Water-Supply and Irrigation Paper No. 126 Series P, Hydrographic Progress Reports, 31

DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

PROGRESS OF STREAM MEASUREMENTS

FOR

THE CALENDAR YEAR 1904

PREPARED UNDER THE DIRECTION OF F. H. NEWELL

BY

N. C. GROVER and JOHN C. HOYT

PART III.—Susquehanna, Patapsco, Potomac, James, Roanoke, Cape Fear, and Yadkin River Drainages

WASHINGTON
GOVERNMENT PRINTING OFFICE
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DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
HYDROGRAPHIC BRANCH,
Washington, D. C., February 4, 1905.

SIR: I transmit herewith the manuscript of Part III of a series of twelve papers which compose the Report of Progress of Stream Measurements for the Calendar Year 1904. Parts I to VI of this report contain the results of the data collected in the territory east of the Mississippi River. Parts VII to XII are devoted to the data collected in the territory west of the Mississippi River.

The larger part of the original data for this report was collected under the direction of district hydrographer N. C. Grover, who was assisted by H. D. Comstock. The assembling of the data and their preparation for publication were done under the direction of John C. Hoyt, who has been assisted by R. H. Bolster, Robert Follansbee, Willis E. Hall, and A. H. Horton.

I request that this manuscript be published as one of the series of Water-Supply and Irrigation Papers.

Very respectfully,

F. H. NEWELL, *Chief Engineer.*

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

PROGRESS REPORT OF STREAM MEASUREMENTS FOR THE CALENDAR YEAR 1904.

PART III.

By N. C. GROVER and JOHN C. HOYT.

INTRODUCTION.

The hydrographic work of the United States Geological Survey includes the collection of facts concerning and the study of conditions affecting the behavior of water from the time it reaches the earth as rain or snow until it joins the oceans or great navigable rivers. These investigations became a distinct feature of the work of the Survey in the fall of 1888, when an instruction camp was established at Embudo, N. Mex. Since that date the work has been continually and gradually extended as larger funds became available. The first distinctive appropriation for gaging streams was made by the act of August 18, 1894, which contained an item of $12,500, "for gaging the streams and determining the water supply of the United States, including the investigation of underground currents and artesian wells in the arid and semiarid sections." (Digest of Appropriations for 1895, p. 270.)

Since that time a similar act has been passed each year and the appropriations have gradually increased, as shown in the following table:

Annual appropriations for hydrographic surveys.

Year ending June 30, 1895	$12,500
Year ending June 30, 1896	20,000
Year ending June 30, 1897	50,000
Year ending June 30, 1898	50,000
Year ending June 30, 1899	50,000
Year ending June 30, 1900	50,000
Year ending June 30, 1901	100,000
Year ending June 30, 1902	100,000
Year ending June 30, 1903	200,000
Year ending June 30, 1904	200,000
Year ending June 30, 1905	200,000

The chief feature of the work of the hydrographic division is the systematic study of the flow of the surface waters and the conditions affecting the same. In this connection other information that may be of use to the engineer or others in hydrographic studies, such as river profiles, duration and extent of damage by floods, water-power data, etc., is collected. Furthermore, the work has been so directed that the information collected will be of direct value in the commercial and agricultural development of the country.

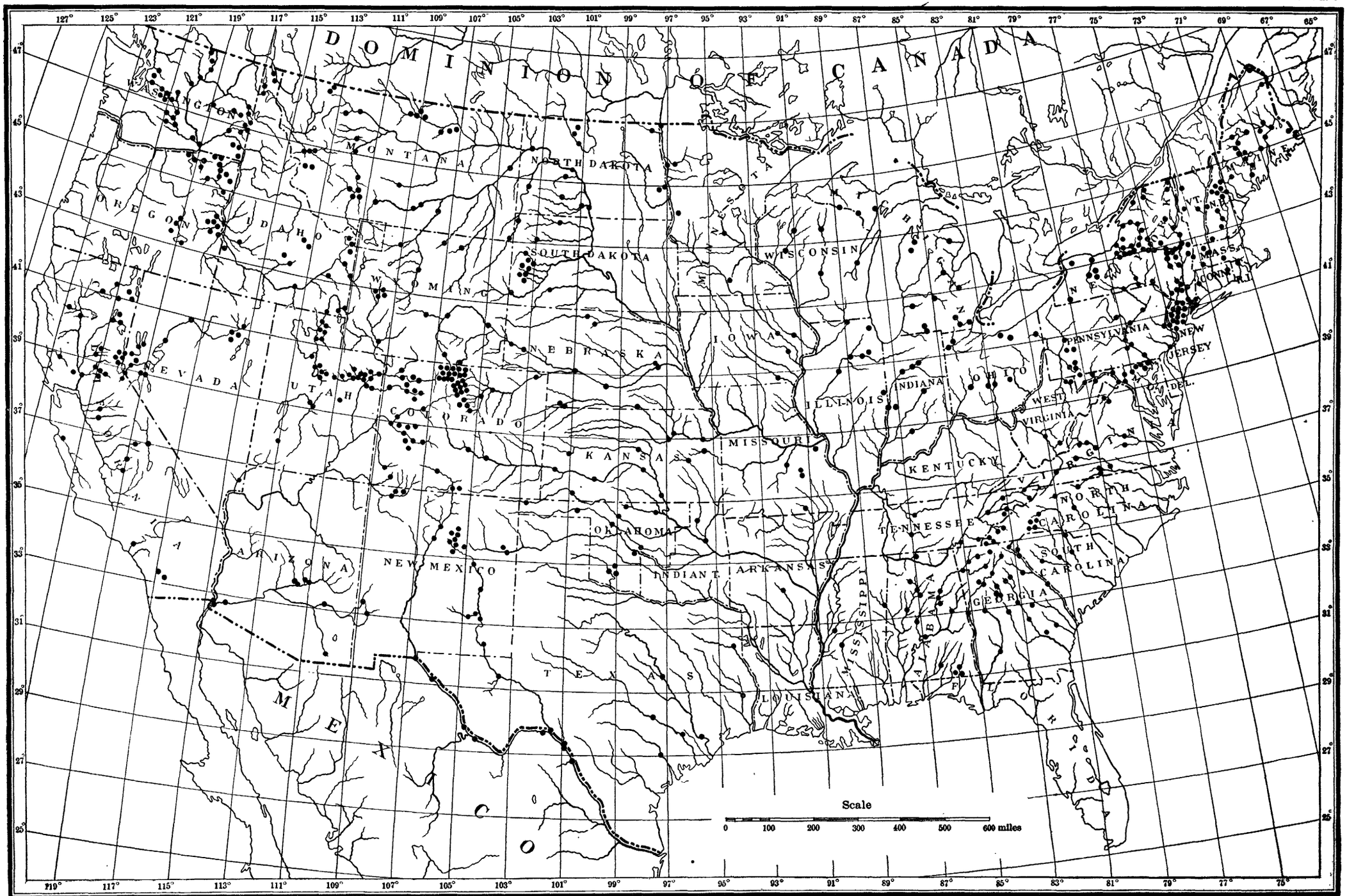
As a result of the increased appropriations since June 30, 1902, the work has been largely extended and thoroughly systemized. The various States have been grouped into districts, each of which is under the supervision of a district hydrographer who, with a corps of assistants, devotes his whole time to the study of the hydrographic resources of his district.

The methods used in the collection of these data and in their preparation for publication are given in detail in Water-Supply Paper No. 94. (Hydrographic Manual, U. S. Geol. Survey.)

The general plan of stream gaging which has been developed is to obtain eventually data in regard to the flow of all the important streams in the United States. With this in view gaging stations are established at points where the data will be of greatest commercial value. At these stations discharge measurements are taken from time to time at typical river stages, and the daily surface fluctuation is obtained by means of gage readings. From these two factors it is possible to estimate both the total flow and its distribution through the period of observations.

The selection of the site for a gaging station and the length of time the station is maintained depend largely upon the needs of each locality. If the stream is to be used for water power, special efforts are made to obtain information concerning the low-water flow. If water is to be stored, the high waters are given special attention. In all sections certain permanent stations are maintained for general statistical purposes to show the conditions which exist through long periods. They also act as primary stations, and are used in connection with short series of measurements to determine the flow in particular portions of the drainage basin.

Gaging stations are divided into two general classes: First, current-meter stations; and second, weir stations. The former class is subdivided as to location into bridge, cable, boat, and wading stations. Fig. 1 shows a cable station with car, tag-line, inclined gage, etc. In addition to the bridge, cable, or boat, the equipment of a current-meter gaging station consists in a gage for determining the daily fluctuations of the water surface, bench marks to which the zero of the gage is referred, and permanent marks on the bridge or a tagged line indicating the points of measurement. Where the current is swift some appli-



MAP OF THE UNITED STATES, SHOWING LOCATION OF PRINCIPAL RIVER STATIONS MAINTAINED DURING 1904.

ance—generally a secondary cable—is necessary to hold the meter in position below the surface.

Gaging stations are generally located at bridges, if the channel conditions are satisfactory, as from them the meter can be easily manipulated, and the cost of the equipment is comparatively small. The stations are located as far as possible at points where the channel is straight, both above and below the gaging section, and where there are no cross currents, backwater, or boils. The bed of the stream should be as clear as possible from large projections and of a permanent character. The banks should be high, and should overflow at high stages only. Great care is taken in the selection and equipment of gaging stations, in order that the data may have the required degree of accuracy.

On many of the larger rivers where water power is developed by dams estimates of flow are obtained by observing the head on the crest and using a weir formula. On the smaller streams sharp-crested weirs are in some cases erected.

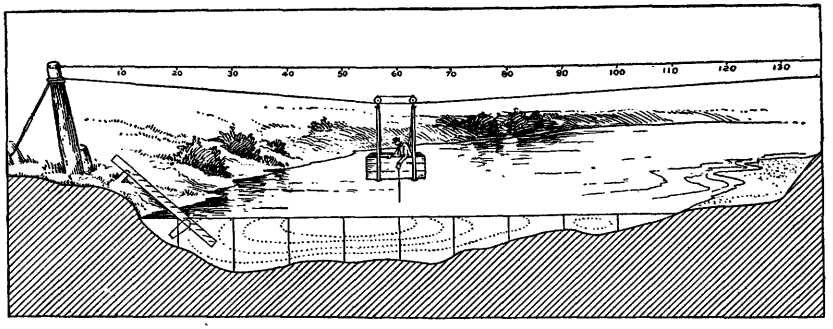


FIG. 1.—Cable station, showing section of river, car, gage, etc.

The principal instrument used in stream-measurement work is the current meter, by which the velocity of the flow of water is determined. After years of experience the Survey has adopted the Price current meter for general work. This meter, as is shown on Pl. II, is made in two sizes, known as the large and small Price. The small Price has been largely developed by the officers of the Survey, using the Price acoustic meter as a basis.

A discharge measurement is the determination of the quantity of water flowing past a certain point at a given time. This quantity is the product of two factors: (1) The mean velocity, which is the function of the cross section, surface slope, wetted perimeter and roughness of bed; (2) the area, which depends upon the permanency of the bed and the fluctuations of the surface, which govern the depth.

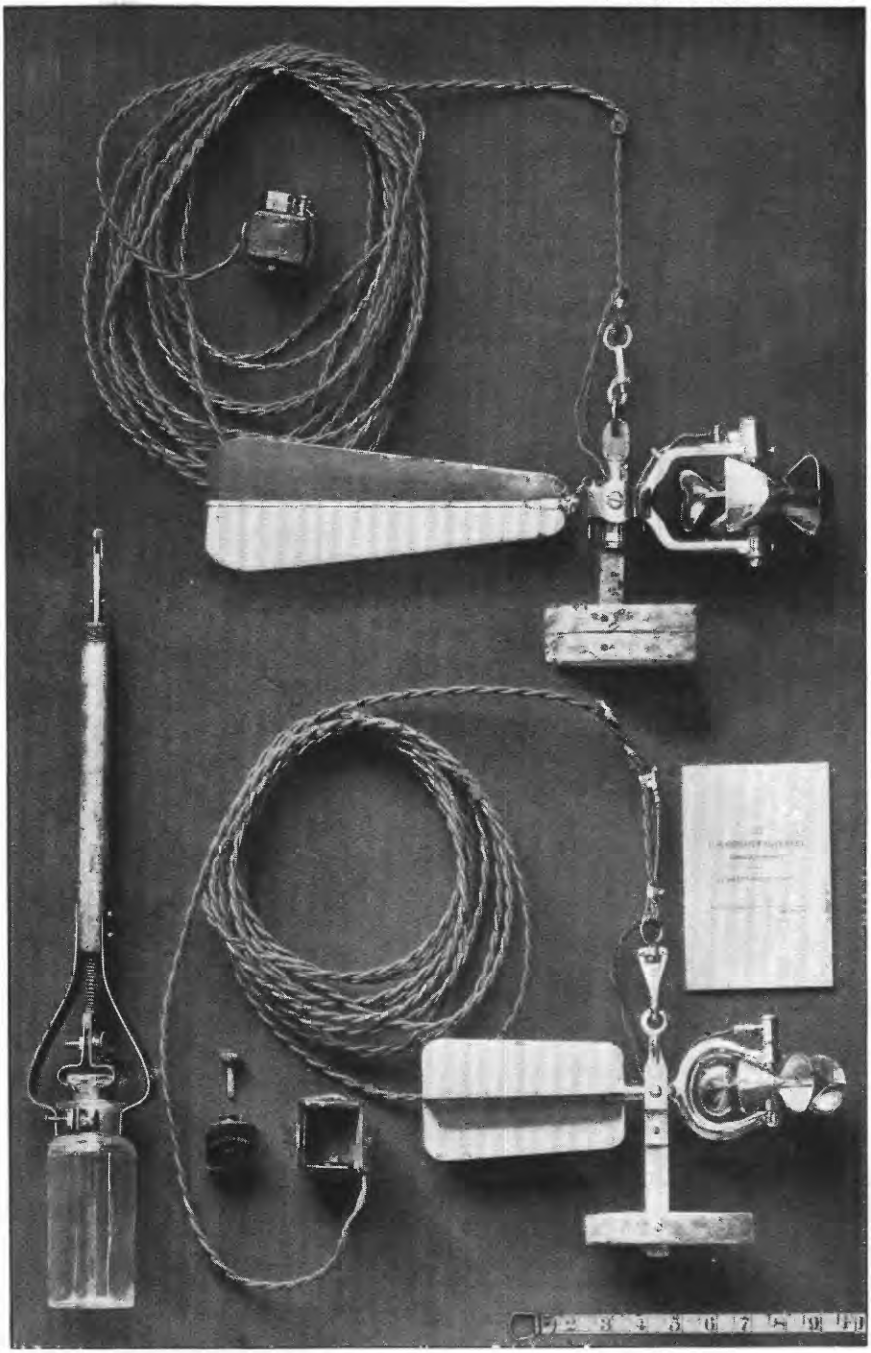
In making the measurement an arbitrary number of points are laid off perpendicular to the thread of the stream (see fig. 1). These points

are usually at regular intervals varying from 2 to 20 feet, depending upon the size and conditions of the stream. They are known as measuring points, and at them the observed data, the velocities and soundings, are taken. The perpendiculars dropped from the measuring points divide the gaging section into strips, and for each strip or pair of strips the mean velocity, area, and discharge are determined independently; thus conditions existing in one part of the stream are not distributed to parts where they do not apply.

The methods of obtaining velocity with the current meters which are in general use may be grouped into three classes: Single point, multiple point, and integration.

The single-point method consists in holding the meter either at the depth of the thread of mean velocity, or at an arbitrary depth, for which the coefficient for reducing to mean velocity has been determined. Extensive experiments by vertical velocity-curves show that the thread of mean velocity lies at from 0.5 to 0.7 of the total depth. In general practice the thread of mean velocity is considered to be at 0.6 depth, and it is at this depth that the meter is held in the majority of the measurements, this being known as the six-tenth depth method. It is found by a large number of vertical velocity-curve measurements, taken on various streams and under various conditions, that the coefficient for reducing the velocity obtained at six-tenths depth to mean velocity is practically unity, ranging, in a series of 910 measurements made at 39 gaging stations, between 94 and 104 per cent, with a mean for the 910 observations of 100 per cent. In the other principal single-point method the meter is held near the surface, usually 1 foot below, or low enough to be out of the action of the wind or other disturbing influences. This is known as the subsurface method. The coefficient for reducing the velocities taken at the subsurface has been found by repeated experiments with vertical velocity-curves to be from 85 to 95 per cent, depending upon the depth of the stream and velocity and channel conditions. This method is specially adapted for flood measurements, or when the velocity is so great that the meter can not be kept at 0.6 depth.

The three principal multiple-point methods in general use are: The vertical velocity-curve; top and bottom; and top, bottom, and mid depth. In the vertical velocity-curve method a series of velocity determinations are taken in the vertical at regular intervals, usually from 0.5 to 1 foot apart. By plotting these velocities as abscissas and their depths as ordinates, and drawing a smooth curve through these points, the vertical velocity-curve is produced, which shows the change in velocity from the surface to the bottom of the stream. The mean velocity in the vertical is then obtained by dividing the depth into the area bounded by this mean velocity-curve and the initial line. Owing to the length of time it takes to make these measurements, they



PRICE ELECTRIC CURRENT METERS, WITH BUZZERS.

are seldom used except for determining coefficients for purposes of comparison, and for measurements under ice.

In the second multiple-point method the meter is held from 0.5 to 1 foot below the surface and about 0.5 foot above the bottom, and the mean of the velocities at these two points is taken as the mean velocity for that vertical. This method is not well adapted for general work, as the roughness of the bottom disturbs the velocity at that point. For shallow streams with comparatively smooth beds good results are obtained by this method. In the third multiple-point method the meter is held at mid depth, at 0.5 foot below the surface and at 0.5 foot above the bottom, and the mean velocity is determined by dividing the sum of the top velocity, twice the mid-depth velocity, and the bottom velocity, by 4.

The vertical-integration method consists in moving the meter at a slow, uniform speed from the surface to the bottom and back again to the surface. The number of revolutions and the time taken in the operation is noted, and the mean velocity is found by dividing the number of revolutions by the number of seconds taken in the run. This method has the advantage in that the velocity at each point of the vertical is measured twice. It is well adapted for measurements under ice and as a check on the point methods.

The area, which is the other factor for determining the discharge of the stream, depends upon the stage of the river, which is taken on a gage, and the general contour of the bed of the stream, which is found by sounding. The soundings are usually taken at each measuring point at the time of the discharge measurement, either by using the meter and cable or by a special sounding line or rod. For stations with permanent beds standard cross sections are usually taken during low water. These sections serve to check the soundings which are taken at the time of the measurements, and from them any change which may have taken place in the bed of the stream can be detected. They are also used for obtaining the area for use in computations of high-water measurements, as accurate soundings are hard to obtain at high stages.

In computing the discharge measurements from the observed velocities and depths at the various points of measurements the measuring section is divided into elementary strips, as shown in fig. 1, and the mean velocity, area, and discharge are determined separately for either a single or double strip. The total discharge and area are the sums of those for the various strips, and the mean velocity is obtained by dividing the total discharge by the total area.

The volume of water flowing in a stream is known as run-off. In expressing it various units are used, depending upon the kind of work for which the data are needed. Those used in this report are "second-feet," "acre-feet," "run-off per square mile," and "run-off in depth in inches," and may be defined as follows:

Second-foot is an abbreviation for cubic foot per second, and is the body of water flowing in a stream 1 foot wide, 1 foot deep, at a rate of 1 foot per second.

The acre-foot is the unit of capacity used in connection with storage for irrigation work, and is equivalent to 43,560 cubic feet. It is the quantity required to cover an acre to a depth of 1 foot. There is a convenient relation between the second-foot and the acre-foot; 1 second-foot flowing for twenty-four hours will deliver 86,400 cubic feet, which equals 1.9835 acre-feet, or, approximately, 2 acre-feet.

The expression "second-feet per square mile" means the number of cubic feet of water flowing each second from every square mile of drainage area.

"Depth in inches" means the depth of water in inches that would have covered the drainage area, uniformly distributed, if all the water could have accumulated on the surface. This quantity is used for comparing run-off with rainfall, which quantity is usually given in depth in inches.

It should be noticed that "acre-feet" and "depth in inches" represent the actual quantities of water which are produced during the periods in question, while "second-feet," on the contrary, is merely a rate of flow, into which the element of time does not enter.

The base data for computing the daily discharge of a stream are the various discharge measurements and the daily gage heights, and sufficient discharge measurements should be had to cover the range of gage heights. The fundamental laws upon which these computations are based are the following:

(1) The discharge will remain constant so long as the conditions at or near the gaging station remain constant;

(2) Neglecting the change of slope due to the rise and fall of the stream, the discharge will be the same whenever the stream is at a given stage; and

(3) The discharge is both a function of, and increases gradually with, the gage heights.

As the beds of many streams are changeable, the problem divides itself into two classes: (1) Those of streams with permanent or practically permanent beds, and (2) those of streams with changeable beds. The base data and methods of obtaining them are the same for either class, and it is only in the computation of the mean daily flow that different methods are necessary.

In determining the daily discharge of streams with permanent beds, the results of the discharge measurements are plotted on cross-section paper, with gage heights as ordinates and discharges as abscissas. Through these points a smooth curve is drawn, which shows the discharge for any gage height, and from which a rating table is prepared. The mean velocity and area determined for each discharge measure-

ment are also plotted. Through these points the curves of mean velocity and of area are drawn, and the rating curve is largely determined by taking the product of the mean velocity and the area at various stages as determined by these curves. These curves of mean velocity and area are of special value in determining the location of the rating curve for stages at which actual discharge measurements are not available and for extending the discharge curve outside the limits of the measurements. In the preparation of the rating table the discharge for each tenth or half-tenth on the gage is found from the curve. The first and second differences of these discharges are then taken and adjusted according to the law that they shall either be constant or increasing, never decreasing. The discharges in the table are then changed in accordance with these adjusted differences. In making up the station-rating curve, the individual discharge measurements and the conditions under which they were taken are carefully studied, in order that proper weight shall be given to each measurement. Rating curves in general take the form of a parabola, and as a rule the high-water portion of the curve approaches a straight line. For stations of permanent character, the results of the measurements from year to year should be within 5 per cent of the curve, with the exception of those taken during high water, when the probable error may be as high as 10 per cent.

The determination of the daily discharge of streams with changeable beds is difficult, and unless frequent discharge measurements are made, the results obtained are only roughly approximate. For streams with continually shifting beds, such as Colorado River and Rio Grande, discharge measurements are made every two or three days, and the discharges for the intervening days are obtained by interpolation, modified by the gage heights for these days. For stations with beds which shift slowly, or are only materially changed during floods, station rating curves and tables can be prepared for the periods between changes, and satisfactory results can be obtained with two or three measurements a month, providing measurements are taken soon after the changes occur.

In determining the flow for periods when the streams are frozen, special rating curves and tables have to be prepared from measurements taken under these conditions. The methods of constructing these curves and tables are the same as for open sections. The discharge measurements, however, are taken either by integration in verticals or by vertical velocity-curves, as sufficient experiments have not been made on ice-covered streams to determine the laws which govern the position of the thread of mean velocity.

The Report of Progress of Stream Measurements for the Calendar Year 1904, of which this is Part III, is published in a series of twelve

Water-Supply Papers, Nos. 124–135, inclusive, under the following subtitles:

Part 1. Atlantic coast of New England drainage.
Part 2. Hudson, Passaic, Raritan, and Delaware River drainages.
Part 3. Susquehanna, Patapsco, Potomac, James, Roanoke, Cape Fear, and Yadkin River drainages.
Part 4. Santee, Savannah, Ogeechee, Altamaha rivers, and Eastern Gulf of Mexico drainage.
Part 5. Eastern Mississippi River drainage.
Part 6. Great Lakes and St. Lawrence River drainage.
Part 7. Hudson Bay, Minnesota, Wapsipinicon, Iowa, Des Moines, and Missouri River drainages.
Part 8. Platte, Kansas, Meramec, Arkansas, and Red River drainages.
Part 9. Western Gulf of Mexico drainage.
Part 10. Colorado River and the Great Basin drainage.
Part 11. The Great Basin and Pacific Ocean drainages in California.
Part 12. Columbia River and Puget Sound drainage.

The territory covered by each paper is given in the subtitle, and the larger drainages are, for convenience in arrangement, subdivided into smaller ones, under which the data are arranged, as far as practicable, geographically.

These papers contain the data that have been collected at the regular gaging stations, the results of the computations based upon the observations and such other information that has been collected that has a direct bearing on these data, including, as far as practicable, descriptions of the drainage areas and the streams draining them.

For each regular station are given, as far as available, the following data:

1. Description of station.
2. List of discharge measurements.
3. Gage height table.
4. Rating table.
5. Table of estimated monthly and yearly discharges and run-off.

The descriptions of stations give, as far as possible, such general facts about the locality and equipment as would enable the reader to find the station and use the same. They also give, as far as possible, a complete history of all the changes that have occurred since the establishment of the station that would be factors in using the data collected.

The discharge measurement table gives the results of the discharge measurements made during the year. This includes the date, the hydrographer's name, the gage height, and the discharge in second-feet.

The table of daily gage-heights gives for each day the fluctuations of the surface of the river as found from the mean of the gage readings taken on that day. At most of the stations the gage is read in the morning and in the evening.

The rating table gives discharges in second-feet corresponding to each stage of the river as given by the gage heights.

In the table of estimated run-off the column headed "Maximum" gives the mean flow for the day when the mean gage height was the highest, and it is the flow as given in the rating table for that mean gage height. As the gage height is the mean for the day, there might have been short periods when the water was higher and the corresponding discharge larger than given in this column. Likewise in the column of "Minimum" the quantity given is the mean flow for the day when the mean gage height was lowest. The column headed "Mean" is the average flow for each second during the month. Upon this the computations for the two remaining columns which are defined on page 12 are based.

In the computations for the tables of this report the following general and special rules have been used:

Fundamental rules for computation.

1. The highest degree of precision consistent with the rational use of time and money is imperative.
2. All items of computation should be expressed by at least two and by not more than four significant figures.
3. Any measurement in a vertical velocity, mean velocity, or discharge curve whose per cent of error is 5 times the average per cent error of all the other measurements should be rejected.
4. In reducing the number of significant figures, or the number of decimal places, by dropping the last figure, the following rules apply:

(a) When the figure in the place to be rejected is less than 5, drop it without changing the preceding figure. Example: 1,827.4 becomes 1,827.

(b) When the figure in the place to be rejected is greater than 5, drop it and increase the preceding figure by 1. Example: 1,827.6 becomes 1,828.

(c) When the figure in the place to be rejected is 5, and it is preceded by an even figure, drop the 5. Example: 1,828.5 becomes 1,828.

(d) When the figure in the place to be rejected is 5, and it is preceded by an odd figure, drop the 5 and increase the preceding figure by 1. Example: 1,827.5 becomes 1,828.

5. In constructing and applying rating tables a maximum limit of one-half per cent error should seldom be exceeded.

Special rules for computation.

1. Rating tables are to be constructed as close as the data upon which they are based will warrant. No decimals are to be used when the discharge is over 50 second-feet.
2. Daily discharges shall be applied directly to the gage heights as they are tabulated.
3. Monthly means are to be carried out to one decimal place when the quantities are below 100 second-feet. Between 100 and 10,000 second-feet, the last figure in the monthly mean shall be a significant figure. This also applies to the yearly mean.
4. Second-feet per square mile and depth in inches for the individual months shall be carried out at least to three significant figures, except in the case of decimals, where the first significant figure is preceded by one or more naughts (0), when the quantity shall be carried out to two significant figures. Example: 1.25; .125; .012; .0012. The yearly means for these quantities are always to be expressed in three significant figures and at least two decimal places.

The results of the stream measurements made during previous years by the United States Geological Survey can be found in the following Survey publications. A detailed index of these reports is given in Water-Supply Paper No. 119.

1888. Tenth Annual Report, Part II.
1889. Eleventh Annual Report, Part II.
1890. Twelfth Annual Report, Part II.
1891. Thirteenth Annual Report, Part III.
1892. Fourteenth Annual Report, Part II.
1893. Bulletin No. 131.
1894. Bulletin No. 131; Sixteenth Annual Report, Part II.
1895. Bulletin No. 140.
1896. Water-Supply Paper No. 11; Eighteenth Annual Report, Part IV.
1897. Water-Supply Papers Nos. 15 and 16; Nineteenth Annual Report, Part IV.
1898. Water-Supply Papers Nos. 27 and 28; Twentieth Annual Report, Part IV.
1899. Water-Supply Papers Nos. 35 to 39, inclusive; Twenty-first Annual Report, Part IV.
1900. Water-Supply Papers Nos. 47 to 52, inclusive; Twenty-second Annual Report, Part IV.
1901. East of the Mississippi River, Water-Supply Papers Nos. 65 and 75.
West of the Mississippi River, Water-Supply Papers Nos. 66 and 75.
1902. East of the Mississippi River, Water-Supply Papers Nos. 82 and 83.
West of the Mississippi River, Water-Supply Papers Nos. 84 and 85.
1903. East of the Mississippi River, Water-Supply Papers Nos. 97 and 98.
West of the Mississippi River, Water-Supply Papers Nos. 99 and 100.
1904. East of the Mississippi River, Water-Supply Papers Nos. 124 to 129, inclusive.
West of the Mississippi River, Water-Supply Papers Nos. 130 to 135, inclusive.

A limited number of these are for free distribution, and as long as the supply lasts they may be obtained by application to the Director United States Geological Survey or to members of Congress. Other copies are filed with the Superintendent of Public Documents, Washington, D. C., from whom they may be had at nominal cost. Copies of Government publications are, as a rule, furnished to the public libraries in our large cities, where they may be consulted by those interested.

COOPERATION AND ACKNOWLEDGMENTS.

Most of the measurements presented in this paper have been obtained through local hydrographers. Acknowledgment is extended to other persons and corporations who have assisted local hydrographers or have cooperated in any way, either by furnishing records of the height of water or by assisting in transportation.

The following list, arranged alphabetically by States, gives the names of the resident hydrographers and others who have assisted in furnishing and preparing the data contained in this report:

Maryland.—Resident hydrographer, E. G. Paul during first half and N. C. Grover during the last half of the year, assisted by H. D. Comstock. Acknowledgment is due to the State Geological Survey for cooperation in the work to the extent of paying the observers.

New Jersey.—Resident hydrographer, E. G. Paul during first half and N. C. Grover during the last half of the year, assisted by H. D. Comstock.

Pennsylvania.—Resident hydrographer, E. G. Paul during first half and N. C. Grover during the last half of the year, assisted by R. J. Taylor and H. D. Comstock. Acknowledgments are due to E. Mather, president of the board of water commissioners, and C. M. Nagle, chief engineer, Harrisburg; James F. Fisher, city engineer of Williamsport, Pa., for cooperation in securing gage heights on Susquehanna River, and Dr. Cary T. Hutchinson, for discharge measurements and records of gage height at McCall Ferry.

Virginia.—Resident hydrographer, E. G. Paul during first half and N. C. Grover during the last half of the year. Acknowledgments are due to J. D. Hofford, manager of the Willson Aluminum Company, at Holcomb Rock, Va., for gage heights of James River at that place.

West Virginia.—Resident hydrographer, E. G. Paul in the first half and N. C. Grover in the last half of the year.

SUSQUEHANNA RIVER DRAINAGE BASIN.

Susquehanna River rises in New York and flows southwestward a short distance below the New York-Pennsylvania line, where it turns to the southeast; near Wilkesbarre it again bends to the southwest and flows in this direction as far as Northumberland, where it is joined by the West Branch. Below Northumberland it flows southward and southeastward to Chesapeake Bay. Its total drainage area is about 27,400 square miles, and is larger than that of any other stream on the Atlantic slope of the United States. It is not navigable above the fall line near its mouth.

As the drainage basin embraces such a large area, it is varied in character. In New York the stream, with its tributaries, flows through a rolling and sometimes rather broken country, bounded by a mountainous region on the north. In this part of the course its bed is of gravel or sand, with an occasional rock ledge. Its banks are moderately high and not extensively subject to overflow. In Pennsylvania it enters a mountain region, and its course is in places tortuous as it winds among the parallel ranges. Its bed is generally composed of drift materials, gravel, sand, and bowlders, and its banks are high. Below the mouth of the West Branch the slope becomes more irregular, and at several places there are rapids where the stream flows over a rock bottom. In the lower part of its course, from Marietta to Havre de Grace, the stream occupies a deep, broad valley, varying in width from a few hundred feet to more than a mile. On either shore it is, for the most part, bounded by rocky bluffs and table-lands having elevations from 100 to 500 feet above its waters.

The West Branch has its source in the mountains of Cambria County, Pa., at an elevation of 2,000 feet or more above the sea. It flows generally eastward through Pennsylvania and joins the main stream at Northumberland. Its total drainage area is about 7,030 square miles. In its upper course this tributary drains a mountainous country, while in its middle and lower course the surface is hilly.

Juniata River rises in Center County, Pa., and flows in a southeasterly direction into Susquehanna River 15 miles above Harrisburg. Its drainage basin is mountainous and for the most part covered with forest growth. It has an area of 3,530 square miles.

All available hydrographic data for Susquehanna River basin have been collected and published in Water-Supply Papers 108 and 109. The former of these treats principally of the quality of the water, while the latter gives all data available as to fluctuations in stage and quantity of water flowing.

Water-Supply Paper No. 109 contains records of flow at the gaging stations described in this paper and at the following additional stations:

West Branch at Allenwood, Pa.
Tioughnioga at Chenango Forks, N. Y.
Cayuta at Waverly, N. Y.
Chenango at Oxford, N. Y.
Eaton and Madison brooks at Madison County, N. Y.
Diversions from Chenango River drainage basin.

During 1904 the United States Geological Survey has maintained the following gaging stations in this basin:

Susquehanna at Binghamton, N. Y.
Susquehanna at Wilkesbarre, Pa.
Susquehanna at Danville, Pa.
Susquehanna at Harrisburg, Pa.
Susquehanna at McCall Ferry, Pa.
Chenango at Binghamton, N. Y.
Chemung at Chemung, N. Y.
West Branch at Williamsport, Pa.
Juniata at Newport, Pa.
Broad Creek at Mill Green, Md.
Deer Creek at Churchville, Md.

The United States Weather Bureau maintains river stations in this basin at the following points:

Susquehanna at Towando, Pa.
Susquehanna at Selinsgrove, Pa.
West Branch at Clearfield, Pa.
West Branch at Lock Haven, Pa.
Juniata at Huntingdon, Pa.

SUSQUEHANNA RIVER AT BINGHAMTON, N. Y.

This gaging station was established July 31, 1901. A standard chain gage is attached to the upstream side of the left span of the Washington Street Bridge, which is situated about 800 feet upstream

from the junction of Chenango and Susquehanna rivers. On account of the unfavorable conditions produced by a rift, which extends diagonally across the stream underneath the bridge, discharge measurements are made at Exchange Street Bridge, 1,900 feet upstream. The gage is upstream from the crest of the rift and over a stretch of smooth water extending to the dam, 2,800 feet above. Gage readings are unaffected by backwater from Chenango River at ordinary stages. The bench mark is a chiseled draft on the corner of the left bridge abutment, on the upstream side. Its elevation is 23.71 feet above gage datum. The gage is read twice each day by E. F. Weeks. All records and estimates for this station for years prior to 1905 have been revised and republished in Water-Supply Paper No. 109.

The observations at this station during 1904 have been made under the direction of R. E. Horton, district hydrographer.

Discharge measurements of Susquehanna River at Binghamton, N. Y., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Ft. per sec.*	*Feet.*	*Second-feet.*
March 8	C. C. Covert	3,975	3.58	[a] 11.24	14,254
March 12	do	2,846	2.60	[a] 7.90	7,400
April 8	R. E. Horton	2,524	4.50	6.94	11,118
July 13	C. C. Covert	736	1.07	2.04	786
September 10	do	825	1.29	2.13	1,061
November 21	H. R. Beebe	1,011	2.64	2.86	2,674

[a] Ice gorge causes backwater.

Mean daily gage height, in feet, of Susquehanna River at Binghamton, N. Y., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.28	3.67	3.57	7.72	5.06	2.46	2.02	2.40	2.28	4.12	3.08	2.98
2	3.35	3.40	3.29	9.02	4.53	2.48	1.99	2.35	2.25	3.35	3.00	2.82
3	[a] 3.42	3.59	3.92	8.00	4.08	2.38	2.14	2.98	2.28	2.90	2.92	2.85
4	3.88	3.67	[b] 6.65	6.95	3.68	2.36	2.14	2.95	2.28	2.80	2.88	2.70
5	3.52	3.55	8.48	6.20	3.51	2.38	2.06	2.60	2.20	2.68	2.82	2.85
6	3.58	3.15	7.68	6.15	3.33	2.41	2.09	3.52	2.22	2.62	2.80	2.68
7	3.30	4.42	7.52	6.35	3.13	2.46	2.04	3.40	2.28	2.62	2.92	2.68
8	3.28	10.49	11.40	6.98	2.98	2.57	2.04	2.72	2.22	2.52	2.90	2.60
9	3.15	11.92	13.62	7.14	2.86	3.67	2.04	2.50	2.22	2.45	2.80	2.60
10	3.20	10.85	12.25	8.74	2.80	4.23	2.04	2.38	2.20	2.42	2.75	2.68
11	3.10	8.62	9.80	8.24	2.69	3.43	2.04	2.50	2.18	2.40	2.75	2.58
12	2.98	7.15	8.02	6.94	2.65	2.93	1.99	2.45	2.18	2.88	2.75	2.98
13	2.78	6.09	6.88	6.09	2.65	2.65	2.04	2.30	2.20	5.60	2.70	2.50
14	2.72	5.27	6.08	5.51	2.49	2.50	2.02	2.22	2.15	4.68	2.70	2.58
15	2.85	4.77	5.30	4.97	2.59	2.43	1.95	2.20	3.00	3.65	2.68	2.58
16	3.05	6.12	4.75	4.61	3.22	2.45	1.92	2.28	3.10	3.45	2.70	2.58
17	2.85	[b] 6.85	4.28	4.49	3.45	2.33	2.05	2.22	2.82	2.95	2.78	2.60

[a] Anchor ice. January 6, river frozen nearly across.
[b] Heavy anchor ice. River frozen over 2,000 feet downstream from junction of the two rivers. Ice gorge causes backwater March 4–15.

Mean daily gage height, in feet, of Susquehanna River at Binghamton, N. Y., for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug	Sept.	Oct.	Nov.	Dec.
18	3.00	6.07	3.85	4.39	3.17	2.33	2.28	2.18	2.55	2.80	2.75	2.48
19	2.98	5.67	3.55	4.49	2.92	2.23	2.10	2.18	2.42	2.70	2.65	2.60
20	3.08	5.22	3.92	4.37	3.22	2.17	2.05	2.22	2.35	2.62	2.65	2.40
21	3.80	4.72	4.45	4.17	3.05	2.20	1.98	2.90	2.30	5.95	2.82	2.45
22	2.78	4.52	4.30	3.97	2.75	2.13	2.00	3.18	2.30	7.48	3.58	2.58
23	7.02	4.92	7.42	3.97	2.67	2.14	1.98	4.55	2.28	6.95	3.72	2.40
24	7.82	5.72	11.40	3.77	2.59	2.09	2.00	4.20	2.18	5.32	3.55	2.55
25	[a] 8.27	5.52	12.12	3.79	2.62	2.06	2.02	3.38	3.52	4.40	3.38	3.08
26	6.85	4.67	15.92	3.96	2.52	2.02	2.02	2.92	3.25	4.40	3.32	3.15
27	5.95	4.19	15.70	3.95	2.49	1.99	2.05	2.78	3.22	4.35	3.18	3.40
28	5.25	3.75	12.62	[b] 5.83	2.45	1.99	2.52	2.63	2.85	3.92	2.90	8.80
29	4.42	3.67	8.50	6.36	2.36	2.04	2.58	2.48	2.65	3.65	2.78	9.60
30	4.27	.....	6.90	5.63	2.36	1.99	3.12	2.38	2.80	3.42	2.88	7.05
31	3.89	.....	6.72	.....	2.36	.....	2.65	2.35	.....	3.18	.....	5.25

[a] Current of stream very sluggish. [b] Backwater from Chenango River.

Rating table for Susquehanna River at Binghamton, N. Y., for 1901 to 1904, inclusive.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.75	210	3.9	5,255	7.2	15,260	11.6	30,860
1.8	315	4.0	5,510	7.4	15,920	11.8	31,580
1.9	525	4.1	5,770	7.6	16,590	12.0	32,300
2.0	740	4.2	6,030	7.8	17,270	12.2	33,020
2.1	960	4.3	6,300	8.0	17,950	12.4	33,740
2.2	1,180	4.4	6,570	8.2	18,650	12.6	34,470
2.3	1,400	4.5	6,845	8.4	19,350	12.8	35,210
2.4	1,625	4.6	7,125	8.6	20,060	13.0	35,950
2.5	1,855	4.7	7,405	8.8	20,780	13.5	37,820
2.6	2,085	4.8	7,690	9.0	21,500	14.0	39,720
2.7	2,315	4.9	7,980	9.2	22,220	14.5	41,650
2.8	2,545	5.0	8,280	9.4	22,940	15.0	43,600
2.9	2,785	5.2	8,880	9.6	23,660	15.5	45,550
3.0	3,025	5.4	9,495	9.8	24,380	16.0	47,500
3.1	3,265	5.6	10,120	10.0	25,100	16.5	49,500
3.2	3,505	5.8	10,760	10.2	25,820	17.0	51,500
3.3	3,755	6.0	11,400	10.4	26,540	17.5	53,500
3.4	4,005	6.2	12,040	10.6	27,260	18.0	55,500
3.5	4,255	6.4	12,680	10.8	27,980	18.5	57,500
3.6	4,505	6.6	13,320	11.0	28,700	19.0	59,500
3.7	4,755	6.8	13,960	11.2	29,420	19.5	61,500
3.8	5,005	7.0	14,600	11.4	30,140	20.0	63,500

Mean daily discharge, in second-feet, of Susquehanna River at Binghamton, N. Y., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3,705	4,680	4,430	16,930	8,430	1,763	784	1,625	1,356	5,770	3,217	2,977
2	3,880	4,005	3,730	21,500	6,985	1,809	718	1,510	1,290	3,880	3,025	2,593
3	4,055	4,480	5,305	17,950	5,770	1,579	1,048	2,977	1,356	2,785	2,833	2,665
4	5,205	4,680	6,740	14,440	4,705	1,532	1,048	2,905	1,356	2,545	2,737	2,315
5	4,305	4,380	9,815	12,040	4,280	1,579	872	2,085	1,180	2,269	2,593	2,665
6	4,455	3,385	8,410	11,880	3,830	1,648	938	4,305	1,224	2,131	2,545	2,269
7	3,755	6,624	10,100	12,520	3,337	1,763	828	4,005	1,356	2,131	2,833	2,269
8	3,705	26,864	15,070	14,600	2,977	2,016	828	2,361	1,224	1,901	2,785	2,085
9	3,385	32,012	19,100	15,095	2,689	4,680	828	1,855	1,224	1,740	2,545	2,085
10	3,505	28,160	16,600	20,600	2,545	6,165	828	1,579	1,180	1,671	2,430	2,269
11	3,265	20,132	12,190	18,825	2,292	4,080	828	1,855	1,136	1,625	2,430	2,039
12	2,977	15,095	8,970	14,440	2,200	2,857	718	1,740	1,136	2,737	2,430	2,977
13	2,499	11,688	7,140	11,720	2,200	2,200	828	1,400	1,180	10,120	2,315	1,855
14	2,361	9,092	5,860	9,805	1,832	1,875	784	1,224	1,070	7,405	2,315	2,039
15	2,665	7,603	5,000	8,130	2,062	1,694	630	1,180	3,025	4,630	2,269	2,039
16	3,145	11,784	7,545	7,125	3,555	1,740	567	1,356	3,265	4,130	2,315	2,039
17	2,665	14,120	6,300	6,845	4,130	1,466	850	1,224	2,593	2,905	2,499	2,085
18	3,025	11,624	5,130	6,570	3,433	1,466	1,356	1,136	1,970	2,545	2,430	1,809
19	2,977	10,344	4,380	6,845	2,833	1,246	960	1,136	1,671	2,315	2,200	2,085
20	3,217	8,940	5,305	6,435	3,555	1,114	850	1,224	1,510	2,131	2,200	1,625
21	5,005	7,461	6,705	5,900	3,145	1,180	696	2,785	1,400	11,240	2,593	1,740
22	2,499	6,901	6,300	5,432	2,430	1,026	740	3,457	1,400	16,250	4,455	2,039
23	14,666	8,040	15,920	5,432	2,246	1,048	696	6,985	1,356	14,440	4,805	1,625
24	17,338	10,504	30,140	4,930	2,062	938	740	6,030	1,136	9,185	4,380	1,970
25	18,895	9,867	32,660	4,980	2,131	872	784	3,955	4,305	6,570	3,955	3,217
26	14,120	7,321	47,110	5,406	1,901	784	784	2,833	3,630	6,570	3,805	3,385
27	11,240	6,004	46,330	5,330	1,832	718	850	2,499	3,555	6,435	3,457	4,005
28	9,030	4,880	34,470	5,080	1,740	718	1,901	2,154	2,665	5,305	2,785	20,780
29	6,624	4,680	19,700	12,520	1,532	828	2,039	1,809	2,200	4,630	2,499	23,660
30	6,219	.....	14,280	10,280	1,532	718	3,313	1,579	2,545	4,055	2,737	14,765
31	5,230	.....	13,640	.....	1,532	.....	2,200	1,510	.....	3,457	.....	9,034

NOTE.—On account of backwater from Chenango River and ice gorges, the discharges from March 4 to 15 and on April 28 are uncertain, and are only estimates.

Estimated monthly discharge of Susquehanna River at Binghamton, N. Y., for 1904.

[Drainage area, 2,400 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	18,895	2,361	5,794	2.41	2.78
February	32,012	3,385	10,530	4.39	4.73
March	47,110	3,730	14,010	5.84	6.73
April	21,500	4,930	10,650	4.44	4.95
May	8,430	1,532	3,088	1.29	1.49
June	6,165	718	1,769	.737	.822
July	3,313	567	1,027	.428	.493
August	6,985	1,136	2,396	.998	1.151
September	4,305	1,070	1,850	.770	.859
October	16,250	1,625	5,016	2.09	2.41
November	4,805	2,200	2,881	1.20	1.34
December	23,660	1,625	4,226	1.76	2.03
The year	47,110	567	5,270	2.20	29.78

SUSQUEHANNA RIVER AT WILKESBARRE, PA.

This gaging station was established by E. G. Paul, March 30, 1899. The standard chain gage is attached to the upstream side of the left span of Market Street Bridge. The length of the chain from the end of the weight to the marker is 40.83 feet. The bench mark is the extreme west end of the stone doorsill of the north entrance to the Coal Exchange Building. Its elevation is 32.99 feet above gage datum.

The Weather Bureau has maintained a gage and has records for this locality since 1888. The datum of that Bureau's gage, which was attached to the left-hand pier, was at the bottom of the dressed-stone portion of the pier, at an elevation 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 this gage. 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 on new gage), as at this elevation the west bank of the river is under water in places.

Discharge measurements are made from the downstream side of the

bridge, which has a total span of 700 feet between abutments. The initial point for soundings is at the end of the iron hand rail on the left bank, downstream side. The channel is straight for about one-fourth mile above and below the station. There is a bar across the river about one-half mile above the station, and another at about the same distance below, with deep water between these two points. The current is sluggish at low stages. The right bank is low and overflows at a gage height of about 20 feet. The left bank is above ordinary floods. The bed of the stream is composed of sand and gravel, and is somewhat shifting. There is but one channel, broken by three bridge piers. A few willows grow under the right span. During low water, measurements have been made by wading at a better cross section, at Retreat, 10 miles below Wilkesbarre. The Market Street Bridge is at such an elevation above the river bed that 65 feet of cable is needed to sound across the section.

Since the establishment of this station the recorded gage height has had a maximum range of 28.5 feet, and the estimated discharge has been between the extremes of 146,800 and 1,000 cubic feet per second. All records and estimates for this station for years prior to 1905 have been revised and republished in Water-Supply Paper No. 109. The gage is read once each day by W. S. Bennett, the bridge keeper.

Observations of fluctuations of Susquehanna River are made by the Weather Bureau above Wilkesbarre, at Towanda, Pa., 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 foot, in October, 1895; the danger line is at 16 feet. The elevation of the zero is 633.7 feet above sea level.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Susquehanna River at Wilkesbarre, Pa., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Ft. per sec.*	*Feet.*	*Second-ft.*
July 20	N. C. Grover	3,864	1.13	4.05	4,382
July 21[a]	do	4,077	1.15	4.20	4,680
September 15	John C. Hoyt	3,670	.96	3.70	3,540
October 1	do	4,220	1.44	4.75	6,090
November 5	H. D. Comstock	4,218	1.47	4.61	6,189
November 7	do	4,057	1.39	4.49	5,660

[a] Measured at Pittston.

Mean daily gage height, in feet, of Susquehanna River at Wilkesbarre, Pa., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	9.00	14.00	10.80	12.00	11.50	5.70	3.50	4.80	3.70	4.80	5.30	4.20
2	8.90	13.00	10.90	15.10	10.50	7.40	3.50	4.40	3.60	5.40	5.10	4.10
3	8.50	12.30	11.50	15.80	9.40	7.00	3.50	4.20	3.50	5.90	4.90	4.20
4	7.20	11.60	16.50	14.00	8.40	6.40	3.50	4.30	3.40	5.20	4.80	4.20
5	6.50	11.00	[a] 18.20	12.00	7.60	6.00	3.50	5.30	3.40	4.70	4.60	3.60
6	6.70	[b] 10.90	17.20	10.70	7.00	9.10	3.50	5.00	3.30	4.50	4.50	3.30
7	7.20	11.60	17.90	10.20	6.70	7.40	3.60	4.40	3.30	4.30	4.50	3.50
8	7.20	[c] 21.70	25.20	10.50	6.30	6.40	3.70	4.60	3.30	4.00	4.50	3.60
9	7.30	25.30	[d] 30.60	11.00	6.00	6.60	4.20	5.00	3.50	4.00	4.50	3.30
10	7.40	24.60	26.60	11.70	5.70	11.60	3.80	4.40	3.50	3.90	4.50	3.20
11	7.30	23.80	24.00	16.20	5.50	10.90	3.70	4.60	3.30	3.80	4.40	3.10
12	7.10	22.00	[e] 22.00	14.30	5.20	8.50	4.10	4.00	3.30	3.80	4.40	3.30
13	7.00	20.30	[e] 19.30	12.10	5.00	7.10	4.50	3.90	3.20	3.90	4.30	3.20
14	7.00	[f] 18.00	[e] 17.40	10.80	4.80	6.20	4.20	3.80	3.10	7.00	4.20	3.30
15	6.70	17.00	[e] 15.90	9.70	4.80	5.60	3.90	3.60	3.60	8.30	4.30	3.20
16	6.40	15.70	[e] 14.90	8.90	6.10	5.20	3.80	3.50	5.50	6.90	4.30	3.30
17	6.20	14.70	[e] 14.00	8.30	8.00	5.10	3.60	3.40	4.30	6.00	4.30	3.30
18	6.00	12.90	[e] 13.00	8.00	7.90	5.60	3.90	3.30	4.80	5.50	4.40	3.30
19	[g] 5.90	12.60	[e] 12.50	7.90	7.10	4.80	3.60	3.30	4.40	5.10	4.30	3.30
20	5.60	[h] 12.90	12.80	7.90	11.20	4.50	3.70	3.20	4.10	4.80	4.30	3.40
21	[i] 5.60	12.70	13.60	7.80	10.20	4.30	4.20	3.20	3.80	5.00	4.30	3.40
22	6.00	12.90	10.50	7.40	8.50	4.10	3.80	3.30	3.60	8.60	4.60	3.40
23	12.70	13.70	9.70	7.10	7.30	4.30	3.50	3.70	3.40	10.20	4.60	3.30
24	[j] 18.20	12.80	16.90	7.10	6.50	4.00	3.40	4.90	3.40	10.20	5.30	3.50
25	13.50	12.70	16.30	7.00	6.50	3.90	3.30	6.40	3.40	8.80	5.50	3.60
26	[k] 11.60	12.60	20.40	6.90	6.70	3.80	3.40	5.80	4.00	7.40	5.20	3.30
27	[k] 10.10	12.00	22.90	7.20	6.50	3.70	3.70	5.30	5.40	6.90	5.00	3.50
28	[k] 9.00	12.00	22.70	7.90	5.90	3.50	3.60	4.60	5.30	6.70	4.80	10.00
29	[k] 8.20	11.50	18.40	12.40	6.00	3.50	3.60	4.30	5.20	6.40	4.20	13.85
30	[k] 9.20	.....	14.20	12.80	5.50	3.40	3.80	4.10	4.70	6.00	4.20	13.30
31	13.90	.....	11.70	.....	5.30	.....	4.10	3.90	.....	5.90	.....	10.80

[a] Ice still unbroken.
[b] Closed with anchor ice as far up as Ransom.
[c] Ice started at 5.15 p. m.; moved until February 10, 12 m. Gorged below city.
[d] Highest gage reading 30.60.
[e] Still gorged.
[f] Ice blocked as far as Tunkhannock, Pa.
[g] Ice started at Pittston at 1.30 p. m., at Wilkesbarre, 2 p. m. River closed December 10 to 28, inclusive.
[h] Ice blocked as far as Laceyville, Pa.
[i] 12 midnight, ice still running; stream nearly full.
[j] River full of running ice all day; 10 p. m., very little ice running.
[k] Anchor ice.

Rating table for Susquehanna River at Wilkesbarre, Pa., from March 30, 1899, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.0	620	4.3	5,070	6.6	13,170	9.8	28,200
2.1	720	4.4	5,340	6.7	13,590	10.0	29,200
2.2	820	4.5	5,620	6.8	14,010	10.2	30,100
2.3	930	4.6	5,910	6.9	14,440	10.4	31,100
2.4	1,050	4.7	6,210	7.0	14,870	10.6	32,100
2.5	1,180	4.8	6,520	7.1	15,300	10.8	33,000
2.6	1,320	4.9	6,830	7.2	15,730	11.0	34,000
2.7	1,470	5.0	7,150	7.3	16,160	11.2	35,000
2.8	1,630	5.1	7,470	7.4	16,600	11.4	36,000
2.9	1,810	5.2	7,800	7.5	17,040	11.6	37,000
3.0	2,000	5.3	8,140	7.6	17,490	11.8	37,900
3.1	2,200	5.4	8,490	7.7	17,950	12.0	38,900
3.2	2,410	5.5	8,850	7.8	18,420	12.2	39,900
3.3	2,620	5.6	9,210	7.9	18,900	12.4	40,800
3.4	2,840	5.7	9,580	8.0	19,380	12.6	41,800
3.5	3,070	5.8	9,950	8.2	20,360	12.8	42,800
3.6	3,300	5.9	10,330	8.4	21,340	13.0	43,700
3.7	3,540	6.0	10,720	8.6	22,320	13.2	44,700
3.8	3,780	6.1	11,120	8.8	23,300	13.4	45,700
3.9	4,030	6.2	11,520	9.0	24,300	13.6	46,700
4.0	4,280	6.3	11,930	9.2	25,300	13.8	47,600
4.1	4,540	6.4	12,340	9.4	26,200	14.0	48,600
4.2	4,800	6.5	12,750	9.6	27,200		

Table based on discharge measurements of 1899, 1900, 1901, 1902, 1903, and 1904. Well defined between 2 feet gage height and 19 feet gage height. Tangent at 8.80 feet gage height with a difference of 500 per tenth. Table applied to tenths.

Mean daily discharge, in second-feet, of Susquehanna River at Wilkesbarre, Pa., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	24,300	48,600	16,600	38,900	36,500	9,580	3,070	6,520	3,540	6,520	8,140	4,800
2	23,800	43,700	16,900	56,000	31,600	16,600	3,070	5,340	3,300	8,490	7,470	4,540
3	21,830	40,300	18,350	61,000	26,200	14,870	3,070	4,800	3,070	10,330	6,830	4,800
4	15,730	37,000	33,300	48,600	21,340	12,340	3,070	5.070	2,840	7,800	6,520	4,800
5	12,750	34,000	40,100	38,900	17,490	10,720	3,070	8,140	2,840	6,210	5,910	3,300
6	13,590	33,500	36,100	32,600	14,870	24,800	3,070	7,150	2,620	5,620	5,620	2,620
7	15,730	37,000	38,900	30,100	13,590	16,600	3,300	5,340	2,620	5,070	5,620	3,070
8	15,730	55,900	74,760	31,600	11,930	12,340	3,540	5,910	2,620	4,280	5,620	3,300
9	16,160	75,100	108,700	34,000	10,720	13,170	4,800	7,150	3,070	4,280	5,620	2,620
10	16,600	71,300	82,900	37,400	9,580	37,000	3,780	5,340	3,070	4,030	5,620	2,410
11	16,160	67,000	68,000	63,900	8,850	33,500	3,540	5,910	2,620	3,780	5,340	2,200
12	15,300	57,600	57,600	50,600	7,800	21,830	4,540	4,280	2,620	3,780	5,340	2,620
13	14,870	49,400	44,900	39,400	7,150	15,300	5,620	4,030	2,410	4,030	5,070	2,410
14	14,870	39,300	36,800	33,000	6,520	11,520	4,800	3,780	2,200	14,870	4,800	2,620
15	13,590	35,300	31,100	27,700	6,520	9,210	4,030	3,300	3,300	20,850	5,070	2,410
16	12,340	30,350	27,500	23,800	11,120	7,800	3,780	3,070	8,850	14,440	5,070	2,620
17	11,520	26,800	31,000	20,850	19,380	7,470	3,300	2,840	5,070	10,720	5,070	2,620
18	10,720	21,850	30,000	19,380	18,900	9,210	4,030	2,620	6,520	8,850	5,340	2,620
19	10,330	21,050	35,500	18,900	15,300	6,520	3,300	2,620	5,340	7,470	5,070	2,620
20	9,210	21,850	42,800	18,900	35,000	5,620	3,540	2,410	4,540	6,520	5,070	2,840
21	9,210	21,350	46,700	18,420	30,100	5,070	4,800	2,410	3,780	7,150	5,070	2,840
22	10,720	21,850	31,600	16,600	21,830	4,540	3,780	2,620	3,300	22,320	5,910	2,840
23	42,300	23,700	27,700	15,300	16,160	5,070	3,070	3,540	2,840	30,100	5,910	2,620
24	79,600	21,550	69,200	15,300	12,750	4,280	2,840	6,330	2,840	30,100	8,140	3,070
25	46,200	21,350	69,200	14,870	12,750	4,030	2,620	12,340	2,840	23,300	8,850	3,300
26	37,000	21,500	98,900	14,440	13,590	3,780	2,840	9,950	4,280	16,600	7,800	2,620
27	29,600	19,600	123,400	15,730	12,750	3,540	3,540	8,140	8,490	14,440	7,150	3,070
28	24,300	19,600	121,300	18,900	10,330	3,070	3,300	5,910	8,140	13,590	6,520	29,200
29	20,360	18,350	81,300	40,800	10,720	3,070	3,300	5,070	7,800	12,340	4,800	47,850
30	25,300	.....	49,900	42,800	8,850	2,840	3,780	4,540	6,210	10,720	4,800	45,200
31	48,100	.....	37,400	.....	8,140	.....	4,540	4,030	.....	10,330	.....	33,000

From February 8 to March 19, 1904, discharges reduced 50 per cent on account of ice gorge.

Estimated monthly discharge of Susquehanna River at Wilkesbarre, Pa., for 1904.

[Drainage area, 9,810 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	79,600	9,210	21,860	2.23	2.57
February	75,100	18,350	35,720	3.64	3.92
March	123,400	16,600	52,530	5.34	6.16
April	63,900	14,440	31,290	3.19	3.56
May	36,500	6,520	15,750	1.61	1.86
June	37,000	2,840	11,180	1.14	1.27
July	5,620	2,620	3,636	.371	.428
August	12,340	2,410	5,194	.529	.610
September	8,850	2,200	4,119	.420	.469
October	30,100	3,780	11,260	1.15	1.33
November	8,850	4,800	5,972	.609	.679
December	47,850	2,200	7,660	.781	.900
The year	123,400	2,200	17,180	1.75	23.76

SUSQUEHANNA RIVER AT DANVILLE, PA.

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 Mill Street Bridge, 600 feet south of the public square, Danville, Pa., near the Pennsylvania Railroad station, South Danville.

On March 9, 1904, this bridge was carried away in the ice freshet, and from that date until the water dropped below gage height, 5 feet, its stage was observed on the Weather-Bureau gage, which is painted on the pier nearest the right bank. After the water fell below 5 feet, until September 30, its stage was observed approximately by means of temporary gages, which were placed in position by the gage reader, near the pumping station on the right bank. These were usually set by means of a carpenter's level and at times were considerably in error.

It is expected that the new steel bridge will be in such condition that the chain gage may be replaced early in 1905. The total span is about 1,300 feet, broken by six bridge piers, which do not obstruct the flow to any considerable extent. The channel is straight for about one-half mile above and below the station. The right bank is liable to overflow in extreme freshets. The bed is rocky, with some gravel, and is permanent. The current is good, except at extreme low water.

Since the establishment of the gage the record shows a range in

gage height of nearly 25 feet, and the extremes of high and low water within that period are estimated at 163,000 and 830 cubic feet per second, respectively. The bench mark is the extreme south end of the stone doorsill at the east entrance to the city filtering plant. Its elevation is 31.7 feet above gage datum. All records and estimates for this station for years prior to 1905 have been revised and republished in Water-Supply Paper No. 109.

Observations at this station during 1904 have been under the direction of N. C. Grover, district hydrographer.

Mean daily gage height, in feet, of Susquehanna River at Danville, Pa., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	(a)	14.70	11.40	11.05	8.10	4.00	2.00	2.40	1.90	.....	.....	.....
2	(a)	14.10	11.30	10.85	8.00	4.20	2.00	2.50	1.90	.....	.....	.....
3	(a)	13.30	11.80	10.60	7.50	4.70	1.90	2.50	1.80	.....	.....	.....
4	(a)	12.70	g12.90	10.40	6.40	4.20	1.90	2.70	1.70	.....	.....	.....
5	(a)	12.10	13.80	10.40	5.30	4.70	1.80	2.90	1.70	.....	.....	.....
6	(a)	11.70	16.00	9.70	4.20	5.10	2.40	2.50	1.60	.....	.....	.....
7	(a)	11.50	17.25	9.30	3.70	5.50	2.30	2.40	1.50	.....	.....	.....
8	(a)	13.10	19.95	8.80	3.60	4.70	2.10	2.70	1.50	.....	.....	.....
9	(a)	d20.00	h24.00	8.20	3.60	4.30	2.10	2.90	1.40	.....	.....	.....
10	(a)	e23.86	.....	7.90	3.40	4.90	2.00	2.40	1.40	.....	.....	.....
11	(a)	21.25	.....	7.40	3.30	7.10	1.90	1.90	1.40	.....	.....	.....
12	(a)	19.50	.....	6.80	3.30	6.20	1.90	1.70	1.30	.....	.....	.....
13	(a)	18.05	.....	6.30	3.20	4.80	2.00	1.70	1.30	.....	.....	.....
14	(a)	16.90	.....	6.10	3.10	4.70	2.40	1.60	1.60	.....	.....	.....
15	(a)	15.40	.....	5.80	2.90	4.50	2.60	1.60	1.90	.....	.....	.....
16	(a)	f13.90	.....	5.40	2.70	4.30	2.20	1.50	2.20	.....	.....	.....
17	(a)	13.00	.....	5.00	3.90	4.00	1.90	1.40	1.90	.....	.....	.....
18	(a)	12.40	.....	4.70	4.50	3.70	1.80	1.70	1.70	.....	.....	.....
19	(a)	11.00	.....	4.30	6.30	3.30	1.80	1.60	1.60	.....	.....	.....
20	(a)	10.60	.....	4.10	6.90	3.00	1.70	1.50	1.50	.....	.....	.....
21	(a)	11.20	.....	4.00	7.20	2.80	1.70	1.50	1.50	.....	.....	.....
22	(c)	12.30	.....	3.70	6.30	2.60	1.60	1.40	1.90	.....	.....	.....
23	(a)	12.30	.....	3.50	4.90	2.60	1.90	1.40	2.40	.....	.....	.....
24	b19.85	12.40	.....	3.30	4.40	2.50	2.00	1.80	2.90	.....	.....	.....
25	c24.00	12.00	.....	3.30	4.10	2.50	1.80	2.40	2.30	.....	.....	.....
26	23.25	11.70	.....	3.20	4.70	2.30	1.70	2.90	2.00	.....	.....	.....
27	19.85	11.70	14.25	3.00	4.40	2.20	1.50	2.60	2.20	.....	.....	.....
28	17.90	11.40	13.80	4.20	3.90	2.20	1.80	2.50	2.70	.....	.....	.....
29	16.00	11.10	13.35	5.30	3.70	2.10	1.80	2.30	2.10	.....	.....	.....
30	15.55	.....	12.55	6.90	3.70	2.10	2.00	2.00	2.40	.....	.....	.....
31	15.05	.....	11.75	.....	3.90	.....	2.20	1.90	.....	.....	.....	.....

a River frozen.
b The ice started at 11.30 a. m.
c The ice gorged 1 p. m.
d The river is still frozen over.
e The ice broke and gorged and left an open place by the bridge.
f The ice is still gorged in the river.
g The ice gorge is still in the river above and below town.
h The ice started at 4 o'clock and the water backed up to 29 feet.

NOTE.—The gage heights for 1904 are somewhat uncertain, therefore no estimates of flow have been made.

SUSQUEHANNA RIVER AT HARRISBURG, PA.

In 1890 regular daily observations of the stage of Susquehanna River at Harrisburg were started by E. Mather, president of the Harrisburg Water Board. These observations have been continued since that time, and have been furnished to the United States Geolgical Survey through the courtesy of Mr. Mather.

The gage is located in the pump well at the pump house of the city waterworks, the well being connected with the river by two large mains. The datum of the gage is the low-water mark of 1803, and is marked on a large, sloping rock, about 40 feet from the left bank at low water and about halfway between the Walnut Street Bridge and the pumping station. The original readings are taken in feet and inches, and for convenience in computations have been reduced to feet and tenths.

The first discharge measurement was made at this station in March, 1897, by Mr. E. G. Paul, and measurements have been made here by engineers of the United States Geological Survey since that date. The measuring section is at the lower side of the Walnut street toll bridge, at which point the river is divided into two channels by Fosters Island, which is here about 1,200 feet wide. This island has low and sloping banks, and during extreme floods is completely overflowed.

At ordinary stages the left channel is 1,350 feet wide, broken by six bridge piers; the right channel is 1,300 feet wide, broken by seven piers. The banks of the river are high. The bed is composed of hard material and is permanent, except in the spans adjacent to the island. The velocity never becomes too sluggish to measure. The initial point for soundings is the upright at the end of the handrail on the downstream side at the left bank.

During the spring and summer of 1903 a new bridge was built across Susquehanna River at Market street, which is about 1,200 feet below the gaging station. The piers of this new bridge obstruct the channel of the river by between 10 and 15 per cent of the total cross section. In the latter part of 1903 and early in 1904 the old piers on this site were removed, so that the river channel was left in such condition that the effect on the stage of the river at Walnut Street Bridge remained practically unchanged.

In the summer of 1904 certain changes and improvements were made at the pumping station, and a partial dam was made in the river just below the pumping station. The effect of this dam was to raise the apparent stage of the water at the gage.

On July 18, 1904, a standard chain gage was attached to the guard rail on the upstream side of Walnut Street Bridge in the left-hand span. The datum of this gage is also the low-water mark of 1803, and it is believed that it records truly the stage of the river to that datum,

and that the changes in bridges below or in the pumping station above do not appreciably affect the records obtained from it.

The length of chain is 39.38 feet. The datum is referred to a bench mark on the left abutment at the top upstream outer corner of the bridge seat; elevation, 32.99 feet.

Observations at the gage in the pumping station are made by the engineer, C. M. Nagle, each morning before starting the pumps. Observations at the standard chain gage are made by Thomas Numbers, toll collector, once daily. All records and estimates for this station for years prior to 1905 have been revised and republished in Water-Supply Paper No. 109.

Observations at this station during 1904 have been under the direction of N. C. Grover, district hydrographer.

Minimum, maximum, and mean discharge of Susquehanna River at Harrisburg, Pa., for 1891 to 1904, inclusive.

Year.	Minimum.			Maximum.			Mean discharge.
	Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.	
		Feet.	*Sec.-feet.*		*Feet.*	*Sec.-feet.*	*Sec.-feet.*
1891	Oct. 4–7, inclusive.	1.60	10,200	Feb. 19	19.00	334,500	52,200
1892	Oct. 31–Nov. 8, inclusive.	.50	4,070	Apr. 6	14.65	224,200	37,250
1893	Aug. 16–19, inclusive, 25.	.35	3,500	May 6	16.50	267,400	40,550
1894	Sept. 5–6	.25	3,160	May 22	25.60	543,500	39,970
1895	Oct. 30–31	.05	2,570	Apr. 11	13.65	205,400	29,330
1896	Sept. 5–13	.25	3,160	Apr. 1–2	14.60	223,200	34,600
1897	Sept. 15, Oct. 21	.50	4,070	Mar. 26	11.50	165,306	32,320
1898	Oct. 3–7	.65	4,740	Mar. 24	15.65	245,900	40,490
1899	Oct. 24 and 25	.15	2,850	Mar. 7	13.00	193,000	31,000
1900	Sept. 28 and 29	—.04	2,360	Mar. 2	13.10	194,900	29,950
1901	Nov. 12	1.00	6,550	Dec. 16	21.40	405,100	42,380
1902	Sept. 23, 24, 25	.85	5,760	Mar. 2	23.90	484,100	47,100
1903	Oct. 7	1.40	8,850	....do	16.85	276,500	54,510
1904		0.84	5,708				32,318
For the 14 years.	Sept. 28–29, 1900	—.04	2,360	May 22, 1894.	25.60	543,500	38,855

Discharge measurements of Susquehanna River at Harrisburg, Pa., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
March 9	Tillinghast and Sawyer	40,670	6.2	15.6	[a]261,860
July 15	N. C. Grover	11,870	2.22	3.08	26,408
September 13	J. C. Hoyt	6,646	.90	1.10	5,950
September 29	do	8,730	1.34	1.78	11,660
October 1	N. C. Grover	8,460	1.48	1.85	12,560
November 4	Hoyt and Comstock	8,972	1.39	1.82	12,600

[a] River running full of ice. Measurement approximate.

Mean daily gage height, in feet, of Susquehanna River at Harrisburg, Pa., for 1904.[a]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.16	4.41	9.41	6.40	7.65	3.65	1.90	1.58	1.43	1.78	2.08	1.79
2	2.16	4.16	11.50	10.15	6.65	3.90	1.73	1.68	1.28	1.68	1.98	1.54
3	4.00	4.00	11.91	13.06	6.40	4.23	1.98	1.93	1.23	1.53	1.88	1.44
4	3.16	4.75	13.50	11.15	5.65	4.23	1.90	1.93	1.23	1.78	1.78	1.24
5	3.16	3.41	22.00	9.40	4.90	3.98	1.65	1.88	1.18	1.93	1.68	1.29
6	2.91	4.41	19.41	7.73	4.06	4.90	1.73	1.78	1.13	1.73	1.64	.94
7	2.91	3.75	16.33	6.73	3.98	5.23	1.73	2.08	1.08	1.58	1.60	1.29
8	2.83	3.83	21.16	6.15	3.81	4.73	2.23	2.03	.98	1.48	1.54	1.09
9	2.83	5.50	15.91	6.06	3.48	3.98	2.56	1.78	.98	1.38	1.54	1.24
10	[b]2.83	9.08	15.00	6.40	3.40	3.56	2.56	1.68	1.18	1.23	1.49	1.19
11	3.00	9.33	12.00	8.48	3.15	4.31	4.48	1.88	1.18	1.18	1.59	.84
12	3.58	8.41	9.16	9.15	2.98	5.40	5.06	1.63	1.18	1.23	1.54	.94
13	3.83	9.91	7.91	7.98	2.90	4.65	4.40	1.58	1.13	1.23	1.59	1.69
14	4.91	13.50	6.58	7.15	2.56	3.90	3.73	1.48	1.08	1.23	1.69	1.44
15	4.66	12.50	6.08	6.31	2.81	3.23	3.23	1.33	1.38	1.38	1.64	1.49
16	4.50	11.58	5.58	5.25	3.15	2.90	2.90	1.33	1.58	2.93	1.59	1.39
17	5.00	10.16	5.25	5.15	3.40	2.65	2.56	1.28	1.98	2.73	1.54	1.30
18	5.00	9.91	4.83	5.06	3.65	2.81	2.28	1.23	2.18	2.38	1.49	1.50
19	4.25	9.16	4.66	4.56	3.98	2.81	2.08	1.13	1.78	2.13	1.59	1.50
20	4.08	9.16	4.66	4.48	4.98	2.56	1.98	1.18	1.78	1.88	1.59	1.50
21	4.16	8.66	5.00	3.90	6.06	2.56	2.03	1.28	1.63	1.73	1.49	1.40
22	4.66	9.16	5.58	3.31	6.56	2.65	1.88	1.18	1.43	1.88	1.54	1.40
23	5.50	10.16	6.66	3.73	5.31	2.56	1.93	1.28	1.33	2.93	1.59	1.50
24	[c]15.50	10.16	7.08	3.56	4.56	2.56	2.98	1.28	1.18	3.76	1.69	1.60
25	11.50	10.75	10.41	3.40	4.23	2.73	2.13	1.28	1.18	4.06	1.69	1.60
26	10.16	10.41	11.00	3.48	3.81	2.48	1.83	1.68	1.08	3.58	1.79	1.60
27	7.66	10.58	15.25	3.48	3.98	2.31	1.73	2.33	1.03	3.03	1.89	1.80
28	6.83	9.50	13.83	3.73	3.90	2.06	1.68	2.08	1.13	2.68	1.84	1.90
29	5.83	9.08	12.50	4.90	3.65	1.98	1.78	1.83	1.63	2.53	1.74	2.10
30	4.75	.....	10.16	6.98	3.31	1.81	1.68	1.63	1.73	2.48	1.84	9.40
31	4.50	.....	8.41	.....	3.40	.....	1.63	1.53	.....	2.28	.....	8.40

[a] From January 1 to July 17, inclusive, gage readings were taken at the pump house. From July 18 to the end of the year the readings were taken at the Walnut Street Bridge. Beginning with April 1 the readings at the pump house were too high by 0.6 foot, owing to the fact that a cofferdam was built just below the intake. This correction has been applied; therefore the gage readings for the complete year are referred to the low-water datum of 1903.

[b] River frozen over at 5 a. m.

[c] Several ice gorges existed both above and below Harrisburg from January 24 to March 13. These caused the backing up of the water, thus increasing the gage height.

Rating table for Susquehanna River at Harrisburg, Pa., from 1891 to 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
−0.05	2,330	2.4	16,950	5.8	65,000	12.0	174,500
+0.0	2,440	2.5	17,960	6.0	68,400	12.5	183,600
.1	2,710	2.6	19,010	6.2	71,900	13.0	193,000
.2	3,000	2.7	20,100	6.4	75,500	13.5	202,500
.3	3,330	2.8	21,210	6.6	79,200	14.0	212,000
.4	3,680	2.9	22,340	6.8	82,900	14.5	221,300
.5	4,070	3.0	23,480	7.0	86,500	15.0	231,000
.6	4,500	3.1	24,620	7.2	90,000	15.5	242,300
.7	4.980	3.2	25,760	7.4	93,400	16.0	254,500
.8	5,500	3.3	26,910	7.6	96,700	16.5	267.400
.9	6,020	3.4	28,130	7.8	100,100	17.0	280.400
1.0	6,550	3.5	29,430	8.0	103,500	17.5	293,600
1.1	7,090	3.6	30,800	8.2	106,900	18.0	306,700
1.2	7,650	3.7	32,200	8.4	110,300	19.0	334,500
1.3	8,240	3.8	33,600	8.6	113,800	20.0	363,100
1.4	8,850	3.9	35,000	8.8	117,300	21.0	392,600
1.5	9,520	4.0	36,400	9.0	120,800	22.0	423,100
1.6	10,200	4.2	39,200	9.2	124,300	23.0	454,600
1.7	10,930	4.4	42,200	9.4	127,800	24.0	487,000
1.8	11,700	4.6	45,400	9.6	131,400	25.0	520,200
1.9	12,500	4.8	48,600	9.8	134,900	26.0	554,400
2.0	13,300	5.0	51,900	10.0	138,400	27.0	589,400
2.1	14,160	5.2	55,100	10.5	147,200		
2.2	15,050	5.4	58,400	11.0	156,300		
2.3	15,980	5.6	61,700	11.5	165,300		

Mean daily discharge, in second-feet, of Susquehanna River at Harrisburg, Pa., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	(a)	(a)	(a)	75,500	97,600	31,500	12,500	10,060	9,048	11,540	13,980	11,620
2	(a)	(a)	(a)	141,000	80,100	35,000	11,160	10,780	8,120	10,780	13,140	9,792
3	(a)	(a)	(a)	194,200	75,500	39,600	13,140	12,740	7,824	9,724	12,340	9,114
4	(a)	(a)	(a)	159,000	62,500	39,600	12,500	12,740	7,824	11,540	11,540	7,882
5	(a)	(a)	(a)	127,800	50,200	36,120	10,560	12,340	7,538	12,740	10,780	8,180
6	(a)	(a)	(a)	98,900	37,200	50,200	11,160	11,540	7,258	11,160	10,490	6,228
7	(a)	(a)	(a)	81,600	36,120	55,600	11,160	13,980	6,982	10,060	10,200	8,180
8	(a)	(a)	(a)	71,000	33,740	47,500	15,330	13,550	6,442	9,384	9,792	7,036
9	(a)	(a)	(a)	69,400	29,170	36,120	18,590	11,540	6,442	8,726	9,792	7,882
10	(a)	(a)	(a)	75,500	28,130	30,250	18,590	10,780	7,538	7,824	9,452	7,594
11	(a)	(a)	(a)	111,660	25,190	40,800	43,480	12,340	7,538	7,538	10,130	5,708
12	(a)	(a)	(a)	123,400	23,250	58,400	52,900	10,420	7,538	7,824	9,792	6,228

a The ice gorge during January, February, and March make it impossible to estimate daily flow.

Mean daily discharge, in second-feet, of Susquehanna River at Harrisburg, Pa., for 1904— Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
13	(a)	(a)	(a)	103,200	22,340	46,200	42,200	10,060	7,258	7,824	10,130	10,860
14	(a)	(a)	(a)	89,200	18,590	35,000	32,620	9,384	6,982	7,824	10,860	9,114
15	(a)	(a)	(a)	73,900	21,320	26,100	26,100	8,420	8,726	8,726	10,490	9,452
16	(a)	(a)	(a)	55,900	25,190	22,340	22,340	8,420	10,060	22,680	10,130	8,788
17	(a)	(a)	(a)	54,300	28,130	19,550	18,590	8,120	13,140	20,440	9,792	8,240
18	(a)	(a)	(a)	52,900	31,500	21,320	15,790	7,824	14,870	16,750	9,452	9,520
19	(a)	(a)	(a)	44,800	36,120	21,320	13,980	7,258	11,540	14,420	10,130	9,520
20	(a)	(a)	(a)	43,500	51,540	18,590	13,140	7,538	11,540	12,340	10,130	9,520
21	(a)	(a)	(a)	35,000	69,400	18,590	13,550	8,120	10,420	11,160	9,452	8,850
22	(a)	(a)	(a)	27,030	78,400	19,550	12,340	7,538	9,048	12,340	9,792	8,850
23	(a)	(a)	(a)	32,620	56,900	18,590	12,740	8,120	8,420	22,680	10,130	9,520
24	(a)	(a)	(a)	30,250	44,800	18,590	23,250	8,120	7,538	33,040	10,860	10,200
25	(a)	(a)	(a)	28,130	39,600	20,440	14,420	8,120	7,538	37,240	10,860	10,200
26	(a)	(a)	(a)	29,170	33,740	17,760	11,940	10,780	6,982	30,520	11,620	10,200
27	(a)	(a)	(a)	29,170	36,120	16,080	11,160	16,270	6,712	23,820	12,420	11,700
28	(a)	(a)	(a)	32,620	35,000	13,820	10,780	13,980	7,258	19,880	12,020	12,500
29	(a)	(a)	(a)	50,200	31,500	13,140	11,540	11,940	10,420	18,270	11,230	14,160
30	(a)	(a)	(a)	86,100	27,030	11,780	10,780	10,420	11,160	17,760	12,020	b51,120
31	(a)	(a)	(a)	.....	28,130	.....	10,420	9,724	.....	15,790	.....	b44,120

a The ice gorge during January, February, and March make it impossible to estimate daily flow.
b Discharge for December 30 and 31 reduced to 40 per cent on account of ice gorge.

Estimated monthly discharge of Susquehanna River at Harrisburg, Pa., for 1904.

[Drainage area, 24,030 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January a	.....	.....	30,410	1.27	1.47
February a	.....	.....	38,590	1.61	1.74
March a	.....	.....	102,000	4.24	4.89
April	194,200	27,030	74,230	3.09	3.45
May	97,600	18,590	41,740	1.74	2.01
June	58,400	11,780	29,320	1.22	1.36
July	52,900	10,420	18,020	.750	.865
August	16,270	7,258	10,420	.434	.500
September	14,870	6,442	8,657	.360	.402
October	37,240	7,538	15,240	.634	.731
November	13,980	9,452	10,760	.448	.500
December	51,120	5,708	8,448	.352	.405
The year	.....	.....	32,320	1.350	18.320

a Owing to an ice gorge below Harrisburg the monthly mean for January, February, and March has been estimated by taking 89 per cent of means for McCall Ferry. Practically open conditions exist at the latter station.

SUSQUEHANNA RIVER AT M'CALL FERRY, PA.

This station is located at a narrow and rocky part of the Susquehanna River about 20 miles above its mouth and 1 mile above the village of McCall Ferry. It was established on May 17, 1902, by Boyd Ehle while investigating a power development there. For a considerable distance along this portion of the river the bank on the York County shore is the retaining wall of an abandoned canal which can be overtopped only in the greatest floods. The Lancaster shore, on the opposite side, is made up of almost equally vertical rock, and the railroad which skirts it has never yet been flooded at this point.

The gaging section first selected for this station is located at Duncan Run, where two islands, Hartman and Streepers, divide the river into three channels, ranging in width from 100 to 500 feet. At ordinary low water, however, two of these are dry, thus confining the discharge to the main or westernmost channel. The river bed at this section is of mica schistose rock, with some projecting bowlders and large irregularities. The flow, however, is comparatively free from the boils so common in a river of this character.

The discharge measurements at this section are made from a boat held in place by a rope stretched between the towpath and Streepers Island, the gaging points, 10 feet apart, being indicated by a tagged wire, which is also used in keeping the boat parallel to the current of the stream.

In order to provide for measuring the large floods which occur in the winter and spring months, a cable station was established by Mr. Ehle in the fall of 1902 about 1,000 feet downstream from the Duncan Run section. The banks of the river and the conditions of the river bed are very similar to those at the upper section, the only difference being that the bed is somewhat more irregular. During the low-water period of the fall of 1902 a careful survey was made of the section at the cable station and a contour map with 1-foot intervals was prepared from which the effective areas could be accurately determined, thus eliminating the error in discharge due to possible inaccuracies in the soundings at the time of the measurements. The width of the stream at this point is about 1,300 feet and the maximum depth during a gaging was 46 feet.

The car cable, a three-quarters inch 37-wire strand with a span of 1,450 feet, is anchored to 3-inch eyebolts set in cement in the solid rock on either side of the river. A 2-inch turn-buckle is provided at the York County end to regulate its height above the water. A high cliff on one shore and a large red oak on the other give the cable a 10-foot clearance over the highest floods on record. The car that runs on the cable accommodates two people and is propelled by a sheave provided with a crank. Eighty feet upstream from the main cable is

suspended a five-eighths inch secondary cable, along which runs a trolley carrying a guy rope to hold the meter against the current. Measuring points for this section are 50 feet apart, and are indicated by red and white bands painted on the main cable, the intermediate distances being readily estimated by counting the revolutions of the sheaves.

The measurements at both of the above stations are referred to two permanent gages, designated Nos. 2 and 5. These are painted on the rock, and give elevations directly above sea level. Gage No. 2 is located at a point about three-fourths of a mile below the village of McCall Ferry, in the tailrace of the proposed power house, and has been read daily since June, 1902. The records in the following tables have been referred to this gage. Gage No. 5 is placed about 2 miles below McCall Ferry, at the foot of Cullys Falls, so located in order to be entirely out of the influence of the proposed dam. One of the purposes of such extensive preparations as have been made at this point is to obtain data for determining the coefficient of discharge over ogee-faced weirs under high heads, and it is for use in these investigations that gage No. 5 was established.

The methods used in carrying on the work at the McCall Ferry station are practically the same as those employed by the hydrographers of the United States Geological Survey. Every effort has been made to eliminate any source of error, and vertical velocity-curve determinations were made wherever possible. At Duncan Run, in order to make these measurements, an 80-pound weight, with pulley and rope attached, was dropped to the bottom, so that the meter could be pulled down without being washed too far from the section. When the surface velocity, or 0.6 method, was used, the results were reduced by coefficients determined from these vertical velocity-curves. At the cable station the secondary cable, with the aid of the guy rope, made it possible to get vertical velocity-curve measurements at much greater velocities and depths. A No. 12 telegraph wire was found to be more satisfactory at such times for holding the meter than the insulated cable ordinarily used, as it offered less resistance to the current, would allow the meter to sink deeper, and, being less bowed by the water, would show more accurately its depth below the surface. In this way vertical velocity-curves were obtained to depths of 20 feet and in currents of 10 feet per second.

During the highest stages, when the velocity sometimes reaches 17 feet per second, readings could be taken only at the surface. These results were, however, reduced by coefficients determined from the vertical velocity-curve for each measuring point.

All records and estimates for this station for years prior to 1905 have been published in Water-Supply Paper No. 109.

Discharge measurements of Susquehanna River at McCall Ferry, Pa., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.[a]	Discharge.
		Sq. ft.	*Ft. per sec.*	*Feet.*	*Second-ft.*
March 8[a]	R. H. Anderson	54,500	[c]11.6	146.6	631,000
May 11[a]	do	7,035	[c]4.7	119.00	34,400
September 29[b]	W. G. Steward	3,717	2.16	114.75	7,940

[a] At cable section. [b] At Duncan Run section. [c] Reduced surface velocities.

Mean daily gage height, in feet, of Susquehanna River at McCall Ferry, Pa., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	116.6	120.0	120.0	123.9	125.2	119.4	116.8	115.8	115.5	116.2	117.1	116.0
2	116.3	119.0	121.0	129.2	124.4	119.3	116.5	115.7	115.3	116.1	116.9	115.9
3	115.9	118.5	122.0	132.6	123.3	119.9	116.3	116.0	115.1	116.0	116.8	115.8
4	[a]115.8	117.9	122.9	130.0	122.5	120.4	116.0	116.6	115.5	115.8	116.5	115.5
5	116.0	117.3	128.0	127.0	121.5	120.2	116.0	116.6	115.3	115.9	116.3	115.3
6	116.5	117.0	128.0	125.0	120.9	120.8	116.0	116.4	115.1	115.5	116.2	115.3
7	116.9	118.5	126.4	123.9	120.0	122.3	116.2	116.6	115.0	115.8	115.9	115.1
8	115.8	119.4	[b]146.6	123.1	119.8	121.4	116.5	116.7	114.9	115.7	115.7	115.0
9	115.5	121.5	130.2	123.2	119.5	120.1	117.0	116.7	114.8	115.5	115.5	114.8
10	115.5	125.0	130.4	123.4	119.3	119.9	117.5	117.0	114.7	115.4	115.7	114.7
11	116.0	125.7	130.9	124.6	119.0	119.6	119.9	117.5	114.7	115.3	115.5	114.5
12	116.8	124.3	126.6	127.3	118.6	121.7	121.0	117.0	114.8	115.4	115.5	114.4
13	117.1	122.7	124.9	125.9	118.3	121.0	121.1	116.4	115.0	115.4	115.6	114.2
14	117.3	121.9	123.6	124.4	118.3	119.9	119.9	116.0	115.3	115.4	115.9	114.2
15	117.3	121.0	122.3	123.6	118.2	119.3	119.0	115.7	115.8	115.3	116.0	114.4
16	117.4	120.4	121.5	122.6	119.0	118.5	118.5	115.5	116.1	115.4	116.0	115.3
17	117.0	119.5	121.1	121.9	119.5	118.3	118.7	115.3	116.4	118.2	115.9	114.6
18	116.6	118.6	120.7	121.6	119.7	118.0	117.4	115.2	117.0	118.0	115.8	114.6
19	116.4	118.0	120.9	121.0	120.3	118.0	117.0	115.2	116.8	117.5	115.7	114.6
20	116.0	117.8	121.0	120.6	121.3	117.9	116.8	115.3	116.5	116.8	115.7	114.5
21	116.0	118.0	121.6	120.2	122.7	117.8	116.6	115.7	116.3	117.0	115.7	114.6
22	117.4	120.0	122.6	120.1	123.8	117.2	116.5	115.6	116.0	117.3	115.6	114.5
23	122.3	120.9	123.0	119.9	122.8	118.0	116.4	115.5	115.8	117.5	115.5	114.5
24	[c]120.7	120.1	123.9	119.5	121.0	117.9	116.4	115.4	115.6	118.7	115.7	114.8
25	129.3	120.7	128.3	119.3	120.6	118.0	117.8	115.3	115.2	119.7	115.7	115.0
26	126.8	120.7	130.0	119.2	119.9	117.8	117.4	115.4	114.9	120.0	115.8	114.9
27	124.0	120.3	131.6	119.3	120.2	117.3	116.5	115.7	114.8	119.3	116.0	115.0
28	123.0	119.8	132.9	119.7	119.9	116.9	116.3	116.9	114.6	118.5	116.3	115.1
29	122.3	119.0	130.7	121.0	119.6	116.8	116.0	116.6	114.8	117.9	115.7	115.5
30	121.4	.....	128.9	122.1	119.0	116.7	116.0	116.1	115.8	117.8	116.1	116.2
31	120.5	.....	125.3	.....	119.6	.....	115.9	115.8	.....	117.5	.....	123.0

[a] Entire river covered with 14- to 18-inch ice.
[b] Ice moved at 2 p. m.
[c] Ice broke and went out of deeps at 5.30 p. m.; 133.8 maximum reading during night, 24th and 25th.

Rating table for Susquehanna River at McCall Ferry, Pa., for 1902 to 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
114.0	5,160	116.4	15,610	120.6	44,200	126.0	112,900
114.1	5,500	116.5	16,150	120.8	46,100	126.5	119,900
114.2	5,840	116.6	16,690	121.0	48,000	127.0	127,000
114.3	6,200	116.7	17,240	121.2	50,000	127.5	134,100
114.4	6,560	116.8	17,800	121.4	52,100	128.0	141,100
114.5	6,930	116.9	18,360	121.6	54,300	128.5	148,300
114.6	7,310	117.0	18,930	121.8	56,600	129.0	155,300
114.7	7,700	117.2	20,120	122.0	59,000	129.5	163,400
114.8	8,100	117.4	21,320	122.2	61,500	130.0	172,500
114.9	8,500	117.6	22,560	122.4	64,000	130.5	182,800
115.0	8,920	117.8	23,820	122.6	66,500	131.0	194,100
115.1	9,340	118.0	25,110	122.8	69,000	131.5	205,800
115.2	9,770	118.2	26,430	123.0	71,500	132.0	217,300
115.3	10,210	118.4	27,780	123.2	74,000	132.5	228,600
115.4	10,660	118.6	29,140	123.4	76,400	133.0	240,000
115.5	11,120	118.8	30,500	123.6	78,900	133.5	251,200
115.6	11,580	119.0	31,900	123.8	81,500	134.0	262,000
115.7	12,060	119.2	33,300	124.0	84,200	134.5	273,600
115.8	12,540	119.4	34,700	124.2	87,000	135.0	285,300
115.9	13,040	119.6	36,100	124.4	89,900	135.5	297,200
116.0	13,540	119.8	37,500	124.6	92,800	136.0	309,300
116.1	14,040	120.0	39,100	124.8	95,700		
116.2	14,560	120.2	40,700	125.0	98,600		
116.3	15,080	120.4	42,400	125.5	105,900		

Mean daily discharge, in second-feet, of Susquehanna River at McCall Ferry, Pa., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	16,690	39,100	39,100	82,800	101,500	34,700	17,800	12,540	11,120	14,560	19,520	13,540
2	15,080	31,900	48,000	158,400	89,900	34,000	16,150	12,060	10,210	14,040	18,360	13,040
3	13,040	28,460	59,000	230,900	75,200	38,300	15,080	13,540	9,340	13,540	17,800	12,540
4	12,540	24,460	70,200	172,500	65,300	42,400	13,540	16,690	11,120	12,540	16,150	11,120
5	13,540	20,720	141,100	127,000	53,200	40,700	13,540	16,690	10,210	13,040	15,080	10,210
6	16,150	18,930	141,100	98,600	47,050	46,100	13,540	15,610	9,340	11,120	14,560	10,210
7	18,360	28,460	118,500	82,800	39,100	62,800	14,560	16,690	8,920	12,540	13,040	9,340
8	12,540	34,700	[a]300,000	72,700	37,500	52,100	16,150	17,240	8,500	12,060	12,060	8,920
9	11,120	53,200	176,500	74,000	35,400	39,900	18,930	17,240	8,100	11,120	11,120	8,100
10	11,120	98,600	180,700	76,400	34,000	38,300	21,940	18,930	7,700	10,660	12,060	7,700
11	13,540	108,700	192,000	92,800	31,900	36,100	38,300	21,940	7,700	10,210	11,120	6,930
12	17,800	88,500	121,300	131,300	29,140	55,400	48,000	18,930	8,100	10,660	11,120	6,560
13	19,520	67,700	97,100	111,500	27,100	48,000	49,000	15,610	8,920	10,660	11,580	5,840
14	20,720	57,800	78,900	89,900	27,100	38,300	38,300	13,540	10,210	10,660	13,040	5,840

[a] Maximum discharge, 631,000 mean daily discharge estimated.

Mean daily discharge, in second-feet, of Susquehanna River at McCall Ferry, Pa., for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
15	20,720	48,000	62,800	78,900	26,430	34,000	31,900	12,060	12,540	10,210	13,540	6,560
16	21,320	42,400	53,200	66,500	31,900	28,460	28,460	11,120	14,040	10,660	13,540	10,210
17	18,930	35,400	49,000	57,800	35,400	27,100	29,820	10,210	15,610	26,430	13,040	7,310
18	16,690	29,140	45,100	54,300	36,800	25,110	21,320	9,770	18,930	25,100	12,540	7,310
19	15,610	25,110	47,050	48,000	41,550	25,110	18,930	9,770	17,800	21,940	12,060	7,310
20	13,540	23,820	48,000	44,200	51,100	24,460	17,800	10,210	16,150	17,800	12,060	6,930
21	13,540	25,110	54,300	40,700	67,700	23,820	16,690	12,060	15,080	18,930	12,060	7,310
22	21,320	39,100	66,500	39,900	81,500	20,120	16,150	11,580	13,540	20,720	11,580	6,930
23	62,800	47,050	71,500	38,300	69,000	25,110	15,610	11,120	12,540	21,940	11,120	6,930
24	45,100	39,900	82,800	35,400	48,000	24,460	15,610	10,660	11,580	29,820	12,060	8,100
25	160,000	45,100	145,500	34,000	44,200	25,110	23,820	10,210	9,770	36,800	12,060	8,920
26	124,100	45,100	172,500	33,300	38,300	23,820	21,320	10,660	8,500	39,100	12,540	8,500
27	84,200	41,550	208,100	34,000	40,700	20,720	16,150	12,060	8,100	34,000	13,540	8,920
28	71,500	37,500	237,700	36,800	38,300	18,360	15,080	18,360	7,310	28,460	15,080	9,340
29	62,800	31,900	187,200	48,000	36,100	17,800	13,540	16,690	8,100	24,460	12,060	11,120
30	52,100	.....	153,900	60,200	31,900	17,240	13,540	14,040	12,540	23,820	14,040	14,560
31	43,300	.....	103,000	.....	36,100	.....	13,040	12,540	.....	21,940	.....	71,500

Estimated monthly discharge of Susquehanna River at McCall Ferry, Pa., for 1904.

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	160,000	11,120	34,170	1.28	1.48
February	108,700	18,930	43,360	1.62	1.75
March	300,000	39,100	114,600	4.28	4.93
April	230,900	33,300	78,400	2.93	3.27
May	101,500	26,430	46,720	1.75	2.02
June	62,800	17,240	34,580	1.29	1.44
July	49,000	13,040	21,410	.800	.922
August	21,940	9,770	13,880	.519	.598
September	18,930	7,310	11,050	.413	.461
October	39,100	10,210	18,700	.698	.805
November	19,520	11,120	13,320	.498	.556
December	71,500	5,840	10,890	.407	.469
The year	300,000	5,840	36,760	1.37	18.70

CHENANGO RIVER AT BINGHAMTON, N. Y.

This station was established July 31, 1901. A standard chain gage is attached to the hand rail on the upstream side of the first span from the right bank of Court Street Bridge in Binghamton. The bench mark is a circular chisel draft on the upstream corner of the bridge seat on the left abutment. Its elevation is 34.02 feet above gage datum. The bridge to which the gage is attached stands squarely across the stream at a point where there is a good bed of gravel and small cobblestones and a smooth, uniform current. The channel is obstructed by three masonry piers supporting the four spans of the bridge, 79 feet clear width each, the bridge having a total length of 337 feet between abutments. A small rift between the station and the confluence of Chenango River with the Susquehanna, about 2,500 feet below, cuts off backwater at ordinary stages of the rivers. For periods during freshets or at times when there is an abnormal rise on one or both streams, either record may be affected by backwater and a too great discharge indicated. For freshets of considerable duration the effect of backwater on the stage of the two streams may become inconsiderable.

In estimating run-off of Chenango River the area directly tributary to storage reservoirs, from which diversion is made to supply Erie Canal, has been deducted from the total natural drainage area. The diversion area of six reservoirs at the head of Chenango River, whose outflow is turned into Erie Canal through Oriskany Creek, is 30 square miles. The diversion area of De Ruyter reservoir, at the head of Tioughnioga River, whose outflow is turned into Erie Canal through Limestone Creek, is 18 square miles. These two areas have been subtracted from the natural drainage area of 1,580 square miles, giving an effective area of 1,532 square miles. This estimate is approximate, as no allowance for direct inflow to feeder channels from additional areas, nor for waste into the original stream, has been made. The gross area from which more or less run-off is diverted is about 105 square miles. Gage readings on Chenango River, as well as those on Susquehanna River at Binghamton, are taken by E. F. Weeks. All records and estimates for this station for years prior to 1905 have been revised and republished in Water-Supply Paper No. 109.

The observations at this station during 1904 have been made under the direction of R. E. Horton, district hydrographer.

Discharge measurements of Chenango River at Binghamton, N. Y., in 1904.

Date.	Hydrographer.	Area.	Mean velocity.	Gage height.	Discharge.
		Sq. ft.	*Ft. per sec.*	*Feet.*	*Second-feet.*
March 8	C. C. Covert	3,702	3.45	[a]14.90	9,104
April 8	R. E. Horton	2,459	5.42	10.86	11,632
July 12	C. C. Covert	595	.87	5.42	516
September 10	do	417	1.15	5.55	539
November 22	H. R. Beebe	1,022	2.45	6.86	2,505

[a] Backwater, caused by ice jam.

Mean daily gage height, in feet, of Chenango River at Binghamton, N. Y., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.42	7.32	7.60	11.30	8.72	7.14	5.59	6.10	5.70	7.69	6.22	6.15
2	6.55	7.20	7.40	12.90	8.19	6.79	5.73	7.08	5.72	6.85	6.20	5.95
3	[b]6.42	7.18	7.88	[a]11.70	7.79	6.56	5.63	7.35	5.70	6.41	6.12	5.80
4	6.45	7.20	10.38	10.50	7.42	6.42	5.61	6.88	5.72	6.21	6.07	5.75
5	6.68	7.05	11.92	9.45	7.19	6.64	5.51	6.32	5.65	6.11	6.04	5.65
6	[c]6.82	6.75	11.08	10.08	6.99	6.59	5.49	6.72	5.65	6.01	6.17	5.72
7	6.68	8.12	[e]10.95	10.30	6.82	6.34	5.51	6.65	5.60	6.01	6.23	5.80
8	6.60	13.92	14.78	10.88	6.67	6.25	5.58	6.28	5.52	5.96	6.16	5.75
9	6.58	15.30	16.90	11.01	6.55	6.88	5.48	6.10	5.50	5.88	6.11	5.62
10	6.48	14.28	15.65	12.97	6.44	7.98	5.40	6.02	5.50	5.80	6.11	5.55
11	6.38	12.05	13.70	12.42	6.34	6.93	5.30	5.98	5.40	6.05	6.06	5.58
12	6.30	10.60	11.40	10.84	6.26	6.48	5.50	5.92	5.31	7.60	6.06	5.62
13	6.25	9.50	10.30	9.91	6.18	6.25	5.55	5.85	5.31	8.95	6.01	5.70
14	6.20	8.70	9.52	9.29	6.14	6.15	5.35	5.75	5.34	7.85	6.02	5.55
15	6.15	8.20	8.75	8.74	6.26	6.08	5.40	5.72	6.09	7.03	5.95	5.65
16	6.15	[e]9.38	8.20	8.49	7.36	6.53	5.60	5.65	5.91	6.40	6.08	5.65
17	6.12	10.18	7.65	8.39	7.36	6.11	5.65	5.70	5.67	6.42	6.10	5.65
18	[b]6.15	10.05	7.42	8.39	6.84	5.94	6.68	5.62	5.54	6.26	5.95	5.65
19	6.30	9.52	7.22	8.40	6.64	5.84	6.55	5.55	5.40	6.16	5.92	5.60
20	6.45	8.98	7.48	8.23	7.30	5.84	6.08	5.78	5.36	6.12	5.90	5.60
21	6.30	8.62	7.88	7.98	7.10	5.84	5.88	6.82	5.46	5.79	6.08	5.60
22	6.30	8.35	7.78	7.98	6.70	5.82	5.82	6.50	5.68	10.79	6.80	5.60
23	[d]10.36	8.62	11.30	8.00	6.47	5.72	5.65	8.25	5.66	9.76	6.68	5.65
24	11.18	9.35	[f]15.15	7.93	6.73	5.60	6.10	7.55	5.56	8.15	6.50	5.92
25	11.60	9.38	15.90	8.13	6.47	5.54	6.02	6.65	6.70	7.38	6.38	6.50
26	10.20	8.70	19.82	8.43	6.40	5.54	5.92	6.32	6.42	7.41	6.32	6.25
27	9.35	8.25	19.90	8.13	6.50	5.47	6.20	6.20	6.29	7.23	6.18	6.72
28	8.65	7.95	16.15	10.13	6.50	5.46	6.22	[a]6.05	6.15	6.92	5.98	12.75
29	8.10	7.88	12.08	10.19	6.40	5.46	6.65	5.90	5.95	6.68	5.80	13.28
30	7.88	.....	10.62	9.39	6.26	5.49	6.90	5.80	6.92	6.53	6.20	10.15
31	7.60	.....	10.58	.....	6.76	.....	6.32	5.72	.....	6.32	.....	5.25

[a] Interpolated.
[b] Anchor ice.
[c] River partly frozen over.
[d] Current very sluggish.
[e] Backwater.
[f] Ice went out.

Rating table for Chenango River at Binghamton, N. Y., for 1901 to 1904, inclusive.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
5.0	160	7.4	3,200	10.6	8,590	15.4	18,240
5.1	256	7.5	3,350	10.8	8,970	15.6	18,660
5.2	352	7.6	3,500	11.0	9,350	15.8	19,080
5.3	450	7.7	3,650	11.2	9,730	16.0	19,500
5.4	550	7.8	3,800	11.4	10,110	16.2	19,940
5.5	650	7.9	3,950	11.6	10,490	16.4	20,380
5.6	760	8.0	4,100	11.8	10,870	16.6	20,820
5.7	875	8.1	4,250	12.0	11,250	16.8	21,260
5.8	995	8.2	4,400	12.2	11,650	17.0	21,700
5.9	1,115	8.3	4,550	12.4	12,050	17.2	22,140
6.0	1,235	8.4	4,700	12.6	12,450	17.4	22,580
6.1	1,365	8.5	4,850	12.8	12,850	17.6	23,030
6.2	1,495	8.6	5,020	13.0	13,250	17.8	23,490
6.3	1,625	8.7	5,190	13.2	13,650	18.0	23,950
6.4	1,755	8.8	5,360	13.4	14,050	18.2	24,410
6.5	1,885	8.9	5,530	13.6	14,460	18.4	24,870
6.6	2,025	9.0	5,700	13.8	14,880	18.6	25,340
6.7	2,165	9.2	6,060	14.0	15,300	18.8	25,820
6.8	2,305	9.4	6,420	14.2	15,720	19.0	26,300
6.9	2,450	9.6	6,780	14.4	16,140	19.2	26,780
7.0	2,600	9.8	7,140	14.6	16,560	19.4	27,260
7.1	2,750	10.0	7,500	14.8	16,980	19.6	27,760
7.2	2,900	10.2	7,860	15.0	17,400	19.8	28,280
7.3	3,050	10.4	8,220	15.2	17,820		

Remarks: Tangent at 19.5 feet. Difference above this point 260 per tenth.

Mean daily discharge, in second-feet, of Chenango River at Binghamton, N. Y., for 1904.

Day.	Jan.	Feb.	Mar.	Apr	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1,781	3,050	3,500	9,920	5,190	2,825	749	1,365	875	3,650	1,521	1,430
2	1,955	2,900	3,200	13,050	4,400	2,291	911	2,750	899	2,375	1,495	1,175
3	1,781	2,900	3,950	10,680	3,800	1,969	793	3,125	875	1,768	1,391	995
4	1,820	2,900	5,750	8,400	3,200	1,781	771	2,420	899	1,508	1,326	935
5	2,137	2,675	9,000	6,510	2,900	2,081	661	1,651	815	1,378	1,287	818
6	2,333	2,235	8,500	7,680	2,585	2,011	640	2,193	815	1,248	1,456	899
7	2,137	4,250	8,300	8,040	2,333	1,677	661	2,095	760	1,248	1,534	995
8	2,025	15,090	8,985	9,160	2,123	1,560	738	1,599	672	1,187	1,443	935
9	1,997	18,030	11,400	9,350	1,955	2,420	630	1,365	650	1,091	1,378	783
10	1,859	15,930	10,700	13,150	1,807	4,100	550	1,261	650	995	1,378	705
11	1,729	11,350	8,950	12,050	1,677	2,495	450	1,211	550	1,300	1,313	738
12	1,625	8,590	6,670	9,065	1,573	1,859	650	1,139	460	3,500	1,313	783
13	1,560	6,600	5,700	7,320	1,469	1,560	705	1,055	460	5,615	1,248	875

Mean daily discharge, in second-feet, of Chenango River at Binghamton, N. Y., for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
14	1,495	5,190	4,950	6,240	1,417	1,430	500	935	490	3,875	1,261	705
15	1,430	4,400	4,170	5,275	1,573	1,339	550	899	1,352	2,675	1,175	818
16	1,430	6,420	3,600	4,850	3,125	1,927	760	815	1,127	1,755	1,339	818
17	1,391	7,860	3,020	4,700	3,125	1,378	815	875	839	1,781	1,365	818
18	1,430	7,590	2,800	4,700	2,361	1,163	2,137	782	694	1,573	1,175	818
19	1,625	6,600	2,680	4,700	2,081	1,043	1,955	705	550	1,443	1,139	760
20	1,820	5,700	3,015	4,475	3,050	1,043	1,339	971	510	1,391	1,115	760
21	1,625	5,020	3,555	4,100	2,750	1,043	1,091	2,333	610	983	1,339	760
22	1,625	4,625	3,350	4,100	2,165	1,019	1,019	1,885	851	8,970	2,305	760
23	8,130	5,020	9,920	4,100	1,846	899	815	4,475	827	7,050	2,137	818
24	9,730	6,330	17,715	4,025	2,207	760	1,365	3,425	716	4,325	1,885	1,139
25	10,490	6,420	19,290	4,325	1,846	694	1,261	2,095	2,165	3,200	1,729	1,885
26	7,860	5,190	28,280	4,775	1,755	694	1,139	1,651	1,781	3,200	1,651	1,560
27	6,330	4,475	28,540	4,325	1,885	620	1,495	1,495	1,612	2,975	1,469	2,193
28	5,105	4,025	19,830	7,770	1,885	610	1,521	1,300	1,430	2,480	1,211	12,750
29	4,250	3,950	11,450	7,860	1,755	610	2,095	1,115	1,175	2,137	995	13,810
30	3,950	.....	8,590	6,420	1,573	640	2,450	995	2,480	1,927	1,495	7,770
31	3,500	.....	8,590	.....	2,249	.....	1,651	899	.....	1,651	.....	401

The daily discharge during January, February, and March are only approximate, owing to the ice conditions. From March 4 to 22, 1904, the discharge was estimated from the measurement of March 8, which was approximately 50 per cent of normal conditions. This was due to an ice gorge.

Estimated monthly discharge of Chenango River at Binghamton, N. Y., for 1904.

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	10,490	1,391	3,160	2.06	2.37
February	18,030	2,235	6,390	4.17	4.50
March	28,540	2,680	8,966	5.84	6.73
April	13,150	4,025	7,037	4.59	5.12
May	5,190	1,417	2,376	1.55	1.79
June	4,100	610	1,518	.990	1.105
July	2,450	450	1,060	.691	.807
August	4,475	705	1,641	1.07	1.23
September	2,480	460	953	.621	.693
October	8,970	983	2,587	1.69	1.95
November	2,305	995	1,429	.932	1.04
December	13,810	401	1,981	1.29	1.49
The year	28,540	401	3,258	2.12	28.82

CHEMUNG RIVER AT CHEMUNG, N. Y.

Chemung River is formed at Painted Post, N. Y., by the confluence of Tioga and Cohocton rivers. Cohocton River lies entirely in the State of New York. Tioga River receives, just above its mouth, Canisteo River, a large tributary, which also has its drainage basin in New York to the south of the Cohocton. The drainage of Tioga River above the Canisteo is mainly in Pennsylvania. Chemung River flows southeasterly through Corning, Elmira, and Chemung, crosses the State line and flows for a short distance in Pennsylvania, then returns to New York and again crosses to Pennsylvania near Waverly, finally emptying into Susquehanna River near Athens, Bedford County, Pa. The total length of the river is about 40 miles, of which 30 miles lie in New York. It is a sluggish stream, with low banks and a broad valley or flood plain, which is often overflowed. It was formerly paralleled by a canal, which has now been abandoned. The principal water-power development on the river is at Elmira, N. Y.

The topographic features of the drainage basin are, as a rule, bold and broad. The hills rise to a height of several hundred feet on either side, and within a short distance of the stream; the upland plateau is to a large extent wooded, has impervious soil, no lake storage, and few marsh areas. Tributaries are ramifying and uniformly distributed, though not very numerous, and dry gullies or flood channels are common. The concentration of storm waters from the three large streams which unite just above Corning makes possible excessive floods. Dikes have been erected in the cities of Elmira and Corning for protection. One of the highest recorded freshets in the stream occurred June 1, 1889. It was preceded by phenomenal rainfall, aggregating several inches in a few hours during the night of May 31. The discharge at this time has been estimated by F. Collingwood at 67 second-feet per square mile from 2,055 square miles, or 138,000 second-feet.

The gaging station was established September 7, 1903, by R. E. Horton. It is located at the suspension highway bridge, midway between Chemung, N. Y., and Willawana, Pa., near the State line. The bridge has a single span of 395 feet. A standard chain gage is attached to the upstream side of the bridge near the right bank, and is read twice each day by Daniel L. Orcutt. Discharge measurements are made from the downstream side of the bridge. The initial point for soundings is the face of the right abutment on the downstream side. The channel is straight for 700 feet above and 800 feet below the station; the current is good. The right bank is high, cleared, and is not subject to overflow. The left bank is of medium height, wooded, and will overflow at high water. The bed of the stream is composed of gravel, and is clean and permanent. There is but one channel at

all stages. The bench mark is formed by three nails driven into a telephone pole 70 feet to the right of the initial point for soundings and about 30 feet upstream; elevation 29.88 feet above gage datum. The pole is marked with black paint, "U. S. G. S. B. M."

All records and estimates for this station for years prior to 1905 have been revised and republished in Water-Supply Paper No. 109.

The observations at this station during 1904 have been made under the direction of R. E. Horton, district hydrographer.

Discharge measurements of Chemung River at Chemung, N. Y.

Date.	Hydrographer.	Gage height.	Discharge.
1903.		*Feet.*	*Second-feet.*
August 27	C. C. Covert	2.89	809
September 7	R. E. Horton	3.29	1,354
October 2	H. H. Halsey	2.47	611
October 12	C. C. Covert	6.72	8,766
1904.			
March 11	C. C. Covert	5.75	6,170
April 9	R. E. Horton	5.64	5,717
July 15	C. C. Covert	3.05	1,042
September 9	do	1.90	220

Mean daily gage height, in feet, of Chemung River at Chemung, N. Y.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.												
1										2.24	2.98	2.90
2										2.40	2.88	2.88
3										2.52	3.88	2.88
4										2.57	2.83	2.88
5										2.74	2.86	2.82
6										3.30	2.90	2.59
7									3.29	3.37	3.08	3.69
8									2.24	4.62	2.98	2.79
9									3.19	9.97	4.93	2.69
10									3.16	7.78	2.90	2.64
11									4.84	8.80	2.88	2.49
12									4.56	6.74	2.86	2.49
13									3.84	6.12	2.80	2.69
14									3.46	4.97	2.73	2.69
15									3.22	4.47	2.68	2.69
16									3.06	4.20	2.76	2.74
17									2.96	3.92	7.06	2.74
18									3.44	7.04	8.13	2.64
19									3.46	6.24	5.88	2.64
20									3.29	4.90	4.88	2.64
21									2.99	4.42	4.26	2.69
22									2.84	4.12	3.98	2.74
23									2.54	3.87	3.88	2.79

Mean daily gage height, in feet, of Chemung River at Chemung, N. Y.—Continued.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.												
24	.....	.....	.....	.....	.....	.....	.....	.....	2.34	4.72	3.83	2.79
25	.....	.....	.....	.....	.....	.....	.....	.....	2.34	3.54	3.78	2.79
26	.....	.....	.....	.....	.....	.....	.....	.....	2.29	3.44	3.38	2.74
27	.....	.....	.....	.....	.....	.....	.....	.....	2.24	3.32	3.23	2.69
28	.....	.....	.....	.....	.....	.....	.....	.....	2.24	3.30	3.10	2.54
29	.....	.....	.....	.....	.....	.....	.....	.....	2.22	3.24	3.10	2.44
30	.....	.....	.....	.....	.....	.....	.....	.....	2.26	3.22	3.10	2.54
31	.....	.....	.....	.....	.....	.....	.....	.....	.....	3.13	.....	2.64
1904.												
1	3.00	[a] 3.85	3.57	6.50	7.20	7.05	2.60	2.50	2.00	2.35	2.40	2.05
2	2.95	3.50	3.37	9.00	6.25	5.85	2.88	2.42	2.02	2.42	2.30	2.00
3	2.90	3.45	3.67	7.05	5.45	5.35	2.70	2.98	2.00	2.22	2.22	1.90
4	2.90	3.35	8.57	5.75	5.02	4.85	2.62	2.82	1.95	2.10	2.20	1.90
5	2.90	4.00	5.72	5.38	4.62	7.70	2.60	2.70	2.00	2.15	2.25	1.90
6	2.90	4.20	4.72	5.15	4.40	5.95	2.58	2.60	1.98	2.18	2.20	1.90
7	2.85	5.90	7.69	5.20	4.18	5.10	2.95	2.45	1.92	1.88	2.20	1.85
8	2.90	[a] 16.70	[b] 15.97	5.25	4.00	4.62	2.85	2.35	1.95	1.95	2.22	1.65
9	3.00	8.70	9.68	5.75	3.80	5.35	2.72	2.20	1.90	1.90	2.12	2.25
10	3.00	6.85	6.48	9.55	3.70	6.15	2.75	2.15	1.90	1.95	2.18	2.10
11	3.00	5.85	5.02	7.40	3.58	4.90	3.90	2.20	1.95	1.95	2.20	2.10
12	3.00	5.40	4.90	6.55	3.40	4.42	3.68	2.18	1.95	2.10	2.20	2.10
13	3.00	4.75	4.50	5.75	3.38	4.00	3.45	2.10	1.95	2.62	2.12	2.00
14	3.00	4.22	4.30	5.15	3.30	3.70	3.45	2.08	1.90	3.65	2.08	2.00
15	3.00	3.95	4.05	4.80	5.15	3.48	3.02	2.00	1.90	3.15	2.05	2.00
16	[c] 3.15	3.65	3.88	4.80	6.75	4.05	2.82	2.00	1.90	2.82	2.25	2.00
17	3.20	[d] 4.85	3.62	4.80	5.65	3.80	2.70	2.00	1.90	2.70	2.15	1.90
18	3.20	4.55	3.78	5.10	5.00	3.42	2.62	1.95	1.90	2.60	2.20	1.90
19	3.20	[e] 4.30	3.92	5.10	9.45	3.22	2.50	1.95	1.90	2.50	2.05	1.95
20	3.20	4.15	5.98	4.85	8.40	3.12	2.40	2.05	1.88	2.45	2.00	2.00
21	3.35	4.00	6.78	4.42	6.60	3.02	2.30	2.05	1.80	2.52	2.00	2.10
22	3.50	[f] 4.12	5.20	4.55	5.40	3.10	2.35	2.30	1.75	3.40	2.00	2.05
23	[g] 11.35	4.05	[h] 10.90	4.60	4.95	3.05	2.25	2.75	1.80	3.40	2.00	2.18
24	[a] 9.55	4.32	11.40	4.50	5.35	3.05	2.72	2.88	1.82	3.18	2.02	2.10
25	6.65	4.12	10.25	4.55	5.25	2.88	2.78	2.70	2.00	3.05	2.20	2.10
26	5.30	4.05	[b] 13.20	4.82	4.75	2.80	2.55	2.45	2.15	2.85	2.15	2.15
27	4.90	3.90	11.05	4.65	4.82	2.70	2.60	2.30	2.38	2.75	2.00	2.60
28	4.20	3.37	7.28	9.10	5.40	2.65	2.50	2.12	2.35	2.65	1.95	6.40
29	4.22	3.57	5.95	8.50	4.25	2.60	2.70	2.10	2.35	2.60	2.10	5.15
30	4.25	.....	5.60	7.42	4.00	2.60	2.80	2.08	2.35	2.45	1.95	3.90
31	4.05	.....	5.70	.....	5.85	.....	2.62	2.00	.....	2.30	.....	3.80

[a] No ice.
[b] Water over flats highest point 17 feet.
[c] River freezing over below gage.
[d] River frozen over.
[e] Thickness of ice 5 inches.
[f] Thickness of ice 12 inches.
[g] Ice running.
[h] River over the flats.

Rating table for Chemung River at Chemung N. Y., from August 27, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.75	146	4.00	2,255	6.30	7,575	8.60	14,260
1.80	170	4.10	2,420	6.40	7,855	8.70	14,560
1.90	220	4.20	2,590	6.50	8,135	8.80	14,860
2.00	273	4.30	2,765	6.60	8,415	8.90	15,160
2.10	328	4.40	2,950	6.70	8,700	9.00	15,460
2.20	385	4.50	3,140	6.80	8,985	9.10	15,760
2.30	445	4.60	3,340	6.90	9,270	9.20	16,060
2.40	510	4.70	3,550	7.00	9,560	9.30	16,360
2.50	575	4.80	3,765	7.10	9,850	9.40	16,660
2.60	645	4.90	3,990	7.20	10,140	9.50	16,960
2.70	720	5.00	4,220	7.30	10,430	9.60	17,260
2.80	800	5.10	4,455	7.40	10,720	9.70	17,560
2.90	890	5.20	4,695	7.50	11,010	9.80	17,860
3.00	985	5.30	4,940	7.60	11,300	9.90	18,160
3.10	1,085	5.40	5,190	7.70	11,590	10.00	18,460
3.20	1,190	5.50	5,445	7.80	11,880	11.00	21,460
3.30	1,300	5.60	5,700	7.90	12,170	12.00	24,460
3.40	1,415	5.70	5,960	8.00	12,460	13.00	27,460
3.50	1,540	5.80	6,220	8.10	12,760	14.00	30,460
3.60	1,670	5.90	6,485	8.20	13,060	15.00	33,460
3.70	1,805	6.00	6,750	8.30	13,360	16.00	36,460
3.80	1,945	6.10	7,020	8.40	13,660		
3.90	2,095	6.20	7,295	8.50	13,960		

The above table is applicable only for open-channel conditions. It is based upon 8 discharge measurements made during 1903 and 1904. It is fairly well defined between gage heights 1.90 and 3.30 feet. The table has been extended above gage height 6.70 feet. Above gage height 8.00 feet the rating curve is a tangent, the difference being 300 per tenth. The rating table has been applied to the nearest hundredth of a foot to gage height 6.00, to the nearest half-tenth of a foot to gage height 9.00, to the nearest tenth of a foot above gage height 9.00 feet.

Mean daily discharge, in second-feet, of Chemung River at Chemung, N. Y.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.												
1										409	966	890
2										510	872	872
3										589	2,065	872
4										624	827	872
5										752	854	818
6										1,300	890	638
7									1,289	1,380	1,065	1,791
8									409	3,382	966	792

Mean daily discharge, in second-feet, of Chemung River at Chemung, N. Y.—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.												
9									1,180	18,460	4,059	712
10									1,148	11,880	890	675
11									3,855	14,860	872	568
12									3,260	8,840	854	569
13									2,005	7,020	800	712
14									1,490	4,157	748	712
15									1,212	3,083	705	712
16									1,045	2,590	768	752
17									947	2,127	9,705	752
18									1,465	9,705	12,910	675
19									1,490	7,435	6,432	675
20									1,289	3,990	3,945	675
21									975	2,988	2,695	712
22									836	2,454	2,223	752
23									603	2,050	2,065	792
24									471	3,593	1,990	792
25									471	1,592	1,917	792
26									439	1,465	1,392	752
27									409	1,323	1,223	712
28									409	1,300	1,085	603
29									397	1,234	1,085	536
30									421	1,212	1,085	603
31										1,116		675
1904.												
1				8,135	10,140	9,705	645	575	273	478	510	300
2				15,460	7,435	35,860	872	523	284	523	445	273
3				9,705	5,318	5,065	720	966	273	397	397	220
4				6,090	4,267	3,877	660	818	246	328	385	220
5				5,140	3,382	11,590	645	720	273	356	415	220
6				4,575	2,950	6,617	631	645	262	374	385	220
7				4,695	2,556	4,455	938	542	231	210	385	195
8			36,460	4,817	2,255	3,382	845	477	246	246	397	100
9			17,560	6,090	1,945	5,065	736	385	220	220	339	415
10			8,135	17,260	1,805	7,158	760	356	220	246	374	328
11			4,267	10,720	1,644	3,990	2,095	385	246	246	385	328
12			3,990	8,275	1,415	2,988	1,778	374	246	328	385	328
13			3,140	6,090	1,392	2,255	1,477	328	246	660	339	273
14			2,765	4,575	1,300	1,805	1,477	317	220	1,732	317	273
15			2,337	3,765	4,575	1,515	1,005	273	220	1,138	300	273
16			2,065	3,765	8,842	2,337	818	273	220	818	415	273
17			1,697	3,765	5,830	1,945	720	273	220	720	356	220
18			1,917	4,455	4,220	1,440	660	246	220	645	385	220
19			2,127	4,455	16,660	1,212	575	246	220	575	300	246
20			6,697	3,877	13,660	1,106	510	300	210	542	273	273
21			8,985	2,988	8,415	1,005	445	300	170	589	273	328
22			4,695	3,240	5,190	1,085	477	445	146	1,415	273	300
23			21,160	3,340	4,105	1,035	415	760	170	1,415	273	374
24			22,660	3,140	5,065	1,035	736	872	180	1,169	284	328
25			19,060	3,240	4,817	872	784	720	273	1,035	385	328
26			28,060	3,810	3,658	800	610	542	356	845	356	356
27			21,460	3,445	3,810	720	645	445	497	760	373	645
28			10,430	15,760	5,190	683	575	339	477	682	246	7,855
29			6,617	13,960	2,678	645	720	328	477	645	328	4,575
30			5,700	10,720	2,255	645	800	317	477	542	246	2,095
31			5,960		6,352		660	273		445		1,945

Estimated monthly discharge of Chemung River near Chemung, N. Y., for 1903–4.

[Drainage area, 2,440 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1903.					
September 7–30	3,855	397	1,146	0.47	0.42
October	18,460	409	3,981	1.63	1.88
November	12,910	705	2,265	.93	1.04
December	1,791	536	757	.31	.36
1904.					
March 8–31	36,460	1,697	10,331	4.23	3.90
April	17,260	2,988	6,645	2.72	3.03
May	16,660	1,300	4,940	2.02	2.33
June	35,860	645	4,063	1.67	1.86
July	2,095	415	820	3.36	.387
August	966	246	463	.190	.219
September	497	146	267	.109	.122
October	1,732	210	656	.269	.310
November	510	246	347	.142	.158
December	7,855	100	785	.322	.371
The year	36,460	100	2,932	1.20	12.69

SUSQUEHANNA RIVER (WEST BRANCH) AT WILLIAMSPORT, PA.

This station was established March 1, 1895, by George D. Snyder, who was at that time city engineer, and daily gage heights have been recorded since that date. On August 16, 1901, a standard chain gage was installed on the upper side of Market Street Bridge by E. G. Paul. The length of the chain from the end of the weight to the marker is 40.29 feet. The bench mark is a cut in the face of the left abutment 10.07 feet above gage datum. Discharge measurements are made from the lower side of the bridge. The initial point for soundings is the face of the abutment on the left bank. The channel is straight for several hundred feet above and below the station, is broken by four bridge piers, and is about 1,000 feet wide at the station. There is a dam about one-half mile above. Both banks are high and rocky. The bed of the stream is composed of gravel and silt, and will probably change to some extent in the shore spans. The current velocity is sufficient for accurate measurement except at extreme low stages. During nearly ten years, from March, 1895, to January, 1905, the range of gage height at this station has been 21.3 feet, and the estimated maximum and minimum discharges have been 164,100 and 410 cubic feet per second, respectively. The gage is read once each day by

Henry H. Guise, who is employed in the city engineer's office. All records and estimates for this station for years prior to 1905 have been revised and republished in Water-Supply Paper No. 109.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Susquehanna River (West Branch) at Williamsport, Pa., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Ft. per sec.*	*Feet.*	*Second-feet.*
July 19	R. J. Taylor	3,874	1.09	2.07	4,220
September 14	J. C. Hoyt	2,550	0.53	0.52	1,340
September 30	do	3,040	0.67	1.10	2,060

Mean daily gage height, in feet, of Susquehanna River (West Branch) at Williamsport, Pa., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.2	3.8	2.7	6.2	7.8	3.6	2.3	1.0	0.4	0.8	1.0	0.6
2	2.2	3.4	7.0	16.8	7.0	3.7	2.1	.9	.4	1.0	1.0	.5
3	2.0	3.0	7.5	13.6	6.2	3.7	1.9	.9	.4	1.0	1.0	.5
4	2.0	2.8	19.0	9.8	5.5	3.5	1.7	.9	.3	.9	1.0	.4
5	1.8	3.0	16.5	8.0	5.0	6.1	1.5	.8	.3	.8	.9	[a].4
6	1.8	2.4	9.2	6.8	4.5	4.5	1.5	.7	.3	.8	.9	.4
7	1.7	2.6	7.4	6.4	4.2	3.7	1.7	.7	.2	.7	.8	.4
8	1.7	[b]5.0	17.4	6.0	3.9	3.4	1.8	.7	.2	.7	.7	.4
9	1.7	[c]10.5	13.5	6.0	3.6	3.2	3.4	.6	.2	.6	.6	.4
10	1.7	[c]7.6	9.8	8.8	3.3	3.2	4.4	.5	.2	.6	.6	.4
11	1.7	[c]6.0	7.6	9.2	3.2	3.3	8.1	.5	.2	.6	.7	.4
12	1.7	[c]5.2	6.5	7.9	3.0	3.3	6.7	.4	.5	.5	.7	.4
13	1.7	[c]4.3	5.8	7.2	2.8	2.9	5.4	.4	.6	.7	.7	.3
14	1.7	3.8	5.3	6.6	2.5	2.7	4.6	.5	.5	1.2	.8	.3
15	1.6	4.0	5.0	5.8	3.0	2.4	3.8	.5	.5	1.5	.8	.3
16	1.6	[d]3.8	4.4	5.2	3.4	2.6	3.4	.5	.6	1.4	.7	.3
17	1.5	[d]3.6	4.1	5.2	3.3	3.1	3.0	.3	.5	1.3	.7	.3
18	1.5	[d]3.5	3.8	5.1	3.2	2.8	2.5	.3	.5	1.2	.7	.2
19	1.5	3.3	4.0	5.0	4.7	2.6	2.1	.3	.4	1.1	.7	.2
20	1.5	[d]3.0	4.5	4.5	7.7	2.3	2.0	.4	.3	1.0	.7	.2
21	1.4	2.9	6.5	4.2	7.2	2.3	1.7	.5	.3	1.1	.6	.2
22	1.5	2.8	6.7	3.9	6.0	3.0	1.5	.5	.2	1.5	.6	.2
23	7.7	2.7	6.6	3.6	5.2	3.7	1.3	.9	.2	1.7	.6	.2
24	13.3	3.7	[e]9.9	3.3	4.7	4.0	1.3	1.0	.2	1.6	.7	.3
25	9.8	4.2	10.3	3.2	4.4	3.2	1.2	1.2	.2	1.5	.6	.3
26	7.0	3.8	11.3	3.6	4.2	2.8	1.1	1.0	.3	1.5	.6	.3
27	5.4	3.0	[f]12.6	4.3	4.0	2.3	1.1	.9	.6	1.4	.6	.4
28	4.9	2.7	10.6	5.1	3.8	2.1	1.1	.7	1.0	1.3	.6	1.8
29	3.	2.5	8.0	6.8	3.5	1.9	1.1	.6	1.0	1.3	.5	5.4
30	3.2	.....	6.9	8.4	3.3	1.7	1.0	.6	1.1	1.2	.5	5.5
31	3.6	.....	6.0	.....	3.3	.....	1.0	.5	.....	1.1	.....	4.4

[a] River frozen December 5 to 28, 1904.
[b] Ice running.
[c] Slush ice running.
[d] Anchor ice running.
[e] Noon river 18 feet.
[f] Extreme height.

Rating table for Susquehanna River (West Branch) at Williamsport, Pa., from 1895 to 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
—0.2	410	2.2	4,530	6.0	18,330	10.6	47,400
.0	600	2.3	4,770	6.2	19,330	10.8	49,000
.1	710	2.4	5,010	6.4	20,340	11.0	50,600
.2	830	2.5	5,250	6.6	21,360	11.2	52,200
.3	970	2.6	5,500	6.8	22,380	11.4	53,800
.4	1,120	2.7	5,760	7.0	23,400	11.6	55,500
.5	1,280	2.8	6,020	7.2	24,600	11.8	57,200
.6	1,440	2.9	6,300	7.4	25,700	12.0	58,900
.7	1,610	3.0	6,580	7.6	26,900	12.2	60,700
.8	1,780	3.2	7,170	7.8	28,100	12.4	62,500
.9	1,960	3.4	7,780	8.0	29,300	12.6	64,300
1.0	2,140	3.6	8,400	8.2	30,500	12.8	66,100
1.1	2,320	3.8	9,030	8.4	31,800	13.0	67,900
1.2	2,510	4.0	9,690	8.6	33,100	13.2	69,800
1.3	2,700	4.2	10,400	8.8	34,400	13.4	71,700
1.4	2,890	4.4	11,150	9.0	35,800	13.6	73,600
1.5	3,080	4.6	11,940	9.2	37,200	13.8	75,500
1.6	3,270	4.8	12,750	9.4	38,600	14.0	77,500
1.7	3,460	5.0	13,600	9.6	40,000	14.5	82,600
1.8	3,660	5.2	14,500	9.8	41,400	15.0	87,800
1.9	3,860	5.4	15,420	10.0	42,800		
2.0	4,070	5.6	16,370	10.2	44,300		
2.1	4,300	5.8	17,340	10.4	45,800		

Mean daily discharge, in second-feet, of Susquehanna River (West Branch) at Williamsport, Pa., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4,530	9,030	5,760	19,330	28,100	8,400	4,770	2,140	1,120	1,780	2,140	1,440
2	4,530	7,780	23,400	107,800	23,400	8,710	4,300	1,960	1,120	2,140	2,140	1,280
3	4,070	6,580	26,300	73,600	19,330	8,710	3,860	1,960	1,120	2,140	2,140	1,280
4	4,070	6,020	135,100	41,400	15,890	8,090	3,460	1,960	970	1,960	2,140	1,120
5	3,660	6,580	104,300	29,300	13,600	18,830	3,080	1,780	970	1,780	1,960	1,120
6	3,660	5,010	37,200	22,380	11,540	11,540	3,080	1,610	970	1,780	1,960	1,120
7	3,460	5,500	25,700	20,340	10,400	8,710	3,460	1,610	830	1,610	1,780	1,120
8	3,460	13,600	115,000	18,330	9,360	7,780	3,660	1,610	830	1,610	1,610	1,120
9	3,460	46,600	72,600	18,330	8,400	7,170	7,780	1,440	830	1,440	1,440	1,120
10	3,460	26,900	41,400	34,400	7,470	7,170	11,150	1,280	830	1,440	1,440	1,120
11	3,460	18,330	26,900	37,200	7,170	7,470	29,950	1,280	830	1,440	1,610	1,120
12	3,460	14,500	20,850	28,700	6,580	7,470	21,870	1,120	1,280	1,280	1,610	1,120
13	3,460	10,770	17,340	24,600	6,020	6,300	15,420	1,120	1,440	1,610	1,610	970
14	3,460	9,030	14,960	21,360	5,250	5,760	11,940	1,280	1,280	2,510	1,780	970

Mean daily discharge, in second-feet, of Susquehanna River (West Branch) at Williamsport, Pa., for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
15	3,270	9,690	13,600	17,340	6,580	5,010	9,030	1,280	1,280	3,080	1,780	970
16	3,270	9,030	11,150	14,500	7,780	5,500	7,780	1,280	1,440	2,890	1,610	970
17	3,080	8,400	10,040	14,500	7,470	6,870	6,580	970	1,280	2,700	1,610	970
18	3,080	8,090	9,030	14,050	7,170	6,020	5,250	970	1,280	2,510	1,610	830
19	3,080	7,470	9,690	13,600	12,340	5,500	4,300	970	1,120	2,320	1,610	830
20	3,080	6,580	11,540	11,540	27,500	4,770	4,070	1,120	970	2,140	1,610	830
21	2,890	6,300	20,850	10,400	24,600	4,770	3,460	1,280	970	2,320	1,440	830
22	3,080	6,020	21,870	9,360	18,330	6,580	3,080	1,280	830	3,080	1,440	830
23	27,500	5,760	21,360	8,400	14,500	8,710	2,700	1,960	830	3,460	1,440	830
24	70,700	8,710	42,100	7,470	12,340	9,690	2,700	2,140	830	3,270	1,610	970
25	41,400	10,400	45,000	7,170	11,150	7,170	2,510	2,510	830	3,080	1,440	970
26	23,400	9,030	53,000	8,400	10,400	6,020	2,320	2,140	970	3,080	1,440	970
27	15,420	6,580	64,300	10,770	9,690	4,770	2,320	1,960	1,440	2,890	1,440	1,120
28	13,170	5,760	47,400	14,050	9,030	4,300	2,320	1,610	2,140	2,700	1,440	3,660
29	8,090	5,250	29,300	22,380	8,090	3,860	2,320	1,440	2,140	2,700	1,280	7,640
30	7,170	.....	22,890	31,800	7,470	3,460	2,140	1,440	2,320	2,510	1,280	8,010
31	8,400	.....	18,330	.....	7,470	.....	2,140	1,280	.....	2,320	.....	4,220

Estimated monthly discharge of Susquehanna River (West Branch) at Williamsport, Pa., for 1904.

[Drainage area, 5,640 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	70,700	2,890	9,477	1.68	1.94
February	46,600	5,010	10,320	1.83	1.97
March	135,100	5,760	36,070	6.40	7.38
April	107,800	7,170	23,760	4.21	4.70
May	28,100	5,250	12,080	2.14	2.47
June	18,830	3,460	7,170	1.27	1.42
July	29,950	2,140	6,219	1.10	1.27
August	2,510	970	1,541	.273	.315
September	2,320	830	1,170	.207	.231
October	3,460	1,280	2,309	.409	.472
November	2,140	1,280	1,648	.292	.326
December	8,010	1,120	1,660	.294	.339
The year	135,100	830	9,450	1.68	22.83

JUNIATA RIVER AT NEWPORT, PA.

This station, which is about 15 miles above the mouth of the river, was established March 21, 1899, by E. G. Paul. The standard chain gage has until the autumn of 1904 been located on the covered wagon bridge, 800 feet east of the public square at Newport, Pa. In the latter part of 1904 this bridge was removed and a steel structure will be erected on the same site. A standard chain gage will be attached to the new bridge immediately after its completion. In the meantime a temporary vertical staff gage, which has the same datum as the bench mark, has been attached to the exposed end of a sewer which discharges near the bridge, and the daily record of stage of river has been kept continuously. Bench mark No. 1 is on the extreme east end of the stone doorsill, east front of Ewing's store building, near end of bridge. The elevation above gage datum is 28.83 feet. Bench mark No. 2 is on shelf in southeast corner of underpinning of store of J. M. Ewing, elevation 27.37 feet above gage datum. This is a bench mark of the Pennsylvania Railroad and according to their levels is 390.69 feet above sea level. Discharge measurements have been made from the lower side of the wagon bridge to which the gage was attached. The channel is straight for one-half mile above and below the station. Both banks are high and are not subject to overflow. There is a single channel broken by three bridge piers. The piers do not interfere with the flow of the stream and there is little eddying and boiling near them. The bed is of hard material and is probably permanent. There is a good measurable velocity at all stages.

During nearly five years the range in gage height has been 22.8 feet, and the estimated maximum and minimum discharge has been 292,500 and 230 cubic feet per second, respectively.

The gage is read once each day by A. R. Bortel. All records and estimates for this station for years prior to 1905 have been revised and republished in Water-Supply Paper No. 109.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Juniata River at Newport, Pa., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
1904.		*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
July 16	N. C. Grover	1,520	2.73	4.28	4,152

Mean daily gage height, in feet, of Juniata River at Newport, Pa., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.2	4.0	7.5	6.7	6.7	4.9	3.7	3.3	3.0	2.9	2.9	2.5
2	4.2	5.0	12.0	13.4	6.1	5.6	3.7	3.3	3.0	2.9	2.9	2.8
3	4.5	5.0	7.2	9.4	5.7	6.0	3.7	3.7	3.0	2.9	2.9	2.9
4	4.6	5.0	13.5	7.7	5.3	5.4	3.7	3.6	3.0	2.9	2.9	3.2
5	4.6	8.0	8.9	6.7	5.0	5.9	3.7	3.6	3.0	2.9	2.9	2.9
6	4.6	8.5	6.0	5.7	4.8	5.9	3.7	3.5	3.0	2.9	2.8	3.1
7	4.6	11.5	5.5	5.7	4.7	5.4	4.4	3.9	2.9	2.9	2.8	3.2
8	4.5	8.5	14.0	5.3	4.6	4.7	5.1	3.5	2.9	2.9	2.8	3.2
9	4.5	6.5	10.0	5.3	4.5	4.6	5.8	3.3	3.0	2.9	2.8	3.2
10	4.5	5.0	7.2	6.3	4.4	4.5	7.2	3.3	3.0	2.9	2.8	3.1
11	4.4	4.6	6.0	6.3	4.3	5.1	8.7	3.2	3.0	2.9	2.9	3.1
12	4.2	4.2	6.0	6.0	4.2	4.6	7.1	3.2	3.0	2.9	2.9	3.1
13	4.1	4.0	5.2	5.7	4.2	4.4	5.5	3.1	3.0	2.9	2.9	3.1
14	4.1	3.9	5.2	5.3	4.2	4.2	5.3	3.1	2.9	2.9	2.9	3.1
15	4.1	4.1	5.0	5.0	4.2	4.0	4.7	3.1	2.9	2.9	2.9	3.1
16	4.1	4.2	4.8	4.8	4.2	4.0	4.7	3.1	3.0	2.9	2.9	3.1
17	4.0	4.4	4.5	4.8	4.2	4.4	4.1	3.0	3.0	2.9	2.9	3.1
18	4.0	5.0	4.5	4.7	4.3	3.9	3.9	3.2	3.0	2.9	2.9	3.1
19	4.0	4.6	4.8	4.4	4.5	3.9	3.8	3.1	3.0	2.9	2.9	3.1
20	4.0	4.7	4.5	4.4	6.7	3.9	3.9	3.2	2.9	2.9	2.8	3.1
21	4.0	4.7	5.8	4.3	5.9	3.7	3.7	3.2	2.9	3.3	2.8	3.1
22	4.0	5.0	5.5	4.2	5.5	5.7	3.6	3.2	2.9	3.3	2.8	3.1
23	5.4	5.0	5.8	4.2	4.9	5.5	3.5	3.2	2.9	3.2	2.8	3.1
24	[a]11.0	5.4	8.0	4.0	4.6	5.3	3.8	3.2	2.9	3.1	2.7	3.2
25	7.0	7.2	7.5	4.0	4.5	4.4	3.8	3.1	2.9	3.1	2.7	3.2
26	5.5	7.4	6.9	4.0	4.6	4.0	3.7	3.1	2.9	3.0	2.7	3.2
27	4.5	5.9	6.2	4.2	4.7	3.5	3.7	3.0	2.9	2.9	2.7	3.5
28	4.1	4.8	6.2	4.6	4.5	3.8	3.5	3.0	2.9	2.9	2.6	3.7
29	3.8	4.5	5.6	6.5	4.4	3.7	3.4	3.1	2.9	2.9	2.6	3.8
30	3.7	.....	5.2	7.5	4.2	3.7	3.3	3.1	2.9	2.9	2.5	3.8
31	3.8	.....	5.0	.....	4.6	.....	3.3	3.0	.....	2.9	.....	3.8

[a] Ice moved out.

Rating table for Juniata River at Newport, Pa., from 1899 to 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.5	230	4.7	5,180	6.9	14,570	10.2	38,500
2.6	320	4.8	5,510	7.0	15,170	10.4	40,300
2.7	430	4.9	5,850	7.1	15,770	10.6	42,200
2.8	570	5.0	6,200	7.2	16,370	10.8	44,100
2.9	750	5.1	6,550	7.3	16,970	11.0	46,000
3.0	950	5.2	6,910	7.4	17,570	11.2	48,000
3.1	1,160	5.3	7,270	7.5	18,170	11.4	50,100
3.2	1,370	5.4	7,640	7.6	18,770	11.6	52,200
3.3	1,580	5.5	8,010	7.7	19,380	11.8	54,300
3.4	1,790	5.6	8,390	7.8	20,000	12.0	56,400
3.5	2,000	5.7	8,770	7.9	20,640	12.2	58,600
3.6	2,210	5.8	9,150	8.0	21,300	12.4	60,800
3.7	2,430	5.9	9,540	8.2	22,700	12.6	63,100
3.8	2,650	6.0	9,930	8.4	24,100	12.8	65,400
3.9	2,880	6.1	10,330	8.6	25,500	13.0	67,700
4.0	3,120	6.2	10,740	8.8	27,000	13.2	70,100
4.1	3,380	6.3	11,200	9.0	28,500	13.4	72,600
4.2	3,650	6.4	11,720	9.2	30,100	13.6	75,100
4.3	3,930	6.5	12,270	9.4	31,700	13.8	77,600
4.4	4,220	6.6	12,830	9.6	33,400		
4.5	4,530	6.7	13,400	9.8	35,100		
4.6	4,850	6.8	13,980	10.0	36,800		

Mean daily discharge, in second-feet, of Juniata River at Newport, Pa., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3,650	3,120	18,170	13,400	13,400	5,850	2,430	1,580	950	750	750	230
2	3,650	6,200	56,400	72,600	10,330	8,390	2,430	1,580	950	750	750	570
3	4,530	6,200	16,370	31,700	8,770	9,930	2,430	2,430	950	750	750	750
4	4,850	6,200	73,850	19,380	7,270	7,640	2,430	2,210	950	750	750	1,370
5	4,850	21,300	27,700	13,400	6,200	9,540	2,430	2,210	950	750	750	750
6	4,850	24,800	9,930	8,770	5,510	9,540	2,430	2,000	950	750	570	1,160
7	4,850	51,100	8,010	8,770	5,180	7,640	4,220	2,880	750	750	570	1,370
8	4,530	24,800	80,100	7,270	4,850	5,180	6,550	2,000	750	750	570	1,370
9	4,530	12,270	36,800	7,270	4,530	4,850	9,150	1,580	950	750	570	1,370
10	4,530	6,200	16,370	11,200	4,220	4,530	16,370	1,580	950	750	570	1,160
11	4,220	4,850	9,930	11,200	3,930	6,550	26,200	1,370	950	750	750	1,160
12	3,650	3,650	9,930	9,930	3,650	4,850	15,770	1,370	950	750	750	1,160
13	3,380	3,120	6,910	8,770	3,650	4,220	8,010	1,160	950	750	750	1,160
14	3,380	2,880	6,910	7,270	3,650	3,650	7,270	1,160	750	750	750	1,160
15	3,380	3,380	6,200	6,200	3,650	3,120	5,180	1,160	750	750	750	1,160
16	3,380	3,650	5,510	5,510	3,650	3,120	5,180	1,160	950	750	750	1,160
17	3,120	4,220	4,530	5,510	3,650	4,200	3,380	950	950	750	750	1,160

Mean daily discharge, in second-feet, of Juniata River at Newport, Pa., for 1904—Cont'd.

Day.	Jan.	Feb.	Mar.	Apr.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
18	3,120	6,200	4,530	5,180	3,930	2,880	2,880	1,370	950	750	750	1,160
19	3,120	4,850	5,510	4,220	4,530	2,880	2,650	1,160	950	750	750	1,160
20	3,120	5,180	4,530	4,220	13,400	2,880	2,880	1,370	750	750	570	1,160
21	3,120	5,180	9,150	3,930	9,540	2,430	2,430	1,370	750	1,580	570	1,160
22	3,120	6.200	8,010	3,650	8,010	8,770	2,210	1,370	750	1,580	570	1,160
23	7,640	6,200	9,150	3,650	5,850	8,010	2,000	1,370	750	1,370	570	1,160
24	46,000	7.640	21,300	3,120	4,850	7,270	2,650	1,370	750	1,160	430	1,370
25	15,170	16,370	18,170	3,120	4,530	4,220	2,650	1,160	750	1,160	430	1,370
26	8,010	17,570	14,570	3,120	4,850	3,120	2,430	1,160	750	950	430	1,370
27	4,530	9,540	10,740	3,650	5,180	2,000	2,430	950	750	750	430	2,000
28	3,380	5,510	10,740	4,850	4,530	2,650	2,000	950	750	750	320	2,430
29	2,650	4,530	8,390	12,270	4,220	2,430	1,790	1,160	750	750	320	2,650
30	2,430	.....	6,910	18,170	3,650	2,430	1,580	1,160	750	750	230	2,650
31	2,650	.....	6,200	.....	4,850	.....	1,580	950	.....	750	.....	2,650

Estimated monthly discharge of Juniata River at Newport, Pa., for 1904.

[Drainage area, 3,476 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January [a]	46,000	2,430	5,722	1.65	1.90
February	51,100	2,880	9,756	2.81	3.03
March	80,100	4,530	17,150	4.93	5.68
April	72,600	3,120	10,710	3.08	3.44
May	13,400	3,650	5,742	1.65	1.90
June	9,930	2,000	5,160	1.48	1.65
July	26,200	1,580	4,968	1.43	1.65
August	2,880	950	1,460	.420	.484
September	950	750	850	.245	.273
October	1,580	750	856	.246	.284
November	750	230	607	.175	.195
December	2,650	230	1,344	.386	.445
The year	80,100	230	5,360	1.54	20.93

[a] Frozen January 1 to 23. Rating table assumed to apply correctly.

BROAD CREEK AT MILL GREEN, MD.

The basin of this creek lies wholly in Harford County, Md. It is generally hilly and is composed of farming lands. It is tributary to Susquehanna River at a point a few miles above the fall line. This station was established on December 14, 1904, by F. H. Tillinghast, and is best reached from Cardiff, Md. A standard chain gage is attached to a steel highway bridge in the village of Mill Green; the

length of chain from the end of the weight to the marker is 14.97 feet. Gage datum is referred to bench marks as follows: 1. Chiseled square on upstream end of right abutment; elevation, 10.60 feet. 2. Top of chord of bridge directly over pulley of gage; elevation, 16.31 feet. 3. Nail in large blazed tree about 100 feet upstream from bridge on left bank; elevation, 12.83 feet. All elevations are above the datum of the gage. The channel is straight for 200 feet above and 500 feet below the station. The bed is rough and the velocity of the current at the bridge is small at low stages of the stream. Low-water measurements may be made by wading at a point about 100 feet above the station. The gage is read twice daily by James F. Snodgrass.

The maintenance of this station during 1904 was under the direction of N. C. Grover, district hydrographer.

DEER CREEK NEAR CHURCHVILLE, MD.

This creek has its headwaters in York County, Pa., flows southeasterly through Baltimore and Harford counties, Md., and is tributary to Susquehanna River opposite Port Deposit. Its basin is hilly and generally in farming lands. Slopes are steep, and at several places small power plants are in use. This station was established December 14, 1904, by F. H. Tillinghast, and is best reached by driving from Belair. A standard chain gage is attached to the highway bridge on the Deer Creek road about 3 miles north from Churchville. The length of chain from the end of the weight to the marker is 15.20 feet. The datum of the gage is referenced by the following bench marks: 1. Chiseled square on the downstream end of the right abutment; elevation, 14.10 feet. 2. Top of eyebar of bottom chord in middle of second panel from the right bank; elevation, 14.68 feet. The channel is straight for 500 feet above and below the station. The bed is generally smooth, is composed of sand, with a few bowlders, and is practically permanent. The current has a good velocity at all stages. The gage is read twice daily, by Harris Archer.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer, and the following measurement was made November 8: Width, 70 feet; area of section, 86 square feet; mean velocity, .85 feet per second; gage height, 1.48 feet; discharge, 73 second-feet.

GUNPOWDER RIVER DRAINAGE BASIN.

The headwaters of Gunpowder River lie in York County, Pa., near the Maryland line. Thence the river flows southeasterly through Baltimore County, Md., and empties into Chesapeake Bay about 10 miles northeast of Baltimore. The river, although small, has steep

slopes, and the powers have considerable value on account of the small distance to a large city. A portion of the water supply for Baltimore is taken from this river at Loch Raven, and the city has purchased all power rights below this place. As the city increases in size it is probable that a larger proportion of the flow of the river will be taken. Little Gunpowder Falls, which is tributary below the fall line, has the same general characteristics as the larger river. Throughout its entire length it forms the boundary line between Harford and Baltimore counties, Md. There are several small power developments.

GUNPOWDER FALLS AT GLENCOE, MD.

This station was established on December 15, 1904, by F. H. Tillinghast. It is located at a steel highway bridge near the Pennsylvania Railroad station of Glencoe. A standard chain gage is attached to the upstream truss of the bridge. The length of the chain from the end of the weight to the marker is 22.13 feet. It is referenced by bench marks as follows: (1) Chiseled cross on downstream corner of left abutment; elevation, 18.30 feet. (2) Top of iron standard of gate at railroad crossing nearest bridge; elevation, 19.77 feet. The channel is straight for a distance of 300 feet above and 300 feet below the station. The bed is smooth and of sand, shifting slightly. The velocity of the current is good at all stages of the river. The gage is read twice daily by Samuel Wilhelm, the station agent at Glencoe.

The maintenance of this station during 1904 was under the direction of N. C. Grover, district hydrographer.

LITTLE GUNPOWDER FALLS NEAR BELAIR, MD.

This station was established on December 13, 1904, by F. H. Tillinghast. A standard chain gage is attached to a steel highway bridge on the road from Belair to Kingsville and at a distance of about 9 miles from Belair, from which place it is best reached by livery. The length of chain from the end of the weight to the marker is 13.36 feet. Its datum is referred to bench marks as follows: 1. Chiseled square on downstream end of right abutment; elevation, 13.36 feet. 2. Top of pulley wheel; elevation, 12.96 feet. The measurements are made from the upstream side of the bridge to which the gage is attached. The channel is straight for 300 feet above and 100 feet below the station. The bed is sand, with bowlders, and may shift slightly in the sand. The velocity of the current is good at all stages. There is a flood plain about 100 feet wide on the right bank. The gage is read twice daily by A. D. Unkart.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Little Gunpowder Falls, near Belair, Md., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
November 8	N. C. Grover	33	27	1.22	1.40	33
November 30	do	27.5	30	1.27	1.46	38

PATAPSCO RIVER DRAINAGE BASIN.

Patapsco River is formed by the junction of the North Branch and the South, or Piney Branch, near Mariottsville, Md., and flows in a southeasterly direction into Chesapeake Bay 13 miles south of Baltimore. Both branches rise in the central part of Maryland, and the whole basin, which has an area of about 350 square miles, lies within that State.

The river carries a small volume of water, but has considerable slope, so that a large number of water powers have been developed along its course. These, although small, are made valuable by their proximity to a large city.

The drainage basin is hilly and largely under cultivation. It has no lakes or artificial reservoirs, and the flow of the stream is variable. The maximum estimated flow at the gaging station at Woodstock, Md., where the drainage area is 250 square miles, is about 12,000 cubic feet per second, while the minimum estimated flow has been about 70 cubic feet per second. The record from which these estimates have been taken extends over a period of eight and one-half years. The freshets do not, however, cause very large rises of the water, because of the steep slope of the stream. The maximum recorded difference in gage height at Woodstock has been 13 feet, while the usual range within a year is about 3 or 4 feet.

The bed is generally rock. The banks are of rock and very little land is subject to overflow. The Baltimore and Ohio Railroad follows the stream closely throughout nearly its entire length.

PATAPSCO RIVER AT WOODSTOCK, MD.

This station was established August 6, 1896, by E. G. Paul. The original wire gage was destroyed when the bridge was repaired January 20–25, 1899. A new wire gage was established January 30, 1899, on the same datum. A standard chain gage was installed by W. C. Sawyer, November 11, 1903, on the upper side of the bridge. The datum was not changed. The length of the chain from the end of the weight to the marker is 28.28 feet. The bench mark is a United States Geological Survey standard copper bolt set in the face of the

retaining wall at the entrance to the college grounds at the north end of the bridge. Its elevation is 22.06 feet above gage datum. Discharge measurements are made from the upper side of the iron highway bridge to which the gage is attached. It is located 1½ miles below the junction with the North Branch and near the railroad station. The initial point for soundings is near the right bank. The channel is straight for 150 feet above and several hundred feet below the station. At ordinary stages the river flows in one channel 100 feet wide; at high stages it flows in two channels 220 feet wide. The velocity is rapid. Both banks are high and are not subject to overflow. The right bank is without trees; the left is wooded. The bed of the stream is rough and is composed of bowlders and cobblestones. It is subject to slight change at extreme high water.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Patapsco River at Woodstock, Md., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
July 12	Grover and Hoyt	102	89	2.02	3.91	180
September 30	E. C. Murphy	59	34	1.18	3.25	40
September 30 [a]	do	43	23	1.74	3.25	40

[a] Wading ½ mile above.

Mean daily gage height, in feet, of Patapsco River at Woodstock, Md., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.95	3.95	4.00	4.15	3.60	3.65	3.60	3.65	3.40	3.45	3.60	3.65
2	3.95	3.90	4.00	4.15	3.75	3.50	3.60	3.60	3.45	3.40	3.50	3.55
3	3.95	3.90	4.00	3.95	3.75	3.70	3.55	3.90	3.35	3.40	3.45	3.60
4	[a] 4.00	3.85	4.00	3.90	3.70	3.65	3.40	3.75	3.55	3.35	3.40	3.60
5	[a] 4.00	3.85	4.00	3.85	3.75	3.50	3.50	3.75	3.50	3.35	3.40	3.65
6	[a] 4.00	3.85	4.00	3.75	3.65	4.10	3.45	3.70	3.40	3.50	3.50	3.55
7	[a] 4.00	5.75	4.00	4.00	3.75	3.85	3.80	3.60	3.40	3.40	3.45	3.50
8	[a] 4.00	3.85	5.65	3.95	3.55	3.75	5.15	3.55	3.40	3.45	3.45	3.65
9	[a] 4.00	3.75	5.10	4.10	3.75	3.60	4.05	3.50	3.35	3.45	3.60	3.55
10	[a] 4.00	3.75	4.90	3.85	3.90	3.65	3.60	3.55	3.35	3.45	3.55	3.35
11	[a] 4.00	3.75	4.45	3.90	3.75	3.80	4.10	3.55	3.30	3.50	4.10	3.70
12	[a] 4.00	3.75	4.35	3.85	3.70	3.45	[b] 5.55	3.70	3.40	4.05	3.70	3.65
13	[a]	3.75	4.10	3.75	3.65	3.75	4.75	3.40	3.45	4.00	3.85	3.85
14	[a]	3.70	3.95	3.80	3.70	3.55	3.80	3.45	3.70	3.75	4.10	3.85
15	[a]	3.70	4.05	3.70	4.20	3.60	3.65	3.45	5.05	3.70	4.00	3.90
16	[a]	3.70	4.10	3.85	3.90	3.50	3.55	3.35	3.85	3.55	3.95	4.05
17	[a]	3.70	3.90	3.70	3.65	3.70	3.50	3.55	3.45	3.50	3.85	4.00
18	[a]	3.80	4.10	3.80	3.70	3.60	3.55	3.60	3.35	3.50	3.80	4.05
19	[a]	3.80	4.05	3.75	4.00	3.60	3.60	3.50	3.55	3.45	3.85	4.10
20	[a]	3.85	4.10	3.70	3.75	3.65	3.55	4.15	3.50	3.50	3.80	4.00
21	[a]	4.00	4.10	3.70	3.70	3.60	3.50	3.85	3.55	5.35	3.80	3.95
22	[c] 7.05	11.30	4.20	3.75	3.55	3.60	3.50	3.95	3.50	4.00	3.70	4.00

[a] Ice. [b] Maximum height 7.3. [c] Breaking up of ice. Maximum gage height 10.1.

Mean daily gage height, in feet, of Patapsco River at Woodstock, Md., for 1904—Cont'd.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
23	7.10	4.75	4.20	3.70	3.70	3.50	3.50	3.80	3.55	3.60	3.60	4.10
24	4.05	4.05	4.10	3.65	3.75	3.45	3.75	3.65	3.45	3.55	3.60	4.15
25	4.05	4.05	4.00	3.85	3.60	3.30	3.90	3.50	3.45	3.50	3.50	4.25
26	4.05	4.05	4.05	3.75	3.60	3.55	3.60	3.55	3.45	3.50	3.50	4.10
27	4.05	4.05	4.00	3.85	3.60	3.65	3.55	3.55	3.55	3.55	3.65	4.40
28	4.05	4.05	3.95	3.90	3.60	3.55	3.60	3.40	3.50	3.45	3.55	5.35
29	4.05	4.05	3.85	4.00	3.45	3.55	3.55	3.35	3.45	3.45	3.60	4.40
30	3.95	.....	3.95	3.80	3.55	3.50	3.60	3.40	3.50	3.45	3.60	4.20
31	4.00	.....	4.05	.....	3.75	.....	3.55	3.35	.....	3.60	.....	4.25

POTOMAC RIVER DRAINAGE BASIN.

Potomac River, which drains a total area of about 14,500 square miles, is formed by the junction of the North and South branches about 15 miles below Cumberland, Md., thence it pursues a southeasterly course, forming for its entire length the southerly boundary for the State of Maryland and the northerly boundaries for the States of West Virginia and Virginia, and empties into Chesapeake Bay.

The North Branch rises in the Alleghenies near the western corner of the State of Maryland, and the South Branch rises in the Alleghenies in Virginia and West Virginia. These branches, with their tributaries and the tributaries of the main stream as far down as Shenandoah River, drain a series of narrow and generally fertile valleys lying between the parallel ranges which make up the system of the Alleghenies in this region. Their slopes are not as a rule very large, and their beds are of gravel and sand. The slopes of their drainage basins are, however, generally very steep, and after a rain the water collects quickly in the rivers. There are few lowlands to overflow and no lakes whatever in the region, consequently these streams, and with them the Potomac River, are subject to very sudden and heavy freshets, while in dry seasons their discharge becomes small. The record of gage height at Point of Rocks, Md., covering a period of nearly ten years, shows a maximum range in gage height of 29 feet, and for several of the years the range has been more than 20 feet in each year. The corresponding maximum and minimum discharges have been estimated at 217,000 and 400 cubic feet per second, respectively.

The slopes of the tributary basin of Shenandoah River are, in many instances, steep, but the valley through which it flows is generally broader and more lands are subject to overflow. The slope of the river itself is usually greater than the slopes of the tributaries above mentioned. As a result the fluctuations in this stream are not so great, having a maximum range of about 19 feet at Millville in ten years, while the average annual fluctuation is 10 feet or less. The

discharge in this period has ranged between 57,000 and 300 cubic feet per second.

From the junction of its two branches below Cumberland, Md., the Potomac cuts through the mountains at nearly right angles. Its valley is narrow, its slope in many places great, the bed is generally gravel and bowlders with ledge rock at a small depth, which often appears at the surface. The banks are generally high and not subject to overflow. It crosses the fall line a few miles above Washington and reaches tidewater at Georgetown. As a water-power stream the principal disadvantage is the wide variability of its flow. All other conditions are favorable. A very insignificant amount of water power has been developed.

The Baltimore and Ohio Railroad follows the river for its entire length, while the Shenandoah Valley Railroad and the Cumberland Valley Railroad cross the stream. The Chesapeake and Ohio Canal follows it from Cumberland to Georgetown.

The United States Weather Bureau maintains river stations in this basin as follows:

Potomac at Cumberland, Md.
Potomac at Harpers Ferry, W. Va.
Shenandoah at Riverton, Va.

During 1904 the United States Geological Survey has maintained gaging stations in this basin as follows:

Potomac at Point of Rocks, Md.
Potomac (North Branch) at Piedmont, W. Va.
Potomac (South Branch) at Springfield, W. Va.
Antietam at Sharpsburg, Md.
Shenandoah at Millville, W. Va.
Shenandoah (South Branch) at Front Royal, Va.
Shenandoah (North Branch) at Riverton, Va.
Monocacy at Frederick, Md.

POTOMAC RIVER (NORTH BRANCH) AT PIEDMONT, W. VA.

This station was established June 27, 1899, by E. G. Paul. It is located at the iron highway bridge connecting Luke, Md., with Piedmont, W. Va. The standard chain gage is attached to the hand rail on the lower side of the bridge in the span next to the right bank. The length of the chain from the end of the weight to the marker is 38.87 feet. The bench mark is the top of a small shoulder in the face of the sandstone ledge which forms the right abutment of the bridge. It is about 4 feet above the ground and 10 feet downstream from the bridge. The point is indicated by an arrow cut in the vertical face of the ledge. Its elevation is 20.40 feet above gage datum. Discharge measurements are made from the lower chord of the bridge to which the gage is attached, from the downstream side. The initial point for soundings is the face of the pier on the right bank. The channel is

straight for 1,200 feet above and 600 feet below the station. The current has a moderate velocity. The right bank is high and rocky and will not overflow. The left bank is low and liable to overflow, but all water passes beneath the bridge. The bed of the stream is composed of gravel and cobblestones, is free from vegetation and is permanent. The gage is read twice each day by Charles H. Beck.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Potomac River (North Branch) at Piedmont, W. Va., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
July 8	Hoyt & Hall	115	158	0.73	2.80	116
September 9	E. C. Murphy	50	21	.62	1.99	13
September 28	do	47	27	.74	1.99	20

Mean daily gage height, in feet, of Potomac River (North Branch) at Piedmont, W. Va., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.90	3.20	4.70	4.70	4.45	3.95	3.00	2.35	1.90	2.00	2.00	2.10
2	2.95	3.05	4.55	5.25	4.20	3.85	3.10	2.55	1.90	2.00	2.00	2.05
3	3.00	3.10	4.85	4.75	3.95	3.80	3.05	2.40	2.00	2.05	2.05	2.20
4	3.55	3.05	5.55	4.35	3.85	3.70	2.85	2.40	1.85	2.00	2.10	2.30
5	3.10	3.05	4.40	4.15	3.75	3.80	2.70	2.40	2.00	1.95	2.10	2.20
6	2.95	3.10	4.20	4.00	3.65	3.90	2.65	2.35	2.10	1.95	2.00	2.20
7	3.15	6.20	4.65	3.90	3.60	3.75	2.70	2.25	1.90	2.00	2.10	2.25
8	3.00	6.10	5.55	3.90	3.50	3.60	2.80	2.20	1.90	2.15	2.10	2.20
9	2.90	4.70	4.70	4.30	3.50	3.50	2.80	2.05	1.95	2.10	2.10	2.05
10	2.80	4.05	4.30	4.15	3.60	3.60	3.45	2.15	2.10	2.10	2.10	2.00
11	2.80	3.80	4.25	3.95	3.45	3.50	3.20	2.20	2.00	2.15	2.20	2.10
12	2.80	3.60	4.30	3.85	3.35	3.40	3.05	2.20	2.00	2.20	2.20	2.10
13	2.70	3.25	4.05	3.85	3.20	3.25	2.90	2.20	2.00	2.40	2.20	2.20
14	2.70	3.35	3.95	3.70	3.20	3.20	2.80	2.20	2.00	2.25	2.20	2.30
15	2.60	3.45	3.85	3.70	3.40	3.20	2.70	2.15	2.05	2.20	2.20	2.30
16	2.60	3.25	3.65	3.75	3.40	3.00	2.60	2.15	2.10	2.15	2.20	2.30
17	2.60	3.05	3.55	3.90	3.20	3.10	2.50	2.20	2.10	2.10	2.20	2.30
18	3.15	3.00	3.85	3.80	3.70	3.00	2.45	2.10	2.10	2.05	2.20	2.30
19	3.00	3.10	3.95	3.70	5.95	2.90	2.35	2.10	2.10	2.10	2.30	2.30
20	2.95	3.00	4.40	3.60	5.00	3.00	2.35	2.15	2.00	2.10	2.30	2.30
21	3.80	3.20	4.50	3.50	5.00	3.05	2.50	2.20	2.10	2.20	2.30	2.30
22	[a]6.80	4.45	4.95	3.45	4.60	3.60	2.90	2.20	2.15	2.20	2.30	2.30
23	6.65	4.25	6.60	3.40	4.25	3.45	3.20	2.20	2.10	2.20	2.30	2.30
24	5.30	4.85	5.60	3.35	4.05	3.05	2.90	2.20	2.10	2.20	2.30	2.45
25	4.25	4.10	5.05	3.45	3.90	2.90	2.70	2.20	1.90	2.20	2.25	4.80
26	4.00	3.70	4.95	3.90	3.75	2.80	2.70	2.10	2.05	2.20	2.25	4.00
27	3.55	3.55	4.80	4.65	3.85	2.70	2.60	2.10	2.00	2.10	2.20	4.10
28	3.25	3.50	4.40	5.25	3.85	2.75	2.50	1.90	2.00	2.20	2.15	4.80
29	3.30	4.75	4.10	4.95	3.60	3.25	2.60	2.00	2.00	2.10	2.10	4.05
30	3.40	.....	4.00	4.55	3.50	3.05	2.50	2.00	2.00	2.00	2.10	3.20
31	3.25	.....	4.45	.....	3.50	.....	2.40	1.90	.....	2.10	.....	3.20

[a] Ice went out 1.05 p. m.

POTOMAC RIVER AT POINT OF ROCKS, MD.

This station was established by C. C. Babb, February 17, 1895, at the steel highway bridge at Point of Rocks, Md. As originally placed, the gage was located in the third span of the bridge from the north shore. The next year (1896) the wire became rusted and broke frequently, and a new wire gage was placed on the lower side of the first span of the bridge and referred to a different datum. During 1897 there was a further change in the length of the wire of the gage, which was not recorded, and therefore it has been necessary to discard the records during those two years—that is, 1896 and 1897. The length of the cable of the original wire gage was 44.22 feet. The measurements of 1895 are considered correct within themselves, but there was a difference between the datum of that gage and that of the present standard of 0.4 foot, making it necessary to deduct that amount from the gage readings of 1895 in order to reduce them to the present datum.

Since January 25, 1898, there has been no change in the datum of the gage. At that time it was referred to a bench mark, which is 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 and 41.75 feet above the datum of the gage. A second bench mark was established in July, 1904. It is a cross chiseled on the lower step of the upstream wing wall on the left bank of the river, being just across the towpath, 15 feet from the canal. Its elevation is 24 feet above gage datum.

A standard chain gage was installed at this station September 2, 1902, to take the place of the wire gage then in use. It is bolted to the guard rail on the lower side of the bridge in the second span from the left bank. The length of the chain from the end of the weight to the marker is 44.22 feet.

Discharge measurements are made from the eight span steel toll bridge to which the gage is attached. The initial point for soundings is the left end of the lower guard rail, 0.4 foot beyond the center of the end pin, on the downstream side of the bridge. The channel is straight for 500 feet above and 200 feet below the station. It is 1,300 feet wide, broken by 7 bridge piers. Both banks overflow only at extremely high water and are not wooded. In the two right spans the bed is composed of mud and is subject to some change; in the other spans the bed is composed of gravel and cobblestones and is permanent. The current does not flow at right angles with the bridge in all of the spans. The gage is read once each day by George H. Hickman.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Potomac River at Point of Rocks, Md., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per. sec.*	*Feet.*	*Second-feet.*
July 11	Hoyt and Grover	1,104	6,725	2.50	[a] 3.87	16,830

[a] Gage varied 0.82 during measurements.

Mean daily gage height, in feet, of Potomac River at Point of Rocks, Md., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.5	3.0	5.3	2.4	5.6	6.7	1.4	1.4	0.9	0.6	0.6	0.8
2	1.5	2.9	4.4	2.6	4.0	7.8	1.3	1.3	.8	.6	.6	.8
3	2.0	2.9	4.0	3.0	3.6	5.2	1.3	1.2	.8	.6	.7	.8
4	2.3	3.3	3.8	3.5	3.0	4.6	1.3	1.2	.8	.6	.7	.8
5	1.8	4.8	4.0	3.1	2.8	4.1	1.2	1.2	.9	.6	.7	.8
6	1.5	4.9	4.2	3.5	2.6	5.0	1.5	1.2	1.0	.6	.7	.8
7	1.5	4.9	4.5	3.0	2.5	4.4	1.5	1.3	.9	.6	.7	.8
8	1.5	3.3	5.0	2.4	2.8	4.0	1.6	1.4	.8	.6	.7	.8
9	1.6	3.5	4.8	2.3	2.7	3.6	1.6	1.5	.7	.5	.7	.8
10	1.6	5.7	5.4	2.3	2.6	3.2	1.7	1.4	.7	.5	.7	.9
11	1.6	5.0	4.5	2.6	2.5	2.8	2.9	1.3	.7	.5	.7	.9
12	1.7	3.9	3.8	3.1	2.5	2.6	2.6	1.3	.8	.6	.7	.9
13	1.6	3.6	3.3	2.8	2.4	2.5	3.4	1.2	1.0	.7	.7	.9
14	1.6	3.5	2.8	2.6	2.3	2.4	3.1	1.2	.9	.7	.8	.9
15	1.6	3.4	2.6	2.5	2.2	2.2	3.0	1.1	.9	.6	.8	.9
16	1.5	3.8	2.4	2.2	2.2	2.1	2.8	1.1	1.0	.6	.8	.9
17	1.5	3.8	2.4	2.1	2.1	2.0	2.4	1.1	1.0	.5	.7	.9
18	1.5	3.9	2.2	2.1	2.2	1.8	2.0	1.0	.9	.5	.8	.9
19	1.5	3.9	2.1	2.0	2.3	1.6	1.8	1.0	.8	.5	.8	.9
20	1.5	3.8	2.2	1.9	3.1	1.5	1.6	1.0	.7	.6	.8	1.0
21	1.5	3.8	2.3	1.9	6.2	1.5	1.4	1.0	.8	1.0	.7	1.0
22	2.0	4.5	2.4	1.8	4.7	2.5	1.4	.9	1.0	.9	.7	1.0
23	4.0	5.6	2.5	1.7	4.0	3.0	1.3	.9	.9	.8	.7	1.0
24	5.2	6.0	2.7	1.7	3.6	2.8	1.3	1.0	.8	.7	.7	1.0
25	[a] 7.4	6.6	3.7	1.6	3.1	2.5	1.3	1.0	.8	.7	.7	1.1
26	5.1	6.6	3.4	1.5	2.8	2.1	1.4	2.0	.8	.7	.7	1.4
27	3.6	7.6	3.0	1.6	2.5	1.7	1.4	1.1	.7	.7	.7	1.5
28	3.3	6.6	2.8	2.0	2.4	1.5	1.4	1.1	.7	.7	.7	1.8
29	3.2	6.0	2.6	3.7	2.3	1.5	1.5	1.0	.7	.6	.8	1.8
30	3.0	.....	2.5	6.3	2.2	1.4	1.5	1.0	.7	.6	.8	1.9
31	3.0	.....	2.4	.....	2.4	.....	1.5	.9	.....	.6	.....	2.0

[a] Ice gorge caused river to rise.

Rating table for Potomac River at Point of Rocks, Md., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.50	1,300	1.80	5,590	3.00	11,455	5.20	23,660
.60	1,345	1.90	6,070	3.10	11,950	5.40	24,970
.70	1,445	2.00	6,550	3.20	12,450	5.60	26,320
.80	1,640	2.10	7,035	3.40	13,470	5.80	27,710
.90	1,900	2.20	7,520	3.60	14,500	6.00	29,140
1.00	2,200	2.30	8,005	3.80	15,550	6.50	32,790
1.10	2,550	2.40	8,490	4.00	16,620	7.00	36,440
1.20	2,935	2.50	8,980	4.20	17,710	7.50	40,290
1.30	3,340	2.60	9,475	4.40	18,820	8.00	44,140
1.40	3,760	2.70	9,970	4.60	19,970	9.00	52,240
1.50	4,195	2.80	10,465	4.80	21,160	10.00	60,540
1.60	4,645	2.90	10,960	5.00	22,390	11.00	68,940
1.70	5,110						

The above table is applicable only for open-channel conditions. It is based upon discharge measurements made during 1900 to 1904, inclusive. It is not very well defined. Above gage height 10 feet the rating curve is a tangent, the difference being 840 per tenth.

Estimated monthly discharge of Potomac River at Point of Rocks, Md., for 1904.

[Drainage area, 9,654 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	39,520	4,195	8,757	0.907	1.05
February	41,060	10,960	20,180	2.09	2.25
March	24,970	7,035	13,460	1.39	1.60
April	31,330	4,195	9,270	.960	1.07
May	30,600	7,035	11,540	1.20	1.38
June	42,600	3,760	12,120	1.26	1.41
July	13,470	2,935	5,612	.581	.670
August	6,550	1,900	2,872	.297	.342
September	2,200	1,445	1,742	.180	.201
October	2,200	1,300	1,414	.146	.168
November	1,640	1,345	1,490	.154	.172
December	6,550	1,640	2,550	.264	.304
The year	42,600	1,300	7,584	.786	10.617

POTOMAC RIVER (SOUTH BRANCH) NEAR SPRINGFIELD, W. VA.

A gaging station was established at the Baltimore and Ohio Railroad bridge, 3 miles southwest of Springfield, by C. C. Babb, in April, 1894. This station was discontinued in 1896 for want of an observer. On June 26, 1899, a station was established by E. G. Paul at the highway bridge 1½ miles below the original station, near Grace Station. This bridge was carried away by flood in February, 1902. The present station was established August 28, 1903, by E. G. Paul. It is located at the steel highway bridge 2½ miles east of Springfield, W. Va. The bridge has two spans of 150 feet each. During high water the river flows beneath both spans, but at low stages the stream flows beneath the left span only. There is a dam located about 2 miles above the station, and a small island above and also one below. A standard chain gage is located in the center of the left span on the downstream side of the bridge. The length of chain from the end of the weight to the marker is 34.76 feet. Bench mark No. 1 is a nail in a large sycamore tree, 15 feet downstream from the left approach to the bridge. The nail is in the side of the tree away from the river and about 6 feet above the ground. Its elevation is 18.80 feet above gage datum. Bench mark No. 2 is a nail in a large willow tree on the left bank of the river, about 65 feet upstream from the bridge. It is in the side of the tree away from the river and about 2½ feet above the ground. Its elevation is 14.52 feet above gage datum. The initial point for soundings is the river face of the left abutment at the downstream side of the bridge. The channel is straight for several hundred feet above and below the station. Both banks are low and liable to overflow. The bed of the stream is of gravel. The gage is read twice each day by Miss Olivia Blue.

The observations at this station during 1904 have been under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Potomac River (South Branch) near Springfield, W. Va., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
July 9	Hoyt & Hall	143	312	.79	2.50	248
September 9	E. C. Murphy	122	211	.54	2.00	115
September 29	do	108	65	2.05	1.99	[a] 133

[a] Below regular station by wading.

Mean daily gage height, in feet, of Potomac River (South Branch) near Springfield, W. Va., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	a2.60	2.80	3.75	3.65	5.40	3.45	2.80	2.40	2.00	1.80	1.80	1.80
2	a2.60	2.80	4.60	4.05	4.85	3.50	2.65	2.50	2.00	1.80	1.80	1.80
3	a2.60	2.80	4.20	3.95	4.35	3.45	2.60	2.70	2.00	1.80	1.80	1.80
4	a2.60	2.70	4.35	3.70	4.15	3.40	2.60	2.80	2.00	1.80	1.80	1.90
5	a2.60	2.60	4.10	3.50	3.90	4.35	2.60	2.80	2.00	1.80	1.80	1.90
6	a2.60	2.60	3.65	3.35	3.65	4.30	2.50	2.60	2.00	1.85	1.80	1.90
7	a2.60	3.00	3.45	3.20	3.30	3.90	2.50	2.60	2.00	1.85	1.80	1.90
8	a2.60	b6.40	5.55	3.20	3.50	3.80	2.60	2.55	2.00	1.80	1.80	1.90
9	a2.60	4.85	5.60	3.15	3.40	3.35	2.50	2.50	2.10	1.80	1.80	1.95
10	a2.60	3.55	4.60	3.20	3.60	3.10	2.85	2.40	2.15	1.80	1.90	2.00
11	a2.60	3.20	4.05	3.30	3.40	2.95	4.50	2.30	2.10	1.80	1.90	2.00
12	a2.60	2.70	3.85	3.25	3.25	3.10	3.85	2.25	2.10	1.80	1.90	2.20
13	a2.60	2.85	3.65	3.20	3.10	3.10	3.50	2.20	2.10	1.80	1.90	2.20
14	a2.60	2.95	3.50	3.20	3.00	3.00	2.95	2.10	2.20	1.80	1.90	2.20
15	a2.60	3.05	3.35	3.00	3.00	2.70	2.85	2.10	2.15	1.80	1.90	2.20
16	a2.60	2.95	3.15	2.85	3.00	2.95	2.55	2.10	2.05	1.80	1.90	2.20
17	a2.60	2.90	3.10	2.80	3.00	2.85	2.45	2.00	2.00	1.80	1.80	2.20
18	2.60	2.65	3.10	3.00	3.25	3.10	2.50	2.00	2.00	1.80	1.80	2.20
19	2.60	2.95	3.10	3.00	8.05	3.00	2.55	2.00	2.00	1.80	1.80	a2.10
20	2.60	2.90	3.05	3.00	7.95	5.65	2.60	2.00	1.90	1.80	1.80	2.10
21	2.60	2.95	3.05	3.00	6.30	4.70	2.70	2.00	1.90	1.90	1.80	2.10
22	2.85	3.50	3.40	2.90	5.40	3.95	2.60	2.00	1.90	1.90	1.80	2.10
23	9.05	4.50	3.90	2.80	4.80	3.60	2.80	2.00	1.90	1.90	1.80	2.10
24	5.40	4.05	4.55	2.80	4.30	3.45	2.90	2.00	1.90	1.90	1.80	2.10
25	4.05	3.00	4.45	2.70	3.95	3.20	2.80	2.00	1.80	1.80	1.80	2.20
26	3.45	3.25	4.15	2.80	3.75	2.90	2.50	2.00	1.80	1.80	1.80	2.25
27	3.00	2.95	3.95	3.05	3.80	2.75	2.70	2.00	1.80	1.80	1.80	2.50
28	c2.90	2.95	3.80	8.60	4.20	2.55	2.60	1.90	1.80	1.80	1.80	2.85
29	2.65	2.95	3.45	8.10	3.65	2.75	2.50	2.10	1.80	1.80	1.80	3.50
30	2.75	.....	3.45	6.60	3.45	2.90	2.40	2.10	1.80	1.80	1.80	3.90
31	c2.90	.....	3.35	.....	3.45	.....	2.40	2.00	.....	1.80	.....	3.90

a Frozen over. b Ice going out. c Slush ice.

ANTIETAM CREEK NEAR SHARPSBURG, MD.

Antietam Creek 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 is largely cultivated. This station was established June 24, 1897, by A. P. Davis. It is located a few hundred feet below the bridge on the toll road from Sharpsburg to Keedysville, Md. There is an old dam, not now in use, just below the bridge. The gage is a vertical rod driven into the gravel of the stream bed and spiked to a tree on the left bank near the cable. The bench mark is a copper bolt set in a ledge of rock on the left bank, at a point about 125 feet above the cable. Its elevation is 16.34 feet above gage datum. Discharge measurements are made from a steel-wire cable, which is supported by the forks of sycamore trees on each bank and is anchored to timbers set in the ground. A tagged wire is suspended above the cable. The initial point for soundings is a staple in the tree on the left bank. The channel is straight for 300 feet above

and below the station. It has a width at ordinary stages of about 100 feet; is shallow and unobstructed. There is a good measurable velocity at all stages. The right bank is low and liable to overflow; the left bank is high and rocky, and both are fringed with trees. The bed of the stream is composed of gravel, free from vegetation, and is permanent. There is but one channel at all stages. The gage is read once each day by Charles E. Hammond, the toll gatherer.

The observations at this station during 1904 have been under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Antietam Creek near Sharpsburg, Md., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
July 1	Hoyt and Hall	85	154	1.03	1.79	158
July 11	Hoyt and Grover	90	159	.94	1.79	150

Mean daily gage height, in feet, of Antietam Creek near Sharpsburg, Md., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.90							1.60	1.50	1.45	1.50	1.45
2	1.90							1.60	1.50	1.45	1.50	1.45
3	1.75							1.80	1.50	1.40	1.45	1.45
4	2.10							1.65	1.60	1.55	1.50	1.45
5	1.90							1.60	1.55	1.50	1.50	1.40
6	1.90							1.60	1.50	1.45	1.45	1.50
7	1.80							1.60	1.45	1.50	1.40	1.45
8	1.80							1.50	1.55	1.45	1.50	1.45
9	1.80							1.50	1.45	1.45	1.50	1.45
10	1.85							1.50	1.85	1.50	1.50	1.50
11	1.85							3.00	1.60	1.50	1.50	1.55
12	1.90						2.20	1.80	1.55	1.50	1.50	1.40
13	1.85						2.20	1.65	1.50	1.75	1.60	1.60
14	1.85						1.90	1.55	1.65	1.60	1.50	1.50
15	1.70						1.75	1.60	1.65	1.50	1.65	1.45
16	1.70						1.70	1.60	1.80	1.45	1.50	1.55
17	1.70						1.70	1.60	1.60	1.40	1.50	1.55
18	1.80						1.70	1.60	1.50	1.50	1.40	1.55
19	1.80						1.70	1.65	1.40	1.50	1.40	1.55
20	1.80						1.60	1.60	1.65	1.50	1.50	1.60
21	1.85						1.65	1.60	1.60	1.65	1.50	1.65
22	3.90						1.60	1.60	1.60	1.95	1.55	1.65
23	[a]6.00						1.70	1.85	1.55	1.65	1.55	1.55
24							1.75	1.75	1.50	1.60	1.50	1.60
25							1.85	1.60	1.45	1.50	1.55	1.65
26							1.70	1.60	1.50	1.55	1.50	1.75
27							1.60	1.55	1.55	1.50	1.45	1.70
28							1.60	1.45	1.50	1.50	1.35	1.80
29							1.85	1.50	1.50	1.55	1.45	2.15
30							1.70	1.50	1.45	1.45	1.50	2.05
31							1.60	1.50		1.50		1.75

[a] Ice carried gage away; reestablished July 12.

Rating table for Antietam Creek near Sharpsburg, Md., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.35	90	2.30	298	3.30	720	4.30	1,270
1.40	95	2.40	332	3.40	775	4.40	1,325
1.50	108	2.50	367	3.50	830	4.50	1,380
1.60	121	2.60	402	3.60	885	4.60	1,435
1.70	137	2.70	440	3.70	940	4.70	1,490
1.80	155	2.80	482	3.80	995	4.80	1,545
1.90	179	2.90	525	3.90	1,050	5.00	1,655
2.00	206	3.00	570	4.00	1,105	6.00	2,205
2.10	234	3.10	615	4.10	1,160	7.00	2,755
2.20	265	3.20	665	4.20	1,215		

The above table is applicable only for open-channel conditions. It is based upon 12 discharge measurements made during 1898 to 1904, inclusive. It is well defined between gage heights 1.60 feet and 3.50 feet. The table has been extended beyond these limits. Above gage height 3.20 feet the rating curve is a tangent, the difference being 55 per tenth.

Estimated monthly discharge of Antietam Creek near Sharpsburg, Md., for 1904.

[Drainage area, 293 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January 1–23	2,205	137	292	0.997	0.853
July 12–31	265	121	151	.515	.383
August	570	102	137	.468	.540
September	167	95	116	.396	.442
October	193	95	113	.386	.445
November	129	90	107	.365	.407
December	250	95	123	.420	.484

SHENANDOAH RIVER AT MILLVILLE, W. VA.

This station was established April 15, 1895, by C. C. Babb. It is located about one-fourth mile above the Baltimore and Ohio Railroad station at Millville, W. Va. It is best reached by driving from Harpers Ferry, W. Va. The vertical gage is spiked to a large sycamore tree on the left bank a few hundred feet downstream from the cable.

Bench mark No. 1 is a copper plug in the upstream side of the base of the second tree downstream from the gage. Its elevation is 6.68 feet above the zero of the gage. Bench mark No. 2 is the upper surface of the head of a wire nail driven horizontally in a blaze on the base of the first tree upstream from the gage. Its elevation is 7.42 feet above the zero of the gage. Bench mark No. 3 is the upper surface of the head of a wire spike driven in a blaze on the tree to which the gage is fastened on the side away from the river; elevation 9.43 feet. Discharge measurements are made from a three-fourths inch cable from which is suspended a car. The cable, which is suspended over the branches of two large sycamore trees and is securely anchored to the bank at both ends, has a total span of 500 feet. The initial point for soundings is the side of a tree nearest the river at the cable on the left bank. The channel is straight for several hundred feet above and below the station, and the current is swift and unobstructed. Both banks are low, liable to overflow, and are without trees. There is but one channel at all stages. The bed of the stream is composed of mud and rocks. The gage is read once each day by W. R. Nicewarner, the railroad station agent.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Shenandoah River at Millville, W. Va., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
June 13	F. H. Brundage	500	1,771	1.06	1.70	1,883
July 4	Hoyt and Hall	505	1,578	.72	1.20	1,137
July 10	Hoyt and Grover	499	1,561	.88	1.34	1,371
September 28	E. C. Murphy	490	1,147	.49	.50	564
October 20	do	485	1,126	.44	.41	494

Mean daily gage height, in feet, of Shenandoah River at Millville, W. Va., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.80	(a)	(a)	1.80	3.30	4.00	1.50	1.15	0.60	0.45	0.45	0.45
2	.85	(a)	(a)	1.80	3.30	2.60	1.40	1.05	.60	.40	.45	.45
3	1.20	(a)	(a)	1.75	2.70	2.33	1.30	1.10	.60	.40	.40	.50
4	1.20	(a)	(a)	1.70	2.40	2.10	1.20	1.25	.60	.40	.50	.50
5	1.00	(a)	(a)	1.60	2.15	2.60	1.10	1.40	.60	.40	.45	.50
6	1.00	(a)	(a)	1.50	2.10	2.85	1.20	1.40	.60	.40	.45	.55
7	1.10	(a)	(a)	1.50	1.95	4.00	1.15	1.70	.60	.45	.45	.50
8	1.10	(a)	2.30	1.50	2.00	2.90	1.30	1.80	.60	.45	.45	.50
9	1.30	(a)	4.90	1.60	2.00	2.40	1.25	1.45	.55	.40	.40	.50
10	1.20	(a)	3.50	1.70	2.30	2.15	1.35	1.40	.55	.40	.40	.50
11	1.20	(a)	3.00	2.45	2.50	2.00	5.60	1.35	.50	.40	.50	.85

a No observation, gage broken down by ice.

Mean daily gage height, in feet, of Shenandoah River at Millville, W. Va., for 1904—Con.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
12	1.10	(a)	2.50	2.40	2.45	1.85	3.70	1.40	0.50	0.50	0.45	0.50
13	1.10	(a)	2.30	2.20	2.30	1.75	2.80	1.35	.60	.50	.50	.65
14	1.00	(a)	2.00	2.00	2.05	1.50	2.10	1.30	.60	.55	.60	.65
15	1.00	(a)	1.90	1.75	1.90	1.40	1.75	1.10	.90	.50	.60	.75
16	1.00	(a)	1.80	1.65	1.85	1.35	1.50	1.05	.90	.50	.50	.60
17	1.00	(a)	1.75	1.60	1.80	1.40	1.40	1.00	.80	.50	.50	1.65
18	1.00	(a)	1.70	1.55	1.80	1.65	1.30	1.00	.75	.50	.50	1.80
19	1.00	(a)	1.60	1.45	1.90	1.40	1.30	.95	.70	.50	.55	1.55
20	1.10	(a)	1.50	1.45	2.30	1.35	1.20	.90	.65	.45	.50	.80
21	1.30	(a)	1.45	1.30	3.50	1.60	1.20	.90	.60	.60	.50	.70
22	1.60	(a)	1.50	1.25	2.95	1.70	1.20	.85	.65	.60	.50	.70
23	2.30	(a)	1.60	1.20	2.45	1.90	1.15	.90	.60	.60	.50	.70
24	2.60	(a)	1.60	1.15	2.15	1.60	1.10	.80	.55	.55	.50	.70
25	(a)	(a)	1.65	1.10	2.00	1.45	1.20	.90	.50	.50	.50	.80
26	(a)	(a)	1.80	1.10	1.95	1.30	1.30	.80	.50	.50	.45	1.15
27	(a)	(a)	1.85	1.30	2.30	1.20	1.20	.75	.50	.45	.45	1.10
28	(a)	(a)	1.80	2.50	1.95	1.15	1.10	.70	.50	.40	.45	1.30
29	(a)	(a)	1.75	4.30	1.70	1.10	1.10	.60	.50	.40	.45	2.25
30	(a)	.....	1.70	3.85	1.70	1.60	1.25	.55	.45	.40	.45	1.20
31	(a)	.....	1.70	.....	1.55	.....	1.10	.60	.....	.40	.....	1.10

a No observation, gage broken down by ice.

The gage heights were affected by ice conditions during latter half of December.

Rating table for Shenandoah River at Millville, W. Va., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.40	475	1.70	1,865	3.00	4,560	4.30	8,105
.50	540	1.80	2,025	3.10	4,805	4.40	8,415
.60	610	1.90	2,200	3.20	5,055	4.50	8,730
.70	685	2.00	2,395	3.30	5,305	4.60	9,045
.80	765	2.10	2,590	3.40	5,560	4.70	9,360
.90	850	2.20	2,790	3.50	5,820	4.80	9,680
1.00	945	2.30	2,990	3.60	6,085	4.90	10,000
1.10	1,055	2.40	3,200	3.70	6,355	5.00	10,320
1.20	1,170	2.50	3,410	3.80	6,630	6.00	13,520
1.30	1,295	2.60	3,630	3.90	6,910	7.00	16,720
1.40	1,430	2.70	3,860	4.00	7,195	8.00	19,920
1.50	1,570	2.80	4,090	4.10	7,490	9.00	23,120
1.60	1,715	2.90	4,320	4.20	7,795		

The above table is applicable only for open-channel conditions. It is based upon discharge measurements made during 1895 to 1904, inclusive, special weight being given to 1904 measurements. It is fairly well defined between gage heights 0.40 feet and 7 feet. The table has been extended beyond these limits. Above gage height 4.70 feet the rating curve is a tangent, the difference being 320 per tenth.

Estimated monthly discharge of Shenandoah River at Millville, W. Va., for 1904.

[Drainage area, 2,995 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January 1–24	3,630	765	1,251	0.418	0.373
March 8–31	10,000	1,500	2,651	.885	.790
April	8,105	1,055	2,205	.736	.821
May	5,820	1,643	2,916	.974	1.12
June	7,195	1,055	2,463	.822	.917
July	12,240	1,055	1,910	.638	.736
August	2,025	575	1,075	.359	.414
September	850	508	617	.206	.230
October	610	475	519	.173	.199
November	610	475	527	.176	.196
December	2,890	508	892	.298	.344

SHENANDOAH RIVER (SOUTH BRANCH) NEAR FRONT ROYAL, VA.

This station was established June 26, 1899, by A. P. Davis. It is located about 1 mile above the ford, which is near the Norfolk and Western Railroad station. This railroad follows the right bank of the stream. The gage is a vertical timber spiked to a large sycamore tree on the left bank about 800 feet upstream from the cable. Bench mark No. 1 is a headless spike on the river side of an elm tree on the left bank, 8 feet downstream from the gage. It is 1½ feet above ground and has an elevation of 10.49 feet above the zero of the gage. Bench mark No. 2 is nail driven horizontally into the downstream side of the stump of a large sycamore tree 270 feet downstream from the gage. It is 0.5 foot above the ground and is immediately below a blaze. Its elevation is 14.55 feet above the zero of the gage. Discharge measurements are made from a cable, which has a span of 300 feet and is suspended over the branches of two large sycamore trees, with its right end fastened to the tree and its left end anchored in the ground. The initial point for soundings is on the main cable 0.5 foot from the tree on the left bank. The channel is straight for 600 feet above and below the station and the current is sluggish. The river may overflow the right bank, but will not overflow the railroad embankment a few feet back from the river, except at extreme flood stages. The left bank is low, liable to overflow, and is fringed with trees. The bed of the stream is composed partly of rock and partly of sand, and is liable to shift in places. The gage is read twice each day by Miss Brentie Johnson.

Between January 25 and June 30, 1904, the stage of river was observed by means of temporary gages set by the observer, and consequently the record between those dates is approximate.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Shenandoah River (South Branch) near Front Royal, Va., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
June 11	F. H. Brundage	310	846	1.35	4.79	1,140
June 30	Hoyt and Hall	310	936	.97	4.55	906
September 27	E. C. Murphy	274	509	.77	3.50	390
October 19	do	275	516	.64	3.42	331

Mean daily gage, in feet, of Shenandoah River (South Branch) near Front Royal, Va., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.44	5.69	4.84	5.19	6.39	4.94	4.50	4.10	3.60	3.40	3.42	3.45
2	6.24	5.59	4.84	5.04	5.84	5.04	4.40	4.05	3.60	3.40	3.40	3.39
3	6.24	5.79	5.04	4.84	5.44	5.29	4.30	4.10	3.60	3.40	3.40	3.50
4	6.54	5.74	4.94	4.69	5.14	6.19	4.20	4.30	3.60	3.40	3.40	a3.50
5	6.54	5.74	5.04	4.64	5.09	6.44	4.10	4.40	3.60	3.40	3.42	3.50
6	6.29	5.49	4.99	4.59	4.99	6.49	4.10	4.50	3.65	3.40	3.40	3.45
7	6.19	5.54	5.04	4.59	4.99	5.99	4.05	4.70	3.70	3.40	3.43	3.41
8	6.09	6.34	6.29	4.59	4.99	5.39	4.00	4.45	3.70	3.40	3.45	3.45
9	6.04	6.14	6.39	4.69	5.14	5.04	4.20	4.40	3.70	3.40	3.50	3.45
10	5.94	6.34	6.69	5.24	5.69	4.94	5.50	4.75	3.70	3.40	3.42	3.51
11	5.89	6.34	5.99	5.74	5.84	4.74	7.90	4.60	3.70	3.40	3.40	4.15
12	5.99	6.19	5.74	5.69	5.64	4.69	7.40	4.50	3.70	3.45	3.40	b4.40
13	5.99	5.09	5.54	5.34	5.34	4.64	5.40	4.40	3.70	3.55	3.40	4.60
14	6.04	5.99	5.19	5.14	5.24	4.54	4.75	4.20	3.65	3.45	3.55	4.80
15	5.89	5.89	5.09	4.94	4.89	4.49	4.55	4.15	4.20	3.40	3.50	3.95
16	5.74	5.89	4.99	4.84	4.89	4.39	4.40	4.10	3.95	3.40	3.52	4.10
17	5.74	5.84	4.89	4.79	4.89	4.59	4.35	4.00	3.70	3.40	3.50	4.10
18	5.79	5.89	4.89	4.64	5.29	4.64	4.30	4.00	3.60	3.40	3.45	4.20
19	5.89	5.09	4.89	3.54	5.69	4.39	4.35	3.90	3.60	3.40	3.45	3.90
20	5.84	6.24	4.69	4.49	7.59	4.54	4.25	3.80	3.60	3.45	3.40	3.90
21	5.84	6.34	4.69	4.49	6.74	4.99	4.10	3.80	3.50	3.55	3.42	3.70
22	6.39	6.89	4.69	4.39	5.89	5.14	4.10	3.75	3.50	3.50	3.40	3.70
23	8.24	8.39	4.94	4.39	5.44	5.04	4.00	3.65	3.50	3.45	3.43	3.87
24	9.64	8.64	4.94	4.29	5.24	4.74	4.30	3.60	3.50	3.40	3.43	3.95
25	7.24	7.69	4.94	4.39	5.09	4.39	4.40	3.60	3.50	3.40	3.42	3.90
26	6.54	6.14	5.04	4.44	4.99	4.29	4.30	3.55	3.50	3.40	3.40	3.80
27	6.29	6.34	5.09	5.49	4.94	4.34	4.20	3.50	3.40	3.42	3.40	3.95
28	6.14	5.74	5.09	6.24	4.89	4.39	4.35	3.50	3.40	3.40	3.40	3.90
29	5.94	5.19	4.99	6.79	4.89	4.69	4.15	3.50	3.40	3.40	3.40	4.50
30	5.84	.....	5.24	6.64	4.79	4.52	4.20	3.55	3.40	3.40	3.40	4.20
31	5.74	.....	5.29	.....	4.79	.....	4.20	3.60	.....	3.40	.....	4.00

a Ice running in river. b River frozen entirely across.

Gage heights are approximate from January 25 to March 1.

Rating table for Shenandoah River (South Branch) near Front Royal, Va., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.30	305	4.70	1,045	6.10	2,665	7.50	5,080
3.40	330	4.80	1,130	6.20	2,815	7.60	5,260
3.50	359	4.90	1,220	6.30	2,970	7.70	5,440
3.60	392	5.00	1,315	6.40	3,130	7.80	5,620
3.70	429	5.10	1,420	6.50	3,295	7.90	5,800
3.80	470	5.20	1,530	6.60	3,465	8.00	5,980
3.90	515	5.30	1,640	6.70	3,640	8.20	6,340
4.00	565	5.40	1,755	6.80	3,820	8.40	6,700
4.10	615	5.50	1,870	6.90	4,000	8.60	7,060
4.20	670	5.60	1,990	7.00	4,180	8.80	7,420
4.30	735	5.70	2,115	7.10	4,360	9.00	7,780
4.40	805	5.80	2,245	7.20	4,540	9.50	8,680
4.50	880	5.90	2,380	7.30	4,720	10.00	9,580
4.60	960	6.00	2,520	7.40	4,900		

The above table is applicable only for open-channel conditions. It is based upon seven discharge measurements made during 1900 to 1904, inclusive. It is well defined between gage heights 3.40 feet and 8 feet. The table has been extended beyond these limits. Above gage height 7 feet the rating curve is a tangent, the difference being 180 per tenth.

Estimated monthly discharge of Shenandoah River (South Branch) near Front Royal, Va., for 1904.

[Drainage area, 1,569 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	8,932	2,167	3,031	1.93	2.23
February	7,132	1,410	2,840	1.81	1.95
March	3,623	1,037	1,571	1.00	1.15
April	3,802	728	1,403	.894	.997
May	5,242	1,122	1,802	1.15	1.33
June	3,279	728	1,332	.849	.947
July	5,800	565	1,089	.694	.800
August	1,088	359	614	.391	.451
September	670	330	402	.256	.286
October	376	330	336	.214	.247
November	376	330	339	.216	.241
December	1,130	328	534	.340	.392
The year	8,932	328	1,274	.812	11.02

SHENANDOAH RIVER (NORTH BRANCH) NEAR RIVERTON, VA.

This station was established June 26, 1899, by A. P. Davis. It is located about 2 miles above Riverton, Va., a short distance from the Southern Railway station. It is most easily reached by driving from Front Royal, Va. The vertical gage rod is spiked to timber and to a sycamore tree on the left bank about 100 feet above the cable station. Bench mark No. 1 is a wire nail driven into a pear tree and is located near the fence and 150 feet from the left bank of the river. Its elevation above the zero of the gage is 26.75 feet. Bench mark No. 2 is formed by three wire nails driven flush in the surface of a stump 50 feet downstream from the fence line of the road, at the edge of the field, on the side toward the river. Its elevation is 20.44 feet above the zero of the gage. The original gage was a vertical timber bolted to a large sycamore tree on the right bank. On September 10, 1900, the gage was moved to the left bank and its datum was lowered 1 foot, causing all readings to be increased by 1 foot. The gage at this station washed out in the flood of February 22, 1902, and the station was temporarily abandoned until August 17, 1902, when it was reestablished by E. G. Paul, the zero of the new gage being at the same elevation as the zero of the former gage. Discharge measurements are made by means of a cable, car, and tagged wire just above the ford. The cable has a span of 260 feet, is supported by timbers, and anchored in the ground at each end. The initial point for soundings is 0.5 foot from the timber which supports the tag wire on the left bank. The channel is straight for 600 feet above and below the station. The current has a moderate velocity. Both banks are low and liable to overflow, with a fringe of trees along each bank. The bed of the stream is rocky, permanent, and free from vegetation. There is but one channel at all stages. The gage is read twice each day by L. W. Burke.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Shenandoah River (North Branch) near Riverton, Va., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
June 10	F. H. Brundage	232	417	1.39	4.81	578
July 1	Hoyt and Hall	235	425	1.13	4.71	[a] 480
September 27	E. C. Murphy	234	240	.39	3.95	93
October 19	do	235	292	.45	4.11	130

[a] Average of two measurements.

Mean daily gage height, in feet, of Shenandoah River (North Branch) near Riverton, Va., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	[a] 4.20	.....	.....	4.88	5.85	5.65	4.72	4.30	4.10	4.05	4.00	4.02
2	[a] 4.20	.....	.....	5.00	5.70	5.05	4.50	4.45	4.05	4.00	4.00	4.05
3	[a] 4.20	.....	.....	4.98	5.40	4.85	4.38	4.40	4.15	3.95	4.05	4.10
4	[a] 4.20	.....	.....	4.88	5.10	4.80	4.30	4.50	4.15	4.00	4.05	4.10
5	[a] 4.20	.....	[b] 4.70	4.80	5.05	4.85	4.35	4.50	4.10	4.10	4.00	4.10
6	[a] 4.20	.....	4.65	4.72	5.00	6.05	4.35	4.80	4.05	4.10	4.05	4.20
7	[a] 4.20	.....	4.70	4.72	4.90	6.70	4.32	4.50	4.05	4.00	4.05	4.20
8	[a] 4.20	.....	6.20	4.70	4.90	5.30	4.35	4.50	4.10	4.05	4.00	4.10
9	[a] 4.20	.....	6.20	4.75	4.90	4.95	4.40	4.45	4.05	4.00	4.00	4.10
10	[a] 4.20	.....	5.60	5.10	5.00	4.80	6.15	4.38	4.10	4.00	4.10	4.15
11	[a] 4.20	.....	5.15	5.38	4.95	4.72	6.82	4.40	4.10	4.00	4.10	4.20
12	[a] 4.20	.....	5.00	5.15	4.90	4.60	6.00	4.35	4.10	4.10	4.05	[d] 4.50
13	[a] 4.20	.....	4.90	5.00	4.80	4.50	5.75	4.35	4.05	4.00	4.10	4.50
14	[a] 4.20	.....	4.80	4.90	4.80	4.50	5.10	4.30	4.20	4.05	4.10	4.50
15	[a] 4.20	.....	4.78	4.80	4.75	4.40	4.85	4.20	4.20	4.00	4.05	4.50
16	[a] 4.20	.....	4.70	4.72	4.80	4.45	4.70	4.30	4.15	4.05	4.10	4.50
17	[a] 4.20	.....	4.70	4.65	4.70	4.45	4.60	4.20	4.15	4.05	4.10	4.50
18	[a] 4.20	.....	4.68	4.55	4.70	4.42	4.55	4.22	4.10	4.05	3.98	4.50
19	[a] 4.20	.....	4.60	4.58	4.78	4.50	4.50	4.20	4.10	4.00	4.00	4.50
20	[a] 4.20	.....	4.52	4.50	6.45	4.75	4.70	4.22	4.05	4.05	4.00	4.50
21	[a] 4.20	.....	4.55	4.45	5.70	5.25	4.55	4.20	4.25	4.05	4.00	4.50
22	[a] 4.20	.....	4.52	4.48	5.35	5.30	4.40	4.20	4.10	4.00	4.10	4.50
23	[c] 4.20	.....	4.65	4.40	5.15	4.85	4.38	4.30	4.05	4.10	4.10	4.50
24	.....	.....	4.75	4.40	4.95	4.62	4.35	4.35	4.10	4.10	4.10	4.50
25	.....	.....	4.80	4.38	4.78	4.45	4.50	4.20	4.00	4.00	4.02	4.50
26	.....	.....	4.80	4.50	5.15	4.40	4.50	4.25	4.00	4.10	4.00	4.55
27	.....	.....	4.80	4.60	4.95	4.35	4.40	4.20	3.98	4.05	4.05	4.60
28	.....	.....	4.78	6.00	4.80	4.40	4.40	4.20	4.05	4.05	4.00	4.65
29	.....	.....	4.70	7.05	4.70	4.38	4.65	4.10	4.05	4.10	4.05	4.46
30	.....	.....	4.70	6.40	4.60	4.75	4.55	4.10	4.10	4.02	4.10	4.45
31	.....	.....	4.78	.....	4.80	.....	4.45	4.15	.....	4.05	.....	4.35

[a] Frozen up.
[b] The gage was put back March 5, just as it was before, and read from that date.
[c] Ice breaking up.
[d] River frozen Dec. 12 to 25.

MONOCACY RIVER NEAR FREDERICK, MD.

This station was established August 4, 1896, by E. G. Paul, and is located at the county bridge on the toll road leading from Frederick to Mount Pleasant, Md. It is 4 miles northeast of Frederick, about 2,000 feet above the mouth of Israel Creek, and 3,000 feet below the mouth of Tuscarora Creek. The original wire gage has been replaced by a standard chain gage, which is located in the middle of the first span from the right bank and is attached to the bridge floor on the lower side of the bridge. The length of the chain from the end of the weight to the marker is 35.20 feet. The bench mark is a hole drilled in the top of a coping stone on the lower wing of the right abutment, about 100 feet back from the initial point for soundings. Its elevation is 29.17 feet above gage datum. Discharge measurements are made

from the two-span iron highway bridge. The initial point for soundings is a cross cut in the face of the parapet wall on the lower wing of the right abutment. The channel is straight for 300 feet above and 100 feet below the bridge. The bridge has a total span of 310 feet. The channel at this point is 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 and the left from the upper side of the bridge, as these are better than a continuous section on either side of the bridge. The pier and island obstruct the flow to some extent, causing dead water for 20 feet to the right of the pier at low water and eddies at high water. Both banks are low, liable to overflow, and covered with a fringe of trees, but all water passes beneath the bridge. The bed is composed of gravel and cobblestones, except near the banks, where it is composed of silt and is subject to change. The gage is read twice each day by E. L. Derr.

The observations of this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Monocacy River near Frederick, Md., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
July 12	Hoyt and Grover	172	384	1.24	5.18	475
September 26	N. C. Grover	195	184	0.54	3.71	100
October 20[a]	E. C. Murphy	56	55	1.78	3.67	98

[a] Made above bridge by wading.

Mean daily gage height, in feet, of Monocacy River near Frederick, Md., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.6	4.9	8.1	5.8	4.9	7.4	4.4	4.2	3.8	3.7	3.7	3.7
2	4.9	4.9	7.5	7.2	4.7	6.4	4.3	4.9	3.8	3.7	3.7	3.7
3	4.8	5.4	6.1	6.4	4.7	5.9	4.2	4.7	3.8	3.6	3.7	3.7
4	[a]5.5	4.9	6.2	5.4	4.7	5.3	4.2	4.5	3.8	3.6	3.7	3.7
5	[a]5.1	4.6	5.9	5.4	4.7	7.3	4.1	4.3	3.8	3.5	3.7	3.7
6	[a]4.9	4.6	5.9	5.4	4.7	6.9	4.1	4.0	3.9	3.5	3.7	3.7
7	[a]4.7	8.2	17.0	5.4	4.7	6.8	4.4	4.0	3.9	3.5	3.7	3.7
8	[a]4.6	[b]14.2	[c]17.2	5.6	4.9	5.6	6.1	4.2	3.9	3.5	3.7	3.7
9	[a]4.6	6.4	8.1	7.7	4.9	5.4	7.1	4.5	3.9	3.5	3.7	3.7
10	[a]4.6	6.1	6.5	7.2	5.7	5.1	8.1	4.5	4.9	3.5	3.9	3.9
11	[a]4.6	5.9	6.6	6.3	5.4	5.3	7.2	[d]12.6	5.2	3.5	3.8	4.0
12	[a]4.6	5.4	6.9	5.9	4.7	5.1	6.1	5.6	4.9	3.6	3.8	4.0
13	[a]4.6	5.1	6.2	5.6	4.7	4.9	7.4	4.6	4.8	5.7	3.9	4.0
14	[a]4.6	[a]4.9	5.9	5.3	4.7	4.7	6.4	4.2	4.8	5.2	4.2	4.0
15	[a]4.6	[a]4.9	5.7	5.1	5.0	4.5	5.2	4.2	4.7	4.6	4.1	4.0
16	[a]4.6	[a]4.9	5.6	5.1	4.9	4.5	4.2	4.1	4.7	3.8	4.0	4.0
17	[a]4.5	[a]4.9	5.6	5.0	4.8	4.5	4.1	4.1	4.6	3.7	4.0	4.0

[a] Frozen at gage.
[b] Due to thawing.
[c] Thaw. Maximum gage height, 22.9, due to rain.
[d] Rain.

Mean daily gage height, in feet, of Monocacy River near Frederick, Md., for 1904— Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
18	a 4.5	a 4.9	5.5	4.9	4.8	4.5	4.1	4.0	4.6	3.6	3.9	4.0
19	a 4.5	a 4.9	5.5	4.8	5.2	4.5	4.1	4.0	4.6	3.6	3.9	4.0
20	a 4.5	a 4.9	5.8	4.8	5.1	b 9.7	4.0	4.2	5.6	3.6	3.9	4.0
21	a 4.5	a 4.9	6.1	4.7	4.9	7.3	4.0	4.7	5.2	3.7	3.8	4.0
22	a 4.5	c 13.8	6.5	4.6	4.7	5.9	4.0	4.7	4.9	4.8	3.8	4.0
23	c 19.9	12.2	6.8	4.6	4.6	4.8	4.0	4.6	4.6	4.4	3.8	4.0
24	11.5	9.0	6.1	4.6	4.5	4.5	5.1	4.5	4.4	4.1	3.8	4.2
25	6.1	6.8	5.9	4.6	4.4	4.3	5.1	4.2	3.9	3.9	3.8	4.4
26	5.9	5.1	5.7	4.7	4.4	4.2	5.1	4.2	3.7	3.8	3.8	5.1
27	4.6	4.9	5.6	4.9	4.4	4.1	5.1	4.1	3.9	3.8	3.8	b 6.5
28	4.6	4.8	5.4	5.3	4.4	4.1	5.0	3.9	4.1	3.7	3.7	9.2
29	5.5	4.8	5.2	5.2	4.3	4.2	4.9	3.8	3.9	3.7	3.7	8.9
30	6.1	.....	5.1	5.1	4.3	4.2	4.4	3.8	3.7	3.7	3.7	7.5
31	5.9	.....	5.4	.....	4.5	.....	4.2	3.8	.....	3.7	.....	5.5

a Frozen at gage. b Rain. c Ice broke.

Rating table for Monocacy River near Frederick, Md., from January 1, 1902, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.50	73	4.90	460	6.60	1,420	14.00	7,340
3.60	86	5.00	500	6.80	1,580	15.00	8,140
3.70	101	5.10	540	7.00	1,740	16.00	8,940
3.80	118	5.20	580	7.20	1,900	17.00	9,740
3.90	137	5.30	630	7.40	2,060	18.00	10,540
4.00	158	5.40	680	7.60	2,220	19.00	11,340
4.10	181	5.50	730	7.80	2,380	20.00	12,140
4.20	207	5.60	780	8.00	2,540	21.00	12,940
4.30	235	5.70	835	8.50	2,940	22.00	13,740
4.40	268	5.80	890	9.00	3,340	23.00	14,540
4.50	303	5.90	945	10.00	4,140	24.00	15,340
4.60	340	6.00	1,000	11.00	4,940	25.00	16,140
4.70	380	6.20	1,120	12.00	5,740		
4.80	420	6.40	1,260	13.00	6,540		

The above table is applicable only for open-channel conditions. It is based upon 26 discharge measurements made during 1896–1904. It is well defined between gage heights 3.65 feet and 10 feet. The table has been extended beyond these limits. Above gage height 6.50 feet the rating curve is a tangent, the difference being 80 per tenth.

Estimated monthly discharge of Monocacy River near Frederick, Md., for 1904.

[Drainage area, 665 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	12,060	305	1,001	1.51	1.74
February	7,460	340	1,409	2.12	2.29
March	9,900	540	1,690	2.54	2.93
April	2,300	340	750	1.13	1.26
May	835	235	405	.609	.702
June	3,900	181	814	1.22	1.36
July	2,620	158	610	.917	1.06
August	6,220	118	447	.672	.775
September	780	101	283	.426	.475
October	835	73	160	.241	.278
November	207	101	122	.183	.204
December	3,500	101	487	.732	.844
The year	12,060	73	682	1.02	13.918

JAMES RIVER DRAINAGE BASIN.

The headwaters of James River lie in the high mountains in the extreme western part of Virginia. It is formed by the confluence of Jackson and Cowpasture rivers in the extreme northern part of Botetourt County, Va., thence it flows easterly across the State and empties into Chesapeake Bay through Hampton Roads.

The river with all of its tributaries lies wholly in Virginia. Its total length is about 335 miles and its total drainage area about 9,700 square miles. The basin is varied in character, changing from the mountainous section in the upper part to low, flat, and often swampy areas as tide water is approached. Jackson and Cowpasture rivers flow from narrow valleys between steep hills over beds of sand and gravel with rock ledges in places, and are bordered with fertile bottom lands. In this portion of the basin the water collects quickly, causing rapid rises in the river below. The James, cutting as it does through the ridges of the mountains, flows alternately across fertile valleys with a gentle current and through breaks in the ridges with rocky and precipitous banks, the fall in these localities being often considerable. It crosses the fall line at Richmond.

Near Clifton Forge and again near Balcony Falls the James flows through ridges of the Alleghenies, with sharp falls over beds of solid rock. At other points similar though less pronounced falls and rapids

occur, as the river cuts through the lesser foothills. Between these mountainous or hilly sections the flow is through broad and fertile valleys over sand and gravelly beds with gentle slope. The fall line is finally crossed at Richmond. A considerable number of dams have been built in the river, generally for diverting water into the old James and Kanawha canal, which followed the river from Richmond to Buchanan, and was at one time utilized throughout that entire distance. The use of this canal has now been abandoned, however, and its right of way is owned and for considerable distances occupied by the Chesapeake and Ohio Railroad. The use of the dams was abandoned with the canal, and in many instances they have not been utilized for power purposes although in good repair.

The principal utilized power on the river is at Richmond. Fluctuations in stage are great. The record of gage height at Cartersville, Va., which extends over a period of five years, shows a range in gage height of nearly 25 feet. The estimated discharge has varied between 75,000 and 500 cubic feet per second.

Prof. D. C. Humphrey made a survey of the river from Richmond to Cliftonforge in 1897, and the profile developed by him was published in Part IV of the Nineteenth Annual Report of the United States Geological Survey, pages 162–173.

Gages were established on James River in 1893 by 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 Cliftonforge. 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 were resumed, excepting at Scottsville, Balcony Falls, and Eagle Mountain, where the gages have been abandoned.

At Boshers 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.

The United States Weather Bureau maintains river stations in this basin as follows:

James at Lynchburg, Va.
James at Columbia, Va.
James at Richmond, Va.

During 1904 the United States Geological Survey has maintained gaging stations in this basin as follows:

James at Buchanan, Va.
James at Holcomb Rock, Va.
James at Cartersville, Va.
North (of James) at Glasgow, Va.
Appomattox at Mattoax, Va.

JAMES RIVER AT BUCHANAN, VA.

This station was established August 18, 1895, by C. C. Babb. It is located at the iron highway bridge near the Chesapeake and Ohio Railway station, and one-half mile from the Norfolk and Western Railway station. It is about 20 miles above the mouth of North River and one-half mile above the mouth of Purgatory Creek. The United States Weather Bureau maintained a gage at this point for about two years before measurements were made by the Geological Survey. On April 3, 1897, the datum of the original wire gage was lowered 2 feet to avoid negative readings. On November 21, 1903, the wire gage was replaced by a standard chain gage installed by W. C. Sawyer. It is located on the upstream side of the bridge near the center of the left span. The length of the chain from the end of the weight to the marker is 35 feet. Bench mark No. 1 is the top of the upper end of the third floor beam from the left bank. Its elevation is 29.87 feet above gage datum. Bench mark No. 2 is the top of a stone post under the southwest corner of the porch of the Chesapeake and Ohio Railway station. Its elevation is 24.50 feet above gage datum. Bench mark No. 3 is a copper bolt in a ledge of rock on the left bank 500 feet above the station. Its elevation is 16.14 feet above gage datum. This bench mark was established November 21, 1903, at which time the old bench mark on this ledge could not be found. Bench mark No. 4 is the top of the upper end of the seventh floor beam from the left bank. Its elevation is 29.92 feet above gage datum. Discharge measurements are made from the lower side of the two-span iron highway bridge, which has a total span of 350 feet. The initial point for soundings is the end of pin on the lower side of bridge at the left bank. The channel is straight for 800 feet above and for about the same distance below the station. The current has a moderate velocity and is broken by the middle pier of the two-span bridge. Both banks are high, not liable to overflow, and without trees. The bed of the stream is rocky and free from vegetation. The gage is read twice each day by U. H. Hyde.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of James River at Buchanan, Va., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
June 17	R. H. Bolster	320	1,119	1.34	2.98	1,498
August 8	N. C. Grover	323	860	.90	2.32	775
September 17	R. H. Bolster	284	707	.56	1.81	393
September 30	do	284	687	.53	1.74	[a] 364
October 19	do	284	676	.46	1.70	[a] 314

[a] Slight change in bed.

Mean daily gage height, in feet, of James River at Buchanan, Va., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.35	2.71	4.74	3.39	4.72	4.89	3.10	2.42	1.82	1.72	1.75	1.80
2	2.36	2.85	5.44	3.70	4.29	8.02	2.85	2.28	1.80	1.73	1.75	1.80
3	2.28	2.73	4.76	3.71	3.89	8.74	2.71	2.18	1.90	1.73	1.75	1.80
4	2.38	2.42	4.12	3.57	3.79	6.39	2.55	2.10	1.90	1.72	1.75	1.80
5	2.47	2.42	3.32	3.43	3.59	5.38	2.47	2.40	1.90	1.70	1.77	1.80
6	2.43	2.36	3.96	3.27	3.46	4.56	2.45	2.37	1.88	1.70	1.78	1.82
7	2.38	2.62	8.27	3.19	3.39	4.12	2.37	2.29	1.85	1.70	1.77	1.85
8	2.38	4.19	7.20	3.25	3.54	4.04	2.46	2.39	1.80	1.70	1.75	1.85
9	2.33	4.39	6.26	4.47	3.69	3.62	2.31	2.20	1.81	1.70	1.75	1.90
10	2.30	3.69	5.11	4.27	3.59	3.42	2.26	2.20	1.84	1.70	1.75	1.92
11	2.30	3.32	4.48	3.95	3.49	3.34	2.25	2.63	1.85	1.70	1.71	1.93
12	2.28	3.02	4.08	3.77	3.32	3.23	2.49	2.44	1.91	1.70	1.71	1.92
13	2.22	2.82	4.10	3.57	3.16	3.09	2.34	2.25	1.90	1.70	1.75	1.90
14	2.18	2.65	3.86	3.47	3.14	2.93	2.24	2.16	1.85	1.70	1.85	1.90
15	2.08	2.55	3.78	3.33	3.22	2.76	2.19	2.10	1.82	1.70	1.95	1.88
16	1.98	2.47	3.76	3.25	3.34	2.83	2.10	2.00	1.80	1.70	1.90	1.87
17	1.98	2.29	3.54	3.17	3.24	3.00	2.08	2.25	1.80	1.70	1.88	1.85
18	1.98	2.28	3.38	3.05	4.86	3.15	2.01	2.10	1.80	1.70	1.85	1.85
19	1.98	2.55	3.32	2.95	10.12	3.04	2.00	2.20	1.80	1.70	1.83	1.85
20	2.03	2.69	3.22	2.89	7.19	3.17	1.90	2.10	1.80	1.70	1.83	1.85
21	2.13	2.52	3.12	2.79	5.72	3.48	1.90	2.10	1,80	1.75	1.80	1.83
22	2.45	3.22	3.04	2.75	4.86	3.32	1.90	2.10	1.80	1.75	1.80	1.82
23	5.18	5.92	3.32	2.70	4.38	3.01	2.04	2.10	1.78	1.75	1.87	1.82
24	4.78	4.65	4.56	2.65	4.04	2.76	2.19	2.00	1.78	1.75	1.85	1.80
25	3.73	4.32	4.24	2.63	4.04	2.62	2.22	1.97	1.77	1.75	1.83	1.92
26	3.36	3.39	4.04	2.94	4.10	2.54	2.22	1.95	1.77	1.75	1.83	2.12
27	3.10	3.55	3.94	6.40	4.34	2.48	2.20	1.90	1.75	1.75	1.83	2.29
28	2.70	3.33	3.74	8.07	4.32	2.74	2.21	1.90	1.75	1.75	1.83	2.35
29	2.40	3.61	3.57	6.30	3.78	3.42	2.20	1.85	1.75	1.75	1.80	2.42
30	2.39	.....	3.42	5.35	3.54	3.22	2.15	1.85	1.75	1.75	1.80	2.29
31	2.56	.....	3.28	.....	3.64	.....	2.07	1.82	.....	1.75	.....	2.22

Rating table for James River at Buchanan, Va., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.70	330	2.40	861	3.40	2,100	4.40	3,840
1.75	356	2.50	960	3.50	2,250	4.50	4,030
1.80	385	2.60	1,060	3.60	2,410	4.60	4,220
1.85	416	2.70	1,170	3.70	2,570	4.70	4,420
1.90	449	2.80	1,285	3.80	2,740	4.80	4,620
1.95	484	2.90	1,405	3.90	2,910	4.90	4,825
2.00	520	3.00	1,535	4.00	3,090	5.00	5,035
2.10	598	3.10	1,670	4.10	3,270		
2.20	681	3.20	1,810	4.20	3,460		
2.30	768	3.30	1,950	4.30	3,650		

The above table is applicable only for open-channel conditions. It is based upon 5 discharge measurements made during 1904 up to gage height 3 feet. Above 3 feet the curve is based upon three measurements made in 1901 and 1903. It is well defined between gage heights 1.70 and 4 feet.

Measurements above 5 feet gage height are estimated.

Estimated monthly discharge of James River at Buchanan, Va., for 1904.

[Drainage area, 2,058 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	5,413	506	1,164	0.566	0.653
February	7,110	750	1,916	.931	1.00
March	14,010	1,587	3,749	1.82	2.10
April	13,330	1,093	2,937	1.43	1.60
May	20,880	1,726	3,771	1.83	2.11
June	15,640	940	3,143	1.53	1.71
July	1,670	449	762	.370	.427
August	1,093	397	647	.314	.362
September	456	356	397	.193	.215
October	356	330	341	.166	.191
November	484	335	388	.189	.211
December	881	385	484	.235	.271
The year	20,880	330	1,642	.798	10.850

JAMES RIVER AT HOLCOMB ROCK, VA.

This station was established by the Willson Aluminum Company, of Holcomb Rock, Va., in 1899, in connection with measurements to determine the horsepower available at that point. During 1899 the records were fragmentary, but at the commencement of 1900 daily records were taken, which have been furnished to the Geological Survey through the courtesy of George O. Seward, general manager of the company. The gage consists of a copper float 8 by 8 by 8 inches, with a vertical rod 1½ inches square attached to it. The rod, which extends up through the powerhouse floor, is graduated to tenths of a foot. The copper float is inclosed in a 12-inch by 12-inch by 12-foot box, which rests solidly on the bottom of the river. The box is perforated, so that the water in it will always stand at the same level as the water in the river, while the float, being inclosed, is not in danger of being broken by floating timber. The fluctuations of the river are read directly from the rod, which moves up or down with the float as it responds to the variations in the height of the river.

Mean daily gage height, in feet, of James River at Holcomb Rock, Va., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.30	1.75	.....	2.30	4.00	3.80	2.01	1.25	0.95	0.75	0.90	0.70
2	1.40	1.70	.....	2.60	3.70	7.25	1.80	1.40	.95	.25	.70	.75
3	1.10	1.55	.....	2.50	3.15	8.80	1.70	1.30	1.00	1.15	.65	.80
4	1.20	1.50	.....	2.50	2.80	6.70	1.65	1.30	.85	.80	.75	1.05
5	1.65	1.50	.....	2.40	2.65	5.00	1.60	1.30	1.00	.80	.80	1.10
6	1.55	1.55	3.05	2.25	2.50	6.35	1.65	1.30	1.00	.40	.20	1.10
7	1.40	2.25	4.50	2.20	2.35	3.25	1.56	1.30	.90	.85	.95	1.25
8	1.40	3.05	8.95	2.25	2.65	3.25	1.40	1.60	.90	.75	.75	1.20
9	1.40	3.60	6.85	2.55	2.85	2.75	1.40	1.30	.80	.25	.70	1.20
10	1.35	3.05	4.95	3.25	3.15	2.55	1.40	1.40	.90	.75	.75	1.00
11	1.40	2.40	4.05	3.15	2.90	2.35	1.45	1.90	.65	.85	.70	.65
12	1.35	2.10	3.50	2.85	2.65	2.20	1.60	1.90	.95	.85	.80	1.25
13	1.30	2.00	3.30	2.65	2.40	2.10	1.50	1.50	.95	.75	.20	.90
14	1.25	1.85	3.10	2.45	2.30	1.95	1.45	1.20	.95	.75	1.15	.75
15	1.10	1.60	2.85	2.25	2.30	1.75	1.25	1.40	1.00	.80	.85	.75
16	1.20	1.80	2.80	2.25	2.35	1.85	1.30	1.45	1.00	.00	.90	.85
17	.85	1.60	2.65	2.05	2.30	2.10	1.25	1.30	.95	.45	.90	.80
18	1.30	1.45	2.50	2.10	2.50	1.85	1.20	1.50	.75	.70	.80	.80
19	1.15	1.60	2.35	2.05	10.00	1.95	1.00	.90	.90	.60	.80	.80
20	1.15	1.70	2.15	1.95	8.05	1.85	1.20	1.35	.90	.65	.20	.65
21	1.20	1.60	2.20	1.80	5.50	2.60	1.10	1.05	.90	.85	.95	.85
22	1.45	3.20	2.15	1.70	4.30	2.50	1.20	1.30	.80	.95	.75	.90
23	3.75	5.50	2.10	1.70	3.60	2.10	1.30	1.30	.80	1.00	.80	.90
24	3.85	4.35	2.55	1.70	3.10	1.90	1.20	1.15	.80	.70	.80	.90
25	3.20	3.55	3.45	1.60	3.05	1.80	1.40	1.15	.45	.75	.90	.95
26	2.50	3.15	3.10	1.60	3.15	1.60	1.40	1.05	1.10	.70	.80	.95
27	2.20	2.60	2.85	2.65	3.30	1.60	1.25	1.00	.85	.75	.85	.85
28	1.90	.....	2.75	8.75	3.30	2.05	1.30	1.00	.80	.70	.90	1.45
29	1.75	.....	2.55	5.90	2.80	2.10	1.55	1.10	.70	.80	.85	1.35
30	1.75	.....	2.44	4.85	2.50	2.15	1.40	.90	.70	.05	.75	1.30
31	1.65	.....	2.30	.....	2.40	.....	1.00	1.00	.....	.75	.....	1.25

JAMES RIVER AT CARTERSVILLE, VA.

This gaging station was established January 1, 1899, by D. C. Humphreys, and is located at the highway bridge crossing the James between Pemberton and Cartersville, one-half mile from the railroad station at Pemberton and 50 miles above Richmond, Va. The original wire gage was attached to the bridge and 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. This gage was verified June 23, 1899. The original wire gage was replaced by a standard chain gage installed July 24, 1903, by B. S. Drane. The length of the chain from the end of the weight to the marker is 37.98 feet. Bench mark No. 1 is a standard copper plug set in the capstone of the right abutment at its lower end. It is inclosed by a ring of white paint and is marked by the letters "B.M.U.S.G.S.Hydro." Its elevation is 31.74 feet above gage datum. Bench mark No. 2 is a spot of white paint on the inner eyebar of the lower chord of the bridge, under the pulley end of the gage box. Its elevation is 32.91 feet above gage datum. To provide for readings over 10 feet, two additional markers, respectively 10 and 20 feet below the first, have been placed. The gage is attached to the timbers of the second span from the right bank on the downstream side, at the same height as the hand rail. Discharge measurements are made from the lower side of the bridge to which the gage is attached. The initial point for soundings is the right end of the downstream hand rail. Distances are marked with white paint on the rail. The channel is straight for one-third mile above the station and for 1 mile below. Both banks are high and will overflow only at extreme flood stages. The bed of the stream is composed of rocks and sand and is somewhat shifting. The gage is read once each day by B. W. Palmore, the postmaster.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of James River at Cartersville, Va., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
June 23	R. H. Bolster	688	2,546	1.96	2.84	4,994
September 13	do	639	1,202	1.08	.75	1,301
October 3	do	638	1,169	.96	.70	1,117
October 22	J. C. Hoyt	638	1,265	1.11	.85	1,405

Mean daily gage height, in feet, of James River at Cartersville, Va., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.60	2.10	3.38	3.30	5.90	3.85	2.55	1.45	0.81	0.80	0.65	0.85
2	1.68	2.00	3.30	3.10	5.00	5.20	2.52	1.72	1.00	.75	.75	.88
3	1.50	1.90	4.85	3.10	4.32	7.52	2.10	3.10	.90	.70	.75	.90
4	1.38	1.85	4.85	3.30	3.77	10.00	1.85	2.52	.85	.55	.72	1.00
5	1.35	1.80	4.30	3.28	3.48	7.40	1.70	1.58	.80	.50	.80	1.00
6	1.35	1.88	3.90	3.00	3.22	5.98	1.62	3.37	.70	.55	.72	1.60
7	2.25	3.32	6.08	3.10	3.10	4.92	1.48	2.00	.85	.55	.70	1.70
8	2.55	3.80	13.00	3.05	6.30	4.40	1.85	2.35	.85	.70	.70	1.52
9	1.90	3.50	11.10	3.10	4.92	4.08	1.90	1.70	.80	.65	.70	1.30
10	1.55	4.80	9.18	3.65	5.12	3.60	2.00	1.30	.98	.55	.75	1.38
11	1.45	4.52	6.65	4.55	4.80	3.30	2.55	1.80	1.10	.52	.80	1.28
12	1.47	3.25	5.50	4.10	4.20	2.85	1.52	1.90	.95	.50	.78	1.22
13	1.62	2.90	4.70	3.78	3.75	2.62	1.40	2.12	.78	.50	1.00	1.02
14	1.55	2.75	4.60	3.40	3.42	2.45	1.60	2.00	1.25	.50	1.45	1.10
15	1.50	2.52	4.40	3.20	3.25	2.30	1.48	1.90	3.80	.50	1.32	1.15
16	1.45	2.22	4.00	3.00	3.12	2.18	1.30	1.77	2.43	.68	1.10	1.40
17	1.35	2.20	3.70	2.75	3.02	2.15	1.38	1.40	1.80	.68	1.00	1.38
18	1.40	1.80	3.58	2.58	3.43	2.22	1.40	2.00	.98	.65	.92	2.15
19	1.25	1.90	3.50	2.55	5.13	2.18	1.30	1.95	.98	.55	.95	2.30
20	1.35	2.00	3.20	2.40	10.55	2.15	1.25	1.90	.88	.60	.93	2.22
21	1.45	2.25	3.15	2.30	9.15	2.32	1.10	1.45	.82	.60	.90	[a]2.30
22	1.68	4.60	3.00	2.20	6.15	2.40	1.00	1.23	.95	.82	.85	[a]2.50
23	2.42	6.22	2.90	2.10	5.32	2.85	1.30	1.21	.90	.82	.88	[a]2.30
24	3.00	6.29	2.85	2.08	4.50	2.52	2.08	1.20	.88	.78	.95	1.48
25	5.60	6.15	2.85	2.05	3.98	2.18	2.00	1.28	.82	.75	.90	1.65
26	4.02	4.63	4.30	2.00	3.55	1.88	1.55	1.19	.80	.78	.90	1.90
27	3.48	4.12	4.00	3.00	3.52	1.80	1.62	1.00	.75	.70	.85	1.80
28	3.25	3.95	3.98	6.00	3.50	1.65	2.05	1.00	.68	.62	.85	2.10
29	2.85	3.50	3.65	9.60	3.60	2.00	1.90	.98	.82	.62	.80	2.20
30	1.90	.....	3.30	7.42	3.45	2.35	1.95	.80	.85	.70	.75	1.90
31	2.10	.....	4.00	.....	3.02	.....	1.60	.65	.....	.75	.....	1.75

[a] River frozen.

Rating table for James River at Cartersville, Va., from January 1, 1897, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.50	755	3.20	5,890	5.90	12,170	11.00	28,400
.60	935	3.30	6,100	6.00	12,430	11.20	29,120
.70	1,115	3.40	6,310	6.20	12,970	11.40	29,840
.80	1,295	3.50	6,520	6.40	13,520	11.60	30,560
.90	1,475	3.60	6,740	6.60	14,080	11.80	31,280
1.00	1,660	3.70	6,960	6.80	14,650	12.00	32,000
1.10	1,845	3.80	7,180	7.00	15,230	12.50	33,850
1.20	2,030	3.90	7,400	7.20	15,810	13.00	35,700
1.30	2,215	4.00	7,620	7.40	16,410	13.50	37,600
1.40	2,400	4.10	7,840	7.60	17,010	14.00	39,500
1.50	2,585	4.20	8,060	7.80	17,630	14.50	41,450
1.60	2,770	4.30	8,290	8.00	18,250	15.00	43,400
1.70	2,955	4.40	8,520	8.20	18,890	16.00	47,400
1.80	3,140	4.50	8,750	8.40	19,530	17.00	51,400
1.90	3,330	4.60	8,980	8.60	20,186	18.00	55,400
2.00	3,520	4.70	9,210	8.80	20,840	19.00	59,400
2.10	3,710	4.80	9,440	9.00	21,500	20.00	63,400
2.20	3,900	4.90	9,680	9.20	22,180	21.00	67,400
2.30	4,095	5.00	9,920	9.40	22,860	22.00	71,400
2.40	4,290	5.10	10,160	9.60	23,540	23.00	75,400
2.50	4,485	5.20	10,400	9.80	24,220	24.00	79,400
2.60	4,680	5.30	10,640	10.00	24,900	25.00	83,400
2.70	4,880	5.40	10,890	10.20	25,600	26.00	87,400
2.80	5,080	5.50	11,140	10.40	26,300	27.00	91,400
2.90	5,280	5.60	11,390	10.60	27,000	28.00	95,400
3.00	5,480	5.70	11,650	10.80	27,700	29.00	99,400
3.10	5,680	5.80	11,910				

The above table is applicable only for open-channel conditions. It is based upon 23 discharge measurements made during 1897 to 1904, inclusive. It is well defined between gage heights 0.40 feet and 5 feet. The table has been extended beyond these limits. Above gage height 15 feet the rating curve is a tangent, the difference being 400 per tenth.

Estimated monthly discharge of James River at Cartersville, Va., for 1904.

[Drainage area, 6,230 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	11,390	2,123	3,662	0.587	0.676
February	13,240	3,140	6,200	.995	1.070
March	35,700	5,180	9,786	1.57	1.81
April	23,540	3,520	6,645	1.07	1.19
May	26,825	5,480	9,043	1.45	1.67
June	24,900	2,863	6,785	1.09	1.22
July	4,583	1,660	2,975	.477	.550
August	6,205	1,025	2,918	.468	.540
September	7,180	1,079	1,692	.271	.302
October	1,331	755	1,012	.162	.187
November	2,493	1,025	1,425	.229	.256
December	4,485	1,385	2,755	.442	.510
The year	35,700	755	4,575	.734	9.980

NORTH (OF JAMES) RIVER NEAR GLASGOW, VA.

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, Va. Its drainage basin is largely under cultivation, except in the upper part, where it is mountainous and covered with forest growth. This station was established August 21, 1895, by C. C. Babb, assisted by D. C. Humphreys. It is located at the county bridge, three-fourths of a mile from the post-office at Glasgow, Va., and 1 mile above the mouth of North River. The original gage was of the wire type. On July 22, 1903, a vertical rod gage was placed in position. This consists of a 2 by 6 inch rod, nailed to a 3 by 6 inch oak timber, which is sunk to a firm foundation and securely nailed and braced to an overhanging tree on the right bank below the bridge. This gage was established on the same datum as the original wire gage and was read from the bridge. On November 24, 1903, a standard chain gage was established on the lower side of the bridge in the right span. Its datum is the same as that of the wire gage and rod gage, which it replaces. The length of the chain from the marker to the end of the weight is 28 feet. Bench mark No. 1 is a standard copper plug set in the downstream end of the capstone of the right abutment. It is inclosed in a ring of white paint and is marked by the

letters "B. M. U. S. G. S. Hydro." Its elevation is 23.90 feet above gage datum. Bench mark No. 2 is the upper surface of the upper chord over the pulley of the chain gage. Its elevation is 32.28 feet above gage datum. Discharge measurements are made from the lower side of the bridge to which the gage is attached. The initial point for soundings is the center of the end pin of the downstream truss on the left bank. Originally measurements were made from the sidewalk on the upstream side of the bridge, at which point there is a good section. Beginning with 1902, measurements were made from the lower side of the bridge on account of the removal of the sidewalk. The section on the lower side of the bridge is not as favorable for accurate measurements on account of sunken logs and on account of the bridge piers. The channel is straight for 600 feet above and below the station and has a width of 240 feet, broken by two iron piers. Both banks are high, fringed with trees, and not liable to overflow, except at very high water. The bed of the stream is rocky near the right bank and is composed of rocks and mud near the left. The gage is read once each day by B. G. Baldwin.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of North (of James) River near Glasgow, Va.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
June 14	F. H. Brundage	206	648	0.81	1.13	523
September 19	R. H. Bolster	197	504	.34	.45	170
September 30	do	197	512	.35	.49	179
October 19	do	197	506	.31	.46	157

Mean daily gage height, in feet, of North (of James) River near Glasgow, Va., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.90	1.15	1.85	1.55	1.95	2.95	1.00	0.70	0.40	0.50	0.40	0.60
2	.90	1.10	2.05	1.55	1.70	2.75	1.00	.65	.45	.50	.40	.60
3	.90	1.10	1.95	1.45	1.45	3.45	1.85	.70	.50	.35	.40	.60
4	1.20	.90	1.75	1.45	1.35	2.95	1.80	.90	.50	.45	.40	.60
5	1.00	1.00	1.65	1.40	1.30	2.45	1.05	.85	.50	.45	.40	.60
6	.90	1.00	1.65	1.40	1.30	1.95	.90	2.00	.50	.45	.45	.60
7	.85	1.20	1.95	1.35	1.25	1.75	.85	1.15	.50	.45	.50	.70
8	.80	2.60	4.90	1.35	1.80	1.70	.80	.95	.50	.45	.50	.70
9	.75	2.00	3.10	1.95	1.85	1.60	.80	.90	.50	.45	.50	.65
10	.70	1.75	2.55	1.95	1.95	1.45	.85	.90	.50	.40	.50	.60
11	.70	1.65	2.20	1.75	1.85	1.40	1.85	1.90	.50	.45	.50	.60
12	.65	1.60	2.05	1.65	1.75	1.35	1.00	1.15	.50	.45	.50	.60
13	.68	1.50	1.95	1.55	1.70	1.30	.90	1.00	.50	.45	.60	.60
14	.70	1.25	1.85	1.45	1.60	1.15	.85	.95	.50	.45	.70	.55

Mean daily gage height, in feet, of North (of James) River near Glasgow, Va., for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
15	.95	1.25	1.75	1.35	1.55	1.15	.80	.90	.80	.45	.60	.50
16	.85	1.30	1.65	1.25	1.55	1.15	.70	.80	.65	.45	.60	.50
17	.50	1.30	1.55	1.20	1.45	1.45	.65	.70	.55	.40	.50	.50
18	.65	1.50	1.50	1.15	1.45	1.35	.65	.70	.50	.45	.50	.45
19	.60	1.75	1.45	1.15	4.90	1.30	.70	.75	.45	.45	.55	.40
20	.60	5.30	1.35	1.15	3.30	1.15	.65	.70	.40	.45	.55	.50
21	1.65	6.00	1.35	1.05	2.40	1.05	.65	.70	.40	.45	.60	.50
22	.90	7.50	1.35	1.00	2.10	2.05	.70	.75	.40	.45	.50	.50
23	3.80	7.20	1.35	.95	1.90	1.45	.80	.85	.40	.45	.50	.50
24	2.60	6.40	1.75	.95	1.80	1.05	.80	.75	.40	.40	.50	.50
25	2.10	1.95	1.70	.95	1.70	1.00	.90	.70	.40	.45	.50	.60
26	1.85	1.70	1.55	.95	1.70	1.00	.85	.70	.40	.45	.50	.60
27	1.65	1.55	1.60	2.15	1.60	1.00	.90	.60	.35	.45	.50	.80
28	1.58	1.55	1.60	3.50	1.55	1.35	.80	.55	.35	.45	.50	.90
29	1.50	1.35	1.45	2.90	1.45	1.15	.75	.50	.45	.45	.45	.80
30	1.50	.....	1.60	2.30	1.35	1.05	.75	.50	.40	.45	.60	.75
31	1.25	.....	1.55	.....	1.30	.....	.70	.50	.....	.40	.....	.60

Rating table for North (of James) River near Glasgow, Va., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.35	125	1.10	510	2.50	1,810	3.90	4,120
.40	142	1.20	580	2.60	1,940	4.00	4,320
.45	160	1.30	650	2.70	2,080	4.10	4,530
.50	179	1.40	720	2.80	2,220	4.20	4,740
.55	199	1.50	800	2.90	2,370	4.30	4,960
.60	220	1.60	880	3.00	2,520	4.40	5,180
.65	242	1.70	970	3.10	2,680	4.50	5,410
.70	265	1.80	1,060	3.20	2,840	4.60	5,640
.75	290	1.90	1,150	3.30	3,010	4.70	5,880
.80	320	2.00	1,240	3.40	3,180	4.80	6,120
.85	350	2.10	1,340	3.50	3,360	4.90	6,370
.90	380	2.20	1,450	3.60	3,540	5.00	6,620
.95	410	2.30	1,560	3.70	3,730		
1.00	440	2.40	1,680	3.80	3,920		

The above table is applicable only for open-channel conditions. It is based upon 6 discharge measurements made during 1903 and 1904. It is well defined between gage heights 0.45 feet and 2.00 feet, and from gage height 2.00 to 5.00 feet a fair determination has been computed.

Estimated monthly discharge of North (of James) River near Glasgow, Va., for 1904.

[Drainage area, 831 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	3,920	179	646	0.777	0.896
February	14,310	380	2,555	3.07	3.31
March	6,370	685	1,218	1.47	1.69
April	3,360	410	890	1.07	1.19
May	6,370	615	1,175	1.41	1.63
June	3,270	440	974	1.17	1.31
July	1,105	242	404	.486	.560
August	1,240	179	370	.445	.513
September	320	125	170	.205	.229
October	179	125	158	.190	.219
November	265	142	183	.220	.245
December	380	142	222	.267	.308
The year	14,310	125	747	.898	12.10

APPOMATTOX RIVER AT MATTOAX, VA.

This station was established August 27, 1900, by E. W. Myers. It is located on the two-span deck railroad bridge at Mattoax station, 27 miles southeast of Richmond, on the road to Danville. It is equipped with a standard chain gage, which is attached to the outside of the guard rail of the first span from the right bank. The length of the chain from the end of the weight to the marker is 48.82 feet. A permanent bench mark, consisting of a United States Geological Survey standard iron post, was established August 29, 1903, by B. S. Drane. This post is set at the northwest corner of the Mattoax passenger station, with an elevation of 48.68 feet above gage datum. Bench mark No. 2 is on the outer upstream edge of the top of the upper chord of the upstream truss, opposite the 2-foot mark on the gage scale. Its elevation is 46.60 feet above gage datum. Discharge measurements are made from the downstream side of the railroad bridge to which the gage is attached. The initial point for soundings is the end of the downstream guard rail at the right bank. Distances along this rail are indicated by white paint. The channel is straight for 400 feet above and for 100 feet below the station. The current is moderately swift. The right bank is high and is not subject to overflow. The left bank is high, but overflows beneath the second span of the bridge at high water. The bed of the stream is composed of rock and sand,

and is clean and permanent. There is but one channel at all stages, broken at extreme flood stages by the central pier of the bridge. The sand bottom beneath the second span is subject to change in high water. The gage is read once each day by J. C. Carter.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Appomattox River at Mattoax, Va., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
June 24	R. H. Bolster	66	150	1.37	1.23	205
August 4	N. C. Grover	70	209	1.40	2.01	293
October 4	R. H. Bolster	69	121	1.39	.81	168
October 22	J. C. Hoyt	68	183	1.48	1.72	270

Mean daily gage height, in feet, of Appomattox River at Mattoax, Va., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.70	3.50	4.55	3.75	3.50	1.70	1.50	1.15	0.75	1.15	1.02	1.40
2	2.50	3.65	4.25	3.40	3.00	4.45	1.40	1.50	1.25	1.05	1.07	1.38
3	2.50	2.75	3.65	3.10	2.70	9.05	1.85	1.25	1.35	.90	1.10	1.92
4	2.45	2.70	3.50	2.75	2.50	10.30	1.20	2.30	1.20	.80	1.12	2.92
5	1.65	2.50	3.35	2.55	2.35	5.60	.90	1.30	.85	.80	1.22	2.80
6	1.20	3.10	3.10	2.55	2.25	3.20	.80	1.20	1.35	.83	1.35	6.70
7	1.92	6.25	4.90	2.70	2.25	2.50	.80	1.20	1.10	.85	1.42	7.72
8	2.75	9.00	9.75	3.50	3.50	2.25	.75	.90	.90	.90	1.22	5.73
9	2.60	7.00	11.70	3.55	5.35	2.05	.90	.80	.80	.85	1.22	3.45
10	2.10	5.40	12.60	3.10	4.00	1.95	1.15	3.50	2.00	.83	1.18	2.80
11	2.05	4.50	11.20	2.95	5.75	1.75	1.30	4.80	2.00	.90	1.18	2.45
12	2.30	3.10	4.60	2.55	4.20	1.90	1.05	4.60	.95	.90	1.15	2.06
13	3.15	2.70	4.20	2.45	3.05	1.70	1.02	2.45	.85	.88	1.60	1.45
14	2.35	2.60	3.65	2.30	2.25	1.50	1.10	1.45	.75	.88	3.80	1.82
15	2.25	2.50	4.10	2.25	3.05	1.40	1.15	1.10	14.00	.82	5.65	2.08
16	2.25	2.75	3.75	2.30	6.10	1.35	.85	1.10	15.25	.88	3.20	1.88
17	2.50	4.45	3.60	2.35	3.75	1.40	.80	.95	15.20	.79	2.35	2.50
18	2.20	3.50	3.65	2.25	3.20	1.30	.85	1.00	4.00	.88	2.04	2.20
19	1.85	2.40	3.50	2.10	5.10	1.40	.95	4.80	2.15	.85	1.72	2.62
20	1.50	3.50	3.45	2.10	7.00	1.25	.60	5.70	1.80	.78	1.62	2.40
21	1.85	5.50	3.15	2.05	4.30	1.15	.65	1.70	1.50	1.80	1.63	2.38
22	3.05	8.30	3.55	2.00	3.25	1.15	1.10	1.30	1.35	1.82	1.52	2.40
23	3.50	11.75	3.65	2.00	2.30	1.20	.80	2.70	1.25	1.39	1.63	1.98
24	4.50	12.60	3.45	1.95	2.45	1.25	2.00	1.10	1.15	1.50	1.62	3.62
25	3.80	12.85	3.45	2.00	2.20	1.05	4.80	1.00	1.15	1.10	1.73	6.22
26	3.50	8.00	3.40	2.00	2.00	.95	3.75	.80	1.10	1.05	1.47	6.65
27	3.20	4.60	4.25	2.95	1.85	.90	2.50	.80	1.10	1.12	1.40	5.40
28	3.10	3.85	4.90	9.00	1.75	3.95	2.65	.70	1.05	1.15	1.32	5.35
29	3.00	4.15	4.25	8.40	1.65	4.25	1.80	.70	1.00	1.20	1.33	5.65
30	1.60	.....	3.60	4.45	1.65	3.00	2.00	.80	1.60	1.06	1.38	3.45
31	1.65	.....	3.85	.....	1.50	.....	1.60	.80	.....	1.03	.....	2.70

Rating table for Appomattox River at Mattoax, Va., from August 25, 1900, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.40	140	2.70	496	6.00	1,490	10.60	3,624
.50	150	2.80	519	6.20	1,576	10.80	3,722
.60	160	2.90	542	6.40	1,662	11.00	3,820
.70	170	3.00	565	6.60	1,748	11.50	4,065
.80	180	3.10	590	6.80	1,834	12.00	4,310
.90	190	3.20	615	7.00	1,920	12.50	4,555
1.00	200	3.30	640	7.20	2,012	13.00	4,805
1.10	212	3.40	665	7.40	2,104	13.50	5,055
1.20	224	3.50	690	7.60	2,196	14.00	5,315
1.30	237	3.60	715	7.80	2,288	14.50	5,575
1.40	251	3.70	740	8.00	2,380	15.00	5,845
1.50	265	3.80	765	8.20	2,474	15.50	6,115
1.60	282	3.90	790	8.40	2,568	16.00	6,395
1.70	299	4.00	815	8.60	2,662	17.00	6,965
1.80	316	4.20	875	8.80	2,756	18.00	7,555
1.90	333	4.40	935	9.00	2,850	19.00	8,170
2.00	350	4.60	995	9.20	2,946	20.00	8,815
2.10	370	4.80	1,065	9.40	3,042	21.00	9,490
2.20	390	5.00	1,135	9.60	3,138	22.00	10,200
2.30	410	5.20	1,205	9.80	3,234	23.00	10,930
2.40	430	5.40	1,275	10.00	3,330	24.00	11,700
2.50	450	5.60	1,345	10.20	3,428		
2.60	473	5.80	1,415	10.40	3,526		

The above table is applicable only for open-channel conditions.

Estimated monthly discharge of Appomattox River at Mattoax, Va., for 1904.

[Drainage area, 745 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	965	224	465	0.624	0.719
February	4,730	430	1,369	1.84	1.98
March	4,605	590	1,192	1.60	1.84
April	2,850	342	639	.858	.957
May	1,920	265	665	.893	1.03
June	3,477	190	584	.784	.875
July	1,065	160	283	.380	.438
August	1,380	170	368	.494	.570
September	5,980	175	806	1.08	1.20
October	319	178	206	.277	.319
November	1,362	202	325	.436	.487
December	2,251	248	732	.983	1.13
The year	5,980	160	636	.854	11.545

ROANOKE RIVER DRAINAGE BASIN.

Roanoke River proper is formed by the confluence of Dan and Staunton rivers at Clarksville, Mecklenburg County, Va., 185 miles above the mouth of the stream, though the name "Roanoke" is also applied to the upper waters of Staunton River. These streams drain, respectively, 3,798 and 3,546 square miles. Staunton River is the more northerly of the two, its drainage basin lying entirely in Virginia. It rises among the eastern foothills of the Blue Ridge southwest of Roanoke and Salem, being known in this part of its course as the Roanoke, and flows at first northeast, then southeast through Montgomery, Roanoke, Bedford, Campbell, Halifax, and Mecklenburg counties to the junction with the Dan.

A large part of the area drained by the Dan lies in North Carolina. The stream rises in Surry County, N. C., and in Patrick County, Va., and flows at first southeast through Stokes County, N. C., then northeast through Rockingham and Caswell counties, N. C., and through Pittsylvania, Halifax, and Mecklenburg counties, Va., to the junction with the Staunton.

Roanoke River drains a total area of about 9,200 square miles and empties into Albemarle Sound a short distance below Plymouth, N. C.

It is navigable at all stages for 120 miles to Weldon, N. C., where the river crosses the fall line.

The rainfall on the basin above the fall line is about 48 inches per annum and is evenly distributed throughout the year. The average amount probably increases slightly as the stream is ascended, though the records of rainfall over the basin are too incomplete to decide this matter. The slopes in the headwaters and in the upper tributaries are steep, freshets on the river are violent, and the fluctuations of height occur with great rapidity. Rises of 50 feet and over have been noted at Weldon, and freshets in which the rate of rise is 10 feet a day or more are frequent.

The United States Weather Bureau maintains gages on Roanoke River at Clarksville, Va., and Weldon, N. C., and on Dan River at Danville, Va. Gaging stations were maintained by the United States Geological Survey during 1904 as follows: Roanoke (upper portion of Staunton) at Roanoke, Va.; Staunton at Randolph, Va.; Banister at Houston, Va.; Dan at South Boston, Va.; Dan at Madison, N. C., and Mayo at Madison, N. C.

ROANOKE RIVER AT ROANOKE, VA.

This station was established July 10, 1896, by D. C. Humphreys. The original gage of the wire type was replaced November 28, 1903, by a standard chain gage installed by W. C. Sawyer. The datum is the same as that of the gage which it replaced. The length of the chain from the end of the weight to the marker is 27.50 feet. Bench mark No. 1 is the downstream upper edge of the second floor beam from the left abutment. Its elevation is 21.98 feet above gage datum. Bench mark No. 2 is a standard copper bolt set in the face of the lower wing wall of the left abutment, about 4 feet above the ground. Its elevation is 19.70 feet above gage datum. Discharge measurements were made from the Walnut Street Bridge, at which the gage is located, up to July 21, 1903. Since that time they have been made from the Jefferson Street Bridge, at which the section is more suitable. The initial point for soundings is the left end of the downstream hand rail. The channel is nearly straight and has a width of 160 feet between abutments, broken by one pier. The current is rapid. The bed of the stream is composed of coarse gravel and small bowlders. The right bank is above high water, but the left is liable to overflow at extreme flood stages. The gage is read once daily by Richard P. Royer.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Roanoke River at Roanoke, Va., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
June 20	F. H. Brundage	111	269	1.09	1.32	294
August 8	N. C. Grover	113	345	1.37	1.67	473
September 16	R. H. Bolster	108	214	.59	.80	129
September 29	do	106	186	.49	.68	93
October 18	do	105	170	.44	.63	76

Mean daily gage height, in feet, of Roanoke River at Roanoke, Va., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.95	0.75	1.75	1.15	1.05	2.45	2.10	1.50	0.85	0.65	0.65	0.70
2	.90	.75	1.80	1.10	1.05	3.25	1.50	1.70	1.20	.65	.65	.70
3	.80	.80	1.65	1.05	1.05	1.95	1.20	1.40	1.30	.60	.65	.75
4	.30	.95	1.55	1.05	1.05	1.45	1.00	1.50	.95	.60	.65	.90
5	1.05	.70	1.45	1.05	1.05	1.55	1.10	1.60	.95	.65	.75	.80
6	.65	.95	1.35	1.00	1.10	1.35	1.00	2.60	.90	.60	.70	1.00
7	.80	1.15	2.55	1.00	1.10	1.25	1.00	1.65	.85	.60	.75	1.00
8	.80	1.80	2.75	1.10	1.20	1.35	1.00	1.70	.80	.65	.75	.90
9	.80	1.40	2.05	1.15	1.20	1.15	.95	2.00	.80	.65	.75	.80
10	.80	1.25	1.80	1.15	1.30	2.05	1.50	3.00	.80	.65	.70	.80
11	.90	1.10	1.65	1.10	1.25	1.55	1.20	3.60	.75	.65	.70	.75
12	.90	1.10	1.45	1.25	1.15	1.75	1.10	2.40	.80	.65	.70	.70
13	.80	1.05	1.45	1.20	1.10	1.45	.95	1.60	.80	.65	.75	.70
14	.80	1.10	1.40	1.10	1.05	1.35	.90	1.40	.80	.65	.90	.70
15	.30	.95	1.40	1.15	1.15	1.20	.80	1.40	.90	.60	.85	.70
16	.85	.85	1.30	1.05	1.10	1.30	.80	1.40	.85	.65	.75	.70
17	.85	1.05	1.25	1.05	1.05	1.55	.70	1.15	.75	.65	.80	.75
18	.60	.90	1.20	.95	1.10	1.45	.70	1.15	.75	.65	.80	.75
19	1.35	.95	1.20	1.05	2.35	1.25	.70	1.10	.75	.65	.75	.70
20	.60	1.10	1.15	1.05	1.95	1.40	.70	1.15	.75	.65	.75	.65
21	.80	.95	1.15	.90	1.65	1.60	.70	1.00	.75	.65	.75	.65
22	.85	1.10	1.10	.85	1.45	1.40	.70	1.00	.75	.65	.75	.65
23	1.45	1.80	1.10	1.05	1.35	1.20	1.00	1.00	.70	.65	.75	.65
24	1.25	1.50	1.25	.75	1.25	1.10	1.20	.95	.70	.65	.75	.70
25	1.05	1.30	1.25	.85	1.25	1.00	.95	.95	.70	.65	.75	.70
26	1.05	1.25	1.25	.95	1.55	1.00	1.70	.90	.70	.65	.70	.80
27	.90	1.15	1.25	.95	1.35	1.40	1.30	.90	.70	.65	.70	.90
28	.85	1.10	1.25	1.45	1.25	1.40	2.75	.85	.70	.70	.70	.90
29	.95	1.35	1.20	1.15	1.05	1.20	1.50	.90	.70	.65	.70	.80
30	.85	.....	1.15	1.15	1.05	1.20	1.30	.85	.70	.65	.70	.70
31	.75	.....	1.15	.....	1.65	.....	1.20	.85	.....	.65	.....	.70

Rating table for Roanoke River at Roanoke, Va., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.30	43	0.95	167	2.20	850	4.00	2,905
.35	47	1.00	181	2.30	940	4.20	3,175
.40	52	1.10	212	2.40	1,030	4.40	3,445
.45	58	1.20	247	2.50	1,130	4.60	3,715
.50	65	1.30	286	2.60	1,230	4.80	3,985
.55	73	1.40	330	2.70	1,330	5.00	4,255
.60	82	I.50	380	2.80	1,435	5.20	4,525
.65	92	1.60	430	2.90	1,545	5.40	4,795
.70	103	1.70	490	3.00	1,660	5.60	5,065
.75	115	1.80	550	3.20	1,900	5.80	5,335
.80	127	1.90	620	3.40	2,140	6.00	5,605
.85	140	2.00	690	3.60	2,390	7.00	6,955
.90	153	2.10	770	3.80	2,645	8.00	8,305

The above table is applicable only for open-channel conditions. It is based upon discharge measurements made during 1896 to 1904. It is well defined between gage heights 0.60 feet and 7 feet. The table has been extended beyond these limits. Above gage height 4 feet the rating curve is a tangent, the difference being 135 per tenth.

Estimated monthly discharge of Roanoke River at Roanoke, Va., for 1904.

[Drainage area, 388 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	355	43	150	0.387	0.446
February	550	103	229	.590	.636
March	1,380	212	395	1.02	1.18
April	355	115	202	.521	.581
May	985	196	292	.753	.868
June	1,960	181	417	1.07	1.19
July	1,380	103	264	.680	.784
August	2,390	140	453	1.17	1.35
September	286	103	133	.343	.383
October	103	82	91	.235	.271
November	153	92	111	.286	.319
December	181	92	118	.304	.350
The year	2,390	43	238	.613	8.358

STAUNTON RIVER AT RANDOLPH, VA.

This station was originally established August 27, 1900, by E. W. Myers, and is located on the railroad bridge about five-eighths of a mile southwest of the Southern Railway station at Randolph, Va. The present gage was installed by B. S. Drane, May 20, 1903. It is a standard chain gage, and occupies practically the same position as the wire gage which it replaced. It is attached to the upstream guard rail in the middle of the second span from the left bank. The datum is the same as that of the original gage. The length of the chain from the end of the weight to the marker is 43.13 feet. Bench mark No. 1 is the top of the floor beam nearest the zero of the gage scale, at a point 0.2 foot downstream from the adjacent tie. Its elevation is 42.01 feet above the gage datum. Bench mark No. 2 is a copper bolt set in the capstone on the downstream side of the left abutment, about 3 feet from the end of the ties. Its elevation is 37.01 feet above gage datum. Discharge measurements are made from the bridge to which the gage is attached. The current is moderately rapid and has a well-distributed velocity. The channel is straight for a considerable distance above and below the station, and has a width at ordinary stages of above 400 feet, broken by one bridge pier. The bed is composed mainly of firm material, and is permanent. The bridge makes a small angle with the normal to the direction of the current. The gage is read once daily by J. E. Figg, the station agent.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Staunton River at Randolph, Va., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
June 22	F. H. Brundage	233	865	2.37	4.47	2,049
September 27	R. H. Bolster	220	468	1.68	2.70	787
October 22	do	224	517	1.59	2.92	822

Mean daily gage height, in feet, of Staunton River at Randolph, Va., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.5	3.9	5.4	4.5	4.9	11.8	6.2	5.9	4.6	2.7	2.9	3.4
2	4.6	4.2	5.2	4.4	5.1	12.2	5.8	6.0	4.8	2.8	2.8	3.7
3	4.5	4.4	5.0	4.3	5.0	8.6	5.6	6.2	4.9	2.9	2.7	3.9
4	4.4	4.8	5.1	4.4	5.2	6.9	5.4	6.4	4.7	3.0	2.8	3.8
5	4.5	5.2	5.2	4.5	5.1	5.6	4.2	7.9	4.5	2.9	2.9	3.7
6	4.6	7.1	5.0	4.6	5.1	5.4	4.3	8.2	4.6	3.1	3.0	3.8
7	4.4	7.4	5.4	4.5	5.4	5.2	3.9	6.8	4.4	2.9	3.1	3.9
8	4.2	7.2	5.6	4.4	5.6	5.1	3.6	5.5	4.2	2.8	3.0	3.9
9	4.0	6.9	5.9	4.3	5.8	4.9	3.5	6.6	3.9	2.7	3.2	4.2

Main daily gage height, in feet, of Staunton River at Randolph, Va., for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
10	4.1	6.6	6.1	4.4	6.0	5.0	3.6	9.4	4.0	2.9	3.6	4.1
11	4.3	6.2	6.2	4.4	6.2	4.8	3.4	9.2	4.1	2.8	3.9	4.2
12	4.5	5.6	6.4	4.5	5.8	4.9	3.5	5.6	4.6	2.7	4.3	4.4
13	4.4	5.1	6.2	4.4	5.4	5.2	3.6	4.5	5.8	2.6	4.9	4.8
14	4.7	4.6	5.9	4.5	4.9	4.7	3.7	4.2	6.4	2.7	4.7	4.5
15	4.8	4.8	5.7	4.7	4.3	4.9	3.8	3.9	6.1	2.6	4.6	4.6
16	4.9	5.1	5.6	4.8	5.7	5.1	3.6	3.6	5.4	2.7	4.3	4.4
17	4.6	5.3	5.5	4.6	6.9	5.3	3.5	3.5	4.2	2.6	3.7	4.2
18	4.4	6.1	5.2	4.4	8.4	5.0	3.3	3.7	4.1	2.5	3.3	4.1
19	4.2	6.8	5.0	4.3	7.2	5.1	3.1	3.9	3.8	2.6	3.1	3.8
20	3.8	7.4	4.8	4.1	6.5	5.3	3.2	4.1	3.6	2.7	3.2	3.7
21	4.2	8.2	5.0	4.0	5.6	5.5	3.0	4.2	3.7	3.4	3.3	3.9
22	4.8	10.4	5.3	3.9	5.4	5.2	2.8	4.4	3.4	2.9	3.2	4.3
23	5.3	9.6	5.6	3.8	5.5	5.2	2.7	4.3	3.1	2.8	3.1	4.8
24	5.4	8.2	5.4	3.9	5.3	5.4	3.3	4.5	3.0	2.7	2.9	5.2
25	5.2	6.8	5.1	3.8	4.9	5.3	3.9	4.6	2.8	2.7	3.0	5.1
26	4.9	6.2	4.9	5.9	4.6	5.5	5.8	4.8	2.9	2.8	3.1	4.9
27	4.6	5.8	4.7	7.1	4.4	5.7	7.6	4.5	2.7	2.9	3.0	4.7
28	4.3	5.4	4.5	6.9	4.2	5.8	8.1	4.7	2.9	2.8	3.2	4.5
29	4.0	5.3	4.6	5.7	4.0	6.7	7.2	4.9	2.8	2.7	3.1	4.2
30	3.9	.....	4.5	4.8	3.8	6.4	6.7	5.2	2.8	2.8	3.3	4.3
31	3.8	.....	4.4	.....	6.9	.....	5.8	5.1	.....	2.7	.....	3.9

Rating table for Staunton River at Randolph, Va., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.50	590	3.90	1,620	5.30	2,775	7.40	4,720
2.60	655	4.00	1,700	5.40	2,860	7.60	4,920
2.70	725	4.10	1,780	5.50	2,950	7.80	5,120
2.80	795	4.20	1,860	5.60	3,040	8.00	5,320
2.90	865	4.30	1,940	5.70	3,130	8.50	5,820
3.00	935	4.40	2,020	5.80	3,220	9.00	6,340
3.10	1,005	4.50	2,100	5.90	3,310	9.50	6,865
3.20	1,080	4.60	2,180	6.00	3,400	10.00	7,390
3.30	1,155	4.70	2,265	6.20	3,580	10.50	7,915
3.40	1,230	4.80	2,350	6.40	3,770	11.00	8,440
3.50	1,305	4.90	2,435	6.60	3,960	11.50	8,980
3.60	1,380	5.00	2,520	6.80	4,150	12.00	9,530
3.70	1,460	5.10	2,605	7.00	4,340		
3.80	1,540	5.20	2,690	7.20	4,530		

The above table is applicable only for open-channel conditions. It is based upon 14 discharge measurements made during 1902 to 1904, inclusive. It is well defined between gage heights 2.70 feet and 4.60 feet. The table has been extended beyond these limits. Above gage height 4.60 feet the rating curve is probably accurate to within 10 per cent.

Estimated monthly discharge of Staunton River at Randolph, Va., for 1904.

[Drainage area, 3,076 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	2,860	1,540	2,087	0.678	0.782
February	7,810	1,620	3,667	1.19	1.28
March	3,770	2,020	2,787	.906	1.04
April	4,435	1,540	2,224	.723	.807
May	5,720	1,540	2,939	.955	1.10
June	9,750	2,265	3,397	1.10	1.23
July	5,420	725	2,117	.688	.793
August	6,760	1,305	2,899	.942	1.09
September	3,770	725	1,801	.586	.654
October	1,230	590	787	.256	.295
November	2,435	725	889	.289	.322
December	2,690	1,230	1,881	.612	.706
The year	9,750	590	2,290	.744	10.10

DAN RIVER AT MADISON, N. C.

This station was established May 14, 1903, by E. W. Myers. It is located at the Southern Railway bridge about one-fourth mile from Madison and one-half mile above the mouth of Mayo River. The standard chain gage is located on the upstream side of the bridge in the sixth panel of the first span from the left end. The length of the chain from the end of the weight to the marker is 35.24 feet. Bench mark No. 1 is the edge of the top of a large wire nail driven flush into the top corner of the wooden floor beam beneath the gage box on the upstream side of the bridge. The point is indicated by the letters "B. M." in white paint. When the gage reads zero, the water surface is 34.10 feet below this bench mark. Bench mark No. 2 is a standard iron bench-mark post set in cleared level ground on the left or south side of the railway track. It is 77 feet west of the initial point for soundings, and 9 feet south of the south rail of the track. Its elevation above the water surface when the gage reads zero is 36.21 feet. Discharge measurements are made from the upstream side of the covered wooden two-span railway bridge and its wooden approaches. The initial point for soundings is the end of the guard rail of the trestle over the left bank. Distances are measured along the upstream guard rail and are marked with white paint. Above the station the channel is straight for about 600 feet and the velocity of

the current is good. About 300 feet below the station the channel makes an abrupt turn. The right bank is low and overflows. There is a long trestle approach to the bridge on this side, and all water passes beneath the bridge and approaches. The left bank is low and overflows.

There is a small stream entering from this side. The bed of the stream is sandy and probably permanent. There is but one channel at all stages. The gage is read once each day by B. F. Reynolds.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrograper.

Discharge measurements of Dan River at Madison, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
January 23	B. S. Drane	151	405	1.90	2.18	772
March 10	do	151	321	1.97	1.80	631
Do	do	151	318	1.96	1.79	623
April 15	do	149	224	1.83	1.06	411
April 16	do	149	224	1.84	1.09	412
June 6	do	150	196	1.81	.90	356
Do	do	150	198	1.82	.90	361
June 7	do	152	344	1.98	1.90	682
September 26	do	148	159	1.59	.50	254
September 27	do	148	159	1.59	.52	254
December 19	do	148	150	1.85	.58	278
December 20	do	148	159	1.98	.65	314

Mean daily gage height, in feet, of Dan River at Madison, N. C., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.90	1.00	1.50	1.65	1.00	2.40	1.80	1.20	1.50	0.35	0.30	0.50
2	.95	.55	1.50	1.55	1.00	2.70	1.20	3.80	1.85	.30	.30	.45
3	1.00	.95	1.45	1.40	1.00	1.90	.85	3.25	1.50	.30	.30	1.45
4	.60	.80	1.40	1.30	1.00	1.45	.75	1.85	1.20	.30	.35	1.10
5	.55	.80	1.35	1.25	.90	1.10	.70	1.00	1.40	.30	.80	.75
6	.65	1.35	1.20	1.20	.90	.90	.90	2.20	1.10	.30	.70	2.50
7	1.00	1.60	1.40	1.40	.90	2.30	1.00	5.40	.80	.30	.40	1.50
8	1.00	4.05	4.80	1.60	2.00	1.20	.80	3.60	.80	.25	.40	1.20
9	.85	2.35	2.45	1.50	1.55	1.10	.70	2.20	.80	.20	.40	.80
10	.90	1.60	1.90	1.60	1.80	.80	.75	5.20	.70	.20	.40	.75
11	1.10	1.20	1.70	1.30	1.35	4.00	1.00	2.80	1.00	.20	.35	.65
12	1.00	1.20	1.55	1.25	1.10	3.10	1.10	2.20	.80	.20	.30	.60
13	1.10	1.10	1.40	1.10	1.00	2.00	1.35	1.60	.60	.20	.50	.55
14	1.00	1.25	1.45	1.15	.90	1.30	.90	1.20	1.00	.20	.50	.50
15	.75	1.30	1.60	1.10	1.60	1.10	.50	1.10	1.00	.20	.55	.50
16	.70	1.20	1.35	1.15	1.10	.90	.40	3.70	1.20	.20	.60	.50
17	.90	.80	1.10	1.10	.90	2.20	.55	1.85	1.10	.20	.55	.70
18	.75	.90	1.25	1.00	7.30	1.80	.50	1.30	1.10	.20	.50	.70

Mean daily gage height, in feet, of Dan River at Madison, N. C., for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
19	.65	1.20	1.40	1.00	3.10	3.70	.40	1.00	1.00	.20	.50	.60
20	.70	2.65	1.20	1.00	1.80	1.50	.45	4.00	.50	.25	.50	.60
21	1.15	1.75	1.20	.90	1.40	1.30	.50	5.90	.50	.30	.50	.60
22	1.05	5.50	1.30	.90	1.25	2.20	2.70	2.45	.50	.30	.45	.60
23	2.05	4.05	1.25	.85	1.10	1.25	1.90	1.65	.50	.30	.50	.50
24	1.50	2.80	10.30	.80	1.00	.90	2.70	1.50	.50	.30	.45	.85
25	1.25	2.05	3.90	.90	1.05	.80	1.50	1.35	.40	.30	.45	.95
26	1.10	1.65	2.50	1.00	1.00	.70	1.00	1.20	.40	.30	.40	1.00
27	1.00	1.60	2.50	2.00	.90	.60	1.20	1.10	.40	.30	.40	1.30
28	.75	1.50	2.70	1.90	.90	.90	1.40	1.00	.40	.30	.40	2.65
29	.35	1.50	2.10	1.35	.80	3.90	3.00	.90	.40	.30	.45	1.95
30	1.15	.....	1.80	1.20	.80	2.40	2.30	.90	.40	.30	.50	1.40
31	1.05	.....	1.60	.....	.80	.....	3.50	.80	.....	.30	.....	1.10

Rating table for Dan River at Madison, N. C., from May 7, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.20	180	0.60	278	1.00	386	1.80	642
.25	192	.65	291	1.10	416	1.90	676
.30	204	.70	304	1.20	446	2.00	710
.35	216	.75	317	1.30	476	2.10	744
.40	228	.80	330	1.40	508	2.20	778
.45	240	.85	344	1.50	540	2.30	813
.50	252	.90	358	1.60	574	2.40	849
.55	265	.95	372	1.70	608	2.50	885

The above table is applicable only for open-channel conditions. It is based upon 10 discharge measurements made during 1904 and 4 measurements made during 1903. It is well defined between gage heights 0.50 foot and 2.50 feet.

Discharge estimated above 2.50 gage height.

Estimated monthly discharge of Dan River at Madison, N. C., for 1903–4.

Month	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
1903.			
May 8–31	2,465	574	992
June	3,300	710	1,199
July	2,735	416	742
August	4,250	401	910
September	2,495	358	541
October	813	330	398
November	1,020	317	418
December	795	265	388

Estimated monthly discharge of Dan River at Madison, N. C., for 1903–4—Continued.

Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
1904.			
January	727	216	376
February	2,375	265	659
March	5,255	416	808
April	710	330	463
May	3,455	330	550
June	1,575	278	653
July	1,335	228	480
August	2,615	330	865
September	659	228	349
October	216	180	195
November	330	204	242
December	953	240	386
The year	5,255	180	502

DAN RIVER AT SOUTH BOSTON, VA.

This station, which was established on August 27, 1900, by E. W. Myers, is in the town of South Boston, Va., on the railroad bridge of the Norfolk and Western Railroad which crosses the river at that place. On May 18, 1903, B. S. Drane replaced the wire gage with a standard chain gage. The datum was not changed. The gage is located on the downstream guard rail near the center of the first span from the left bank. The length of the chain from the end of the weight to the marker is 35.02 feet. Bench mark No. 1 is the sharp inner corner toward the left bank of the plate attached to the inner surface of the struts at the center of the left span and to the bearing of the wooden floor beam and tie. The elevation of the top of the plate is 32.86 feet above gage datum. Bench mark No. 2 is the top of a standard copper bolt set in the capstone of the abutment of the viaduct by means of which the Southern Railway crosses the highway a short distance upstream from the Norfolk and Western and Southern Railway crossing. Its elevation is 30.65 feet above gage datum.

Discharge measurements are made from the bridge to which the gage is attached. The initial point for soundings is the left end of the downstream guard rail. This is a very good station for the gaging of all except the very highest stages of flow. At extreme heights the river spreads out over a flood plain of considerable width. The trestle connecting the bridge with the embankment on the south side of the river is on a curve of rather high degree. The bed of the stream is of

coarse sand and probably shifts only slightly. The gage is read twice daily by J. Mercer East.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Dan River at South Boston, Va., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
June 21	F. H. Brundage	253	1,542	1.57	2.68	2,422
September 15	R. H. Bolster	295	3,820	2.85	10.82	10,890
September 28	do	243	1,152	1.20	1.22	1,385
October 20	J. C. Hoyt	238	1,015	.89	.745	904

Mean daily gage height, in feet, of Dan River at South Boston, Va., for 1904.

Day.	Jan	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.95	2.15	2.40	2.25	2.30	3.20	3.10	4.67	1.25	1.28	0.35	1.38
2	1.85	1.80	2.20	2.25	1.80	4.99	2.90	4.60	2.37	.72	.68	1.48
3	2.10	2.05	2.15	2.20	1.40	5.45	2.47	5.00	4.75	.20	.98	1.95
4	1.75	1.90	2.30	2.00	1.70	3.55	1.95	3.77	4.02	.42	1.02	2.65
5	1.62	2.10	2.25	1.75	1.45	2.45	1.35	2.00	2.79	.47	1.02	3.98
6	a.55	2.25	2.35	1.65	1.40	1.80	.92	1.67	2.10	.95	.72	5.18
7	.62	2.20	3.50	1.75	1.90	2.65	.87	1.57	1.30	.67	.42	4.62
8	1.45	6.10	4.55	1.80	1.80	3.15	1.57	4.80	.95	.37	.68	3.68
9	2.07	6.05	4.95	1.70	1.65	2.55	1.05	7.25	1.72	.15	1.12	2.70
10	1.90	3.80	4.20	1.90	1.80	1.95	.92	11.15	1.32	.02	1.18	1.92
11	2.05	2.95	3.25	1.95	1.80	1.80	1.32	9.70	1.05	—.05	1.20	1.52
12	2.17	2.70	2.65	1.70	1.80	3.55	1.55	6.15	.92	.62	1.02	1.42
13	2.07	2.05	2.60	1.50	1.50	4.85	1.60	3.75	1.47	.63	1.78	1.68
14	2.00	1.90	2.50	1.40	1.50	2.63	1.42	2.65	3.97	.65	2.88	1.55
15	1.82	2.15	2.45	1.40	2.40	1.73	1.22	1.82	10.75	.68	2.38	1.58
16	1.55	2.30	2.40	1.40	2.40	1.43	1.22	1.52	9.05	.28	1.68	1.68
17	1.45	1.55	2.25	1.45	3.70	1.40	.87	1.27	3.27	.02	1.58	1.72
18	1.42	1.60	2.10	1.40	4.05	1.33	.65	1.37	1.82	.25	1.48	1.68
19	1.55	2.05	2.05	1.35	8.00	1.30	.92	1.40	1.07	.70	1.42	1.20
20	1.27	4.20	2.10	1.35	4.40	1.23	.67	1.52	1.37	.62	.88	1.38
21	1.45	4.00	1.80	1.30	2.70	2.50	.68	1.37	1.37	.52	.48	1.68
22	1.70	8.50	1.65	1.30	2.25	2.05	.77	3.77	1.37	1.42	.58	1.58
23	2.85	11.05	2.10	1.30	1.70	1.78	2.15	3.37	1.37	.68	1.62	1.50
24	3.00	8.05	5.45	1.30	1.60	1.48	4.67	2.27	1.37	.38	1.52	1.62
25	2.90	4.55	9.70	1.30	1.55	1.28	6.30	1.50	1.12	.35	1.50	1.62
26	2.10	3.80	5.30	1.35	1.50	1.02	2.50	1.37	1.13	1.18	1.40	1.95
27	1.95	3.05	4.05	1.60	1.35	.85	2.05	1.27	1.32	1.05	.82	2.35
28	1.75	3.15	3.80	2.35	1.30	1.32	2.10	1.05	1.32	.85	.38	2.10
29	.82	2.55	3.55	3.25	1.15	1.95	2.97	.72	1.28	.68	1.18	1.98
30	.88	.....	2.80	2.80	1.10	2.77	4.17	.85	1.22	.45	1.42	1.78
31	1.08	.....	2.45	.....	1.00	.....	4.52	1.07	.....	.28	.....	1.75

a Ice.

Rating table for Dan River at South Boston, Va., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.00	400	1.70	1,635	3.40	2,989	6.20	5,453
.10	451	1.80	1,713	3.50	3,070	6.40	5,644
.20	510	1.90	1,791	3.60	3,152	6.60	5,838
.30	574	2.00	1,870	3.70	3,234	6.80	6,034
.40	642	2.10	1,949	3.80	3,317	7.00	6,234
.50	713	2.20	2,028	3.90	3,400	7.20	6,434
.60	786	2.30	2,107	4.00	3,484	7.40	6,638
.70	861	2.40	2,186	4.20	3,653	7.60	6,845
.80	937	2.50	2,265	4.40	3,824	7.80	7,055
.90	1,014	2.60	2,345	4.60	3,997	8.00	7,275
1.00	1,091	2.70	2,425	4.80	4,172	8.50	7,830
1.10	1,168	2.80	2,505	5.00	4,349	9.00	8,415
1.20	1,245	2.90	2,585	5.20	4,528	9.50	9,030
1.30	1,323	3.00	2,665	5.40	4,709	10.00	9,700
1.40	1,401	3.10	2,746	5.60	4,892	10.50	10,420
1.50	1,479	3.20	2,827	5.80	5,077	11.00	11,190
1.60	1,557	3.30	2,908	6.00	5,264	11.50	11,990

The above table is applicable only for open-channel conditions. It is based upon discharge measurements made during 1903 and 1904. It is fairly well defined. The table has been extended below gage height 0.75 foot.

Estimated monthly discharge of Dan River at South Boston, Va., for 1904.

[Drainage area, 2,750 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	2,665	750	1,663	0.605	0.697
February	11,270	1,518	3,239	1.18	1.27
March	9,290	1,596	2,847	1.04	1.20
April	2,868	1,323	1,663	.605	.675
May	7,275	1,091	1,999	.727	.838
June	4,755	976	2,147	.781	.871
July	5,548	824	1,877	.683	.788
August	11,430	876	2,901	1.05	1.21
September	10,795	1,029	2,250	.818	.913
October	1,417	375	772	.281	.324
November	2,569	608	1,233	.448	.500
December	4,510	1,245	1,953	.710	.819
The year	11,430	375	2,045	.744	10.11

MAYO RIVER AT MADISON, N. C.

This station was established as a bench-mark station April 16, 1904, by B. S. Drane. It is located about one-half mile from Madison, N. C., at the highway bridge on the road to Mayodan, N. C., and about 1,000 feet above the junction of Mayo and Dan rivers. Discharge measurements are made from the downstream side of the two-span bridge resting on three stone piers. The initial point for soundings is over the left end of the bridge, downstream side. The channel is straight for about 600 feet above and 1,000 feet below the station. The current is swift. Both banks are high, wooded, and not liable to overflow. The bed of the stream is composed of sand, with some rock along the left bank. There is but one channel. At low stages all water passes under the left span; at higher stages, under both spans. Two cotton mills about 3 miles upstream will control the flow at all times, and freshets in Dan River will also cause backwater at the station. The bench mark is the upper edge of a small tie plate on the upstream side of the bottom of the third strut from the left bank on the upstream side of the bridge. Its elevation is 28 feet above datum.

Discharge measurements of Mayo River at Madison, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
April 16	B. S. Drane	59	249	1.13	1.82	281
June 7	do	60	270	.90	2.09	244
September 27	do	61	250	.81	1.24	202

BANISTER RIVER AT HOUSTON, VA.

This river, which drains a total area of 520 square miles, has its headwaters in Pittsylvania County, Va., flows southwesterly through this and Halifax counties, and is tributary to Dan River at a point about 5 miles below South Boston. The basin is hilly and generally in farming lands, with small forest areas. This station was established September 28, 1904, by R. H. Bolster, and is located at a covered highway bridge one and a fourth miles below the railway station at Houston, Va., and about one-fourth of a mile below the mouth of Terrible Creek. A standard chain gage is attached to the upstream side of the bridge near the left pier; the length of chain is 33.50 feet. A board gage at the mouth of Terrible Creek has been set to read the same as the chain gage at 2.3 feet above gage datum and has been used since November 27. A high-water gage from 19 to 30 feet is painted on the northeast corner of Mr. Yates's mill.

The datum of the chain gage is referred to bench marks as follows: No. 1, chiseled cross at the top of the left abutment, upstream side of bridge; elevation, 25.27 feet. No. 2, top of foundation at northeast corner of Mr. Yates's mill, directly under the high-water gage; elevation, 19.12 feet. No. 3, nail in 10-inch tree 50 feet northeast of bridge over Terrible Creek; elevation, 16.48 feet.

The channel is straight for about 1,000 feet above and below the station. Both banks are low and liable to overflow. The bed of the stream is of gravel and sand, and probably changes somewhat. There is one channel, broken by one pier at low water and by two piers at medium stages. The gage is read twice daily by J. A. Yates.

The observations at this station during 1904 have been made under the direction of N. C. Grover, district hydrographer.

Discharge measurements of Banister River at Houston, Va., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
September 28 ..	R. H. Bolster.....	73	126	1.44	2.31	181
October 22.....	.....do	72	131	1.24	2.30	162

Mean daily gage height, in feet, of Banister River at Houston, Va., for 1904.[a]

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1.....	2.05	2.12	2.32	12.....	2.00	2.25	2.65	23.....	.....	2.15	2.38	2.78
2.....	2.00	2.22	2.32	13.....	1.95	2.92	2.68	24.....	.....	2.10	2.38	2.98
3.....	2.00	2.20	3.08	14.....	1.95	4.05	2.40	25.....	.....	2.00	2.32	3.65
4.....	2.00	2.25	3.15	15.....	1.95	3.10	2.38	26.....	.....	2.20	2.32	3.35
5.....	2.05	2.52	3.80	16.....	1.90	2.65	2.48	27.....	.....	2.20	2.30	3.50
6.....	2.00	2.48	6.08	17.....	2.00	2.48	2.68	28.....	2.15	2.12	2.30	3.88
7.....	2.00	2.32	4.60	18.....	1.90	2.35	2.85	29.....	2.70	2.15	2.30	3.55
8.....	2.00	2.28	3.40	19.....	2.05	2.35	2.72	30.....	2.28	2.10	2.32	2.95
9.....	1.90	2.28	3.05	20.....	2.00	2.30	2.85	31.....	.....	2.10	.....	2.98
10.....	2.00	2.20	2.90	21.....	2.35	2.30	2.80					
11.....	1.95	2.25	2.75	22.....	2.30	2.35	2.62					

[a] Gage heights from September 28 to November 26 refer to the bridge gage. For the remainder of the year they refer to the gage at the mouth of Terrible Creek.

PEDEE, OR YADKIN, RIVER DRAINAGE BASIN.

The Yadkin River, or the Pedee, as it is called below the junction with the Uharie, rises on the eastern slope of the Blue Ridge, in Caldwell and Watauga counties, N. C., and flows at first southeast, then turns abruptly northeast and flows in this direction for about 60 miles, then bends again abruptly and flows south and southeast across North Carolina and South Carolina, emptying into Winyah Bay at Georgetown, S. C. The total length of the stream, from source to

mouth, following its general direction, is from 275 to 300 miles, while it is probably 400 miles or more if all the windings be followed.

The Pedee drains a total area of about 17,000 square miles, of which about 9,700 square miles are in North Carolina and 7,300 in South Carolina. The stream crosses the fall line near Cheraw, S. C., in a series of rapids extending over a number of miles, with no very great fall at any one place or in any short distance.

Small amounts of power may be developed on some of the tributaries of this stream in South Carolina, but the power possibilities of the basin in this State are unimportant. In North Carolina the stream can be made to furnish power in large quantities at a number of places, and large amounts may be secured on many of the tributaries. This stream and its tributaries are among the most important power streams in the Southern States.

Below the great bend, where the river turns to the south, the valley of the stream averages about 50 miles in width. At many points the river is bordered by wide expanses of bottom lands, which are at times subject to overflow, and which are fertile and very productive. At other places the river is confined between bold and abrupt banks, and in one case it flows for several miles in a very narrow channel, only 60 feet wide in places, in a deep ravine between the flanking hills, forming the noted "Narrows." Above the great bend the valley is only from 15 to 20 miles wide, and the elevations of the divides which separate the basin of the Yadkin from those adjacent are much higher, so that the tributary streams have a large fall.

The upper part of the drainage basin is rough and mountainous and largely forest covered, and throughout this part of its course the flow of the stream is more constant than would be expected.

The average rainfall over the part of the basin in North Carolina is probably between 48 and 51 inches, approximating the lower figure over the lower portions, and possibly exceeding 51 inches over the higher and more mountainous portions, the precipitation increasing as the stream is ascended. This total amount is rather evenly distributed among the seasons.

The highest flood ever known at Wilkesboro, it is stated, occurred in March, 1899, the stream at this place rising 28 feet above low water. The greatest flood recorded at the gaging station at Salisbury, N. C., occurred in December, 1901, the stream reaching an extreme height on the gage of 19.7 feet and having a probable discharge of about 130,000 second-feet, or about 38 second-feet per square mile. The flood of March, 1899, produced a rise of about 1 foot less than this flood of December. The most destructive flood ever experienced on the stream occurred in May, 1901, but the recorded gage height at the Salisbury station was less for this flood than for either of the others

mentioned, and the general testimony of those living along the banks is to the same effect.

The minimum recorded flow at the Salisbury station occurred in September, October, and November, 1897, when the basin of the stream experienced the most severe drought in its history. The flow fell to 900 second-feet several times during this period, or the basin above the station was discharging at an average rate of 0.26 second-foot per square mile. The maximum flow is thus about 144 times the minimum.

The United States Weather Bureau maintains river stations at this basin as follows:

Pedee at Cheraw, S. C.
Pedee at Smiths Mills, S. C.

During 1904 the United States Geological Survey has maintained gaging stations in this drainage basin as follows:

Yadkin at Salisbury, N. C.
Yadkin at North Wilkesboro, N. C.
Reddie at North Wilkesboro, N. C.
Mulberry, at North Wilkesboro, N. C.
Roaring at Roaring River, N. C.
Mitchell at Burch, N. C.
Fisher at Crotchfield, N. C.
Ararat at Siloam, N. C.

YADKIN RIVER NEAR SALISBURY, N. C.

This station was established by C. C. Babb, September 24, 1895, at the Southern Railway bridge about 6 miles east of Salisbury, N. C. Measurements were made from the decked railroad bridge, from which the original wire gage was also suspended. During the year 1899 the location of the measuring station and wire gage was changed to a new iron highway bridge about 300 yards above, the gage being set to read the same as the original one. Early in 1903 it was decided that the original location at the railroad bridge was better; so the station was again changed to it, but the gage was located on the plank walk supported by the lower members of the bridge. The new gage is a standard gage, and is fastened to lower member of the bridge along the plank walk, near the middle of the first span from right bank. The length of the gage chain from the end of the weight to the marker is 28.66 feet.

Bench mark No. 1 is the top of the inside eyebar of the lower chord on the downstream side, in the fourth panel from the right end of the bridge, opposite a point 80 feet from the initial point for soundings. It is marked with white paint and has an elevation of 27.28 feet above gage datum. Bench mark No. 2 is the top of the anchor-bolt head at the right downstream corner of the foot plate on the right abutment,

downstream side. Its elevation is 26.82 feet above gage datum. The discharge measurements are made from the walk to which the gage is attached. The bridge is a four-span iron bridge of the decked type, having a total length of about 650 feet between stone abutments, the left bank abutment being at the edge of the high rocky bluff, while that at right bank is connected with the hill by a short earth embankment. The river is confined by the abutments at all stages, and occupies practically the whole width at low water.

The channel is straight for a long distance below, but curves considerably above. The bed of the river is rocky, and the depth of water is fairly uniform. Current is good, even at lowest stages. The initial point for soundings is the end of the bridge at right bank. The gage is read once daily by J. T. Yarbrough, the bridge keeper.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Yadkin River near Salisbury, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
February 16	B. S. Drane	523	2,061	1.38	2.06	2,843
March 17	do	522	2,132	1.44	2.19	3,075
April 25	do	523	2,090	1.22	2.08	2,543
July 22	do	564	1,332	1.96	1.94	2,611
Do	do	528	2,128	1.38	2.22	2,942
September 7	do	524	2,184	1.78	2.52	3,892
September 28	do	520	1,779	.82	1.44	1,465
Do	do	562	1,120	1.36	1.42	1,526
December 17	do	522	1,942	1.08	1.82	2,090

Measurements made at different sections.

Mean daily gage height, in feet, of Yadkin River near Salisbury, N. C., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.75	1.95	2.46	2.00	1.85	2.30	4.20	2.35	1.65	1.35	1.35	1.45
2	1.85	1.74	2.35	2.05	1.95	4.65	3.05	2.25	3.10	1.25	1.35	1.50
3	1.90	1.80	2.25	1.95	1.75	5.10	2.60	3.00	3.00	1.25	1.35	1.95
4	1.92	1.88	2.20	2.05	1.80	3.10	2.25	2.55	2.35	1.30	1.50	2.30
5	1.65	1.90	2.15	1.90	2.05	2.55	2.05	2.05	2.80	1.25	1.75	2.15
6	1.80	1.85	2.00	1.85	2.10	2.30	1.85	2.40	3.15	1.30	2.10	3.00
7	1.45	2.05	2.20	1.85	1.90	2.10	2.10	2.65	2.50	1.30	2.05	3.05
8	1.85	3.35	[a]5.20	1.95	2.20	3.00	1.90	4.85	2.15	1.35	1.60	2.55
9	1.85	3.45	4.55	1.90	2.35	2.45	1.80	3.70	1.80	1.35	1.50	2.00
10	1.90	2.75	3.25	2.35	2.75	2.05	2.05	3.50	1.70	1.30	1.45	1.90
11	1.98	2.25	2.75	2.20	2.25	2.25	2.45	3.65	2.05	1.30	1.50	1.80

[a] Extreme height March 8, 1904, 4 p. m. was 6 feet.

Mean daily gage height, in feet, of Yadkin River near Salisbury, N. C., for 1904— Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
12	1.85	2.15	2.50	1.90	2.25	4.20	1.95	3.80	1.80	1.30	1.50	1.85
13	1.80	2.10	2.40	1.85	2.00	3.25	1.85	3.00	1.60	1.25	1.45	1.70
14	1.85	2.04	2.40	1.80	1.85	2.30	1.80	2.45	1.65	1.30	2.70	1.70
15	1.82	2.10	2.35	1.80	2.35	2.00	1.65	2.15	1.60	1.20	2.65	1.65
16	1.78	2.00	2.25	1.80	2.35	1.90	1.85	2.80	1.60	1.10	2.05	1.65
17	1.78	1.96	2.05	1.90	1.95	1.85	1.85	3.80	1.60	1.25	1.70	1.65
18	1.90	1.80	1.95	1.95	2.00	2.60	1.85	2.90	1.50	1.20	1.60	1.70
19	1.64	1.75	1.95	1.75	6.60	2.50	1.65	2.25	1.50	1.20	1.60	1.85
20	1 70	3.00	2.10	1.75	4.25	2.50	1.55	2.00	1.50	1.30	1.50	1.70
21	1.68	2.80	2.10	1.70	2.85	2.35	1.55	2.50	1.50	1.25	1.65	1.65
22	1.68	3.95	1.95	1.70	2.40	2.10	1.70	2.85	1.50	1.30	1.50	1.60
23	1.95	5.10	2.05	1.70	2.30	2.25	2.15	2.45	1.50	1.20	1.55	1.60
24	2.60	4.20	2.30	1.70	2.00	1.90	3.55	2.30	1.50	1.20	1.60	1.65
25	2.38	3.10	4.40	1.90	1.95	1.80	2.85	2.45	1.40	1.20	1.60	1.85
26	1.95	2.55	3.30	1.75	1.85	1.65	2.25	2.50	1.45	1.30	1.55	1.95
27	1.85	2.48	2.65	2.00	1.90	1.75	2.30	1.90	1.45	1.35	1.45	2.05
28	1.92	2.70	2.70	2.30	1.85	2.05	2.55	1.95	1.40	1.35	1.55	2.65
29	1.75	2.68	2.35	2.00	1.75	4.05	3.15	1.90	1.50	1.35	1.50	2.85
30	1.60	.....	2.10	1.90	1.85	6.35	5.05	1.65	1.35	1.30	1.45	2.50
31	1.78	.....	2.05	.....	1.70	.....	3.00	1.65	.....	1.30	.....	2.05

Rating table for Yadkin River near Salisbury, N. C., from January 1, 1904, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.10	1,050	2.20	3,015	3.30	6,250	4.80	11,780
1.20	1,170	2.30	3,270	3.40	6,585	5.00	12,600
1.30	1,300	2.40	3,540	3.50	6,930	5.20	13,440
1.40	1,445	2.50	3,820	3.60	7,280	5.40	14,280
1.50	1,600	2.60	4,110	3.70	7,630	5.60	15,120
1.60	1,770	2.70	4,400	3.80	7,985	5.80	15,960
1.70	1,950	2.80	4,695	3.90	8,345	6.00	16,800
1.80	2,140	2.90	4,995	4.00	8,710	6.50	18,900
1.90	2,340	3.00	5,300	4.20	9,455		
2.00	2,550	3.10	5,610	4.40	10,220		
2.10	2,775	3.20	5,925	4.60	10,990		

The above table is applicable only for open-channel conditions. It is based upon 9 discharge measurements made during 1904 and 10 made during 1903. It is fairly well defined between gage heights 1.40 feet and 2.60 feet. The table has been extended below gage height 1.40 feet. Above gage height 5 feet the rating curve is a tangent, the difference being 420 per tenth.

Estimated monthly discharge of Yadkin River near Salisbury, N. C., for 1904.

[Drainage area, 3,399 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	4,110	1,300	2,226	0.655	.755
February	13,020	2,026	4,151	1.22	1.32
March	13,440	2,445	4,177	1.23	1.34
April	3,405	1,950	2,370	.697	.778
May	19,320	1,950	3,521	1.04	1.20
June	18,270	1,860	4,770	1.40	1.56
July	12,810	1,685	3,624	1.07	1.23
August	11,987	1,860	4,434	1.30	1.50
September	5,768	1,372	2,376	.699	.780
October	1,372	1,050	1,268	.373	.430
November	2,775	1,372	1,931	.568	.634
December	5,455	1,523	2,630	.774	.892
The year	19,320	1,050	2,873	.919	12.42

YADKIN RIVER AT NORTH WILKESBORO, N. C.

This station was established April 10, 1903, by E. W. Myers. It is located at the lower highway bridge between Wilkesboro and North Wilkesboro, about one-half mile below North Wilkesboro railroad station and about three-fourths of a mile below the mouth of Reddie River. The scale of the standard chain gage is fastened to the downstream guard rail with its zero 7.63 feet east of the center of the second strut from the west end of the span. The distance from the end of the weight to the marker is 33.38 feet.

Bench mark No. 1 is the top surface of the outer eyebar of the lower chord opposite a point 100 feet from the initial point for soundings. When the gage reads zero the water surface is 30.75 feet below this bench mark. Bench mark No. 2 is the top corner of the pulley frame above the hole in the box which incloses the chain. When the gage reads zero the water surface is 31.88 feet below this bench mark.

Discharge measurements are made from the downstream side of the steel highway bridge to which the gage is attached. The bridge consists of a single steel span about 125 feet long, under which the river flows at ordinary stages, and three wooden spans about 50 feet each on the right bank. There are also wooden trestle approaches about 170 feet long on the right bank and about 40 feet on the left

bank. The initial point for soundings is the end of the downstream guard rail at the left end of the bridge. Distances are measured along this guard rail and are marked in white paint. The channel is straight above the station, but makes a very slight curve beneath the bridge. Below the station the channel is straight for about 600 feet. The water is swift both above and below. The right bank is low and is subject to overflow, but all water must pass beneath the bridge and its approaches. The left bank is high and rocky and does not overflow at the bridge. Above the bridge it (the left bank) is subject to overflow. The bed of the stream is rocky, with sand in places. There is a single channel at all stages. The gage was read once each day during 1904 by U. H. Wyatt.

The observations at this station during 1904 have been made under the direction of M. R. Hall, district hydrographer.

Discharge measurements of Yadkin River at North Wilkesboro, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
March 11	B. S. Drane	95	434	2.30	1.17	1,000
March 12	do	95	399	2.26	.92	903
April 18	do	93	308	1.87	.31	574
April 19	do	93	306	1.88	.26	575
June 8	do	96	396	2.54	1.24	1,004
Do	do	96	396	2.55	1.22	1,009
September 22	do	93	218	2.13	.09	465
Do	do	93	218	1.96	.09	428
December 21	do	92	229	2.13	.07	452
Do	do	92	226	2.06	.03	432

Mean daily gage height, in feet, of Yadkin River at North Wilkesboro, N. C., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.30	[a]0.40	0.85	0.60	0.20	4.60	2.50	1.25	0.50	0.00	−0.05	−0.05
2	.30	−[b].20	.80	.50	.20	2.70	1.25	1.20	.70	.00	− .05	− .05
3	.30	[a].40	.70	.45	1.30	1.75	.90	1.35	.45	.00	− .05	.20
4	−[b].05	[b].20	.65	.40	2.20	1.40	.75	.70	.40	− .05	.25	.10
5	−[b].05	[b].20	.50	.35	1.10	1.10	1.00	.95	2.40	.05	1.30	.10
6	.10	[a].50	.40	.30	.90	2.15	1.15	1.50	.85	.00	.25	1.30
7	.40	.50	7.50	.50	.90	1.45	.80	.75	.60	.00	.00	.40
8	.20	1.95	3.70	.50	1.10	1.50	1.35	2.25	.50	.00	.00	.20
9	.20	.85	2.10	1.05	2.90	.95	.70	1.20	.45	− .05	.00	.10
10	.25	.60	1.50	.55	2.20	.95	1.20	2.15	.40	− .10	.00	.10
11	.25	.55	1.20	.50	1.60	1.50	.70	1.60	.40	− .10	− .05	.10
12	.30	.45	.90	.40	1.20	1.10	.85	1.20	.45	− .10	.05	.05
13	.30	.30	.75	.35	.95	.85	.55	.95	.40	− .10	.60	.00

[a] Thaw. [b] Freeze.

Mean daily gage height, in feet, of Yadkin River at North Wilkesboro, N. C., for 1904— Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
14	.30	.40	.80	.30	.75	.70	.40	.90	.55	— .10	.75	— .10
15	*a* .00	.35	.70	.25	.90	.65	.40	1.70	.30	— .10	.20	.00
16	*b* .20	.30	.55	.20	.60	.65	.40	1.60	.20	— .10	.10	.00
17	.25	.10	.50	.25	.50	1.95	.60	.75	.20	— .10	.00	.10
18	.05	.30	.50	.25	9.80	.90	.35	.50	.10	— .10	.00	.10
19	—*a* .05	.30	.50	.25	3.40	.90	.25	.40	.10	— .10	.00	— .10
20	— .20	.45	.45	.20	2.00	1.00	.20	1.05	.10	— .10	.00	— .10
21	*b* .30	.30	.55	.20	1.40	.75	.20	1.20	.10	— .10	.00	.10
22	.35	2.35	.80	.20	1.10	.70	.20	1.25	.10	— .10	.00	— .05
23	.20	1.90	.65	.20	.90	.50	.20	.75	.00	— .15	.00	— .05
24	.90	1.15	1.60	.20	.75	.45	.30	4.50	.00	— .15	.00	.00
25	.60	.80	1.25	.20	.90	.40	1.60	1.40	.00	— .15	— .10	.10
26	.50	.70	1.00	.65	.90	.50	1.20	1.05	10	— .15	— .10	.05
27	.35	.80	1.10	.65	.60	.55	.15	.80	.10	— .05	— .10	.30
28	.35	.90	.85	.40	.50	4.80	.95	.65	.05	— .05	— .10	1.70
29	*a* .25	.90	.70	.30	.40	2.50	6.70	.60	.05	— .05	— .10	.60
30	*a* .10	.....	.60	.25	.80	1.65	1.35	.50	.00	— .05	— .05	.15
31	*a* .10	.....	.60	.....	1.70	.....	.85	.45	.....	— .05	.....	.25

a Freeze. *b* Thaw.

Rating table for Yadkin River at North Wilkesboro, N. C., from January 1, 1904, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.00	417	.60	710	1.20	1,010	1.80	1,345
.10	465	.70	760	1.30	1,060	1.90	1,410
.20	513	.80	810	1.40	1,115	2.00	1,475
.30	562	.90	860	1.50	1,170		
.40	611	1.00	910	1.60	1,225		
.50	660	1.10	960	1.70	1,285		

The above table is applicable only for open-channel conditions. It is based upon 10 discharge measurements made during 1904. It is well defined between gage heights 0 feet and 1.30 feet. The table has been extended beyond these limits. Above gage height 2 feet the discharge has been estimated.

Estimated monthly discharge of Yadkin River at North Wilkesboro, N. C., for 1904.

[Drainage area 498 square miles.]

Room.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	860	322	532	1.07	1.23
February	1,730	322	742	1.49	1.61
March	9,300	611	1,171	2.35	2.71
April	935	513	602	1.21	1.35
May	14,500	513	1,467	2.95	3.40
June	4,375	611	1,224	2.46	2.74
July	7,650	513	1,032	2.07	2.39
August	3,950	611	1,059	2.13	2.46
September	1,770	417	594	1.19	1.33
October	417	345	381	.765	.882
November	1,060	369	461	.926	1.03
December	1,285	369	506	1.02	1.18
The year	14,500	322	814	1.64	22.31

REDDIE RIVER AT NORTH WILKESBORO, N. C.

This station was established as a bench-mark station April 18, 1904, by B. S. Drane. It is located at the highway bridge just without the town of North Wilkesboro, N. C., and about one-half mile above the mouth of Reddie River. Discharge measurements are made from the downstream side of the single-span, covered, bridge, the meter being lowered outside the floor. The initial point for soundings is the left end of the bottom rail downstream hand rail. The channel is straight for about 500 feet above and below the station. The current is swift. Both banks are high and not subject to overflow. The bed of the stream is composed of sand, and is somewhat shifting. There is only one channel for all stages. A small lumber mill and dam a short distance above the station will affect the flow during low water. The bench mark is the upper edge of the lower rail of the downstream guard rail, by the side of a notch, 66 feet from the initial point for soundings. Its elevation is 27 feet above datum.

Discharge measurements of Reddie River at North Wilkesboro, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
April 18	B. S. Drane	57	61	1.22	1.98	75
June 9	do	59	91	1.69	2.26	153
September 23	do	50	51	1.57	1.66	80

MULBERRY RIVER NEAR NORTH WILKESBORO, N. C.

This station was established as a bench-mark station November 7, 1903, by B. S. Drane. It is located at the Southern Railway bridge about 2 miles east of North Wilkesboro, N. C., and less than one-half mile above the mouth of Mulberry River. Discharge measurements are made from the downstream side of the bridge. The initial point for soundings is the streamward face of the left trestle bent. The channel is curved for 100 feet above and below the station. The current is swift. The right-bank approach is over a long trestle and the stream overflows under this during high stages. The left bank is rocky and the section is bounded by the masonry abutment of the railroad fill. The bed of the stream is rocky along the left bank, sandy along the right bank, and is permanent. There is but one channel. The current is broken at all but the lowest stages by one or more of the trestle bents supporting the bridge. High water in Yadkin River will probably back up to this point. The bench mark is the apex of the triangular downstream end of the iron bearing through which pass the iron tension rods midway between the ends of the truss, on the downstream side of the bridge, about 2 feet east of the second bent from the left bank. Its elevation is 24 feet above datum.

Discharge measurements of Mulberry River near North Wilkesboro, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
April 19	B. S. Drane	15	25	1.62	1.12	41
June 8	do	25	31	1.98	1.30	61
September 22	do	21	21	1.37	.91	29

ROARING RIVER AT ROARING RIVER, N. C.

This station was established as a bench-mark station April 20, 1904, by B. S. Drane. It is located at the Southern Railway bridge, a short distance above the mouth of Roaring River, at Roaring River, N. C.

Discharge measurements are made from the downstream side of the one-span bridge. The initial point for soundings is on the downstream guard-rail, exactly over the left end of the bridge. The channel is straight for about 200 feet above and 500 feet below the station. The current is swift. The banks rise gradually, but all water passes beneath the bridge and its approaches. The bed of the stream is composed of sand and gravel and is slightly shifting. There is but one channel at all stages, broken during high water by the piers and trestle approaches of the bridge. High water in Yadkin River will make this site of no value as a gaging station, but it is good at ordinary stages. The bridge crosses the river almost at right angles to the current. The bench mark is the edge of the outermost eyebar of the downstream lower chord, at a point midway between the ends of the bridge opposite the iron tension rods. Its elevation is 27 feet above gage datum.

Discharge measurements of Roaring River at Roaring River, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
April 20	B. S. Drane	62	103	1.20	1.55	125
June 9	do	78	105	1.70	1.93	178
September 23	do	63	53	1.36	1.10	72

MITCHELL RIVER AT BURCH, N. C.

This station was established as a bench-mark station April 20, 1904, by B. S. Drane. It is located at the Southern Railway bridge at Burch, N. C., a few hundred feet above the mouth of Mitchells River. Discharge measurements are made from the downstream side of the one-span railway bridge. The initial point for soundings is the end of the downstream guard-rail at the left end of the bridge. The channel is straight for about 700 feet above and 300 feet below the station. Both banks are high, clean, and not liable to overflow. The bed of the stream is composed of sand and gravel, and is slightly shifting. There is but one channel at all stages. Good measurements can be made at ordinary stages, but high water in Yadkin River renders the station of no value as a gaging point. The bridge crosses the stream diagonally. The bench mark is the upper edge of the outermost eyebar of the lower chord, downstream side, midway between the ends of the bridge, 62.5 feet from the initial point for soundings. Its elevation is 27 feet above datum.

Discharge measurements of Mitchell River at Burch, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
April 20	B. S. Drane	84.5	169	.57	2.07	96
September 23	do	65	150	.46	1.99	69

FISHER RIVER NEAR CRUTCHFIELD, N. C.

This station was established as a bench-mark station April 20, 1904, by B. S. Drane. It is located about 2 miles east of Crutchfield, N. C., at the Southern Railway bridge, just above the mouth of the river. Discharge measurements are made from the upstream side of the one-span bridge. The initial point for soundings is the right end of the upstream guard rail. The channel is curved for about 500 feet above and 100 feet below the station. The current is very sluggish. Both banks are high, and not liable to overflow. The bed of the stream is composed of deep mud and silt, and is obstructed along the right bank by the ironwork of an old bridge burned here. There is but one channel for all stages.

High water in Yadkin River will make the station valueless at such times, and the station has little to recommend it except its accessibility. Bench mark No. 1 is the upstream edge of the upper surface of the I beam forming the upstream lower chord, at a point 90 feet from the initial point for soundings. Its elevation is 27 feet above datum. Bench mark No. 2 is the upper edge of the head of a large wire nail driven into a triangular-shaped blaze in the downstream face of a large willow tree on the left bank, 100 yards above the bridge. Its elevation is 12.15 feet above gage datum.

Discharge measurements of Fisher River near Crutchfield, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
April 20	B. S. Drane	87	265	0.59	1.40	156
September 24	do	103	320	.25	1.06	80

ARARAT RIVER NEAR SILOAM, N. C.

This station was established as a bench-mark station April 21, 1904, by B. S. Drane. It is located at the Southern Railway bridge about 1 mile east of Siloam, N. C., and a short distance above the mouth of the river. Discharge measurements are made from the downstream

side of the single-span bridge, having a short trestle approach at each end. The initial point for soundings is a point on the downstream guard rail at the left end of the truss. The channel is straight for about 500 feet above and 150 feet below the station. The current is swift. Both banks slope gradually. All water passes beneath the bridge and approaches. The bed of the stream is composed of sand, free from vegetation, and somewhat shifting. There is but one channel at all stages. Flood stages will flow around the cribwork pier on each bank, supporting the ends of the iron bridge.

High water in Yadkin River will make this valueless as a gaging site, but it is a good point for low-water measurements. The bridge crosses the stream almost at right angles. The bench mark is the surface of the outer eyebar of the lower chord of the bridge, downstream side, exactly midway between the ends of the bridge, just outside the iron tension rods. Its elevation is 28 feet above gage datum.

Discharge measurements of Ararat River near Siloam, N. C., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second-feet.*
April 21	B. S. Drane	111	169	1.64	1.08	277
June 9	do	114	217	1.41	1.63	306
September 24	do	111	210	.81	.80	170

MISCELLANEOUS DISCHARGE MEASUREMENTS IN THE YADKIN BASIN.

The following is a list of miscellaneous discharge measurements made in the Yadkin River drainage basin during 1904:

Yadkin River at Crutchfield, N. C.—A gaging made from the ferry April 21 gave the following results: Width, 227 feet; area, 690 square feet; mean velocity, 1.48 feet per second; discharge, 1,023 second-feet. No bench marks were established, but the gage at Salisbury showed a uniform stage of 1.70 feet gage height from April 21 to 24.

Elkin Creek at Elkin, N. C.—This stream enters Yadkin River from the north at the town of Elkin, N. C. Gagings have been made from the Southern Railway bridge, just above the mouth of the creek, as follows: April 19—width, 26 feet; area, 68 square feet; mean velocity, 0.36 foot per second; gage height, 0.80 foot; discharge, 24 second-feet. June 9—width, 26 feet; area, 59 square feet; mean velocity, 0.46 foot per second; gage height, 1.14 feet; discharge, 27 second-feet. The bench mark is the top of the outer eyebar of the downstream lower chord on the right side of the second strut from the left end of the bridge. Its elevation is 25 feet above the datum of the gage.

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PUBLICATIONS OF UNITED STATES GEOLOGICAL SURVEY.

[Water-Supply Paper No. 126.]

The publications of the United States Geological Survey consist of (1) Annual Reports; (2) Monographs; (3) Professional Papers; (4) Bulletins; (5) Mineral Resources; (6) Water-Supply and Irrigation Papers; (7) Topographic Atlas of United States, folios and separate sheets thereof; (8) Geologic Atlas of United States, folios thereof. The classes numbered 2, 7, and 8 are sold at cost of publication; the others are distributed free. A circular giving complete lists may be had on application.

The Professional Papers, Bulletins, and Water-Supply Papers treat of a variety of subjects, and the total number issued is large. They have therefore been classified into the following series: A, Economic geology; B, Descriptive geology; C, Systematic geology and paleontology; D, Petrography and mineralogy; E, Chemistry and physics; F, Geography; G, Miscellaneous; H, Forestry; I, Irrigation; J, Water storage; K, Pumping water; L, Quality of water; M, General hydrographic investigations; N, Water power; O, Underground waters; P, Hydrographic progress reports.

Most of the above publications may be obtained or consulted in the following ways:

1. A limited number are delivered to the Director of the Survey, from whom they may be obtained, free of charge, on application.

2. Every member of Congress is allotted a certain number, from whom they may be obtained, free of charge, on application.

3. Other copies are deposited with the Superintendent of Documents, Washington, D. C., from whom they may be had at practically cost.

4. Copies of all Government publications are furnished to the principal public libraries in the large cities throughout the United States, where they may be consulted by those interested.

Series P.—The hydrographic progress reports contain the results of stream measurements. A report is issued for every calendar year, containing the results of data collected during that year. These reports were first published as a part of the Director's annual report or as a bulletin; they are now published as water-supply and irrigation papers. The following is a list, by years, of the publications containing the progress reports of stream measurements. A detailed index of these reports is published as Water-Supply Paper No. 119.

1888. Tenth Annual Report, Part II.
1889. Eleventh Annual Report, Part II.
1890. Twelfth Annual Report, Part II.
1891. Thirteenth Annual Report, Part III.
1892. Fourteenth Annual Report, Part II.
1893. Bulletin No. 131.
1894. Bulletin No. 131; Sixteenth Annual Report, Part II.
1895. Bulletin No. 140.
1896. Water-Supply Paper No. 11; Eighteenth Annual Report, Part IV.
1897. Water-Supply Papers Nos. 15 and 16; Nineteenth Annual Report, Part IV.
1898. Water-Supply Papers Nos. 27 and 28; Twentieth Annual Report, Part IV.
1899. Water-Supply Papers Nos. 35, 36, 37, 38, and 39; Twenty-first Annual Report, Part IV.
1900. Water-Supply Papers Nos. 47, 48, 49, 50, 51, and 52; Twenty-second Annual Report, Part IV.
1901. East of the Mississippi River, Water-Supply Papers Nos. 65 and 75.
West of the Mississippi River, Water-Supply Papers Nos. 66 and 75.
1902. East of the Mississippi River, Water-Supply Papers Nos. 82 and 83.
West of the Mississippi River, Water-Supply Papers Nos. 84 and 85.
1903. East of the Mississippi River, Water-Supply Papers Nos. 97 and 98.
West of the Mississippi River, Water-Supply Papers Nos. 99 and 100.
1904. East of the Mississippi River, Water-Supply Papers Nos. 124, 125, 126, 127, 128, and 129.
West of the Mississippi River, Water-Supply Papers Nos. 130, 131, 132, 133, 134, and 135.

The hydrographic branch of the Geological Survey and the Reclamation Service have suboffices in different parts of the United States, from which work in the respective localities is carried on and where data may be obtained on application. These offices are located as follows:

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Author.

Grover, N[athan] C.

. . . Report of progress of stream measurements for the calendar year 1904. Prepared under the direction of F. H. Newell by N. C. Grover and John C. Hoyt. Pt. III.—Susquehanna, Patapsco, Potomac, James, Roanoke, Cape Fear, and Yadkin River drainages. Washington, Gov't print. off., 1905.

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Reference.

U. S. Dept. of the Interior.

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