The Wabash River Flood of 1913, at Lafayette, Ind.

R. L. Sackett.

The principal factors affecting the flood discharge of rivers in cubic feet per second per square mile are:

The duration and intensity of rainfall.

The topography of the watershed.

The geology of the watershed.

Temperature and condition of the soil and surface.

Presence of lakes.

Slope and general character of the channel.

Data has not yet been collected so carefully and for long enough periods to permit predicting flood stages with any accuracy.

Tiefenbacher gives the following estimate of the flood discharge of European streams in cubic feet per second (See Ency. Brit., Eleventh Ed., Vol. XIV, p. 77):

In flat country 8.7 to 12.5 cubic feet second per square mile.

In hilly country 17.5 to 22.5 cubic feet second per square mile.

In moderately mountainous districts 36.2 to 45.0 cubic feet second per square mile.

In very mountainous districts 50 to 75 cubic feet second per square mile.

Various formulas have been proposed to express the maximum flood flow such as

O'Connell proposed, Q equals $K\sqrt{M}$ where K varies "from 0.43 for small rivers draining meadow land" to 67.5 for the Danube.

Q is the discharge in cubic feet per second.

M is the area in square miles.

Fanning proposed, Q equals 200 M for New England Rivers.

Dredge gives, Q equal $1300 \frac{M}{L^{\frac{2}{3}}}$ where L is the length of the catchment area in miles.

Kuichling plotted available data and derived the following formulas:

$$Q = \left(\frac{44000}{M + 170} + 20,\right) M, \text{ for floods exceeded occasionally;}$$

$$\text{and } Q + \left(\frac{127000}{M + 370} + 7.4\right) M, \text{ for floods exceeded rarely.}$$

In U. S. Geolog. Survey Bulletin No. 147,

$$Q = \left(\frac{46790}{M + 320} + 15\right) M, \text{ is proposed.}$$

Many other formulas have been proposed and are given in a paper by Mr. Fuller in the Trans. Amer. Soc. C. E., Vol. XXXIX, p. 1063.

When applied to the Wabash they give widely varying results because none of them was made for the topographical and meteorological conditions which characterize our floods.

Fig. 1. Drainage Area of the Wabash River above Lafayette, Ind.

The following extract from an article by the author in Engineering News, April 24, 1913, will explain the conditions causing and accompanying this flood.

A series of heavy rains, extending over the entire drainage area of the Wabash River, commenced March 21 and continued at intervals until March 26, raising the river to unprecedented heights, causing the loss of many lives and the destruction of several million dollars of property.

Previous floods which did much damage occurred June 11, 1858, August

5, 1878, February 17, 1883, and March 15, 1907. The flood of 1913 reached a mark 22 inches higher than the record of 1883 at Lafayette, Ind., and exceeded all records at Peru and Logansport by as high as 8 feet. The flood of 1883 was produced at Lafayette by an ice jam which formed about a mile below the city. The damage done was due to slack water, while the present flood caused the partial destruction of three large steel bridges by extraordinary erosion of the river bottom in the restricted sections.

One student lost his life in an attempt to rescue men marooned on the Brown-street levee, when the latter washed out on the west of them and the bridge fell on the east of them. High water closed the gas works, the two water-works pumping stations, the city heating and lighting plant and many industries; one light and power plant continued in operation although its condensers and pumps were under 7 feet of water.

The drainage area with its tributaries above Lafayette, as shown in Fig. 1, includes an area of about 7,300 square miles, of which 400 are in Ohio. The whole of this area is in a glaciated area, the depth gradually decreasing east of this point until near Logansport, Ind., the bed of the river is in rock. East of that point the deposit varies in thickness.

The drainage area is practically clear of forests and under cultivation. The average fall of the river is about 18 inches per mile here and increases in the upper portions. There are numerous islands and sand bars which form and are swept away in periods of high water. The soil wash is high and the loss therefrom is a matter of great moment. The high turbidity is, of course, a factor in the erosive action which is so characteristic of the rivers of the Mississippi Valley.

The elevation of the head waters above M. H. T., New York harbor, is about 1,000 feet; at Huntington, 699 feet; at Logansport, 583 and at Lafayette, 500 for low water.

Rainfall data preliminary to the hydrograph, Fig. 3, are given in Table I.

TABLE I. RAINFALL DATA OVER WABASH RIVER DRAINAGE AREA.

(Measured by Experiment Station at Purdue University.)

Date	Inches.
Average annual precipitation	50
Greatest annual precipitation, 1909	55
Greatest monthly precipitation June, 1902	11.37
Greatest precipitation in twenty-four hours, August 12, 1912	4.30
Rainfall for March, 1913	7.05

The hydrograph shows a remarkable relationship between rainfall and runoff for a watershed of this area—7,300 square miles. From March 1 to

March 20 inclusive, only 0.94 inches of rain fell. From Fig. 3 it is apparent that according to the government rain gage at Purdue, and a private gage, about 1 inch of water fell preceding the 23d, enough to thoroughly saturate the soil. On the 23d, 1.75 inches of rain fell; another inch on the 24th; 1.35 on the 25th-26th and snow on the 26th, which did not immediately melt. While there are no other rain gages on the watershed above this point from which records were obtainable, it is quite probable that the diagram represents average conditions. (See Table in *Engineering News*, April 3,1913, p. 381.)

The daily maximum temperature during the flood period is also shown on Fig. 3. While there had been no snow the saturated condition of the ground, which was free from frost, the temperature and the distribution of rainfall caused the highest known stage of the river.

Gagings of the Wabash River here have been made by students at Purdue University for several years and by the Weather Bureau and U. S. Geological Survey.

From these we find the following greatest annual discharge:

Date.	*Max. for Year in Cu. Ft. per Sec.*
1904, March 27	70,000 (estimated.)
1907, March 15	41,500
1908, March 7	57,000
1909, February 25	44,000
1910, January 19	49,000
1911, January 29	31,000
1912, March 20	45,900
1913, March 26*	95,400 (including flow over levee.)

From the above data it is evident that the flood of 1913 was greater than any other recent one.

The maximum flood rate at Lafayette was less than 20 cubic feet per second per square mile. For Logansport, the flood of 1904 gave less than 20 cubic feet per second per square mile.

These are low rates and as the rainfall did not average as great as has been recorded for equal areas otherwheres it was not a flood which would occur only once in a hundred years, but may be expected more frequently than that.

*Note.—A more extended investigation of the flood gagings indicates that the maximum discharge may have reached 130,000 cubic feet per second.

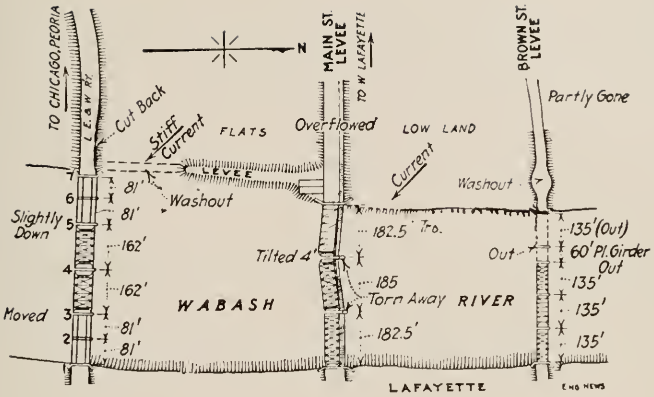

Fig. 2. The Three Bridges Across the Wabash at Lafayette.

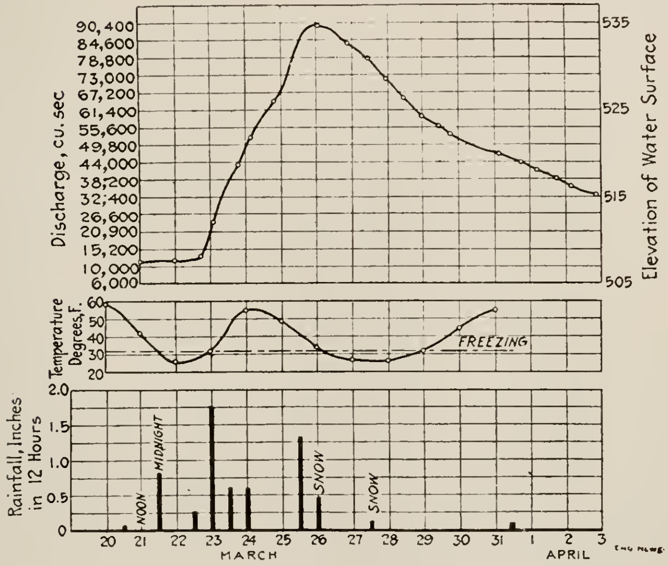

Fig. 3. Hydrograph of the Wabash River, Lafayette, Ind., March 20-April 2, 1913.

From the data so far available for floods in the Ohio River Valley, Fuller proposes as the maximum 24 hour flow:

Q equals 150 M, where M is the catchment area in square miles and Q is total cubic feet per second.

As a result the maximum expected flood flow here would be 180,000 cubic feet per second.

The average flood is given as, Q equals 75 M, which equals the recorded discharge of last March.

Another method of discussing the question of future floods is by their expected frequency. For those eastern streams where data has been collected for some time it appears that a flood of twice the average flood discharge may be expected about once in 40 years.