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THE SEDIMENT OF THE POTOMAC RIVER.

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THE United States Geological Survey in May, 1891, established a gauging station on the Potomac River at Chain Bridge, D.C., for the measurement of the discharge of the river at that place. From that date to the present time daily readings of the height of the river have been maintained, which, taken in connection with the measurements of discharge, makes it possible to compute the daily discharges of the river at this place. A detailed account of the methods and results of this branch of the work may be found in a paper by the writer in the Transactions of the American Society of Civil Engineers, No. 537, Vol. 27, and entitled "The Hydrography of the Potomac River Basin." This article deals with the discharge of the river and its relation to the rainfall in the basin. It is also stated that measurements of the amount of sediment transported by the river were being made. The results are now available and are here given for publication.

Daily heights of the Potomac River at Great Falls, about sixteen miles above the City of Washington, have been kept since 1878 by the officials of the Washington aqueduct, together with a daily record termed "condition of water." Owing to the fact, however, that the dam across the river at Great Falls was not completed until 1886, the two sets of records previous to this latter date are valueless for discussion.

The results of this article are based in part upon the records of "condition of water," which are made as follows: A horizontal metallic tube, 36 inches long and with glass ends, is filled with water, and the distance at which a ball immersed therein can be seen from one end is noted. The observations vary from 1 inch in very muddy water to 36 inches, which is considered as clear. Samples of the river water at Great Falls were collected and were sent in to the main office in Washington, where they were analyzed quantitatively in so far as the determination of the ratio of the weight of the contained sediment to the total weight of the sample. At the same time the "condition of water" was recorded. Fifty-five samples were analyzed, with condition of water ranging from 1 to 36 inches. These quantities were plotted on cross-section paper, with condition of water as abscissæ and ratios of sediment to water as ordinates. Through the points thus obtained a smooth curve was drawn, from which a table was constructed, giving for each inch of condition of water the corresponding ratio of sediment. In order to obtain the total amount of sediment transported by the river for any length of time the discharge of the river for that period must be multiplied by the average ratio of the sediment to the water for the same period.

Simultaneous gauge readings of the height of the river at Great Falls and at Chain Bridge were maintained for a year and a half. From these observations a table was constructed, giving for the gauge height at one place the corresponding gauge height at the other. From the fact that no large tributary enters the river between these two points, the daily discharges at Great Falls may be computed from the table of gauge relations and from the daily discharges of the river at Chain Bridge. The daily ratio of sediment to water was found from the daily record of condition of water and the rating table of ratios and condition of water. Knowing then the daily discharge of the river in cubic feet per second and the daily ratio, it is simply a matter of multiplication of second-feet times the ratio times the weight of one cubic foot of water to obtain the weight of the total amount of sediment passing down the river per second. In this way the daily amounts of sediment from 1886 to 1891, inclusive, have been computed.

In considering the value of these figures, it would seem at first sight that the above method of measurement for condition of water was crude to base scientific results upon. The observations are not made for that purpose, but are more for the benefit of the fishermen in the vicinity of Washington. They have the advantage of being simple and inexpensive and can be maintained by an inexperienced observer. Another very important fact in their favor for this river is that, owing to the absence of lakes and extensive swamps throughout the basin, such as are found in the glacial region further north or the swampy regions of the extreme south, the coloring matter of this river is almost wholly due to mineral sediments and very little to vegetable deposits. It would be more accurate if daily samples of the water could be analyzed, but it would be expensive and would require a long time-interval before the results would be of value. There is a six years' record of condition of water, or over 2,000 observations. From a series of measurements certain average values for this record have been computed. Any one observation may depart greatly from this average, but when considered in connection with the total number of observations the effect of its departure from the mean is inappreciable.

The lowest record is 36 inches. In some cases the ball is just able to be seen at this mark; in others distant objects are plainly visible. There is here an arbitrary limit for the curve, which ought to extend considerably below this point, but taken in connection with the rest of the range, and especially with the upper part, where the ratios are large, the weight of this lower end is small. Errors will also arise depending upon the cloudiness of the day. However, errors due to this method of sediment measurement are not cumulative, but may be either plus or minus, and in a large number of observations tend to equalize each other.

It is therefore considered that the results are sufficiently accurate for all ordinary purposes.

The following facts are brought out. The average annual discharge of the Potomac River from a drainage area of 11,043 square miles is 20,160 second-feet, varying from 2,000 second-feet in time of low water up to 470,000 second-feet during the great flood of 1889. The total annual amount of sediment transported is 5,557,250 tons, or 353 pounds per second, and distributed through the six years from 1886 to 1891 as follows: 1886, 4,283,000 tons; 1887, 2,372,800 tons; 1888, 4,996,800 tons; 1889, 10,142,600 tons; 1890, 5,994,000 tons; and 1891, 5,544,300 tons. The average daily amount varied from 1 pound to 21,900 pounds per second. It is found from these figures that the average annual amount of sediment is to the weight of the annual discharge of water as 1 to 3,575. Assuming that one cubic foot of sediment weighs 100 pounds, this average amount of sediment would cover one square mile 3.98 feet in depth, and if spread over the drainage area would cover it 0.0043 inches in depth. At this latter rate it would take the river 2,770 years to erode one foot from the drainage area.

These results appear in the following table, together with similar data compiled for several other large rivers. The first column gives the name of the river; second, its drainage area in square miles; third, the average annual discharge of the river in cubic feet per second. The fourth column gives the total amount of sediment, in tons, annually transported by the river; fifth, the ratio of the weight of this sediment to the weight of the water annually discharged; the sixth, the height of a column in feet having a base of one square mile that the sediment would cover; the seventh, the depth in inches that the drainage area would be covered if this total amount of sediment should be spread over it; and the last column the authority for the data. The discharge