03611500 Ohio River at Metropolis, Illinois

(This station is operated by the USGS Kentucky Water Science Center)

Review of peak discharge for the flood of February 1, 1937

Location: This flood was located under the Interstate Highway I-24 bridge south of Metropolis, Ill., at 37.1344N and 88.6859W.

Published peak discharge: The peak discharge, as published in NWIS, is 1,850,000 ft^3/s and occurred on February 1, 1937. Footnotes state that the peak is a maximum daily average and that it is affected to an unknown degree by regulation and diversion. The peak discharge and date agree with those listed in Costa (1987a, 1987b).

A very detailed station analysis written for January and February 1937 contains a statement about flow regulation as follows:

> "Crest discharge at Metropolis was decreased about 32,000 second-feet by storage in Norris and Wheeler Reservoirs on Tennessee River, as reported by Tennessee Valley Authority."

Drainage area: 203,000 mi^2.

Data for storm causing flood: Abnormally intense rains began falling in the upper Mississippi and Ohio Valleys in December 1936 and continued through January 1937. Runoff resulted in one of the greatest floods in hundreds of years. The Ohio River was at flood stage for 1,000 mi between Pittsburg, PA, and Cairo, Ill., for a week. About 90 percent of Gallatan County, Ill., was reported to be underwater (Hoyt and Langbein, 1955). Aerial photograph of Ohio River at bridge where measurement was made is shown in figure A247.

Method of peak discharge determination: The peak discharge is based on almost daily current-meter measurements made before, during, and after the peak discharge. For this review, measurements 176 through 202 (26 measurements), made during January 14 through February 18, 1937, were available for review.

The flow of the Ohio River during this period was divided into two channels: (1) the main channel that flows adjacent to Metropolis, Ill., on the right bank and Paducah, KY, on the left bank and (2) an overflow channel that carries Ohio River flow during extreme peaks such as the 1937 flood.

The main channel discharge was measured by current meter from the Metropolis railroad bridge where the gaging station is located. Flow in the center part of the main channel was deep (90 ft maximum during the peak) and had moderate velocities (exceeding 10 ft/s in some verticals). Consequently, it was not possible to make depth soundings in the center part of the main channel where approximately 88 percent of the total flow occurred. The discharge measurement notes are not clear as to how depths in this part of the river were obtained during the time of the actual measurement. Most probably, they were based on soundings taken at an earlier or later time when velocities were low enough to permit depth sounding. It is clear, however, that the center part of the main channel flow was recomputed at a later time and that the recomputations are based on a standard cross section defined by four discharge measurements made between February 18 and 27, 1937. Spot checking indicates that the depths used in the original measurement range from about -6 to +10 ft from those used in the recomputed measurement. The cross-section area for the recomputed part of the measurement is 3.7 percent less than that for the same part of the original measurement.

Velocities in the main channel, where depth soundings could not be made, were measured at 0.2 depth, using the original depths as the basis for computing the meter settings. A factor of 0.92 was used to adjust the surface velocities for this section of the channel. This adjustment factor was based on a number of vertical-velocity curves defined at a river stage about 12 ft lower than the peak stage. In addition, a number of velocity observations made at 0.2 and 0.8 depths at a lower stage also were used to verify the 0.92 coefficient. All velocity coefficient data were defined by the same four measurements listed previously for the standard cross section.

Flow in the overbank sections on either side of the deep part of the main channel was measured directly with actual depth and velocity soundings. This was a small percentage of the total peak discharge.

All discharge measurements were computed using the "mean-section" method, which was standard practice prior to 1950. Use of the current "mid-section" method probably would make little difference in the final results.

The overflow channel was measured by current meter from a boat at a cross section located a short distance downstream of what is now Interstate 24. During the peak discharge, the overflow channel carried only about 4 percent of the total discharge.

The overflow channel is known as an "ancient" channel of the Ohio River. Water from the Ohio River spilled into the overflow channel at Golconda, about 35 mi upstream of Metropolis, and re-entered the Ohio and Mississippi Rivers near their confluence near Cairo. A map (fig. 34 in the main body of this report) scanned from an old report of the 1937 flood shows the overall configuration of the overflow channel.

The overflow was only 4 percent of the total flow and was measured almost daily by boat at a cross section near New Columbia just north of Metropolis (see fig. 34). Depths and velocities for the overflow were not excessive, and this part of the peak-flow measurement should not introduce significant errors.

The rating curve for the Metropolis gage is affected by backwater at medium and high stages and in 1937 was defined by frequent discharge measurements and based on a relation between two gages using a stage-ratio method. This method purportedly allowed for changes in water-surface slope. However, because current-meter measurements were made throughout the range of flow for the 1937 flood, the rating curve did not play a significant part in determination of the peak discharge.

Possible sources of error: The most likely source of error in the current-meter measurements would be errors in depth in the deepest part of the channel. The center part of the peak-flow measurement is based on depth measurements made about 3 weeks after the peak and at a stage at least 12 ft lower than the peak. Condition of the streambed during the peak is not known, and it is possible that there could have been significant scour occurring during the peak. A spot check of depths on both sides of the center part of the main channel, where actual soundings are available, indicates the possibility of some scour. These checks were made for measurements before, during, and after the peak (measurement nos. 181–182, 184–187; measurement no. 184 was the peak measurement). In almost every check, the standard cross-section depth was less than the sounded depth. The maximum difference was 6.7 ft for one vertical, and all other differences were less than 5 ft. The center section is about 2,600 ft wide, so assuming an average scour of 5 ft, the additional area would have been about 13,000 ft^2, which is about 7 percent of the total area of the center section.

If there are errors in depth, then there also are errors in setting the meter for the 0.2-depth velocity sounding. This would result in errors in velocity, but because the shape of the vertical-velocity curve is reasonably vertical in the upper range, the error in velocity should be minimal.

Recommendations of what could have been done differently: There are no recommendations for this site. Almost daily discharge measurements, using the best available equipment and techniques, are the best that can be done.

Site visit and review: No site visit was made. Detailed reviews of 26 current-meter measurements were made.

Recommendation: The original peak discharge of 1,850,000 ft^3/s should be accepted as published, and rated good.

In this case, the peak discharge is published as a mean daily rather than an instantaneous value. For a long-duration high peak, which this obviously is, there should be little difference between mean daily and instantaneous peaks.

Figure A247. Aerial photograph of Metropolis, Ohio. Ohio River flows from right to left; bridge where discharge measurements were made in January and February 1937, appears in left-center of photograph.