DEPARTMENT OF THE INTERIOR

WATER-SUPPLY

AND

IRRIGATION PAPERS

OF THE

UNITED STATES GEOLOGICAL SURVEY

No. 35

OPERATIONS AT RIVER STATIONS, 1899.—PART I

WASHINGTON
GOVERNMENT PRINTING OFFICE
1900

IRRIGATION REPORTS.

The following list contains titles and brief descriptions of the principal reports relating to water supply and irrigation, prepared by the United States Geological Survey since 1890:

1890.

First Annual Report of the United States Irrigation Survey, 1890; octavo, 123 pp.

Printed as Part II, Irrigation, of the Tenth Annual Report of the United States Geological Survey, 1888-89. Contains a statement of the origin of the Irrigation Survey, a preliminary report on the organization and prosecution of the survey of the arid lands for purposes of irrigation, and report of work done during 1890.

1891.

Second Annual Report of the United States Irrigation Survey, 1891; octavo, 395 pp.

Published as Part II, Irrigation, of the Eleventh Annual Report of the United States Geological Survey, 1889-90. Contains a description of the hydrography of the arid region and of the engineering operations carried on by the Irrigation Survey during 1890; also the statement of the Director of the Survey to the House Committee on Irrigation, and other papers, including a bibliography of irrigation literature. Illustrated by 29 plates and 4 figures.

Third Annual Report of the United States Irrigation Survey, 1891; octavo, 576 pp.

Printed as Part II of the Twelfth Annual Report of the United States Geological Survey, 1890-91. Contains "Report upon the location and survey of reservoir sites during the fiscal year ended June 30, 1891," by A. H. Thompson; "Hydrography of the arid regions," by F. H. Newell; "Irrigation in India," by Herbert M. Wilson. Illustrated by 93 plates and 190 figures.

Bulletins of the Eleventh Census of the United States upon irrigation, prepared by F. H. Newell; quarto.

No. 35, Irrigation in Arizona; No. 60, Irrigation in New Mexico; No. 85, Irrigation in Utah; No. 107, Irrigation in Wyoming; No. 153, Irrigation in Montana; No. 157, Irrigation in Idaho; No. 163, Irrigation in Nevada; No. 178, Irrigation in Oregon; No. 193, Artesian wells for irrigation; No. 198, Irrigation in Washington.

1892.

Irrigation of western United States, by F. H. Newell; extra census bulletin No. 23, September 9, 1892; quarto, 22 pp.

Contains tabulations showing the total number, average size, etc., of irrigated holdings, the total area and average size of irrigated farms in the subhumid regions, the percentage of number of farms irrigated, character of crops, value of irrigated lands, the average cost of irrigation, the investment and profits, together with a résumé of the water supply and a description of irrigation by artesian wells. Illustrated by colored maps, showing the location and relative extent of the irrigated areas.

1893.

Thirteenth Annual Report of the United States Geological Survey, 1891-92, Part III, Irrigation, 1893; octavo, 486 pp.

Consists of three papers: "Water supply for irrigation," by F. H. Newell; "American irrigation engineering" and "Engineering results of the Irrigation Survey," by Herbert M. Wilson; "Construction of topographic maps and selection and survey of reservoir sites," by A. H. Thompson. Illustrated by 77 plates and 119 figures.

A geological reconnaissance in central Washington, by Israel Cook Russell, 1893; octavo, 108 pp., 15 plates. Bulletin No. 108 of the United States Geological Survey; price, 15 cents.

Contains a description of the examination of the geologic structure in and adjacent to the drainage basin of Yakima River and the great plains of the Columbia to the east of this area, with special reference to the occurrence of artesian waters.

1894.

Report on agriculture by irrigation in the western part of the United States at the Eleventh Census, 1890, by F. H. Newell, 1894; quarto, 283 pp.

Consists of a general description of the condition of irrigation in the United States, the area irrigated, cost of works, their value and profits; also describes the water supply, the value of water, of artesian wells, reservoirs, and other details; then takes up each State and Territory in order, giving a general description of the condition of agriculture by irrigation, and discusses the physical conditions and local peculiarities in each county.

Fourteenth Annual Report of the United States Geological Survey, 1892-93, in two parts; Part II, Accompanying papers, 1894; octavo, 597 pp.

Contains papers on "Potable waters of the eastern United States," by W J McGee; "Natural mineral waters of the United States," by A. C. Peale; "Results of stream measurements," by F. H. Newell. Illustrated by maps and diagrams.

 (Continued on third page of cover.)

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UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

OPERATIONS AT RIVER STATIONS, 1899

A REPORT OF THE

DIVISION OF HYDROGRAPHY

OF THE

UNITED STATES GEOLOGICAL SURVEY

PART I

WASHINGTON
GOVERNMENT PRINTING OFFICE
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CONTENTS.

LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
DIVISION OF HYDROGRAPHY,
Washington, March 1, 1900.

SIR: I have the honor to transmit herewith a manuscript giving the results of operations at the river stations in the eastern portion of the country during the calendar year 1899, together with related data, for publication in the series of papers upon water supply and irrigation. The data for the central and western portions of the country will be transmitted as the succeeding numbers of the series.

Very respectfully,

F. H. NEWELL,
Hydrographer in Charge.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

OPERATIONS AT RIVER STATIONS, 1899.

PART I.

INTRODUCTION.

The following pages contain descriptions of the river stations maintained during 1899 by the United States Geological Survey, together with tables of the average daily height of water and results of measurements of discharge. The rating tables constructed from the latter and applicable in general for the calendar year will be given at the end of the publication. Similar facts have been printed for the year 1896 in Water-Supply Paper No. 11, for 1897 in Water-Supply Papers Nos. 15 and 16, and for 1898 in Water-Supply Papers Nos. 27 and 28. The stations have been arranged in geographic order. A description of each station is given, together with all of the discharge measurements, followed by the tables of gage heights and ratings.

The material above noted consists essentially of the results of operations at the river stations, and forms the basis for computations of daily, monthly, and annual flow. In order to make these necessary computations considerable time and labor is involved and the resulting facts can be most clearly and concisely given by diagrams. The preparation of the computations and the diagrams necessitates unavoidable delays, and therefore it has been the custom to present the facts, such as are given herewith, as soon as possible after the close of the calendar year, so that the original data may be available at an early date to all who are concerned with their use. While these original figures are being printed the computations of final results are being prepared, and, with the illustrations, have in the past been made to form a part of the annual report of the Director of the Geological Survey. For example, the results for 1896, mentioned above, as given in Water-Supply Paper No. 11, are fully discussed in Part IV of the Eighteenth Annual Report; the original data for 1897, given in Water-Supply Papers Nos. 15 and 16, are published in final form in the Nineteenth Annual Report, Part IV, and the data for 1898, given in Water-Supply Papers Nos. 27 and 28, are published in the Twentieth Annual Report, Part IV. In the same way the figures herewith given form the basis for conclusions being prepared for publication in Part IV of the Twenty-first Annual Report.

ACKNOWLEDGMENTS.

Most of the measurements herewith presented have been obtained through local hydrographers, a comparatively small part of the work having been conducted directly from the office of the Geological Survey at Washington. Acknowledgment is therefore due to each of these persons individually. Thanks should also be extended to individuals and corporations who have cooperated in various ways, either by furnishing readings of height of water or assisting in transportation. The following list gives the names of the resident hydrographers or persons cooperating, this being arranged alphabetically by States.

Arizona: W. A. Farish, civil engineer, Phenix.

California: J. B. Lippincott, civil engineer, Los Angeles.

Colorado: A. L. Fellows, civil engineer, Denver.

Georgia and Alabama: Prof. B. M. Hall, civil engineer, Atlanta, and Prof. W. S. Yeates, State geologist, Atlanta.

Idaho: N. S. Dils, civil engineer, Caldwell.

Kansas: W. G. Russell, Russell; Prof. E. C. Murphy, State University, Lawrence.

Maryland: Prof. W. B. Clark, State geologist, Baltimore.

Montana: S. M. Emery, director experiment station, Bozeman; Prof. Samuel Fortier, Bozeman; Prof. Fred. D. Smith, Missoula.

Nebraska: Prof. O. V. P. Stout, State University, Lincoln, assisted by Adna Dobson and Glenn E. Smith.

Nevada: L. H. Taylor, civil engineer, Golconda.

New Mexico: P. E. Harroun, civil engineer, Albuquerque.

North and South Carolina: Prof. J. A. Holmes, State geologist, Chapel Hill, North Carolina, assisted by E. W. Myers.

Texas: Prof. Thomas U. Taylor, State University, Austin.

Utah: Prof. Samuel Fortier, civil engineer, Corinne, assisted by J. L. Rhead and J. S. Baker; later, Prof. George L. Swendsen, Logan.

Virginia and West Virginia: Prof. D. C. Humphreys, Washington and Lee University, Lexington, Virginia.

Washington: Sydney Arnold, civil engineer, North Yakima; William J. Ware, civil engineer, Port Angeles.

Wyoming: A. J. Parshall, civil engineer, Cheyenne.

In a number of instances related data have been inserted, such, for example, as results of computation of daily flow at mill dams, made by local engineers, and data of river heights obtained from the United States Weather Bureau, or Corps of Engineers, United States Army. Reference to these facts, mainly unpublished, has been, or will be, made in other publications of this survey, and they are therefore placed in consecutive order for convenience of reference.

The methods of measuring the discharge of various streams and of preparing the computations have been described on pages 18 to 30 of the Nineteenth Annual Report, Part IV, and on pages 20 to 22 of the Twentieth Annual Report, Part IV. The tables used in facilitating computations are also given on pages 29 to 32 of Bulletin No. 140.

CLASSIFICATION OF FIELD WORK.

In order to make a comprehensive study of the surface waters of the United States four classes of work are in hand:

1. Maintenance of long-record river stations.
2. Maintenance of short-record river stations.
3. Reconnaissance along streams.
4. Detailed reservoir surveys.

The long-record river stations are designed to show the influence of climatic fluctuations upon the volume of a river at a given locality. Only a few of these long-record stations can be maintained in any one State or section. Under this head are included only the localities where the conditions are highly favorable for accuracy of results as furnishing a standard of comparison. At such points especial care is taken to verify the gage readings and to make frequent measurements of discharge to give assurance that the rating table is correct. From the results obtained here it is possible to compare one year with another and ascertain which are years of high or low water or of medium flow.

The short-record river stations are established for the purpose of obtaining the flow at a given point for a short period. Each short-record station is discontinued as soon as the results are considered sufficient for probable industrial development. Reasonable care is taken to verify the results at these stations, but necessarily not the same refinement needed as in the case of the long-record stations.

Reconnaissance along important streams is systematically carried forward whenever the season is favorable, preferably during low water. Measurements of discharge are made wherever practicable during the progress of this work and observation of height maintained at some one point during the time of the reconnaissance. At important points level lines are run to obtain the fall, particularly where water power may be developed.

Reservoir sites are being examined and surveyed in various parts of the country whenever suitable localities are discovered by reconnaissance or are brought to attention in other ways. Contour maps are prepared of the lands to be flooded, showing the capacity of the reservoir at various depths. More detailed surveys are also made at the dam sites, and in some cases holes drilled down to and into the bed rock to ascertain the character of the foundations. From the information thus obtained estimates of cost are made. The matter is more fully described in the Twentieth Annual Report, Part IV, pages 25 to 43.

ACCURACY OF RESULTS.

In making the survey and examinations of the flow of streams in various parts of the United States the object in view has been to obtain facts of general application at a cost commensurate with the probable application of the results. It is recognized that with a given expenditure the number of measurements made will depend largely upon the accuracy and precautions employed, and the question at once arises as to what degree of precision should be sought. For example, to ascertain the flow of water at a certain point within 5 per cent of the actual flow may cost $10; within 3 per cent, $25; within 2 per cent, $100, and so on, the cost increasing in an ascending ratio as an approach is made to absolute accuracy. In the example given it is a matter of judgment whether to make measurements at a cost of $100 at ten points within 5 per cent of the flow, or at one point within 2 per cent. For general information concerning the hydrography of the country, such as that sought by this survey, it is obvious that the measurements at the ten points are better than the single measurement of greater accuracy; on the other hand, conditions may be imagined, for example, where water or power is being purchased, when the more expensive single measurement is important.

It is impracticable to assign definite limits to the degree of accuracy of the measurements and computations of river flow, since circumstances vary widely, but as a rule the limit has been set, as above stated, that they shall be within the range of ordinary practical application. The low-water flow or the floods of a given season are never repeated, being higher or lower in subsequent years. By continuing measurements through a decade the range within general limits is known, but may be passed during the succeeding decade. Great accuracy, therefore, in ascertaining the flow at any given time is not necessary for drawing general conclusions, as various assumptions must enter to modify the application of the facts.

In stating results of discharge measurements whole numbers have been used and decimals dropped from the figures obtained by computation. This rule is applied in all cases where the flow exceeds 10 cubic feet per second; where it is less than this decimals may or may not be used, although even here a false conception of accuracy may be given. In obtaining averages or totals representing the flow through considerable periods of time there may be some discrepancies involved through this omission of fractions, but it is not believed that the practical value of the work can be improved by introducing into the computation a higher degree of refinement than is possible or desirable in the field work.

EXPENSE OF MAINTAINING STATIONS.

During 1899 blank forms were sent to all resident hydrographers of the Geological Survey, with the request that they give a full description of each station, with reasons for its establishment and maintenance, together with an itemized statement of the costs incurred in making the measurements and in computing the results. These estimates have been compared with the actual expense incurred during the calendar year, and the results have been analyzed to ascertain what may be called the normal cost of maintaining river stations in various parts of the United States, and to ascertain which of the stations were requiring an expenditure out of proportion to the value of the results.

Whenever the cost of a station is excessive, a careful study of the necessity of that station has been made to determine whether the data obtained are of sufficient value to warrant the extra expenditure. In a few cases it has seemed advisable to discontinue stations on account of the expense of maintenance; but on the whole the result of the analysis has been gratifying, inasmuch as it has shown very few stations which could be considered excessively expensive, and in most of these cases the results obtained have been considered sufficiently valuable to warrant their continuance.

The conditions obtaining in the various parts of the country are so different that the annual cost of maintenance is not fairly comparable. This difference is due to several causes, the chief of which is the great distance between stations in some of the Western States when compared with stations in the Eastern States. This makes additional expense for railroad fare and also for services for the increased time spent in traveling. In most States passes are granted the hydrographers by the railroad companies when upon official business, but this is not true in all States. The beds of some rivers are rocky and permanent in character, necessitating only a few measurements a year, while others are sandy and shifting, requiring many measurements in order to construct discharge curves of any value. An extreme example of the latter case is the Gila River upon which measurements were made nearly every day in the year. The pay of the local observer varies with the distance he is obliged to travel daily to reach the gage.

For the reasons given above, the country has been divided into several sections according to the conditions at the stations. All of the stations in the States bordering on the Atlantic Ocean are considered in one class. These are 57 in number and are under the charge of 4 resident hydrographers. The rivers in the northern part of this section, as far south as Virginia, have as a rule been gaged at points where their beds are rocky, and require only about 4 measurements a year in order to construct reliable discharge curves, as the curves constructed in the previous years need few changes. South of Virginia the gagings have been made where the beds of the rivers are for the most part soft and changeable, requiring from 6 to 8 measurements a year.

The normal cost of each gaging in the Atlantic States is $11.50. This includes every expense incident to the gaging, and may be divided approximately as follows:

Hydrographer's services in the field	$5.00
Hydrographer's services for computation	2.00
Services of assistant	.50
Cost of local transportation	1.00
Sundry expenses, including board, lodging, etc	3.00
Total	11.50

Hydrographers are obliged to travel, on the average, 200 miles for each gaging, but with few exceptions passes have been granted.

The pay of the observer averages $36 a year. This makes the total cost of an ordinary station in the Atlantic States $82 if 4 gagings are made during the year and $105 if 6 gagings are made.

The river stations in Kansas and Nebraska are in general under the same conditions, and are here considered together. The river beds are more or less changeable, so that, in order to obtain reliable discharge curves, it is necessary to make from 10 to 20 gagings a year at each station, with an average of about 12. The normal cost of each gaging is $12, divided in about the same proportion as in the Atlantic States. For the ordinary stations, therefore, the total cost of gaging for one year would be $144, and adding $40, the average cost of observers' services for one year in this section, gives $184 as the total cost of maintaining the station.

In Colorado the character of the river beds varies considerably in the different parts of the State. Some have a rocky, permanent bed, and others a soft, changeable one, requiring frequent gagings. For this reason the number of gagings required each year at the different stations varies from 2 to 10, with an average of about 6. The average cost of making a measurement is $13; the average cost of observations is $30, making a total cost of $108 for one year. The expense incurred in 1899 has not been as great as here mentioned, as fewer measurements per year have been made.

In Montana, at those stations under the charge of Prof. Fred. D. Smith, from whom reports have been received, the average cost of a gaging is found to be $10; and allowing 10 measurements a year and $30 for observations, the normal cost of maintaining a station for one year is $130.

In Wyoming the average cost of gagings is $30. Allowing 7 measurements a year and $26 for observations, this makes $236 as the normal cost of maintaining a station for one year. This large expenditure is necessitated by the great distances traveled.

In Idaho the average cost of making a gaging is $20. Allowing 6 measurements a year at each station and $36 for observers, we have $156 as the normal cost of each station for one year.

In California we can say, roughly, that the average cost of a gaging is $30, and making 10 measurements a year; and paying $36 for observers, we have a total cost of $336 a year as the expense of maintaining a station.

These comparisons have been made in order that some idea might be obtained as to the proper cost of maintaining stations. If the cost of any particular station is much higher than the normal cost of stations in that section, it is important that a careful study be made to determine whether or not the measurements are of such value as to warrant the additional expenditure. If not, the station should be discontinued.

DETERMINATION OF DISCHARGE FROM SLOPE.

At various times attempts have been made to obtain data as to slope or fall per mile of the water surface of various rivers, in order to use this factor in estimates of the flow of the stream, and thus make comparison with the discharge as measured by current meters. It has been quite difficult, however, to do this, and the results have been somewhat unsatisfactory, owing to the uncertainty in determining the slope of the stream, considerable latitude of judgment being possible.

Careful leveling along the banks of most streams of moderate size shows that the water surface is alternately approximately level, then has a distinct fall, and again is nearly level; in other words, as expressed in the South, the stream consists alternately of pools and riffles. These may be imperceptible to the eye, but are detected by careful leveling. In determining the slope of the stream the question therefore arises as to whether this shall be determined for the immediate proximity of a given cross section, either at a pool or a riffle, or be taken to include a number of these, and thus extend several thousand feet or even several miles. On the selection of this distance depends, to a large extent, the slope of the stream, the amount varying within wide limits.

The desirability of again taking up this matter was brought to the attention of this office in July, 1899, by Mr. Desmond FitzGerald, chief engineer, to the special commissioners of the Chicago Drainage Canal. Instructions were sent to each field party to endeavoı to make such measurements wherever it could be done without notable increase of cost. So many practical difficulties were encountered it has been found that for these observations to have value they should be made by a field party especially equipped for the purpose and provided with appliances such as are rarely at hand in making ordinary meter measurements.

A few such measurements were made during the past season by different hydrographers, and they will now be considered. The following abbreviations will be used in this connection: D=discharge; A=area, in square feet; V=velocity, in feet per second; W=width, in feet, or practically wetted perimeter; $R=\frac{A}{W}$, hydraulic mean radius; S=slope; n=coefficient of roughness. Kutter's formula has the form $V=C\sqrt{R\,S}$, in which C is a constant to be found.

Etowah River at Canton, Georgia.—On September 5, 1899, B. M. Hall made a survey of this river to find the correct value of n for a 1,500-foot section along the stream. After measuring 1,500 feet, running levels, and placing temporary gage at upper point, he did not have time to make a discharge measurement, but applied the slope to the measurement made August 28, 1897, when the following were found: Gage height, 0.30 foot; area, 423 square feet; mean velocity, 1.061 feet per second; discharge, 449 second-feet. The slope was 0.06 foot in 1,500 feet=0.00004. W=115; therefore $R=\frac{423}{115}=3.68$, and $\sqrt{R\,S}=0.012132$. Substituting in the formula $V=C\sqrt{R\,S}$, we get C=87.4, and from the table in Trautwine, 17th edition, page 276, we find n=0.022.

Loup River at Columbus, Nebraska.—A series of slope measurements to determine the value of n were made by Glenn E. Smith, under the direction of Prof. O. V. P. Stout, of the University of Nebraska, at the gaging station on Loup River. Gage heights were taken on two gages, the auxiliary gage being placed 1,200 feet downstream from the main gage rod. The following were the three observations:

Measurements of Loup River at Columbus, Nebraska.

Date.	Main gage.	Lower gage.	Width.	Area.	Mean velocity.	Discharge.	R
1899.	*Feet.*	*Feet.*	*Feet.*	*Square feet.*	*Feet per second.*	*Second-feet.*	
Sept. 3	4.40	3.30	525	875	2.17	1,902	1.67
Sept. 17	4.40	3.31	525	826	2.23	1,840	1.57
Oct. 5	4.60	3.52	525	953	2.52	2,402	1.81

The following are the computations for the three days: September 3: $S=\frac{1.1}{1,200}=0.00093$; R=1.67; V=2.17. Substituting in the formula $V=C\sqrt{R\,S}$, we obtain C=55.0, and from the table n=0.028.

September 17: S=0.00091; R=1.57; V=2.23. C, therefore, =59.0 and n=0.026.

October 5: S=0.00090; R=1.81; V=2.52. C is found to equal in this case 62.3 and n = 0.026.

Niobrara River at Fort Niobrara, Nebraska.—The following table shows the results of similar measurements made on this river under the direction of Professor Stout. All gage heights are referred to the zero of the main gage. The upper auxiliary gage is 600 feet above and the lower auxiliary gage 600 feet below the main rod.

Measurements of Niobrara River at Fort Niobrara, Nebraska.

Date.	Main gage.	Upper gage.	Lower gage.	Area.	Mean velocity.	Discharge.	Width.	R
1899.	*Feet.*	*Feet.*	*Feet.*	*Square feet.*	*Feet per second.*	*Second-feet.*	*Feet.*	
Aug. 30	1.35	2.32	0.60	196	3.57	700	154	1.27
Sept. 13	1.15	2.20	.60	200	3.47	695	154	1.30
Sept. 26	1.05	2.10	.40	198	3.70	732	154	1.29
Oct. 7	1.15	2.05	.55	215	3.61	776	154	1.40
Oct. 20	.80	2.08	.30	199	4.27	849	154	1.29

As there were three gages read, three different slopes can be determined, as follows: Between the upper and middle gage, between the middle and lower gage, and, finally, between the upper and lower gage. They do not correspond well, as shown in the table immediately following, the slope between the middle and lower gage being constantly less than the slope between the upper and middle gage, and of course the slope between the upper and lower gage is the mean between them.

Comparison of slope measurements at Fort Niobrara, Nebraska.

Gage rod.	Aug. 30.	Sept. 13.	Sept. 26.	Oct. 7.	Oct. 20.
Upper and middle	0.00161	0.00175	0.00175	0.00150	0.00213
Middle and lower	.00125	.00091	.00109	.00100	.00083
Lower and upper	.00143	.00133	.00142	.00125	.00148

The following determinations of the values of C and n are based on the slope as found by the readings on the upper and lower gages. The computations are not carried out, but the results are shown in the following table:

Table showing values of C and n.

	C	n
1899.		
August 30	84.1	0.018
September 13	83.5	.018
September 26	86.8	.018
October 7	86.5	.018
October 20	97.7	.016

One comparison is made between the values of C and n as determined by considering the three different slopes for a single measurement, and for this purpose the gaging on September 13 is used. On this date R=1.30; V=3.47; S, for upper and middle gage, =0.00175; C is found to equal 73.5 and n 0.020. For middle and lower rod, S=0.00091, and C, therefore, =101.0, and n= 0.015. The following table shows these values of C and n for the three slopes on September 13:

Table showing values of C and n on September 13, 1899.

Gage rod.	C	n
Upper and middle	73.5	0.020
Middle and lower	101.0	.015
Lower and upper	83.5	.018

For comparison with results obtained on September 13 it is assumed that the slope determined was made between the upper and lower gages 0.00133. Substituting in Kutter's formula the value of n, as found from the determinations of the slope of the upper and middle rod, we get a discharge of 840 second-feet. Assuming the same slope as above—that is, between the upper and lower rod—and taking the value of n as found between the middle and lower rod, =0.015, and substituting again in Kutter's formula, we get a discharge of 610 second-feet. These latter results are not satisfactory. In this case, with 0.015, 0.018, 0.020 as the three assumed values of n, we get discharges of 610, 695, and 840 second-feet, respectively. The measured discharge, as determined by current meter, for this date was 695 second-feet.

Readings on slope gages were taken for a short period in 1896 on Frenchman River, at Palisade, Nebraska, as shown in the Eighteenth Annual Report, Part IV, page 198, and in Water-Supply Paper No. 11, page 56.

Bear River at Battlecreek, Idaho, and Collinston, Utah.—Measurements of the fall of the surface of Bear River at Battlecreek, Idaho, and at Collinston, Utah, were made by Prof. Samuel Fortier. Stakes were driven into the channel of the stream about 10 feet from each shore line, at points 100 feet below and 100 feet above the cable suspended across the stream. These four stakes were pointed on the top and driven about 1.5 inches below the surface of the water. A small wire nail was driven into the top of each stake until level with the surface of the water, allowance being made for the pulsation of the surface. The elevations of the tops of these nails were then carefully ascertained with a level.

At Battlecreek, Idaho, the bed of Bear River consists of clay near the right bank, small cobblestones in the center, and gravel and pebbles near the left side. The banks are somewhat irregular. The fall, S = 0.00062; water area, A = 443 square feet; mean velocity, V = 2.36 feet per second; hydraulic mean radius, R = 2.31; wetted perimeter, 191 feet; n = 0.027; C, in Chezy's formula, 62.58; the discharge, D, was 1,046 second-feet.

At Collinston, Utah, the bed of Bear River consists of cobble rock stones and bowlders. The fall was found to be, S = 0.00131; A = 427 square feet; V = 2.333 feet per second; R = 1.58; wetted perimeter, 270; n = 0.029; C, in Chezy's formula, 51.28; the discharge, 996 second-feet.

ESTIMATION OF DISCHARGES AT MILLDAMS.

On rivers which, like those in New England, have been used for water power, it is often difficult to find a section where measurements with the current meter can be readily made. The milldams placed at short intervals back up water or introduce conditions unfavorable to direct measurement of flow. On the other hand, the facilities at the milldams are often excellent for noting the height of water, as gages are frequently maintained in the interest of the mill owners. In a number of cases where controversies have arisen concerning water power or there now exist contracts for the division of the available flow, elaborate computations have been made showing the discharge over the dams and through the various openings leading to the mill wheels. Occasionally these computations of flow are sufficiently extensive to have general interest in showing the run-off from a given drainage area, but more often the results are fragmentary.

Probably the earliest and most thorough determination of the flow of a river by estimating the amount taken by mills and passing over the dam is that begun by Mr. J. B. Francis over a half century ago on the Merrimac River at Lawrence, Massachusetts. This may be considered as the model of all attempts of this kind. Similar computations, based upon the Francis formula, have been made on other New England streams, notably on Connecticut River at Holyoke, Massachusetts, and on Kennebec River at Waterville, Maine. The uncertainty as to the application of certain constants or factors is such that estimates of this kind are apt to be misleading unless made by an engineer thoroughly familiar not only with the fundamental data, but with all of the varying local conditions. In order to make computations of daily discharge and correction for changes in the conduits diverting water above the dam, it is necessary to maintain records of various facts besides the height of water. To facilitate the keeping of such records blanks have usually been prepared with a space for entering the depth of water on the crest of the dam, and the length of this in linear feet—especially when modified from day to day by the use of flashboards. These records of depth are usually made night and morning, and occasionally are noted every two or three hours throughout the day. Besides these, spaces are provided for reading the height of water at the headrace and tailrace of each mill, giving data for the working head on the water wheels. The number of wheels, the size and kind, the number of hours operated, and other facts concerning their use are also given, in order to compute the probable flow through each wheel and add this to the amount passing over the dam. Corrections must usually be introduced for leakage and for the amount escaping through waste ways. It is evident that for any given locality with a number of mills the recording of the facts not only requires care and time, but some display of intelligence on the part of the workmen, to whom the recording is necessarily intrusted.

All of the conditions above noted, and the uncertainty regarding accuracy of the constants used in the computations, tend to make the estimates not only complicated, but introduce more or less doubt as to the value of the results. This is particularly true when there are a number of mills taking water from the impounded river and in seasons of low water when the greater proportion passes through the mill wheels. At a number of localities where such estimates are made all of the water enters the mill races during the summer, leaving the crest of the dam dry.

Estimates of the flow of streams at milldams have been recently extended to certain streams in New York, most of which are tributary to Mohawk River. These were begun in October, 1898, by Mr. George W. Rafter, who was at that time employed on special water-supply investigations for the United States Board of Engineers on Deep Waterways. This board, consisting of three engineers designated by the President, one from the Engineer Corps of the United States Army, one from the Coast and Geodetic Survey, and one from civil life, was authorized by act of Congress approved June 4, 1897 (30 Stat. L., 50). Its purpose is to make surveys and examinations, including estimates of cost of deep waterways between the Great Lakes and the Atlantic tide waters, as recommended by the report of the Deep Waterways Commission, transmitted to Congress on January 18, 1897.[1] The work of the board was continued by the act of July 1, 1898 (30 Stat. L., 636), providing that estimates should be prepared for cost of waterways 21 and 30 feet in depth, and by act of March 3, 1899 (30 Stat L., 1109).

Under the direction of Mr. Rafter about 20 stations for studying sources of supply for deep waterways have been established in the State of New York, the locations of which are shown by fig. 12, on page 79 of Part IV of the Twentieth Annual Report of the Geological Survey.

In each case these points of measurement are at dams built to furnish power for mills, or constructed by the State for supplying water to the Erie Canal and its feeders. The dams thus employed as weirs are of various sections and materials. A few are of stone, solidly built, but most are of timber. Some of the latter are tight, while others

[1] Report of the United States Deep Waterways Commission, prepared at Detroit, Michigan, December 18-22, 1896, House Doc. No. 192, Fifty-fourth Congress, second session.

leak, and in these cases estimates have been made of the quantity flowing through the dam. Usually the estimate was made at the establishment of the river station, and leakage was considered as being constant. In a few instances current-meter measurements were made of the leakage, and the quantity found was used as a correction in the computations.

In examining the dams in the rivers it was found that many of them were irregular in longitudinal profile of crest. In a number of cases they were so repaired as to give a horizontal crest, but at several localities it was impossible to eliminate this irregularity. In these cases a careful profile of the crest was plotted and divided into parts in such a way that the crest of each portion could be considered as horizontal without introducing serious errors. Computations were then made of the flow through each section irrespective of its neighbor, and the quantities in all sections were added together to give the total flow over the dam. These computations were made for different heights of water and plotted graphically with the head on the crest in feet as ordinates and the discharge in second-feet as abscissas. A smooth curve was then drawn through these points, from which discharges have been read for various heads. In a number of instances these curves have been revised, using coefficients determined at a later time.

In order to compute the discharge over dams, it is necessary to make certain assumptions or employ coefficients obtained by experiment. The coefficients for determining the flow over broad-crested weirs are somewhat uncertain, especially with high heads. The most reliable coefficients are those determined by experiments of Bazin's, published in the Annales des Ponts et Chaussées.[1] In those experiments the head on the crest of the weir never exceeded 1½ feet. As the coefficients over broad-crested weirs vary considerably with the head, it is a matter of judgment what coefficients to apply when the heights exceed those experimented upon by Bazin. Profiles of the dams as constructed in the river seldom correspond exactly with the profile for which the coefficients were determined. For each case it is necessary to assume an experimental profile which corresponds most closely with the measuring dam. In order to eliminate these two sources of error, experiments were instituted at Cornell University to determine coefficients for experimental flat-crested weirs as used by Bazin with heads on crest as high as 6 feet, and also upon other forms of weirs corresponding to those of the dams over which measurements are made.[2]

In making these experiments the first question that arose was to determine the actual quantity of water flowing over the experimental

[1] Annales des Ponts et Chaussées, Ire partie, 1898, 2e Trimestre, No. 24, p. 151 to 264. Expériences Nouvelles sur l'Écoulement en Déversoir (6e article), par M. H. Bazin, Inspecteur général des Ponts et Chaussées.

[2] On flow of water over dams, by George W. Rafter: Proc. Am. Soc. Civ. Eng., March, 1900, Vol. XXVI, No. 3, pp. 226-319.

weirs. To determine this a sharp-crested weir was constructed of exactly the same dimensions as that experimented upon by Bazin, for which he (Bazin) has published accurate coefficients. Bazin's coefficients for this sharp-crested weir were determined only for small heads.

In order to obtain accurate coefficients for sharp-crested weirs for a greater head, another weir of shorter length was placed below the Bazin weir in the same flume. Knowing the actual quantity flowing over the Bazin weir, and carrying the height on crest to the limit of the Bazin experiments, it was possible to determine coefficients for sharp-crested weirs for heads as high as about 6 feet. The coefficients determined from this second sharp-crested weir were then used to find the actual quantity of water flowing over all experimental sections used thereafter. Gates were so arranged that the quantity of water flowing in the flumes could be varied at will, and starting with a high head the water was gradually reduced in quantity, reducing thereby the head on the crest to zero. The gates were allowed to remain in each of the eight or ten positions from ten minutes to an hour, so that the flow for that interval was constant. By reading the head of the sharp-crested weir, the water flowing at the given width of gate opening could be determined. At the same time the head on the experimental weir was read and, noting the quantity, the coefficients computed for use in the formula $q = CLH^{\frac{3}{2}}$. In this formula $C = m\sqrt{2g}$ of Bazin's formula. One run was made for each experimental weir, and eight or ten points of the curve were determined. The experimental weir, which was constructed of wood, was then torn out and one of another section put in its place. When all worked well it required one day for experimentation on each section. Experiments were made on forms of weirs corresponding to nearly all of the dams over which the flow was measured.[1]

Practically all the computations of the flow of streams made by the Board on Deep Waterways had been completed before these coefficients for high heads were determined, so that Bazin's coefficients were used instead of the Cornell coefficients, although in Mr. Rafter's opinion the Cornell coefficients would be more accurate. It was proposed to recompute back records, using the Cornell coefficients, but lack of time and funds have prevented. The monthly totals have, however, been approximately corrected. There are some discrepancies between Bazin's and the Cornell coefficients, even for low heads, which are attributed to difference in the construction of the experimental weirs and the consequent action of the air cushion. It is possible that the conditions in the Cornell experiments are nearer those in actual dams.

As has been stated, most of the measuring stations are dams furnishing power for mills, and of course a large quantity of water passes

[1] On flow of water over dams, by George W. Rafter: Proc. Am. Soc. Civ. Eng., March, 1900, Vol. XXVI, No. 3, pp. 226-319.

through the mill race and wheels and not over the dam. In order to determine this quantity of water, gages are used, as before noted, above the wheels in the headrace and below the wheels in the tailrace, so that by simultaneous readings the head on the wheels at any time may be determined. The size and type of wheels used in each mill and the dimension of the gates were ascertained. In many cases, especially in the case of new wheels, records of careful ratings made at Holyoke, Massachusetts, were obtained for the particular wheels installed in the mills. Where these could be obtained they were used to determine the flow through the wheels. In other cases it was necessary to rely upon the figures published in the trade catalogues for the quantity of water flowing through the various wheels at the various heads, although these quantities are not always accurate. In some of the headraces there are overflows which must be taken into account as the head increases, and over which the flow is somewhat uncertain. When the State dams were used, as in most cases, in New York the flow through the canal feeders was measured once and assumed to be constant thereafter.

The following table gives a list of the New York streams, the flow of which has been computed as described above. Their drainage areas are also given. The numbers in the first column are those shown in the Twentieth Annual Report, Part IV, fig. 12, where the location of the points of observation is given.

Streams measured by the United States Board of Engineers on Deep Waterways.

No.	Streams.	Locality.	Drainage area.
			Sq. miles.
1	Seneca River	Baldwinsville	3,103
2	Oswego River	Fulton	4,916
3	Chittenango Creek	Bridgeport	307
4	Oneida Creek	Kenwood	59
5	Wood Creek	Near mouth	
6	Fish Creek, west branch	McConnellsville	187
7	Fish Creek, east branch	Above Point Rock	104
8	Salmon River	About 1 mile above falls	191
9	Mohawk River	Ridge Mills	153
10	Ninemile Creek	1 mile below Stittville	63
11	Oriskany Creek	State Dam, Oriskany	144
12	do	Coleman	141
13	Sauquoit Creek	New York Mills	52
14	West Canada Creek	Middleville	519
15	Mohawk River	Little Falls	1,306
16	East Canada Creek	Dolgeville	256
17	Garoga Creek	3 miles above the Mohawk	81
18	Cayadutta Creek	Below Johnstown	40
19	Schoharie Creek	State Dam, Fort Hunter	947
20	Mohawk River	State Dam, Rexford Flats	3,385
21	Hudson River	Mechanicville	4,500
22	do	Fort Edward	
23	Schroon River	Warrensburg	563
24	Black River	Watertown	1,389

The results obtained at the localities named above, from September, 1898, to May, 1899, inclusive, as computed by Mr. George W. Rafter, are given in the following table. The numbers in the first column of the preceding table refer to the same numbers in this table:

Estimated monthly discharge of various New York rivers in cubic feet per second.

No.	1898.				1899.				
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1			3,137	2,689	2,851	1,769	3,875	4,543	2,568
2			6,220	5,300	6,150	4,075	7,830	11,000	6,586
3	129	320	550	530	600	450	711	820	230
4		76	95	75	97	79	126	160	58
5									
6	108	300	340	180	385	170	530	1,040	215
7	250	310	380	201	209	251	342	751	295
8			490	315	522	200	468	2,220	605
9		324	356	216	332	199	422	952	275
10	398	98	92	135	225	85	210	340	47
11		325	327	327	295	291	342	466	119
12									
13	27	56	57	57	58	58	111	127	38
14		1,071	1,125	922	1,028	1,422	1,058	3,365	1,456
15	2,378	2.493	2,891	2,036	2,753	1,510	3,757	8,102	2,651
16	638	581	689	564	816	439	519	1,978	633
17		140	190	77	43	47	160	500	99
18	16	64	91	44	39	31	74	251	31
19	409	1,422	2,447	1,853	2,584	2,224	4,072	4,380	858
20				4,550	5,850	4,000	9,250	17,400	4,150
21	3,872	7,895	9,243	5,436	6,668	5,258	9,618	23,645	9,752
22									
23	166	263	464	783	606	478	564	2,877	3,150
24	1,744	3,607	4,510	2,752	4,704	2,381	5,112	14,172	5,840

TURBIDITY.

Many attempts have been made to determine the amount of silt carried by water in suspension, but as a rule these necessitate elaborate operations of filtering, drying, and weighing. One of the most convenient methods for field work is that recently applied by Mr. Allen Hazen, who has prepared an arbitrary scale dependent upon the degree of opacity of the water. Observations of turbidity are taken by putting a stick into the water under examination and noting the distance beneath the surface at which a given object—usually a small wire—can be seen. The turbidity is then read from a scale graduated on this stick. This is most conveniently accomplished by having a second or smaller stick placed in front of the first, the end of which is brought to the water line at a point where the wire can just be seen. Upon removing the two together the position of the smaller stick on the scale gives the turbidity.

Observations are taken in the open air, as too high results are obtained under a roof, even with good light. They preferably should be made in the middle of the day, and not in direct sunlight. In case the sun is shining the observer can stand so that his shadow covers the water immediately above the stick and wire. The observer stands erect with his feet a little above the water, although some variation in this respect does not materially influence the results.

The stick should be about 5 feet long and five-eighths of an inch square. A platinum wire should be inserted at a point about 1 inch from the end at rightangles and projecting 1 inch. This wire should be about 0.04 inch in diameter. The stick is then graduated, the figures being inversely proportional to the distances from the wire, 1.00 coming at 1 inch. The following table gives the graduations up to 50 inches:

Scale of turbidity.

Turbidity.	Inches.	Turbidity.	Inches.	Turbidity.	Inches.
2.00	0.50	0.10	10.00	0.05	20.00
1.50	.66	.09	11.11	.04	25.00
1.20	.83	.08	12.50	.03	33.30
1.00	1.00	.07	14.30	.02	50.00
.50	2.00	.06	16.70	.01	100.00

MEASUREMENTS AT RIVER STATIONS.

KENNEBEC RIVER AT WATERVILLE, MAINE.

This river has been described by Prof. Dwight Porter in the Nineteenth Annual Report, Part IV, pages 65 to 84, the general location of the stream being shown on Plate IX. Computations of discharge at Waterville, Maine, were made by Mr. Sumner Hollingsworth from about 1892 to the time of his death, which occurred June 27, 1899. Additional figures have been furnished by Mr. James L. Dean, engineer of the Hollingsworth & Whitney Company, a slightly different system of computation being employed by Mr. Dean, as it has been impracticable to introduce the corrections made by Mr. Hollingsworth, the principles upon which he worked not being fully recorded. Corrections were probably made for loss of head in the tailrace and leakage. The figures of daily discharge from 1892 to August 31, 1898, as computed by Mr. Sumner Hollingsworth, are given in Water-Supply Paper No. 27, page 14; those subsequent to the above date have been furnished by Mr. Dean.

Concerning those for 1899, Mr. Dean states that the figures subsequent to May 1 have not been computed with the same care as previous records, but they are believed to be correct for most practical purposes. The discharge over the dam was computed as usual, but that from the wheels was not estimated separately for each day, using the head of each wheel, and the speed of rotation, as heretofore done. Instead of this the average performance was taken. A comparison of gage readings and water discharges shows little connection, as flashboards are used on the dam. The Sunday flow is also irregular, as the mill at Waterville is sometimes operated Saturday night, drawing the water from the pond, so that there is no flow except leakage on Sunday. During the season of low water there is usually less passing on Sunday than on week days, as at many mills on the river the dams are closed in order to fill the ponds.

Daily discharge in second-feet of Kennebec River at Waterville, Maine.

1898.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2,475	2,539	4,170	20,385	36,048	14,341	4,385	3,790	2,477	2,691	6,382	3,752
2	2,284	2,955	4,188	16,556	39,372	13,776	4,343	2,707	2,489	2,862	5,182	3,740
3	2,222	2,687	5,648	13,871	38,301	10,900	3,440	2,887	2,453	2,180	4,691	3,667
4	2,715	3,090	5,163	12,143	37,358	8,791	3,490	2,833	1,437	1,831	4,115	1,747
5	2,771	2,775	2,997	10,830	37,730	9,846	4,343	2,809	2,510	1,865	3,467	3,336
6	3,431	3,068	4,094	10,150	37,569	10,301	4,272	3,712	2,392	2,119	3,231	3,227
7	1,807	3,475	5,070	7,080	31,580	9,189	4,477	3,252	3,093	1,570	3,880	3,221
8	4,826	2,994	5,033	6,563	29,880	9,098	4,203	4,374	3,073	1,269	3,675	3,262
9	5,434	3,744	4,767	7,472	28,753	12,541	5,464	4,218	3,018	1,150	4,133	2,995
10	4,492	3,154	4,623	10,457	25,636	14,318	1,745	4,017	3,042	961	3,351	2,635
11	3,025	3,829	5,329	15,299	22,059	12,086	4,111	3,048	3,050	1,585	5,332	1,792
12	3,286	3,317	6,752	19,848	21,899	11,322	4,484	3,413	3,057	1,731	5,856	3,268
13	3,240	3,680	8,397	44,854	24,042	11,003	4,267	2,927	2,505	1,585	4,896	2,235
14	3,287	3,912	9,880	47,141	34,332	10,777	3,776	1,130	1,913	1,288	3,332	1,873
15	4,909	4,026	11,534	50,381	32,988	12,514	4,327	3,443	1,480	1,299	3,465	1,888
16	3,717	4,042	12,816	49,415	27,500	11,295	3,994	2,499	1,560	3,665	3,264	1,883
17	3,891	3,764	12,215	47,112	24,756	10,584	3,611	2,560	1,530	6,031	3,490	2,160
18	3,453	3,221	11,918	47,321	23,440	9,478	3,896	2,491	1,570	5,055	3,698	1,723
19	3,460	3,267	12,484	44,700	23,153	9,196	3,938	2,622	1,607	4,454	5,018	2,315
20	3,505	2,885	13,218	39,327	20,592	11,129	3,747	2,526	1,876	3,264	8,798	2,447
21	3,893	3,172	14,580	36,671	19,088	10,855	3,835	913	2,223	2,872	8,935	2,560
22	4,614	3,764	17,177	33,789	18,570	9,950	5,038	3,425	1,851	2,690	8,046	2,274
23	2,542	2,133	16,615	30,792	17,073	8,334	3,871	2,866	1,888	6,036	7,184	2,778
24	2,321	3,437	15,987	34,352	15,277	9,483	3,418	3,425	1,916	6,318	6,007	3,013
25	2,866	4,352	17,812	52,119	15,993	8,864	3,747	2,849	3,689	4,924	7,811	2,489
26	2,032	3,933	17,029	45,520	15,589	7,508	3,879	4,432	5,443	4,288	7,923	2,471
27	3,136	3,653	16,560	38,083	15,639	5,267	3,385	4,218	4,788	6,514	10,037	2,761
28	2,905	4,387	18,928	37,354	14,611	4,326	4,189	3,940	3,581	15,319	3,672	2,464
29	2,727		19,762	33,652	16,632	5,689	3,444	3,396	3,778	11,127	2,758	2,499
30	1,738		17,711	31,767	16,962	6,715	3,204	3,555	3,247	9,229	3,723	2,067
31	2,607		27,432		16,298		2,832	2,857		7,672		2,178
Mean,	3,213	3,402	11,287	29,833	25,120	9,983	3,908	3,133	2,618	4,047	5,178	2,620

1899.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2,529	2,458	3,382	6,343	41,348	13,292	6,386	4,020	1,985	1,200	1,405	1,405
2	2,202	2,198	3,047	6,114	39,433	12,783	4,924	3,800	1,985	1,297	2,759	1,405
3	2,274	2,187	3,333	6,080	36,354	10,632	5,164	4,380	1,403	1,445	4,025	1,000
4	2,159	2,163	3,324	5,945	36,864	11,573	3,178	4,088	1,695	1,269	4,025	2,855
5	2,452	1,580	1,960	6,125	30,725	12,183	5,080	4,380	1,985	1,823	1,636	3,476
6	2,451	2,509	3,331	6,135	30,358	11,076	4,943	2,865	1,695	1,303	3,258	3,040
7	2,449	2,173	3,563	6,343	30,025	10,516	5,264	4,788	1,985	1,330	3,039	1,950
8	1,739	2,071	3,516	6,859	29,257	11,679	5,164	4,968	1,985	800	2,565	1,985
9	2,757	2,057	3,502	7,441	26,688	12,450	3,836	4,234	2,275	1,069	2,275	1,695
10	2,519	2,152	3,428	8,904	24,760	12,450	4,943	4,015	1,646	755	2,058	900
11	2,400	2,141	3,357	9,472	22,244	10,638	4,943	4,015	2,275	561	1,695	1,405
12	2,386	2,244	2,302	9,272	20,182	10,213	4,832	3,880	1,985	1,564	1,200	1,105
13	2,404	2,348	3,353	10,999	18,665	6,024	4,943	2,420	1,985	1,822	1,478	1,985
14	2,436	1,964	3,423	19,504	19,543	7,006	5,738	3,880	1,985	1,245	1,985	4,898
15	1,678	1,844	3,624	22,940	14,849	6,693	4,943	3,400	1,985	924	1,985	4,501
16	2,731	2,392	3,773	37,830	14,944	7,432	4,943	3,400	1,695	1,405	1,985	4,608
17	2,439	2,434	3,501	30,458	17,275	5,881	4,832	3,120	1,200	1,695	1,768	2,400
18	2,631	2,727	3,253	30,190	15,044	6,707	5,180	3,500	1,405	1,405	1,695	2,638
19	2,434	2,198	1,960	36,964	15,044	7,274	5,180	2,560	1,985	1,115	1,100	1,985
20	2,628	2,915	3,320	41,348	15,597	6,453	4,832	1,670	2,275	1,405	1,405	2,565
21	2,440	2,734	3,080	34,395	16,162	7,006	5,424	2,634	2,275	1,115	2,275	2,275
22	2,094	2,744	2,778	30,090	18,296	7,237	6,210	3,220	2,565	918	1,695	2,275
23	2,709	2,451	2,711	38,466	17,275	7,237	5,588	2,840	2,275	1,405	2,058	2,265
24	2,154	2,745	2,837	45,172	15,872	9,432	6,368	2,534	1,500	1,400	1,985	1,900
25	2,435	2,929	2,770	41,348	15,791	5,593	5,785	2,180	1,885	1,105	1,985	1,900
26	2,450	1,420	2,030	42,736	11,380	7,274	5,785	2,158	1,615	1,115	1,400	1,900
27	2,454	3,059	2,786	45,422	12,539	7,237	5,424	1,620	1,320	1,115	1,405	2,275
28	2,434	3,362	2,740	39,533	12,203	6,849	5,785	2,120	2,104	1,115	1,695	2,775
29	1,245		2,998	41,248	13,027	7,006	4,088	2,560	2,116	1,000	1,695	1,695
30	2,513		3,962	29,200	13,535	6,386	2,400	2,100	2,100	1,115	1,100	1,405
31	2,453		6,820		12,783		4,020	2,380		1,115		1,405
Mean	2,357	2,364	3,218	23,429	21,228	8,807	5,036	3,217	1,906	1,224	2,021	2,254

ANDROSCOGGIN RIVER AT RUMFORD FALLS, MAINE.

This river receives the drainage from the Rangeley and other lakes, near the border line between Maine and New Hampshire. It flows in a general southerly and southeasterly direction, descending with rapid fall and furnishing considerable power. It is described by Prof. Dwight Porter in the Nineteenth Annual Report, Part IV, pages 84 to 97. The discharge at Rumford Falls since 1892 has been ascertained by Mr. Charles A. Mixer, resident engineer of the Rumford Falls Power Company. Figures of daily discharge up to the end of December, 1895, have been printed in Water-Supply Paper No. 27, pages 11 to 14. The table is continued for the years 1896 to 1898 in the Twentieth Annual Report, Part IV, pages 67 to 69. These figures are obtained by adding the actual measured quantities passing through the wheels and the computed flow over the dam, using the customary Francis weir formula.

Mr. Mixer has prepared a table giving the departure of the precipitation of 1899 from the normal, which is taken at 43.41 inches, showing that for this latter year there was only 31.58 inches, or a deficiency of 27 per cent. This emphasizes the importance of water storage, not only for such rare periods, but also for equalizing the fluctuations from month to month during every year. The lowest monthly run-off, 0.71 inch in depth, was in August, the month of greatest evaporation. At this time the run-off was 0.07 inch more than the precipitation. The lowest daily discharge for the year, 1,124 second-feet, was 0.48 second-foot per square mile. The total annual run-off averages 53 per cent of the total precipitation as measured at Rumford Falls; but in 1899 the percentage rose to 59, the increase presumably being due to storage. The records of precipitation have not been kept for a sufficiently long period to give a wide range in fluctuation, but, judging from the effect on the wells, there has been no such period of drought for from fifty to seventy-five years.

Comparison of rainfall at Rumford Falls, Maine.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Normal	3.23	4.28	3.55	2.99	3.92	3.63	4.48	3.49	3.34	2.78	4.74	2.98
1899	3.18	2.56	5.89	1.50	1.59	2.27	4.71	.64	3.00	2.05	1.94	1.95
Normal accumulation	3.23	7.51	11.06	14.05	17.97	21.60	26.08	29.57	32.91	35.69	40.43	43.41
1899 accumulation	3.18	5.74	11.63	13.13	15.02	17.29	22.00	22.64	25.64	27.69	29.63	31.58
Accumulated excess	------	------	.57	------	------	------	------	------	------	------	------	------
Accumulated deficiency	.05	1.77	------	.88	2.95	4.31	4.08	6.93	7.27	8.00	10.80	11.83

Daily discharge in second-feet of Androscoggin River at Rumford Falls, Maine, for 1899.

[Drainage area, 2,320 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2,398	1,832	1,926	2,029	24,057	3,773	3,224	1,521	1,359	2,130	2,186	1,230
2	2,441	1,861	1,955	2,088	24,077	3,495	3,600	1,557	1,453	1,784	3,172	1,247
3	1,933	1,736	1,877	1,998	21,468	3,383	2,800	1,492	1,247	1,709	2,865	1,700
4	2,124	1,825	1,791	1,974	19,480	3,400	1,700	1,601	1,455	1,532	2,232	1,792
5	2,255	1,810	1,738	2,024	16,631	3,042	1,510	1,758	1,466	1,566	2,030	1,289
6	2,613	1,789	1,780	2,009	15,111	2,988	1,485	1,717	1,469	1,454	1,925	1,170
7	2,675	1,768	1,978	2,129	14,368	3,574	1,718	1,636	1,434	1,527	2,060	1,290
8	2,275	1,773	2,017	2,436	14,358	3,625	1,823	1,325	1,332	1,330	1,899	1,018
9	2,267	1,619	1,801	2,460	13,970	3,264	1,900	1,442	1,328	1,368	1,843	1,016
10	2,192	1,606	1,712	2,688	12,874	3,295	1,779	1,274	1,141	1,400	1,778	1,010
11	2,074	1,462	1,706	2,954	12,035	3,761	1,934	1,335	1,281	1,482	1,674	1,084
12	1,931	1,812	1,754	3,147	11,182	3,150	1,589	1,357	1,357	1,351	1,230	1,253
13	2,316	1,814	1,646	2,975	10,721	2,984	2,366	1,317	1,319	1,231	1,170	5,274
14	2,059	1,957	2,037	3,054	10,054	3,012	1,818	1,261	1,368	1,452	1,171	3,354
15	2,084	1,981	2,007	4,236	9,122	2,797	1,494	1,209	1,529	1,230	1,516	1,965
16	2,127	1,929	1,913	6,808	7,630	3,494	1,651	1,250	1,274	1,234	1,476	1,626
17	2,135	1,919	1,846	6,490	7,134	3,524	1,250	1,221	1,243	1,413	1,561	1,183
18	2,137	1,920	1,843	7,457	5,960	3,230	1,232	1,326	1,300	1,432	1,343	1,331
19	2,325	1,886	1,834	9,509	5,340	3,186	1,563	1,455	1,470	1,405	1,300	1,781
20	1,924	1,824	1,826	11,127	5,706	3,079	1,173	1,453	1,524	2,096	1,489	1,795
21	1,848	1,899	1,819	11,543	6,497	3,024	1,271	1,349	1,788	1,744	1,860	2,051
22	1,835	1,960	1,823	12,461	6,028	3,529	2,433	1,331	2,043	1,500	1,914	1,929
23	2,093	2,029	1,818	14,599	5,369	3,198	3,682	1,676	2,202	1,368	1,866	1,805
24	2,058	2,111	1,816	17,372	4,821	3,049	1,927	1,462	1,794	1,347	1,825	1,412
25	2,003	1,928	1,818	17,371	4,443	3,060	1,634	1,571	1,124	1,455	1,628	1,298
26	2,106	1,819	1,862	20,017	4,328	2,793	1,490	1,557	1,381	1,443	1,500	1,689
27	1,944	1,816	1,763	23,287	4,019	3,127	1,443	1,265	2,971	1,637	1,370	1,343
28	2,098	1,931	1,831	20,787	4,151	2,717	1,233	1,329	2,397	1,511	1,571	1,278
29	1,697	......	1,839	21,319	4,465	3,297	1,142	1,382	2,223	2,767	1,382	1,097
30	1,760	......	1,948	22,920	4,290	3,282	1,170	1,464	2,124	2,548	1,224	1,048
31	1,721	......	1,976	......	3,849	......	1,267	1,372	......	2,220	......	1,437
Mean	2,111	1,843	1,848	8,709	10,114	3,238	1,817	1,428	1,580	1,604	1,733	1,606

COBBOSSEECONTEE RIVER AT RESERVOIR DAM NEAR AUGUSTA, MAINE.

This stream receives the overflow from a group of lakes lying from 5 to 15 miles westerly from Augusta, Maine, and empties into Kennebec River 8 miles below that city. It is described by Prof. Dwight Porter in the Nineteenth Annual Report, Part IV, page 79. A record of the water passing the upper dam on this stream has been furnished by Mr. Alexander H. Twombly, engineer of the Forest Paper Company, Yarmouthville, Maine. At the reservoir dam are gates by which the supply of water for the mill is regulated, and there is also a water wheel which operates a pumping station. When this wheel is in operation the regulating gates are shut down enough to deliver a constant supply of water to the mill, as shown by the tables on page 29. The great Cobbosseecontee dam furnishes a supplemental supply to this reservoir and water is occasionally drawn from it. At the point of measurement the water is shut back entirely on Sundays and holidays, as shown by the table. In the tables the reference "Gates up; all that flows" covers the period when there was no means of ascertaining the discharge, it being less than 220 second-feet and from that as low as 120 second-feet, diminishing probably at a constant rate. After November 1, 1899, the discharge, however small, can be measured.

Daily discharge in second-feet of Cobbosseecontee River, at the upper dam, near Augusta, Maine.

[Drainage area, 230 square miles.]

1890.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	------	300	290	290	290	393	300
2	------	300	290	290	290	379	300
3	------	300	------	290	290	379	300
4	------	------	290	290	290	379	300
5	------	306	290	290	------	368	300
6	------	326	290	290	290	357	300
7	------	356	290	------	290	347	------
8	------	374	290	290	300	347	300
9	------	374	290	290	300	333	300
10	------	340	------	290	300	333	300
11	------	314	290	290	300	326	300
12	------	306	290	290	------	300	300
13	------	156	290	290	300	300	300
14	------	300	290	------	300	300	------
15	------	300	290	290	300	300	300
16	340	300	290	290	300	------	300
17	356	300	------	290	300	300	300
18	356	------	290	290	300	379	300
19	356	------	290	290	------	445	300
20	340	290	290	290	300	431	300
21	326	290	290	290	300	418	------
22	------	290	290	290	300	405	300
23	300	290	290	290	300	393	300
24	300	290	34	290	337	379	300
25	306	290	290	290	337	368	------
26	314	290	290	290	337	357	290
27	314	------	280	290	345	347	290
28	306	290	290	------	345	337	------
29	------	290	290	290	345	337	290
30	300	290	290	290	379	300	290
31	------	290	------	------	393	------	290
Mean	324	307	290	290	313	356	298

1891.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	290	850	839	2,169	300	300	300	290	285	260	(a)	(a)
2	290	780	774	2,114	300	300	300	------	285	260	(a)	(a)
3	290	713	713	2,059	------	300	300	285	280	260	(a)	(a)
4	------	713	653	2,059	300	300	------	285	280	------	(a)	(a)
5	290	682	594	2,059	300	300	------	285	280	260	(a)	(a)
6	290	620	567	1,940	300	300	300	285	------	250	(a)	220
7	290	590	540	1,836	300	------	300	290	280	250	(a)	220
8	290	------	540	1,782	300	300	300	290	280	250	(a)	220
9	290	373	515	1,598	300	300	300	------	280	250	(a)	220
10	290	435	540	1,567	------	300	300	285	280	250	(a)	(a)
11	------	458	743	1,495	300	300	300	285	280	------	(a)	(a)
12	300	458	807	1,514	300	300	------	285	270	250	(a)	(a)
13	300	458	807	1,514	300	300	290	285	------	250	(a)	(b)
14	300	548	1,801	1,365	300	------	290	285	270	250	(a)	(a)
15	300	529	1,753	1,223	300	300	290	285	270	250	(a)	(a)
16	300	590	1,573	1,270	300	300	290	------	270	250	(a)	(a)
17	300	602	1,364	1,318	------	300	290	285	270	250	(a)	(a)
18	300	574	1,286	1,318	300	300	290	285	270	------	(a)	(a)
19	300	516	1,241	1,318	300	300	------	285	270	220	(a)	(a)
20	300	516	1,204	1,318	306	300	290	285	------	220	(a)	(b)
21	300	483	1,167	1,273	314	------	290	285	270	220	(a)	(a)
22	300	483	1,531	1,050	316	300	290	285	270	220	(a)	(a)
23	503	363	2,199	1,013	300	300	290	------	270	220	(a)	(a)
24	1,120	363	2,365	300	------	300	290	285	260	220	(a)	220
25	1,100	393	2.365	300	300	300	290	285	260	------	(a)	(b)
26	1,063	620	2,585	314	300	300	------	285	260	220	(a)	(b)
27	1,063	942	2,531	306	300	300	290	285	------	(a)	(a)	(b)
28	1,063	907	2,344	306	300	------	290	285	260	(a)	(a)	220
29	1,063	------	2,344	300	300	300	290	285	260	(a)	(a)	220
30	1,079	------	2,344	300	300	300	290	------	260	(a)	(a)	220
31	1,001	------	2,295	------	------	------	290	285	------	(a)	------	220
Mean	516	576	1,385	1,277	301	300	293	286	272	242	------	------

a Water so low only gage record kept.
b Water shut back Sundays and holidays.

Daily discharge in second-feet of Cobbosseecontee River, at the upper dam, near Augusta, Maine—Continued.

1892.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	220	270	280	280	------	280	280	280	280	280	280	280
2	220	270	280	280	280	280	280	280	280	------	280	280
3	------	270	280	------	280	280	------	280	280	280	280	280
4	220	280	280	280	280	280	------	280	------	280	280	------
5	250	280	280	280	280	------	280	280	280	280	280	280
6	250	280	------	294	280	280	280	280	280	280	------	280
7	250	------	280	294	280	280	280	------	280	280	280	280
8	250	280	280	294	------	280	280	280	280	280	280	280
9	250	280	280	286	280	280	280	280	280	------	280	280
10	------	280	280	------	280	280	280	280	280	280	280	280
11	250	280	280	306	280	280	(*a*)	280	------	280	280	------
12	250	280	280	294	280	------	(*a*)	280	280	280	280	280
13	250	280	------	280	280	280	(*a*)	280	280	280	------	280
14	250	------	280	280	280	280	(*a*)	------	280	280	280	280
15	270	280	280	280	------	280	(*a*)	280	280	280	280	280
16	270	280	280	280	280	280	(*a*)	280	280	------	280	280
17	------	280	280	------	280	280	(*a*)	280	280	280	280	280
18	270	280	280	280	280	------	280	280	------	280	280	------
19	270	280	280	280	280	------	280	280	280	280	280	280
20	276	280	------	280	280	280	280	280	280	280	------	280
21	276	------	280	280	280	280	280	------	280	280	280	280
22	270	280	280	280	280	280	280	280	280	280	280	280
23	270	280	280	280	280	280	280	280	280	------	280	280
24	------	280	280	------	280	280	------	280	280	280	------	280
25	270	280	280	280	280	280	280	280	------	280	280	------
26	270	280	280	280	280	------	280	280	280	280	280	280
27	270	280	------	280	280	280	280	280	280	280	------	280
28	270	------	280	280	280	280	280	------	280	280	280	280
29	270	280	280	280	280	280	280	280	280	280	280	280
30	270	------	280	280	280	280	280	280	280	------	280	280
31	------	------	280	------	280	------	------	280	------	280	------	280
Mean	258	279	280	283	280	280	280	280	280	280	280	280

a Water shut back.

1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	------	280	280	535	435	300	280	280	(*a*)	------	250	220
2	280	280	280	314	458	300	------	280	(*a*)	250	250	220
3	280	280	280	300	509	300	280	280	(*a*)	250	250	------
4	280	280	280	300	596	------	------	280	270	250	250	220
5	280	280	------	300	1,079	300	280	280	(*a*)	220	------	220
6	280	280	280	300	1,295	300	280	------	(*a*)	(*a*)	220	220
7	280	280	280	300	1,179	300	280	280	(*a*)	(*a*)	220	220
8	------	280	280	300	985	300	280	270	(*a*)	(*a*)	220	220
9	280	280	280	------	713	300	------	270	270	220	220	220
10	280	280	280	300	620	300	280	270	------	220	220	------
11	280	280	280	314	590	------	280	270	270	220	220	220
12	280	------	------	481	562	280	280	270	270	220	------	220
13	280	280	280	682	562	280	280	------	270	(*a*)	220	220
14	280	280	509	650	887	280	280	270	270	(*a*)	220	220
15	------	280	620	650	1,262	280	280	270	(*a*)	(*a*)	220	220
16	280	280	620	1,040	1,354	280	------	270	(*a*)	220	220	220
17	280	280	535	1,079	1,552	280	280	270	(*a*)	220	220	------
18	280	280	509	1,001	2,680	------	280	270	270	220	220	220
19	280	------	458	962	2,481	280	280	270	270	(*a*)	------	220
20	280	280	435	925	2,002	280	280	------	270	(*a*)	220	220
21	280	280	393	887	1,900	280	280	270	270	(*a*)	220	220
22	------	280	393	962	1,752	280	280	270	(*a*)	(*a*)	220	220
23	280	280	356	962	1,660	280	------	270	(*a*)	(*a*)	220	220
24	280	280	356	925	1,428	280	280	270	(*a*)	(*a*)	220	------
25	280	280	356	780	1,052	------	280	270	250	250	220	------
26	280	------	458	713	562	280	280	270	250	250	------	220
27	280	280	590	620	326	280	280	------	250	250	220	220
28	280	280	620	650	326	280	280	270	250	250	220	220
29	------	------	562	620	326	280	280	270	250	------	220	220
30	280	------	780	393	326	280	------	270	250	250	------	220
31	280	------	620	------	307	------	280	270	------	250	------	------
Mean	280	280	422	629	1,025	287	280	272	263	236	225	220

a Water shut back.

Daily discharge in second-feet of Cobbosseecontee River, at the upper dam, near Augusta, Maine—Continued.

1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	220	220	220	------	300	925	------	280	280	270	250	250
2	220	220	220	314	300	889	280	280	------	250	250	------
3	220	220	220	314	300	674	280	280	------	250	250	250
4	220	------	------	306	280	326	------	280	280	250	------	250
5	220	220	220	306	280	326	280	------	280	250	250	250
6	220	220	220	306	------	326	280	280	280	250	250	250
7	------	220	220	306	280	326	280	280	270	------	250	250
8	220	220	220	26	280	326	------	280	270	250	250	250
9	220	220	220	326	280	326	280	280	------	250	250	------
10	220	220	220	314	280	200	280	280	270	250	250	250
11	220	------	------	314	280	326	280	280	270	250	------	250
12	220	220	276	314	280	314	280	------	270	250	250	250
13	220	220	483	314	------	300	280	280	270	250	250	250
14	------	220	483	314	280	300	280	280	270	------	250	250
15	220	220	426	------	280	280	------	280	270	250	250	250
16	220	220	426	430	280	280	280	280	------	250	250	------
17	220	220	410	430	280	------	280	280	270	250	250	250
18	220	------	405	430	280	280	280	280	270	250	------	250
19	220	220	405	314	280	280	280	------	270	250	250	250
20	220	220	630	314	------	280	280	280	270	250	250	250
21	------	220	900	314	280	280	280	280	270	------	250	250
22	220	220	887	26	280	280	------	280	270	250	250	250
23	220	220	692	326	280	280	280	280	------	250	250	------
24	220	220	306	314	280	------	280	280	270	250	250	250
25	220	------	14	314	280	280	280	280	270	250	------	------
26	220	220	314	306	336	280	280	------	270	250	250	250
27	220	220	314	300	523	280	280	280	270	250	250	250
28	------	220	314	300	499	280	280	280	270	------	250	250
29	220	------	300	------	370	280	------	280	270	250	------	250
30	220	------	300	300	523	280	280	280	------	250	250	------
31	220	------	300	------	862	------	280	280	------	250	------	250
Mean	220	220	364	303	333	350	280	280	272	251	250	250

1895.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	250	250	------	250	385	280	280	280	------	220	(a)	------
2	250	250	------	250	318	------	280	280	270	220	(a)	220
3	250	------	------	250	300	280	280	280	270	220	------	220
4	250	220	220	250	290	280	------	------	270	(a)	(a)	220
5	250	220	220	250	------	280	280	280	270	(a)	(a)	220
6	------	220	220	250	280	280	280	280	270	------	(a)	220
7	250	220	220	14	280	280	------	280	270	220	(a)	220
8	250	220	------	343	280	280	280	280	------	(a)	(a)	------
9	250	220	220	733	280	------	280	280	270	(a)	(a)	220
10	250	------	------	2,619	280	280	280	280	250	(a)	------	220
11	250	220	220	1,301	280	280	280	------	250	(a)	(a)	220
12	250	220	220	1,384	------	280	280	270	250	(a)	(a)	220
13	------	220	220	300	280	280	280	270	250	------	(a)	220
14	250	220	220	74	280	280	------	270	250	(a)	(a)	220
15	250	220	220	2,603	280	280	280	270	------	(a)	(a)	------
16	250	220	220	2,461	280	------	280	270	250	(a)	(a)	220
17	250	------	------	1,698	280	280	280	270	250	(a)	------	220
18	250	220	220	1,609	280	280	280	------	250	(a)	220	220
19	250	220	220	1,400	------	280	280	270	250	(a)	220	220
20	------	220	220	1,271	280	280	280	270	(a)	------	220	220
21	250	220	220	480	------	280	------	270	(a)	(a)	220	220
22	250	220	220	664	280	280	280	270	------	(a)	220	------
23	250	220	220	358	280	------	280	270	220	(a)	220	220
24	250	------	------	385	280	280	280	270	220	(a)	------	220
25	250	220	220	385	280	280	280	------	220	(a)	220	------
26	250	220	220	385	------	280	280	270	220	(a)	220	250
27	------	220	220	385	280	280	280	270	220	------	220	250
28	250	------	220	409	280	280	------	270	220	(a)	------	250
29	250	------	220	409	280	280	280	270	------	(a)	220	14
30	250	------	220	409	280	------	280	270	220	(a)	220	264
31	250	------	------	------	280	------	280	270	------	(a)	------	343
Mean	250	223	220	785	287	280	280	273	247	220	220	222

a Gates up; natural flow.

Daily discharge in second-feet of Cobbosseecontee River, at the upper dam, near Augusta, Maine—Continued.

1896.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	270	......	901	300	280	280	280	250	250	......	250
2	451	......	1,959	993	300	280	280	......	250	250	220	250
3	276	270	2,698	901	......	280	280	280	250	250	220	250
4	264	270	1,959	856	300	280	......	280	250	......	220	250
5	......	270	1,637	856	300	280	......	270	250	250	220	250
6	270	270	1,219	856	300	280	280	270	......	250	220	......
7	270	270	1,219	856	280	......	280	270	250	250	220	250
8	270	270	1,226	856	280	280	280	270	250	250	......	250
9	270	......	1,368	769	280	280	280	......	250	250	220	250
10	270	270	1,368	727	......	280	280	270	250	250	220	250
11	270	270	946	727	280	280	280	270	250	......	220	250
12	......	270	1,038	727	280	280	......	270	250	250	220	250
13	270	270	1,086	727	280	280	280	270	......	250	220	......
14	270	270	1,038	812	280	......	280	270	250	220	220	250
15	270	270	901	812	280	280	280	270	270	220	......	250
16	270	......	769	901	280	280	280	......	270	220	220	250
17	270	270	727	946	......	280	280	270	270	220	220	250
18	270	270	685	1,188	280	280	280	270	250	......	250	250
19	......	270	856	1,236	280	280	......	270	250	220	250	250
20	270	270	993	1,039	280	280	280	270	......	220	250	......
21	270	270	1,581	901	280	......	280	270	250	220	250	250
22	270	270	1,429	992	280	280	280	270	250	220	......	250
23	270	......	1,275	1,039	280	280	280	......	250	220	250	250
24	270	280	1,056	901	......	280	280	270	250	220	250	250
25	270	280	728	769	280	280	280	270	250	......	250	......
26	......	280	686	644	280	280	......	270	250	220	......	250
27	270	280	812	526	280	280	280	270	......	220	250	......
28	270	280	769	300	280	......	280	270	250	220	250	250
29	270	280	727	300	280	280	280	270	250	220	......	250
30	270	......	644	300	......	280	280	......	250	220	250	250
31	270	......	727	......	......	......	280	250	......	220	......	250
Mean	277	272	1,138	812	284	280	280	270	252	232	233	250

1897.

1	250	250	250	497	280	600	280	......	280	280	270	270
2	250	250	250	517	......	477	280	280	280	280	270	270
3	......	250	250	574	368	573	280	280	280	......	270	270
4	250	250	250	350	624	523	......	280	280	280	270	270
5	250	250	250	620	630	477	100	280	......	280	270	......
6	250	250	250	650	320	262	280	280	280	280	270	270
7	250	......	......	650	320	336	280	280	280	280	......	270
8	250	250	250	650	320	336	280	......	280	280	270	270
9	250	250	250	620	74	320	280	280	280	280	270	270
10	......	250	250	620	373	320	280	280	280	......	270	270
11	250	250	250	650	393	512	......	280	280	280	270	270
12	250	250	250	590	393	559	280	280	......	280	270	......
13	250	250	250	421	393	679	280	280	280	280	270	270
14	250	......	......	310	......	679	280	280	280	270	......	270
15	250	250	250	356	489	436	280	......	280	(*a*)	270	270
16	250	250	250	522	244	354	280	280	280	(*a*)	270	270
17	......	250	250	497	509	320	280	280	280	(*a*)	270	270
18	250	250	250	497	833	294	......	280	280	(*a*)	270	280
19	250	550	250	473	769	286	280	280	......	(*a*)	270	......
20	250	250	250	453	739	6	280	280	280	(*a*)	270	280
21	250	......	......	320	709	286	280	280	280	(*a*)	......	280
22	250	250	250	294	391	436	280	......	280	(*a*)	270	280
23	250	250	250	286	6	654	280	280	280	(*a*)	270	280
24	......	250	250	280	280	365	280	280	280	......	270	280
25	250	250	250	14	280	294	......	280	280	270	270	21
26	250	250	250	286	280	286	280	280	......	270	270	......
27	250	250	250	280	280	......	280	280	280	270	270	280
28	250	......	......	286	320	280	280	280	280	270	......	280
29	250	......	250	286	19	280	280	......	280	270	270	280
30	250	......	250	280	914	280	280	280	280	270	270	280
31	......	......	306	......	772	......	280	280	......	......	......	280
Mean	250	250	252	438	425	397	273	280	280	276	270	265

a Gates up; all that flows.

Daily discharge in second-feet of Cobbosseecontee River, at the upped dam, near Augusta, Maine—Continued.

1898.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	280	280	413	......	478	280	280	280	270	250	250	250
2	......	280	394	......	478	280	280	280	270	......	250	250
3	280	280	443	1,016	478	280	......	280	270	250	250	250
4	280	280	408	1,038	455	280	19	280	......	250	250	......
5	280	280	408	1,038	455	......	280	280	250	250	250	270
6	280	......	387	1,038	433	280	280	280	250	250	......	270
7	280	280	466	1,038	433	280	280	......	250	250	250	270
8	280	280	529	1,038	273	280	280	280	250	250	250	270
9	......	280	503	1,038	333	280	280	280	250	......	250	270
10	280	280	474	1,003	333	280	......	280	250	250	250	270
11	280	280	456	584	314	280	280	280	......	250	250	......
12	280	280	559	531	300	......	280	280	250	250	250	270
13	280	......	597	326	300	280	280	280	250	250	......	270
14	280	280	821	326	300	280	280	......	250	250	250	270
15	280	280	1,148	334	......	280	280	280	250	250	250	270
16	......	300	1,111	376	300	280	280	270	250	......	250	270
17	280	300	1,039	413	300	280	......	270	250	220	250	270
18	280	300	969	433	300	280	280	270	......	220	250	......
19	280	300	969	433	300	......	280	270	250	220	250	270
20	280	300	1,016	433	300	280	280	270	250	220	......	270
21	280	328	1,222	433	300	280	280	......	250	220	250	270
22	280	328	1,184	433	......	280	280	270	250	220	250	270
23	......	333	1,147	433	300	280	280	270	250	......	250	270
24	280	445	1,222	433	300	280	......	270	250	220	......	270
25	280	504	1,261	555	280	280	280	270	......	220	250	......
26	280	477	1,222	732	280	......	280	270	250	220	250	270
27	280	435	1,125	682	280	280	280	270	250	220	......	270
28	280	433	1,147	478	280	280	280	......	250	250	250	270
29	280	......	1,184	478	......	280	280	270	250	250	250	270
30	......	......	1,147	620	280	280	280	270	250	......	250	270
31	280	......	1,147	......	280	......	......	270	......	250	......	270
Mean	280	324	843	633	337	280	270	275	252	238	250	268

1899.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	270	270	300	300	280	280	280	270	(a)	160	160
2	270	270	270	306	300	280	......	280	270	(a)	180	160
3	270	270	270	306	300	280	280	280	......	(a)	180	......
4	270	270	270	306	300	......	19	280	270	(a)	170	180
5	270	......	......	359	300	280	280	280	250	(a)	......	180
6	270	270	270	373	300	280	280	......	250	(a)	180	180
7	270	270	250	395	......	280	280	280	250	(a)	175	170
8	......	270	270	502	300	280	280	280	250	(a)	170	150
9	270	270	270	842	300	280	......	280	(a)	(a)	170	135
10	270	270	270	1,198	300	280	280	280	......	(a)	150	......
11	270	270	270	1,262	300	......	280	280	250	(a)	150	120
12	270	......	......	984	300	280	280	280	250	(a)	......	120
13	270	270	270	772	300	280	280	......	250	(a)	150	120
14	270	270	270	809	......	280	280	280	(a)	(a)	150	120
15	......	270	270	809	290	280	280	280	(a)	(a)	140	120
16	270	270	270	787	290	280	......	270	(a)	(a)	130	140
17	270	270	270	947	290	280	280	270	......	(a)	130	......
18	270	270	270	1,243	290	......	280	270	250	(a)	130	140
19	270	......	......	1,387	290	280	280	270	(a)	(a)	......	135
20	270	270	270	1,427	290	280	280	......	(a)	(a)	160	135
21	270	270	270	1,403	......	280	280	270	(a)	(a)	170	135
22	......	270	270	1,331	280	280	280	270	(a)	(a)	180	135
23	270	270	270	1,145	20	280	......	270	(a)	(a)	180	135
24	270	270	270	1,130	280	280	280	270	......	(a)	180	......
25	270	270	270	870	280	......	280	270	220	(a)	180	......
26	270	......	......	669	280	280	280	270	(a)	(a)	......	150
27	270	270	270	635	280	280	280	......	(a)	(a)	170	150
28	270	270	270	470	......	280	280	270	(a)	(a)	165	140
29	......	......	280	324	280	280	280	270	(a)	(a)	150	140
30	270	......	280	......	280	280	......	270	(a)	(a)	......	140
31	270	......	280	......	280	......	280	270	......	......	......	......
Mean	270	270	270	803	281	280	270	275	252	......	162	144

a Gates up; all that flows.

MERRIMAC RIVER AT MANCHESTER, NEW HAMPSHIRE.

This stream receives the drainage from a considerable portion of the White Mountain area in New Hampshire. Its flow is regulated by a number of large lakes near the headwaters, the outlets of many of which are controlled by dams. The fall of the stream is considerable and developments of water power have taken place to an extent probably greater than in any other part of the United States. At Manchester records of the height are taken several times a day, generally on the even hours. Mr. H. W. Allen, of the Amoskeag Manufacturing Company, states that the ordinary flow of Merrimac River at that place for eight months of the year is 2,100 second-feet. With this quantity all the water wheels can be run. The minimum low-season flow for this year he would call 1,084 second-feet. The length of the main dam is 400 feet, and the wing 231 feet. The dam is 177.99 feet above mean tide water at the mouth of the river. Three-foot flashboards can be used in all months except March, April, and May, and then only 2-foot boards. The pondage extends to Hooksett, 8 miles, and covers 443.65 acres. The highest water on the dam of which there is record was on March 2, 1896, when there was 10.95 feet in height, flowing over. The drainage area above Manchester is 2,839 square miles.

MERRIMAC RIVER AT LAWRENCE, MASSACHUSETTS.

The longest and most careful series of computations of river flow are probably those kept at Lawrence, Massachusetts, having been begun by Mr. J. B. Francis for the Essex Company, and maintained by Mr. Hiram Mills and Mr. R. A. Hale. These extend over fifty years, but have never been published in full. The maximum, minimum, and mean discharge by months, from 1890 to 1897, has been printed in the Nineteenth Annual Report, Part IV, pages 113 to 115, and similar figures for 1898 have been given in the Twentieth Annual Report, Part IV, page 73, accompanied by a diagram showing the fluctuations from 1891 to 1898, inclusive.

Daily discharge of Merrimac River, at Lawrence, Massachusetts, in cubic feet per second.

1897.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2,807	3,776	3,963	14,238	9,957	9,153	5,642	9,220	3,074	2,647	2,374	5,150
2	1,943	2,931	3,636	14,616	10,049	8,090	7,037	8,574	3,467	1,872	2,782	4,406
3	2,180	2,775	3,669	15,348	10,908	7,394	6,497	7,539	3,840	440	4,666	4,246
4	4,009	2,740	4,780	15,908	11,538	7,673	5,470	6,576	2,438	3,449	9,216	3,591
5	4,000	2,730	5,943	16,067	12,514	9,028	5,010	6,352	2,547	2,757	7,604	3,216
6	4,816	1,902	6,944	18,116	11,949	10,517	5,454	6,877	2,864	2,544	5,474	6,430
7	6,707	2,390	8,042	21,048	10,727	10,469	4,805	6,374	4,460	2,570	3,897	8,992
8	7,325	5,779	10,500	22,974	9,443	9,068	4,725	5,027	2,854	2,496	4,879	7,925
9	5,285	7,946	9,385	22,611	7,829	8,397	4,969	5,164	2,685	1,534	3,741	6,598
10	4,032	9,427	9,125	24,513	7,613	15,264	3,803	4,551	2,760	340	4,109	5,971
11	5,005	9,094	10,100	24,483	6,582	40,872	3,393	4,575	2,072	2,542	5,680	5,172
12	3,990	7,589	12,300	21,510	7,714	35,923	4,841	5,043	1,424	2,498	6,950	5,334
13	3,313	6,214	13,680	17,953	8,840	26,829	3,370	5,006	3,736	2,582	8,033	8,124
14	3,364	4,821	13,350	16,235	14,051	21,473	16,921	4,280	2,934	2,669	7,923	9,850
15	2,989	5,429	11,243	15,873	24,681	19,643	32,498	3,729	2,644	2,428	7,441	15,100
16	2,026	4,759	10,365	18,789	19,305	17,539	41,499	4,983	2,684	2,454	6,259	32,300
17	1,834	4,539	8,904	23,407	14,171	14,996	26,568	4,073	2,658	1,892	6,231	36,800
18	4,030	4,343	8,472	23,271	11,448	12,675	16,903	4,159	1,930	3,805	6,909	28,504
19	3,231	4,392	8,092	20,629	9,481	11,416	13,672	4,721	1,044	2,770	7,378	20,203
20	3,104	3,398	9,216	18,710	8,301	9,217	11,173	4,522	3,717	2,716	6,019	14,157
21	2,965	3,467	11,156	17,085	7,607	10,348	9,853	2,860	3,020	2,502	4,801	12,113
22	3,025	4,847	13,373	14,605	6,657	10,297	9,137	3,169	2,804	2,390	5,331	10,563
23	2,357	4,306	13,627	13,078	5,752	9,375	8,650	5,118	2,768	1,525	4,960	10,878
24	2,322	3,812	16,735	12,203	6,313	7,931	9,098	3,520	2,446	398	4,851	9,169
25	4,049	4,241	18,717	13,761	5,676	7,117	10,241	4,480	1,886	3,096	3,022	9,170
26	2,997	4,036	17,871	15,884	6,716	6,877	12,121	5,467	1,370	2,566	5,424	7,065
27	2,783	3,427	15,549	16,933	8,226	6,478	11,661	5,285	4,019	2,341	4,390	7,633
28	2,771	2,869	12,944	15,214	9,060	6,376	10,466	3,996	3,087	2,506	7,816	6,116
29	2,699	......	11,758	12,341	10,277	5,569	9,070	3,640	2,874	2,268	9,714	5,831
30	1,994	......	11,498	10,947	10,626	5,246	9,782	5,007	2,671	1,648	6,924	5,653
31	1,721	......	12,777	......	9,616	......	10,448	3,340	......	176	......	5,410
Mean	3,409	4,571	10,571	17,611	10,117	12,708	10,799	5,072	2,759	2,207	5,827	10,376

1898.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4,751	5,000	10,050	19,795	16,279	9,964	3,853	3,575	3,357	2,455	8,384	9,778
2	4,246	5,550	9,500	17,566	14,774	8,697	2,826	2,833	3,224	2,077	7,759	9,856
3	8,200	5,100	9,240	15,026	13,387	7,771	2,623	2,617	2,580	3,951	7,157	9,141
4	6,520	5,325	8,840	13,254	12,708	7,131	2,741	2,575	2,163	3,034	6,525	8,271
5	5,790	5,250	8,350	12,195	12,535	7,124	4,516	2,624	2,714	3,055	5,871	11,050
6	5,650	5,400	6,850	11,459	12,647	7,865	3,225	1,893	3,847	3,761	5,204	16,808
7	5,380	6,150	8,800	11,004	12,630	7,163	2,721	1,969	3,146	5,827	6,114	17,398
8	5,500	6,070	8,350	10,740	11,583	6,774	2,768	4,112	3,134	5,759	5,477	15,190
9	5,260	5,600	8,940	10,128	11,144	6,585	2,015	3,056	3,043	5,393	5,319	12,245
10	7,580	6,200	10,080	9,529	10,035	6,276	1,135	2,949	2,307	6,080	5,617	9,637
11	6,520	6,150	11,380	9,742	8,452	5,619	3,805	3,563	1,705	4,897	9,353	8,591
12	5,910	7,330	14,080	10,058	8,109	5,267	2,918	4,020	3,750	4,667	15,304	8,855
13	6,040	7,320	17,600	10,386	8,552	5,706	2,707	3,221	2,910	4,484	14,746	6,699
14	7,180	10,460	28,800	11,072	12,530	5,598	2,620	3,032	2,630	4,043	12,781	6,330
15	8,170	10,120	36,000	11,507	11,834	6,832	2,533	4,744	2,556	3,367	10,971	6,532
16	7,540	9,980	35,100	13,588	10,458	8,511	1,859	3,645	2,483	4,361	9,784	6,715
17	9,700	8,400	30,000	17,111	9,959	7,213	1,018	3,412	1,720	6,023	8,962	6,279
18	7,770	7,750	26,100	17,021	9,505	5,205	3,551	3,115	372	5,325	8,622	5,908
19	6,790	8,460	25,200	15,048	8,858	4,506	2,517	3,337	2,800	4,982	9,810	6,841
20	6,040	6,850	25,000	14,330	8,307	5,923	2,568	3,359	2,460	5,055	15,303	6,378
21	7,300	9,080	27,600	13,717	7,472	7,026	2,581	5,459	2,335	6,075	19,785	6,144
22	9,340	9,270	30,200	13,493	7,302	7,908	2,920	6,261	2,264	7,421	17,553	6,084
23	9,140	9,930	25,800	12,121	7,404	6,694	2,360	5,469	2,399	10,178	14,351	6,876
24	11,480	10,430	22,300	13,666	6,160	6,590	2,327	4,439	1,760	11,583	11,625	9,007
25	11,100	10,790	21,800	25,342	7,316	5,790	3,919	4,892	1,867	9,962	11,699	10,290
26	10,500	10,740	20,000	30,362	10,501	5,142	2,851	5,403	6,075	8,307	11,113	9,534
27	9,450	8,900	17,000	27,394	14,041	5,458	2,724	4,913	5,144	8,909	9,627	8,892
28	8,960	10,700	17,900	22,139	15,785	5,110	2,709	4,527	4,525	13,699	6,872	8,425
29	8,040	......	18,000	19,424	15,081	4,567	2,713	5,306	4,198	14,473	6,253	6,572
30	6,620	......	18,400	18,612	13,713	3,908	1,753	3,806	3,830	10,534	8,677	6,024
31	6,750	......	19,700	......	11,811	......	1,081	3,657	......	9,565	......	5,792
Mean	7,394	7,797	18,612	15,229	10,996	6,464	2,660	3,799	2,910	6,429	9,887	8,779

Daily discharge of Merrimac River, at Lawrence, Massachusetts, in cubic feet per second—Continued.

1899.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5,661	5,145	7,360	16,700	22,870	4,277	2,019	2,925	2,188	497	2,829	2,677
2	6,511	4,919	7,810	14,840	23,647	3,907	387	2,370	1,666	3,156	3,542	1,941
3	6,004	4,841	7,379	15,160	23,410	3,231	2,131	2,423	509	2,519	3,632	904
4	6,643	3,659	6,837	14,590	23,158	2,701	1,500	2,659	1,987	2,337	3,692	3,219
5	7,863	3,531	6,992	14,680	18,876	4,292	3,691	1,806	3,359	2,193	2,889	2,834
6	10,816	5,458	10,630	15,190	15,125	3,601	2,770	749	3,120	2,282	4,645	2,846
7	11,519	4,240	13,059	16,400	12,428	3,065	2,927	3,604	2,743	1,739	3,617	2,768
8	10,373	4,501	12,859	18,400	11,694	2,944	2,044	2,784	2,378	288	3,205	2,847
9	10,024	4,087	11,968	25,000	10,618	3,214	570	2,186	1,745	2,244	3,034	1,868
10	8,747	4,308	10,628	29,200	9,652	2,450	3,984	2,248	426	2,156	3,024	665
11	7,572	3,344	9,194	29,400	8,827	1,981	3,346	2,635	2,664	2,204	2,473	3,192
12	6,831	3,075	9,161	28,200	8,564	3,806	2,996	1,886	2,307	2,107	863	2,715
13	6,358	4,731	13,795	26,000	7,706	3,076	3,176	372	2,247	2,007	3,729	2,236
14	5,611	3,576	18,900	25,600	7,131	2,731	2,948	3,123	2,250	959	3,069	3,369
15	6,126	3,740	18,600	30,000	7,440	2,457	2,055	2,768	2,217	61	2,879	5,051
16	8,214	3,845	17,500	34,400	6,376	2,857	685	2,196	1,441	2,020	2,770	3,772
17	9,681	3,933	15,200	38,200	6,422	2,317	3,678	2,125	69	1,962	2,846	2,478
18	11,329	3,617	15,000	35,527	5,932	2,481	2,810	2,468	1,960	2,061	1,999	3,969
19	10,799	4,092	12,330	33,498	5,650	4,430	2,851	1,857	1,762	2,354	548	2,814
20	9,211	5,747	12,920	34,623	5,213	2,866	2,476	355	1,804	2,460	3,462	2,892
21	7,823	5,749	12,040	34,310	5,468	2,894	2,488	2,098	2,168	1,373	3,076	3,387
22	6,839	6,083	12,210	30,583	6,800	3,101	1,706	2,257	2,496	50	2,914	3,868
23	7,317	6,550	11,500	27,846	5,897	2,865	525	2,187	1,816	2,126	2,805	2,851
24	6,713	7,098	11,340	29,483	5,654	2,066	3,808	2,123	293	1,667	2,603	2,383
25	7,396	6,885	11,260	31,656	4,909	1,134	2,905	2,136	2,560	1,820	2,312	2,798
26	8,291	6,309	9,400	31 367	4,823	3,582	2,893	1,674	2,633	1,978	1,291	4,334
27	8,192	6,988	11,130	31,157	4,022	2,883	2,599	78	2,453	2,333	3,380	3,667
28	6,870	6,637	10,360	31,816	3,543	2,841	2,949	2,067	2,191	1,399	2,909	2,954
29	5,906	......	11,240	26,805	5,255	2,506	2,241	2,153	2,452	123	2,789	2,916
30	6,808	......	14,600	23,507	3,862	2,846	1,984	2,222	1,906	2,513	947	1,898
31	5,504	......	17,200	....	4,383	....	3,781	2,132	....	2,460	....	593
Mean	7,857	4,882	11,948	26,438	9,528	2,980	2,481	2,086	1,994	1,789	2,792	2,797

NASHUA RIVER AT CLINTON, MASSACHUSETTS.

This river receives the drainage of a portion of central Massachusetts, and flows in a general northerly course into New Hampshire, emptying into Merrimac River. The principal part of the drainage basin is shown on the Worcester, Marlboro, Framingham, and Groton topographic atlas sheets. On its headwaters, near the town of Clinton, the metropolitan water board has under construction what is known as Wachusett reservoir, for the supply of Boston and neighboring towns. Measurements of the flow of Nashua River have been made at Clinton since July, 1896, but these have not been published, as there are unsettled claims for the diversion of the water. The rainfall on the watershed during 1897 was measured at four localities, and ranged from about 50 to 53 inches. The area and capacity of Wachusett reservoir are given for each 5 feet in elevation in the Report of the State Board of Health of Massachusetts for 1895 on "Metropolitan water supply," pages 127 and 128. The outline of the reservoir is also shown on an accompanying plan.

SUDBURY RIVER.

This small stream of eastern Massachusetts, receives water from an area west of Framingham. It flows in a northerly course through meadows and swamps, and joins Assabet River to form Concord River, which in turn continues northerly, entering Merrimac River immediately below the city of Lowell. Storage reservoirs have been constructed by the city of Boston, controlling the greater part of the flow from this basin. The available water has been systematically measured by Mr. Desmond FitzGerald, the record beginning in 1875. The run-off in cubic feet per second, by months, from 1875 to 1898, is given in the Twentieth Annual Report, Part IV, page 75.[1] The following is a continuation of this table. It should be noted that during August the yield of Sudbury River is a minus quantity.

Run-off of Sudbury River and Lake Cochituate watersheds in second-feet per square mile.

Month.	Sudbury River.		Lake Cochituate.	
	1899.	Averages, 1875–1899.	1899.	Averages, 1863–1899.
January	3.54	1.94	2.99	1.78
February	2.14	2.90	2.22	2.53
March	6.51	4.49	5.51	3.32
April	3.90	3.12	2.55	2.60
May	.79	1.68	.60	1.51
June	.10	.74	.10	.70
July	.03	.31	.03	.47
August	−.05	.48	.08	.67
September	.15	.38	.45	.65
October	.18	.83	.54	.92
November	.47	1.47	.45	1.33
December	.34	1.61	.35	1.46
The year	1.51	1.66	1.32	1.49

LAKE COCHITUATE.

This lake drains into Sudbury River below the point of diversion for the water supply of the city of Boston, and has been considered as a separate watershed, with an area of 18.87 square miles, of which 7.6 per cent is water surface. Dudley Pond, which lies just north of the lake, is connected with it, and water is occasionally drawn into the lake. The watershed of this pond is not included in the 18.87 square miles; thus a corresponding deduction must be made in computing the yield. This correction has been made in the accompanying table. Figures of catchment on this area since 1863 are available, these not being considered quite as accurate as those for Sudbury River. The results in inches of depth of run-off from the watershed are given in the following table. The average yield per square mile of this watershed for thirty-seven years, 1863 to 1899,

[1] For low water flow, see Engineering Record, September 16, 1899.

inclusive, is given in the second table, which shows by months the second-feet per square mile, the corresponding depth of run-off in inches, the depth of rainfall, and the percentage collected:

Yield of Lake Cochituate watershed in inches in depth.

[Drainage area, 18.87 square miles.]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1863	1.91	3.12	3.71	4.41	1.44	0.66	2.94	1.54	0.99	1.31	2.64	2.19	26.87
1864	2.41	1.56	4.09	2.65	1.61	.49	.41	.67	.49	1.42	1.24	1.17	18.22
1865	2.06	1.76	4.66	2.71	4.75	.33	.46	.48	.44	.69	1.02	1.13	20.49
1866	.74	2.84	1.78	1.62	1.29	1.09	1.26	.64	1.32	.94	.97	1.55	16.03
1867	1.10	5.24	3.47	2.86	2.18	.66	.56	2.10	.31	1.05	1.11	1.12	21.77
1868	1.23	1.12	3.85	3.49	6.18	1.60	.46	1.15	1.82	.95	1.99	1.17	24.99
1869	1.82	1.87	3.33	2.48	2.17	1.05	.75	.59	1.11	2.33	1.30	3.16	21.96
1870	4.73	3.95	3.37	6.86	1.66	.97	.53	.40	.64	.96	.80	.78	25.66
1871	1.03	2.28	2.53	1.58	2.00	.87	.43	.70	.28	.61	1.23	1.18	14.74
1872	1.10	.89	1.35	2.96	1.10	1.48	.14	1.32	1.70	1.70	1.99	1.20	16.94
1873	3.10	1.58	3.90	6.08	2.66	.45	.61	1.43	.79	2.02	1.86	2.69	27.17
1874	3.12	2.20	1.84	3.18	2.79	1.96	.95	.92	.53	.52	.57	.51	19.09
1875	.15	2.93	2.66	3.17	1.39	1.50	.25	.61	.58	1.21	1.98	1.22	17.65
1876	1.08	1.77	5.20	4.21	1.43	.51	.85	.28	.58	.36	1.85	1.00	19.12
1877	1.20	1.37	6.81	3.24	2.04	.92	.64	.66	.40	1.12	2.69	1.97	23.06
1878	3.25	3.97	5.40	2.86	1.66	.76	.47	.84	.29	.73	2.07	4.04	26.34
1879	1.29	2.32	3.30	4.48	1.40	.77	.33	.95	.61	.60	.72	1.04	17.81
1880	1.47	2.24	1.79	1.57	.44	.06	.33	.23	.24	.28	.66	.59	9.90
1881	1.19	2.23	5.66	1.79	1.26	1.31	.16	.09	.23	.18	.84	1.40	16.34
1882	1.84	3.00	3.67	.93	1.55	.62	.06	.07	.97	.84	.58	.92	15.05
1883	.84	1.59	2.04	1.66	1.26	.07	.02	.07	.44	.44	.40	.94	9.76
1884	1.84	2.86	4.67	4.00	1.39	.67	.26	.61	.13	.34	.62	1.82	19.21
1885	1.90	2.00	2.21	2.36	1.61	.43	.00	.33	.25	.79	2.05	1.64	15.57
1886	2.28	7.93	3.51	2.52	1.09	.18	.25	.14	.30	.42	1.20	2.10	21.92
1887	4.06	4.34	4.70	3.36	1.35	.82	.72	1.33	.64	.49	.70	.96	23.47
1888	1.13	2.77	4.76	3.45	2.37	.53	.47	.94	2.31	2.57	4.21	5.46	30.97
1889	4.50	1.85	2.08	2.17	1.20	1.18	1.63	3.43	1.79	1.91	2.95	3.26	27.95
1890	1.92	2.04	5.87	2.23	1.85	1.41	.33	.46	1.40	3.40	1.49	2.11	24.51
1891	6.26	6.62	8.03	4.31	.88	.77	.50	.72	.76	.79	.83	1.26	31.73
1892	8.03	1.54	3.02	.90	2.03	.49	.33	.56	.60	.57	1.09	.84	15.02
1893	.64	2.55	4.12	2.42	1.83	.75	.38	.77	.42	1.08	0.83	1.48	17.27
1894	1.21	1.67	2.55	2.15	.91	.45	.38	.41	.46	.66	.92	1.14	12.91
1895	1.58	.75	3.50	3.35	.97	.40	.55	.50	.69	1.97	3.51	2.40	20.17
1896	1.72	3.69	5.52	2.01	.62	.71	.38	.47	1.03	1.28	1.40	1.31	20.14
1897	1.64	1.65	3.22	1.85	1.39	1.19	.75	.63	.46	.43	1.68	2.16	17.05
1898	2.27	4.06	3.11	2.69	1.86	.78	.37	1.30	.31	1.61	2.31	2.74	23.41
1899	3.45	2.31	6.35	2.84	.69	.11	.03	.09	.50	.63	.50	.41	17.91
Mean	2.056	2.662	3.828	2,903	1.738	.784	.539	.767	.725	1.059	1.482	1.677	20.220

Average yield per square mile of Lake Cochituate watershed, 1863 to 1899, inclusive

[Drainage area, 18.87 square miles.]

Month.	Second-feet per square mile.	Run-off in inches.	Rainfall in inches.	Per cent.
January	1.78	2.06	4.00	51.4
February	2.53	2.66	3.93	67.8
March	3.32	3.83	4.34	88.2
April	2.60	2.90	3.51	82.7
May	1.51	1.74	3.78	46.0
June	.70	.78	2.96	26.5
July	.47	.54	4.21	13.0
August	.67	.77	4.49	17.1
September	.65	.72	3.44	21.1
October	.92	1.06	4.56	23.2
November	1.33	1.48	4.38	33.9
December	1.46	1.68	3.40	49.3
The year	1.49	20.28	47.00	43.0

MYSTIC LAKE.

The area tributary to Mystic Lake lies about 10 miles north of Boston and contains 26.9 square miles, including about 3 per cent of water surface. It has been the source of water supply for the city of Charlestown since 1864. Upon the annexation of that city to Boston the source of supply passed into the control of the Boston waterworks, this being in 1876. The records of run-off extend from 1878 to 1897, inclusive. On January 1, 1898, the lake was abandoned as a source of water supply and records after that date are not available. The table given below is from the third annual report of the water commissioners of the city of Boston. These records are somewhat less accurate than those for Lake Cochituate, as they involve not only storage in Mystic Lake, which has been determined with a fair degree of accuracy, but also the quantity of water pumped by five engines, the slip of which was somewhat uncertain, and the flow through a fishway. There are also a number of other points on the watershed whose storage should have been considered.

The yield from this watershed in depth in inches for the years 1878 to 1897, inclusive, is given in the table on page 40. The average yield per square mile is given in the following table, these figures being obtained from the engineering department of the Metropolitan Water Board, through Mr. Charles W. Sherman, assistant engineer:

Average yield per square mile of Mystic Lake watershed, 1878 to 1897, inclusive.

[Drainage area, 26.9 square miles.]

Month.	Second-feet per square mile.	Run-off in inches.	Rainfall in inches.	Per cent.
January	1.81	2.09	4.21	49.5
February	2.72	2.86	4.04	70.8
March	3.39	3.91	3.72	105 2
April	2.33	2.61	3.02	86.1
May	1.62	1.87	3.64	51.5
June	.96	1.07	3.20	33.5
July	.49	.56	3.58	15.6
August	.56	.65	4.00	16.3
September	.47	.52	3.17	16.4
October	.69	.80	3.98	20.1
November	1.14	1.28	3.79	33.7
December	1.41	1.63	3.47	46.9
The year	1.46	19.85	43.82	45.3

Records are not available after 1897, although observations have been continued. The watershed is no longer in use as a source of supply, and so many complications enter into an estimate of yield that it is probable that it will not be computed.

Run-off in inches on Mystic Lake watershed, 1878 to 1897, inclusive.

[Drainage area, 26.9 square miles.]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1878	3.55	3.97	4.91	2.21	2.16	0.78	0.48	1.11	0.56	0.71	1.75	3.63	25.82
1879	1.21	2.33	3.31	3.97	1.95	.97	.54	.70	.48	.34	.45	.69	16.94
1880	1.70	2.54	1.95	1.50	.96	.51	.67	.54	.45	.36	.44	.59	12.21
1881	.82	2.14	6.79	2.17	1.51	2.05	.87	.35	.31	.29	.50	.87	18.67
1882	1.37	3.03	4.19	1.16	1.85	.81	.35	.22	.53	.58	.39	.57	15.05
1883	.70	1.43	1.88	1.63	1.20	.52	.30	.22	.18	.39	.42	.44	9.31
1884	1.49	3.89	5.42	3.85	1.48	.85	.58	.60	.23	.27	.35	1.17	20.18
1885	1.79	1.81	2.05	2.03	2.18	.86	.47	.54	.34	.68	2.41	2.39	17.55
1886	2.31	7.70	3.91	3.24	1.27	.55	.41	.25	.32	.38	.88	1.43	22.65
1887	3.16	3.61	3.60	3.75	1.89	1.27	.87	1.35	.48	.57	.71	.91	22.17
1888	1.43	3.32	4.28	3.27	2.88	.84	.39	.54	1.31	2.74	5.04	5.08	31.12
1889	4.51	1.83	1.60	2.27	2.18	1.89	1.33	2.05	1.06	1.21	2.49	3.06	25.48
1890	2.07	2.23	5.37	2.93	3.00	1.92	.43	.46	.58	2.61	1.95	2.49	26.04
1891	6.29	5.97	7.21	3.43	1.40	1.01	.42	.44	.42	.58	.56	.87	28.60
1892	2.49	1.76	3.03	1.33	2.10	1.17	.66	.49	.56	.45	1.07	.87	15.98
1893	.75	2.14	4.52	2.72	4.42	1.04	.47	.69	.41	.55	.71	1.27	19.69
1894	1.37	1.87	3.05	2.27	1.31	.91	.49	.38	.36	.58	.91	.90	14.40
1895	1.55	.87	3.16	2.95	1.13	.54	.60	.80	.36	1.46	2.37	2.12	17.91
1896	1.85	3.40	4.50	3.26	.77	.75	.39	.34	1.06	.89	1.11	1.23	19.55
1897	1.39	1.40	3.46	2.14	1.83	2.19	.50	.95	.41	.39	1.02	1.96	17.64
Mean	2.09	2.86	3.91	2.61	1.87	1.07	.56	.65	.52	.80	1.28	1.63	19.85

CONNECTICUT RIVER AT HOLYOKE, MASSACHUSETTS.

This river, rising in northern New Hampshire and Vermont, flows in a general southerly course, forming the greater part of the boundary between these States, and crosses Massachusetts and Connecticut, emptying into Long Island Sound. Computations of discharge have been made in the southern part of its course at Holyoke, Massachusetts, a short distance above the Connecticut State line. The flow of the river is controlled at this point by the Holyoke Water Power Company. Data of stream flow have been obtained from Mr. A. F. Sickman, assistant engineer of the company. The quantities given are the daily amounts drawn from the pond above the dam, representing the discharge of the river excepting at such times as the surface falls below the crest, when water is ponded over night and Sunday. The results by months, from 1880 to 1895, are published in Bulletin No. 140, pages 37 to 41; for 1896 and 1897, in the Nineteenth Annual Report, Part IV, page 116; and for 1898, in the Twentieth Annual Report, Part IV, page 76.

Daily mean discharge in second-feet of Connecticut River at Holyoke, Massachusetts.

[Drainage area, 8,660 square miles.]

1896.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	47,350	5,500	66,950	34,400	18,300	6,550	3,900	2,300	2,700	4,650	12,050	17,900
2	39,050	4,850	112,050	36,100	16,050	6,350	3,800	2,450	2,850	4,700	11,750	15,750
3	29,700	5,350	103,450	32,300	14,700	6,450	2,350	3,900	2,700	3,600	11,550	12,300
4	23,850	4,850	65,050	24,650	15,000	6,200	750	3,700	2,700	3,500	12,100	8,250
5	12,200	4,800	37,900	19,600	14,350	5,800	1,700	3,750	2,100	4,550	12,800	6,450
6	9,300	5,550	25,100	18,550	13,900	4,650	2,050	3,650	700	4,600	26,800	6,500
7	7,750	17,150	22,050	18,350	13,700	3,850	2,900	3,800	6,150	5,200	30,450	8,550
8	7,300	20,750	19,050	17,550	13,550	5,100	3,450	2,850	7,750	5,250	25,300	8,850
9	7,600	19,700	17,950	17,700	11,900	4,900	4,450	4,100	8,050	5,550	23,900	9,700
10	7,850	17,700	16,900	19,900	11,000	7,100	6,050	4,650	7,200	4,750	21,000	13,900
11	7,100	14,300	14,050	22,700	11,050	8,850	4,500	4,000	6,450	4,300	17,650	13,800
12	7,250	11,650	10,900	26,950	10,700	8,750	4,300	3,750	4,800	4,500	15,800	11,000
13	8,250	10,600	9,350	37,300	10,700	7,750	4,150	3,750	3,900	4,250	15,050	10,400
14	8,250	9,600	9,300	59,350	11,000	6,450	4,100	3,800	4,400	6,600	12,550	9,900
15	7,700	8,750	8,900	71,100	11,000	6,600	4,000	2,050	4,100	10,200	11,600	9,350
16	7,900	7,600	8,550	77,500	9,050	5,950	4,150	1,300	3,800	20,100	11,400	5,950
17	7,700	7,800	8,950	84,450	7,800	5,700	4,100	2,800	3,650	16,850	10,700	4,300
18	5,800	6,400	10,350	89,200	7,650	5,050	2,650	2,800	3,450	14,750	10,000	4,650
19	6,450	6,250	10,750	88,600	7,700	5,050	450	2,800	2,350	13,950	9,650	5,000
20	7,400	6,600	25,250	81,200	7,350	4,250	4,200	2,800	4,650	13,300	9,150	5,150
21	7,100	6,400	29,250	71,050	7,150	3,500	3,900	2,800	6,200	14,150	7,900	6,050
22	7,100	5,550	25,150	61,950	6,900	4,300	3,400	2,800	6,850	18,300	8,150	5,250
23	6,950	5,150	22,300	54,600	5,900	4,400	3,700	550	8,450	22,100	9,450	4,750
24	6,900	6,550	18,400	46,450	5,650	4,450	4,300	3,300	8,100	21,850	8,750	3,900
25	6,200	6,800	15,300	38,300	6,050	4,300	4,150	3,350	6,850	20,500	8,400	3,650
26	6,000	6,500	15,050	30,800	5,800	4,350	4,100	3,300	4,550	19,500	10,500	4,200
27	6,800	6,300	19,750	26,750	5,850	2,550	4,550	2,950	4,250	16,800	13,300	3,400
28	6,350	6,100	23,250	23,150	4,850	3,300	4,450	2,700	4,500	14,500	13,600	4,550
29	6,100	9,600	22,250	20,900	5,350	4,050	4,300	1,900	4,450	13,000	14,600	4,400
30	6,100	......	24,050	19,500	5,150	4,150	4,350	450	4,400	12,050	17,550	4,250
31	6,000	......	26,150	......	5,100	......	4,000	2,800	......	12,200	......	4,300
Mean	10,882	9,096	27,216	42,363	9,684	5,357	3,684	2,965	4,768	10,971	14,115	7,624

1897.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3,350	3,900	4,400	21,900	32,950	22,900	10,200	22,350	6,200	4,950	3,850	21,050
2	3,350	3,600	3,550	22,950	27,800	19,300	9,550	18,950	6,150	3,450	4,550	16,650
3	3,350	3,600	3,500	25,150	28,000	16,750	9,900	16,050	5,300	3,350	17,050	12,800
4	4,700	3,750	4,450	24,600	27,100	16,100	9,550	13,950	4,550	5,000	19,400	10,700
5	4,700	4,300	5,700	27,050	27,500	18,100	8,100	12,800	4,600	4,350	15,850	11,150
6	7,550	2,950	7,550	37,100	26,350	19,600	7,650	12,750	4,800	3,400	13,200	16,800
7	10,100	2,550	11,750	46,250	23,900	20,350	7,950	10,550	4,650	3,150	10,100	15,600
8	10,350	11,100	12,150	44,900	20,550	19,050	9,950	8,750	4,500	3,250	9,850	18,700
9	8,400	13,600	10,550	42,150	17,050	20,200	13,200	8,950	4,450	2,950	9,150	16,850
10	8,600	14,250	10,250	45,150	16,150	60,600	11,950	8,400	4,450	1,300	14,900	16,500
11	7,500	11,150	12,550	36,250	14,500	75,350	9,350	9,150	3,650	3,550	18,050	15,850
12	6,650	8,400	15,700	31,350	15,400	56,950	8,550	13,650	2,550	3,000	17,850	16,650
13	5,900	6,500	15,300	26,600	17,500	41,300	13,050	12,600	5,050	3,900	16,200	22,950
14	5,100	7,250	13,050	25,550	35,800	35,300	37,000	10,200	3,900	5,100	13,700	23,600
15	4,750	6,150	12,250	28,700	44,050	30,000	57,250	8,150	3,450	5,300	12,900	59,850
16	3,750	5,100	10,300	41,300	36,550	24,500	58,350	9,600	3,450	4,400	11,550	70,650
17	3,450	5,200	9,150	48,550	30,000	21,050	50,200	9,150	4,000	2,050	15,400	63,850
18	5,100	5,250	8,200	50,950	24,900	17,800	39,350	11,050	3,700	4,900	19,300	52,600
19	4,900	4,950	8,100	49,350	19,700	15,250	31,350	12,300	2,250	4,700	17,700	37,050
20	4,900	3,950	15,650	44,500	16,850	12,300	23,250	11,800	3,700	4,350	14,600	25,550
21	4,400	3,600	23,750	39,700	14,600	13,300	18,750	9,750	3,550	3,900	12,700	18,950
22	4,700	4,950	23,750	34,500	13,600	13,800	17,550	9,050	3,550	4,650	12,650	15,750
23	3,350	4,900	25,850	30,250	12,450	12,750	19,350	8,650	3,950	2,900	12,350	14,100
24	3,000	4,800	34,650	27,300	13,400	11,250	21,400	8,750	4,650	3,050	11,150	13,200
25	4,100	4,850	33,350	29,050	14,050	10,000	20,550	9,400	4,450	4,400	8,250	10,350
26	3,500	4,850	25,850	34,650	16,250	8,300	21,100	9,700	4,050	3,750	9,000	8,950
27	3,350	3,700	18,600	37,350	18,950	7,900	27,300	9,500	5,150	3,700	22,050	10,450
28	3,600	2,700	16,750	37,250	20,350	9,950	24,800	7,850	4,950	3,150	29,550	10,450
29	4,200	......	16,350	36,950	23,050	9,700	44,150	7,050	4,900	3,100	28,300	9,550
30	2,300	......	16,250	37,050	24,600	9,900	53,650	7,250	4,850	3,050	25,250	9,050
31	2,400	......	19,350	......	24,350	......	32,900	6,450	......	1,750	......	8,950
Mean	5,011	5,780	14,471	35,478	22,524	22,320	23,458	10,792	4,313	3,668	14,880	21,779

Daily mean discharge in second-feet of Connecticut River at Holyoke, Massachusetts—Continued.

1898.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7,650	7,000	8,100	43,500	23,800	14,300	6,000	4,750	5,000	6,300	16,250	12,050
2	7,500	6,600	8,400	37,300	22,150	12,950	6,050	3,800	4,650	4,650	14,050	12,600
3	7,700	7,050	8,050	29,550	20,450	11,550	5,600	3,450	3,600	5,600	12,700	11,500
4	7,650	7,350	8,050	25,850	20,550	10,250	4,800	3,650	3,550	5,050	11,550	11,100
5	7,750	6,900	7,500	22,450	22,100	8,650	4,550	4,700	4,000	6,600	10,700	14,150
6	7,650	6,350	6,950	20,450	22,650	9,200	4,250	4,350	5,500	23,000	8,950	15,250
7	8,100	7,500	7,800	19,400	20,850	9,000	3,300	4,800	6,850	15,500	10,350	14,800
8	9,050	7,350	8,000	18,400	17,950	8,800	3,450	6,250	6,550	12,550	9,850	13,050
9	8,600	7,350	8,550	16,950	17,300	8,000	3,850	6,150	5,950	12,200	9,700	11,550
10	8,750	7,650	9,650	16,050	15,600	8,050	2,850	5,750	5,050	11,650	10,850	12,250
11	8,450	7,850	11,750	18,650	14,400	7,600	4,400	5,450	3,550	9,550	28,750	9,900
12	8,300	8,100	16,950	20,000	14,400	8,300	4,250	4,800	5,050	8,600	29,150	9,400
13	8,750	9,250	30,700	21,950	18,250	10,500	3,850	4,000	4,850	7,800	21,350	5,800
14	13,150	12,250	66,500	23,950	22,000	15,000	3,450	3,150	3,500	7,200	18,800	5,850
15	12,300	12,450	74,900	26,300	22,450	17,900	3,600	4,750	3,900	7,200	16,600	6,150
16	15,450	11,750	64,700	35,750	23,850	17,000	3,200	3,800	4,700	9,800	14,950	6,400
17	14,700	10,400	53,500	37,000	22,500	15,850	600	3,500	3,550	11,550	13,700	6,050
18	11,850	9,900	50,750	34,200	19,200	13,800	4,050	3,450	650	10,400	13,500	6,600
19	10,000	9,350	55,850	31,500	16,550	12,200	3,350	4,600	4,200	10,150	16,200	7,250
20	9,700	8,750	59,750	28,500	15,150	14,800	3,500	3,950	3,550	11,950	24,550	6,500
21	12,950	9,850	76,150	27,350	14,500	14,350	3,250	4,550	3,400	12,650	26,650	6,500
22	16,050	9,350	68,600	25,400	12,350	13,800	3,200	5,350	3,300	13,250	23,750	7,200
23	14,650	9,250	52,100	23,300	12,450	12,800	3,200	4,850	3,200	16,000	20,700	8,550
24	15,000	9,200	49,050	28,450	13,050	11,750	2,250	4,750	3,000	15,450	18,000	11,550
25	13,100	9,000	44,250	46,850	14,550	10,500	4,100	6,700	6,950	13,450	16,450	12,300
26	11,300	8,800	37,900	50,450	23,300	9,050	4,350	7,550	12,000	12,050	14,200	12,650
27	10,500	7,650	35,450	46,700	23,600	9,750	4,450	5,850	12,550	17,850	12,750	11,000
28	9,700	8,600	38,500	39,200	26,800	9,100	4,600	4,950	12,050	22,400	10,850	9,650
29	8,500	....	41,550	33,500	22,350	8,500	4,500	6,950	10,050	21,000	8,850	8,450
30	8,050	....	43,900	28,450	19,450	7,550	3,400	6,950	8,000	18,700	10,550	7,600
31	7,650	....	46,100	....	16,900	....	1,500	6,150	....	18,300	....	7,700
Mean	10,339	8,673	35,482	29,245	19,079	11,395	3,798	4,958	5,423	12,207	15,840	9,689

The figures for 1899 have not been computed at this time, April, 1900.

CONNECTICUT RIVER AT HARTFORD, CONNECTICUT

Observations of the height of Connecticut River are maintained at a point near Hartford by the Connecticut River Bridge and Highway District, Edwin D. Graves, chief engineer, as noted in the Twentieth Annual Report, Part IV, page 77. Daily readings, beginning February 8, 1896, have been obtained, and are given below. Computations of discharge of the river at this point from 1871 to 1886 have been printed in the Fourteenth Annual Report, Part II, beginning on page 140. The gage now being read was placed at the same elevation as the old gage established by the Engineer Corps, United States Army, about 1872.

Daily noon gage height in feet of Connecticut River at Highway Bridge, Hartford, Connecticut.

1896.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	......	18.0	10.6	7.7	3.5	2.5	1.7	1.5	3.0	3.7	7.0
2	......	......	20.0	11.3	7.6	3.7	2.0	1.5	1.5	2.8	3.6	6.8
3	......	......	26.5	12.0	7.0	3.7	2.1	1.6	1.9	2.7	3.7	6.0
4	......	......	25,6	11.6	6.5	3.5	2.2	2.4	2.4	2.5	4.0	5.5
5	......	......	20.0	10.0	6.4	3.5	2.3	2.0	2.7	2.4	4.8	4.4
6	......	......	16.0	9.5	6.0	3.3	2.3	1.8	3.3	3.0	6.0	3.2
7	......	......	13.0	9.0	5.8	3.0	2.3	2.5	3.6	4.1	10,0	4.0
8	......	12.5	9.0	8.5	5.7	2.6	2.3	1.7	4.4	3.2	10.6	4.0
9	......	12.5	7.8	7.6	5.7	3.0	2.4	2.0	4.0	3.3	10.0	5.0
10	......	11.4	6.3	7.5	5.5	3.0	2.4	2.6	3.6	3.4	7.6	5.0
11	......	10.3	5.3	7.8	5.2	3.5	2.4	2.7	4.3	3.4	7.4	6.5
12	......	9.0	4.8	8.3	5.0	4.0	2.4	2.4	4.0	3.7	6.7	6.4
13	......	7.3	4.4	10.0	4.6	4.4	2.4	2.4	3.6	3.8	6.4	5.3
14	......	6.5	4.5	12.0	4.6	4.5	2.0	1.8	3.4	4.4	6.0	5.0
15	......	6.3	4.5	15.0	4.7	4.4	2.4	1.9	2.8	5.0	5.5	4.8
16	......	6.3	4.5	16.0	4.7	4.3	2.5	2.0	2.3	4.9	5.0	4.7
17	......	6.3	4.6	18.0	4.2	4.0	2.7	1.8	2.4	4.7	4.5	2.5
18	......	6.3	4.8	20.8	3.5	3.7	2.5	1.7	2.0	4.5	4.0	4.0
19	......	6.3	4.9	22.0	3.4	3.7	1.5	1.6	2.3	4.4	4.0	4.5
20	......	6.0	8.0	22.2	3.7	3.2	.6	1.5	2.7	4.0	3.8	4.6
21	......	5.3	10.8	21.0	3.5	3.0	1.3	1.5	3.2	4.0	4.0	4.7
22	......	5.3	11.4	19.8	3.4	2.4	2.0	1.5	3.5	4.0	4.0	4.5
23	......	5.5	10.0	18.4	3.0	2.4	2.2	1.6	3.4	4.8	4.0	4.3
24	......	5.9	9.0	17.0	2.8	2.5	2.0	1.6	3.4	5.2	4.5	4.2
25	......	6.0	8.0	15.5	3.6	2.0	2.6	1.7	3.4	5.7	4.0	3.9
26	......	6.0	7.0	13.5	3.3	2.4	2.7	1.5	3.3	6.0	4.6	3.7
27	......	11.0	6.0	11.0	3.0	2.6	2.7	1.5	3.5	5.5	5.0	3.5
28	......	14.0	6.9	11.0	3.4	2.8	2.8	1.5	3.6	5.0	5.5	4.0
29	......	16.5	8.9	9.0	3.4	3.0	2.7	1.5	3.7	5.0	5.9	3.5
30	......	......	9.5	8.0	3.5	2.0	2.6	1.6	4.0	5.0	6.5	4.0
31	......	......	9.8	......	3.5	......	2.5	1.6	......	4.0	......	3.5

1897.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.4	3.7	3.8	8.8	13.5	10.0	5.0	17.0	4.3	2.5	3.0	9.5
2	3.4	3.8	4.0	9.6	12.4	9.0	5.1	13.0	3.8	3.3	3.9	8.0
3	3.4	3.9	3.8	9.8	11.7	8.0	5.0	10.5	4.6	3.5	5.0	6.8
4	3.4	4.5	4.8	10.2	11.0	8.0	4.8	8.6	3.9	3.0	8.0	6.0
5	4.8	4.0	5.0	10.5	11.4	7.0	4.8	8.5	3.5	2.7	7.3	6.0
6	5.9	3.8	6.5	12.2	11.0	8.0	4.5	8.2	3.3	2.6	6.8	7.4
7	5.7	4.1	7.0	13.5	10.3	6.7	4.2	7.7	3.3	2.7	5.6	10.0
8	5.6	6.8	8.2	15.5	9.3	8.6	4.0	6.7	3.3	2.8	4.7	9.7
9	5.5	9.4	7.5	15.3	7.6	7.1	5.0	5.5	2.8	2.8	4.6	8.8
10	5.5	9.5	6.8	17.4	7.4	12.0	5.8	5.5	2.8	2.0	4.7	8.0
11	4.5	9.0	7.1	17.0	7.0	18.0	5.0	5.0	3.3	1.6	5.5	8.0
12	5.0	8.1	8.0	15.2	6.5	20.6	4.6	7.2	3.0	3.0	8.0	8.0
13	4 5	7.0	9.0	13.7	7.0	18.3	5.0	8.2	3.0	2.5	8.5	9.1
14	3.9	6.4	8.9	11.4	9.6	16.3	11.5	7.0	3.2	2.8	7.8	11.5
15	3.5	.5.7	8.8	10.8	15.0	13.8	18.6	6.2	2.8	3.0	6.8	14.0
16	4.0	5.8	7.8	11.0	14.7	12.0	20.8	5.0	3.0	3.0	6.0	19.6
17	3.0	5.4	6.7	15.0	14.0	10.1	20.0	6.8	3.0	2.6	5.8	20.4
18	3.4	5.2	5.6	16.5	12.1	9.0	18.3	6.9	3.0	2.4	6.5	19.0
19	3.5	5.5	5.6	17.3	10.5	8.0	16.8	6.0	2.9	2.8	7.5	16.0
20	3.8	5.4	7.8	16.7	9.4	7.2	14.0	6.0	2.8	3.0	7.6	13.0
21	4.3	5.3	10.0	15.6	8.0	6.0	10.0	6.5	2.8	3.7	7.1	9.4
22	4.5	5.2	11.0	14.5	7.9	6.0	9.0	5.0	2.6	4.0	6.5	8.0
23	3.9	5.9	11.0	13.0	6.8	6.0	12.2	5.3	2.7	3.7	6.0	6.5
24	3.5	6.2	12.2	11.8	6.4	5.8	12.7	5.2	3.0	3.6	5.5	5.5
25	3.2	5.6	13.8	11.8	6.3	5.3	12.7	4.9	3.0	3.2	5.0	6.2
26	2.7	5.0	12.8	12.0	6.7	4.6	11.5	5.2	3.0	2.7	5.3	7.5
27	2.6	5.0	11.4	13.3	7.0	4.4	10.2	6.0	3.0	4.0	6.0	8.5
28	2.8	4.0	9.8	13.5	8.0	3.8	12.0	5.2	3.0	3.0	9.0	8.6
29	3.0	......	8.5	13.4	8.6	4.4	12.4	5.6	2.9	3.0	11.0	8.6
30	3.6	......	7.8	13.5	9.2	4.7	19.3	4.2	3.4	3.0	10.4	8.6
31	3.7	......	8.0	......	10.0	......	20.6	4.5	......	3.0	......	8.4

Daily noon gage height in feet of Connecticut River at Highway Bridge, Hartford, Connecticut—Continued.

1898.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	8.0	7.8	6.0	15.4	13.2	8.0	4.5	4.0	3.7	5.0	8.1	....
2	7.7	7.8	5.8	15.5	12.5	7.0	4.2	4.0	3.2	4.0	7.4	6.5
3	7.5	7.8	5.6	13.8	11.6	6.7	4.0	4.3	3.0	4.5	6.6	6.6
4	7.4	7.7	5.4	12.4	10.9	6.4	4.0	4.6	3.0	3.2	6.3	7.5
5	7.2	7.6	5.0	10.5	10.0	6.2	4.0	4.5	3.0	4.0	5.8	8.5
6	6.9	7.5	4.6	9.9	10.4	6.0	3.8	4.4	3.2	6.1	5.6	9.5
7	6.8	7.4	4.9	9.4	10.5	5.8	3.4	4.2	3.4	9.0	5.4	8.8
8	7.5	7.3	5.4	9.0	9.8	5.6	3.0	4.0	3.7	6.0	5.1	8.5
9	7.4	7.3	5.8	8.6	9.0	4.8	3.0	3.9	3.6	5.8	5.3	7.3
10	7.3	7.5	6.4	8.5	8.4	4.7	2.8	4.0	3.7	5.6	5.0	6.2
11	7.2	7.5	6.8	8.4	7.9	4.5	2.7	3.8	3.4	5.1	8.6	6.3
12	7.0	7.4	8.0	8.7	7.6	4.7	2.6	3.2	3.0	5.0	13.0	6.3
13	6.8	8.5	10.8	9.0	8.0	5.0	2.4	3.5	3.0	4.5	12.0	5.8
14	8.1	9.7	17.4	9.5	9.6	6.5	2.2	3.4	3.2	5.0	10.0	5.7
15	9.5	9.8	20.0	9.7	9.8	8.0	2.0	3.2	3.2	5.5	9.0	5.9
16	9.8	9.0	21.0	10.0	10.2	7.7	1.9	3.0	3.4	5.8	7.9	6.0
17	9.8	8.4	20.0	12.0	10.4	7.4	1.8	2.7	3.0	6.0	7.6	6.0
18	8.8	7.6	19.0	14.5	10.2	7.0	1.6	2.6	2.5	5.8	7.2	5.9
19	7.5	7.8	18.0	13.0	9.0	7.2	3.0	2.6	2.0	5.5	10.0	6.0
20	6.0	8.2	18.8	12.2	8.2	7.4	3.1	4.0	2.2	5.7	11.3	6.0
21	8.2	12.0	19.1	11.6	7.8	7.5	3.1	4.6	3.2	6.3	12.4	6.0
22	10.0	12.0	21.2	12.5	7.3	7.0	3.3	3.9	2.4	7.2	11.7	5.9
23	10.6	10.3	20.5	13.5	6.8	6.5	3.3	3.7	3.2	7.1	10.7	6.0
24	11.4	9.0	18.2	14.5	7.4	6.0	3.4	3.4	3.0	7.0	9.6	8.0
25	10.4	7.8	17.3	15.5	8.0	5.8	3.5	4.4	4.5	7.2	9.0	7.7
26	9.0	6.8	16.5	16.5	10.0	5.5	3.5	5.2	5.5	6.6	8.2	7.5
27	9.0	6.5	15.5	17.0	11.2	5.4	3.6	4.9	6.3	7.1	7.5	7.0
28	8.5	6.0	14.5	16.5	13.6	5.1	3.7	4.0	6.6	9.7	6.4	6.5
29	7.8	....	14.8	14.9	12.7	4.8	3.8	4.0	6.3	9.7	6.1	6.5
30	7.5	....	15.3	14.0	11.8	4.5	3.8	4.3	5.0	9.2	6.0	6.4
31	7.0	....	15.4	....	10.3	....	3.9	4.5	....	8.7	....	6.7

1899.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.5	6.0	8.7	9.2	19.3	4.0	2.7	3.1	2.2	1.5	4.5	3.5
2	7.6	5.7	8.7	9.3	18.4	4.0	2.7	2.5	3.0	.6	4.7	3.6
3	7.7	5.6	8.5	9.5	18.1	4.0	2.8	3.0	2.7	.8	4.8	3.7
4	7.7	5.4	7.5	9.2	18.0	3.7	2.9	2.9	2.9	1.9	4.9	3.8
5	7.8	5.5	7.2	8.5	17.0	3.4	2.9	3.4	3.0	2.2	5.0	3.9
6	10.2	5.7	8.7	8.6	15.8	3.3	3.0	3.6	2.8	2.1	5.0	4.0
7	11.5	5.6	9.8	9.0	14.0	3.2	3.0	2.5	2.7	2.1	5.0	4.2
8	11.0	6.2	9.0	11.0	12.5	3.7	3.0	2.5	2.7	2.0	4.5	4.3
9	10.5	5.6	8.6	13.1	10.9	3.0	3.1	2.6	2.8	2.0	4.4	4.4
10	8.0	5.0	8.0	15.4	9.4	3.0	3.1	2.2	2.5	2.5	4.3	4.5
11	8.5	4.5	7.5	15.1	8.5	3.0	3.2	3.2	2.2	2.5	4.2	4.6
12	8.6	4.5	8.5	14.5	8.0	3.0	3.2	3.2	2.3	2.5	4.1	4.7
13	8.2	4.5	9.7	15.1	7.5	2.7	2.5	3.2	2.3	2.4	4.0	4.8
14	8.0	4.7	11.0	15.5	7.0	2.6	2.6	2.8	2.8	2.5	4.5	4.8
15	8.1	5.0	11.0	18.5	6.5	2.6	2.6	2.2	2.4	2.7	4.0	4.8
16	8.2	5.2	11.2	20.0	6.5	2.6	2.7	2.6	3.2	2.8	3.5	4.8
17	8.5	5.5	10.5	21.5	6.2	3.0	2.7	3.4	2.8	2.9	3.5	4.8
18	10.0	5.5	9.5	20.6	6.0	3.0	2.7	3.5	2.8	3.0	3.5	4.8
19	9.5	5.5	9.7	20.2	5.7	3.0	2.8	3.2	2.4	2.5	3.4	4.7
20	8.5	6.0	10.1	20.5	5.5	3.0	2.9	3.4	2.7	2.0	3.4	4.6
21	7.9	6.5	9.2	21.5	5.5	3.0	2.9	3.2	2.6	2.2	3.4	5.0
22	7.3	6.6	8.4	21.2	5.5	3.0	3.0	3.0	3.2	2.4	3.6	4.9
23	6.8	6.8	7.8	20.9	5.5	3.4	3.0	2.6	3.5	2.6	3.7	4.8
24	7.0	7.2	7.7	20.8	5.2	3.3	3.1	2.2	3.1	2.8	3.9	4.7
25	8.0	7.1	7.4	21.3	5.2	3.2	3.0	3.0	2.7	3.0	4.0	4.6
26	8.0	7.7	7.0	21.6	4.6	3.1	4.2	2.7	3.0	3.0	4.5	4.6
27	8.0	7.7	6.5	22.0	4.5	3.0	3.7	2.6	3.0	3.0	5.0	4.5
28	7.5	8.5	6.5	21.9	4.3	2.9	4.4	2.5	2.8	4.0	5.0	4.4
29	7.0	....	7.5	21.0	4.2	3.2	4.2	3.2	3.1	4.1	5.0	4.3
30	6.5	....	8.8	20.0	4.5	2.7	3.0	3.2	3.0	4.2	3.4	4.2
31	6.2	....	9.0	....	4.3	....	2.5	2.8	....	4.3	....	4.1

MOHAWK RIVER AT RIDGE MILLS, NEW YORK.

Mohawk River rises in Lewis County, New York, and flows southerly through Oneida County, and turning to the east finally empties into Hudson River. It is shown through the greater portion of its length on the Oneida, Oriskany, Utica, Fonda, Amsterdam, Schenectady, and Cohoes topographic sheets of the United States Geological Survey. The measurements on this stream and its tributaries were instituted as previously described on page 20 by Mr. George W. Rafter for the United States Board of Engineers on Deep Waterways. The station at Ridge Mills is located at the dam of the Rome waterworks, 3 miles above Rome. The drainage area of the Mohawk River at this point is 153 square miles. Two gages are read twice a day by Daniel Brown, engineer at pumping station—one above the dam showing the height on the crest and one in the tailrace in order to determine the head on the wheels. The crest of the dam has an irregular profile, and in order to facilitate computation is divided into three parts. The flow over section *A* was computed from Bazin's experiments of November and December, 1895, series No. 162, with $q=8.025\ mLH^{3/2}$. The flow over sections *B* and *C*, which is over flashboards, is computed from Francis's formula for sharp-crested weirs. Experiments were conducted at Cornell University on an experimental weir corresponding to Bazin's series No. 162, and from the coefficients obtained a discharge curve plotted to correspond with the discharge curve of Bazin's. All computations of flow at this point made before June 1, 1899, were made by using Bazin's coefficients, but in subsequent computations the Cornell coefficients were used. The dam is of timber, backed with stone, and has very little leakage.[1]

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[1] On flow of water over dams, by George W. Rafter: Proc. Am. Soc. Civ. Eng., March, 1900, Vol. XXVI, No. 3, p. 311.

Estimated daily discharge in second-feet of Mohawk River at Ridge Mills, New York, for 1899.

[Drainage area 153 square miles.]

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	339	262	218	....	93	75	339
2	319	252	233	....	203	75	75
3	279	232	248	....	233	105	75
4	259	249	131	....	253	135	129
5	214	202	146	....	200	95	158
6	232	127	131	....	310	135	158
7	232	262	126	....	290	145	172
8	262	322	121	....	260	135	190
9	259	669	125	85	290	135	575
10	279	499	129	85	310	165	575
11	249	379	139	85	340	125	147
12	282	359	169	95	260	135	....
13	282	339	265	89	310	145	....
14	302	339	245	85	260	145	....
15	402	319	275	99	310	145	....
16	399	399	295	115	240	145	115
17	359	519	230	135	220	135	158
18	339	399	230	112	290	135	158
19	282	382	245	85	290	145	....
20	279	339	245	79	290	165	....
21	262	302	265	79	240	165	....
22	259	382	295	56	260	145	151
23	299	299	272	56	260	145	151
24	259	282	289	56	310	145	129
25	259	275	262	60	540	135	151
26	259	262	269	69	220	145	172
27	249	289	309	69	310	135	172
28	249	165	309	53	340	165	172
29	249	133	278	53	360	....	172
30	229	178	315	79	260	....	339
31	....	178	200	....	260	....	339
Mean	281	310	226	81	278	136	207

NINEMILE CREEK AT STITTVILLE, NEW YORK.

This stream rises in the northern part of Oneida County, New York, and flows south into Mohawk River. A portion of its course is shown on the Oneida topographic sheet of the Geological Survey. Observations were made on this creek at Stittville, which is reached by the Rome, Watertown and Ogdensburg Railroad. The drainage area of Ninemile Creek at Stittville is 63 square miles. The station was located at an old timber dam built to furnish power to a gristmill and sawmill. One gage was read at the bridge above the dam, giving the height on crest, and one at tailrace below the dam, which, with the upper gage, gave the head on wheels. The dam had a somewhat irregular crest, but was repaired by the Board on Deep Waterways. The flow over section *A*, which is the bulkhead, is computed from Bazin's experiments in October, 1887, series No. 115, with $q=8.025mLH^{\frac{3}{2}}$. The flow over section *B*, which is a spillway, is computed from Bazin's experiments of July, 1894, series 130, with $q=8.025mLH^{\frac{3}{2}}$. A new curve was later drawn, based upon experiments carried on at Cornell University, corresponding to Bazin's series, Nos. 115 and 120. This dam leaks badly, so that low-water flows are of questionable accuracy. There are in the mill two standard Leffel wheels, one a 23-inch wheel and the other a 40-inch wheel, and a record was kept of the head on the wheels and the amount of openings, so that the quantity of water passing through the wheels can be computed. The results obtained from this station were of such questionable accuracy that the station was abandoned on June 30, 1899.

ORISKANY CREEK AT COLEMAN, NEW YORK.

This stream rises in Oneida County, New York, and flows in a northerly direction, emptying into Mohawk River. It is shown through a part of its course on the Oriskany topographic sheet of the United States Geological Survey. Observations for the computation of flow of Oriskany Creek have been made at Coleman, 5 miles above the junction of the creek with Mohawk River, and at Oriskany, 2 miles farther down. The station at Coleman was located at Reeders Mills. The dam located here impounds water to furnish power for the picking mill and cotton mill on the west bank and for the gristmill and sawmill on the east bank. The gages were read above the dam, giving the height on crest, and in the headraces and tailraces of each of the mills, giving the heads on wheels. The dam is of earth, with a timber crest, irregular in profile. For convenience in computation the crest has been divided into nine parts. The flow over this dam was computed from Bazin's experiments of November, 1895, series No. 170. The station was established September 20, 1898, and continued until February 28, 1899, when it was abandoned.

ORISKANY CREEK AT ORISKANY, NEW YORK.

The drainage area of Oriskany Creek at this station is 144 square miles. The flow is measured over the State dam, the gage showing the height on crest being located on the left bank just above the dam. The crest is of irregular profile, and in order to facilitate computation is divided into three parts. No experiments have been made to determine coefficients for a dam of this section, so it was considered by Mr. George W. Rafter that the mean between the coefficients obtained by Bazin in his experiments, series Nos. 141 and 117, would best fit the conditions at this dam. Experiments were afterwards conducted at Cornell University on a similar section. For a cross section of this dam reference should be made to the paper on "Flow of water over dams," by George W. Rafter: Proc. Am. Soc. Civ. Eng., March, 1900, p. 312. All computations of discharge up to June 1 were made from coefficients as determined by Bazin; all subsequent observations have been computed by using the Cornell coefficients. Water passing through the Erie Canal feeder is determined by knowing the relative heights of the gage above the dam and of the one below the gates in the feeder. The difference between these two readings gives the head on the gate. The stem of the gates is marked so that the amount of openings at any time can be determined. Readings of the two gages and the two gate stems are made twice a day by Frank Baker.

Estimated daily discharge in second-feet of Oriskany Creek at Oriskany, New York, for 1899.

[Drainage area, 144 square miles.]

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	90	(a)	206	83	180	320	90
2	80	(a)	206	87	138	175	103
3	80	(a)	167	73	108	115	73
4	80	(a)	126	10	99	138	108
5	80	(a)	126	75	119	144	80
6	80	138	177	108	132	346	107
7	80	184	177	101	122	374	99
8	80	170	195	133	138	429	40
9	80	104	195	176	95	364	30
10	80	100	195	180	58	394	10
11	89	117	195	159	106	634	45
12	94	124	195	95	97	534	340
13	89	124	195	73	92	564	330
14	94	124	195	87	26	584	80
15	104	124	206	85	72	564	65
16	101	208	206	89	45	484	80
17	94	208	206	115	106	524	40
18	113	197	206	123	58	584	65
19	113	183	206	119	71	202	250
20	113	183	206	138	48	53	130
21	113	270	206	161	82	124	110
22	113	270	206	129	73	154	50
23	118	270	206	162	85	174	50
24	118	196	206	102	88	214	70
25	118	196	206	112	70	174	50
26	118	196	194	181	70	438	40
27	118	196	184	222	54	318	30
28	113	196	184	216	158	318	35
29	113	196	184	185	72	582	30
30	113	196	98	206	55	789	65
31	....	196	98	....	115	....	70
Mean	99	180	186	126	91	360	89

a No record July 1 to 5.

SAUQUOIT CREEK AT NEW YORK MILLS, NEW YORK.

This creek rises in Oneida County, New York, and flows in a northerly direction, emptying into Mohawk River. It is shown in a part of its course on the Oriskany topographic sheet of the United States Geological Survey. Observations of flow are made on this creek at New York Mills, at which point the creek has a drainage area of 52 square miles. One gage is located at the dam, which furnishes power for mill No. 3, and is read by E. D. Cronk. A gage in the headrace near the mill wheels and one in the tailrace, are read by Robert Hughes. The first gage gives the head on crest of weir, and the two located at the mill give the head on wheels. The quantity flowing through the wheels is added to the flow over the dam to give the total flow of the creek. The dam is of earth, with plank facing, and there is little leakage. For a cross section of this dam see Mr. Rafter's paper on "Flow of water over dams." The profile of the crest of the dam is somewhat irregular, and in order to facilitate computation has been divided into nine parts. Each part is assumed to have a horizontal crest line.

The flow over each part has been computed separately for various heads and a curve drawn showing the relation of the total quantity flowing over the dam to various gage heights. From this curve the total quantity for each head can be read off at once without making a separate computation for each part of the dam. The flow over sections *A* to *E*, inclusive, in this dam was computed by using the coefficients determined by Bazin's experiments of 1895, series No. 175, with $q=8.025mLH^{\frac{3}{2}}$. The flow over sections *F* and *G*, which is over flashboards, was computed from Francis's formula for sharp-crested weirs, with $q=3.33LH^{\frac{3}{2}}$. In the mill there are two 27-inch Hercules turbines, and records are made of the head on wheels and the opening of the gates twice each day. These turbines were rated by the Holyoke Power Company, so that by noting the head and the gate openings the quantity of water passing through the wheels can be computed.

Estimated daily discharge, in second-feet, of Sauquoit Creek at New York Mills, New York, for 1899.

[Drainage area, 52 square miles.]

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	42	12	17	18	0	53	19
2	34	....	11	5	29	42	13
3	18	27	43	0	24	21	23
4	30	10	30	0	21	26	32
5	42	30	12	33	15	29	22
6	56	27	0	32	16	32	26
7	48	18	26	6	8	32	26
8	39	16	25	21	13	24	19
9	23	25	22	12	18	24	12
10	34	31	0	0	18	19	14
11	31	30	25	22	18	29	16
12	28	27	14	19	18	29	72
13	20	19	0	19	16	29	64
14	19	22	25	8	7	24	38
15	30	13	22	5	13	24	32
16	34	30	18	15	18	21	35
17	38	23	5	0	15	24	35
18	34	27	18	19	16	21	38
19	30	27	5	19	18	24	32
20	30	19	0	13	14	26	42
21	23	11	22	14	12	26	54
22	21	3	19	21	18	26	35
23	25	0	16	10	24	25	32
24	23	27	5	0	18	21	30
25	24	30	15	22	22	18	25
26	26	22	10	15	19	22	32
27	20	27	0	22	15	24	28
28	19	11	22	13	7	24	16
29	20	14	30	18	19	21	19
30	21	0	18	10	32	21	13
31	....	27	5	....	26	....	14
Mean	29	20	15	14	17	26	29

WEST CANADA CREEK AT MIDDLEVILLE, NEW YORK.

This creek rises in the southwestern part of Hamilton County, New York, and flows in a southwesterly direction through Herkimer County, emptying into Mohawk River. It has considerable fall throughout its length, with chances of water-power development. Measurements of flow have been made at Middleville, at the dam of the Nelson Knitting Company. The drainage area of West Canada

Creek at this point is 519 square miles. There is a gage located just above the dam which gives the depth of water on crest; also a gage in the headrace and one in the tailrace of the Nelson Knitting Mill. There are also gages in the tailraces of the gristmill and planing mill located below on the same headrace. By these gages the flow is determined over the dam, through the wheels of the Nelson Knitting Company's mill, and at the gristmill and planing mill. The dam is of timber, with very little leakage. In the Nelson Knitting Mill is one 66-inch standard Leffel turbine, in the planing mill one 24-inch Rochester turbine, in the sawmill one 28-inch Chase turbine, and in the gristmill one 36-inch Camden turbine. Observations of the height and amount of gate opening of these wheels are made twice a day by E. J. Nelson. Near the center of the dam there is an ice slide 56 feet in length. The profile of the crest is nearly horizontal except at the ice slide. The flow over this dam is computed from Bazin's experiments of December, 1895, series No. 170. The experimental section of weir corresponding to the Rexford Flats dam agrees more closely to the form of the Middleville dam than the experimental weir used by Bazin. A revised discharge curve has been drawn, using the coefficients as found in the Cornell University experiment No. 15, corresponding to the Rexford Flats dam. For a cross section of this dam see Mr. Rafter's paper "On flow of water over dams."[1]

Estimated daily discharge in second-feet of West Canada Creek at Middleville, New York, for 1899.

[Drainage area 519 square miles.]

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1,114	198	273	257	480	1,281	330
2	763	140	292	191	510	2,867	580
3	593	200	345	145	470	1,744	710
4	550	116	316	145	436	1,199	710
5	531	240	237	210	337	1,040	518
6	480	240	155	205	253	831	540
7	294	256	286	195	288	469	1,750
8	314	204	262	219	190	542	1,670
9	258	675	256	169	232	482	840
10	182	293	242	145	220	390	700
11	130	807	246	188	234	420	640
12	283	443	214	201	210	410	3,150
13	297	445	125	221	239	342	4,710
14	248	343	254	205	219	313	2,530
15	753	236	246	204	140	372	740
16	839	430	253	189	241	343	840
17	499	600	239	145	238	363	640
18	320	560	235	197	235	372	1,060
19	339	479	174	208	217	220	1,880
20	331	345	110	213	152	337	3,520
21	373	327	226	239	261	310	2,530
22	346	225	245	238	190	363	1,400
23	263	140	257	204	245	293	990
24	203	241	229	145	225	273	1,150
25	155	241	254	209	238	273	900
26	283	241	183	476	231	249	840
27	273	244	110	433	267	312	580
28	280	239	255	248	224	292	540
29	308	171	247	213	965	310	640
30	275	115	262	386	1,040	310	540
31		234	269		629		860
Mean	397	324	235	221	324	577	1,259

[1] Proc. Am. Soc. Civ. Eng., March, 1900, Vol. XXVI, No. 3, p. 315.

MOHAWK RIVER AT LITTLE FALLS, NEW YORK.

The second point of measurement of Mohawk River was at Little Falls, where the drainage area of the Mohawk River is 1,306 square miles. There is at this point a stone dam which furnishes power for the Astronga Knitting Mill and the Little Falls Paper Company's mill. The gage in the headrace of the Astronga Knitting Mill gives the height on the crest of the dam and with the gage in the tailrace gives the head on the wheels. These two gages are read by J. J. Gilbert. There is a gage in the headrace and one in the tailrace of the Little Falls Paper Company's mill, giving the head on the wheels. Record of these gages is kept by William Hoffman. The dam varies somewhat in section from one side of the river to the other. The crest of the dam is horizontal and is divided into two parts to facilitate computation, on account of the variation in sections. The flow over section *A* was computed from Bazin's experiments of July, 1887, No. 117; and that over section *B*, from Bazin's experiments of June, 1894, series No. 135. A revised discharge curve was later used, based upon Cornell experiments Nos. 16 and 17. In the Astronga Knitting Mill there is installed one 43-inch and one 54-inch T. H. Risdon & Co.'s turbine; and in the Little Falls Paper Company's mill one 60-inch Camden, one 36-inch Camden, and one 42-inch Camden, also one 60-inch wheel built by M. Reddy. Records are kept of the flow through all of these wheels whenever running.

Estimated daily discharge, in second-feet, of Mohawk River at Little Falls, New York, for 1899.

[Drainage area, 1,306 square miles.]

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1,957	569	506	278	704	2,829	1,425
2	1,610	493	506	271	651	6,600	1,130
3	1,321	359	135	30	651	4,738	1,950
4	1,075	424	136	396	491	3,081	1,475
5	1,466	490	166	545	534	3,262	1,425
6	1,216	663	0	382	399	2,847	1,000
7	1,016	627	133	272	240	1,908	800
8	1,062	651	131	275	160	1,718	920
9	962	1,660	131	211	357	1,628	1,050
10	764	2,593	130	7	297	1,451	7,000
11	1,176	1,800	316	273	274	717	2,075
12	660	1,320	383	270	305	1,112	5,950
13	660	1,222	0	270	274	1,526	10,300
14	685	941	329	211	258	1,448	7,750
15	960	884	352	230	196	1,150	6,650
16	1,860	643	351	184	354	1,069	2,875
17	1,800	1,315	244	55	339	1,120	1,280
18	965	1,211	251	278	344	1,037	1,000
19	568	1,086	216	267	339	984	4,130
20	1,010	1,008	65	281	355	1,070	7,850
21	1,105	767	158	220	331	1,120	6,500
22	985	95	223	249	142	1,145	5,120
23	866	363	235	129	350	1,066	4,450
24	745	496	203	55	401	987	1,575
25	851	496	203	238	392	900	1,525
26	759	516	246	225	369	829	1,175
27	634	496	136	556	387	822	875
28	585	510	348	920	314	969	950
29	560	460	188	642	1,398	969	700
30	535	50	219	723	2,293	886	450
31	....	697	277	....	1,882	....	380
Mean	1,014	803	223	298	509	1,700	2,959

EAST CANADA CREEK AT DOLGEVILLE, NEW YORK.

This creek rises in Hamilton County, New York, and flows in a southerly direction between Fulton and Herkimer counties into Mohawk River. Observations are taken on this creek at Dolgeville, about 7 miles from its junction with the Mohawk, reached from Little Falls by a branch of the New York Central Railroad. The station is located at the stone dam, which furnishes power for the Dolgeville Electric Light Company. The dam is about 19 feet high, of solid stone masonry, and the water impounded is conducted from the dam to the power house, a distance of about 500 feet, through a wrought-iron flume 10 feet in diameter. A gage located on the abutment of the dam and one in the tailrace of the power house are read twice each day by Henry Meyer, who is employed in the power house. The crest of the dam is horizontal, and flow over it is computed from Bazin's experiments of July, 1887, series No. 117. Experiments known as No. 13 were carried on at Cornell University to determine coefficients of flow over a weir of similar form. In the power house there are installed three Smith-Vaile Victor wheels; two of them 36 inch and one 15 inch. Records are kept of the daily head on these wheels and the amount of gate openings.

Estimated daily discharge in second-feet of East Canada Creek at Dolgeville, New York, for 1899.

[Drainage area 256 square miles.]

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	390	145	165	108	70	1,000	175
2	320	100	225	178	165	1,560	310
3	240	148	240	178	150	840	330
4		94	180	99	150	710	400
5		150	135	128	145	480	310
6		150	99	118	140	520	260
7	220	170	165	113	140	410	190
8	260	230	160	108	130	380	190
9	220	309	160	75	120	360	190
10	220	383	160	108	140	340	200
11	238	283	170	108	130	310	230
12	220	213	180	120	125	110	1,850
13	220	213	50	108	120	260	2,820
14	230	213	40	108	120	260	1,420
15	280	195	20	108	150	260	1,040
16	270	294	125	108	120	310	880
17	192	380	30	108	125	230	710
18	154	280	125	108	160	260	1,240
19	180	210	40	108	150	150	1,590
20	200	170	40	125	155	260	610
21	300	165	120	125	150	240	1,330
22	230	135	120	120	115	220	840
23	210	99	120	120	125	220	740
24	162	145	130	120	150	220	490
25	134	165	140	120	145	190	390
26	190	175	120	225	145	180	240
27	190	160	40	225	140	180	360
28	180	175	120	180	140	180	310
29	160	165	120	170	300	180	310
30	160		120	190	380	180	280
31		155	120		262		160
Mean	221	196	122	127	153	367	658

GAROGA CREEK AT FORT PLAIN, NEW YORK.

This stream rises in Fulton County, New York, and flows in a southwesterly direction into Mohawk River. Observations for the computation of flow have been taken at Levi Yoran's mill, at Fort Plain. The dam here located is of wood and fairly tight. Gages were read above the dam, giving the height on crest, and in the tailrace of the mill. The water is conducted from the creek above the dam through the mill by a 4-foot circular flume laid underground. The flow over this dam is computed from Bazin's experiments of July, 1894, series No. 130, with $q=8.025mLH^{\frac{3}{2}}$. Experiments were afterwards conducted at Cornell University, from which new coefficients were determined and a revised discharge curve plotted. In the mill there is installed one 28-inch and one 11-inch Lesner turbine, made at Fultonville, New York. These wheels were seldom used, but when they were run careful records were kept of the head and gate openings, so that the quantity passing through the wheels added to the flow over the dam would give the total flow of the creek. On May 30, 1899, observations at this station were discontinued.

CAYADUTTA CREEK AT JOHNSTOWN, NEW YORK.

This creek rises in Fulton County, New York, and flows in a southerly direction into Mohawk River near Fonda. Observations are made at the dam of the Johnstown Electric Light and Power Company, 1 mile below Johnstown, the record being kept by E. Shook, superintendent. The dam is 33 feet high, is built of timber, and has very little leakage. The impounded water is carried from above the dam to the wheelhouse through a 5-foot circular wooden flume. Gages are read above the dam, giving the height on crest, and in the tailrace, which show the head on wheels. The profile of the crest is somewhat irregular, and to facilitate computation has been divided into four parts, the crest lines of each part being assumed horizontal. The flow over section *C*, which is the regular spillway, is computed from Bazin's experiments of July, 1894, series No. 130, with $q=8.025mLH^{\frac{3}{2}}$. The flow over sections *A*, *B*, and *D*, which are the bulkheads, is computed from Bazin's experiments of July, 1887, series No. 115. Experiments upon sections which are considered to correspond more closely with the conditions at Johnstown were carried on at Cornell University, and a revised discharge curve derived, using the coefficients determined by the Cornell experiments. In the computation for the revised discharge curve the coefficients derived from experiment No. 12, corresponding to Bazin's experiment No. 115, were used for sections *A*, *B*, and *D*; and those determined by experiment No. 2, corresponding to Bazin's series No. 135, were used for section *C*.

For a cross section of this dam see Mr. Rafter's paper "On flow of water over dams."[1]

Estimated daily discharge in second-feet of Cayadutta Creek at Johnstown, New York, for 1899.

[Drainage area, 40 square miles.]

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	30	21	20	16	12	33	19
2	28	15	22	20	24	31	-------
3	29	24	32	12	24	28	14
4	17	17	22	19	25	48	37
5	29	20	21	28	17	34	27
6	28	20	11	16	15	26	23
7	18	19	19	23	19	28	23
8	30	34	20	22	9	26	23
9	21	16	20	17	18	22	23
10	19	27	20	7	20	27	13
11	18	25	17	16	24	26	27
12	30	18	23	19	23	20	238
13	25	18	8	20	13	28	207
14	24	16	20	17	20	28	145
15	25	18	20	19	17	30	55
16	25	13	20	20	24	20	40
17	25	23	20	11	26	21	44
18	17	25	20	19	33	20	36
19	25	26	19	20	21	6	51
20	37	20	9	21	(a)	27	85
21	32	19	15	20	(a)	27	62
22	33	23	16	17	(a)	26	42
23	32	8	14	19	(a)	25	26
24	32	18	16	14	21	24	19
25	18	22	16	20	18	26	56
26	29	19	14	32	18	14	60
27	26	16	11	36	19	30	25
28	30	17	15	26	16	28	24
29	30	17	16	27	30	28	20
30	22	14	16	26	30	15	19
31	-------	25	16	-------	-------	-------	11
Mean	26	20	18	20	21	26	49

a Repairing dam; water drawn off October 20 to 23.

SCHOHARIE CREEK AT FORT HUNTER, NEW YORK.

Schoharie Creek rises in Green County, New York, and flows in a northerly direction through Schoharie and Montgomery counties, and empties into Mohawk River near Tribes Hill Station. Observations for the computation of flow are made on this creek at the State dam, which impounds water for the feeder of the Erie Canal at Fort Hunter. The dam is of timber and practically free from leakage. The profile of the crest of the dam is somewhat irregular, and to facilitate computation is divided into six parts, each part being assumed horizontal. The value of the coefficients of flow over this dam has been obtained by taking the mean of the coefficients for series Nos. 117 and 141 of Bazin's experiments. Cornell experiments No. 114, performed upon the section corresponding to the Rexford Flats dam, was considered to conform more closely to the conditions at Fort Hunter than the sections used by Bazin, and a revised discharge curve was drawn,

[1] Proc. Am. Soc. Civ. Eng., March, 1900, Vol. XXVI, No. 3, p. 316.

using the Cornell coefficients.[1] A measurement of Schoharie Creek was made near the village of Schoharie, New York, by students of the Summer School of Surveying of the Massachusetts Institute of Technology in June, 1889, under the direction of Prof. George F. Swain. Measurement was made by means of a Fteley meter. The results showed a discharge of 972 second-feet.

Estimated daily discharge in second-feet of Schoharie Creek at Fort Hunter, New York, for 1899.

[Drainage area 947 square miles.]

Day.	June.	July. *a*	Aug. *a*	Sept. *a*	Oct.	Nov.	Dec.
1	495				4,147	1,215	661
2	495				2,247	1,895	661
3	595				2,047	1,795	711
4	595				2,527	1,215	761
5	495				2,747	1,215	841
6	495				2,247	1,045	841
7	495				2,047	1,215	786
8	425				1,827	1,215	786
9	405				2,047	1,065	841
10	395				1,247	1,045	786
11	395				1,247	1,215	841
12	395				1,827	1,895	786
13	395				1,827	2,115	881
14	395				2,247	1,795	961
15	395				1,827	1,795	1,111
16	395				2,527	1,215	1,181
17	395				1,247	1,215	1,051
18	395				1,077	1,045	1,111
19	395				867	1,045	1,261
20	395				1,247	1,045	1,111
21	395				1,077	915	1,261
22	395				867	915	1,261
23	395				1,247	735	1,261
24	395				1,077	735	1,111
25	395				2,247	795	1,051
26	395				2,047	735	1,051
27	395				2,427	705	961
28	395				1,827	615	961
29	395				2,247	615	1,261
30	395				2,427	575	1,261
31					1,827		1,261
Mean	413				1,880	1,155	989

a Data not sufficient to compute record for July, August, and September

MOHAWK RIVER AT SCHENECTADY, NEW YORK.

A few measurements of the flow of Mohawk River have been made at Freeman's toll bridge, about one-fourth of a mile above the Delaware and Hudson Canal Company's railroad bridge and about 1 mile below the New York Central and Hudson River Railroad bridge. A temporary station was established here on January 28, 1899, and maintained until September 30, 1899, by Prof. Elton D. Walker, of Union College, Schenectady, New York. The observer is Mrs. J. Diggin. The equipment consists of a wire gage with a 4-pound iron sash weight and galvanized line. The graduated rod is fastened to the guard rail on the upstream side of the northwest section of the

[1] On flow of water over dams, by George W. Rafter: Proc. Am. Soc. Civ. Eng., March, 1900, Vol. XXVI, No. 3, p. 317.

bridge and is marked in tenths of a foot from zero to 17 feet. There is a bench mark on the upstream end of the top of the capstone on the pier nearest the northwest or right bank of the river. A second bench mark is the southerly corner of the top of the masonry bridge seat on the upstream end of the northwest abutment. Both bench marks are 23.96 feet above the zero of the gage. The initial point for soundings is the face of the bridge seat on the upstream end of the southeast abutment. The channel is approximately straight and of uniform width for 600 feet above and half a mile below the site. The section is obstructed by three piers and crib foundations, but is otherwise good. The swiftest current is through the southeast span. The right bank is low and liable to overflow, but the road running to the northwest prevents the overflow passing around the bridge except in unusually high freshets. The left bank is high, being the towpath of the Erie Canal, and is not liable to overflow except in extremely high freshets occurring at the time of an ice jam in the river below. Measurements are made from the upstream side of the bridge. The three following discharge measurements were made during 1899 by Prof. E. D. Walker: April 3, gage height 7.18 feet, discharge 5,298 second-feet; May 26, gage height 6.22 feet, discharge 2,092 second-feet; June 30, gage height 5.38 feet, discharge 482 second-feet.

Daily gage height in feet of Mohawk River at Schenectady, New York, for 1899.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	6.60	8.15	7.45	8.60	(*a*)	5.33	5.20	5.10
2	6.30	8.05	7.60	8.45	(*a*)	5.30	5.18	5.17
3	6.10	7.50	7.40	8.75	(*a*)	5.30	5.35	5.15
4	6.10	7.20	7.10	7.95	(*a*)	5.30	5.35	5.17
5	6.10	8.00	7.80	7.40	(*a*)	5.23	5.40	5.20
6	6.70	13.80	8.43	7.00	(*a*)	5.23	5.38	5.18
7	6.10	10.93	9.53	6.70	(*a*)	5.22	5.20	5.15
8	6.10	9.00	10.15	6.55	5.50	5.30	5.20	5.20
9	6.20	8.80	11.13	6.45	5.45	5.33	5.15	5.20
10	6.30	8.20	9.80	6.25	5.43	5.78	5.15	5.12
11	6.10	7.85	9.30	6.20	5.40	6.10	5.15	5.10
12	5.90	7.65	10.90	6.20	5.38	5.98	5.18	5.10
13	5.90	11.84	11.80	6.45	5.30	5.70	5.20	5.08
14	5.90	10.15	12.93	6.50	5.28	5.50	5.20	5.05
15	5.95	9.40	13.50	6.60	5.33	5.48	5.15	5.05
16	6.00	8.70	12.88	6.55	5.30	5.45	5.12	5.05
17	6.00	8.60	11.55	6.40	5.70	5.40	5.10	5.00
18	6.00	7.70	11.25	6.58	5.72	5.70	5.12	5.03
19	6.00	7.30	11.20	6.80	5.53	5.68	5.05	5.00
20	6.15	8.40	11.50	6.98	5.43	5.55	5.12	5.10
21	6.30	8.50	11.55	7.35	5.45	5.45	5.10	5.10
22	6.85	7.90	11.10	7.25	5.90	5.45	5.08	5.10
23	8.85	7.65	10.70	6.95	5.55	5.30	5.05	5.10
24	8.84	7.75	10.69	6.58	5.45	5.25	5.10	5.10
25	8.00	7.95	10.60	6.35	5.40	5.23	5.10	5.08
26	7.70	7.70	10.45	6.22	5.40	5.20	5.08	6.53
27	7.35	7.80	10.40	6.10	5.38	5.20	5.10	8.05
28	8.10	7.25	10.00	6.05	5.33	5.20	5.12	6.35
29		7.10	9.45	6.20	5.38	5.20	5.05	5.90
30		7.75	8.85	6.70	5.35	5.32	5.10	5.75
31		7.23		7.00		5.15	5.10	(*b*)

a Repairing bridge. *b* Discontinued September 30.

MOHAWK RIVER AT REXFORD FLATS, NEW YORK.

Observations of river height are made at Rexford Flats, 4 miles below Schenectady, for the computation of flow of Mohawk River. This is a State dam, built of solid masonry, with a timber apron, and furnishes water for the feeder of the Erie Canal. Gages are read showing the height on crest of the dam and the head on the feeder gate, so that the amount of water flowing over the dam into the feeder can be determined. The profile of the crest of the dam is irregular, and to facilitate computation has been divided into five sections. The value of the coefficients for any depth on the crest of this dam has been obtained by taking the mean of the corresponding coefficients for series Nos. 117 and 141 of Bazin's experiments. Experiments were carried on at Cornell University to determine the coefficients of flow over an experimental weir of the exact form of the one located at Rexford Flats. This was known as "Cornell experiment No. 14." A revised discharge curve was computed, using the coefficients as determined by these experiments. H. R. Betts is the observer at this station. In comparing the results obtained at Little Falls and Rexford Flats, Mr. Robert E. Horton, who has made the computations, states that he has not been able to reconcile them, the former appearing to be the more accurate and the latter too small in proportion. For a cross section of this dam see the paper "On flow of water over dams," by George W. Rafter: Proc. Am. Soc. Civ. Eng., March, 1900, p. 312.

Daily discharge in second-feet of Mohawk River at Rexford Flats, New York, for 1899.

[Drainage area, 3,385 square miles.]

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2,288	928	328	228	2,728	1,368	1,328
2	2,288	928	328	228	2,928	1,368	1,328
3	2,078	679	438	228	2,928	2,928	3,208
4	2,078	608	438	228	2,628	5,028	2,448
5	2,078	608	528	228	2,628	6,528	2,628
6	1,538	608	608	228	2,628	6,528	2,908
7	1,538	438	328	228	2,478	8,628	3,578
8	1,538	438	278	228	2,328	9,028	4,548
9	1,378	608	278	228	2,178	7,928	6,078
10	1,378	528	278	228	1,428	4,828	8,328
11	1,128	438	278	228	728	2,778	8,958
12	1,128	438	278	228	728	2,178	10,028
13	928	378	278	228	728	1,578	10,828
14	928	328	278	228	728	1,928	15,828
15	1,038	328	278	238	1,228	2,078	21,358
16	1,038	328	278	278	1,578	1,578	24,228
17	2,928	758	278	278	1,828	1,368	19,128
18	3,528	928	278	278	1,928	1,368	13,128
19	4,628	678	278	278	1,428	1,128	8,128
20	5,128	678	228	278	1,348	1,128	10,228
21	2,628	438	228	278	1,348	1,228	6,328
22	3,228	328	228	278	1,348	1,478	4,928
23	2,168	328	228	278	1,228	1,578	4,578
24	2,168	308	228	278	1,148	1,578	4,578
25	2,078	288	228	278	1,128	1,468	2,428
26	1,538	288	278	3,228	1,028	1,368	2,928
27	1,538	328	278	9,178	828	1,128	2,928
28	1,538	438	238	6,328	728	1,128	2,828
29	1,428	328	208	1,678	1,228	1,128	2,628
30	1,538	378	208	2,778	1,348	1,368	2,428
31	....	338	208	....	1,348	....	2,228
Mean	2,014	498	294	980	1,608	2,824	7,001

SCHROON RIVER AT WARRENSBURG, NEW YORK.

This river rises in Essex County, along the southern slopes of the highest mountains in the Atlantic group, and flows in a general southerly direction for about 45 miles, until it joins Hudson River, as described in Water-Supply Paper No. 24, page 43. There are no developed water powers excepting that at Warrensburg, near the mouth. At this point records of river height have been kept by J. Goodfellow, the superintendent of the Schroon River Pulp Company, The dam at this point was built in 1893, and is said to be as tight as any of its kind. The observations were begun in 1895, the gages being established by Mr. George W. Rafter in connection with his investigations of the Upper Hudson storage surveys, in progress at that time. Mr. Wallace Greenalch, as assistant to Mr. Rafter, computed the flow of the river, but in his opinion these computations were to a certain extent vitiated by the possible leakage through the dam and complications introduced by flashboards being continually changed.

HUDSON RIVER AT FORT EDWARD, NEW YORK.

This river, as a whole, has been described in Water-Supply Papers Nos. 24 and 25. Estimates of flow have been made at two points, the upper at Fort Edward, about halfway between the mouth of Schroon River and Albany, and the lower at Mechanicville, above the mouth of Mohawk River. Records are being kept of the height of water surface above the crest of the dam at Fort Edward by the International Paper Company, B. A. Carr, superintendent. The estimated discharge was computed at the office of the State engineer and surveyor, but without taking the modifications introduced by the flashboards into account. The data were later placed in the hands of Mr. Robert E. Horton, but he has had opportunity to compute the flow during only one or two months. There is a peculiarity in regard to the method of reading the gage, but otherwise the results are satisfactory and worthy of computation.

HUDSON RIVER AT MECHANICVILLE, NEW YORK.

A daily record of the height of water passing over the dam of the Duncan Company, at Mechanicville, New York, has been kept, with few omissions, since 1887, as described in the report prepared by George W. Rafter.[1] These observations are made twice daily, at 7 a. m. and at 4 p. m., except Sundays, when the afternoon observations are omitted. The depth of the water on the crest of the dam is measured at a point sufficiently removed from the crest not to be influenced by the curve of the water surface. Besides these readings,

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[1] Water-Supply and Irrigation Paper No. 24, page 78.

the difference in elevation between the surface of the water at the entrance and discharge from the water wheels is noted. The flow, as stated by R. P. Bloss, the engineer of the Duncan Company, is obtained by the use of Francis's formula for weirs with wide crests: $q=3\ LH^{\frac{3}{2}}$, in which q is the discharge in cubic feet per second, H the head in feet on crest of the dam, and L the length of the dam, which, in this case, is 794 feet. The coefficient used (3) was determined for dam of similar cross section. When the water wheels are in operation the head on wheels is determined by observation, and the amount of water used on each wheel under the given head is taken directly from the table given by the water-wheel builder. There being no leakage of the dam or canal the sum of the flow over the dam and the flow through the wheels gives the total flow of the river at the time of the observation.

Daily discharge in second-feet of Hudson River at Mechanicville, New York.

[Drainage area, 4,500 square miles.]

1896.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	24,147	3,177	22,189	21,647	9,050	6,627	2,324	2,374	2,077	2,991	3,484	13,028
2	22,847	3,289	32,900	20,147	7,252	6,627	2,324	2,736	1,770	3,441	3,652	11,650
3	19,547	3,402	27,525	18,947	7,027	6,027	2,234	3,099	1,770	3.916	3,332	8,200
4	15,627	3,402	25,880	16,097	6,802	4,752	2,324	2,949	1,770	4,016	3,332	7,290
5	11,652	3,527	26,230	14,774	6,202	4,477	2,324	2,674	1,770	4,116	3,652	7,450
6	7,677	3,477	18,122	13,452	6,202	4,477	2,324	2,324	3,055	3,841	23,335	7,575
7	5,677	13,327	17,247	14,327	5,677	4,389	2,999	2,324	4,341	3,666	25,735	7,700
8	5,602	7,427	16,822	13,127	5,402	4,302	2,724	2,324	3,316	3,916	24,235	6,853
9	5,677	6,302	16,397	13,127	4,902	5,277	2,799	2,412	2,916	3,916	22,735	7,850
10	5,602	5,177	14,247	13,677	5,002	6,227	2,774	2,499	2,791	3,441	19,085	11,493
11	5,377	5,177	11,837	13,827	5,102	8,127	2,774	2,449	2,616	3,678	16,985	10,922
12	5,139	4,377	8,502	15,708	4,477	7,927	2,624	2,399	2,541	3,916	15,735	10,067
13	4,902	4,202	7,327	17,589	4,527	6,027	2,474	2,424	2,441	3,391	14,135	9,259
14	4,902	4,027	7,127	25,314	3,802	6,127	2,624	2,399	2,341	3,791	12,680	8,450
15	4,702	4,377	6,789	34,414	3,602	6,227	2,324	2,374	2,491	7,416	11,582	7,950
16	4,302	3,864	6,452	39,775	3,877	5,677	2,324	2,384	2,491	6,766	10,485	6,253
17	4,152	3,352	6,027	48,300	3,877	6,127	2,324	2,394	2,291	5,741	10,680	9,125
18	3,877	3,677	5,602	55,400	3,877	4,677	2,324	2,424	2,241	5,278	9,635	6,750
19	4,127	4,077	5,677	59,393	3,352	4,152	2,324	2,499	2,266	4,816	8,380	5,350
20	4,377	4,152	15,702	52,050	3,227	4,077	2,324	2,474	3,503	4,366	7,635	5,138
21	4,152	3,752	11,977	45,400	3,227	4,139	2,949	2,394	4,741	4,016	6,965	4,925
22	4,027	3,677	10,077	37,436	2,977	4,202	4,324	2,374	4,691	4,541	7,025	4,300
23	3,952	3,739	8,177	32,314	2,952	3,177	5,349	2,361	4,116	4,166	7,085	4,400
24	3,677	3,802	6,102	26,230	3,052	3,002	4,774	2,349	3,716	4,166	6,585	3,435
25	3,802	3,952	6,302	21,672	3,152	2,777	3,424	2,374	3,666	4,141	6,385	3,918
26	3,877	3,802	7,877	18,349	2,977	2,677	3,074	2,324	2,991	4,116	9,185	4,400
27	3,952	3,677	13,997	15,027	3,152	2,427	2,724	2,324	2,991	3,116	10,485	4,350
28	3,527	3,677	9,177	12,102	3,527	2,489	2,449	2,324	2,991	2,916	11,535	4,300
29	3,277	11,477	12,787	10,077	3,802	2,552	2,349	2,324	2,791	3,116	12,110	3,675
30	3,177	......	16,397	9,477	5,027	2,377	2,474	2,324	2,866	3,241	12,685	3,950
31	3,177	......	20,147	......	5,827	......	2,374	2,324	......	3,316	......	4,300
Mean	6,791	4,668	13,600	24,972	4,610	4,738	2,772	2,442	2,879	4,106	11,352	6,913

Daily discharge in second-feet of Hudson River at Mechanicville, New York—Continued.

1897.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4,110	3,595	3,000	13,028	13,950	9,300	5,950	14,290	4,000	2,290	2,150	17,121
2	4,550	3,300	2,664	12,906	13,100	8,400	5,050	13,650	3,800	2,245	3,475	15,655
3	4,485	3,675	3,065	13,028	12,250	6,830	4,500	11,810	3,295	3,065	10,550	13,539
4	4,420	4,512	11,193	13,789	12,114	11,950	4,500	11,650	3,295	2,290	10,149	11,466
5	4,300	3,300	7,050	14,550	12,728	13,950	4,500	9,450	3,033	2,170	8,817	13,509
6	6,623	4,230	13,950	18,670	12,250	12,425	4,500	8,825	2,770	2,150	7,314	20,531
7	5,600	6,346	11,225	21,450	13,150	10,900	3,932	7,400	2,715	2,150	5,915	16,404
8	5,350	8,450	8,500	21,300	11,810	8,725	4,650	6,485	2,664	2,150	5,752	15,435
9	5,185	5,975	8,815	20,750	10,155	10,600	5,430	5,570	2,540	2,150	5,752	14,437
10	5,130	5,350	12,900	23,806	8,500	25,986	4,750	5,150	2,450	3,180	9,266	13,462
11	5,075	4,200	14,550	18,890	8,400	27,188	4,650	6,025	2,340	2,150	9,224	12,927
12	3,880	3,932	14,110	13,973	9,350	24,790	4,550	13,350	2,370	2,150	11,254	13,000
13	3,595	3,180	12,900	15,918	10,450	22,170	6,750	11,350	2,400	2,450	12,243	17,150
14	3,370	3,328	10,925	15,550	22,550	19,550	23,150	9,650	2,664	3,000	13,768	15,559
15	3,300	3,475	8,950	16,940	19,625	17,280	31,060	9,238	2,370	3,135	10,794	31,178
16	3,595	3,180	8,400	22,269	17,188	15,900	22,750	8,825	2,715	3,065	10,000	35,706
17	3,853	3,295	7,150	23,340	14,750	13,150	18,670	9,450	2,450	4,110	13,300	32,515
18	4,110	3,135	6,830	23,908	13,650	11,200	16,390	8,250	2,340	2,664	11,800	29,702
19	3,300	2,930	6,830	24,476	11,500	9,220	14,110	7,550	4,000	2,900	11,620	23,114
20	3,300	2,820	12,900	23,621	12,100	9,220	11,950	7,775	2,290	2,664	10,650	15,379
21	3,300	3,058	15,375	20,950	11,300	9,220	11,193	7,050	2,664	2,370	8,628	12,207
22	3,350	3,295	17,850	19,625	11,810	8,950	11,350	6,500	2,540	2,346	9,354	8,486
23	3,435	4,120	18,470	17,150	10,980	7,025	11,950	5,950	2,180	2,150	8,182	6,900
24	3,555	4,212	23,010	16,941	10,150	7,250	12,230	6,830	2,380	3,070	7,451	4,819
25	3,675	3,135	23,957	19,346	9,300	6,220	11,425	7,775	2,290	2,290	6,368	2,785
26	2,925	3,050	19,950	21,750	10,000	5,820	10,620	7,775	3,930	2,150	7,395	2,293
27	2,875	3,000	17,973	25,200	10,330	5,485	9,450	6,750	2,664	2,150	15,402	4,122
28	3,350	3,000	15,912	22,450	11,650	5,150	8,950	6,025	2,770	2,150	15,848	7,047
29	3,530	....	13,850	19,017	10,950	4,400	19,550	5,513	2,370	2,150	19,456	6,467
30	3,530	....	13,028	17,625	10,700	7,400	20,950	5,000	2,380	2,150	16,984	6,467
31	3,563	....	13,350	....	10,450	....	14,930	4,550	....	3,135	....	6,467
Mean	4,007	3,895	12,214	19,074	12,167	11,855	11,109	8,241	2,756	2,524	9,995	14,382

1898.

1	5,512	5,235	5,295	20,306	13,474	9,490	3,179	3,005	*a* 4,345	3,222	7,954	6,300
2	4,689	5,095	5,280	18,018	11,545	8,159	3,014	3,888	*a* 4,007	2,877	7,667	6,130
3	5,035	5,272	5,208	15,810	9,702	7,558	3,007	6,225	*a* 4,145	2,835	6,590	5,698
4	5,186	4,151	5,208	13,890	10,820	6,292	3,007	5,722	*a* 4,340	2,780	6,500	5,185
5	5,306	4,353	5,055	11,932	10,570	5,808	3,364	6,031	4,547	11,210	5,890	5,994
6	5,485	6,475	5,200	10,692	11,300	5,508	2,588	5,832	4,145	20,089	5,803	6,500
7	6,626	5,203	5,250	9,928	11,032	4,729	2,453	5,415	4,007	9,472	5,890	6,322
8	7,256	5,000	5,186	8,787	10,250	4,399	2,314	5,091	4,930	8,261	5,503	5,456
9	5,890	4,826	6,819	8,158	9,700	4,249	2,220	4,335	4,217	7,872	5,872	4,150
10	6,168	4,826	7,431	7,924	8,695	3,978	1,163	3,926	3,813	6,960	6,238	4,675
11	5,951	6,325	10,361	7,915	7,875	3,425	2,000	3,743	3,368	6,038	20,256	4,345
12	5,298	10,022	20,994	7,646	8,420	3,857	2,182	3,387	3,304	6,109	16,262	4,290
13	11,499	13,042	27,300	8,553	11,054	4,299	2,058	3,331	3,188	5,331	14,510	3.739
14	10,975	10,425	39,389	9,815	10,585	4,945	2,080	3,148	2,732	4,829	13,202	3.540
15	10,160	9,074	36,375	9,824	10,161	7,662	2,184	3,362	2,597	6,888	11,385	3.850
16	10,647	8,100	32,325	12,188	9,967	6,872	2,159	3,250	2,487	7,838	10,366	4,007
17	9,672	5,682	30,625	12,575	10,082	5,681	1,163	3,223	2,597	8,125	9,722	4,495
18	7,515	7,480	32,325	12,188	10,637	4,620	2,192	3,235	2,873	7,250	8,910	4,590
19	7,008	7,788	29,935	11,155	9,404	4,851	2,224	3,660	2,873	6,500	8,922	4,590
20	7,952	7,571	30,000	11,157	9,412	5,593	2,175	4,507	3,365	6,508	10,505	4,885
21	13,757	8,009	36,235	10,922	8,355	4,603	2,192	4,495	2,975	6,418	11,167	5,035
22	10,170	7,906	34,035	10,127	7,954	4,399	3,188	4,718	2,899	6,310	10,366	5,035
23	9,780	7,258	30,615	9,815	8,000	4,198	3,565	3,927	2,666	6,894	9,610	6,908
24	11,458	6,542	27,450	9,627	8,400	4,348	3,549	5,779	3,297	7,578	8,898	8,369
25	9,436	6,263	24,860	20,440	9,491	4,097	3,928	*a* 11,167	5,231	7,178	8,685	7,747
26	8,628	5,992	21,860	24,210	11,953	4,024	4,565	*a* 9,953	6,878	6,693	7,847	6,885
27	7,788	5,294	19,600	24,338	14,758	4,115	4,258	*a* 8,125	5,706	9,382	6,413	5,872
28	7,719	5,911	19,910	20,440	15,327	3,556	3,656	*a* 8,250	4,775	11,042	5,820	4,618
29	6,624	....	20,660	18,165	14,140	3,508	3,352	*a* 6,109	4,345	10,485	6,300	4,628
30	5,361	....	23,560	14,873	12,727	3,238	3,175	*a* 4,829	3,650	10,059	6,300	4,828
31	4,860	....	22,640	....	10,490	....	3,015	*a* 4,217	....	9,953	....	5,348
Mean	7,723	6,754	20,225	13,047	10,525	5,069	2,751	5,029	3,810	7,516	8,978	5,291

a Discharge August 25 to September 4, not exact, owing to irregular flashboards.

Daily discharge in second-feet of Hudson River at Mechanicville, New York—Continued.

1899.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4,262	3,910	7,847	7,980	26,900	3,990	2,220	1,520	1,713	......	4,564	3,005
2	4,262	4,268	7,040	7,159	27,617	3,796	1,047	629	1,561	4,042	8,889	3,414
3	5,209	4,268	6,403	6,955	25,551	3,601	2,128	1,213	......	3,453	12,020	3,753
4	6,065	4,150	......	7,934	22,472	2,220	......	1,153	1,293	2,850	11,899	5,545
5	9,146	4,002	......	9,405	19,242	2,990	2,741	1,085	1,860	2,745	10,346	6,678
6	8,460	4,223	16,501	9,955	15,152	2,840	1,610	......	1,764	2,650	11,049	5,974
7	8,355	4,048	12,266	11,719	12,662	2,728	1,670	1,494	1,706	2,571	9,308	5,210
8	8,350	4,275	9,077	19,708	10,960	2,805	1,211	1,616	1,680	......	8,140	4,558
9	8,026	3,448	8,665	18,275	9,270	2,525	......	1,475	1,466	2,590	7,166	3,806
10	6,562	3,665	7,909	15,062	8,587	2,290	3,000	484	......	2,712	6,662	3,265
11	5,766	3,622	7,315	15,582	7,446	......	3,533	1,148	1,480	2,903	6,182	3,569
12	5,250	4,062	11,739	16,875	7,550	2,399	3,296	993	1,598	2,874	5,490	4,979
13	5,272	4,196	15,437	17,145	7,155	2,505	3,243	......	1,471	2,926	6,321	11,183
14	5,960	4,508	12,153	21,378	7,060	2,230	3,002	1,580	1,567	2,353	5,536	14,576
15	7,435	4,600	10,555	27,975	7,772	2,135	2,800	1,680	1,484	......	5,179	14,979
16	8,910	4,798	10,012	29,730	7,346	3,078	......	1,501	1,549	2,177	4,858	13,452
17	10,155	5,598	9,080	31,112	5,738	3,060	2,861	1,815	......	2,132	5,283	9,646
18	9,685	5,691	7,895	29,667	5,729	2,762	3,338	979	711	1,853	4,857	9,534
19	7,339	5,620	9,322	29,711	5,928	2,950	2,860	1,390	1,636	1,798	4,359	9,968
20	6,385	5,267	11,350	33,940	5,917	2,508	2,560	......	957	1,997	4,838	10,950
21	6,297	4,855	9,670	36,210	5,925	2,372	2,485	1,610	941	2,185	4,729	11,048
22	5,770	5,686	9,337	36,210	6,187	2,280	2,295	1,123	1,448	......	4,587	10,721
23	5,697	10,083	8,645	37,146	5,313	2,105	......	1,743	1,464	2,466	4,297	9,642
24	5,522	7,501	8,657	38,283	4,756	1,878	2,240	2,460	......	2,698	3,964	8,068
25	6,950	5,583	8,095	39,064	4,710	304	2,233	1,383	1,516	2,372	3,731	8,241
26	5,775	5,255	7,492	41,475	4,462	1,878	2,188	1,463	2,116	2,304	3,472	7,821
27	5,438	6,450	6,895	40,064	4,117	2,241	2,021	......	6,000	2,128	4,027	5,832
28	4,545	10,326	6,615	38,300	3,985	2,290	2,140	1,756	5,127	2,216	3,495	5,435
29	4,290	......	7,835	33,908	4,125	2,368	1,686	1,738	4,413	......	3,439	4,889
30	4,345	......	8,765	30,292	3,787	2,512	......	1,739	4,870	3,198	3,318	4,075
31	4,066	......	7,602	......	3,918	......	2,055	1,477	......	3,815	......	2,585
Mean	6,437	5,141	9,316	24,607	9,591	2,539	2,402	1,417	2,054	2,616	6,066	7,303

SAWKILL RIVER NEAR KINGSTON, NEW YORK.

The Sawkill, a small stream which supplies Kingston, New York, with water, has been measured by Mr. William Rich Hutton, at a point about 4.5 miles above its mouth in Esopus Creek, its discharge being 1.25 second-feet. On two occasions after heavy rains the discharge at the same place has been more than 8,000 second-feet from a drainage area of 35 square miles. This quantity continued a very short time, probably about an hour. The location of this stream is shown on the Kaaterskill topographic sheet. It rises behind Overlook Mountain, flows by the village of Woodstock, and joins the Esopus about 4 miles below the city of Kingston. Reservoir No. 1 is shown on the map, but reservoir No. 2, constructed in 1897, about 1½ miles below Woodstock, is not given.

In April, 1895, the mountains being covered with snow 12 inches deep, there occurred a south wind and light rain for two days followed by twelve hours of very heavy rain. On the evening of April 4 the water in reservoir No. 1 began to rise rapidly, and about 9 p. m. the noise of the floating logs and ice and the rapidly rising water alarmed the gate keeper so that he moved his more important furniture by boat to higher ground. At midnight the water was at its highest and by 8 a. m. on April 5 it was falling rapidly. From the maximum height of water on the spillway it is computed that the outflow of the reservoir was a little less than 8,000 second-feet. In 1896 it is estimated that a similar flood furnished over 8,000 second-feet.

CROTON RIVER.

This stream receives its waters from the drainage area immediately north of the city of New York and east of Hudson River. It flows in a general southerly and westerly course, emptying into the Hudson above Sing Sing. A number of reservoirs have been built within its basin for the water supply of the city of New York, and a new dam is being constructed about 3.2 miles above the mouth, at what is known as the "Cornell site." The location of the river and principal reservoirs is shown on the West Point, Carmel, Tarrytown, and Stamford topographic sheets of the United States Geological Survey. Figures of the yield of this watershed have been prepared by the engineers of the aqueduct commission. The monthly discharges in second-feet for the years 1870 to 1898 have been printed in the Twentieth Annual Report, Part IV, page 83. The following table, obtained from Mr. W. R. Hill, chief engineer, gives a continuation of this for 1899. The figures of rainfall are those obtained at Boyds Corners, in Croton basin.

Rainfall and run-off of Croton River watershed for 1899.

[Drainage area, 338 square miles.]

Month.	Rainfall.	Run-off.	Month.	Rainfall.	Run-off.
	Inches.	*Sec.-feet.*		*Inches.*	*Sec.-feet.*
January	4.38	1,210	August	0.48	114
February	5.07	943	September	8.81	805
March	7.58	2,217	October	1.48	237
April	1.99	1,240	November	2.05	277
May	1.80	344	December	2.75	263
June	5.38	152			
July	5.99	344	The year	47.76	636

The total depth of run-off in inches during 1899 was 25.55, this being 53 per cent of the rainfall, as given in the above table.

DELAWARE RIVER AT LAMBERTVILLE, NEW JERSEY.

This river rises in Delaware County, New York, flows in a southerly direction, forming the boundary between the States of Pennsylvania and New Jersey, and empties into Delaware Bay. Measurements of flow were made in 1891 by Prof. Dwight Porter and students at the Delaware Water Gap, Pennsylvania. The results show a flow of from 2,000 to 2,200 second-feet during the latter half of June, 1891. This was said to be the lowest June stage for five years. Measurements were made during the drought of 1895 by Prof. L. M. Haupt at Point Pleasant, Pennsylvania, near the intake of the Delaware and Raritan Canal feeder. The discharge above the bridge was 1,657 second-feet and below the bridge 1,328 second-feet. Delaware River was measured by E. G. Paul, June 4, 1899, at Martins Creek, Pennsylvania, 7 miles above the mouth of Lehigh River, and a discharge of 2,724 second-feet was found. Lehigh River was measured on June 5, 1899, by E. G. Paul, at the Glendon Bridge at Easton, Pennsylvania, and was discharging 991 second-feet. Systematic measurements of river height were begun on July 23, 1897, at the covered toll bridge at Lambertville, New Jersey, a town on the Belvidere division of the Pennsylvania Railroad, 16 miles above Trenton. The gage, established by E. G. Paul, consists of a stamped-link brass chain 33 feet long, with a 6-pound sash weight attached. The chain passes over a pulley and the index is referred to a scale painted on a horizontal board 32 feet long, fastened to the studding and inclosed in a wooden cover. The zero of the gage chain is marked by a copper rivet, which is 28.85 feet from the end of the weight, and reads 2 feet when the water is at zero on a gage on the first bridge pier. Measurements are made from the windows of this covered bridge. The initial point for soundings is on the left bank. The channel above and below is nearly straight, the water being sluggish for a short space on the left side. The right bank is high and the bed of the stream is of gravel and sand. The observer is Charles H. Naylor, collector of bridge tolls, Lambertville, New Jersey. Records of measurements may be found as follows: 1897, Nineteenth Annual Report, Part IV, page 122; 1898, Twentieth Annual Report, Part IV, page 85. Three measurements were made during 1899, by E. G. Paul, as follows: March 31, gage height 6.30 feet, discharge 27,737 second-feet; June 2, gage height 3.70 feet, discharge 6,410 second-feet; September 19, gage height 2.75 feet, discharge 2,430 second-feet.

Daily gage height, in feet, of Delaware River at Lambertville, New Jersey, for 1899.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.95	(*a*)	6.80	6.25	4.75	3.60	4.40	4.20	3.45	4.65	3.40	3.80
2	(*a*)	(*a*)	6.80	6.25	4.60	3.60	4.30	4.00	3.35	4.45	3.80	3.80
3	(*a*)	(*a*)	6.30	5.95	4.60	3.30	3.95	4.00	3.35	4.25	4.05	3.80
4	(*a*)	(*a*)	6.25	5.80	4.50	3.20	3.75	3.90	3.30	4.10	4.65	3.80
5	5.40	4.50	7.95	5.65	4.40	3.05	3.65	3.85	3.45	4.05	4.75	3.95
6	6.05	4.45	8.30	5.70	4.30	2.90	3.65	3.70	4.90	3.95	4.60	3.85
7	7.00	4.40	9.65	5.90	4.20	2.95	3.65	3.90	4.35	3.90	4.55	3.90
8	6.55	4.40	8.20	7.40	4.10	2.85	3.60	3.65	3.95	3.85	4.35	3.75
9	6.10	(*a*)	7.20	9.10	4.00	2.90	3.90	3.55	3.85	3.75	3.75	3.75
10	5.80	(*a*)	6.45	8.70	3.90	2.90	3.80	3.45	3.75	3.70	4.10	3.85
11	5.35	(*a*)	6.20	7.65	3.85	2.85	3.75	3.65	3.50	3.60	4.10	3.70
12	5.00	(*a*)	6.30	7.15	4.00	2.70	3.70	3.55	3.90	3.60	4.10	3.75
13	4.80	(*a*)	7.50	7.75	4.00	2.60	3.75	3.35	3.65	3.60	4.25	4.20
14	4.90	(*a*)	9.15	8.45	4.00	2.65	3.55	3.15	3.45	3.50	4.50	5.30
15	5.05	(*a*)	8.10	8.85	3.90	2.60	3.55	3.10	3.35	3.50	4.45	5.60
16	5.40	(*a*)	7.70	9.00	3.80	2.60	3.45	2.95	3.15	3.40	4.35	5.30
17	5.95	(*a*)	6.90	8.90	3.80	2.50	3.60	2.80	3.10	3.40	4.35	5.10
18	6.10	(*a*)	6.45	7.85	3.70	2.60	3.60	2.75	2.85	3.45	4.50	4.85
19	5.50	(*a*)	7.40	7.25	3.80	2.45	3.70	2.50	2.75	3.40	4.50	4.70
20	5.30	7.60	8.70	7.05	3.90	2.40	3.75	2.80	3.90	3.40	4.45	4.65
21	5.30	6.65	9.00	7.15	3.90	2.40	3.55	2.65	3.90	3.40	4.30	4.75
22	4.95	5.70	8.05	7.00	3.80	2.45	3.50	2.75	3.90	3.45	4.20	4.75
23	5.05	6.05	7.70	6.70	3.70	2.75	3.35	2.90	3.75	3.35	4.20	4.65
24	4.95	5.95	7.35	6.15	3.60	3.00	3.25	2.85	3.70	3.30	4.20	5.10
25	7.30	5.65	7.25	5.95	3.60	3.25	3.10	2.60	3.65	3.25	4.10	5.45
26	6.00	5.45	7.00	5.70	3.50	3.70	3.15	2.75	5.40	3.20	4.00	5.45
27	5.60	8.25	6.65	5.50	3.40	4.30	3.40	3.95	6.05	3.20	4.00	5.20
28	5.25	7.20	6.60	5.40	3.40	4.05	4.15	4.20	6.25	3.20	3.95	5.00
29	4.95	......	7.40	5.10	3.20	4.00	4.00	3.75	5.40	3.45	3.90	(*a*)
30	4.95	......	6.80	4.90	3.20	4.00	3.85	3.55	5.00	3.25	3.90	(*a*)
31	4.75	......	6.40	.....	3.40	......	4.30	3.65	......	3.20	......	(*a*)

a Ice.

TOHICKON CREEK AT POINT PLEASANT, PENNSYLVANIA.

This stream drains an area of 102 square miles in the eastern portion of Pennsylvania and, flowing easterly, discharges into Delaware River about 8 miles above Lambertville, New Jersey. Measurements of the stream were begun in 1885 by Mr. Rudolph Hering, and continued by Mr. John E. Codman, hydrographer for the water department of the city of Philadelphia. The results by months from 1890 to 1898, inclusive, are given in the Twentieth Annual Report, Part IV, beginning on page 98. The following table gives the figures of daily flow for 1899:

Daily discharge in second-feet of Tohickon Creek at Point Pleasant, Pennsylvania, for 1899.

[Drainage area, 102.2 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	144	158	793	178	35	15	14	4	18	46	52	34
2	136	125	601	131	31	9	11	399	13	40	181	34
3	154	118	601	97	31	9	19	267	9	27	121	44
4	204	151	708	79	31	10	12	113	93	25	921	49
5	1,172	184	2,819	68	31	9	10	52	42	23	366	44
6	1,360	210	1,109	61	27	8	10	28	28	18	121	39
7	1,400	189	520	73	23	7	8	22	19	20	73	39
8	503	142	277	1,328	23	7	8	17	16	23	58	39
9	503	180	217	389	23	5	7	15	287	20	53	31
10	413	183	203	160	20	8	6	254	210	17	40	23
11	124	110	418	108	28	6	7	417	203	17	35	27
12	158	90	1,225	92	35	6	5	182	499	16	42	44
13	169	119	1,702	87	27	7	7	66	163	13	51	95
14	186	102	416	79	31	5	11	38	58	11	53	101
15	311	65	709	70	31	3	9	28	46	10	47	60
16	432	157	994	153	20	5	5	19	36	9	46	49
17	569	416	308	393	17	5	7	14	18	9	47	44
18	488	782	502	144	20	4	7	12	18	9	45	39
19	258	767	2,492	84	23	3	8	11	23	9	38	39
20	177	695	938	68	20	2	8	8	708	9	34	85
21	116	914	308	61	17	2	3	8	545	9	33	101
22	84	1,414	1,051	58	17	7	5	6	404	9	33	65
23	79	1,582	1,006	53	20	2	3	7	239	14	49	53
24	526	1,000	449	49	17	2	3	7	61	16	57	879
25	2,032	541	220	49	17	7	3	3	42	18	44	913
26	392	616	624	45	15	7	4	2	1,522	18	35	203
27	230	3,222	633	41	12	12	4	359	604	11	30	97
28	145	1,058	779	39	9	5	4	317	158	11	31	79
29	166	......	1,307	39	12	17	6	62	78	10	36	65
30	169	......	520	39	14	27	7	34	51	12	39	53
31	184	......	239	......	15	......	4	27	......	17	......	49
Mean	419	546	797	144	22	7	7	90	27	17	94	113

NESHAMINY CREEK AT FORKS, PENNSYLVANIA.

The drainage basin of this creek is immediately south of that of Tohickon Creek. The waters of Big Neshaminy flow in a general easterly course, and after joining the Little Neshaminy continue southerly and empty into Delaware River about 12 miles above the city of Philadelphia. Measurements of the discharge of the stream have been made at the forks, where the drainage area is 139 square miles. The monthly discharges from 1890 to 1898 are given in the

Twentieth Annual Report, Part IV, beginning on page 104. The following table gives the daily discharge for 1899:

Daily discharge in second-feet of Neshaminy Creek at Forks, Pennsylvania, for 1899.

[Drainage area, 139.3 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	527	213	611	349	67	31	15	27	15	36	144	54
2	453	213	569	280	73	31	13	248	15	31	154	51
3	97	213	540	243	67	27	9	2,162	28	31	162	48
4	71	213	686	221	61	19	10	104	41	27	1,257	57
5	405	173	3,687	201	53	17	14	43	32	22	252	54
6	2,105	119	913	176	50	17	13	23	19	38	145	48
7	1,298	97	573	255	47	13	10	15	15	59	107	41
8	306	97	377	1,047	45	13	13	15	15	53	85	41
9	277	105	388	362	46	15	14	14	13	36	81	36
10	213	97	343	245	38	19	14	488	43	27	81	36
11	213	80	510	204	64	19	13	2,577	58	22	81	36
12	213	72	959	186	89	17	10	151	80	19	85	36
13	213	72	1,318	176	73	17	10	71	68	19	85	65
14	228	72	407	166	53	15	10	48	23	22	77	80
15	203	72	1,172	159	48	15	8	36	15	19	72	60
16	189	89	813	193	48	15	8	27	15	19	68	45
17	457	319	242	301	43	15	9	22	15	22	68	36
18	252	553	722	177	54	15	9	19	13	123	68	31
19	145	574	2,490	149	68	15	8	19	41	113	56	36
20	115	974	742	139	57	15	6	17	430	57	51	57
21	105	1,373	382	129	36	15	6	14	166	41	48	72
22	105	1,373	1,765	115	36	15	6	19	138	32	41	57
23	100	1,402	976	105	44	15	6	19	65	27	77	41
24	1,117	849	405	105	51	13	6	19	41	27	147	792
25	1,927	446	414	105	47	11	6	19	41	22	90	401
26	333	809	490	105	36	13	11	13	578	22	74	125
27	242	3,950	417	101	31	13	23	11	204	22	72	89
28	213	815	1,398	92	31	13	27	13	89	17	63	72
29	213	......	2,417	88	27	14	22	13	63	24	63	72
30	213	......	588	73	22	15	325	14	48	17	63	63
31	213	......	443	......	27	......	68	15	.....	24	......	48
Mean	411	551	895	208	49	16	23	174	80	34	130	89

PERKIOMEN CREEK AT FREDERICK, PENNSYLVANIA.

The drainage area of this stream is immediately west of that of Tohickon Creek. It flows in a general southerly course, emptying into Schuylkill River about 18 miles above Philadelphia. The point of measurement is at Frederick, about 12 miles above the mouth and above two large tributaries, known as West Swamp Creek and Northeast Branch. The monthly discharges from 1890 to 1898, inclusive, are printed in the Twentieth Annual Report, Part IV, beginning on page 90.

The following tables give the daily flow from the time the gage was established to 1899:

Daily discharge in second-feet of Perkiomen Creek at Frederick, Pennsylvania.

[Drainage area, 152 square miles.]

1884.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	......	......	......	......	......	......	......	100	44	155	93
2	......	......	......	......	......	......	......	......	79	58	59	64
3	......	......	......	......	......	......	......	......	71	58	57	64
4	......	......	......	......	......	......	......	......	63	61	71	79
5	......	......	......	......	......	......	......	......	60	58	342	78
6	......	......	......	......	......	......	......	......	53	46	140	828
7	......	......	......	......	......	......	......	......	53	48	91	3,425
8	......	......	......	......	......	......	......	......	50	41	70	380
9	......	......	......	......	......	......	......	......	46	41	50	230
10	......	......	......	......	......	......	......	......	44	41	48	179
11	......	......	......	......	......	......	......	......	38	37	47	187
12	......	......	......	......	......	......	......	......	39	40	62	981
13	......	......	......	......	......	......	......	......	38	36	69	600
14	......	......	......	......	......	......	......	......	33	33	75	256
15	......	......	......	......	......	......	......	......	35	25	75	2,409
16	......	......	......	......	......	......	......	......	37	25	73	516
17	......	......	......	......	......	......	......	......	37	25	52	292
18	......	......	......	......	......	......	......	......	37	20	48	236
19	......	......	......	......	......	......	......	......	38	16	48	186
20	......	......	......	......	......	......	......	60	37	16	57	139
21	......	......	......	......	......	......	......	58	37	21	76	106
22	......	......	......	......	......	......	......	56	47	23	96	465
23	......	......	......	......	......	......	......	56	47	48	93	449
24	......	......	......	......	......	......	......	45	41	51	768	320
25	......	......	......	......	......	......	......	47	37	43	223	247
26	......	......	......	......	......	......	......	50	32	40	142	182
27	......	......	......	......	......	......	......	54	23	41	121	171
28	......	......	......	......	......	......	......	58	23	45	121	199
29	......	......	......	......	......	......	......	89	29	87	262	241
30	......	......	......	......	......	......	......	110	40	168	142	367
31	......	......	......	......	......	......	......	130	......	238	......	1,239
Mean	......	......	......	......	......	......	......	68	48	51	124	491

1885.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1,639	113	123	1,582	124	85	35	28	28	23	86	175
2	373	109	204	710	126	79	25	19	36	23	706	194
3	229	109	242	495	129	58	25	1,582	24	21	306	200
4	174	111	222	3,192	115	47	17	1,673	8	26	155	184
5	173	112	521	627	102	44	9	174	9	34	113	166
6	2,600	104	703	454	93	44	24	89	16	35	89	153
7	981	100	568	319	244	28	17	65	25	41	78	124
8	435	100	238	315	805	41	29	277	23	31	613	115
9	359	98	197	273	358	65	26	135	30	31	862	250
10	291	2,107	189	255	227	47	25	73	31	26	267	970
11	232	210	164	237	192	46	32	60	27	8	162	340
12	251	252	151	238	161	35	31	51	24	15	132	181
13	615	217	151	209	133	36	30	43	20	22	113	1,250
14	313	184	211	189	128	31	22	76	24	70	101	2,546
15	290	193	223	157	132	33	33	86	28	67	83	583
16	587	1,795	418	143	120	41	35	61	32	45	81	308
17	1,372	832	322	143	95	34	27	50	27	42	86	239
18	283	857	204	133	87	28	23	37	19	26	73	217
19	271	274	176	112	90	28	12	34	25	24	60	204
20	228	234	136	117	77	28	21	41	15	22	65	159
21	201	190	136	115	69	23	24	34	20	118	57	140
22	181	149	93	98	80	32	23	32	16	243	46	143
23	163	147	67	92	92	22	15	29	14	95	349	133
24	144	130	81	94	95	28	14	39	21	54	685	139
25	141	115	185	100	87	29	14	41	19	37	440	113
26	153	121	652	150	94	25	10	42	19	38	382	79
27	151	111	911	201	90	21	15	40	10	46	348	67
28	155	101	992	171	74	16	17	46	19	39	261	85
29	145	......	538	139	62	18	26	35	17	39	206	100
30	120	......	250	124	58	30	29	26	24	228	192	87
31	113	......	985	......	60	......	17	28	......	175	......	292
Mean	431	327	331	373	142	37	23	16	22	56	240	321

Daily discharge in second-feet of Perkiomen Creek at Frederick, Pennsylvania—**Continued.**

1886.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	452	280	237	1,548	96	101	83	95	38	30	52	141
2	218	235	214	482	79	88	73	86	41	29	67	114
3	167	236	193	335	89	111	67	74	35	22	33	73
4	950	304	174	303	87	137	71	57	28	27	30	62
5	3,044	214	177	449	84	104	59	50	22	22	51	55
6	516	172	163	4,021	83	76	52	47	28	17	36	44
7	300	155	143	1,626	90	79	47	57	29	23	53	65
8	222	159	163	640	3,094	78	50	61	34	20	55	59
9	255	162	143	445	893	72	42	57	32	23	53	71
10	237	163	153	365	323	181	329	62	26	16	49	63
11	245	4,388	134	282	242	255	190	56	34	29	41	59
12	199	3,638	138	267	209	122	101	50	30	24	36	50
13	152	4,395	150	358	466	73	93	42	29	23	96	116
14	153	1,120	139	327	816	1,967	68	35	33	19	131	374
15	143	809	151	241	349	780	215	34	29	21	77	268
16	148	711	160	203	584	311	280	38	28	19	68	173
17	156	349	152	191	311	231	368	47	36	17	46	171
18	171	304	141	174	217	217	171	44	44	25	373	212
19	164	310	173	176	246	143	401	43	40	25	330	820
20	177	282	184	160	253	111	161	37	31	25	143	445
21	168	135	1,163	146	297	98	120	33	33	30	99	252
22	234	213	651	131	196	97	133	26	31	28	54	172
23	213	202	329	118	278	839	120	25	29	27	382	138
24	152	182	219	125	204	447	84	33	28	23	385	182
25	146	1,555	196	127	198	276	64	34	26	28	1,236	762
26	143	1,661	180	138	173	216	90	30	31	23	1,597	249
27	156	363	184	131	138	153	225	32	30	58	280	203
28	707	225	550	136	181	120	378	27	27	114	168	179
29	1,191	......	535	121	148	100	171	25	25	87	145	123
30	877	......	1,302	106	109	88	111	23	35	89	134	102
31	359	......	1,827	......	104	......	84	29	......	58	......	91
Mean	400	819	336	462	343	256	145	45	31	33	210	190

1887.

1	425	274	326	203	118	93	36	1,416	52	101	46	53
2	338	193	264	212	120	136	34	537	50	79	49	40
3	246	184	269	250	110	140	31	259	50	65	42	42
4	153	269	217	242	109	103	29	158	42	82	41	42
5	90	244	198	197	103	57	1,129	133	42	65	40	67
6	85	196	194	157	92	55	1,474	117	53	84	22	95
7	110	674	395	144	173	101	290	139	71	54	23	77
8	99	1,160	969	133	279	115	156	95	53	47	26	63
9	90	874	788	138	286	89	130	83	31	39	39	58
10	76	515	1,156	121	180	71	437	66	29	36	47	124
11	112	899	649	128	139	61	168	66	25	47	59	1,250
12	102	592	324	117	119	47	107	82	559	46	68	372
13	92	244	285	104	96	41	74	84	278	41	51	195
14	908	206	277	104	79	47	62	66	151	46	42	163
15	1,107	648	208	102	63	41	54	54	111	41	54	384
16	401	658	190	112	71	37	49	68	56	33	52	523
17	288	377	163	98	74	36	373	67	63	30	48	207
18	356	2,369	162	143	64	47	129	114	51	40	47	128
19	280	2,061	170	279	55	52	79	128	49	48	47	180
20	205	530	149	322	54	50	68	77	74	45	106	187
21	152	412	160	166	52	55	60	58	53	77	126	267
22	261	501	530	133	45	49	70	58	52	136	91	325
23	641	428	469	146	41	887	627	239	66	72	70	300
24	4,099	703	365	201	54	295	561	919	50	54	57	238
25	869	417	763	155	71	123	214	266	39	66	60	177
26	560	291	546	252	67	73	140	140	48	65	58	174
27	324	809	314	209	54	56	313	96	59	59	47	155
28	255	504	883	159	47	60	126	69	53	48	52	756
29	1,987	......	477	227	48	47	104	68	62	50	66	995
30	1,069	......	226	176	57	38	131	70	106	46	56	517
31	445	......	227	......	60	......	1,198	58	......	44	......	432
Mean	523	615	397	171	96	103	273	189	83	58	54	277

Daily discharge in second-feet of Perkiomen Creek at Frederick, Pennsylvania—Continued.

1888.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4,305	109	278	424	129	136	50	31	55	110	108	179
2	3,318	103	279	369	124	82	43	77	49	117	144	149
3	765	121	311	317	112	69	38	24	38	96	136	138
4	429	95	338	248	92	62	31	26	44	72	130	143
5	363	257	252	432	75	57	29	36	40	70	120	135
6	279	604	207	2,750	88	55	29	63	38	69	124	144
7	318	461	183	556	104	52	30	85	34	348	119	134
8	773	272	168	347	101	51	27	52	33	161	101	128
9	528	321	153	279	92	48	25	64	175	109	160	143
10	325	253	193	1,545	92	43	84	60	157	83	541	262
11	241	241	692	1,937	117	46	67	38	99	71	491	173
12	209	156	1,150	525	173	50	44	111	211	79	227	146
13	186	146	352	424	186	82	36	180	229	87	176	120
14	288	150	396	341	155	40	30	99	142	87	159	92
15	234	154	380	314	148	39	22	58	101	87	1,307	115
16	255	168	521	517	138	37	19	42	99	81	715	80
17	209	172	862	456	109	42	22	38	2,691	81	381	4,786
18	201	125	512	284	87	47	19	40	5,305	90	249	2,775
19	174	159	444	247	123	43	18	32	576	88	1,344	601
20	151	1,167	779	251	139	35	27	28	342	107	825	328
21	128	3,285	3,539	241	96	36	27	912	2,804	104	370	265
22	121	1,171	1,533	198	79	32	24	3,336	424	81	275	230
23	112	843	429	174	75	29	19	311	253	85	220	201
24	104	708	347	159	82	32	13	137	194	114	193	174
25	113	2,459	403	151	95	33	15	92	170	141	190	179
26	99	2,322	934	134	118	28	17	60	207	100	225	191
27	121	1,290	1,656	124	111	24	23	52	167	525	368	364
28	144	368	1,009	127	129	32	45	52	125	833	327	469
29	121	312	1,412	120	313	147	55	40	106	592	224	235
30	108	......	691	118	171	72	46	43	93	270	201	161
31	114	......	544	......	124	......	53	48	......	184	......	186
Mean	475	643	676	470	122	53	33	202	500	165	338	433

1889.

1	190	208	75	351	241	2,187	245	1,648	60	153	268	352
2	177	190	125	850	199	729	775	657	80	162	226	335
3	168	185	605	333	171	320	1,401	461	78	187	1,004	314
4	159	169	4,235	231	155	232	1,063	393	70	113	679	278
5	215	174	1,480	190	142	209	715	412	67	103	353	236
6	787	190	628	168	125	182	334	334	71	104	266	246
7	508	166	364	142	115	134	232	229	80	123	224	246
8	310	143	282	123	105	118	182	181	71	115	246	305
9	834	142	218	115	94	116	150	164	72	103	5,389	523
10	918	128	185	106	93	172	133	181	78	90	1,147	327
11	360	123	175	100	158	170	398	173	83	87	560	287
12	290	101	165	109	119	374	264	136	132	90	453	281
13	220	104	160	139	104	239	361	131	222	193	1,792	221
14	203	122	165	143	127	153	440	1,234	252	285	1,421	300
15	183	104	158	113	137	387	4,016	1,613	208	389	508	366
16	178	197	150	105	110	754	550	352	219	231	373	322
17	1,553	791	150	93	86	446	276	227	3,130	150	300	616
18	634	1,182	166	91	76	752	199	181	3,020	131	330	537
19	374	452	173	91	60	244	188	158	603	119	2,268	282
20	209	219	167	82	343	162	458	143	410	115	1,029	355
21	578	185	257	71	745	133	223	131	302	209	725	297
22	526	149	558	82	339	168	157	123	234	186	926	252
23	480	113	302	81	189	119	130	115	173	207	471	234
24	281	101	206	71	134	93	113	115	173	178	347	198
25	340	113	184	63	115	90	104	107	439	140	816	193
26	359	114	150	593	148	881	96	100	416	134	620	349
27	724	102	137	1,894	630	627	132	98	261	3,356	670	285
28	871	82	173	1,210	723	249	172	90	185	1,202	2,803	202
29	393	......	175	536	268	175	163	84	153	451	715	181
30	248	......	143	262	177	225	598	74	139	294	462	171
31	235	......	126	......	232	......	5,567	67	......	256	......	161
Mean	436	216	395	285	208	361	640	326	383	311	913	298

Daily discharge in second-feet of Perkiomen Creek at Frederick, Pennsylvania—Continued.

1890.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	151	192	687	415	133	104	45	54	83	55	140	64
2	189	156	372	377	135	136	447	62	71	57	129	84
3	171	213	289	290	117	176	535	49	60	948	125	78
4	193	249	237	1,246	153	167	304	49	64	249	118	125
5	188	298	225	1,124	1,084	117	149	54	69	137	115	130
6	238	192	202	387	536	127	95	74	63	182	112	110
7	186	148	190	360	456	179	71	77	62	451	106	116
8	172	3,699	245	381	283	120	60	65	59	329	89	133
9	152	7,051	165	1,149	220	98	58	148	59	192	83	124
10	141	445	215	847	181	89	52	88	64	135	91	94
11	142	1,521	736	407	165	92	48	64	54	112	138	93
12	132	303	806	316	243	243	43	70	57	108	196	86
13	143	257	444	277	145	664	38	62	796	102	140	85
14	132	1,030	1,156	254	510	189	37	85	331	135	117	80
15	1,368	874	1,397	225	1,172	125	52	95	842	143	104	70
16	1,215	325	626	199	436	103	72	64	876	122	92	71
17	440	287	412	191	268	97	88	45	453	821	200	314
18	202	257	351	177	202	95	125	92	213	264	308	1,006
19	236	228	306	171	175	79	89	119	161	186	174	298
20	386	827	352	167	288	60	61	803	120	191	136	183
21	341	827	1,507	157	375	67	46	260	95	156	112	132
22	201	248	4,048	146	187	122	54	267	91	129	102	145
23	144	212	2,082	139	147	105	53	162	87	623	92	136
24	154	363	699	143	133	107	48	106	75	1,754	91	121
25	154	357	510	198	122	93	109	91	71	632	94	104
26	145	332	855	215	1,514	64	1,018	91	60	349	80	135
27	190	259	425	200	2,510	55	212	699	98	246	79	108
28	129	527	1,583	203	497	49	115	256	86	191	73	97
29	138	......	801	160	278	48	113	139	71	173	76	100
30	368	......	459	142	206	50	103	124	68	238	71	108
31	254	......	395	......	179	......	71	101	......	171	......	93
Mean	271	774	735	355	421	127	142	146	179	309	119	149

1891.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	75	1,917	238	433	105	48	28	163	236	54	51	196
2	1,931	892	206	364	103	54	28	113	210	48	42	53
3	941	760	288	870	214	50	34	84	156	50	42	51
4	298	607	201	421	243	46	36	172	129	38	37	1,225
5	219	322	211	315	139	45	33	187	2,367	38	44	1,184
6	176	260	199	242	115	40	36	146	880	38	49	256
7	149	451	217	211	94	66	33	144	396	42	37	734
8	128	762	236	179	90	117	43	74	235	73	27	456
9	101	652	711	174	92	78	77	53	178	88	30	225
10	94	977	1,260	165	78	52	53	48	145	59	38	169
11	1,705	424	509	379	83	41	37	46	120	42	89	113
12	3,431	303	551	786	76	37	29	45	108	49	124	75
13	400	272	1,352	320	65	36	23	58	99	51	71	75
14	246	239	630	233	67	32	31	58	91	45	59	75
15	206	181	314	205	68	34	45	220	85	42	41	75
16	168	1,312	462	181	96	38	43	151	80	49	52	75
17	206	1,323	233	180	97	38	38	86	77	49	123	75
18	483	781	224	177	77	55	162	228	71	40	193	75
19	304	410	209	160	78	69	413	406	66	31	110	75
20	239	363	883	147	72	65	142	155	51	275	71	60
21	209	832	4,803	135	70	58	73	109	52	173	79	59
22	3,945	1,012	1,275	140	67	84	54	176	66	134	50	80
23	970	432	1,007	158	59	73	47	116	49	220	114	895
24	390	339	640	155	61	54	81	1,169	45	118	303	1,197
25	539	342	426	129	59	36	91	1,915	53	72	138	928
26	446	397	325	107	60	30	47	374	49	67	100	791
27	379	381	298	111	72	20	45	355	47	79	94	779
28	341	215	299	113	65	27	46	573	47	79	83	408
29	782	......	278	104	51	26	812	274	40	70	66	307
30	1,315	......	245	103	55	28	425	362	52	48	49	725
31	852	......	......	......	......	......	352	368	......	48	......	261
Mean.	699	613	624	247	89	49	111	272	209	74	80	379

Daily discharge in second-feet of Perkiomen Creek at Frederick, Pennsylvania—
Continued.

1892.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	201	184	2,073	229	83	127	275	239	75	26	31	174
2	1,482	202	610	213	100	105	184	146	67	24	29	130
3	861	217	246	237	167	90	375	211	56	22	26	117
4	303	178	338	238	153	479	557	126	36	26	26	106
5	235	201	319	203	122	150	192	71	32	28	34	100
6	196	146	311	183	106	144	111	52	33	24	32	89
7	204	155	393	164	114	124	78	45	34	22	26	71
8	214	191	1,673	153	95	96	58	41	32	27	27	427
9	198	216	1,341	138	85	93	51	37	29	28	32	369
10	180	185	625	125	84	429	46	36	28	26	295	186
11	158	173	437	122	71	182	45	134	31	30	319	130
12	182	126	458	120	77	110	42	359	23	32	133	116
13	3,674	121	262	112	74	84	40	135	20	26	76	120
14	3,769	137	190	127	94	69	38	62	71	26	54	357
15	1,066	147	207	265	263	53	39	51	90	29	652	550
16	572	154	178	212	214	50	37	51	54	23	2,836	297
17	412	113	167	146	102	297	27	39	40	24	472	231
18	404	96	145	133	111	149	32	34	34	29	769	180
19	1,879	97	153	128	117	71	31	35	27	31	602	152
20	699	131	150	111	397	71	26	28	23	30	268	142
21	412	159	165	129	365	77	36	25	27	31	192	124
22	316	154	153	204	420	57	36	24	33	30	156	112
23	300	158	173	247	337	41	23	24	42	29	168	117
24	275	151	462	169	241	49	18	26	56	40	88	100
25	288	144	906	131	160	65	18	51	59	43	76	48
26	251	189	570	125	872	59	20	571	61	33	84	58
27	207	209	1,688	106	1,491	64	23	155	58	30	68	58
28	178	155	1,074	87	400	171	22	87	46	29	326	52
29	176	158	1,479	91	219	102	88	68	40	17	506	45
30	185	......	315	102	175	80	176	62	57	4	229	35
31	168	......	259	......	155	......	379	72	......	32	......	33
Mean	634	166	565	158	241	125	101	100	44	27	288	155

1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	258	257	213	157	249	78	36	21	50	26	43	108
2	1,169	597	264	144	343	78	37	30	46	30	41	143
3	268	702	252	138	998	158	37	25	46	27	42	301
4	166	535	202	136	5,139	96	36	22	44	24	867	806
5	128	335	184	118	857	86	36	19	43	25	1,470	265
6	128	244	187	101	979	156	34	16	41	25	372	199
7	94	1,021	168	113	479	197	35	14	36	30	202	204
8	93	714	217	208	349	107	35	15	38	29	158	158
9	122	383	2,224	177	283	68	63	18	41	26	386	137
10	138	3,247	3,546	190	185	59	62	22	32	27	168	168
11	128	1,534	1,221	392	201	51	46	24	32	28	102	243
12	165	512	3,401	345	185	54	40	24	38	29	84	171
13	170	602	1,493	172	177	58	39	22	28	32	87	126
14	145	854	1,039	436	177	49	39	22	25	1,939	91	101
15	132	913	937	1,537	183	44	33	19	40	105	160	109
16	138	1,190	385	506	260	38	97	14	978	53	177	989
17	169	566	320	299	548	37	118	13	315	50	112	1,091
18	190	300	325	235	249	37	60	13	140	36	88	346
19	174	318	297	196	175	43	42	16	93	30	71	226
20	165	251	275	486	138	40	33	1,129	67	34	76	137
21	172	224	353	1,061	122	38	24	289	52	34	84	139
22	173	226	369	407	115	63	22	92	43	34	341	121
23	171	193	315	268	116	86	26	55	39	38	231	135
24	160	173	340	212	115	71	31	1,166	34	74	133	137
25	138	163	335	201	106	43	28	269	33	78	104	141
26	118	153	300	195	97	77	23	110	36	45	78	177
27	102	147	240	320	91	93	21	59	38	43	83	113
28	102	166	206	355	88	67	24	44	29	263	1,118	98
29	116	......	178	211	97	54	26	187	21	161	347	129
30	258	......	172	186	96	39	23	150	25	93	199	149
31	304	......	169	......	84	......	14	69	......	65	......	117
Mean	192	591	649	317	428	72	39	129	83	113	251	241

Daily discharge in second-feet of Perkiomen Creek at Frederick, Pennsylvania—Continued.

1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	109	138	166	120	96	509	131	23	17	36	412	78
2	101	120	197	120	76	348	82	88	27	36	193	339
3	101	98	464	109	57	277	70	154	25	46	908	364
4	97	68	776	149	61	235	45	109	14	55	428	176
5	120	74	822	333	64	212	40	57	15	63	805	126
6	153	88	1,045	175	103	207	571	42	15	51	786	114
7	145	80	1,024	135	128	206	241	35	17	38	369	103
8	125	88	524	128	91	191	99	29	249	45	350	125
9	111	704	390	123	67	167	68	31	483	36	429	387
10	92	1,002	311	117	52	143	55	33	137	2,335	303	223
11	74	638	280	168	48	131	43	31	292	530	261	638
12	62	343	249	329	48	118	38	31	101	182	188	4,132
13	59	198	214	1,119	41	118	38	35	59	209	165	1,641
14	58	182	188	898	36	121	36	52	43	290	161	446
15	67	172	169	446	38	104	34	57	43	160	146	326
16	80	160	176	239	38	91	224	47	40	118	123	266
17	89	152	170	229	37	84	44	43	63	98	133	226
18	92	975	136	190	40	80	29	35	1,123	80	178	187
19	80	1,175	136	170	52	81	23	41	2,490	59	130	161
20	69	1,284	142	163	1,634	77	23	57	934	51	111	151
21	56	632	132	183	8,769	72	31	50	243	48	115	145
22	74	442	161	269	3,787	64	46	46	144	49	126	136
23	88	308	479	262	539	60	38	40	99	55	119	117
24	80	163	291	168	3,541	132	48	38	90	61	120	114
25	97	187	156	138	1,398	298	75	36	71	717	101	111
26	88	165	195	121	708	113	45	30	47	309	95	137
27	62	154	161	113	566	94	38	24	54	179	100	123
28	55	157	126	105	2,442	85	38	22	51	130	78	130
29	76	....	158	93	1,822	68	37	32	46	108	70	145
30	147	....	168	94	541	132	35	26	43	98	72	119
31	168	....	138	....	519	....	31	14	....	513	....	102
Mean	93	355	314	234	885	154	77	45	23	219	252	374

1895.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	102	138	1,192	168	236	51	393	31	30	16	84	51
2	80	128	1,235	327	163	47	151	34	30	16	82	43
3	80	122	454	463	133	43	70	34	33	18	64	155
4	86	136	418	252	128	62	56	35	31	20	47	95
5	84	143	416	181	114	79	667	39	31	25	54	67
6	115	86	240	158	101	138	489	31	29	5	54	55
7	607	98	249	143	108	115	172	22	22	21	44	45
8	839	158	1,238	1,910	106	70	105	24	19	8	45	43
9	544	178	789	4,203	94	50	71	28	23	19	44	38
10	354	222	689	682	78	50	48	24	26	13	33	41
11	2,372	243	711	380	73	55	45	75	26	17	49	45
12	905	214	323	296	134	44	40	133	22	25	65	37
13	566	196	845	1,018	151	52	39	104	18	117	38	33
14	333	186	1,528	845	205	68	37	58	16	177	43	33
15	244	171	448	393	271	55	33	39	6	63	26	30
16	242	152	312	286	151	40	37	31	24	50	52	31
17	249	136	242	232	114	36	43	31	20	41	46	25
18	187	134	313	200	101	34	40	31	18	29	49	29
19	157	141	512	175	87	30	36	29	22	33	55	30
20	137	154	476	151	80	28	31	18	26	11	52	119
21	136	184	317	156	91	30	26	18	26	22	41	127
22	142	225	324	154	120	34	23	26	20	25	36	486
23	151	193	306	154	92	36	26	27	27	24	35	197
24	148	118	334	138	76	32	33	23	27	26	18	118
25	125	114	456	126	72	31	36	18	24	22	39	80
26	2,212	117	496	126	59	35	27	19	24	24	37	71
27	559	198	282	266	236	88	21	23	22	12	39	117
28	235	820	280	247	348	104	23	24	22	33	131	117
29	191	....	222	177	139	87	21	26	4	21	85	71
30	178	....	181	236	85	141	34	38	18	21	55	110
31	165	....	161	....	66	....	30	41	....	24	....	1,191
Mean	404	182	516	475	129	59	94	37	23	32	51	120

Daily discharge in second-feet of Perkiomen Creek at Frederick, Pennsylvania— Continued.

1896.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	327	56	586	351	63	65	51	123	21	179	42	236
2	150	91	338	322	55	53	39	84	20	60	43	160
3	124	106	188	256	57	42	44	73	21	45	54	126
4	91	111	124	189	71	39	41	64	22	38	57	125
5	58	85	119	161	71	36	38	45	38	45	2,439	116
6	47	6,789	95	156	50	34	36	40	758	66	829	97
7	42	2,181	99	166	45	28	39	40	212	60	295	109
8	31	381	92	148	49	30	60	35	81	41	344	120
9	37	347	72	117	42	41	260	28	52	41	377	406
10	40	335	78	120	34	91	457	83	42	39	217	223
11	35	291	80	133	37	95	133	66	39	33	191	150
12	34	196	59	120	38	44	69	35	30	585	282	118
13	34	177	63	108	37	31	47	34	23	2,711	231	102
14	37	569	67	99	23	36	41	32	23	476	178	100
15	38	360	55	86	39	78	40	25	30	259	137	98
16	31	415	60	80	39	82	41	25	39	164	119	85
17	20	121	82	81	25	118	38	26	37	122	113	87
18	22	123	96	98	25	177	33	31	358	98	100	95
19	30	112	1,854	109	32	75	25	34	95	82	89	81
20	31	112	3,150	89	34	49	23	32	81	71	82	60
21	34	90	875	125	65	39	1,532	32	56	63	77	73
22	34	54	618	127	92	40	863	31	52	63	75	70
23	36	52	521	83	65	36	1,143	25	39	52	84	55
24	193	93	259	81	38	37	169	26	31	125	88	58
25	379	116	316	149	35	66	115	31	30	138	87	58
26	156	75	655	114	35	94	79	26	33	82	72	55
27	105	70	700	84	38	125	70	26	34	68	65	52
28	86	69	301	78	165	71	177	31	26	60	175	55
29	60	638	2,520	66	300	124	297	24	36	57	895	58
30	43	....	1,052	67	119	88	1,938	17	287	57	379	47
31	43	....	465	......	74	....	250	20	....	53	....	36
Mean	78	493	504	132	61	65	264	41	88	195	280	107

1897.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	51	46	131	88	82	105	45	86	35	22	70	136
2	78	55	128	85	2,580	88	46	180	113	18	3,089	113
3	85	55	162	76	1,330	80	33	61	159	13	103	95
4	124	49	246	67	381	124	30	54	75	17	169	161
5	318	55	211	139	268	180	34	213	67	17	100	1,942
6	547	965	545	200	199	150	34	117	37	10	70	513
7	83	4,083	315	149	148	105	29	58	33	15	47	386
8	76	846	200	115	124	118	35	55	29	22	34	207
9	61	346	172	1,643	112	899	43	45	34	18	96	168
10	51	204	180	988	124	473	38	53	32	8	120	146
11	52	171	198	311	131	106	30	201	13	15	84	133
12	47	123	221	218	138	127	203	120	8	23	106	360
13	38	110	212	185	4,747	106	248	66	29	22	88	355
14	49	115	168	153	1,566	97	38	49	29	29	41	1,909
15	45	110	199	323	1,003	84	56	48	33	28	44	2,561
16	39	161	189	316	425	75	44	149	36	17	60	229
17	46	184	129	265	365	75	41	167	29	16	87	325
18	117	413	139	216	300	85	213	68	26	27	97	249
19	150	351	322	166	173	85	292	50	23	30	70	185
20	96	153	730	129	153	64	130	47	19	14	51	145
21	1,291	347	392	116	217	61	104	41	23	16	51	151
22	504	664	242	110	221	63	588	39	25	23	67	166
23	157	1,242	201	99	137	63	231	33	22	20	60	141
24	115	457	564	94	202	51	128	30	35	28	60	99
25	136	244	405	80	442	46	77	112	46	88	62	73
26	130	193	208	84	201	50	60	123	38	89	93	71
27	93	158	167	94	126	37	475	52	29	62	1,117	89
28	81	136	146	76	103	35	1,901	37	31	50	317	94
29	69	....	128	70	93	38	729	26	27	49	219	82
30	51	....	120	61	83	35	236	27	22	47	183	88
31	48	....	98	....	99	....	127	28	....	39	....	130
Mean	156	429	241	223	525	128	205	78	40	29	238	364

Daily discharge in second-feet of Perkiomen Creek at Frederick, Pennsylvania—Continued.

1898.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	163	145	153	292	201	113	29	32	40	28	129	363
2	37	137	138	213	160	103	30	38	28	20	90	242
3	69	147	168	178	147	96	34	46	23	29	76	233
4	62	129	183	157	141	93	29	49	19	31	70	1,916
5	45	114	153	151	148	75	29	139	27	23	78	3,406
6	59	114	127	171	199	60	30	104	25	21	63	569
7	101	116	115	184	497	63	28	50	34	18	45	352
8	121	125	115	155	3,493	59	29	43	51	23	94	218
9	102	140	107	129	1,360	46	57	116	45	26	52	100
10	94	182	107	113	495	37	64	332	29	31	1,422	102
11	106	318	102	121	398	39	39	393	25	27	1,100	92
12	205	541	99	127	495	46	35	145	22	27	272	97
13	302	414	99	108	580	54	37	82	19	30	173	100
14	253	307	98	106	415	50	37	56	24	30	167	91
15	542	248	89	323	1,403	41	37	44	25	56	150	78
16	661	272	76	259	1,013	50	37	43	17	56	103	70
17	296	159	85	170	713	56	18	45	15	40	202	72
18	166	166	88	122	377	44	28	46	13	45	447	78
19	147	258	88	113	392	49	39	258	12	39	3,808	111
20	585	5,552	74	126	289	64	190	71	14	71	602	890
21	704	1,650	133	125	345	66	115	60	17	57	312	384
22	375	739	426	102	232	56	73	51	27	162	233	552
23	2,758	474	445	95	211	53	51	50	42	116	763	1,364
24	570	332	341	658	255	51	41	47	54	61	403	452
25	323	265	340	428	422	39	37	47	61	60	317	308
26	454	218	220	433	353	36	39	39	52	235	267	215
27	393	182	173	285	268	37	40	35	43	475	207	189
28	261	166	282	481	219	41	65	30	43	163	213	150
29	205	......	414	641	168	45	74	24	45	93	330	126
30	166	......	894	312	153	41	48	24	38	111	395	139
31	166	......	456	......	131	......	37	38	......	198	......	230
Mean	338	486	206	229	505	56	44	83	30	77	416	428

1899.

1	313	131	651	346	78	76	84	72	53	147	294	68
2	239	130	635	262	82	66	52	346	440	101	286	114
3	239	120	589	248	98	49	45	722	922	99	181	84
4	222	182	753	252	101	38	41	177	318	101	724	69
5	1,014	193	3,525	230	84	36	41	90	174	93	309	71
6	1,315	143	975	185	83	36	41	77	106	98	184	56
7	1,476	148	588	245	74	38	36	66	57	119	138	55
8	394	152	391	1,366	70	39	41	52	43	105	109	64
9	311	174	365	428	87	41	816	48	290	95	107	56
10	239	183	345	296	73	48	163	157	227	80	104	44
11	195	158	475	251	101	49	71	1,021	213	72	88	43
12	165	170	1,519	219	213	43	43	224	369	67	110	146
13	150	222	1,552	187	129	38	42	90	189	57	112	250
14	245	236	510	178	125	39	43	66	97	53	62	127
15	410	225	848	170	123	44	38	54	71	57	62	84
16	475	255	879	260	83	34	35	46	54	48	92	75
17	789	233	437	501	93	26	38	52	46	51	77	67
18	443	683	853	263	201	29	42	42	55	65	60	55
19	196	992	2,423	196	210	27	42	37	58	80	58	133
20	192	1,311	780	160	129	26	40	36	748	81	67	182
21	164	1,495	421	146	86	82	33	29	385	67	65	127
22	145	1,507	1,146	136	70	65	27	53	206	63	53	79
23	147	1,767	893	118	96	41	25	61	184	57	159	57
24	1,081	869	517	113	98	43	25	44	115	49	200	662
25	2,693	469	417	120	70	83	26	39	110	34	116	531
26	378	1,184	534	114	57	110	70	34	3,363	34	79	177
27	289	4,043	513	99	60	74	82	502	462	60	75	133
28	212	883	1,002	87	60	165	98	197	258	62	81	91
29	201	......	1,377	81	71	501	89	84	174	51	66	59
30	153	......	555	76	122	220	817	64	168	71	65	51
31	129	......	466	......	93	......	158	63	......	78	......	47
Mean	472	659	869	245	100	74	104	150	332	74	139	124

WISSAHICKON CREEK NEAR PHILADELPHIA, PENNSYLVANIA.

The drainage basin of this creek is immediately adjacent to Philadelphia, and between Little Neshaminy and Perkiomen creeks. Measurements of flow were begun in April, 1897, under the direction of Mr. John E. Codman, at a point about 100 yards above the junction of the creek with Schuylkill River. The results for 1897 and 1898 have been printed in the Twentieth Annual Report, Part IV, and the daily flow to June 1, 1899, is given in the following table:

Daily discharge in second-feet of Wissahickon Creek, near Philadelphia, Pennsylvania, for 1899.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	Day.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	141	119	285	191	89	45	18	147	227	273	129	96	......
2	106	106	245	175	96	42	19	118	350	603	129	90	......
3	106	110	233	175	103	42	20	116	466	340	123	73	......
4	120	204	233	173	93	33	21	115	436	202	115	68	......
5	412	204	1,059	159	80	21	22	106	779	521	106	75	......
6	574	113	365	151	80	......	23	106	630	328	106	96	......
7	573	113	241	166	87	......	24	259	359	232	106	96	......
8	220	113	204	451	87	......	25	925	250	202	106	75	......
9	194	113	186	205	75	......	26	184	245	216	106	64	......
10	154	113	198	152	75	......	27	142	1,285	198	106	64	......
11	140	113	198	140	105	......	28	133	423	434	101	54	......
12	132	113	198	140	108	......	29	136	......	813	98	50	......
13	118	113	540	140	90	......	30	136	......	260	95	59	......
14	144	113	208	137	87	......	31	136	......	218	......	54	......
15	149	113	346	129	87	......							
16	140	113	359	142	87	......	Mean	207	271	326	146	81	......
17	232	149	186	142	87	......							

SCHUYLKILL RIVER NEAR PHILADELPHIA, PENNSYLVANIA.

This river receives the drainage of the portion of southeastern Pennsylvania lying between the Lehigh River on the north and the Susquehanna River on the south. It flows in a general southeasterly course, emptying into Delaware River, the city of Philadelphia being located at the junction of these streams. Records of the height of the river at Fairmount pool have been kept for many years, but not in such form as to be useful in computing daily discharges. In 1898, however, careful estimates were prepared by Mr. John E. Codman, the results being given in the Twentieth Annual Report, Part IV, page 97. The figures for 1899 are given in the following table:

These do not represent the total flow of the stream, but the amount wasted over the flashboards at Fairmount dam. To this must be added the pumpage from the river, amounting to 275,000,000 gallons per day, or 425 second-feet; also the leakage, amounting to 71,000,000 gallons per day, or 110 second-feet; also the quantity used for power at Fairmount, amounting to an average per day of 272,000,000 gallons, or 421 second-feet. There has been no method for obtaining the daily flow when the water does not waste over the flashboards. When the water is below the overflow line recourse is had to pumping, and the draft is on the storage of the pool. As soon as the water begins to rise after a rain the turbine wheels are started and, thus it often occurs that no water flows to waste for from one to three months in succession.

Daily discharge in second-feet of Schuylkill River above Philadelphia, Pennsylvania, for 1899, being amount wasted over flashboards at Fairmount Dam.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	573	566	11,170	5,321	......	440	385	514	......	......	60	......
2	170	566	8,532	4,156	......	204	......	......	......	......	605	......
3	26	347	6,717	3,352	......	341	......	2,421	964	......	477	......
4	135	1.023	6,421	2,910	......	179	......	414	217	......	1,961	......
5	3,033	1,250	17,735	2,481	......	......	......	......	......	......	3,002	......
6	6,017	781	13,186	2,210	......	......	......	......	......	......	1,415	......
7	8,945	825	4,748	2,945	......	......	......	......	......	......	703	......
8	2,521	342	7,120	7,735	......	......	......	......	......	......	831	......
9	1,470	31	5,504	7,651	......	......	1,185	......	......	......	733	......
10	1,035	......	4,805	5,068	46	......	385	......	179	......	622	......
11	816	......	4,468	3,824	......	......	......	4,775	......	......	......	......
12	511	......	4,961	3,920	357	......	......	2,213	173	......	......	......
13	248	......	11,906	2,478	369	......	......	641	130	......	83	857
14	436	......	7,918	2,478	31	......	......	......	......	......	83	1,012
15	693	......	7,046	2,478	......	......	......	......	......	......	......	159
16	950	50	8,948	2,478	......	......	......	......	......	......	......	260
17	1,854	902	5,619	2,902	......	......	......	......	......	......	......	......
18	1,421	3,301	5,310	2,478	277	......	......	......	......	......	......	68
19	569	3,858	14,442	2,075	1,061	......	......	......	......	......	......	570
20	523	4,990	10,540	1,582	532	......	......	......	550	......	......	610
21	526	5,908	10,748	1,012	240	......	......	......	1,489	......	......	331
22	305	8,656	11,230	849	25	......	......	......	1,042	......	......	331
23	305	9,746	11,548	337	......	......	......	......	49	......	......	......
24	4,226	4,914	8,034	212	......	......	......	......	......	......	397	1,201
25	14,980	4,984	6,326	......	......	......	......	......	......	......	397	3,854
26	7,082	1,605	6,134	......	......	624	......	......	10,923	......	......	2,902
27	1,752	17,177	5,874	......	......	241	......	1,775	5,653	......	......	2,489
28	1,951	18,045	8,622	......	......	......	......	637	2,155	......	......	2,077
29	1,175	......	13,757	......	......	1,238	......	......	1,154	......	......	1,277
30	967	......	9,085	......	......	1,752	215	468	494	......	......	298
31	1,120	......	6,718	......	519	......	1,920	336	......	......	......	......

Total monthly yield, in cubic feet, of Schuylkill River above Philadelphia, Pennsylvania, for 1899.

January	11,445,838,000	July	3,475,700,000
February	12,484,000,000	August	3,964,400,000
March	28,187,700,000	September	5,258,910,000
April	11,957,000,000	October	2,587,900,000
May	5,153,450,000	November	4,896,500,000
June	3,856,560,000	December	5,086,600,000

NORTH BRANCH OF SUSQUEHANNA RIVER AT WILKESBARRE, PENNSYLVANIA.

This stream rises in New York State and flows in a southwesterly direction until it crosses the Pennsylvania State line, when it flows to the southeast, turning again near Wilkesbarre to the southwest, and joins the West Branch of the Susquehanna on the western border of Northumberland County to form Susquehanna River. Measurements of flow are made at Wilkesbarre and Danville, Pennsylvania.

Observations of fluctuations of Susquehanna River are made by the Weather Bureau above Wilkesbarre, at Towanda, Pennsylvania, where the drainage area is estimated to be 8,000 square miles. The river gage, made of iron 1 foot wide and one-half inch thick, is on the east side of the road bridge over Susquehanna River, and is securely bolted to the masonry of the pier. The graduation is from 0 to 25 feet. The highest water was 29 feet in March, 1869, and the lowest,

—0.1, in October, 1895. The danger line is at 16 feet. The elevation of the zero is 633.7 feet.

The Wilkesbarre station was established by E. G. Paul on March 30, 1899, and is located at the Market street bridge. The gage is a sash chain and weight inclosed in a long, narrow box, covering 12 feet of the scale board. The scale board is divided into feet and tenths and painted the color of the ironwork. The length of the chain from zero to extreme end of weight is 40.83 feet. The initial point of sounding is at the end of the iron guard rail on the left bank. The channel is straight for a quarter of a mile above and below the station, the current sluggish but unobstructed. The right bank is low and liable to overflow; the left bank is above ordinary floods. The bed of the stream is of sand and gravel, somewhat shifting. The observer is O. Hemstreet, the bridge superintendent, Wilkesbarre, Pennsylvania. When this gage was established there was found to be a gage painted on the bridge pier, being a portion of one established by the Weather Bureau. The lower part of this gage, erected in January, 1898, originally consisted of heavy cast-brass plates graduated to feet and tenths. The gage plates were made in 4-foot sections and bolted to the stone bridge pier. The two lower sections of the brass plates had been torn away by ice, so that there was no graduation below the 8-foot mark, but readings were made by the figures painted on the stone pier. The zero of this old gage is at the base of the dressed-stone portion of the pier, and is reported to be 535 feet above sea level. During low stages of the river the water recedes from the pier, rendering it impracticable to read the gage. So far as could be ascertained, this has not been connected with the city datum. On account of the low water, which in 1897 had gone below the city datum, it was decided to put the zero of the new gage 4 feet below the zero of the old Weather Bureau gage, so as to obviate minus readings. In order, therefore, to compare with former records, it is necessary to add 4 feet to the old figures. The danger mark of this Weather Bureau gage is at 14 feet, or 18 feet of new gage, as at this elevation the west bank of the river is under water in places. River reports from this locality were furnished as early as 1888. During low water, measurements were made by wading at a better cross section, at Retreat, 10 miles below Wilkesbarre. The following measurements were made by E. G. Paul during 1899:

Measurements of North Fork of Susquehanna River at Wilkesbarre, Pennsylvania.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1899.	*Feet.*	*Second-ft.*	1899.	*Feet.*	*Second-ft.*
March 30	9.00	24,800	September 17	2.30	851
June 6	4.30	3,668	September 18	2.30	*a*1,096
July 26	2.80	*a*1,924	October 16	2.35	*a*1,114
July 27	2.80	1,357			

a Made at Retreat, Pennsylvania, 10 miles below Wilkesbarre.

Daily gage height, in feet, of North Branch of Susquehanna River at Wilkesbarre, Pennsylvania, for 1899.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		8.40	6.40	4.50	3.60	2.70	3.10	2.50	2.50	3.40
2		8.10	6.20	5.50	3.30	2.60	2.90	2.50	3.00	3.40
3		7.70	6.30	5.30	3.30	2.70	2.60	2.50	8.30	3.40
4		7.20	6.30	5.10	3.20	2.60	2.60	2.50	6.70	3.40
5		6.90	6.40	4.60	3.00	3.20	2.50	2.50	7.30	3.50
6		6.90	6.10	4.30	3.00	3.00	2.50	2.60	6.60	3.50
7		7.40	5.70	3.60	2.80	2.80	2.50	2.60	6.90	3.50
8		10.35	5.60	3.50	2.90	2.50	2.40	2.50	5.30	3.70
9		14.10	5.40	3.50	2.80	2.50	2.40	2.50	5.00	3.60
10		14.20	5.30	3.50	2.80	2.50	2.40	2.50	4.50	3.50
11		12.80	5.10	3.30	2.80	2.50	2.40	2.50	4.20	3.50
12		11.10	5.20	3.20	2.90	2.50	2.50	2.50	4.30	3.60
13		11.30	5.10	3.20	2.90	2.70	2.50	2.40	4.90	7.70
14		14.00	5.00	3.20	3.00	2.80	2.50	2.40	4.70	9.60
15		14.30	5.00	3.00	3.20	2.80	2.40	2.40	4.60	9.60
16		13.90	4.80	3.10	3.30	2.80	2.40	2.40	4.50	8.50
17		13.40	4.80	3.20	3.10	2.90	2.30	2.30	5.20	7.70
18		12.50	4.70	3.20	3.00	2.70	2.30	2.30	5.20	7.30
19		11.30	4.90	3.00	3.00	2.40	2.30	2.30	5.30	6.50
20		10.50	4.90	3.00	3.00	2.30	2.30	2.30	5.00	6.50
21		9.90	5.40	3.10	3.10	2.30	2.30	2.30	4.70	8.30
22		9.40	5.90	3.00	3.00	2.60	2.30	2.30	4.60	8.40
23		9.00	5.80	3.00	3.00	2.50	2.30	2.30	4.30	7.40
24		8.50	5.70	2.90	2.90	2.50	2.30	2.30	4.20	6.60
25		8.00	5.50	2.90	2.80	2.40	2.20	2.30	4.00	8.40
26		7.40	5.40	3.10	2.80	2.40	2.50	2.20	3.80	8.00
27		7.60	5.10	3.10	2.80	2.40	2.40	2.30	3.80	7.40
28		7.40	4.90	3.30	2.80	2.40	2.50	2.30	3.70	6.30
29		7.10	4.80	3.80	2.80	4.60	2.50	2.50	3.60	9.10
30	9.00	6.60	4.80	4.00	2.60	4.10	2.60	2.50	3.50	7.90
31	8.70		4.70		2.60	3.40		2.50		

NORTH BRANCH OF SUSQUEHANNA RIVER AT DANVILLE, PENNSYLVANIA.

This station, 52 miles below Wilkesbarre and 11 miles above the mouth of the West Branch, was established on March 25, 1899, by E. G. Paul. It is located at the Mill street bridge, 600 feet south of the public square, Danville, Pennsylvania. The length of the wire gage from zero to the end of the weight is 42.85 feet. This gage is referred to a pine-board scale nailed to the hand rail of the bridge and divided into feet and tenths. The initial point of soundings is at the end of the wooden hand rail on right bank. The channel is straight for half a mile above and below the station. The left bank is high, but the right bank is subject to overflow. The bed of the stream is rocky, with some gravel, and is unchangeable. The following measurements were made by E. G. Paul during 1899:

March 25, gage height, 10.00 feet; discharge, 47,646 second-feet.
June 8, gage height, 3.00 feet; discharge, 3,927 second-feet.
July 27, gage height, 2.40 feet; discharge, 2,272 second-feet.
September 16, gage height, 2.00 feet; discharge, 1,427 second-feet.
October 17, gage height, 1.90 feet; discharge, 1,163 second-feet.

Daily gage height, in feet, of North Branch of Susquehanna River at Danville, Pennsylvania, for 1899.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	....	6.95	4.80	3.30	3.20	2.20	2.80	2.10	2.10	3.10
2	....	6.80	4.65	3.40	3.00	2.20	2.60	2.10	2.60	3.00
3	....	6.35	4.60	3.70	2.80	2.60	2.50	2.10	2.60	3.00
4	....	6.00	4.60	3.60	2.70	2.30	2.50	2.10	6.10	3.00
5	....	5.65	4.60	3.50	2.60	2.20	2.30	2.00	5.40	3.00
6	....	5.50	4.55	3.30	2.60	2.20	2.20	2.00	5.70	2.90
7	....	5.65	4.35	3.20	2.60	2.50	2.20	2.00	5.20	3.10
8	....	6.90	4.15	3.00	2.50	2.30	2.10	2.00	4.70	3.10
9	....	10.50	3.80	3.00	2.50	2.20	2.40	2.10	4.30	3.10
10	....	11.60	3.70	2.90	2.50	2.20	2.20	2.10	3.90	3.00
11	....	10.45	3.70	2.90	2.50	2.60	2.10	2.00	7.30	3.00
12	....	9.15	3.75	2.90	2.40	2.30	2.20	2.00	3.90	3.10
13	....	8.95	3.80	2.70	2.60	2.40	2.10	2.00	3.70	4.20
14	....	10.75	3.70	2.70	2.70	2.30	2.10	1.90	4.00	6.80
15	....	11.55	3.70	2.60	2.60	2.30	2.10	1.90	3.90	7.80
16	....	11.40	3.60	2.60	2.80	2.30	2.00	1.90	3.80	7.60
17	....	10.85	3.60	2.60	2.80	2.30	1.90	1.90	3.90	6.70
18	....	10.05	3.70	2.60	2.70	2.30	1.90	1.90	4.30	6.10
19	....	9.05	3.60	2.60	2.70	2.30	1.80	1.90	4.40	5.70
20	....	8.25	3.60	2.50	2.50	2.20	1.80	1.90	4.30	5.40
21	....	7.75	3.60	2.50	2.50	2.10	1.90	1.90	4.10	5.60
22	....	7.35	3.80	2.50	2.50	2.10	1.90	1.90	3.80	6.90
23	....	7.05	3.80	2.50	2.50	2.10	1.80	1.90	3.90	6.30
24	....	6.65	3.80	2.50	2.50	2.10	1.80	1.90	3.60	6.30
25	10.00	6.20	3.80	2.50	2.50	2.00	1.80	1.90	3.40	6.50
26	9.25	5.85	3.70	2.70	2.40	2.00	1.90	1.90	3.40	7.10
27	8.10	5.70	3.60	2.60	2.40	2.00	1.90	1.90	3.30	6.90
28	7.35	5.65	3.50	2.60	2.40	2.30	1.80	1.80	3.20	6.40
29	7.30	5.35	3.30	2.90	2.40	2.20	1.90	1.90	3.10	5.80
30	7.55	5.10	3.20	3.20	2.40	3.50	2.10	1.90	3.10	5.00
31	7.45	....	3.20	....	2.30	3.20	....	1.90	....	.....

WEST BRANCH OF SUSQUEHANNA RIVER AT ALLENWOOD, PENNSYLVANIA.

The West Branch of Susquehanna River rises in Cambria County, Pennsylvania, and flows in a general northeasterly direction, meeting the North Branch on the western border of Northumberland County and forming Susquehanna River.

Observations of height of water on the West Branch have been made by the Weather Bureau at Lockhaven, Pennsylvania, 47 miles above Allenwood. The drainage area is given as 3,740 square miles, and the width of river 1,125 feet. The gage is in two sections. The lower section is painted on the side wall of the canal lock, and the upper is on the highway bridge over the river. The elevation of the zero is 555.7 feet. The highest water was 18 feet, on June 1, 1889, and the danger line is at ten feet.

Below the junction of the North and West Branches of Susquehanna River observations have been made of height of water by the Weather Bureau at Selins Grove, 45 miles above Harrisburg. The drainage area is given as 17,600 square miles. The river at this point is about 1 mile wide, including an island 400 feet wide. The gage is on the west abutment of a railroad bridge.

A gaging station was established on the West Branch by E. G. Paul on March 25, 1899, at Allenwood, Pennsylvania, 20 miles above the junction with the North Branch. Measurements are made from the public highway bridge, one-fourth of a mile east of the railroad station at Allenwood. The wire gage is 42.15 feet from zero to the end of the weight, and is referred to a pine-board scale fastened to ironwork of the bridge and divided into feet and tenths. The initial point of soundings is at the end of the iron guard rail on the right bank. The channel is straight for one-half a mile above and below the station. The current is sluggish, but unobstructed. The banks are low and subject to overflow at time of high water. The bed of the stream is rocky and constant. The observer is Frank L. Allen, a farmer living 200 feet from the gage. The following measurements were made by E. G. Paul during 1899:

March 24, gage height, 4.90 feet; discharge, 32,031 second-feet.
June 8, gage height, 3.00 feet; discharge, 3,988 second-feet.
July 28, gage height, 2.05 feet; discharge, 1,360 second-feet.
September 15, gage height, 1.90 feet; discharge, 1,234 second-feet.
October 17, gage height, 1.70 feet; discharge, 842 second-feet.

Daily gage height, in feet, of West Branch of Susquehanna River at Allenwood, Pennsylvania, for 1899.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	....	6.70	3.80	3.50	2.90	2.00	2.70	2.00	2.20	2.90
2	....	6.30	3.80	3.50	2.70	2.00	2.70	2.00	3.60	2.80
3	....	5.80	3.80	3.40	2.50	2.00	2.70	1.90	4.20	2.70
4	....	5.35	3.90	3.40	2.50	1.80	2.50	1.90	5.20	2.70
5	....	5.05	3.80	3.30	2.40	1.70	2.40	1.90	4.60	2.70
6	....	4.90	3.60	3.20	2.40	1.70	2.30	1.90	4.00	2.60
7	....	4.80	3.50	3.00	2.30	1.70	2.10	1.90	3.40	2.60
8	....	6.45	3.30	3.00	2.40	1.70	2.00	1.90	3.20	2.60
9	....	7.80	3.40	2.90	2.20	1.70	2.00	1.90	3.00	2.60
10	....	7.40	3.50	2.90	2.00	1.70	2.00	1.80	3.00	2.60
11	....	6.60	3.60	2.70	2.10	1.70	1.90	1.80	3.00	2.60
12	....	6.20	3.70	2.60	2.30	1.70	1.90	1.80	3.20	5.30
13	....	6.50	3.50	2.60	2.20	1.90	1.90	1.70	3.30	8.40
14	....	7.00	3.40	2.60	2.20	1.90	1.90	1.70	3.40	7.40
15	....	6.90	3.30	2.50	2.30	1.90	1.90	1.70	3.50	6.50
16	....	6.80	3.20	2.50	2.20	1.90	1.90	1.70	3.60	5.80
17	....	6.40	3.40	2.50	2.30	1.90	1.90	1.70	3.80	5.10
18	....	5.60	3.80	2.40	2.40	1.90	1.90	1.70	3.90	4.90
19	....	5.40	7.40	2.40	2.60	1.80	1.90	1.70	4.10	4.80
20	....	5.00	6.50	2.40	2.80	1.70	1.90	1.70	4.30	4.70
21	....	4.80	5.75	2.40	3.00	1.70	1.90	1.60	4.10	4.30
22	....	4.70	5.15	2.30	2.70	1.70	1.90	1.60	4.00	4.20
23	4.90	4.50	4.70	2.20	2.50	1.70	1.90	1.60	3.90	4.20
24	4.90	4.40	4.35	2.20	2.30	1.60	1.90	1.60	3.80	5.15
25	4.60	4.30	4.00	2.80	2.20	1.60	1.90	1.60	3.70	7.25
26	4.20	4.30	3.80	2.50	2.20	1.60	1.90	1.60	3.60	5.60
27	4.30	4.30	3.60	2.60	2.10	1.70	2.00	1.60	3.40	5.00
28	6.20	4.20	3.50	2.70	2.00	3.70	2.00	1.60	3.30	4.50
29	6.70	4.30	3.40	2.70	1.90	3.00	2.00	1.60	3.20	4.10
30	7.80	4.10	3.40	2.80	1.80	2.60	2.00	1.60	3.10	3.60
31	7.35	....	3.50	....	2.00	2.60	....	1.60	....	....

JUNIATA RIVER AT NEWPORT, PENNSYLVANIA.

Juniata River rises in Center County, Pennsylvania, and flows in a general southeasterly direction into Susquehanna River 15 miles above Harrisburg. Its drainage area is mountainous and for the most part covered with forest growth. The station was established at Newport, about 15 miles above its junction with the Susquehanna, on March 21, 1899, by E. G. Paul. It is at the covered wagon bridge, 800 feet east of the public square, Newport, Pennsylvania. The wire gage is 39.54 feet long from the end of the weight to the index. A scale board is nailed to the bridge timbers inside of the structure and is divided into feet and tenths. The initial point of soundings is at the end of the woodwork of the bridge on the right bank. The channel is straight for half a mile above and below the station. The current is swift and unobstructed. The banks are high and not subject to overflow. The bed of the stream is rocky and the section constant. The observer is A. R. Bortel, a laborer living in Newport, Pennsylvania, about 800 feet from the gage. The following measurements were made by E. G. Paul during 1899:

March 21, gage height, 6.60 feet; discharge, 13,094 second-feet.
June 9, gage height, 3.20 feet; discharge, 1,903 second-feet.
July 31, gage height, 2.90 feet; discharge, 682 second-feet.
September 14, gage height, 4.55 feet; discharge, 4,625 second-feet.
October 18, gage height, 2.90 feet; discharge, 829 second-feet.

Daily gage height, in feet, of Juniata River at Newport, Pennsylvania, for 1899.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	....	7.00	3.40	3.11	2.70	3.00	3.50	3.20	2.70	3.30
2	....	6.10	3.40	3.60	2.70	3.00	3.50	3.10	4.00	3.30
3	....	5.50	3.60	3.50	2.60	3.00	3.40	3.10	4.90	3.30
4	....	5.10	3.70	3.40	2.50	3.00	3.40	3.10	4.60	3.30
5	....	4.90	3.50	3.30	3.00	3.00	3.20	3.00	4.20	3.30
6	....	4.50	3.40	3.40	3.00	3.00	3.30	3.00	3.90	3.20
7	....	4.30	3.40	3.30	3.00	3.30	3.30	3.00	3.70	3.10
8	....	5.60	3.40	3.20	3.00	3.50	3.30	3.00	3.50	3.10
9	....	7.80	3.60	3.20	3.10	3.30	3.30	2.90	3.50	3.10
10	....	6.90	3.60	2.80	3.30	3.20	3.30	2.90	3.40	3.10
11	....	5.80	4.00	2.80	3.30	3.10	3.30	2.90	3.30	3.10
12	....	5.50	4.10	2.80	3.30	3.10	3.40	2.90	3.30	3.70
13	....	5.10	4.00	2.80	3.10	3.40	4.80	2.90	3.30	4.80
14	....	4.90	3.80	2.70	3.10	3.10	4.80	2.90	3.20	5.50
15	....	4.80	3.80	2.70	3.10	3.10	3.80	2.90	3.20	5.10
16	....	4.70	3.60	2.70	3.00	3.00	3.50	2.90	3.20	4.80
17	....	5.50	3.70	2.70	2.90	3.00	3.30	2.90	3.20	4.30
18	....	4.40	4.10	2.70	2.90	3.00	3.10	2.90	3.10	4.00
19	....	4.30	8.00	2.60	2.90	3.00	3.10	2.90	3.10	4.00
20	....	4.10	7.30	2.60	3.00	3.10	3.10	2.90	3.10	3.70
21	6.50	4.00	7.60	2.60	3.00	3.00	3.10	2.90	3.10	3.70
22	6.00	3.90	5.10	2.60	3.00	3.00	3.10	2.90	3.10	5.00
23	5.70	3.80	4.70	2.50	3.00	2.90	3.10	2.80	3.10	5.00
24	6.00	3.80	4.40	2.50	3.00	2.90	3.10	2.80	3.40	5.00
25	5.50	3.70	4.00	2.50	3.00	2.90	3.10	2.80	4.00	5.80
26	5.20	3.60	3.70	2.50	3.00	2.90	3.10	2.80	4.00	5.50
27	5.10	3.60	3.70	2.50	2.80	2.90	3.10	2.80	3.80	4.50
28	5.10	3.60	3.70	2.60	2.90	4.40	3.20	2.80	3.60	4.30
29	8.80	3.50	3.70	2.70	2.90	4.10	3.30	2.80	3.50	4.10
30	10.30	3.40	4.10	2.70	2.90	5.00	3.30	2.70	3.40	4.10
31	8.30	....	3.11	....	2.90	4.40	....	2.70	....	4.10

SUSQUEHANNA RIVER AT HARRISBURG, PENNSYLVANIA.

Observations of the height of water in the Susquehanna River have been made for several years at the pump house of the waterworks located in the western part of the city of Harrisburg, Pennsylvania, this being about 55 miles below the junction of the north and west branches. A float is located in the pump well connected with the river, which indicates the height of water upon a painted scale. The datum is the low-water mark of 1804. Observations are made by the engineer, C. M. Nagle, each morning before starting the pumps. The record since 1890 has been furnished by E. Mather, president of the Harrisburg Water Company. Measurements of discharge are made from the open iron bridge on Second street. The initial point for soundings is the iron upright on the east end of the bridge. The stream is divided into two channels, with a large island between. The channel above and below the station is straight for about 2,500 feet, the banks high, and the current of moderate velocity. The first measurement was made on March 31, 1897. The results of measurement may be found as follows: 1897, Nineteenth Annual Report, Part IV, pages 122–127; 1898, Twentieth Annual Report, Part IV, page 109. The following measurements were made by E. G. Paul during 1899:

June 11, gage height, 1.75 feet; discharge, 11,746 second-feet.
July 29, gage height, 0.91 foot; discharge, 6,534 second-feet.
September 12, gage height, 0.75 foot; discharge, 5,404 second-feet.
October 25, gage height, 0.16 foot; discharge, 3,625 second-feet.

Daily gage height, in feet, of Susquehanna River at Harrisburg, Pennsylvania, for 1899.

Day.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.25	2.50	8.41	7.25	3.41	2.50	1.75	0.75	1.83	1.08	0.50	1.75
2	3.16	2.00	8.16	6.41	3.08	2.58	1.66	.75	1.50	.83	1.66	1.58
3	2.75	1.91	7.83	5.83	3.08	2.50	1.66	.75	1.25	.83	2.50	1.50
4	3.25	2.25	7.41	5.33	3.41	2.50	1.50	.75	1.08	.75	3.25	1.50
5	3.50	2.58	8.00	4.91	3.16	2.50	1.33	.75	1.08	.66	4.50	1.50
6	5.00	2.66	12.50	4.41	3.16	2.33	1.25	.91	1.00	.66	3.91	1.50
7	8.00	2.83	13.00	4.25	3.00	2.08	1.25	.75	.91	.58	3.75	1.50
8	6.83	2.41	11.41	4.75	2.75	1.91	1.16	.75	.91	.58	3.16	1.50
9	6.08	2.50	9.25	6.83	2.83	1.91	1.16	.83	.83	.58	2.83	1.50
10	5.41	2.41	7.66	8.75	2.66	1.91	1.16	.75	1.00	.66	2.50	1.50
11	4.58	2.41	6.50	8.41	2.75	1.75	1.41	.66	1.00	.58	2.25	1.50
12	4.00	4.41	5.75	7.75	2.75	1.66	1.25	.66	.75	.58	2.16	1.50
13	3.33	4.41	5.75	6.75	2.91	1.66	1.16	1.08	.83	.50	2.08	2.75
14	3.16	4.58	7.50	6.75	2.83	1.58	1.16	1.08	1.41	.50	2.00	5.50
15	3.33	4.58	8.41	8.00	2.58	1.50	1.16	1.25	1.25	.51	2.25	6.33
16	3.66	4.66	8.00	8.00	2.50	1.50	1.08	.91	.83	.41	2.41	6.00
17	4.83	4.83	7.41	7.83	2.50	1.41	1.00	.66	.75	.41	2.41	5.33
18	7.00	4.83	6.41	7.33	2.58	1.25	1.25	.66	.75	.41	2.41	4.58
19	6.33	4.91	4.33	6.83	3.75	1.25	1.25	.50	.58	.41	2.83	4.08
20	5.66	4.75	7.16	6.00	4.75	1.25	1.25	.50	.66	.33	3.00	3.75
21	4.91	4.91	8.50	5.41	5.16	1.25	1.25	.50	.75	.33	2.91	3.75
22	4.33	5.33	8.16	5.08	4.25	1.16	1.33	.50	.66	.33	2.58	3.83
23	4.25	7.50	7.50	4.91	3.91	1.08	1.33	.50	.66	.33	2.50	4.50
24	4.08	7.50	7.16	4.50	3.58	1.00	1.33	.50	.66	.16	2.25	4.25
25	4.16	7.16	7.41	4.41	3.16	1.41	1.16	.50	.66	.16	2.25	5.83
26	5.25	6.83	7.41	4.00	3.00	2.00	1.00	.41	.66	.25	2.25	6.75
27	4.50	7.33	6.83	3.91	2.91	1.66	1.00	.66	1.00	.33	2.16	5.25
28	3.83	9.00	6.33	3.75	2.66	1.50	1.00	4.00	1.33	.33	2.00	4.58
29	3.25	....	6.83	3.66	2.50	1.50	.91	2.66	1.16	.41	2.00	3.83
30	3.00	....	7.83	3.50	2.50	1.75	.83	2.50	1.08	.33	1.83	3.00
31	3.00	....	8.08	....	2.50	....	.75	2.16	....	.33	....	2.25

OCTORARO CREEK AT ROWLANDSVILLE, MARYLAND.

This stream rises in Lancaster County, Pennsylvania, and flows in a southwesterly direction between Lancaster and Chester counties into Maryland, where it empties into the Susquehanna River about five miles below the State line. This station was established November 21, 1896, at the wagon bridge in the village of Rowlandsville, Maryland. The situation is not a good one for making measurements, owing to an eddy along the left bank and the proximity of the mouth of a small tributary, which would cause cross currents in time of high water. The channel is straight, the current swift, the banks high and not subject to overflow. The observations and most of the gagings have been made by Hugh W. Caldwell, of Rowlandsville, Maryland. The record having been continued long enough to have determined the general flow of the stream the station was abandoned September 30, 1899. The following measurements were made by Hugh W. Caldwell during 1899:

Measurements of Octoraro Creek at Rowlandsville, Maryland.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1899.	*Feet.*	*Sec. feet.*	1899.	*Feet.*	*Sec. feet.*
January 24	6.40	1,505	June 28	3.50	185
February 4	4.40	531	June 29	4.00	387
March 15	5.00	666	July 15	3.50	219
March 31	4.80	722	July 28	3.40	186
April 15	4.30	507	August 7	3.50	171
April 21	4.20	470	August 11	5.20	1,044
May 8	4.50	538	August 19	3.40	144
May 20	4.00	413	August 28	3.60	206
June 5	3.80	333	September 25	5.60	1,113
June 16	3.70	189			

Daily gage height, in feet, of Octoraro Creek at Rowlandsville, Maryland, for 1899.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	4.60	3.90	4.30	4.50	4.00	3.80	3.50	3.35	3.50
2	4.80	4.00	4.45	4.40	4.00	3.80	3.40	3.30	3.45
3	4.95	4.00	4.50	4.20	4.00	3.80	3.40	3.25	3.40
4	4.80	4.30	4.80	4.10	4.00	3.70	3.40	3.30	3.30
5	4.95	4.40	7 45	4.00	4.00	3.70	3.55	3.30	3.20
6	5.45	4.40	6.70	3.90	4.00	3.70	3.90	3.30	3.15
7	5.55	4.30	5.75	5.30	4.00	3.60	3.60	3.55	3.20
8	4.80	4.10	5.15	5.05	4.35	3.75	3.85	3.40	3.20
9	4.55	4.00	4.50	4.85	4.35	3.75	3.85	3.35	3.40
10	4.50	3.90	4.05	4.75	4.05	3.90	3.55	5.30	3.40
11	4.50	3.85	3.80	4.65	4.20	3.75	3.50	3.55	3.45
12	4.30	4.20	3.75	4.30	4.25	3.70	3.45	3.45	3.70
13	4.75	4.85	6.30	4.30	4.05	3.70	3.45	3.45	3.50
14	4.40	5.00	4.60	4.30	4.15	3.70	3.45	3.40	3.40
15	4.30	4.70	5.15	4.30	4.00	3.70	3.50	3.40	3.40
16	4.25	4.65	4.70	4.20	4.05	3.70	3.50	3.40	3.30
17	4.15	7.20	4.40	4.25	4.00	3.65	3.40	3.40	3.30
18	4.00	6.90	4.30	4.20	4.25	3.60	3.55	3.40	3.30
19	3.90	6.80	4.25	4.20	4.05	3.60	3.45	3.40	3.35
20	3.85	6.45	4.20	4.20	4.00	3.60	3.40	3.30	3.85
21	3.70	6.15	4.05	4.20	4.00	3.65	3.35	3.25	3.70
22	3.70	5.75	4.00	4.20	3.95	3.60	3.35	3.40	3.60
23	3.60	5.50	4.00	4.20	3.90	3.50	3.30	3.35	3.35
24	6.30	5.25	3.90	4.10	3.90	3.50	3.35	3.30	3.30
25	6.10	5.05	5.20	4.10	3.85	3.65	3.30	3.30	3.50
26	5.60	5.55	4.70	4.10	3.80	3.65	3.65	3.30	6.30
27	4.90	5.05	4.50	4.00	3.80	3.50	3.65	3.50	4.95
28	4.45	4.55	6.95	4.00	3.80	3.50	3.40	3.55	4.65
29	4.25	-------	5.60	4.00	3.80	3.80	3.40	3.50	4.00
30	4.10	-------	5.00	4.00	3.85	3.60	3.40	3.50	4.15
31	4.05	-------	4.80	-------	3.80	-------	3.40	3.50	-------

Discontinued September 30, 1899.

PATAPSCO RIVER AT WOODSTOCK, MARYLAND.

This river rises in the north-central part of Maryland, flows in a southeasterly direction between Baltimore and Howard counties, and empties into Chesapeake Bay. Its watershed is a hilly country largely under cultivation. A station was established at Woodstock August 6, 1896, by E. G. Paul. The drainage area is 251 square miles and is partly shown on the Ellicott and Frederick sheets of the topographic atlas. Measurements are made from the county bridge on the road from Woodstock to Granite, Maryland, 1½ miles below the junction with the North Branch, as shown on the Ellicott atlas sheet. The scale is a board graduated to feet and tenths with small nails, and fastened to the floor timber of the bridge. The bench mark is a United States Geological Survey standard copper bolt, set in the face of the retaining wall of the entrance to the college grounds at the north end of the bridge. It is 22.06 feet above gage datum. The bridge was repaired on January 20–25, 1899, and the gage destroyed. A new gage was established on January 30, 1899, and referred to the same bench mark. The channel is rough and rocky. The banks are high and not subject to overflow. At a time of extreme high water the channel is liable to changes. The observer is David Donovan, a storekeeper at Woodstock, Maryland. The three following measurements were made by E. G. Paul during 1899: January 30, gage height 4.30 feet, discharge 431 second-feet; May 22, gage height 4.20 feet, discharge 400 second-feet; September 6, gage height 3.60 feet, discharge 129 second-feet.

Daily gage height, in feet, of Patapsco River at Woodstock, Maryland, for 1899.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	(a)	3.80	4.85	4.65	4.20	3.95	3.75	3.65	3.60	3.55	3.60	3.70
2	(a)	5.10	4.90	4.50	4.15	4.15	3.60	4.30	3.70	3.55	3.75	3.60
3	(a)	5.00	4.70	4.45	4.20	3.95	3.70	4.10	3.80	3.55	3.70	3.20
4	(a)	4.90	4.75	4.35	4.30	3.95	3.75	3.85	3.65	3.40	3.60	3.60
5	(a)	4.90	8.50	4.40	4.15	3.95	4.25	3.85	3.60	3.60	3.70	3.60
6	(a)	5.20	6.70	4.30	4.25	3.95	4.00	3.85	3.45	3.80	3.60	3.65
7	(a)	5.35	5.20	4.60	4.25	3.80	3.90	3.90	3.40	3.75	3.70	3.55
8	(a)	Ice.	4.90	5.90	4.35	3.85	3.90	3.75	3.75	3.60	3.70	3.60
9	(a)	Ice.	4.70	4.65	4.45	3.95	3.90	3.75	3.45	3.70	3.70	3.65
10	(a)	Ice.	4.70	4.65	4.25	4.20	3.95	3.70	3.70	3.70	3.70	3.75
11	(a)	Ice.	4.75	4.45	4.15	4.20	3.75	3.55	3.55	3.65	3.70	3.75
12	(a)	Ice.	4.75	4.50	4.35	4.15	3.65	3.60	3.55	3.55	3.50	4.05
13	(a)	Ice.	4.65	4.20	4.25	4.10	3.80	3.65	3.55	3.45	3.50	3.90
14	(a)	Ice.	4.55	4.35	4.25	4.05	4.05	3.85	3.50	3.50	3.75	3.80
15	(a)	Ice.	4.85	4.40	4.20	3.95	3.80	3.35	3.50	3.70	3.65	3.65
16	(a)	Ice.	4.80	4.45	4.15	4.00	3.80	3.80	3.45	3.65	3.60	3.60
17	(a)	Ice.	4.60	4.45	4.25	4.10	4.15	3.65	3.35	3.65	3.70	3.30
18	(a)	Ice.	4.75	4.40	4.85	4.00	4.15	3.75	3.45	3.65	3.70	3.85
19	(a)	Ice.	5.30	4.30	4.50	3.95	3.95	3.65	3.45	3.60	3.60	3.95
20	(a)	Ice.	4.85	4.30	4.25	3.75	3.80	3.65	3.35	3.70	3.80	3.95
21	(a)	6.20	4.70	4.30	4.20	3.85	3.75	3.65	4.00	3.55	3.75	3.85
22	(a)	5.75	5.00	4.30	4.20	4.00	3.75	3.60	3.45	3.40	3.75	3.80
23	(a)	5.40	4.90	4.25	4.25	3.85	3.70	3.55	3.40	3.40	3.70	3.20
24	(a)	4.95	4.50	4.25	4.20	3.80	3.90	3.50	3.45	3.55	3.65	3.30
25	(a)	5,15	4.40	4.30	4.10	3.80	3.85	3.50	3.55	3.55	3.70	4.40
26	(a)	4.80	4.40	4.25	4.05	3.85	3.90	3.60	5.90	3.60	3.70	3.95
27	(a)	6.15	4.40	4.30	4.00	4.00	3.85	3.65	4.25	3.65	3.65	3.80
28	(a)	5.05	5.30	4.25	4.10	3.85	3.75	3.90	4.00	3.60	3.75	3.85
29	(a)	......	4.85	4.20	4.00	3.75	3.75	3.90	3.60	3.25	3.70	4.15
30	4.30	......	4.75	4.20	4.00	3.85	3.50	3.55	3.55	3.60	3.70	4.60
31	3.90	......	4.65	......	4.00	......	3.80	3.65	......	3.60	......	......

a Gage out; no readings.

NORTH BRANCH OF POTOMAC RIVER AT PIEDMONT, WEST VIRGINIA.

This stream rises in the western part of West Virginia and flows in a northeasterly direction, forming the boundary between Maryland and West Virginia. At a point about 15 miles below Cumberland it is joined by the South Branch, forming the Potomac River. The drainage area is mapped on Piedmont, St. George, Accident, Grantsville, and Frostburg atlas sheets. Systematic measurements of discharge have been made at Piedmont, West Virginia. This station, established June 27, 1899, by E. G. Paul, is located at the iron highway bridge connecting Luke, Maryland, with Piedmont, West Virginia. The wire gage is 38.87 feet from index to end of weight, and is referred to a scale board 14 feet long, attached to the bridge 90 feet from the first pier, and is divided into feet and tenths. The channel is straight for an eighth of a mile above and below the station. The current is swift and unobstructed. The right bank is high and rocky, but the left bank is low and liable to overflow. The bed of the stream is rocky and permanent in section. The observer is Charles W. Beck, a bookkeeper at Piedmont, West Virginia. A measurement was made by E. G. Paul on June 27, 1899, at a gage height of 3.00 feet, when the discharge was 350 second-feet.

Daily gage height, in feet, of North Branch of Potomac River at Piedmont, West Virginia, for 1899.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		3.15	2.50	2.20	2.20	3.75	2.60
2		2.90	2.35	2.20	2.20	3.90	2.60
3		2.80	2.25	2.10	2.15	3.05	2.60
4		2.70	2.40	2.00	2.10	2.80	2.55
5		2.65	2.40	2.30	2.10	2.70	2.50
6		2.70	2.40	2.20	2.10	2.55	2.40
7		2.80	2.55	2.15	2.20	2.50	2.40
8		2.70	2.30	2.10	2.10	2.40	2.40
9		2.70	2.30	2.20	2.15	2.40	2.35
10		2.70	2.25	2.30	2.10	2.40	2.40
11		2.65	2.10	2.95	2.10	2.40	2.50
12		2.50	2.15	3.40	2.20	2.40	5.20
13		2.40	2.10	2.75	2.10	2.30	4.60
14		2.85	2.10	2.45	2.10	2.30	3.75
15		2.85	2.10	2.35	2.00	2.30	3.60
16		2.50	2.00	2.30	2.20	2.30	3.35
17		2.70	2.00	2.30	2.10	2.30	3.05
18		2.90	2.00	2.15	2.10	2.20	3.15
19		2.65	2.00	2.10	2.10	2.40	3.20
20		2.50	2.00	2.45	2.10	3.35	3.70
21		2.35	2.00	2.90	2.10	3.00	3.30
22			1.95	2.65	2.00	2.80	3.20
23		2.30	1.90	2.40	2.00	2.85	3.10
24		2.30	1.90	2.40	2.10	3.30	3.00
25		2.30	1.90	2.25	2.10	3.20	3.00
26		2.20	1.90	2.20	2.10	3.00	2.90
27	3.00	2.15	2.10	2.30	2.10	2.80	2.80
28	2.90	2.50	3.00	2.55	2,10	2.80	2.80
29	3.85	2.35	2.90	2.40	2.20	2.70	2.80
30	3.50	2.30	2.55	2.25	2.15	2.60	2.80
31		2.45	2.35		2.15		2.70

SOUTH BRANCH OF POTOMAC RIVER AT SPRINGFIELD, WEST VIRGINIA.

This stream rises in Highland County, West Virginia, and flows in a northeasterly direction, joining the North Branch of Potomac River about 15 miles below Cumberland, Maryland, forming Potomac River. The drainage area of the South Branch consists of long, narrow, mountain valleys, sparsely settled and little cultivated, being for the greater part covered with timber. The region being free from manufacturing industries and mining operations, no pollution of the waters occurs. The drainage area is mapped on the following atlas sheets: Romney, Piedmont, Beverly, Franklin, Woodstock, Staunton, and Monterey. A gaging station was established at the railroad bridge, 2 miles south of Springfield, West Virginia, in April, 1894, by Cyrus C. Babb, but was discontinued in 1896 for want of an observer. The present station, established June 26, 1899, by E. G. Paul, is located on the iron highway bridge, one-fourth of a mile from Graces Station and 1 mile from Springfield. The wire gage is 39.4 feet from the zero to the extreme end of the weight, and is referred to a scale graduated to feet and tenths, on the guard rail on the upper side of the bridge 80 feet from the abutment on the left bank. The channel of the stream at this point is curved and the current too sluggish to make satisfactory discharge measurements, and they are, therefore, made from the railroad bridge over the stream 1 mile above. The observer is John E. Grace, of Springfield, West Virginia. A measurement was made by E. G. Paul, June 26, 1899, at a gage height of 4.00 feet, when the discharge was 617 second-feet.

Daily gage height, in feet, of South Branch of Potomac River at Springfield, West Virginia, for 1899.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		3.20	3.40	3.40	3.40	4.60	4.60
2		3.70	3.60	3.40	3.40	4.80	4.10
3		3.70	3.50	3.50	3.40	4.80	4.00
4		3.70	3.40	3.60	3.30	4.80	4.00
5		3.60	3.20	3.60	3.30	4.60	3.80
6		3.60	3.20	3.60	3.20	4.60	3.70
7		3.60	3.20	3.50	3.20	4.50	3.70
8		3.70	3.20	3.50	3.20	4.40	3.50
9		4.20	3.10	3.50	3.20	4.20	3.40
10		3.90	3.10	3.50	3.20	4.10	3.80
11		3.80	3.10	3.40	3.10	4.10	4.00
12		3.60	3.00	3.40	3.10	4.00	5.80
13		3.40	3.00	3.40	3.10	4.00	5.60
14		3.20	3.10	3.40	3.20	4.00	5.60
15		3.10	3.20	3.50	3.20	3.90	5.40
16		3.00	3.20	3.50	3.20	3.80	5.60
17		2.90	3.10	3.50	3.20	3.70	5.60
18		3.00	3.10	3.40	3.20	3.60	5.50
19		3.40	3.00	3.40	3.10	3.60	5.50
20		3.20	3.00	3.40	3.10	3.90	5.40
21		3.20	3.10	3.30	3.10	4.90	5.40
22		3.20	3.20	3.30	3.10	5.90	5.40
23		3.40	3.20	3.20	3.00	5.80	5.00
24		3.50	3.30	3.10	3.00	5.60	4.00
25		3.50	3.30	3.10	3.20	5.60	Ice.
26	4.00	3.40	3.20	3.00	3.40	5.40	Ice.
27	4.20	3.40	3.20	3.00	3.50	5.20	Ice.
28	3.90	3.20	3.10	3.20	3.50	4.80	Ice.
29	4.10	3.20	3.10	3.30	3.80	4.70	Ice.
30	3.40	3.20	3.20	3.40	4.20	4.60	Ice.
31		3.20	3.20		4.40		Ice.

ANTIETAM CREEK AT SHARPSBURG, MARYLAND.

This stream rises in the western part of Maryland and flows in a southerly direction, entering the Potomac 10 miles above Harpers Ferry. Its drainage area is mostly of a hilly character and largely cultivated. A station was established at Myers Mill, 1 mile east of Sharpsburg, Maryland, on the road to Keedysville, Maryland, on June 24, 1897, by Arthur P. Davis. The measurements are made from a three-fourths inch iron cable with 85-foot span, supported by large trees on either side of the stream. The gage is a post driven into the gravel of the stream bed and bolted to an overhanging tree. The initial point for soundings is on the left bank. The channel both above and below the station is straight for 300 feet. The right bank is low and liable to overflow. The left bank is high and rocky. The current is of moderate velocity and the flow unobstructed. The results of measurements may be found as follows: 1897, Nineteenth Annual Report, Part IV, page 149; 1898, Twentieth Annual Report, Part IV, page 122. The following measurements were made by E. G. Paul during 1899: January 27, gage height 2.80 feet, discharge 495 second-feet; May 20, gage height 2.60 feet, discharge 418 second-feet; September 5, gage height 1.80 feet, discharge 118 second-feet.

Daily gage height, in feet, of Antietam Creek at Sharpsburg, Maryland, for 1899.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.80	2.70	4.75	3.40	2.40	2.40	2.10	1.70	1.80	1.80	2.40	1.60
2	2.70	2.60	4.20	3.30	2.45	3.75	1.90	1.60	1.80	1.80	2.25	1.60
3	2.60	2.60	4.10	3.20	2.90	2.60	2.00	2.55	1.70	1.70	2.00	1.60
4	2.70	2.60	3.85	3.20	2.50	2.60	1.85	1.90	2.00	1.60	1.80	1.50
5	3.00	2.80	4.80	3.10	2.50	2.40	1.90	1.80	1.80	1.60	1.80	1.60
6	3.40	2.80	4.40	3.00	2.50	2.40	1.80	1.70	1.80	1.50	1.90	1.50
7	3.55	2.50	4.05	2.90	2.40	2.30	2.00	1.90	1.70	1.50	1.80	1.50
8	3.20	2.40	3.90	3.25	2.55	2.30	1.90	1.70	1.70	1.50	1.50	1.60
9	3.00	2.60	3.60	3.10	2.70	2.45	1.90	1.70	1.85	1.70	1.60	1.60
10	3.00	2.80	3.50	3.00	2.55	2.70	2.00	1.80	1.60	1.60	1.70	1.50
11	2.90	2.60	3.50	2.90	2.50	2.65	1.90	1.80	2.30	1.50	1.60	1.50
12	2.80	2.80	3.40	2.80	2.50	2.40	1.80	2.35	2.10	1.50	1.70	1.60
13	2.90	2.80	3.30	2.80	2.50	2.40	2.15	1.90	1.85	1.50	1.70	1.60
14	3.00	2.80	3.20	2.80	2.40	2.35	2.00	2.00	1.80	1.50	1.60	1.70
15	3.00	2.90	3.20	2.80	2.30	2.30	1.90	1.90	1.70	1.40	1.60	1.80
16	3.00	2.90	3.50	2.80	2.40	2.30	1.85	1.80	1.60	1.80	1.60	1.80
17	3.00	2.80	3.20	2.70	2.20	2.30	1.95	1.90	1.60	1.70	1.80	1.70
18	3.00	2.90	3.20	2.70	3.15	2.20	1.80	1.80	1.70	1.60	1.70	1.70
19	2.90	2.90	3.70	2.70	2.80	2.25	1.85	1.80	2.00	1.60	1.70	1.60
20	2.80	2.80	3.75	2.60	2.60	2.20	1.80	1.60	1.90	1.60	1.70	1.60
21	2.80	3.20	3.40	2.60	2.50	2.20	1.80	1.80	1.90	1.60	1.70	1.70
22	2.80	4.30	3.40	2.60	2.50	2.10	1.80	1.70	1.80	1.60	1.80	1.60
23	2.80	4.10	3.50	2.50	2.50	2.00	2.05	1.80	1.80	1.70	1.80	1.60
24	2.80	3.70	3.40	2.40	2.40	2.10	1.90	1.70	1.70	1.60	1.70	1.85
25	3.25	3.50	3.30	2.50	2.30	2.05	1.70	1.65	1.90	1.60	1.60	2.65
26	2.90	4.50	3.20	2.45	2.30	2.20	1.75	1.70	1.90	1.50	1.60	1.90
27	2.90	5.40	3.00	2.50	2.30	2.10	1.70	3.45	1.80	1.50	1.70	2.00
28	2.80	5.15	3.50	2.50	2.30	2.15	1.60	2.80	1.80	1.50	1.60	1.90
29	2.80	......	3.90	2.50	2.20	2.10	1.60	2.30	1.90	1.50	1.70	1.80
30	2.70	......	3.70	2.40	2.45	2.20	1.60	2.00	1.90	1.60	1.70	1.60
31	2.70	......	3.50	......	2.40	......	1.80	1.90	......	1.60	......	......

NORTH AND SOUTH RIVERS AT PORT REPUBLIC, VIRGINIA.

North and South rivers rise in Rockbridge County, Virginia, and flow in a southeasterly direction, joining at Port Republic to form the

South Fork of the Shenandoah River. The drainage areas of these two rivers are entirely mapped on Franklin, Harrisonburg, Staunton, Buckingham, and Lexington sheets. Systematic measurements are made on the North and South rivers at Port Republic. These stations, described in the Eighteenth Annual Report, Part IV, page 25, were established in August, 1895, by D. C. Humphreys.

The gage for the North River is located on the county highway bridge at Port Republic, Virginia, 500 feet above the mouth of South River. A painted rod is fastened to the third panel of the first span on the lower side of the bridge. It is nailed to the wooden uprights and fastened by wire to the diagonals. Bench mark No. 1, the lower end of the third floor beam from the right bank, is 24.97 feet above zero of the gage. Bench mark No. 2, the bridge seat on lower end of right bank abutment, is 24.60 feet above the datum of the gage.

The gage for South River is located on the county iron bridge just east of the town, 300 feet above the mouth of North River. The graduations of the rod are marked by tacks driven into the rail on the upper side of the bridge at the fourth panel, the zero being 1 foot from the edge of the pulley. Bench mark No. 1, the top of the third floor beam from right bank upper side of bridge, is 22.52 feet above gage datum. The zero of North River gage is 2.56 feet below the zero of South River gage. All gagings of South River include the discharge of mill race. The observer at both gages is T. S. Davis, storekeeper, Port Republic, Virginia. In September, 1898, a new bridge was built to replace the old one, and the stations were soon afterwards abandoned (April 1, 1899), as measurements were made lower down, at Front Royal. Records of measurements may be found as follows: 1895–96, Eighteenth Annual Report, Part IV, pages 25, 26. One measurement was made at each station by E. G. Paul in 1899, as follows: North River, March 11, gage height, 4.80 feet; discharge, 3,423 second-feet. South River, March 11, gage height, 3.70 feet; discharge, 1,592 second-feet.

Daily gage height, in feet, of North River at Port Republic, Virginia, for 1899.

Day.	Jan.	Feb.	Mar.	Apr.	Day.	Jan.	Feb.	Mar.	Apr.
1	2.75	2.30	7.10	*a* 3.00	17	2.70	3.00	4.00	
2	2.75	2.30	5.50		18	2.70	3.00	3.70	
3	2.70	2.30	5.00		19	2.60	3.40	4.00	
4	2.65	2.30	7.40		20	2.60	4.00	4.30	
5	2.65	2.30	14.00		21	2.60	5.50	3.90	
6	5.40	2.30	8.90		22	2.60	7.00	3.60	
7	6.70	2.30	7.50		23	2.60	7.60	3.40	
8	5.00	2.40	5.80		24	2.60	6.00	3.20	
9	4.00	2.40	4.80		25	2.60	4.90	3.10	
10	3.60	2.50	5.30		26	2.60	4.90	3.10	
11	3.40	2.50	4.80		27	2.60	6.00	3.00	
12	3.20	2.50	4.60		28	2.60	9.00	3.00	
13	3.00	2.50	4.00		29	2.50		3.00	
14	2.90	2.70	3.80		30	2.50		3.00	
15	2.80	2.80	4.50		31	2.40		3.00	
16	2.80	3.00	4.20						

a Discontinued April 1.

Daily gage height, in feet, of South River at Port Republic, Virginia, for 1899.

Day.	Jan.	Feb.	Mar.	Apr.	Day.	Jan.	Feb.	Mar.	Apr.
1	2.50	2.10	4.00	*a* 2.50	17	2.50	2.60	3.20	....
2	2.50	2.10	3.60	....	18	2.40	2.60	2.90	....
3	2.40	2.10	3.50	....	19	2.20	2.80	3.20	....
4	2.30	2.10	5.10	....	20	2.20	3.00	2.70	....
5	2.30	2.10	12.00	....	21	2.20	3.50	3.50	....
6	3.40	2.10	6.70	....	22	2.20	5.00	3.20	....
7	5.00	2.10	5.50	....	23	2.20	5.60	3.10	....
8	3.80	2.20	4.00	....	24	2.20	4.10	2.90	....
9	3.60	2.20	3.60	....	25	2.20	3.50	2.80	....
10	3.00	2.30	3.90	....	26	2.20	4.40	2.80	....
11	2.90	2.30	3.70	....	27	2.20	6.50	2.80	....
12	2.75	2.30	3.60	....	28	2.20	5.30	2.70	....
13	2.60	2.30	3.40	....	29	2.20	....	2.70	....
14	2.60	2.40	3.30	....	30	2.20	....	2.60	....
15	2.60	2.50	3.40	....	31	2.10	....	2.50	....
16	2.60	2.60	3.30	....					

a Discontinued April 1.

NORTH BRANCH OF SHENANDOAH RIVER AT RIVERTON, VIRGINIA.

This stream rises in Rockingham County, Virginia, and flows in a northeasterly direction, joining with the South Branch of the Shenandoah at Riverton, Virginia. The station was established at Riverton by A. P. Davis June 26, 1899. Measurements were made from an iron-wire cable, about 260 feet in span, stretched across the river on timber supports, 2 miles northwest of Riverton. The station is most easily reached by a private conveyance from Front Royal, Virginia. The gage is a vertical timber, graduated to feet and tenths, bolted to a large sycamore tree on the right bank of the stream. The initial point of soundings is on the right bank. The channel is straight above and below the station for about 600 feet. The banks are low and liable to overflow in time of high water. Bed of stream is rocky and constant. The observer is O. Menefee, a farmer, Riverton, Virginia. Two observations of river height are taken daily. Two measurements were made by E. G. Paul during 1899, both on September 2, with a gage height of 2.85 feet in each case. One measurement was made at the cross section at the point where the cable spans the stream, giving a discharge of 270 second-feet. The other measurement was made by wading, at a better cross section, 300 feet below the regular station, giving a discharge of 287 second-feet.

Daily gage height, in feet, of North Branch of Shenandoah River at Riverton, Virginia, for 1899.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		2.80	2.68	2.88	2.70	3.20	
2		2.80	2.68	2.88	2.68	2.95	
3		2.78	2.68	2.95	2.60	2.95	2.65
4		2.80	2.70	2.85	2.65	2.95	2.65
5		2.73	2.65	2.73	2.70	2.85	2.63
6		2.73	3.00	2.73	2.68	2.80	2.60
7		2.80	2.95	2.73	2.65	2.80	2.63
8		2.80	2.95	2.70	2.65	2.80	2.65
9		2.80	2.83	2.70	2.68	2.80	2.60
10		2.80	2.80	2.70	2.70	2.80	2.63
11		2.80	2.73	2.70	2.70	2.78	2.65
12		2.78	2.70	2.73	2.70	2.75	2.68
13		2.75	2.70	2.73	2.70	2.73	2.80
14		2.75	2.73	2.70	2.70	2.70	2.85
15		2.70	2.70	2.70	2.70	2.70	2.90
16		2.68	2.78	2.68	2.65	2.70	2.90
17		2.68	2.78	2.70	2.65	2.70	2.90
18		2.78	2.78	2.68	2.70	2.70	2.90
19		2.75	2.70	2.60	2.68	2.70	2.88
20		2.70	2.65	2.80	2.70	2.70	2.80
21		2.68	2.63	2.80	2.65	2.70	2.80
22		2.68	2.63	2.80	2.65	2.70	2.80
23		2.65	2.68	2.80	2.65	2.70	2.80
24		2.58	2.65	2.80	2.65	2.70	2.80
25		2.63	2.63	2.80	2.70	2.70	2.83
26	2.85	2.70	2.65	2.80	2.70		2.88
27	2.88	2.68	2.63	2.78	2.70		3.00
28	2.88	2.85	2.70	2.75	2.70		3.00
29	2.88	3.13	2.68	2.70	2.70		3.00
30	2.80	2.80	2.95	2.70	2.68		3.00
31		2.70	2.90		2.75		

SOUTH BRANCH OF SHENANDOAH RIVER AT FRONT ROYAL, VIRGINIA.

This stream rises in Augusta County, Virginia, and flows in a northeasterly direction, joining the North Branch of the Shenandoah at Riverton to form Shenandoah River. A station was established on the South Branch by A. P. Davis, June 26, 1899. The measurements of flow are made from an iron wire cable 300 feet in span, stretched across the stream 3 miles southwest of Front Royal, Virginia. The gage is a vertical timber divided into feet and tenths and bolted to the trunk of a tree on the left bank of the stream. The initial point for sounding is on the left bank. The channel is straight 600 feet above and below the station, and the current sluggish. The left bank is low and liable to overflow. The bed of the stream is rocky in part, with patches of sand somewhat shifting. The observer is Miss Brentie Johnson, Front Royal, Virginia. One measurement of discharge was made by E. G. Paul, September 1, 1899; gage height, 4.40 feet; discharge, 616 second-feet.

Daily gage height, in feet, of South Branch of Shenandoah River at Front Royal, Virginia, for 1899.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	....	4.30	4.40	4.40	4.45	5.50	4.40
2	....	4.30	4.35	4.35	4.40	8.05	4.40
3	....	4.20	4.20	4.30	4.30	6.70	4.30
4	....	4.20	4.25	4.20	4.30	5.85	4.30
5	....	4.10	4.25	4.50	4.30	5.80	4.20
6	....	4.20	4.20	4.30	4.30	5.65	4.20
7	....	4.20	4.30	4.20	4.30	5.35	4.20
8	....	4.25	4.65	4.15	4.35	5.20	4.20
9	....	4.55	4.30	4.25	4.40	5.05	4.30
10	....	4.70	4.50	4.75	4.40	4.85	4.30
11	....	4.30	4.45	4.65	4.40	4.80	4.30
12	....	4.20	4.30	4.55	4.40	4.70	4.45
13	....	4.15	4.20	4.45	4.30	4.70	6.95
14	....	4.20	4.20	4.40	4.30	4.60	6.25
15	....	4.15	4.20	4.30	4.30	4.60	5.75
16	....	4.25	4.30	4.30	4.20	4.55	5.45
17	....	4.15	4.35	4.30	4.20	4.50	5.25
18	....	4.15	4.25	4.20	4.20	4.50	5.15
19	....	4.15	4.30	4.20	4.20	4.50	5.00
20	....	4.10	4.25	4.55	4.20	4.50	4.95
21	....	4.10	4.20	5.80	4.10	4.50	4.85
22	....	4.10	4.10	5.30	4.15	4.40	4.75
23	....	4.15	4.10	4.85	4.20	4.40	4.70
24	....	4.10	4.00	4.60	4.20	4.50	4.90
25	....	4.10	3.90	5.00	4.20	4.50	4.90
26	4.40	4.05	4.00	4.60	4.20	4.55	5.10
27	4.30	4.10	4.00	4.55	4.20	4.50	5.10
28	4.25	4.20	4.30	4.60	4.20	4.40	5.00
29	4.35	4.30	5.15	4.50	4.20	4.40	5.00
30	4.30	4.80	5.05	4.50	4.20	4.40	5.15
31	....	4.25	4.60	....	4.20	....	....

SHENANDOAH RIVER AT MILLVILLE, WEST VIRGINIA.

This river, formed by the junction of the North Fork and the South Fork at Riverton, Virginia, flows in a northeasterly direction into West Virginia, where it empties into the Potomac at Harpers Ferry.

Observations of the height of Potomac River at the junction of Shenandoah River have been made by the Weather Bureau at Harpers Ferry, West Virginia. The gage is on the west face and north end of the second abutment of the old railroad bridge from the West Virginia side of the river. It is of Portland cement, 15 inches wide, plastered on the face of the pier extending to 32 feet, and continued on the iron upright of the bridge to 36 feet. The top surface of the 6-by-6-inch-square capstone corresponds to the 32-foot mark on the gage. The elevation is 235.5 feet above mean sea level.

A station was established at Millville, West Virginia, April 15, 1895, on Shenandoah River, 4 miles above its mouth. A vertical gage was placed in the river and fastened to a tree, a deep notch being cut in the tree opposite the 8-foot mark. This gage is referred to a bench mark consisting of a copper bolt driven in the foot of a large sycamore tree on the left bank of the river 150 feet below the gage rod, at an elevation of 6.78 feet above the zero mark on the gage. Measurements are made from a cable stretched across the river. The old cable was carried away by the flood of 1896, and a new three-fourths inch galvanized iron wire cable was put in place on June 23, 1897. The cable, about 500 feet in length, is supported on either bank by a large sycamore tree, and is securely anchored on both sides. The channel is straight, current swift and unobstructed. The banks are low and subject to overflow. The observer is W. R. Nicewarner. The results of measurements may be found as follows: 1896, Eighteenth Annual Report, Part IV, page 28; 1897, Nineteenth Annual Report, Part IV, page 151; 1898, Twentieth Annual Report, Part IV, page 127. The following measurements were made by E. G. Paul during 1899:

January 27, gage height, 2.40 feet; discharge, 3,156 second-feet.
March 10, gage height, 5.00 feet; discharge, 10,838 second-feet.
May 16, gage height, 2.10 feet; discharge, 2,753 second-feet.
September 3, gage height, 0.90 foot; discharge, 1,086 second-feet.
October 29, gage height, 0.60 foot; discharge, 766 second-feet.

Daily gage, height in feet, of Shenandoah River at Millville, West Virginia, for 1899.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.50	2.30	Ice.	3.10	1.70	2.05	0.90	1.00	1.10	0.80	1.55	0.80
2	2.20	2.10	Ice.	3.00	1.60	2.35	.90	.80	.90	.70	2.75	.80
3	2.80	1.70	Ice.	2.80	1.60	3.00	.80	.90	.90	.70	3.20	.75
4	2.60	2.00	Ice.	2.70	1.60	2.10	.80	1.30	1.10	.70	2.40	.70
5	3.30	2.40	Ice.	2.60	2.00	1.80	.80	.90	.80	.70	1.90	.75
6	3.80	2.50	Ice.	2.50	1.90	1.50	.80	.80	.70	.70	1.80	.70
7	4.60	2.30	Ice.	2.40	1.90	1.40	.70	1.10	.80	.70	1.60	.70
8	6.70	2.50	Ice.	2.50	1.80	1.40	.80	1.00	.70	.70	1.40	.70
9	5.00	2.50	Ice.	3.10	2.00	1.50	.90	1.20	.70	.80	1.30	.70
10	4.50	2.30	5.00	3.00	2.30	1.40	1.00	1.00	.70	.80	1.20	.70
11	3.80	2.40	5.50	2.90	3.10	1.30	.90	1.60	.80	.70	1.10	.70
12	3.50	(a)	5.20	2.70	2.80	1.40	.80	.90	1.20	.80	1.00	.75
13	3.30	(a)	4.60	2.60	2.60	1.40	.80	.80	.90	.70	1.00	.90
14	3.00	2.30	4.00	2.50	2.70	1.30	.70	.90	.80	.70	1.00	2.90
15	2.90	2.40	4.00	2.40	2.20	1.30	.70	.80	.80	.70	.90	2.20
16	3.00	2.50	4.00	2.30	2.10	1.30	.90	.70	.70	.60	.90	1.90
17	2.90	2.70	4.50	2.20	1.90	1.20	.80	.80	.70	.60	.90	1.60
18	2.90	3.00	3.90	2.20	1.90	1.10	.70	.80	.60	.60	.80	1.40
19	2.90	3.00	3.80	2.20	2.50	1.00	.70	.80	.60	.60	.90	1.30
20	2.80	3.40	3.80	2.20	2.30	1.00	.70	.70	.80	.60	.80	1.20
21	2.60	4.00	3.80	2.20	2.00	1.00	.70	.70	.90	.60	.80	1.20
22	2.40	Ice.	3.70	1.90	1.90	.90	.70	.60	.90	.60	.80	1.10
23	2.40	Ice.	3.50	1.90	1.70	1.00	.60	.60	1.50	.60	.80	1.10
24	2.40	Ice.	3.30	1.90	1.70	.90	.60	.60	1.10	.60	.80	1.10
25	2.40	Ice.	3.10	1.80	1.60	.90	70	.50	1.00	.60	.80	1.30
26	2.30	Ice.	3.00	2.00	1.50	.90	.60	.50	.90	.50	.85	1.20
27	2.50	Ice.	2.90	1.90	1.50	.90	.60	.60	.90	.60	.85	1.70
28	2.30	Ice.	2.90	1.80	1.40	.90	.60	.70	.90	.60	.80	1.40
29	2.20	......	3.00	1.80	1.40	.90	.60	.80	.80	.60	.80	1.65
30	2.10	......	3.60	1.70	1.30	1.00	1.50	1.00	.80	.60	.80	1.10
31	2.10	......	3.30	......	1.60	......	1.00	1.30	......	.70	......	1.10

a No readings.

POTOMAC RIVER AT POINT OF ROCKS, MARYLAND.

This station was established February 17, 1895, as described in Bulletin 140, page 54. It is about 6 miles above the mouth of Monocacy River, and also above a number of smaller streams, and therefore the measurements of discharge do not represent the entire flow of

Potomac River. The drainage area here is estimated to be 9,654 square miles. It is largely mapped on topographic atlas sheets—Harpers Ferry, Winchester, Romney, Piedmont, Warrensburg, Luray, Woodstock, Franklin, Beverly, Harrisonburg, Staunton, Monterey, Buckingham, and Lexington. Catoctin Creek enters the Potomac 1,000 feet above the station. The measurements are made from the highway bridge at Point of Rocks. The wire gage is on the east side of the first span, the scale being marked on the hand rail of the bridge. The gage is referred to two bench marks—one, a copper bolt in a large capstone on the lower wing wall of the north abutment, about 10 feet from the north end of the first iron truss, is 41.30 feet above the datum of the gage. The length of the wire gage is 44.22 feet. The gage was verified on October 29, 1899. The observer is G. H. Hickman. The records of flow may be found as follows: 1895–96, Eighteenth Annual Report, Part IV, page 32; 1897, Nineteenth Annual Report, Part IV, pages 152–153; 1898, Twentieth Annual Report, Part IV, page 131. The following measurements were made by E. G. Paul during 1899:

January 28, gage height, 3.80 feet; discharge, 17,330 second-feet.
May 20, gage height, 8.15 feet; discharge, 45,986 second-feet.
September 5, gage height, 0.80 foot; discharge, 2,360 second-feet.
October 29, gage height, 0.50 foot; discharge, 1,628 second-feet.

Mr. William Rich Hutton, of 35 Broadway, New York, states that in the summer of 1856 he made a careful examination of the flow of Potomac River a short distance below the Great Falls, using loaded poles reaching as near as possible to the bottom and placed at 5-foot intervals across the width of the river. The water was then at the lowest stage known to persons who had observed the river for many years. The discharge was 1,063 second-feet. Mr. Hutton was of the opinion that the river was as low in 1862, but no measurements were made in that year.

In 1839 a civil engineer, Mr. M. C. Ewing, assistant to Major Turnbull, United States topographic engineer, during the construction of the Alexandria Aqueduct above Georgetown, reported the discharge below Little Falls to be 1,904 second-feet. Mr. Thomas L. Patterson, of Cumberland, is reported to have found the discharge at that point in the low water of 1838 to be 24 second-feet, and at Patterson Creek, some 12 miles below, 48 second-feet. Figures of discharge of Potomac River are given in the statement regarding the extension of the Chesapeake and Ohio Canal in House Ex. Doc. No. 208, Forty-third Congress, first session; also in House Ex. Doc. No. 137, Forty-fourth Congress, first session.

Daily gage height, in feet, of Potomac River at Point of Rocks, Maryland, for 1899.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.00	2.40	11.90	5.30	1.60	2.00	1.00	0.70	0.90	0.70	0.80	0.80
2	3.40	2.00	9.20	4.50	1.60	2.40	1.00	.70	.90	.60	1.50	.80
3	2.90	2.10	8.20	4.00	2.10	3.80	1.10	.70	.80	.60	2.50	.80
4	2.70	2.10	7.60	3.60	1.70	2.60	1.00	.90	.80	.60	2.00	.80
5	2.30	2.00	8.50	3.30	1.70	2.10	.90	1.00	.80	.60	1.80	.80
6	4.10	2.00	16.55	3.00	2.10	1.80	1.00	1.10	.70	.60	1.40	.70
7	6.90	2.00	12.90	2.80	2.00	1.60	2.00	1.10	.70	.70	1.40	.70
8	8.10	2.30	10.00	3.00	1.90	1.50	1.00	1.10	.60	.70	1.30	.70
9	6.80	2.30	8.10	3.50	2.00	1.40	1.00	1.00	.60	.70	1.20	.70
10	5.40	3.60	6.00	3.40	2.40	1.70	.90	1.00	.60	.60	1.00	.70
11	4.60	4.20	5.80	4.20	4.50	1.80	.90	.90	.60	.60	.90	.70
12	3.90	4.20	5.60	4.50	3.80	1.70	.80	.80	.80	.60	.90	.80
13	3.60	4.00	5.00	3.40	3.40	1.70	.80	.60	1.20	.60	.80	.80
14	3.40	3.90	4.80	3.20	3.20	1.60	.80	.60	1.10	.50	.80	1.20
15	3.40	3.80	4.50	3.00	2.80	1.50	.90	.60	1.00	.50	.80	3.00
16	4.00	4.00	4.60	2.80	2.50	1.50	1.10	.70	.90	.50	.80	2.10
17	5.70	4.50	4.70	2.70	2.30	1.40	.90	.70	.80	.50	.80	1.70
18	5.20	5.00	4.40	2.60	2.40	1.40	.70	.60	.70	.50	.70	1.50
19	4.70	5.20	5.20	2.50	8.55	1.30	.70	.60	.70	.50	.70	1.60
20	4.40	5.40	5.40	2.40	6.30	1.30	.70	.60	.90	.50	.70	1.50
21	4.00	6.00	5.30	2.20	5.00	1.20	.70	.60	.70	.50	.70	1.30
22	3.50	8.50	4.70	2.10	3.60	1.20	.70	.50	.80	.50	.70	1.10
23	3.30	14.80	4.20	2.00	3.00	1.10	.70	.50	.90	.50	.80	1.00
24	3.20	13.70	4.00	2.00	2.70	1.10	.60	.50	.90	.50	.80	1.20
25	3.30	9.00	3.90	2.00	2.40	1.00	.60	.50	.90	.50	.90	1.80
26	4.80	6.00	3.70	1.90	2.10	1.00	.60	.50	1.00	.50	.90	2.10
27	4.70	9.25	3.50	1.90	2.00	1.00	.60	1.20	.80	.50	.80	1.60
28	3.90	13.90	3.40	1.80	1.80	1.20	.60	1.10	.70	.50	.80	1.50
29	3.20	......	3.60	1.70	1.70	1.10	.50	1.10	.70	.50	.80	1.60
30	2.80	......	8.60	1.70	1.70	1.00	.80	1.00	.80	.50	.80	1.60
31	2.60	......	7.00	......	1.80	......	.80	1.00	......	.60	......	1.60

MONOCACY RIVER AT FREDERICK, MARYLAND.

Monocacy River rises in the south-central part of Pennsylvania and flows in a southerly direction through Frederick County, Maryland, entering Potomac River near the Montgomery County line. A station was established by E. G. Paul, August 4, 1896, at the county iron bridge on the turnpike, 4 miles northeast of Frederick, on the road leading from Frederick to Mount Pleasant, Maryland, and about 2,000 feet above the mouth of Israel Creek and 3,000 feet below the mouth of Tuscarora Creek, as shown on the Frederick atlas sheet. The drainage area is 665 square miles at this point and 1,000 square miles at the mouth. The gage is attached to the floor timber on the lower side of the bridge. The length of the wire is 35.20 feet. The bench mark is a cross cut in the top face of the capstone on the lower retaining wall of the bridge abutment on the right bank of the stream, and is 29.17 feet above gage datum. The stream at this station has two channels, being divided by a small, low island, which serves as a foundation for the middle pier of the bridge. The right channel is measured from the lower side of the bridge, and the left channel from the upper side, as these sections are freer from rocks than a continuous section on either side of the bridge. The stream is subject to high water and sudden floods, owing to the character of its upper watershed. The observer is E. L. Derr, a farmer near Frederick, Maryland. Records of measurement can be found as follows:

1896, Eighteenth Annual Report, Part IV, page 35; 1897, Nineteenth Annual Report, Part IV, pages 153–155; 1898, Twentieth Annual Report, Part IV, page 129. Two measurements were made by E. G. Paul during 1899. The first, May 22, at a gage height of 5.20 feet, when the dischage was 633 second-feet. The second one was on September 6, at a gage height of 4.00 feet, with a discharge of 153 second-feet.

Daily gage height in feet of Monocacy River at Frederick, Maryland, for 1899.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.40	5.20	11.50	7.10	4.80	7.10	4.10	3.90	4.30	4.00	7.30	4.10
2	5.00	5.20	10.10	6.90	4.80	11.10	4.10	4.00	4.30	3.90	6.40	4.10
3	5.50	5.80	9.20	6.50	5.00	7.05	4.10	5.10	5.40	3.90	6.30	4.10
4	6.00	5.60	8.70	6.10	4.90	5.20	4.00	5.00	5.00	3.90	6.00	4.10
5	6.30	5.90	17.15	6.00	4.90	4.90	4.00	5.00	4.50	3.80	5.30	4.10
6	12.75	5.70	11.45	6.00	4.80	4.70	4.50	4.90	4.00	3.80	5.00	4.00
7	14.85	5.50	8.90	7.60	4.80	4.50	4.40	4.50	3.90	3.90	4.50	4.00
8	12.50	5.40	7.80	12.60	5.20	4.50	4.20	4.00	3.80	3.90	4.40	3.90
9	10.20	6.00	7.50	8.50	6.60	5.50	4.30	4.00	3.70	4.10	4.30	3.90
10	6.10	6.00	7.40	6.90	5.60	6.85	4.20	4.00	4.00	4.10	4.30	3.90
11	6.10	6.00	7.40	6.50	5.40	6.90	4.20	4.00	4.00	4.00	4.20	3.90
12	5.70	6.00	7.30	6.20	5.80	6.50	4.10	4.20	3.90	4.00	4.10	4.80
13	5.80	6.00	7.10	5.90	5.40	5.20	4.30	4.00	3.90	3.90	4.10	5.95
14	6.00	6.00	6.50	5.60	5.00	4.90	4.20	3.90	3.80	3.90	4.10	5.50
15	6.80	6.00	6.50	5.60	5.00	6.20	4.20	3.90	3.80	3.90	4.10	4.50
16	6.60	6.00	9.70	5.60	4.90	5.10	4.50	3.90	3.80	3.90	4.10	4.40
17	6.60	6.20	6.90	5.60	5.20	4.80	4.30	3.90	3.70	3.90	4.10	4.40
18	7.10	6.80	7.90	5.60	6.50	4.50	4.30	3.80	3.70	4.00	4.10	4.30
19	6.40	7.90	13.90	5.60	7.70	4.40	4.20	3.80	3.70	3.90	4.10	4.20
20	5.60	9.00	10.10	5.40	6.90	4.40	4.10	3.80	6.00	3.90	4.10	4.20
21	5.60	12.50	7.90	5.20	6.50	4.40	4.00	3.80	5.30	3.80	4.10	4.50
22	5.60	13.50	7.80	5.10	5.20	4.30	3.90	3.80	5.00	3,80	4.10	4.40
23	5.60	15.65	7.60	5.10	5.20	4.30	3.90	3.80	4.90	3.80	4.10	4.30
24	5.70	11.60	7.20	5.00	5.00	4.30	3.90	3.80	4.50	3.80	5.30	7.10
25	10.40	9.10	6.70	5.00	4.90	4.20	4.30	3.80	4.30	3.80	4.70	6.90
26	8.20	9.10	6.70	5.00	4.80	4.20	4.50	3.80	5.25	3.80	4.40	6.20
27	6.50	17.80	6.70	5.00	4.70	4.20	4.40	4.70	5.50	3.80	4.30	6.00
28	5.20	12.50	10.15	4.90	4.70	4.20	4.30	4.95	5.30	3.80	4.30	5.10
29	5.20	-------	11.00	4.90	4.60	4.20	4.20	4.70	5.00	3.80	4.30	5.10
30	5.20	-------	8.10	4.80	5.00	4.20	4.00	4.30	4.50	3.80	4.20	5.10
31	5.20	-------	7.90	-------	5.00	-------	3.90	4.30	-------	5.00	-------	-------

ROCK CREEK AT ZOOLOGICAL PARK, DISTRICT OF COLUMBIA.

This creek rises in Montgomery County, Maryland, and flows in a southerly direction through the District of Columbia, emptying into Potomac River. A study of the discharge of Rock Creek was begun in 1892, at the request of the Commissioners of the District of Columbia, and a gage rod established by Cyrus C. Babb at Lyons Mill. In August, 1892, a self-registering gage was placed at the bridge, and the record continued until November 30, 1894. The present station was established January 18, 1897, by E. G. Paul, at the bridge of the National Zoological Park, District of Columbia. The upper part of the gage is vertical and is fastened to the bridge abutment, the lower part being inclined and fastened to the iron rods. The bench mark consists of a cross cut in the stone of the bridge pier. It is 9.13 feet above the zero of the gage. The observer is W. V. Kramer, a park watchman.

Daily gage height in feet of Rock Creek at Zoological Park, District of Columbia, for 1899.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.05	2.78	3.30	3.00	2.75	2.88	2.40	2.35	2.40	2.58	3.65	2.53
2	2.75	2.88	3.23	2.93	2.70	2.68	2.40	2.35	2.40	2.50	2.83	2.58
3	2.88	2.88	3.13	2.90	2.73	2.63	2.35	3.90	2.40	2.50	2.80	2.53
4	2.90	2.95	3.10	2.90	2.70	2.60	2.35	3.20	2.40	2.50	3.10	2.50
5	3.33	3.13	4.50	2.90	2.70	2.55	2.60	2.65	2.38	2.50	2.80	2.50
6	3.60	3.00	3.40	2.90	2.70	2.55	2.58	2.90	2.30	2.75	2.70	2.50
7	4.25	3.00	3.18	2.95	2.75	2.55	2.70	2.55	2.30	2.70	2.63	2.50
8	3.23	2.93	3.10	3.80	2.75	2.55	2.50	2.50	2.30	2.58	2.60	2.50
9	3.05	2.63	3.10	3.08	3.23	2.50	2.78	2.48	2.30	2.60	2.60	2.50
10	3.00	2.93	3.08	3.00	2.83	3.63	2.48	2.53	2.30	2.58	2.60	2.50
11	3.00	2.78	3.23	2.90	2.83	2.98	2.43	2.50	2.40	2.55	2.60	2.50
12	3.10	2.78	3.18	2.90	2.98	2.73	2.40	2.48	2.43	2.50	2.58	2.78
13	2.90	2.78	3.13	2.90	2.78	2.65	2.50	2.45	2.30	2.50	2.55	2.75
14	3.00	2.78	3.00	2.90	2.73	2.63	2.70	2.75	2.30	2.50	2.55	2.63
15	3.00	2.95	3.10	2.85	2.70	2.55	2.45	2.50	2.30	2.50	2.55	2.53
16	3.00	2.95	3.30	3.05	2.68	2.50	2.45	2.70	2.25	2.50	2.55	2.50
17	3.10	4.00	3.00	3.00	2.73	2.50	2.90	2.50	2.25	2.50	2.55	2.50
18	3.08	4.25	3.05	2.90	3.25	2.50	2.58	2.45	2.30	2.50	2.55	2.55
19	2.98	4.43	3.90	2.85	2.95	2.50	2.45	2.43	2.43	2.50	2.58	2.60
20	2.93	4.05	3.33	2.85	2.78	2.50	2.40	2.40	3.00	2.50	2.55	2.60
21	3.13	3.88	3.10	2.80	2.70	2.48	2.40	2.40	2.63	2.50	2.55	2.60
22	2.85	4.18	3.18	2.80	2.70	2.45	2.40	2.73	2.55	2.45	2.55	2.55
23	2.85	4.10	3.18	2.80	2.68	2.45	2.40	2.45	2.40	2.45	2.60	2.50
24	2.85	3.50	3.03	2.80	2.65	2.45	2.40	2.35	2.35	2.48	2.63	2.93
25	3.68	3.20	3.00	2.80	2.60	2.48	2.40	2.30	2.65	2.45	2.60	2.95
26	3.08	3.15	3.00	2.80	2.60	2.53	2.50	2.30	5.25	2.45	2.60	2.68
27	3.00	3.70	3.00	2.83	2.60	2.50	2.50	2.55	3.75	2.50	2.55	2.53
28	2.88	3.33	3.23	2.78	2.60	2.48	2.40	2.75	2.85	2.50	2.55	2.60
29	2.85	-------	3.45	2.75	2.65	2.45	2.40	2.48	2.60	2.50	2.55	2.53
30	2.83	-------	3.15	2.75	2.60	2.43	2.40	2.40	2.60	2.50	2.55	2.53
31	2.85	-------	3.03	-------	2.60	-------	2.38	2.40	-------	2.63	-------	2.50

NORTH ANNA RIVER, VIRGINIA.

Measurements of North Anna River, a tributary of Pamunkey River, were made in August, 1896, by J. O. Smith and A. Langstaff Johnston, of Richmond, Virginia, at Mr. Smith's mill, at a point about 1 mile above the Hanover County line; also at McGeehees Bridge, about 3 miles above the mill. At that time the river was at its lowest stage for the year. During the winter the volume is believed to be four or five times greater. The measurements at the mill gave an average area of 148 square feet and an average velocity of 0.69 foot per second, the total discharge being 102 second-feet. The measurements at McGeehees Bridge showed an average area of 184 square feet and an average velocity of 0.50 foot per second, giving a discharge of 92 second-feet.

NORTH RIVER AT GLASGOW, VIRGINIA.

This river rises on the western slope of the Shenandoah Mountains, and flows in a southeasterly direction across the valley between the Shenandoah and Blue Ridge ranges, emptying into James River about 17 miles south of Lexington, Virginia. Its watershed is largely under cultivation, except in the upper part, where it is mountainous and covered with forest growth. The entire drainage area is mapped on the Lexington, Monterey, Staunton, and Natural Bridge atlas sheets. This station was established at the East Glasgow County Bridge, about 1 mile above the mouth of North River, by C. C. Babb and D. C. Humphreys, on August 21, 1895. The height of water is observed by means of a wire gage, the board being placed on the guard rail on the lower side of the bridge, and graduated in feet and tenths. This gage is referred to a bench mark at the top of the top chord of the bridge over the gage pulley at an elevation of 32.24 feet. The distance from the end of the weight to the marker of the gage is 27.86 feet. The measurements of discharge are made from the bridge, the initial point for soundings being on the left bank. The channel is straight for about 200 feet above and below the station; the current rather sluggish, but with sufficient velocity for measurements. There is a dam on the North River 10 miles above the station, but its influence on the flow is scarcely noticeable. The right bank is high, but the left bank is subject to overflow in very high water. The bed is of rock and gravel, and fairly permanent. The observer is B. G. Baldwin, a merchant of Glasgow, Virginia. Results of measurements may be found as follows: 1895–96, Eighteenth Annual Report, Part IV, page 38; 1897, Nineteenth Annual Report, Part IV, page 162; 1898, Twentieth Annual Report, Part IV, page 135. The following discharge measurements were made during 1899 by D. C. Humphreys:

March 30, gage height, 2.82 feet; discharge, 2,039 second-feet.

June 27, gage height, 0.95 foot; discharge, 227 second-feet.

August 7, gage height, 0.92 foot, discharge 218 second-feet.

At this last measurement the velocity was barely sufficient to turn the meter and surface floats indicated that the discharge should be somewhat greater.

Daily gage height, in feet, of North River at Glasgow, Virginia, for 1899.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.05	1.80	(a)	2.60	1.42	1.38	0.90	0.72	0.85	0.95	2.50	0.73
2	2.10	1.72	(a)	2.43	1.42	1.48	.80	.72	.82	.90	1.50	.75
3	2.00	1.80	(a)	2.35	1.43	1.40	.82	.73	.82	.85	1.35	.78
4	2.30	2.30	(a)	2.20	1.42	1.30	.80	.75	.82	.85	1.25	.76
5	2.52	b2.80	13.05	2.15	1.42	1.25	.80	.75	.80	.85	1.20	.76
6	4.01	3.30	(a)	2.10	1.48	1.21	.78	.75	.71	.85	1.10	.78
7	7.00	3.15	(a)	2.10	1.52	1.15	.80	.90	.71	.84	1.05	.75
8	b5.38	2.80	(a)	2.80	1.62	1.12	.80	.80	.70	.87	1.00	.78
9	3.75	2.30	(a)	2.55	3.75	1.10	.80	.73	1.10	.98	.95	.78
10	3.80	2.30	(a)	2.42	2.85	1.10	.95	.73	1.00	.90	.93	.75
11	2.95	2.28	(a)	2.35	2.45	1.08	.88	.72	.90	.85	.92	.73
12	2.60	b2.27	(a)	2.30	1.85	1.30	.80	.72	1.00	.82	.92	1.25
13	2.45	2.26	(a)	2.22	2.30	1.40	.80	.73	.95	.80	.92	2.10
14	2.45	2.25	(a)	2.12	2.25	1.30	.80	.77	.90	.75	.84	1.85
15	2.38	2.25	(a)	2.10	2.15	1.20	.80	1.92	.80	.70	.80	1.50
16	2.35	2.26	(a)	2.00	2.00	1.20	.80	1.10	.75	.65	.80	1.42
17	2.28	2.30	(a)	1.94	1.90	1.18	.80	.88	.73	.68	.83	1.25
18	2.25	2.45	(a)	1.90	1.80	1.10	.80	.80	.72	.68	.80	1.12
19	2.20	2.75	(a)	1.82	1.80	1.02	.75	.72	.72	.70	.65	1.12
20	2.10	3.30	(a)	1.80	1.62	1.00	.72	.72	2.62	.70	.80	1.08
21	2.05	4.80	(a)	1.77	1.58	.95	.72	.72	1.32	.72	.79	1.05
22	2.02	6.85	(a)	1.72	1.55	.92	.72	.70	1.22	.70	.78	1.00
23	2.00	5.45	(a)	1.68	1.52	.90	.70	.70	1.15	.73	.78	1.10
24	1.90	5.35	(a)	1.65	1.46	.90	.70	.63	1.00	.73	.74	1.12
25	2.00	5.15	(a)	1.62	1.38	.95	.71	.62	1.00	.72	.74	1.20
26	2.05	......	(a)	1.65	1.30	1.00	.72	.62	.98	.72	.72	1.30
27	2.00	6.15	(a)	1.62	1.28	.95	.75	b1.00	1.10	.72	.70	1.10
28	2.00	......	(a)	1.60	1.25	.95	.75	1.62	1.08	.72	.65	1.15
29	1.95	......	(a)	1.53	1.22	1.00	.74	1.35	1.00	.71	.70	1.20
30	1.90	......	2.90	1.48	1.48	.97	.72	1.02	.98	.70	.75	1.21
31	1.85	......	2.72	......	1.46	......	.72	.92	......	.85	......	1.00

a No observations. b Interpolated.

JAMES RIVER AT BUCHANAN, VIRGINIA.

This river rises in the Allegheny Mountains, on the western border of Virginia, and flows in an easterly direction across the State into Chesapeake Bay. The upper part of its drainage area is mountainous and largely covered with forests, while in the eastern part of the State the river flows through a flat and cultivated area. Measurements of flow are made at Buchanan, in Botetourt County, and at Cartersville, 50 miles above Richmond. The station at Buchanan was established by C. C. Babb and D. C. Humphreys, August 18, 1895. It is about 20 miles above the mouth of North River and one-half mile above the mouth of Purgatory Creek, as shown on the Natural Bridge topographic atlas sheet. The area as far as this point is mapped on the Natural Bridge, Staunton, Monterey, Lewisburg, Dublin, Christiansburg, and Roanoke sheets. The United States Weather Bureau had maintained a gage here for about two years before measurements were made by the Geological Survey. The wire gage is suspended from the steel highway bridge which crosses the river on two spans. On April 3, 1897, the zero of this gage was lowered 2 feet to avoid negative readings. The gage is referred to a scale divided into feet and tenths, and to two bench marks. First, the top of the upper end of the third floor beam from left bank is 30.00 feet above the zero of the gage. Second, the top of a stone post under the southwest corner of the porch of the Chesapeake and Ohio Railroad passenger station is 24.68 feet above zero of gage. A third bench mark is on a permanent ledge of rock on the left bank about 500 feet above the bridge, and at an elevation of 17.48 feet above the zero of the gage. The initial point of soundings is on the left bank, upper side of the bridge, marked with the end pin of the truss. The channel is straight, the flow fairly swift, and without obstructions. The bed is rocky; banks high and not subject to overflow. The observer is U. H. Hyde, a telegraph operator for the Chesapeake and Ohio Railroad, at Buchanan, Virginia. The results of measurement may be found as follows: 1895–96, Eighteenth Annual Report, Part IV, page 41; 1897, Nineteenth Annual Report, Part IV, page 172; 1898, Twentieth Annual Report, Part IV, page 136. During 1899 three measurements of discharge were made by D. C. Humphreys; the first on March 30, at a gage height of 5.54 feet, gave a discharge 6,804 second-feet; the second on July 6, at a gage height of 2.06 feet, gave a discharge 558 second-feet, and the third on August 11, at a gage height of 1.80 feet, gave a discharge of 364 second-feet.

Daily gage height, in feet, of James River at Buchanan, Virginia, for 1899.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.45	3.10	7.45	4.75	3.80	3.60	3.00	1.90	1.90	1.90	1.80	1.80
2	3.55	3.00	6.55	4.40	3.80	3.70	2.10	1.90	1.90	1.90	1.90	1.80
3	3.40	3.00	6.40	4.30	3.80	3.60	2.10	1.80	1.90	1.90	2.10	1.80
4	3.40	3.40	11.20	4.20	3.80	3.60	2.00	1.80	2.00	1.90	2.30	1.80
5	3.95	4.90	19.05	4.10	3.70	3.60	2.00	1.80	2.10	1.90	2.20	1.80
6	5.95	6.80	13.55	4.10	3.70	3.50	2.05	1.80	2.00	1.80	2.20	1.80
7	10.25	8.40	8.15	4.00	4.05	3.40	2.12	1.80	1.90	1.80	2.10	1.80
8	7.70	7.30	6.70	5.00	5.35	3.30	2.35	1.90	1.80	1.80	2.10	1.80
9	5.95	6.30	5.90	5.75	7.70	3.30	2.35	1.90	2.00	1.80	2.10	1.80
10	5.20	4.50	5.55	5.40	6.65	3.30	2.15	1.90	2.10	1.80	2.00	1.80
11	4.60	4.05	5.35	5.00	5.85	3.30	2.00	1.90	2.20	1.80	2.00	1.80
12	4.20	4.00	5.15	4.85	5.65	3.30	2.00	1.90	2.10	1.80	1.90	2.30
13	4.00	4.00	4.95	4.70	5.60	4.45	2.00	1.90	2.10	1.80	1.90	3.50
14	3.85	3.95	4.65	4.60	6.20	4.50	2.00	2.00	2.00	1.80	1.90	3.05
15	4.15	3.50	4.75	4.45	5.70	4.25	1.90	2.60	2.00	1.80	1.90	2.95
16	4.30	3.60	5.55	4.45	5.20	3.95	1.90	2.45	1.90	1.80	1.90	2.60
17	4.20	3.75	5.30	4.30	4.85	3.70	1.90	2.20	1.90	1.80	1.80	2.45
18	4.20	4.15	5.05	4.05	4.65	3.55	1.90	2.00	1.80	1.80	1.80	2.30
19	4.05	4.85	7.15	4.00	4.50	3.40	1.90	1.90	2.45	1.80	1.80	2.20
20	3.75	5.70	7.80	3.90	4.35	3.30	1.90	1.90	3.60	1.80	1.80	2.20
21	3.60	8.20	6.35	3.90	4.05	3.20	1.90	1.80	3.40	1.70	1.80	2.10
22	3.50	10.20	5.65	3.80	4.00	3.10	1.80	1.80	2.65	1.70	1.80	2.10
23	3.50	9.35	5.20	3.80	3.90	3.10	1.80	1.80	2.35	1.70	1.80	2.10
24	3.40	7.35	4.80	3.70	3.90	3.00	1.80	1.80	2.20	1.70	1.80	2.10
25	3.40	6.15	4.55	3.70	3.90	3.15	1.80	1.80	2.10	1.70	1.80	2.10
26	3.60	5.40	4.25	3.85	3.80	3.10	1.80	1.80	2.10	1.70	1.80	2.25
27	3.50	8.90	4.10	4.20	3.60	3.65	1.90	1.90	2.00	1.70	1.80	2.30
28	3.40	9.65	4.00	4.00	3.60	3.30	1.90	1.80	2.00	1.70	1.80	2.20
29	3.30	-------	4.80	4.00	3.50	3.20	2.00	2.00	2.00	1.70	1.80	2.20
30	3.20	-------	5.55	3.90	3.60	3.10	2.00	1.90	1.90	1.70	1.80	2.20
31	3.10	-------	5.75	-------	3.60	-------	1.90	1.90	-------	1.70	-------	2.20

JAMES RIVER AT CARTERSVILLE, VIRGINIA.

Observations of the height of James River are made by the Weather Bureau at Lynchburg, Virginia, 48 miles below Buchanan and about 100 miles above Cartersville. The drainage area is given as 3,700 square miles. The gage is on the first pier of the Amherst bridge, at the foot of Ninth street, on the side facing Lynchburg, about 100 feet from the shore. The elevation is 494.7 feet above mean sea level. The highest water was about 27 feet on September 30, 1870, and the lowest —0.3 foot on September 12–15, 1895.

Gages were established on James River in 1893 by Mr. F. B. Isaacs, engineer for water power of the Chesapeake and Ohio Railway Company, at Ninemile Locks, Columbia, Scottsville, Lynchburg, Balcony Falls, Buchanan, Eagle Mountain, and Clifton Forge. Records of heights of water at these points were made twice daily from 1893 to 1897, and freshet reports were obtained for these years. The gages were not referred to any fixed datum, but the zero of each gage was set at what was considered ordinary low water in the river. During the latter part of 1899 records have been resumed, excepting at Scottsville, Balcony Falls, and Eagle Mountain, where the gages have been abandoned.

At Bosher's dam, 9 miles above Richmond, is a gage where the height of water is recorded twice daily, showing the supposed head on the crest of dam. This crest, however, is so irregular that the coefficient of discharge has not been ascertained. Another complication exists in the fact that water is deflected into a canal, the quantity not being known.

Observations are maintained by the Weather Bureau at Richmond, Virginia, the gage being at the foot of Virginia street, near Fourteenth, immediately east of the Richmond and Danville Railroad bridge. It is a standard brass Weather Bureau gage embedded in the cement buttress. The elevation of the zero is 2.8 feet.

A gaging station was established January 1, 1899, by Prof. D. C. Humphreys, and is located at the highway bridge crossing the James at Cartersville, on half mile from railroad station and 50 miles above Richmond, Virginia. The drainage area is mapped on the following atlas sheets: Goochland, Farmville, Palmyra, Gordonsville, Harrisonburg, Buckingham, Lexington, Lynchburg, Appomatox, Natural Bridge, Lewisburg, Christiansburg, Roanoke, Staunton, Monterey, and Dublin. The wire gage is attached to a horizontal gage rod fastened to the bridge and is referred to a bench mark, the top of the lower end of the fourth floor beam from the right bank, which is 32.04 feet above the zero of the gage. The gage was verified June 23, 1899. The channel is straight for one-third of a mile above and 1 mile below the station, the current fairly swift, and the bottom somewhat sandy and shifting. The banks are high and not subject to overflow except in extreme high water. The observer is Julien I. Palmore, clerk in a store at Cartersville, Virginia. The following measurements were made by Prof. D. C. Humphreys and F. H. Anschutz. Prior to 1899 two measurements were made, which have not previously been published:

September 8, 1897, gage height, 0.42 foot; discharge, 603 second-feet.
July 16, 1898, gage height, 1.04 feet; discharge, 1,323 second-feet.
January 3, 1899, gage height, 3.82 feet; discharge, 7,156 second-feet.
June 23, 1899, gage height, 1.46 feet; discharge, 2,686 second-feet.

Daily gage height, in feet, of James River at Cartersville, Virginia, for 1899.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.40	3.30	13.90	6.05	3.00	2.30	1.53	1.30	1.40	1.30	4.97	1.20
2	4.40	3.25	10.35	5.62	2.85	2.20	1.35	1.10	1.32	1.15	4.15	1.20
3	3.70	3.20	8.80	5.15	2.80	2.70	1.25	1.00	2.90	1.10	3.60	1.20
4	4.00	4.30	9.40	4.65	3.05	2.40	1.12	.90	1.44	1.10	5.30	1.20
5	4.00	5.65	20.25	4.60	2.80	2.27	1.22	.85	1.35	1.10	3.30	1.20
6	8.20	7.50	24.70	4.25	2.80	2.10	1.25	2.30	1.15	1.05	2.80	1.20
7	19.50	8.80	19.25	4.15	3.65	2.05	1.30	2.00	1.15	1.00	2.50	1.20
8	15.40	10.50	13.17	9.55	4.50	1.97	1.47	1.45	1.30	1.80	2.20	1.15
9	11.74	8.75	10.40	8.50	5.00	1.75	1.20	1.35	1.60	2.00	1.95	1.10
10	9.00	6.40	10.90	8.15	6.20	1.80	1.15	1.10	1.44	2.05	1.85	1.00
11	7.05	5.10	8.60	7.12	6.50	2.00	1.06	1.00	1.27	1.50	1.60	1.00
12	5.98	5.10	7.30	6.15	7.30	2.30	1.24	1.26	1.20	1.40	1.50	1.10
13	5.40	5.10	7.10	4.90	5.05	3.10	1.09	1.19	1.30	1.30	1.45	3.15
14	5.17	5.10	6.90	4.70	5.65	3.45	1.02	1.09	1.31	1.20	1.75	2.80
15	5.17	6.00	8.12	4.50	5.15	3.40	1.00	1.10	1.13	1.10	1.50	3.10
16	4.70	7.75	10.65	4.15	5.15	3.47	1.07	2.64	1.05	1.10	1.30	2.90
17	5.47	14.00	8.30	4.07	4.45	3.00	1.00	2.12	1.00	1.00	1.30	2.80
18	5.15	9.75	8.05	3.95	3.90	2.10	1.04	1.40	.92	1.20	1.25	2.40
19	4.73	10.55	17.33	3.75	3.65	2.00	1.15	1.30	.85	1.10	1.25	1.80
20	4.50	10.55	18.32	3.60	3.40	1.78	1.05	1.15	3.40	1.00	1.25	1.80
21	4.20	14.00	12.83	3.55	3.17	1.70	.88	.97	5.40	.98	1.25	1.60
22	4.05	16.10	8.80	3.47	2.86	1.50	.82	.80	3.40	.97	1.25	1.50
23	3.85	16.30	8.00	3.32	2.80	1.48	.80	.80	2.65	.98	1.25	1.45
24	3.75	13.75	7.60	3.17	2.70	1.40	.77	.82	2.10	1.00	1.25	1.60
25	4.30	11.00	6.65	3.08	2.50	1.40	.70	.76	1.30	1.00	1.25	1.80
26	4.10	8.65	6.15	3.05	2.45	1.70	.80	.66	3.50	.98	1.25	2.00
27	3.80	10.90	5.85	3.20	2.45	2.10	2.23	7.00	2.35	.97	1.20	2.10
28	3.75	12.30	5.25	3.25	2.15	1.60	2.30	6.45	1.70	.97	1.20	2.00
29	3.55	......	6.35	3.30	2.05	1.40	1.33	3.50	1.40	.97	1.20	1.80
30	3.50	......	6.15	3.10	2.20	1.80	1.40	2.70	1.30	.97	1.20	1.75
31	3.42	......	6.55	......	2.25	......	1.70	1.84	......	.97	......	1.65

NOTE.—Data concerning other rivers are given in succeeding papers of this series, beginning on page 107 of Water-Supply Paper No 36. By the law approved June 11, 1896 (Stat. L., vol. 29, p. 453), the reports of this series are limited to 100 pages each. It is therefore necessary to arbitrarily subdivide this report on operations at river stations.

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1895.

Sixteenth Annual Report of the United States Geological Survey, 1894–95, Part II, Papers of an economic character, 1895; octavo, 598 pp.

Contains a paper on the public lands and their water supply, by F. H. Newell, illustrated by a large map showing the relative extent and location of the vacant public lands; also a report on the water resources of a portion of the Great Plains, by Robert Hay.

A geological reconnaissance of northwestern Wyoming, by George H. Eldridge 1894; octavo, 72 pp. Bulletin No. 119 of the United States Geological Survey, price, 10 cents.

Contains a description of the geologic structure of portions of the Bighorn Range and Bighorn Basin, especially with reference to the coal fields, and remarks upon the water supply and agricultural possibilities.

Report of progress of the division of hydrography for the calendar years 1893 and 1894, by F. H. Newell, 1895; octavo, 176 pp. Bulletin No. 131 of the United States Geological Survey; price, 15 cents.

Contains results of stream measurements at various points, mainly within the arid region, and records of wells in a number of counties in western Nebraska, western Kansas, and eastern Colorado.

1896.

Seventeenth Annual Report of the United States Geological Survey, 1895–96, Part II, Economic geology and hydrography, 1896; octavo, 864 pp.

Contains papers on "The underground water of the Arkansas Valley in eastern Colorado," by G. K. Gilbert; "The water resources of Illinois," by Frank Leverett, and "Preliminary report on the artesian waters of a portion of the Dakotas," by N. H. Darton.

Artesian-well prospects in the Atlantic Coastal Plain region, by N. H. Darton, 1896; octavo, 230 pp., 19 plates. Bulletin No. 138 of the United States Geological Survey; price, 20 cents.

Gives a description of the geologic conditions of the coastal region from Long Island, N. Y., to Georgia, and contains data relating to many of the deep wells.

Report of progress of the division of hydrography for the calendar year 1895, by F. H. Newell, hydrographer in charge, 1896; octavo, 356 pp. Bulletin No. 140 of the United States Geological Survey; price, 25 cents.

Contains a description of the instruments and methods employed in measuring streams and the results of hydrographic investigations in various parts of the United States.

1897.

Eighteenth Annual Report of the United States Geological Survey, 1896–97, Part IV, Hydrography, 1897; octavo, 756 pp.

Contains a "Report of progress of stream measurements for the calendar year 1896," by Arthur P. Davis; "The water resources of Indiana and Ohio," by Frank Leverett; "New developments in well boring and irrigation in South Dakota," by N. H. Darton, and "Reservoirs for irrigation," by J. D. Schuyler.

1899.

Nineteenth Annual Report of the United States Geological Survey, 1897–98, Part IV, Hydrography, 1899; octavo, 814 pp.

Contains a "Report of progress of stream measurements for the calendar year 1898," by F. H. Newell and others; "The rock waters of Ohio," by Edward Orton, and "A preliminary report on the geology and water resources of Nebraska west of the one hundred and third meridian," by N. H. Darton.

1900.

Twentieth Annual Report of the United States Geological Survey, 1898–99, Part IV, Hydrography, 1900; octavo, 660 pp.

Contains a "Report of progress of stream measurements for the calendar year 1898," by F. H. Newell, and "Hydrography of Nicaragua," by A. P. Davis.

WATER-SUPPLY AND IRRIGATION PAPERS, 1896–1900.

This series of papers is designed to present in pamphlet form the results of stream measurements and of special investigations. A list of these, with other information, is given on the outside (or fourth) page of this cover.

Survey bulletins can be obtained only by prepayment of cost, as noted above. Money should be transmitted by postal money order or express order, made payable to the Director of the United States Geological Survey. Postage stamps, checks, and drafts can not be accepted. Correspondence relating to the publications of the Survey should be addressed to **The Director, United States Geological Survey, Washington, D. C.**

ATER-SUPPLY AND IRRIGATION PAPERS.

umping water for irrigation, by Herbert M. Wilson, 1896.
2. Irrigation near Phœnix, Arizona, by Arthur P. Davis, 1897.
3. Sewage irrigation, by George W. Rafter, 1897.
4. A reconnoissance in southeastern Washington, by Israel C. Russell, 1897.
5. Irrigation practice on the Great Plains, by E. B. Cowgill, 1897.
6. Underground waters of southwestern Kansas, by Erasmus Haworth, 1897.
7. Seepage waters of northern Utah, by Samuel Fortier, 1897.
8. Windmills for irrigation, by E. C. Murphy, 1897.
9. Irrigation near Greeley, Colorado, by David Boyd, 1897.
10. Irrigation in Mesilla Valley, New Mexico, by F. C. Barker, 1898.
11. River heights for 1896, by Arthur P. Davis, 1897.
12. Water resources of southeastern Nebraska, by Nelson Horatio Darton, 1898.
13. Irrigation systems in Texas, by William Ferguson Hutson, 1898.
14. New tests of pumps and water lifts used in irrigation, by O. P. Hood, 1898.
15. Operations at river stations, 1897, Part I, 1898.
16. Operations at river stations, 1897, Part II, 1898.
17. Irrigation near Bakersfield, California, by C. E. Grunsky, 1898.
18. Irrigation near Fresno, California, by C. E. Grunsky, 1898.
19. Irrigation near Merced, California, by C. E. Grunsky, 1899.
20. Experiments with windmills, by Thomas O. Perry, 1899.
21. Wells of northern Indiana, by Frank Leverett, 1899.
22. Sewage irrigation, Part II, by George W. Rafter, 1899.
23. Water-right problems of the Bighorn Mountains, by Elwood Mead, 1899.
24. Water resources of the State of New York, Part I, by George W. Rafter, 1899.
25. Water resources of the State of New York, Part II, by George W. Rafter, 1899.
26. Wells of southern Indiana (continuation of No. 21), by Frank Leverett, 1899.
27. Operations at river stations, 1898, Part I, 1899.
28. Operations at river stations, 1898, Part II, 1899.
29. Wells and windmills in Nebraska, by Erwin Hinckley Barbour, 1899.
30. Water resources of the Lower Peninsula of Michigan, by Alfred C. Lane, 1899.
31. Lower Michigan mineral waters, by Alfred C. Lane, 1899.
32. Water resources of Puerto Rico, by H. M. Wilson, 1900.
33. Storage of water on Gila River, Arizona, by J. B. Lippincott, 1900.
34. Underground waters of a portion of southeastern S. Dak., by J. E. Todd, 1900.
35. Operations at river stations, 1899, Part I, 1900.
36. Operations at river stations, 1899, Part II, 1900.
37. Operations at river stations, 1899, Part III, 1900.

In addition to the above, there are in various stages of preparation other papers relating to the measurement of streams, the storage of water, the amount available from underground sources, the efficiency of windmills, the cost of pumping, and other details relating to the methods of utilizing the water resources of the country. Provision has been made for printing these by the following clause in the sundry civil act making appropriations for the year 1896–97:

Provided, That hereafter the reports of the Geological Survey in relation to the gaging of streams and to the methods of utilizing the water resources may be printed in octavo form, not to exceed 100 pages in length and 5,000 copies in number; 1,000 copies of which shall be for the official use of the Geological Survey, 1,500 copies shall be delivered to the Senate, and 2,500 copies shall be delivered to the House of Representatives, for distribution. [Approved June 11, 1896; Stat. L., vol. 29, p. 453.]

The maximum number of copies available for the use of the Geological Survey is 1,000. This number falls far short of the demand, so that it is impossible to supply all requests. Attempts are made to send these pamphlets to persons who have rendered assistance in their preparation through replies to schedules or who have furnished data. Requests specifying a certain paper and stating a reason for asking for it are granted whenever practicable, but it is impossible to comply with general and indiscriminate demands, such as to have all of the series sent.

Application for these papers should be made either to Members of Congress or to

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Washington, D. C.