical transmission of power for pumping, by H. A. Storrs.
Correct design and stability of high masonry dams, by Geo. Y. Wisner.
Irrigation surveys and the use of the plane table, by J. B. Lippincott.
The use of alkaline waters for irrigation, by Thomas A. Means.

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

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

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

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

103. A review of the laws forbidding pollution of inland waters in the United States, by E. B. Goodell. 1904. 120 pp. (See No. 152.)

Explains the legal principles under which antipollution statutes become operative, quotes court decisions to show authority for various deductions, and classifies according to scope the statutes enacted in the different States.

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

Contains the following reports of general interest. The scope of each paper is indicated by its title.

Description of underflow meter used in measuring the velocity and direction of underground water, by Charles S. Slichter.

The California or "stovepipe" method of well construction, by Charles S. Slichter.

Approximate methods of measuring the yield of flowing wells, by Charles S. Slichter.

Corrections necessary in accurate determinations of flow from vertical well casings, from notes furnished by A. N. Talbot.

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

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

113. The disposal of strawboard and oil-well wastes, by R. L. Sackett and Isaiah Bowman. 1905. 52 pp., 4 pls. 5c.

The first paper discusses the pollution of streams by sewage and by trade wastes, describes the manufacture of strawboard and gives results of various experiments in disposing of the waste. The second paper describes briefly the topography, drainage, and geology of the region about Marion, Ind., the contamination of rock wells and of streams by waste oil and brine.

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

Contains report on "Occurrence of underground waters," by M. L. Fuller, discussing sources, amount, and temperature of waters; permeability and storage capacity of rocks, water-bearing formations; recovery of water by springs, wells, and pumps; essential conditions of artesian flows; and general conditions affecting underground waters in eastern United States.

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

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

119. Index to the hydrographic progress reports of the United States Geological Survey, 1888 to 1903, by J. C. Hoyt and B. D. Wood. 1905. 253 pp. 15c.

Scope indicated by title.

120. Bibliographic review and index of papers relating to underground waters published by the United States Geological Survey, 1879–1904, by M. L. Fuller. 1905. 128 pp. 10c.

Scope indicated by title.

*122. Relation of the law to underground waters, by D. W. Johnson. 1905. 55 pp. 5c.

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

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

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

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

Scope indicated by title.

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

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

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

Contains brief reports of general interest as follows:

Drainage of ponds into drilled wells, by Robert E. Horton. Discusses efficiency, cost, and capacity of drainage wells and gives statistics of such wells in southern Michigan.

Construction of so-called fountain and geyser springs, by Myron L. Fuller.

A convenient gage for determining low artesian heads, by Myron L. Fuller.

146. Proceedings of second conference of engineers of the Reclamation Service, with accompanying papers, compiled by F. H. Newell, chief engineer. 1905. 267 pp. 15c.

Contains brief account of the organization of the hydrographic [water-resources] branch and the Reclamation Service, reports of conferences and committees, circulars of instruction, and many brief reports on subjects closely related to reclamation, and a bibliography of technical papers by members of the service. Of the papers read at the conference those listed below (scope indicated by title) are of more or less general interest:

Proposed State code of water laws, by Morris Bien.

Power engineering applied to irrigation problems, by O. H. Ensign.

Estimates on tunneling in irrigation projects, by A. L. Fellows.

Collection of stream-gaging data, by N. C. Grover.

Diamond-drill methods, by G. A. Hammond.

Mean-velocity and area curves, by F. W. Hanna.

Importance of general hydrographic data concerning basins of streams gaged, by R. E. Horton.

Effect of aquatic vegetation on stream flow, by R. E. Horton.

Sanitary regulations governing construction camps, by M. O. Leighton.

Necessity of draining irrigated land, by Thos. H. Means.

Alkali soils, by Thos. H. Means.

Cost of stream-gaging work, by E. C. Murphy.

Equipment of a cable gaging station, by E. C. Murphy.

Silting of reservoirs, by W. M. Reed.

Farm-unit classification, by D. W. Ross.

Cost of power for pumping irrigating water, by H. A. Storrs.

Records of flow at current-meter gaging stations during the frozen season, by F. H. Tillinghast.

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

Contains a brief account of "A method of computing cross-section area of waterways," including formulas for maximum discharge and areas of cross section.

150. Weir experiments, coefficients, and formulas, by R. E. Horton. 1906. 189 pp., 38 pls. (See Water-Supply Paper 200.) 15c.

Scope indicated by title.

*151. Field assay of water, by M. O. Leighton. 1905. 77 pp., 4 pls. 10c.

Discusses methods, instruments, and reagents used in determining turbidity, color, iron, chlorides, and hardness in connection with the studies of the quality of water in various parts of the United States.

152. A review of the laws forbidding pollution of inland waters in the United States, second edition, by E. B. Goodell. 1905. 149 pp. 10c.

Scope indicated by title.

*155. Fluctuations of the water level in wells, with special reference to Long Island, N. Y., by A. C. Veatch. 1906. 83 pp., 9 pls. 25c.

Includes general discussion of fluctuation due to rainfall and evaporation, barometric changes, temperature changes in rivers, changes in lake level, tidal changes, effects of settlement, irrigation, dams, underground-water development, and to indeterminate causes.

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

Gives account of work in 1905; lists of publications relating to underground waters, and contains the following brief reports of general interest:

Significance of the term "artesian," by Myron L. Fuller.

Representation of wells and springs on maps, by Myron L. Fuller.

Total amount of free water in the earth's crust, by Myron L. Fuller.

Use of fluorescein in the study of underground waters, by R. B. Dole.

Problems of water contamination, by Isaiah Bowman.

Instances of improvement of water in wells, by Myron L. Fuller.

*162. Destructive floods in the United States in 1905, with a discussion of flood discharge and frequency and an index to flood literature, by E. C. Murphy and others. 1906. 105 pp., 4 pls. 15c.

*163. Bibliographic review and index of underground-water literature published in the United States in 1905, by M. L. Fuller, F. G. Clapp, and B. L. Johnson. 1906. 130 pp. 15c.

Scope indicated by title.

*179. Prevention of stream pollution by distillery refuse, based on investigations at Lynchburg, Ohio, by Herman Stabler. 1906. 34 pp., 1 pl. 10c.

Describes grain distillation, treatment of slop, sources, character, and effects of effluents on streams; discusses filtration, precipitation, fermentation, and evaporation methods of disposal of wastes without pollution.

*180. Turbine water-wheel tests and power tables, by R. E. Horton. 1906. 134 pp., 2 pls. 20c.

Scope indicated by title.

*185. Investigations on the purification of Boston sewage, by C–E. A. Winslow and E. B. Phelps. 1906. 163 pp. 25c.

Discusses composition, disposal, purification, and treatment of sewages and recent tendencies in sewage-disposal practice in England, Germany, and the United States; describes character of crude sewage at Boston, removal of suspended matter, treatment in septic tanks, and purification in intermittent sand filtration and coarse material; gives bibliography.

*186. Stream pollution by acid-iron wastes, a report based on investigations made at Shelby, Ohio, by Herman Stabler. 1906. 36 pp., 1 pl. 10c.

Gives history of pollution by acid-iron wastes at Shelby, Ohio, and resulting litigation; discusses effect of acid-iron liquors on sewage purification processes, recovery of copperas from acid-iron wastes, and other processes for removal of pickling liquor.

*187. Determination of stream flow during the frozen season, by H. K. Barrows and R. E. Horton. 1907. 93 pp., 1 pl. 15c.

Scope indicated by title.

*189. The prevention of stream pollution by strawboard waste, by E. B. Phelps, 1906. 29 pp., 2 pls. 5c.

Describes manufacture of strawboard, present and proposed methods of disposal of waste liquors, laboratory investigations of precipitation and sedimentation, and field studies of 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. 40c.

Scope indicated by amplification of title.

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

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

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

Scope indicated by title.

*218. Water-supply investigations in Alaska, 1906–07 (Nome and Kougarok regions, Seward Peninsula; Fairbanks district, Yukon-Tanana region), by F. F. Henshaw and C. C. Covert. 1908. 156 pp., 12 pls. 25c.

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

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

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

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

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

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

Scope indicated by title.

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

Contains the following papers, whose scope is indicated by their titles: Distribution of rainfall, by Henry Gannett; Floods, by M. O. Leighton; Developed water powers, compiled under the direction of W. M. Steuart, with discussion by M. O. Leighton; Undeveloped water powers, by M. O. Leighton; Irrigation, by F. H. Newell; Underground waters, by W. C. Mendenhall; Denudation, by R. B. Dole and Herman Stabler; Control of catchment areas, by 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, method 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 underl ground water, artesian conditions, and oil and gas bearing formations; gives history of wel drilliug in Asia, Europe, and the United States; describes in detail the various methods and the machinery used; discusses loss of tools and geologic difficulties; contamination of well waters and methods of prevention; tests of capacity and measurement of depth; and costs of sinking wells.

*258. Underground water-papers, 1910, by M. L. Fuller, F. G. Clapp, G. C. Matson, Samuel Sanford, and H. C. Wolff. 1911. 123 pp., 2 pls. 15c.

Contains the following papers (scope indicated by titles) of general interest:
Drainage by wells, by M. L. Fuller.
Freezing of wells and related phenomena, by M. L. Fuller.
Pollution of underground waters in limestone, by G. C. Matson.
Protection of shallow wells in sandy deposits, by M. L. Fuller.
Magnetic wells, by M. L. Fuller.

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

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

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; gives results of analyses of waters of the Rio Grande and of Pecos, Gallinas, and Hondo Rivers.

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

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

Contains results of work at gaging stations.

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

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

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

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

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

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

336. Water resources of Hawaii, 1912, by C. H. Pierce and G. K. Larrison. 1914. 392 pp. 50c.

Contains results of stream measurements in 1912.

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

Discusses methods of measuring the winter flow of streams.

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

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

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

(*f*) The discharge of Yukon River at Eagle, Alaska, by E. A. Porter and R. W. Davenport, pp. 67–77, Pls. 4 and 5. Describes briefly the location and size of the Yukon basin, the climatic conditions in the basin, and methods of collecting hydrometric data; compares run-off with precipitation, and gives table showing the discharge of some of the large rivers in the United States as compared with the discharge of the Yukon and the Nile.

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

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

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

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

372. A water-power reconnaissance in south-central Alaska, by C. E. Ellsworth and R. W. Davenport, with a section on southeastern Alaska, by J. C. Hoyt. 1915. 173 pp., 22 pls. 20c.

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

*375. Contributions to the hydrology of the United States, 1915; N. C. Grover, chief hydraulic engineer. Contains:

(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 stream-flow records, by C. H. Pierce, pp. 131–139.

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

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

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

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

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

## 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 economical aspects of irrigation, alkaline drainage, silt and sedimentation; gives brief history of legislation; describes perennial canals in Idaho, California, Wyoming, and Arizona; discusses water storage at reservoirs of the California and other projects, subsurface sources of supply, pumping, and subirrigation.

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

*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, pls. 17. Scope indicated by title.

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

*Hydrography of Nicaragua, by A. P. Davis, pp. 563–637, pls. 64 to 75. Describes the topographic features of the boundary, the lake basin and Rio San Juan; gives a brief résumé of the boundary dispute; discusses rainfall, temperature, and relative humidity, evaporation, resources, and productions, the ship-railway and canal projects; gives the history of the investigations of the Canal Commission, and results of measurements on the Rio Grande, on streams tributary to Lake Nicaragua, and on Rio San Juan and its tributaries.

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

*Hydrography of the American Isthmus, by A. P. Davis, pp. 507-630, Pls. 37 to 50. Describes the physiography, temperature, rainfall, and winds of Central America; discusses the hydrography of the Nicaragua Canal route and the Panama Canal route; gives estimated monthly discharges of many of the streams, rainfall, and evaporation tables at various points.

**PROFESSIONAL PAPERS.**

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

Describes the topography, geology, drainage, forests, climate and population, and transportation facilities of the region, the relation of agriculture, lumbering, mining, and power development to erosion and denudation, and the nature, effects, and remedies of erosion; gives details of conditions in Holston, Nolichucky, French Broad, Little Tennessee, and Hiwassee river basins, along Tennessee River proper, and in the basins of the Coosa-Alabama system, Chattahoochee, Savannah, Saluda, Broad, Catawba, Yadkin, New, and Monongahela rivers.

**BULLETINS.**

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

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

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

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

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

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*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 underground waters, the confining agents, the primary and modifying factors of artesian circulation, the essential and modifying factors of artesian flow, and typical artesian systems.

*479. The geochemical interpretation of water analyses, by Chase Palmer. 1911. 31 pp. 5c.

Discusses the expression of chemical analyses, the chemical character of water and the properties of natural waters; gives a classification of waters based on property values and reacting values, and discusses the character of the waters of certain rivers as interpreted directly from the results of analyses; discusses also the relation of water properties to geologic formations, silica in river water, and the character of the water of the Mississippi and the Great Lakes and St. Lawrence River as indicated by chemical analyses.

# INDEX BY AREAS AND SUBJECTS.

[A=Annual Reports; M=Monograph; B=Bulletin; P=Professional Paper; W=Water-Supply Paper; G F=Geologic folio.]



[1] Many of the reports contain brief subject bibliographies. See abstracts.

[2] Many analyses of river, spring, and well waters are scattered through publications, as noted in abstracts.

# INDEX OF STREAMS.