STATE OF ARKANSAS

ARKANSAS GEOLOGICAL COMMISSION

Norman F. Williams, State Geologist

WATER RESOURCES SUMMARY NUMBER 13

GRAPHS FOR DETERMINING THE APPROXIMATE ELEVATION OF THE 100-YEAR FLOOD IN ARKANSAS

By
Marion S. Hines
U.S. Geological Survey

Prepared by the U.S. Geological Survey in cooperation with the
Arkansas Geological Commission
Little Rock, Arkansas
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INTRODUCTION

Peak flow and peak stage information is needed for the design of structures that will be situated on flood plains. Many methods have been developed to obtain that information. However, the application of these methods requires extensive data collection, surveys, and complicated mathematical analyses. A quick and simple method for determining approximate water-surface elevations and inundated areas associated with given peak flows would be useful in preliminary site selections. This report provides such a method for the 100-year flood on most streams in Arkansas.

DATA AND ANALYSIS

The water-surface elevation of any flood is controlled by many basin features unique to a stream and, to some degree, to a particular site on a stream. Depth of flooding at a site on one stream at an elevation of 1,200 ft (feet) may be similar to that at a site on another stream at an elevation of 300 ft, and depth of flooding at sites on different streams at approximately the same elevation can be dissimilar.

The difference in elevation between "low water" and "high water" seems to have geographic, or regional, significance when compared with drainage area. Median-flow elevation as a measure of "low water" was selected for use in this report because it can be easily estimated from contour "turnbacks" on topographic maps (where contours cross streams). In addition, a field estimate of median-flow elevation, which is more accurate for small streams, can easily be obtained in the fall of the year by differential leveling to the water surface in a stream during a time when there is no direct surface runoff.

The elevations of the 100-year flood and the median flow, technically the 50-percent-duration flow, were determined for about 65 sites on streams in Arkansas and adjacent States. The differences between these elevations (referred to here and shown on figures 1, 2, and 3 as ΔD) were plotted against drainage areas on logarithmetic coordinate paper. The plot revealed a topographic or physiographic association; therefore, the data were separated into three groups according to geographic areas, as shown in figure 4. The individual data groups were plotted to establish a relation between ΔD and drainage area representing average conditions in the delta (fig. 1), the hills (fig. 2), or the mountains (fig. 3). The resulting graphical standard error of estimate for each plot is shown in the following tabulation:

Data group plot	Graphical standard error (percent)
Figure 1	27
Figure 2	19
Figure 3	18

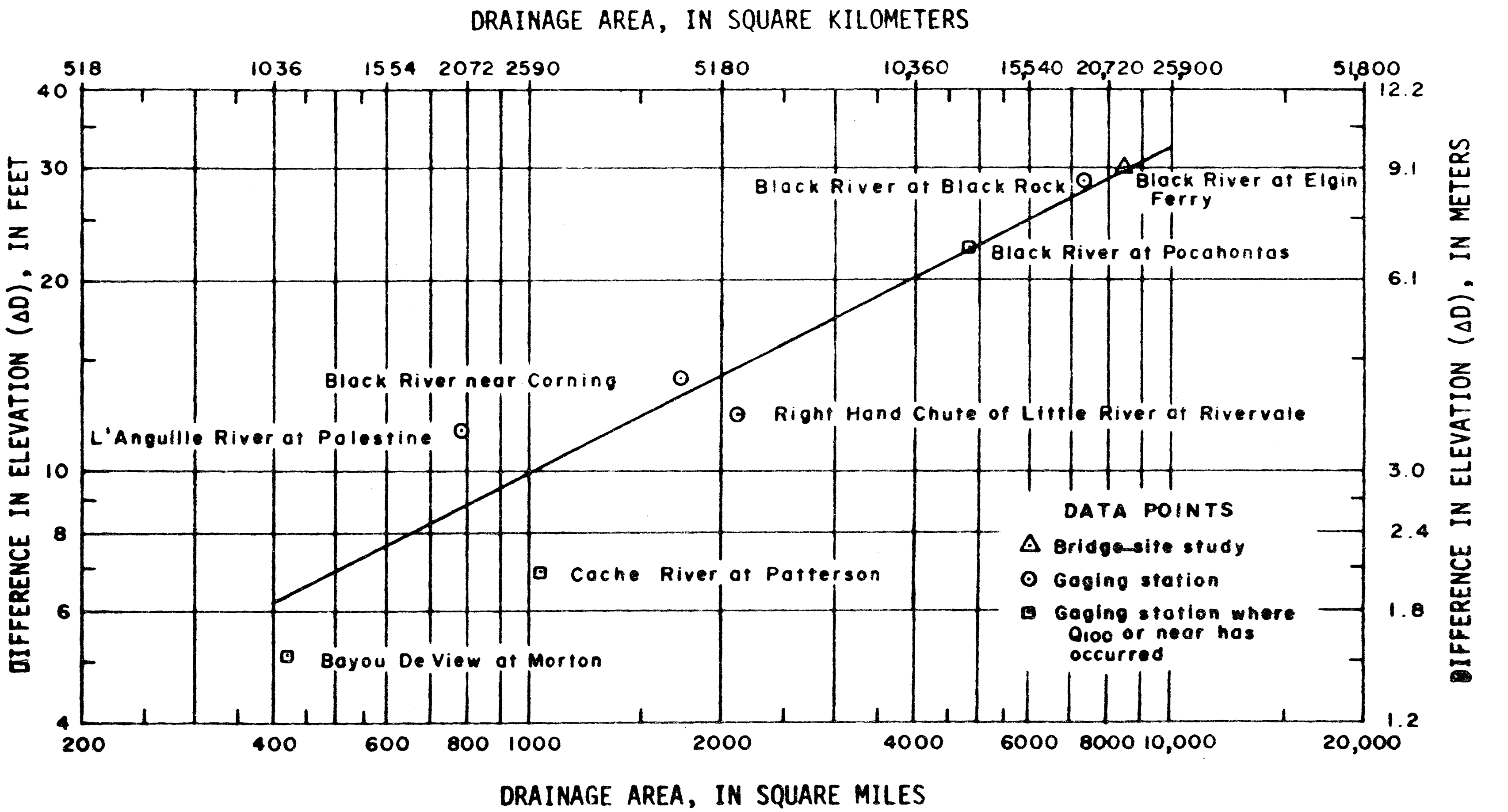

Figure 1.—Elevation of 100-year floodflow minus elevation of 50-percent-duration flow (ΔD), versus drainage area for the delta and the main stem of Black River. For St. Francis River and Tyronza River main stems, use figure 2.

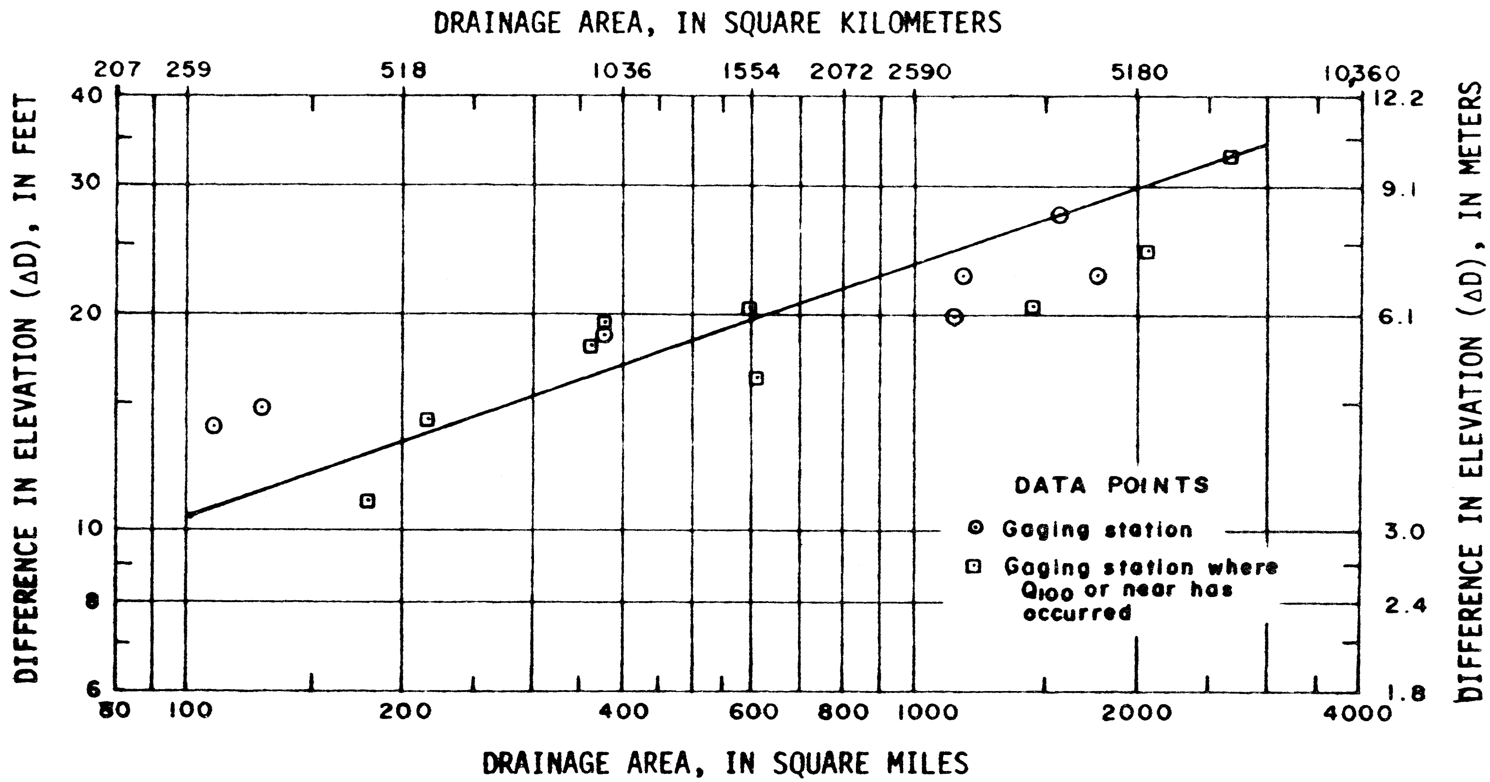

Figure 2.—Elevation of 100-year floodflow minus elevation of 50-percent-duration flow (ΔD), versus drainage area for the hills and the main stems of St. Francis River and Tyronza River. Use this graph for the reach of those mountain streams where there is a relatively wide flood plain. Examples: Mulberry River downstream from gaging station, and Cossatot River downstream from a point 3 miles north of U.S. Highway 71.

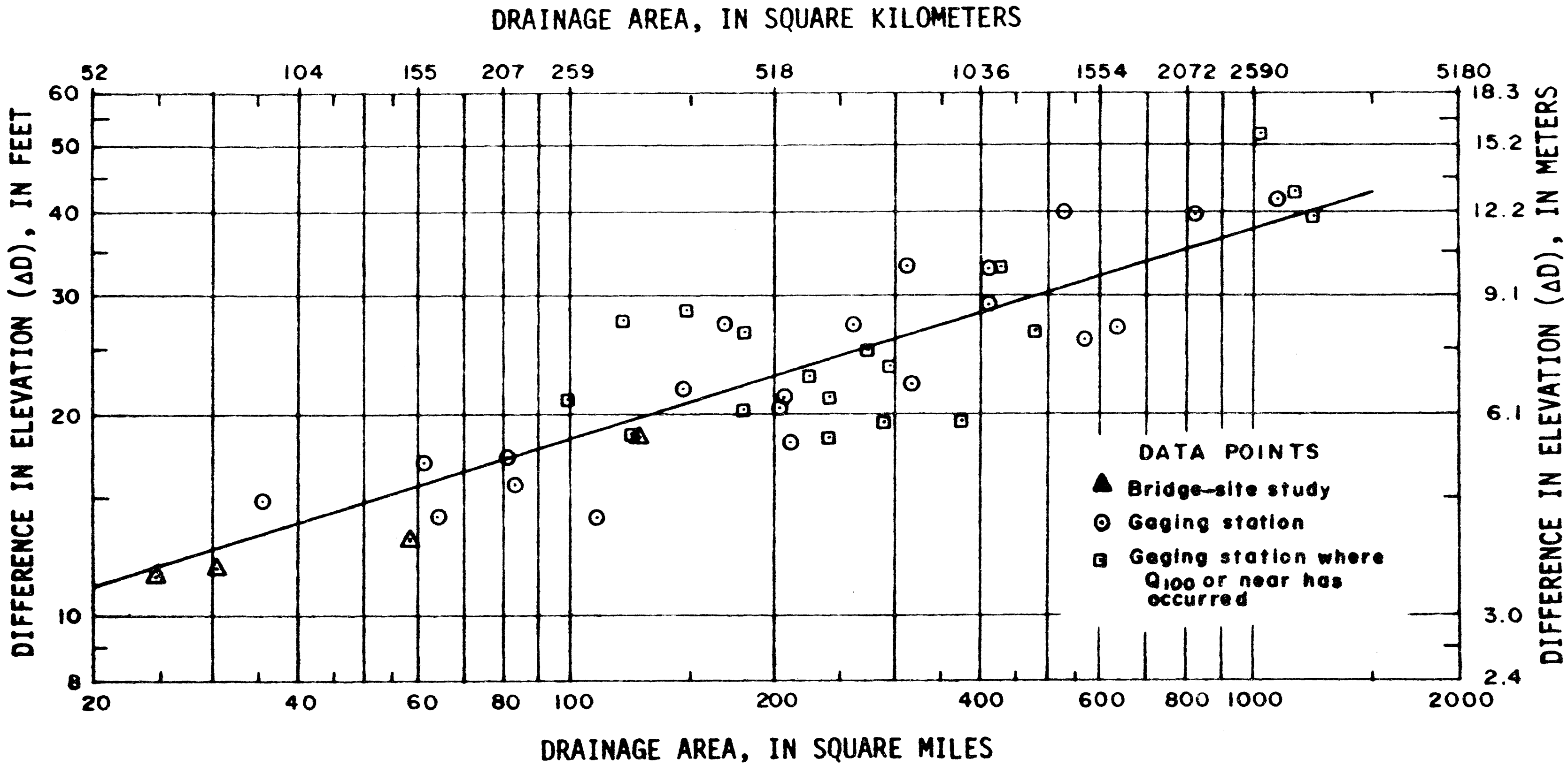

Figure 3.—Elevation of 100-year floodflow minus elevation of 50-percent-duration flow (ΔD), versus drainage area for the mountains. For mountain streams that have extensively wide flood plains, use figure 2.

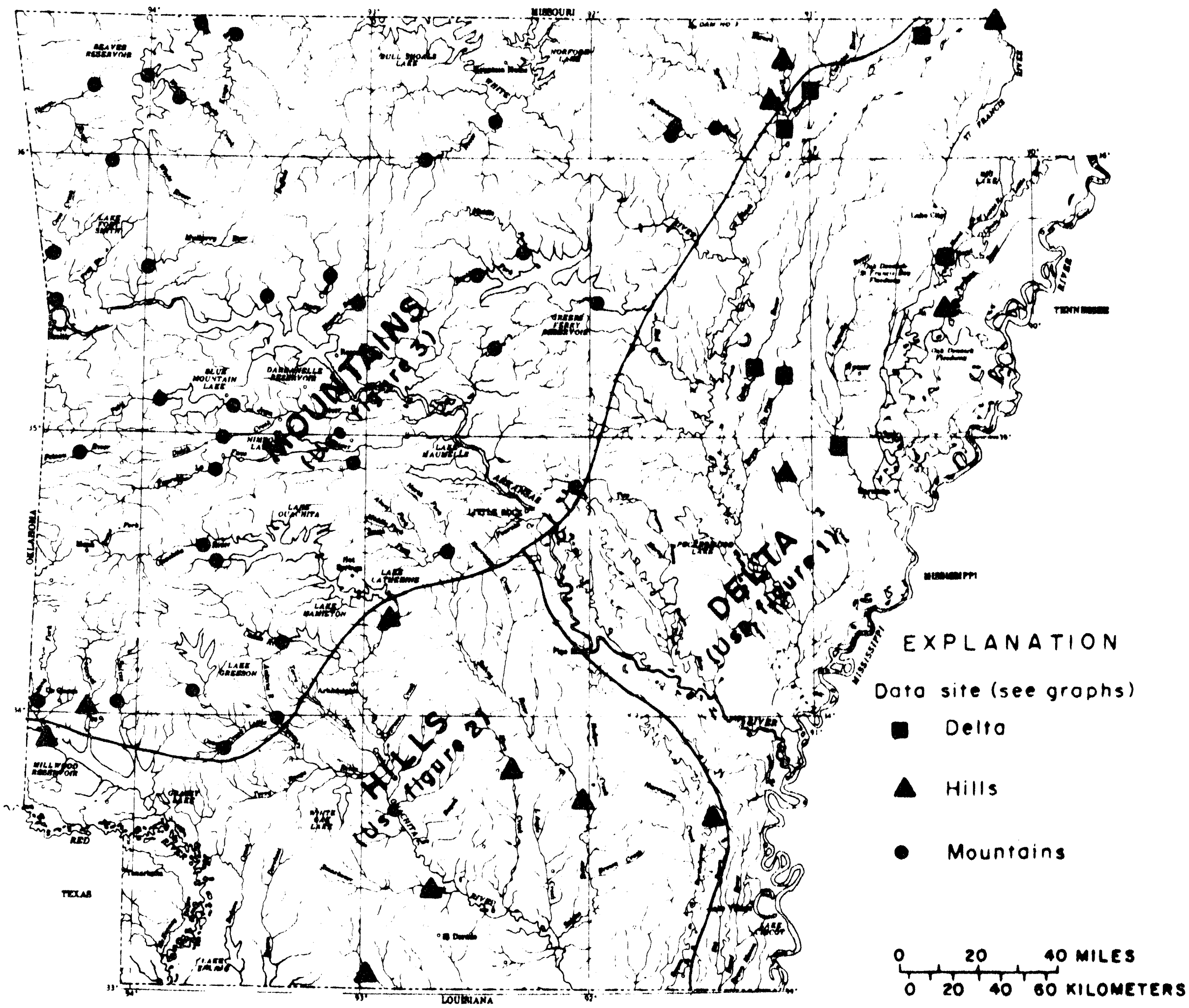

Figure 4.—Geographic divisions of Arkansas for use with figures 1-3, inclusive.

The peak flow for the 100-year flood was obtained by plotting the peak flow for the 2-year, 5-year, 10-year, 25-year, and 50-year frequency floods (Patterson, 1971), and extending the curve through these points to the 100-year frequency. Figure 5 illustrates this procedure.

To obtain the elevation of the 100-year flood, peak-flow and stage data from Patterson (1971) were plotted and curves drawn through the points. About one-half the gaging-station records used in this analysis did not contain peak-flow data at or above the 100-year flood, and the curves had to be extended to the 100-year flood-frequency discharge. Figure 6 illustrates this procedure.

The magnitudes of the 50-percent-duration flows were obtained from Hines (1975). Elevations for the 50-percent-duration flows were obtained from the latest stage-discharge relationships as defined for each gaging station.

The elevation and peak flow of the 100-year flood have been computed as part of the hydrologic analysis for the design of several highway bridges. These 100-year-flood elevations and peak flows have been plotted on the appropriate graph as an additional aid in locating the relationship line. The locations of the relationship lines were finalized after considering the interrelationship of the three lines (figs. 1, 2, and 3) and their interrelationship with the graphs for estimating the 50-year-flood elevation (Hines, 1977). The experience gained during the flood-prone-area mapping program also had a significant influence on graph location.

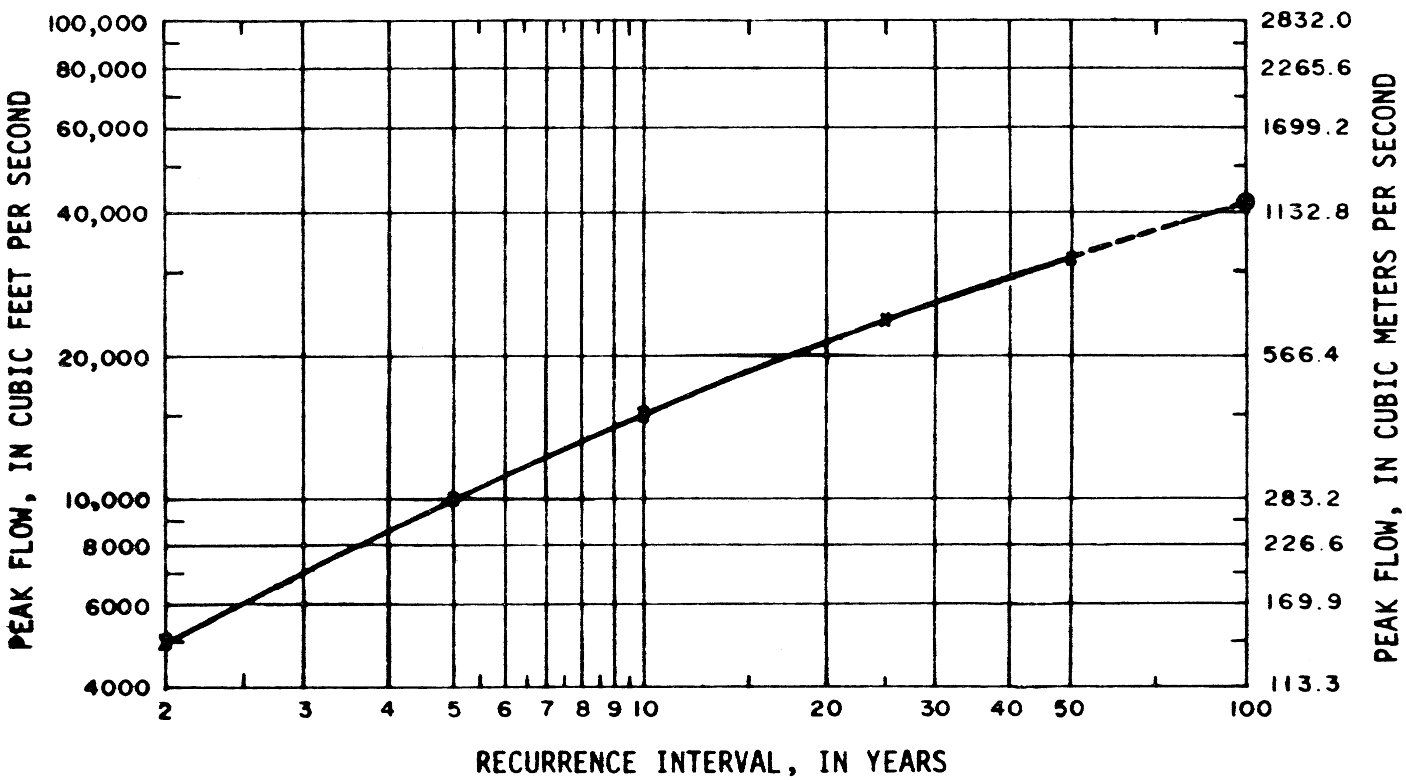

Figure 5.—Flood-frequency curve for Cove Creek near Lee Creek, Ark.

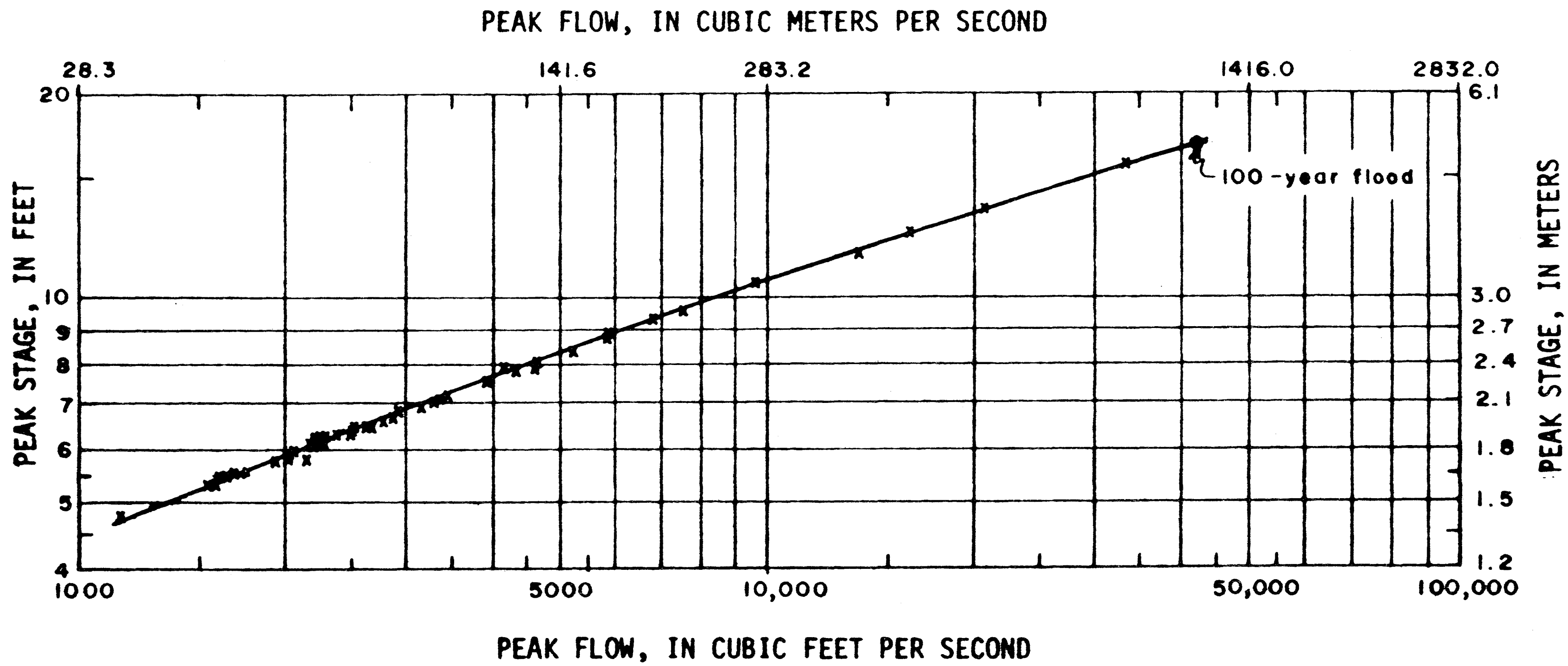

Figure 6.—Peak stage versus peak flow for Cove Creek near Lee Creek.

USE OF GRAPHS

The graphs in figures 1, 2, and 3 may be used to determine the approximate elevation of the 100-year flood for most streams in Arkansas. The particular area of use for each graph is shown on figure 4.

The curve in each figure represents an average stream for each geographic area because of the scatter of plotted points. Therefore, allowance should be made for an unusual stream in any area. An "average" stream in the hills and mountains is a stream that has a clearly defined channel and a small flood plain. However, in the delta, determination of an "average" stream is more difficult, and the data points in figure 1 have been labeled as an aid. The ΔD value for a site on a stream in a narrow gorge that has little if any flood plain will plot above the relationship line as it does for Antoine River at Highway 26, at Antoine, and Cadron Creek at Highway 65, near Guy. Also, the ΔD value for a site on a stream that has a very wide flood plain will plot below the relationship line as it does for Saline River at Interstate Highway 30, at Benton, and South Fourche LaFave River at Highway 7, near Hollis. Therefore, an objective evaluation of the channel and flood plain at a site would allow some refinement of ΔD values determined from figures 1, 2, and 3. The maximum adjustments probably should be limited to a percentage of ΔD, as suggested by the graphical standard error.

Although there appears to be a definite separation of hill streams and mountain streams, the graph for hill streams (fig. 2) is recommended for use at sites on mountain streams where there are unusually wide flood plains. Examples are Cossatot River at Highway 71, east of DeQueen; and Mulberry River at Interstate Highway 40, north of Mulberry. If the "hills" graph (fig. 2) is used instead of the "mountains" graph for mountain streams that have extremely wide flood plains, no adjustment to ΔD values should be made.

The graphs should be used by an experienced hydrologist to determine the approximate elevation of the 100-year flood. Extrapolation of the curves in either direction is not recommended.

Streamflow records are available for more than 100 sites, and peak-stage and peak-flow records are available for more than 100 additional sites. There are many sites where peak-stage records have been collected and where high-water marks have been documented. Most of this flood information is available from either the U.S. Army Corps of Engineers, Soil Conservation Service, Arkansas State Highway and Transportation Department, or the U.S. Geological Survey. The accompanying graphs are for use in the absence, or in support, of other flood information. Methods are available whereby the elevation and peak flow for a design flood may be determined, and these methods should be used when the additional accuracy is required. Additional assistance may be obtained from the U.S. Geological Survey or the Arkansas Geological Commission.

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