TECHNIQUES FOR ESTIMATING FLOOD-PEAK DISCHARGES OF RURAL, UNREGULATED STREAMS IN OHIO

By G. F. Koltun and John W. Roberts

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INVESTIGATION AND ANALYSIS OF FLOODS FROM SMALL NORTHWESTERN, STRIP-MINED, AND FORESTED DRAINAGE BASINS IN OHIO

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CONTENTS

ILLUSTRATIONS

TABLES

TABLES--Continued

APPENDIXES

CONVERSION FACTORS AND ABBREVIATIONS

For the convenience of readers who prefer metric (International System) units to the inch-pound units in this report, values may be converted by use of the following factors:

Multiply inch-pound unit	By	To obtain metric unit
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
foot per mile (ft/mi)	0.1894	meter per kilometer (m/km)
square mile (mi^2)	2.590	square kilometer (km^2)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
acre-foot (acre-ft)	0.001233	cubic hectometer (hm^3)

Temperature is given in degrees Fahrenheit (°F), which can be converted to degrees Celsius (°C) by the following equation:

$$°C = [(°F) - 32]/1.8$$

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called "Sea Level Datum of 1929."

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ABSTRACT

Multiple-regression equations are presented for estimating flood-peak discharges having recurrence intervals of 2, 5, 10, 25, 50, and 100 years at ungaged sites on rural, unregulated streams in Ohio. The average standard errors of prediction for the equations range from 33.4 percent to 41.4 percent.

Peak-discharge estimates determined by log-Pearson Type III analyses using data collected through the 1987 water year are reported for 275 streamflow-gaging stations. Ordinary least-squares multiple-regression techniques were used to divide the State into three regions and to identify a set of basin characteristics that help explain station-to-station variation in the log-Pearson estimates. Contributing drainage area, main-channel slope, and storage area were identified as suitable explanatory variables.

Generalized least-squares procedures, which include historical flow data and account for differences in the variance of flows at different gaging stations, spatial correlation among gaging station records, and variable lengths of station record, were used to estimate the regression parameters. Weighted peak-discharge estimates computed as a function of the log-Pearson Type III and regression estimates are reported for each station. A method is provided to adjust regression estimates for ungaged sites by use of weighted and regression estimates for a gaged site located on the same stream.

Limitations and shortcomings cited in an earlier report on the magnitude and frequency of floods in Ohio are addressed in this study. Geographic bias is no longer evident for the Maumee River basin of northwestern Ohio. No bias is found to be associated with the forested-area characteristic for the range used in the regression analysis (0.0 to 99.0 percent), nor is this characteristic significant in explaining peak discharges. Surface-mined area likewise is not significant in explaining peak discharges, and the regression equations are not biased when applied to basins having approximately 30 percent or less surface-mined area. Analyses of residuals indicate that the equations tend to overestimate flood-peak discharges for basins having approximately 30 percent or more surface-mined area.

INTRODUCTION

Previous reports on the magnitude and frequency of floods in Ohio (Cross, 1946; Cross and Webber, 1959; Cross and Mayo, 1969; Webber and Bartlett, 1977) presented methods for estimating flood-peak discharges of rural, unregulated streams. Webber and Bartlett (1977) developed equations for estimating flood-peak discharges; however, they noted bias for basins that are heavily forested or are located within the Maumee River basin of northwestern Ohio. Furthermore, the 1977 equations are not applicable to basins that have substantial areas of surface mining or urbanization. Techniques for determining flood-flow frequency have been revised since the 1977 equations were developed (Interagency Advisory Committee on Water Data, 1982), and 12 additional years of flood-peak data (1976 through 1987) have been collected.

Purpose and Scope

The purpose of this report is to present techniques for estimating flood-peak discharges for rural, unregulated streams in Ohio. Better representation of flood-peak discharges is emphasized for basins that (1) are located within the Maumee River basin of northwestern Ohio, (2) have been subjected to surface mining and are either unreclaimed or have undergone various degrees of reclamation, or (3) are heavily forested. Multiple-regression equations are given for estimating flood-peak discharges having recurrence intervals of 2, 5, 10, 25, 50, and 100 years at ungaged sites. A method also is provided to adjust discharges estimated for an ungaged site by using weighted and regression flood-frequency estimates for a streamflow-gaging station located on the same stream. Computed flood-frequency discharge estimates are presented for each of the 275 streamflow-gaging stations used in this study. Examples of how to use the multiple-regression equations and the discharge-adjusting method also are provided. For the convenience of the user, the techniques and examples of their use immediately follow the introduction. Methods used to develop the regression equations and weighted estimates of peak discharge are presented in the latter sections of the report.

Approach

Flood-frequency curves were developed for 275 streamflow-gaging stations on rural, unregulated streams following guidelines suggested by the Interagency Advisory Committee on Water Data (1982). Of these 275 stations, 249 are in Ohio (fig. 1, in pocket), thirteen are in Indiana, nine are in Pennsylvania, and four are in Michigan. All 275 streamflow-gaging stations had 10 or more years of recorded annual peak-discharge data.

The data base for this study included 166 continuous-record streamflow-gaging stations, 88 partial-record crest-stage streamflow-gaging stations, and 21 stations having both continuous and partial records. Thirty of the partial-record stations (fig. 1) were established for this study to provide better representation of flood-peak discharges on basins that (1) are located within the Maumee River basin of northwestern Ohio, (2) have been subjected to surface mining, or (3) are heavily forested. Flood-frequency curves were developed for each of the 30 partial-record crest-stage stations from 10 years of flood-peak discharge data collected from water years[1] 1978 through 1987. Basins substantially affected by urbanization were not included in the data base; however, Sherwood (1986) presents techniques for estimating flood-peak discharges, flood volumes, and hydrograph shapes for streams draining small (less than 4.10 square miles) urbanized basins in Ohio.

Ordinary and generalized least-squares multiple-regression techniques were used to develop equations that relate flood-peak discharges having recurrence intervals of 2, 5, 10, 25, 50, and 100 years to selected basin characteristics for the 275 streamflow-gaging stations.

Acknowledgments

This report was prepared in cooperation with the Ohio Department of Transportation and the U.S. Department of Transportation, Federal Highway Administration. Flood-peak discharge data from the network of 30 partial-record crest-stage stations were collected under this cooperative agreement. The remaining streamflow data used in this study have been collected under cooperative agreements with other Federal, State, and local agencies.

TECHNIQUES FOR ESTIMATING FLOOD-PEAK DISCHARGES

The following basin characteristics, determined from U.S. Geological Survey 7.5-minute topographic quadrangle maps, are used in multiple-regression equations to estimate flood-peak discharges having recurrence intervals of 2, 5, 10, 25, 50, and 100 years at ungaged sites on rural, unregulated streams in Ohio (table 1):

> Contributing drainage area (CONTDA), in square miles; area measured in a horizontal plane that contributes surface runoff to a specified location on a stream. This area may be located inside or outside of the natural topographic divides of the basin.

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[1] A water year is the 12-month period from October 1 through September 30, and is designated by the calendar year in which it ends.

Table 1.--Equations for estimating flood-peak discharges of rural, unregulated streams in Ohio

Equation number	Equation	Average standard error of prediction (in percent)	Average equivalent years of record
(1)	$Q_2 = (RC)(CONTDA)^{0.782}(SLOPE)^{0.172}(STORAGE+1)^{-0.297}$	41.4	1.8
(2)	$Q_5 = (RC)(CONTDA)^{0.769}(SLOPE)^{0.221}(STORAGE+1)^{-0.322}$	33.9	3.7
(3)	$Q_{10} = (RC)(CONTDA)^{0.764}(SLOPE)^{0.244}(STORAGE+1)^{-0.335}$	33.4	5.1
(4)	$Q_{25} = (RC)(CONTDA)^{0.760}(SLOPE)^{0.264}(STORAGE+1)^{-0.347}$	34.1	6.9
(5)	$Q_{50} = (RC)(CONTDA)^{0.757}(SLOPE)^{0.276}(STORAGE+1)^{-0.355}$	35.0	8.0
(6)	$Q_{100} = (RC)(CONTDA)^{0.756}(SLOPE)^{0.285}(STORAGE+1)^{-0.363}$	36.3	8.9

where RC is the regression constant for a region from the following matrix:

Region	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
A	56.1	84.5	104	129	148	167
B	40.2	58.4	69.3	82.2	91.2	99.7
C	93.5	133	159	191	214	236

CONTDA is the contributing drainage area (in square miles),
SLOPE is the main-channel slope (in feet per mile), and
STORAGE is the storage area (in percent).

Table 2.--Statistics of selected basin characteristics for streamflow-gaging stations, by region

[CONTDA, contributing drainage area; ft/mi, feet per mile; mi^2, square miles]

Region	Statistic	CONTDA (mi^2)	SLOPE (ft/mi)	STORAGE (percent)
A	Maximum	7,422	994	5.6
	Minimum	.012	1.4	0.0
	Mean	295	52.5	.5
	Median	64.2	12.6	0.0
B	Maximum	6,330	500	13.0
	Minimum	.040	1.3	0.0
	Mean	353	28.3	1.0
	Median	55.0	8.0	0.0
C	Maximum	3,630	145	1.6
	Minimum	.260	3.4	0.0
	Mean	330	30.8	.2
	Median	96.5	13.6	0.0

Main-channel slope (SLOPE), in feet per mile; computed as the difference in elevation at points 10 and 85 percent of the distance along the main channel from a specified location on the channel to the topographic divide, divided by the channel distance between the two points.

Storage area (STORAGE); the percentage of the contributing drainage area occupied by lakes, ponds, and swamps as explicitly shown on U.S. Geological Survey 7.5-minute topographic quadrangle maps.

The multiple-regression equations are applicable to each of three regions delineated on figure 1. The appropriate regression constant must be selected from the regression constant matrix (table 1) to estimate a flood-peak discharge for a specified recurrence interval at an ungaged site within a particular region.

Before using the equations, tests for extrapolation should be made by comparing each measured basin-characteristic value for the ungaged site to the ranges of basin-characteristic values in the regression data set for each region (table 2), or by following the more rigorous procedures outlined in Appendix A. Use of the regression equations is not recommended when a basin-characteristic value is outside the range.

It is suggested that the reader refer to the section "Assessment of the Multiple-Regression Equations" for further information on the accuracy, sensitivity, and limitations of the equations.

Estimating Flood-Peak Discharge for a Site on an Ungaged Stream

The technique for estimating flood-peak discharge for a site on an ungaged stream is illustrated in the following example. The 100-year flood-peak discharge is needed for a site on an ungaged stream in Butler County, Ohio. First, it is confirmed that the basin is rural and the stream is unregulated. Then, by locating the site on figure 1 (in pocket), the Region C multiple-regression equation for estimating 100-year flood-peak discharges is chosen (table 1, page 4):

$$Q_{100} = 236\ (\mathrm{CONTDA})^{0.756}(\mathrm{SLOPE})^{0.285}(\mathrm{STORAGE}+1)^{-0.363}.$$

Basin characteristics for the ungaged site are determined:

CONTDA = 0.290 square miles
SLOPE = 93.0 feet per mile
STORAGE = 0.0 percent

These values are substituted into the Region C equation--

$$Q_{100} = 236\ (0.290)^{0.756}\ (93.0)^{0.285}\ (0.0+1)^{-0.363}$$

$$Q_{100} = 337 \text{ cubic feet per second.}$$

Estimating Flood-Peak Discharge for an Ungaged Site on a Gaged Stream

The technique for estimating flood-peak discharge for an ungaged site on a gaged stream is illustrated in the following example. The 25-year flood-peak discharge is needed for an ungaged site on the Licking River in Licking County, Ohio. This site is located upstream from the discontinued streamflow-gaging station, Licking River at Toboso, Ohio (03147000). First, it is confirmed that the basin is rural and the stream is unregulated. Then, by locating the ungaged site on figure 1 (in pocket), the Region A multiple-regression equation for estimating 25-year flood-peak discharges is chosen (table 1, page 4):

$$Q_{25} = 129\ (CONTDA)^{0.760}(SLOPE)^{0.264}(STORAGE + 1)^{-0.347}.$$

Basin characteristics for the ungaged site are determined:

CONTDA = 537 square miles
SLOPE = 10.7 feet per mile
STORAGE = 0.6 percent

These values are substituted into the Region A equation--

$$Q_{25} = 129\ (537)^{0.760}\ (10.7)^{0.264}\ (0.6 + 1)^{-0.347}$$

$$Q_{25} = 24{,}300 \text{ cubic feet per second.}$$

If the contributing drainage area of an ungaged site on a gaged stream is between 50 and 150 percent of the contributing drainage area of a gaged site on the same stream, then the following method of adjusting the estimated flood-peak discharge of the ungaged site is suggested:

$$Q_{t,a\,(ungaged)} = Q_{t,r\,(ungaged)} \left[R - \frac{2(\Delta CONTDA)\,(R-1)}{CONTDA_{(gaged)}} \right], \qquad (7)$$

where $$R = \frac{Q_{t,w\,(gaged)}}{Q_{t,r\,(gaged)}}$$

and $Q_{t,a\,(ungaged)}$ is the adjusted flood-peak discharge estimate having a recurrence interval of t years for the ungaged site;

$Q_{t,r\,(ungaged)}$ is the multiple-regression equation estimate of flood-peak discharge having a recurrence interval of t years for the ungaged site;

$Q_{t,w\,(gaged)}$ is the weighted flood-peak discharge estimate having a recurrence interval of t years for the gaged site, reported in table 3;

$Q_{t,r\,(gaged)}$ is the multiple-regression equation estimate of flood-peak discharge having a recurrence interval of t years for the gaged site, reported in table 3;

$\Delta CONTDA$ is the absolute value of the difference between the contributing drainage areas of the gaged site and the ungaged site; and

$CONTDA_{(gaged)}$ is the contributing drainage area of the gaged site, reported in table 4 (at back of report).

This method (1) adjusts the regression estimate for the ungaged site by the ratio R when the contributing drainage area of the ungaged site equals the contributing drainage area of the gaged site and (2) prorates the adjustment to one as the contributing drainage area of the ungaged site approaches either 50 percent or 150 percent of the contributing drainage area of the gaged site.

The 537-square-mile drainage area for the ungaged site on the Licking River is between 50 and 150 percent of the 672-square-mile drainage area of the discontinued streamflow-gaging station, Licking River at Toboso, Ohio. Flood-peak discharges having recurrence intervals of 25 years are determined for both sites:

$Q_{25,r\ (ungaged)}$ = 24,300 cubic feet per second (as determined above)

$Q_{25,w\ (gaged)}$ = 31,500 cubic feet per second (table 3)

$$Q_{25,r\ (gaged)} = 129\ (CONTDA)^{0.760}(SLOPE)^{0.264}(STORAGE+1)^{-0.347}$$

(Region A equation from table 1)

where the basin characteristics for the gaged site (table 4) are

CONTDA = 672 square miles;
SLOPE = 8.2 feet per mile;
STORAGE = 0.8 percent.

These values are substituted into the Region A equation:

$$Q_{25,r\ (gaged)} = 129(672)^{0.760}(8.2)^{0.264}(0.8+1)^{-0.347}$$

$Q_{25,r\ (gaged)}$ = 25,800 cubic feet per second.

The absolute value of the difference between contributing drainage areas of the gaged site and the ungaged site (ΔCONTDA) is computed as 135 square miles (672 square miles minus 537 square miles).

These discharge and contributing-drainage-area values are substituted into the equation for adjusting the estimated flood-peak discharge of the ungaged site--

$$Q_{25,a\ (ungaged)} = 24,300 \left[\left(\frac{31,500}{25,800}\right) - \left(\frac{2(135)}{672}\right) \left(\frac{31,500}{25,800} -1\right) \right]$$

$Q_{25,a\ (ungaged)}$ = 27,500 cubic feet per second.

DEVELOPMENT OF FLOOD-FREQUENCY CURVES FOR STREAMFLOW-GAGING STATIONS

Flood-frequency curves were developed for 275 streamflow-gaging stations on rural, unregulated streams having at least 10 years of annual peak-discharge data. Interagency Advisory Committee on Water Data (1982) guideline's for determining flood-flow frequency were followed.

A flood-frequency curve relates annual flood-peak magnitudes to annual exceedance probability. Annual exceedance probability can be expressed as the chance, in percent, of a given flood magnitude being exceeded in any one year. Recurrence interval, which is the reciprocal of the annual exceedance probability, is the average number of years between exceedances of a given flood magnitude. The occurrence of floods is considered to be random in time; therefore, no schedule of regularity is implied. The occurrence of a flood having a 100-year recurrence interval (1-percent annual exceedance probability) does not guarantee that a flood of equal or greater magnitude will not occur the following year or even the following week.

Observed annual flood-peak discharges were transformed to base 10 logarithms and fit to a Pearson Type III distribution. Low outliers were deleted, and adjustments were made for high outliers in light of historic flood information. Station skew was weighted with skew values from a generalized skew map (Interagency Advisory Committee on Water Data, 1982).

The flood-peak discharge at selected annual exceedance probabilities was computed by the equation:

$$\log(Q) = \overline{X} + KS,$$

where $\overline{X}$ is the mean of the logarithms of the observed annual flood-peak discharges;

S is the standard deviation of the logarithms of the observed annual flood-peak discharges; and

K is a function of the weighted skew coefficient and the selected annual exceedance probability.

These computed log-Pearson Type III flood-peak discharge estimates and their associated recurrence intervals (2, 5, 10, 25, 50, and 100 years) are presented in table 3 (at back of report).

DEVELOPMENT OF MULTIPLE-REGRESSION EQUATIONS

Multiple-linear-regression techniques were used to relate selected basin characteristics (table 4, at back of report) to flood-peak discharges with 2-, 5-, 10-, 25-, 50-, and 100-year recurrence intervals for the 275 streamflow-gaging stations. In multiple-linear regression, the dependent variable is assumed to be a linear function of two or more regressor variables. The general form of the multiple-regression equation used in this study is:

$$\log(Q_t) = \log(C) + b_1\log(X_1) + b_2\log(X_2) + ... + b_p\log(X_p),$$

where Q_t is the estimated flood peak discharge, in cubic feet per second, having a t-year recurrence interval, where t equals 2, 5, 10, 25, 50, or 100;

C is a constant;

b_i is the regression coefficient for the ith regressor variable (i=1, ..., p);

X_i is the ith regressor variable (i=1, ..., p); and

p is the total number of regressor variables in the equation.

For computational convenience, the above equation is presented in this report in the algebraically equivalent form:

$$Q_t = C(X_1)^{b_1}(X_2)^{b_2} . . . (X_p)^{b_p} .$$

Selection of Regressor Variables

Ordinary least-squares (OLS) multiple-regression analyses were performed using the SAS[2] statistical procedures RSQUARE and STEPWISE (SAS Institute, 1982) to determine the optimum set of regressor variables. A variety of independent variables providing measures of different basin characteristics were explored as potential regressor variables. These independent variables listed here and explained in Appendix B included contributing drainage area, main-channel slope, main-channel length, mean basin elevation, basin elevation index, basin shape index, storage area, forested area, surface-mined

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[2]Use of trade names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

area, mean annual precipitation, mean minimum January temperature, and 24-hour, 2-year rainfall. The final selection of regressor variables, however, was based on the following criteria:

1. The choice of regressor variables, as well as the signs and magnitudes of their associated regression coefficients, must be hydrologically plausible in the context of peak flows. This criterion takes precedence over all other criteria.

2. All regressor variables should be statistically significant at the 95-percent confidence level.

3. The choice of regressor variables, within the constraints of criteria 1 and 2, should minimize the prediction error sum of squares (PRESS) and maximize the coefficent of determination (R^2, a measure of the proportion of the variation in the dependent variable accounted for by the regression equation).

The variables selected using the criteria described above include (1) the contributing drainage area (CONTDA), (2) main-channel slope (SLOPE), and (3) storage area (STORAGE). Surface-mined area and forested area, two independent variables that were emphasized in this analysis, are not statistically significant in explaining peak discharges.

Analysis of Data on a Statewide Basis

Multiple-regression analyses were first performed on data from the 275 rural, unregulated streamflow-gaging stations in Ohio and adjacent states in an attempt to develop equations that would be applicable statewide. Plots of residuals, the differences between the log-Pearson Type III and regression estimates of peak discharge, for the statewide equations showed evidence of a geographic bias. Consequently, additional regression analyses were performed for selected regions in Ohio.

Analysis of Data by Selected Regions

The State was divided into regions using information on topography, drainage-basin boundaries, and areal trends of residuals for the statewide equations as guides. The locations of region boundaries were chosen so that no unregulated streams were crossed. The regionalization process served to compensate for the geographic bias observed in the statewide residual plots, which was not otherwise accounted for in the regression model. Geographic bias is not evident in the Maumee River basin of northwestern Ohio as had been previously observed by Webber and Bartlett (1977).

Regionalization was accomplished in the regression model by means of a set of indicator variables. The indicator-variable method was used in lieu of separate regression analyses because it gives one estimate of the common error variance for the State and provides more residual degrees of freedom than would result from fitting separate regressions. The effect of the indicator variable is an adjustment in the intercept term for the logarithmic form of the regression equation. For the reader's convenience, the intercept term is combined with the constant and separate equations are reported for each region. Additional information on the use of indicator variables in multiple-regression analyses is provided by Montgomery and Peck (1982).

Ohio ultimately was divided into three regions using the information and method described above. These regions are shown on figure 1.

Generalized Least-Squares Regression

After an acceptable set of regressor variables were determined and the State was regionalized using OLS techniques, generalized least-squares (GLS) regressions were performed. Stedinger and Tasker (1985) found that the GLS procedure provides more accurate parameter (regression coefficient) estimates, better estimates of the accuracy with which the regression model's coefficients are being estimated, and almost unbiased estimates of the model error.

Unlike the OLS procedure, the GLS procedure takes into consideration the variance and spatial correlation structure of the streamflow characteristics and weights each observation accordingly (Tasker and others, 1986). In addition, the time-sampling error in the estimated Q_t streamflow characteristic is accounted for in evaluating the accuracy of the regression equation. A third advantage to the GLS procedure is that historical peak-flow data can be considered in computing the time sampling error in Q_t.

The GLS analyses were performed using procedures incorporated into ANNIE/WDM, a set of programs designed for the storage and interactive analysis of watershed and time-series data (Lumb and others, 1989). The equations developed by generalized least-squares regression are reported for the three regions in table 1.

Weighted estimates of the t-year peak discharges are reported in table 3 for the 275 streamflow-gaging stations. The weighted estimates are preferred for gaged sites over the log-Pearson Type III estimates or the regression estimates alone because they represent a weighted average of two independent estimates. The weighted estimates were

$$Q_{t,w} = 10^{\left(\frac{\log(Q_{t,o})(\omega) + \log(Q_{t,r})(\omega_e)}{\omega + \omega_e}\right)}$$

where $Q_{t,o}$ is the log-Pearson Type III estimate of the t-year peak discharge;

$Q_{t,r}$ is the regression estimate of the t-year peak discharge;

ω_e is the equivalent years of record for the regression estimate as defined by Hardison (1971); and

ω is Either the systematic record length, in years, if no historic peak discharge data are available for the site,

or

the effective record length, in years, as determined below, if historic peak-discharge data are available for the site—

$$\omega = \omega_s + (A * D),$$

where $A = 0.55 - 0.1*(\ln(P/(1-P)))$;

$P = 1 - (N_p/(\omega_h + \omega_s))$;

$D = \min(200,(\omega_h - \omega_s))$;

N_p is the number of historic peaks;

ω_h is the historic record length, in years; and

ω_s is the systematic record length, in years.

ASSESSMENT OF THE MULTIPLE-REGRESSION EQUATIONS

Tests for Collinearity

Tests for collinearity, the condition where regressor variables exhibit near linear dependencies, were conducted using SAS. Severe collinearity can cause appreciable round-off errors in the regression calculations. Moderate collinearity can have a destabilizing effect on parameter estimates, although estimates of the dependent variable may not be adversely affected.

A moderate level of collinearity (defined here as a condition number between 3 and 5 in combination with two or more regressors having variance-decomposition proportions greater than 0.5) is found between the variables CONTDA and SLOPE as determined by eigensystem analysis (SAS, 1982; Belsley and others, 1980). This moderate collinearity should not harm estimation if the conditions for estimation are confined to the regressor space within which the collinearity holds (Montgomery and Peck, 1982). The implication of this constraint is that extrapolation to combinations of regressor variables not represented in the development of the regression equation may lead to poor estimates of Q_t. Past experience with equations developed by Webber and Bartlett (1977), in which these variables also are present together, has demonstrated that satisfactory estimation, without extrapolation, can be done in spite of the collinearity.

Tests for Constant Residual Variance

Tests for constancy of residual variance were performed by plotting the regression residuals against the corresponding estimate of the dependent variable and by plotting the regression residuals against the corresponding values of each individual regressor variable by the SAS procedures REG and PLOT. The equations presented in this report have constant residual variance (characterized by a relatively uniform band of points around the line corresponding to the zero residual), which indicates that the residuals are not a function of regressor magnitude. More specifically, the residuals are not a function of contributing drainage area, main-channel slope, or storage area, thus, the regression equations are equally applicable for the full ranges of these characteristics used in the regression analysis (table 2).

Residuals also were plotted against independent variables not selected for use in the regression equations. These plots can reveal inadequacies in the regression equations caused by parametrical bias or the omission of an important explanatory variable. The residual variance associated with the variable representing forested area appears to be constant. This indicates that there is no bias associated with forested area for the range

(0.0 to 99.0 percent) used in the regression analysis. This lack of bias suggests that the regression equations are applicable to heavily forested basins (assuming the limitations discussed in the section "Limitations of the Equations" are met). The bias noted by Webber and Bartlett (1977) for heavily forested basins could have resulted from a limited or an unrepresentative sample. Residual variance is relatively constant for basins having approximately 30 percent or less surface-mined area. Consequently, unbiased estimates of peak discharge are obtained for those basins.

The equations tend to overestimate peak discharges for basins having approximately 30 percent or more surface-mined area. To illustrate this, average and median ratios of the log-Pearson Type III estimates to regression estimates for the 10 basins with greater than 30 percent surface-mined area are reported in the following table:

Recurrence interval (years)	Average ratio of log-Pearson Type III estimate to the regression estimate	Median ratio of log-Pearson Type III estimate to the regression estimate
2	0.94	0.74
5	.87	.62
10	.87	.59
25	.89	.58
50	.93	.59
100	.97	.60

Accuracy of the Equations

Accuracy of the equations is assessed in terms of the average standard error of prediction and the average equivalent years of record. The average standard error of prediction, a measure of the average expected accuracy with which estimates of peak discharges can be made, was computed by taking the square root of the sum of the average model and sample error variances. The average standard error of prediction was converted to an average percent standard error of prediction by methods described by Hardison (1971). The average equivalent years of record represents an estimate of the number of years of actual stream-flow record required at a site to achieve an accuracy equivalent to the regional regression estimate. The average equivalent years of record is computed as part of the GLS analysis using the method described by Hardison (1971).

The average standard error of prediction and average equivalent years of record are reported along with the regression equations in table 1.

The accuracy of individual discharge estimates can be assessed by computing individual estimates of the model and sample error variances. Techniques for computing these error variance estimates and confidence intervals are discussed in Appendix A.

Sensitivity Analysis

Sensitivity analyses were conducted for the Q_2 and Q_{100} regression equations. For a given equation, one regressor variable at a time was varied from its mean value in fixed increments while the remaining regressor variables were held constant at their mean values. In this way, the effects on the Q_t discharge that are attributable to changes in each of the regressor variables were measured. Figures 2 and 3 show the percentage of change in the estimated Q_2 and Q_{100} values, respectively, as a result of varying the regressor variables from +50 percent to -50 percent of their means. The dependent variable (Q_2 or Q_{100}) will be least affected by changes in regressor variables that plot closest to the horizontal dashed line. Conversely, the dependent variable is most sensitive to changes in variables that plot farthest from the horizontal dashed line. For example, the sensitivity plots for 2- and 100-year peak discharges show that the computation of Q_2 and Q_{100} are most sensitive to changes in the contributing-drainage-area variable (CONTDA).

The basin-characteristics data used in the multiple-regression equations are generally computed or estimated from U.S. Geological Survey 7.5-minute topographic quadrangle maps. The sensitivity plots illustrate the relative magnitude of errors that could be introduced through inaccurate determination of basin characteristics. Although SLOPE and STORAGE are less sensitive than CONTDA, erroneous measures of these variables also could significantly effect the magnitude of the estimated flood-peak discharge.

Because the regional regression equations for a given recurrence interval differ only in their constants, all regions share the same sensitivity characteristics.

Limitations of the Equations

The multiple-regression equations for estimating flood-peak discharges should only be used for unregulated streams draining rural basins. In general, basins having usable storage of less than 103 acre-feet per square mile are considered to be unregulated; however, the flood-peak discharges for an ungaged site located directly below a large reservoir could be considered to be regulated regardless of the usable storage criterion (Benson, 1962).

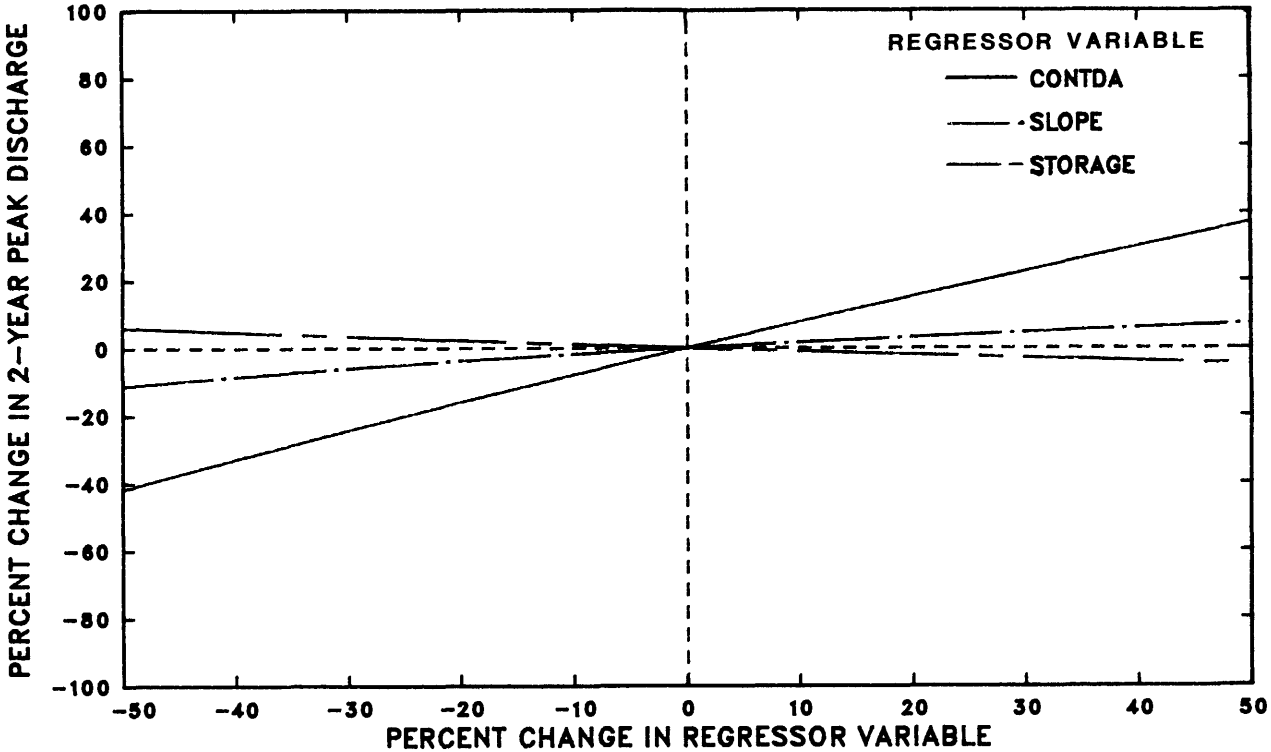

Figure 2.--Sensitivity of computed 2-year flood-peak discharges to change in regressor variables in the multiple-regression equations.

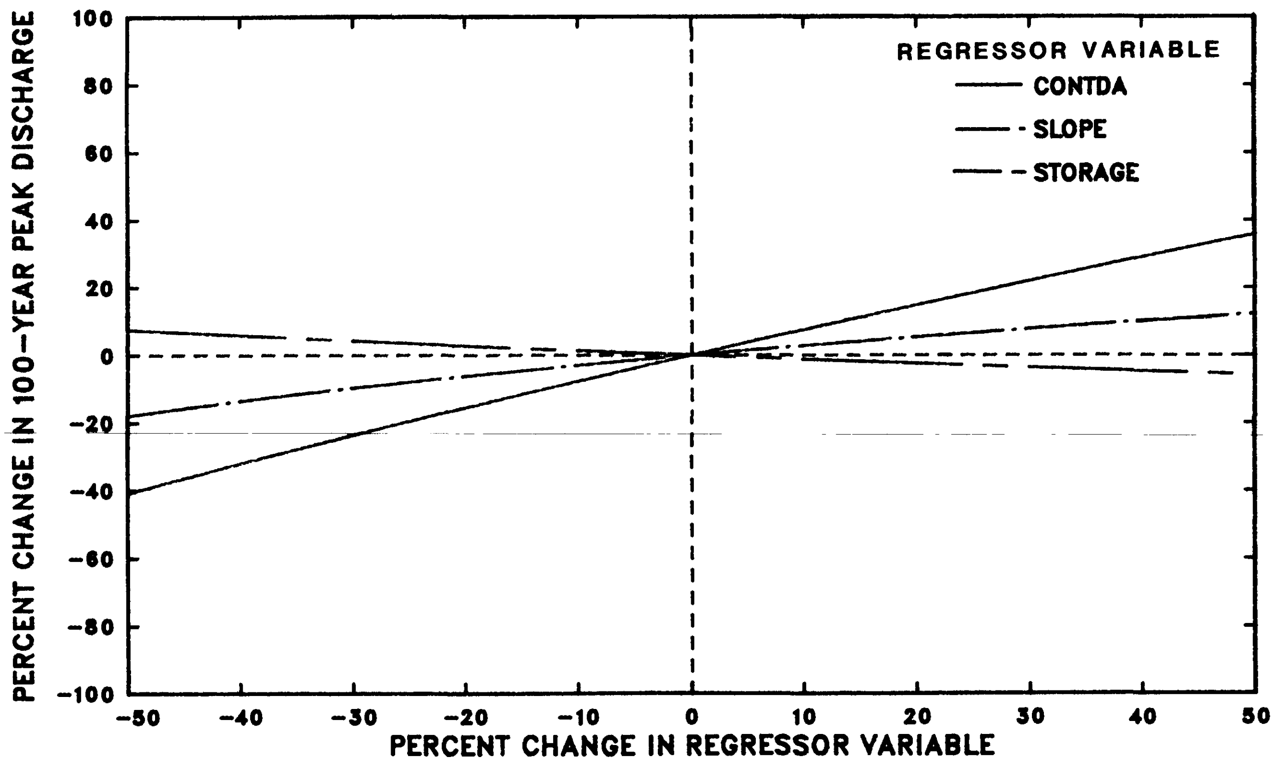

Figure 3.--Sensitivity of computed 100-year flood-peak discharges to change in regressor variables in the multiple-regression equations.

The applicability of the equations is unknown when the basin-characteristic values associated with an ungaged site are outside a space defined by the basin characteristics of the regression data set. This space, called a regressor variable hull (RVH), contains as many dimensions as there are regressor variables in the regression equation (Montgomery and Peck, 1982). If the point defined by the basin characteristics for the ungaged site lies within or on the boundary of the RVH, then the estimation involves interpolation. If the point lies outside the RVH, then the estimation would require extrapolation, which may lead to poor performance of the regression equation. The preferred method for testing for extrapolation involves matrix computations (discussed in Appendix A) that are somewhat unwieldy for routine use. An alternative method of testing for extrapolation, although less rigorous, involves comparing the individual basin characteristics of the ungaged site to the ranges of values observed in the original data for each region. Table 2 presents these ranges so that tests for extrapolation can be made. Use of the regression equations is not recommended when a basin characteristic value is outside the range.

The equations are applicable to basins having surface-mined areas; however, they should be used with caution for streams draining basins with approximately 30 percent or more surface-mined area. Tests for constant residual variance indicate a tendency to overestimate flood-peak discharges above this percentage.

SUMMARY

Flood frequency curves were developed for 275 streamflow-gaging stations on rural, unregulated streams in Ohio and adjacent states. Log-Pearson Type III estimates of flood-peak discharge having recurrence intervals of 2, 5, 10, 25, 50, and 100 years are reported.

Ordinary least-squares multiple-regression techniques were used to divide the State into three regions and identify a set of basin characteristics that help explain station-to-station variation in flood-peak discharge. Contributing drainage area (CONTDA), main-channel slope (SLOPE), and storage area (STORAGE) were identified as suitable explanatory variables.

Equations were developed for estimating flood-peak discharges at ungaged sites on rural, unregulated streams in Ohio. Generalized least-squares (GLS) regression analyses were used to estimate the regression parameters. The average standard errors of prediction for the equations range from 33.4 percent to 41.4 percent. Guidelines for use of the equations are presented along with examples.

Weighted estimates of the t-year peak discharges were computed for each gaging station in the GLS analysis from the log-Pearson Type III and regression estimates. These weighted estimates are reported along with the regression estimates. A method is provided to adjust regression estimates for ungaged sites as a function of contributing drainage area and the weighted and regression estimates for a gaged site located on the same stream.

Limitations and shortcomings noted by Webber and Bartlett (1977) in their report on the magnitude and frequency of floods in Ohio are addressed in this study. Thirty partial-record crest-stage streamflow-gaging stations were established specifically to provide better representation of flood-peak discharges on basins that (1) are located within the Maumee River basin of northwestern Ohio, (2) have been subjected to surface mining and are either unreclaimed or have undergone various degrees of reclamation, or (3) are heavily forested. Geographic bias is no longer evident for the Maumee River basin of northwestern Ohio as a result of additional streamflow-gaging stations, 12 additional years of flood-peak data, and (or) regionalization. No bias is found to be associated with the forested-area characteristic for the range used in the regression analysis (0.0 to 99.0 percent), nor is this characteristic significant in explaining peak discharges. Surface-mined area likewise is not significant in explaining peak discharges, and the regression equations are not biased when applied to basins having approximately 30 percent or less surface-mined area. Analyses of residuals indicate that the equations tend to overestimate flood-peak discharges for basins having approximately 30 percent or more surface-mined area. Therefore, the regression equations presented in this report are applicable to basins that are heavily forested and to basins that have been subjected to surface mining; however, potential bias associated with basins having 30 percent or more surface-mined area should be considered when making flood-peak discharge estimates.

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DATA TABLES

Table 3.--Flood-frequency data for streamflow-gaging stations

[ft^3/s, cubic feet per second. For each station the upper numbers are log-Pearson Type III estimates, the middle numbers are regression estimates, and the lower numbers are weighted estimates]

Station number	Station name	Latitude	Longitude	Flood-peak discharge in ft^3/s, for indicated recurrence interval, in years: 2	5	10	25	50	100	Record: Number of water years	Record: Period	Largest recorded discharge: Calendar year	Largest recorded discharge: Magnitude (ft^3/s)
03022500	French Creek at Saegerstown, Pa.	41°42'50"	80°08'50"	10700	14700	17400	21000	23700	26600	19	1913	1913	26300
				8600	12700	15600	19300	22000	24800		1922-39		
				10600	14500	17200	20700	23400	26200				
03023000	Cussewago Creek near Meadville, Pa.	41°40'20"	80°12'55"	1540	2110	2540	3130	3610	4130	28	1911-38	1913	5250
				2360	3650	4570	5760	6650	7580				
				1570	2240	2810	3620	4300	4990				
03086100	Big Sewickley Creek near Ambridge, Pa.	40°36'27"	80°09'49"	622	1010	1320	1790	2180	2630	16	1963-78	1975	2540
				762	1320	1730	2280	2700	3130				
				637	1080	1440	1960	2390	2840				
03086500	Mahoning River at Alliance	40°55'58"	81°05'41"	2250	3580	4640	6220	7580	9090	46	1942-87	1959	9740
				2320	3640	4590	5820	6740	7690				
				2250	3580	4630	6170	7430	8790				
03087000	Beech Creek near Bolton	40°55'50'	81°08'50"	1080	1580	1910	2310	2600	2890	11	1944-54	1950	2210
				835	1410	1840	2400	2830	3280				
				1040	1540	1890	2340	2690	3030				
03088000	Deer Creek at Limaville	40°58'45"	81°09'35"	1060	1350	1560	1830	2050	2270	15	1942-55	1959	3660
				1070	1670	2110	2660	3080	3520		1959		
				1060	1400	1660	2050	2350	2670				
03089500	Mill Creek near Berlin Center	41°00'01"	80°58'07"	972	1360	1620	1940	2180	2420	36	1942-77	1946	1900
				615	976	1230	1570	1820	2070				
				953	1330	1570	1890	2120	2360				
* 03090500	Mahoning River near Berlin Center	41°02'54"	81°00'05"	5550	7430	8560	9910	10800	11700	12	1931-42	1937	8630
				5160	8270	10500	13500	15600	17900				
				5510	7550	8930	10700	12100	13400				
03092000	Kale Creek near Pricetown	41°08'23"	80°59'43"	1120	1720	2190	2880	3470	4130	46	1942-87	1959	3890
				775	1240	1580	2010	2340	2680				
				1100	1670	2100	2710	3210	3750				
03092090	West Branch Mahoning River near Ravenna	41°09'41"	81°11'50'	887	1340	1680	2150	2540	2950	22	1966-87	1979	2810
				844	1390	1780	2300	2690	3090				
				883	1350	1700	2190	2590	3000				
03092100	Hinkley Creek near Charlestown	41°09'10"	81°10'05"	334	503	636	828	990	1170	23	1947-69	1959	2400
				486	810	1050	1350	1590	1830				
				341	538	703	946	1150	1360				

Table 3.--Flood-frequency data for streamflow-gaging stations--Continued

[ft^3/s, cubic feet per second. For each station the upper numbers are log-Pearson Type III estimates, the middle numbers are regression estimates, and the lower numbers are weighted estimates]

Station number	Station name	Latitude	Longitude	Flood-peak discharge in ft^3/s, for indicated recurrence interval, in years: 2	5	10	25	50	100	Record: Number of water years	Record: Period	Largest recorded discharge: Calendar year	Largest recorded discharge: Magnitude (ft^3/s)
* 03092500	West Branch Mahoning River near Newton Falls	41°10'18"	81°01'16"	2570 1920 2550	3750 2960 3690	4570 3700 4490	5650 4640 5520	6480 5350 6320	7340 6060 7130	40	1927-66	1959	8340
03092600	Ordnance Creek near Newton Falls	41°11'20"	81°01'05"	37 30 36	66 59 64	89 82 86	121 112 117	147 137 142	175 162 168	13	1950-62	1956	103
03093000	Eagle Creek at Phalanx Station	41°15'40"	80°57'16"	2600 2950 2610	3740 4690 3780	4510 5950 4580	5490 7590 5640	6220 8820 6440	6960 10100 7240	58	1927-34 1938-87	1979	8150
03094900	Walnut Creek at Cortland	41°19'49"	80°43'28"	488 390 481	816 642 796	1050 826 1020	1370 1060 1320	1610 1250 1540	1860 1430 1770	31	1947-77	1959	1470
* 03096000	Mosquito Creek at Niles	41°11'02"	80°45'39"	1580 2000 1610	2450 2920 2510	3060 3550 3140	3840 4360 3950	4450 4950 4570	5050 5550 5190	14	1930-43	1943	3080
03098500	Mill Creek at Youngstown	41°04'19"	80°41'26"	1480 2010 1490	2430 3150 2480	3220 3970 3300	4400 5030 4500	5430 5830 5510	6600 6660 6620	35	1913 1944-77	1913	7140
03098700	Crab Creek at Youngstown	41°07'20"	80°38'08"	671 707 673	861 1230 908	992 1620 1100	1160 2130 1370	1290 2530 1590	1430 2930 1810	24	1959-82	1959	2140
03101000	Sugar Run at Pymatuning Dam, Pa.	41°29'50"	80°27'55"	540 611 546	1020 1070 1030	1430 1420 1430	2050 1880 2000	2610 2240 2480	3230 2610 3010	21	1935-55	1937	2800
03102500	Little Shenango River at Greenville, Pa.	40°25'19"	80°22'35"	2530 2520 2530	3750 3930 3760	4630 4930 4650	5840 6230 5870	6800 7200 6840	7820 8210 7850	69	1914-18 1920-23 1926-85	1959	8540
03102900	Clear Creek at Oilworth	41°26'45"	80°39'56"	64 97 66	125 173 130	178 231 186	261 307 270	335 366 342	421 425 422	31	1947-77	1958	749
03102950	Pymatuning Creek at Kinsman	41°26'34"	80°35'18"	1580 1580 1580	2040 2300 2070	2330 2800 2380	2660 3430 2770	2900 3900 3060	3120 4380 3340	22	1966-87	1985	2740

Table 3.--Flood-frequency data for streamflow-gaging stations--Continued

[ft^3/s, cubic feet per second. For each station the upper numbers are log-Pearson Type III estimates, the middle numbers are regression estimates, and the lower numbers are weighted estimates]

Station number	Station name	Latitude	Longitude	Flood-peak discharge in ft^3/s, for indicated recurrence interval, in years: 2	5	10	25	50	100	ber of water years	Period	discharge: Calendar year	discharge: Magnitude (ft^3/s)
03104760	Harthegig Run near Greenfield, Pa.	41°11'10"	80°19'38"	175	273	342	434	504	577	12	1969-80	1980	398
				217	396	534	718	864	1010				
				182	303	399	533	638	745				
03106000	Connoquenessing Creek near Zelienople, Pa.	40°49'01"	80°14'33"	8060	10800	12700	15100	17000	18900	71	1916-86	1924	23000
				5690	8380	10300	12700	14500	16300				
				8020	10700	12500	14900	16700	18600				
03106500	Slippery Rock Creek at Wurtemburg, Pa.	40°53'02"	80°14'02"	7290	10300	12300	14900	16800	18800	74	1912-32	1937	19000
				7060	10700	13300	16700	19200	21800		1934-86		
				7290	10300	12300	15000	17000	19000				
03109000	Lisbon Creek at Lisbon	40°46'55"	80°45'53"	382	614	797	1060	1290	1540	35	1947-81	1958	1500
				309	534	701	921	1090	1260				
				377	603	780	1030	1240	1460				
03109500	Little Beaver Creek near East Liverpool	40°40'33"	80°32'27"	9310	13700	16800	21100	24600	28200	72	1916-87	1941	25000
				8300	12600	15600	19500	22400	25400				
				9290	13600	16800	21000	24400	27900				
03110000	Yellow Creek near Hammondsville	40°32'16"	80°43'31"	3190	4530	5490	6770	7780	8840	47	1941-87	1952	9580
				2950	4490	5480	6660	7490	8310				
				3180	4530	5480	6760	7740	8750				
03110980	Consol Run at Bloomingdale	40°19'56"	80°48'44"	6	12	17	24	30	37	10	1978-87	1980	17
				9	19	27	37	44	51				
				7	15	22	31	38	45				
03111450	Branson Run at Georgetown	40°12'26"	80°55'22"	52	84	109	143	170	199	10	1978-87	1978	134
				91	163	213	274	319	362				
				58	108	147	199	239	277				
03111455	South Fork Short Creek at Georgetown	40°12'27"	80°55'12"	199	308	382	475	544	612	10	1978-87	1980	380
				295	476	593	734	834	927				
				215	350	446	569	658	743				
03111470	Little Piney Fork at Parlett	40°18'07"	80°50'55"	62	129	191	291	385	497	10	1978-87	1987	222
				79	137	176	223	257	289				
				65	132	184	255	310	367				
03111490	Piney Fork Tributary near Piney Fork	40°16'18"	80°50'48"	12	24	35	53	71	92	10	1978-87	1978	73
				40	74	98	127	149	170				
				17	42	64	94	117	141				

Table 3.--Flood-frequency data for streamflow-gaging stations--Continued

[ft^3/s, cubic feet per second. For each station the upper numbers are log-Pearson Type III estimates, the middle numbers are regression estimates, and the lower numbers are weighted estimates]

Station number	Station name	Latitude	Longitude	Flood-peak discharge in ft^3/s, for indicated recurrence interval, in years: 2	5	10	25	50	100	Record: Number of water years	Record: Period	Largest recorded discharge: Calendar year	Largest recorded discharge: Magnitude (ft^3/s)
03111500	Short Creek near Dillonvale	40°11'36"	80°44'04"	2940	4160	4940	5880	6560	7210	46	1942-87	1945	6500
				2740	4260	5250	6440	7270	8110				
				2940	4170	4950	5930	6640	7310				
03111540	Sloan Run Tributary near Harrisville	40°09'07"	80°52'59"	49	133	224	388	552	756	10	1978-87	1978	180
				63	125	176	245	302	358				
				52	130	200	305	395	497				
03114000	Captina Creek at Armstrongs Mills	39°54'31"	80°55'27"	6300	9740	12200	15700	18400	21300	38	1927-35 1959-87	1980	21900
				4160	6740	8630	11100	13000	14900				
				6190	9460	11800	14900	17400	20000				
03114240	Wood Run near Woodsfield	39°46'56"	81°03'21"	64	133	192	284	365	456	10	1978-87	1981	240
				88	175	245	341	418	496				
				69	148	215	313	393	478				
03115280	Trail Run near Antioch	39°37'29"	81°02'54"	629	980	1260	1670	2020	2420	10	1978-87	1981	2020
				458	842	1140	1540	1850	2170				
				593	923	1200	1600	1920	2260				
03115400	Little Muskingum River at Bloomfield	39°33'47"	81°12'14"	7110	9590	11100	13000	14300	15600	23	1959-81	1963	21200
				5130	7930	9940	12500	14500	16600				
				7000	9460	11000	12900	14400	15700				
03115410	Graham Run near Bloomfield	39°32'36"	81°12'52"	20	41	59	86	109	134	10	1978-87	1979	79
				30	62	87	122	151	180				
				22	49	72	105	132	160				
03115510	Moss Run near Wingett	39°28'24"	81°18'52"	220	371	497	690	860	1050	10	1978-87	1980	760
				176	332	455	619	751	884				
				209	353	474	647	789	940				
03115600	Barnes Run near Summerfield	39°46'20"	81°22'26"	540	1090	1580	2350	3060	3870	33	1947-79	1957	2350
				312	571	771	1040	1250	1460				
				520	993	1380	1960	2450	2990				
03115710	Buffalo Run Tributary near Dexter City	39°39'41"	81°26'58"	44	52	58	65	70	75	10	1978-87	1984	69
				42	87	123	173	215	256				
				43	68	91	124	149	173				
03116000	Tuscarawas River at Clinton	40°55'40"	81°37'58"	1320	1810	2130	2540	2840	3140	52	1927-78	1935	2700
				2400	3480	4150	4950	5490	6030				
				1340	1860	2220	2690	3030	3370				

Table 3.--Flood-frequency data for streamflow-gaging stations--Continued

[ft^3/s, cubic feet per second. For each station the upper numbers are log-Pearson Type III estimates, the middle numbers are regression estimates, and the lower numbers are weighted estimates]

Station number	Station name	Latitude	Longitude	Flood-peak discharge in ft^3/s, for indicated recurrence interval, in years: 2	5	10	25	50	100	Record: Number of water years	Record: Period	Largest recorded discharge: Calendar year	Largest recorded discharge: Magnitude (ft^3/s)
03116100	Little Chippewa Creek near Smithville	40°53'39"	81°48'46"	740 494 726	1160 759 1110	1460 927 1380	1860 1130 1730	2180 1270 1990	2510 1410 2240	26	1947-72	1969	3930
03116200	Chippewa Creek at Easton	40°56'47"	81°44'35"	1810 2130 1820	3110 3080 3100	4300 3660 4180	6270 4360 5730	8150 4840 6980	10500 5310 8360	23	1959-81	1969	12500
03117000	Tuscarawas River at Massillon	40°46'13"	81°31'27"	4030 6070 4070	5430 8700 5560	6400 10300 6620	7660 12300 8050	8640 13600 9140	9650 14900 10300	49	1939-87	1969	10700
03117500	Sandy Creek at Waynesburg	40°40'21"	81°15'36"	3430 4310 3450	4910 6440 4980	6000 7790 6140	7530 9410 7730	8770 10500 9020	10100 11700 10400	49	1939-87	1959	15000
03118000	Middle Branch Nimishillen Creek at Canton	40°50'29"	81°21'14"	651 981 659	968 1490 998	1210 1810 1260	1540 2190 1620	1820 2460 1910	2120 2720 2220	46	1942-87	1959	2470
03118500	Nimishillen Creek at North Industry	40°44'03"	81°21'08"	3140 3140 3140	4510 4710 4520	5440 5720 5460	6640 6920 6650	7550 7750 7550	8460 8580 8470	66	1922-87	1959	8600
03119000	Sandy Creek at Sandyville	40°38'04"	81°22'28"	7200 7080 7190	10500 10500 10500	12700 12600 12700	15300 15200 15300	17200 16900 17100	19000 18700 18900	24	1924-47	1937	14200
03119700	Conotton Creek at Jewett	40°21'59"	81°00'13"	491 436 488	753 696 748	938 866 929	1180 1070 1160	1370 1210 1340	1560 1350 1520	35	1947-81	1963	1170
* 03122500	Tuscarawas River near Dover	40°31'47"	81°25'48"	15000 13100 14900	20800 18400 20600	24800 21700 24400	30100 25600 29200	34100 28200 32900	38100 30900 36500	15	1913 1924-37	1913	62000
03123400	Dundee Creek at Dundee	40°35'35"	81°36'13"	147 52 130	273 93 223	368 122 288	498 157 369	600 183 430	704 207 491	21	1966-86	1969 1980	340
03125000	Home Creek near New Philadelphia	40°28'06"	81°24'10"	121 120 121	210 213 210	274 277 274	356 356 356	419 414 418	481 470 480	43	1937-79	1969	378

Table 3.--Flood-frequency data for streamflow-gaging stations--Continued

[ft^3/s, cubic feet per second. For each station the upper numbers are log-Pearson Type III estimates, the middle numbers are regression estimates, and the lower numbers are weighted estimates]

Station number	Station name	Latitude	Longitude	Flood-peak discharge in ft^3/s, for indicated recurrence interval, in years: 2	5	10	25	50	100	Record: Number of water years	Record: Period	Largest recorded discharge: Calendar year	Largest recorded discharge: Magnitude (ft^3/s)
03125300	West Branch Spencer Creek at Hendrysburg	40°03'30"	81°09'30"	202 151 194	420 268 382	596 349 522	846 450 705	1050 524 843	1260 595 982	16	1950-65	1950	740
03125450	Robinson Run near Hendrysburg	40°05'08"	81°10'27"	97 133 104	130 237 158	150 309 198	174 398 251	191 465 290	207 527 327	10	1978-87	1978	147
03127950	Clear Fork near Jewett	40°19'28"	81°01'20"	184 244 194	249 415 290	291 530 363	343 672 458	381 774 528	419 870 597	10	1978-87	1978	300
03128650	Mud Run Tributary at Wainwright	40°25'07"	81°24'57"	10 57 15	19 106 38	26 144 59	37 194 91	47 233 116	58 272 142	10	1978-87	1981	38
*03129000	Tuscarawas River at Newcomerstown	40°15'41"	81°36'33"	21300 23500 21300	31100 32500 31200	38400 38700 38500	48500 46800 48200	56600 52600 56000	65300 59000 64000	17	1913 1922-37	1913	83000
03129012	White Eyes Creek Tributary near Coshocton	40°21'40"	81°47'52"	3 6 3	11 13 11	20 19 20	38 28 33	56 35 46	80 42 61	19	1940-58	1946	35
03129014	White Eyes Creek Tributary near Coshocton	40°21'38"	81°47'07"	110 75 107	251 148 229	388 208 337	620 288 507	843 353 659	1110 419 838	34	1937-70	1957	1140
03129016	White Eyes Creek Tributary near Coshocton	40°21'31"	81°46'57"	30 29 29	68 60 66	106 85 99	172 120 151	235 148 198	313 177 252	25	1938-55 1957-63	1946	193
03129300	Whetstone Creek Tributary near Olivesburg	40°53'15"	82°24'25"	42 36 42	72 66 71	95 90 93	127 121 126	154 146 152	184 171 180	28	1950-77	1969	310
03130500	Touby Run at Mansfield	40°45'53"	82°32'43"	403 397 403	627 701 635	788 931 809	1010 1230 1050	1180 1470 1230	1350 1710 1430	33	1947-78 1987	1987	1030
03132000	Clear Fork at Butler	40°35'37"	82°25'20"	3240 2970 3240	5190 4540 5130	6820 5650 6650	9320 7090 8870	11500 8160 10700	14100 9270 12700	31	1946-75 1987	1987	21300

Table 3.--Flood-frequency data for streamflow-gaging stations--Continued

[ft³/s, cubic feet per second. For each station the upper numbers are log-Pearson Type III estimates, the middle numbers are regression estimates, and the lower numbers are weighted estimates]

	Station number	Station name	Latitude	Longitude	Flood-peak discharge in ft³/s, for indicated recurrence interval, in years: 2	5	10	25	50	100	Record: Number of water years	Record: Period	Largest recorded discharge: Calendar year	Largest recorded discharge: Magnitude (ft³/s)
	03134000	Jerome Fork at Jeromeville	40°48'07"	82°12'01"	2490 3500 2520	3860 5530 3990	5010 7000 5260	6800 8910 7210	8410 10400 8870	10300 11900 10700	30	1926-49 1959 1962-64 1966 1969	1969	27000
*	03136000	Mohican River at Greer	40°30'53"	82°[illegible]1'44"	10800 13300 10800	15100 19100 15300	18000 23200 18600	21900 28500 22900	25000 32400 26200	28100 36600 29600	17	1913 1922-37	1913	55000
	03136500	Kokosing River at Mount Vernon	40°24'20"	82°30'00"	4530 5300 4560	7070 8350 7160	9110 10600 9270	12100 13400 12300	14700 15600 14900	17700 17900 17700	34	1954-87	1959	38000
	03137000	Kokosing River at Millwood	40°23'51"	82°17'09"	9740 9530 9730	16400 14600 16300	21800 18300 21600	29900 23100 29200	36900 26600 35600	44800 30400 42700	54	1913 1922-74	1959	75900
*	03138500	Walhonding River at Nellie	40°20'29"	82°03'56"	19600 19600 19600	29100 28200 29000	35200 34200 35200	42800 42100 42800	48400 47800 48300	53800 54000 53800	17	1913 1922-37	1913	102000
	~~03138900~~	~~Jennings Ditch~~ Tributary near Wooster	~~40°44'45"~~	~~81°55'48"~~	~~76~~ 123 79	~~195~~ 237 204	~~331~~ 327 330	~~600~~ 449 541	~~895~~ 548 738	~~1300~~ 647 977	18	~~1946~~ 1966-82	1946	1880
	03139000	Killbuck Creek at Killbuck	40°28'53"	81°59'10"	3680 8550 3720	6030 12700 6220	8130 15600 8510	11600 19400 12200	14800 22200 15700	18700 25200 19700	57	1931-87	1969	47500
	03139930	Little Mill Creek Tributary near Coshocton	40°24'35"	81°48'08"	63 88 65	135 174 141	203 244 211	315 337 321	420 414 418	546 490 528	35	1937-71	1957	382
	03139940	Little Mill Creek near Coshocton	40°24'03"	81°47'56"	155 177 156	306 339 310	434 467 440	626 640 630	790 779 787	972 919 959	35	1937-71	1969	724
	03139960	Little Mill Creek near Coshocton	40°23'28"	81°48'26"	300 244 296	592 455 571	839 620 798	1210 841 1130	1530 1020 1400	1880 1200 1690	35	1937-71	1957	1400
	03139970	Little Mill Creek Tributary near Coshocton	40°23'29"	81°48'40"	26 38 27	65 75 67	105 105 105	173 146 166	237 179 221	315 212 284	34	1938-71	1957	216

Table 3.--Flood-frequency data for streamflow-gaging stations--Continued

[ft^3/s, cubic feet per second. For each station the upper numbers are log-Pearson Type III estimates, the middle numbers are regression estimates, and the lower numbers are weighted estimates]

Station number	Station name	Latitude	Longitude	Flood-peak discharge in ft^3/s, for indicated recurrence interval, in years: 2	5	10	25	50	100	Record: Number of water years	Record: Period	Largest recorded discharge: Calendar year	Largest recorded discharge: Magnitude (ft^3/s)
03139980	Little Mill Creek	40°23'00"	81°49'05'	414	812	1140	1630	2030	2480	35	1937-71	1957	1590
	near Coshocton			352	645	871	1170	1410	1650				
				409	791	1100	1530	1890	2280				
03139990	Little Mill Creek	40°21'46"	81°50'21"	702	1430	2110	3230	4300	5570	36	1935	1935	9020
	near Coshocton			492	865	1150	1520	1810	2110		1937-71		
				690	1350	1930	2800	3560	4450				
03140000	Mill Creek near	40°21'46"	81°51'45"	1340	2640	3880	5950	7940	10400	51	1937-87	1969	8720
	Coshocton			1250	2100	2730	3550	4190	4840				
				1330	2590	3720	5480	7060	8890				
03140010	Spoon Creek Tributary	40°21'58"	81°47'56"	22	57	92	154	212	283	31	1940-70	1957	240
	near Coshocton			27	55	78	109	134	160				
				22	56	89	140	187	240				
03140020	Spoon Creek Tributary	40°21'56"	81°48'16"	9	22	36	61	85	115	33	1939-71	1957	116
	near Coshocton			19	40	58	82	101	121				
				10	25	41	66	89	117				
03140030	Spoon Creek Tributary	40°21'28"	81°48'08'	14	33	50	79	104	133	30	1940-69	1957	76
	near Coshocton			15	31	44	62	77	92				
				14	32	49	74	96	120				
03142200	Salt Fork near	40°05'05"	81°27'20"	1730	2600	3240	4120	4820	5570	11	1957-67	1963	3890
	Cambridge			1780	2780	3500	4430	5130	5860				
				1740	2640	3300	4230	4940	5690				
03144000	Wakatomika Creek	40°07'57"	82°08'53"	4070	6960	9240	12500	15300	18300	51	1937-87	1979	16800
	near Frazeysburg			3990	6330	8010	10200	11900	13600				
				4060	6920	9140	12300	14800	17500				
* 03144500	Muskingum River at	40°07'13"	81°59'59"	46100	68900	85300	108000	125000	144000	17	1913	1913	228000
	Dresden			51500	71000	84700	102000	115000	129000		1922-37		
				46200	69000	85100	107000	124000	141000				
03144800	Etna Creek at Etna	39°58'08"	82°40'55"	101	172	228	310	380	455	17	1966-82	1979	365
				92	162	214	283	337	391				
				99	169	224	301	362	428				
03145500	Raccoon Creek at	40°03'50"	82°31'35"	4060	6130	7370	8780	9710	10600	10	1940-48	1959	8700
	Granville			2240	3550	4500	5720	6640	7600		1959		
				3850	5740	6870	8150	9040	9860				

Table 3.--Flood-frequency data for streamflow-gaging stations--Continued

[ft^3/s, cubic feet per second. For each station the upper numbers are log-Pearson Type III estimates, the middle numbers are regression estimates, and the lower numbers are weighted estimates]

Station number	Station name	Latitude	Longitude	Flood-peak discharge in ft^3/s, for indicated recurrence interval, in years: 2	5	10	25	50	100	Record: Number of water years	Record: Period	Largest recorded discharge: Calendar year	Largest recorded discharge: Magnitude (ft^3/s)
03145600	Otter Fork near Centerburg	40°17'35"	82°43'09"	125	208	272	364	440	523	31	1947-77	1959	445
				164	272	350	452	530	608				
				127	214	283	381	459	543				
03146000	North Fork Licking River at Utica	40°13'41"	82°27'06"	4910	6370	7320	8520	9410	10300	22	1940-48	1979	10200
				2960	4690	5930	7550	8760	10000		1970-82		
				4750	6120	7060	8300	9250	10200				
03146500	Licking River near Newark	40°03'33"	82°20'23"	11300	17600	22300	28700	33900	39500	48	1940-87	1959	45000
				10000	15400	19300	24300	28100	32100				
				11300	17500	22000	28200	33200	38400				
03147000	Licking River at Toboso	40°03'26"	82°13'12"	12800	20200	25300	32000	37000	42100	45	1903-06	1959	49800
				11000	16600	20600	25800	29700	33700		1913		
				12800	20000	25100	31500	36400	41300		1922-61		
03147900	Timber Run near Zanesville	39°57'00"	82°03'07"	803	1340	1730	2260	2670	3090	31	1947-77	1976	2430
				515	882	1150	1510	1790	2070				
				782	1280	1640	2110	2470	2840				
03148300	Moxahala Creek at Roseville	39°48'38"	82°04'13"	2350	3410	4190	5260	6130	7060	25	1963-87	1963	5600
				1620	2460	3060	3820	4380	4960				
				2300	3270	3970	4900	5620	6370				
03149500	Salt Creek near Chandlersville	39°54'31"	81°51'38"	3310	4180	4730	5390	5870	6350	13	1935-47	1940	5240
				2410	3830	4850	6170	7180	8230				
				3200	4110	4750	5620	6300	6980				
* 03150000	Muskingum River at McConnelsville	39°38'42"	81°51'00"	55800	85900	107000	135000	157000	179000	17	1913	1913	270000
				54700	74600	88500	106000	119000	133000		1922-37		
				55800	85100	105000	132000	152000	172000				
03150600	Tupper Creek at Devola	39°28'24"	81°27'58"	139	224	292	391	475	569	15	1966-80	1980	470
				112	206	278	374	450	527				
				135	218	286	384	463	548				
03157000	Clear Creek near Rockbridge	39°35'18"	82°34'43"	2580	4060	5330	7310	9100	11200	48	1940-87	1948	16000
				2750	4350	5510	7020	8160	9360				
				2580	4070	5350	7260	8890	10700				
03157500	Hocking River at Enterprise	39°33'54"	82°28'29"	6860	11100	14700	20400	25400	31300	57	1907	1907	36000
				10200	15900	20000	25400	29400	33700		1932-87		
				6920	11300	15100	20900	26000	31800				

Table 3.--Flood-frequency data for streamflow-gaging stations--Continued

[ft^3/s, cubic feet per second. For each station the upper numbers are log-Pearson Type III estimates, the middle numbers are regression estimates, and the lower numbers are weighted estimates]

Station number	Station name	Latitude	Longitude	Flood-peak discharge in ft^3/s, for indicated recurrence interval, in years: 2	5	10	25	50	100	Record: Number of water years	Record: Period	Largest recorded discharge: Calendar year	Largest recorded discharge: Magnitude (ft^3/s)
03158100	Hayden Run near	39°28′57″	82°19′06″	83	149	207	298	381	477	12	1966-77	1968	370
	Haydenville			103	190	257	347	418	488				
				86	163	229	324	401	483				
03158220	Glen Run near	39°24′06″	82°11′44″	106	171	219	283	334	387	11	1977-87	1981	250
	Doanville			108	201	272	366	441	516				
				106	180	238	318	382	447				
03159450	Mill Creek near	39°22′46″	82°05′04″	120	197	256	340	409	483	10	1978-87	1981	265
	Chauncey			138	254	343	460	554	647				
				123	216	291	396	481	568				
03159500	Hocking River at	39°19′44″	82°05′16″	12400	18500	23300	30000	35700	41900	73	1907	1907	50000
	Athens			14700	21600	26400	32700	37300	42300		1916-87		
				12400	18600	23400	30300	35900	42000				
03159540	Shade River near	39°03′49″	81°52′55″	3490	4630	5440	6530	7390	8300	22	1966-87	1968	8170
	Chester			3340	5000	6170	7680	8810	9980				
				3480	4670	5560	6810	7800	8830				
03201550	Starr Run near	39°23′46″	82°20′49″	52	83	106	139	166	194	10	1978-87	1983	125
	New Plymouth			45	88	123	168	205	242				
				50	85	114	155	187	221				
03201600	Sandy Run above Big	39°21′45″	82°18′47″	109	270	446	782	1140	1610	11	1971-81	1974	990
	Four Hollow Creek			123	233	319	434	527	620				
	near Lake Hope			111	254	379	568	729	914				
03201700	Big Four Hollow	39°21′48″	82°18′51″	118	308	528	970	1460	2130	13	1971-83	1974	1200
	Creek near Lake			125	237	325	442	536	630				
	Hope			119	280	424	644	839	1070				
03202000	Raccoon Creek at	38°52′25″	82°21′22″	6030	8920	11100	14000	16400	19000	68	1916-35	1968	20000
	Adamsville			9500	13800	16800	20800	23600	26700		1937		
				6070	9060	11300	14400	16900	19600		1939-85		
03205995	Sandusky Creek near	38°25′03″	82°30′36″	100	143	175	219	254	291	10	1978-87	1979	242
	Burlington			100	192	265	363	441	520				
				100	162	216	293	354	416				
03217500	Scioto River at	40°34′28″	83°23′15″	5300	8000	9710	11700	13200	14500	24	1927-35	1959	16300
	LaRue			5030	7380	9020	11100	12700	14400		1938-51		
				5300	7960	9660	11700	13200	14500		1959		

Table 3.--Flood-frequency data for streamflow-gaging stations--Continued

[ft^3/s, cubic feet per second. For each station the upper numbers are log-Pearson Type III estimates, the middle numbers are regression estimates, and the lower numbers are weighted estimates]

Station number	Station name	Latitude	Longitude	Flood-peak discharge in ft^3/s, for indicated recurrence interval, in years: 2	5	10	25	50	100	Record: Number of water years	Record: Period	Largest recorded discharge: Calendar year	Largest recorded discharge: Magnitude (ft^3/s)
03218000	Little Scioto River above Marion	40°37'43"	83°10'11"	1090	1720	2220	2940	3540	4210	38	1939-76	1959	5160
				2050	3140	3910	4910	5660	6440				
				1110	1790	2340	3150	3820	4540				
03219500	Scioto River near Prospect	40°25'10"	83°11'50"	6060	8240	9620	11300	12500	13700	74	1913	1913	27000
				8560	12100	14600	17800	20100	22600		1915-87		
				6100	8320	9750	11500	12800	14000				
03220000	Mill Creek near Bellepoint	40°14'54"	83°10'26"	4480	6450	7840	9680	11100	12600	45	1943-87	1959	20300
				4280	6540	8150	10200	11800	13400				
				4480	6460	7850	9730	11200	12700				
03221000	Scioto River below O'Shaughnessy Dam near Dublin	40°08'36"	83°07'14"	12700	19200	23900	30300	35300	40600	67	1913	1913	74500
				8890	12100	14400	17200	19300	21400		1922-87		
				12700	19000	23400	29400	34000	38800				
03223000	Olentangy River at Claridon	40°34'58"	82°59'20"	3180	4970	6440	8650	10600	12800	41	1947-87	1959	14900
				4070	6300	7900	9980	11500	13200				
				3200	5050	6580	8850	10800	12900				
03224000	Shaw Creek at Shawtown	40°29'00"	82°57'25"	807	1120	1340	1650	1890	2150	10	1947-55	1959	4120
				1030	1650	2100	2690	3140	3600		1959		
				822	1200	1510	1950	2300	2660				
03224500	Whetstone Creek near Ashley	40°27'18"	82°57'28"	2810	4210	5320	6980	8390	9990	20	1955-74	1959	19100
				3110	4970	6330	8100	9440	10800				
				2820	4300	5510	7260	8710	10300				
* 03225500	Olentangy River near Delaware	40°21'18"	83°04'02"	7350	10800	13200	16400	18800	21300	35	1911-35	1913	41600
				7580	11300	13900	17300	19800	22500		1938-47		
				7360	10800	13300	16500	18900	21400				
03226200	Delaware Run near Delaware	40°18'28"	83°06'35"	340	572	741	966	1140	1320	32	1947-78	1959	1050
				299	488	624	802	938	1080				
				338	564	726	942	1110	1270				
03226850	Linworth Run near Linworth	40°06'24"	83°02'35"	78	163	234	337	422	514	12	1966-77	1969	250
				63	118	160	216	260	305				
				75	148	206	284	346	411				
03228000	Scioto Big Run at Briggsdale	39°54'56"	83°03'55"	1200	1850	2350	3060	3650	4280	33	1947-79	1973	3670
				657	1130	1490	1960	2330	2700				
				1160	1740	2180	2780	3270	3780				

Table 3.--Flood-frequency data for streamflow-gaging stations--Continued

[ft^3/s, cubic feet per second. For each station the upper numbers are log-Pearson Type III estimates, the middle numbers are regression estimates, and the lower numbers are weighted estimates]

Station number	Station name	Latitude	Longitude	Flood-peak discharge in ft^3/s, for indicated recurrence interval, in years: 2	5	10	25	50	100	Record: Number of water years	Record: Period	Largest recorded discharge: Calendar year	Largest recorded discharge: Magnitude (ft^3/s)
*03228500	Big Walnut Creek at Central College	40°06'13"	82°53'03"	7040	10600	13000	16100	18500	20900	17	1939-54	1959	23800
				5100	8050	10200	13000	15100	17300		1959		
				6900	10300	12600	15600	17800	20000				
*03228805	Alum Creek at Africa	40°10'56"	82°57'42"	4360	5670	6410	7240	7800	8310	11	1963-73	1963	6460
				3500	5520	6980	8870	10300	11800				
				4260	5640	6520	7600	8390	9180				
*03229000	Alum Creek at Columbus	39°56'42"	82°56'28"	4560	6910	8690	11200	13300	15500	49	1924-36	1959	26400
				4710	7290	9140	11500	13300	15200		1938-73		
				4560	6920	8730	11200	13300	15500				
*03229500	Big Walnut Creek at Reese	39°51'24"	82°57'26"	11900	17500	21200	25800	29300	32800	32	1922-36	1959	59800
				11100	17000	21300	26900	31000	35500		1939-54		
				11900	17400	21200	25900	29500	33100		1959		
03230500	Big Darby Creek at Darbyville	39°42'02"	83°06'37"	8240	13100	16900	22300	26900	31900	65	1922-36	1959	49000
				9630	14300	17600	21900	25000	28400		1938-87		
				8260	13100	16900	22300	26700	31500				
03230600	Hominy Creek at Circleville	39°35'26"	82°55'25"	610	1010	1350	1880	2350	2890	31	1947-77	1968	3820
				438	787	1050	1410	1690	1970				
				596	973	1280	1740	2130	2560				
03230800	Deer Creek at Mount Sterling	39°42'54"	83°15'26"	5460	8240	10100	12400	14100	15800	15	1967-81	1968	11600
				5470	8450	10600	13400	15400	17600				
				5460	8260	10200	12600	14400	16200				
*03231000	Deer Creek at Williamsport	39°35'09"	83°07'22"	8480	15600	21800	31400	40000	49900	36	1927-35	1959	39600
				7150	10900	13600	17000	19600	22400		1938-56		
				8430	15300	20900	29200	36100	43700		1959		
											1961-67		
*03231500	Scioto River at Chillicothe	39°20'29"	82°58'16"	41500	66900	85400	110000	129000	149000	60	1908-67	1913	260000
				42400	60200	72700	89000	101000	114000				
				41500	66700	84900	109000	128000	147000				
03231600	East Fork Paint Creek near Sedalia	39°42'36"	83°27'48"	213	342	436	564	664	768	35	1947-81	1979	710
				227	371	475	610	714	820				
				214	344	441	570	673	778				
03232000	Paint Creek near Greenfield	39°22'45"	83°22'32"	5190	9050	12000	16100	19300	22800	50	1926-35	1968	21700
				5350	8030	9940	12400	14200	16200		1940-56		
				5190	9020	11900	15800	18800	22000		1959-81		

Table 3.--Flood-frequency data for streamflow-gaging stations--Continued

[ft^3/s, cubic feet per second. For each station the upper numbers are log-Pearson Type III estimates, the middle numbers are regression estimates, and the lower numbers are weighted estimates]

Station number	Station name	Latitude	Longitude	Flood-peak discharge in ft^3/s, for indicated recurrence interval, in years: 2	5	10	25	50	100	Record: Number of water years	Record: Period	Largest recorded discharge: Calendar year	Largest recorded discharge: Magnitude (ft^3/s)
03232300	Rattlesnake Creek at Centerfield	39°19'44"	83°28'32"	5170 4660 5110	7140 7050 7130	8320 8750 8390	9670 10900 9980	10600 12600 11100	11500 14300 12200	10	1972-81	1979	7550
*03232500	Rocky Fork near Barretts Mills	39°13'06"	83°23'08"	6380 4530 6140	9350 7430 8950	11400 9570 10900	14000 12400 13500	16000 14500 15500	18000 16700 17500	12	1940-51	1945	13200
*03234000	Paint Creek near Bourneville	39°15'49"	83°10'01"	20000 14100 19800	31600 21100 31000	40500 26100 39400	53000 32600 50700	63300 37400 59800	74400 42600 69300	49	1922-70	1964	56900
03234100	Indian Creek at Massieville	39°15'42"	82°58'08"	1350 648 1290	2380 1160 2140	3230 1550 2810	4530 2060 3740	5670 2460 4520	6970 2880 5380	31	1947-77	1953	5640
*03234500	Scioto River at Higby	39°12'44"	82°51'50"	47800 53000 47900	77700 75000 77600	101000 90500 100000	134000 111000 132000	162000 125000 158000	193000 141000 186000	43	1931-73	1937	177000
03235000	Salt Creek at Tarlton	39°33'20"	82°46'51"	997 674 977	1620 1160 1550	2110 1520 2000	2830 2000 2630	3440 2370 3150	4120 2750 3710	31	1947-77	1968	5360
03235080	Bull Creek near Adelphi	39°27'11"	82°46'46"	348 277 334	660 503 604	928 676 818	1340 907 1120	1700 1090 1360	2120 1270 1630	11	1977-87	1983	1560
03235200	Little Blackjack Branch near South Bloomingville	39°27'23"	82°30'25"	174 116 163	358 221 318	511 303 440	734 414 607	918 503 741	1120 593 881	17	1966-82	1966	683
03235400	West Branch Tar Hollow Creek at Tar Hollow State Park	39°23'35"	82°45'12'	19 55 21	33 109 44	45 153 64	64 213 95	80 261 121	98 310 149	28	1950-77	1968	72
03235500	Tar Hollow Creek at Tar Hollow State Park	39°23'22"	82°45'03'	109 166 113	212 317 228	307 437 333	462 597 498	607 727 641	780 857 804	32	1947-78	1968	957
03235995	Salt Creek near Londonderry	39°17'26"	82°44'45"	10800 6910 10600	16200 11000 15300	20500 13900 18900	26800 17800 23900	32200 20700 27900	38200 23800 32300	30	1938-50 1963-79	1968	59000

Table 3.--Flood-frequency data for streamflow-gaging stations--Continued

[ft^3/s, cubic feet per second. For each station the upper numbers are log-Pearson Type III estimates, the middle numbers are regression estimates, and the lower numbers are weighted estimates]

Station number	Station name	Latitude	Longitude	Flood-peak discharge in ft^3/s, for indicated recurrence interval, in years: 2	5	10	25	50	100	Record: Number of water years	Record: Period	Largest recorded discharge: Calendar year	Largest recorded discharge: Magnitude (ft^3/s)
03236090	South Branch Little Salt Creek near Jackson	39°00'50"	82°39'01"	170	316	444	645	826	1040	11	1975	1980	555
				180	328	441	592	711	831		1978-87		
				171	320	443	618	762	916				
03236100	South Branch Little Salt Creek at Jackson	39°02'38"	82°38'35"	660	887	1030	1200	1310	1430	31	1947-77	1968	1400
				285	503	667	884	1050	1230				
				624	832	966	1140	1260	1380				
03237095	Devers Run at Lucasville	38°52'54"	83°01'13"	190	243	277	319	350	380	10	1978-87	1982	330
				137	259	355	484	586	689				
				176	249	313	401	470	540				
03237210	Rose Run near Portsmouth	38°48'07"	82°59'03"	96	137	164	195	217	238	16	1966-81	1976	187
				145	283	394	543	664	786				
				102	164	211	275	324	372				
03237280	Uppar Twin Creek at McGaw	38°38'37"	83°12'57"	1110	1990	2620	3450	4070	4690	25	1960	1960	7320
				1360	2310	3000	3880	4540	5180		1964-87		
				1120	2020	2670	3520	4150	4790				
03237300	West Branch Turkey Run near Winchester	38°56'56"	83°40'19"	199	353	485	688	868	1080	22	1956-77	1956	720
				170	295	387	504	593	678				
				195	338	451	610	740	879				
03237500	Ohio Brush Creek near West Union	38°48'13"	83°25'16"	20700	29800	36200	44700	51300	58200	56	1927-35	1964	59200
				14200	20700	25300	30900	34900	39000		1941-87		
				20600	29300	35400	43300	49300	55500				
03238400	Harwood Creek near Fayetteville	39°07'51"	83°51'00"	133	221	286	375	445	519	12	1966-77	1970	385
				148	248	319	410	477	542				
				135	228	296	387	457	528				
03238500	Whiteoak Creek near Georgetown	38°51'29"	83°55'43"	10000	13900	16400	19600	22000	24400	60	1924-35	1964	22400
				8990	13200	16100	19700	22300	24900		1940-87		
				10000	13900	16400	19600	22100	24500				
03239000	Little Miami River near Selma	39°48'36"	83°44'21"	1390	2930	4270	6300	8060	10000	25	1953-77	1959	7920
				1740	2790	3550	4540	5290	6080				
				1410	2910	4160	5960	7430	8990				
03239500	North Fork Little Miami River near Pitchin	39°49'40"	83°46'38"	378	848	1330	2180	3030	4110	25	1953-77	1959	3350
				1140	1840	2350	3000	3510	4020				
				405	940	1470	2360	3160	4080				

Table 3.--Flood-frequency data of streamflow-gaging stations--Continued

[ft^3/s, cubic feet per second. For each station the upper numbers are log-Pearson Type III estimates, the middle numbers are regression estimates, and the lower numbers are weighted estimates]

Station number	Station name	Latitude	Longitude	Flood-peak discharge in ft^3/s, for indicated recurrence interval, in years: 2	5	10	25	50	100	Record: Number of water years	Record: Period	Largest recorded discharge: Calendar year	Largest recorded discharge: Magnitude (ft^3/s)
03240000	Little Miami River near Oldtown	39°44'54"	83°55'53"	2720	5130	7220	10500	13400	16700	35	1953-87	1959	14800
				3910	6270	8000	10200	11900	13700				
				2770	5220	7310	10400	13100	16000				
03240500	North Fork Massies Creek at Cedarville	39°45'25"	83°47'25"	701	1500	2240	3460	4600	5940	14	1955-68	1963	3030
				1090	1730	2180	2780	3230	3700				
				733	1540	2230	3240	4080	4990				
03241000	South Fork Massies Creek near Cedarville	39°44'20'	83°45'50"	718	1370	1960	2890	3740	4750	14	1955-68	1963	3470
				725	1160	1470	1880	2190	2510				
				718	1330	1810	2490	3050	3640				
03241500	Massies Creek at Wilberforce	39°43'22"	83°52'58"	1540	2930	4070	5750	7170	8720	35	1953-87	1959	7300
				2270	3680	4720	6070	7100	8170			1963	
				1570	2990	4140	5790	7160	8610				
03241600	Shawnee Creek at Xenia	39°40'32"	83°55'32"	384	679	882	1140	1320	1490	30	1948-77	1968	1820
				294	509	670	880	1050	1210				
				378	662	857	1100	1280	1450				
03242050	Little Miami River near Spring Valley	39°35'00"	84°01'49"	7330	12300	16200	21800	26400	31400	41	1926-35	1963	38000
				8430	13200	16600	21000	24400	27900		1940-52		
				7360	12400	16300	21700	26200	30900		1959		
											1963-64		
											1969-83		
03242100	Wayne Creek at Waynesville	39°31'08"	84°04'47"	258	451	602	817	994	1190	16	1966-81	1974	880
				124	235	321	436	529	622				
				230	377	489	641	766	897				
03242150	Caesar Creek near Xenia	39°37'25"	83°54'09"	3060	3990	4570	5260	5750	6230	15	1969-83	1975	5170
				2460	3970	5070	6510	7600	8740				
				2990	3980	4670	5560	6240	6920				
03242200	Anderson Fork near New Burlington	39°33'59"	83°54'10"	2520	3420	3990	4670	5150	5620	15	1969-83	1975	5510
				2360	3700	4660	5900	6840	7820				
				2500	3460	4100	4920	5550	6150				
*03242300	Caesar Creek at Harveysburg	39°30'27"	84°00'42"	6610	9930	12600	16700	20200	24100	16	1959	1959	26000
				5530	8730	11100	14100	16400	18800		1961-75		
				6530	9730	12200	15800	18700	21700				

Table 3.--Flood-frequency data for streamflow-gaging stations--Continued

[ft^3/s, cubic feet per second. For each station the upper numbers are log-Pearson Type III estimates, the middle numbers are regression estimates, and the lower numbers are weighted estimates]

Station number	Station name	Latitude	Longitude	Flood-peak discharge in ft^3/s, for indicated recurrence interval, in years: 2	5	10	25	50	100	Record: Number of water years	Record: Period	Largest recorded discharge: Calendar year	Largest recorded discharge: Magnitude (ft^3/s)
* 03242500	Little Miami River	39°22'42"	84°05'32"	19300	31300	40100	51900	61200	70800	17	1939-52	1959	67000
	near Fort Ancient			21900	31700	38500	47000	53000	59100		1959		
				19400	31400	39900	51200	59700	68400		1963-64		
03244000	Todd Fork near	39°20'07"	84°05'12"	10500	16100	20200	25800	30300	35000	22	1953-74	1959	25500
	Roachester			7890	11600	14200	17400	19600	21900				
				10300	15500	19100	23800	27400	31000				
* 03245500	Little Miami River	39°10'17"	84°17'53"	30200	43700	53100	65600	75200	85100	54	1916-17	1959	84100
	at Milford			33100	47000	56600	68700	77000	85800		1926-77		
				30200	43800	53200	65800	75300	85100				
03246500	East Fork Little	39°03'09"	84°03'02"	10500	14300	16700	19600	21800	23900	20	1950-53	1964	19800
	Miami River at			8960	12900	15600	18900	21300	23700		1959		
	Williamsburg			10400	14100	16500	19500	21700	23800		1961-75		
03247100	Patterson Run near	39°07'38"	84°06'44"	582	722	800	888	946	999	31	1947-77	1962	952
	Owensville			436	723	930	1190	1390	1580				
				571	723	815	929	1010	1090				
* 03247500	East Fork Little	39°08'13"	84°14'17"	19700	27400	32200	38000	42200	46200	57	1916-20	1964	42400
	Miami River			16200	23400	28300	34500	38800	43300		1925-73		
	at Perintown			19600	27200	32100	37800	42000	46000		1975-77		
03255500	Mill Creek at	39°13'14"	84°26'49"	3310	4310	4930	5680	6210	6720	49	1939-87	1945	5780
	Reading			3440	5060	6180	7570	8550	9540				
				3310	4350	5000	5820	6410	6980				
* 03258000	West Fork Mill Creek	39°13'35"	84°27'22"	3520	5020	5960	7080	7860	8600	14	1939-52	1947	6310
	at Lockland			1780	2670	3280	4040	4580	5110				
				3270	4570	5330	6220	6850	7450				
03260700	Bokengehalas Creek	40°20'50"	83°53'28"	719	1050	1270	1560	1780	2000	30	1958-87	1959	1780
	near De Graff			1570	2650	3450	4500	5310	6140				
				753	1160	1460	1890	2220	2560				
03260800	Stony Creek near	40°17'27"	83°54'36"	1040	1750	2280	3000	3580	4170	18	1958-75	1959	2770
	De Graff			2270	3770	4880	6330	7440	8590				
				1110	1960	2630	3580	4350	5130				
03261500	Great Miami River	40°17'13"	84°09'00"	6800	10700	13700	17900	21300	25100	75	1913-87	1913	44000
	at Sidney			6710	9560	11500	14100	15900	17900				
				6800	10600	13600	17600	20900	24400				

Table 3.--Flood-frequency data for streamflow-gaging stations--Continued

[ft^3/s, cubic feet per second. For each station the upper numbers are log-Pearson Type III estimates, the middle numbers are regression estimates, and the lower numbers are weighted estimates]

Station number	Station name	Latitude	Longitude	Flood-peak discharge in ft^3/s, for indicated recurrence interval, in years: 2	5	10	25	50	100	Record: Number of water years	Record: Period	Largest recorded discharge: Calendar year	Largest recorded discharge: Magnitude (ft^3/s)
03262750	Millers Ditch at Tipp City	39°57'59"	84°10'22"	108	200	276	390	488	596	17	1966-82	1981	625
				98	181	245	330	398	466				
				107	195	266	367	451	538				
03263100	Poplar Creek near Vandalia	39°52'10"	84°11'21"	400	659	853	1120	1330	1560	31	1947-77	1959	1130
				288	530	716	965	1160	1360				
				390	638	826	1080	1290	1510				
03263700	Bridge Creek near Greenville	40°04'13"	84°37'45"	349	553	679	824	922	1010	31	1947-77	1958	754
				293	488	630	815	959	1100				
				346	547	673	824	929	1030				
03264000	Greenville Creek near Bradford	40°06'08"	84°25'48"	3120	4890	6230	8100	9620	11200	55	1913	1913	18200
				4650	7130	8900	11200	12900	14700		1932-54		
				3150	4980	6370	8340	9910	11600		1956		
											1958-87		
03265000	Stillwater River at Pleasant Hill	40°03'28"	84°21'22"	9940	15300	19200	24400	28500	32700	72	1913	1913	51400
				8830	13000	15900	19700	22400	25400		1917-87		
				9910	15200	19100	24100	28100	32100				
03265100	Hog Run Tributary at Laura	40°00'30"	84°25'26"	36	61	80	106	127	150	28	1950-77	1953	204
				47	82	107	140	167	192				
				36	63	84	112	135	159				
03266500	Mad River at Zanesfield	40°21'01"	83°40'28"	409	725	989	1390	1730	2120	33	1947-79	1972	2100
				521	925	1230	1640	1960	2290				
				415	748	1030	1440	1790	2170				
03267000	Mad River near Urbana	40°06'27"	83°47'57"	2470	3840	4810	6100	7090	8120	54	1926-31	1959	8000
				4530	7180	9100	11600	13500	15500		1940-87		
				2510	3950	5010	6440	7570	8730				
03267900	Mad River at Saint Paris Pike at Eagle City	39°57'51"	83°49'54"	5250	6920	7970	9260	10200	11100	22	1966-87	1971	9700
				7120	11000	13800	17500	20200	23100				
				5350	7240	8570	10300	11700	13000				
03268000	Buck Creek at New Moorefield	39°59'31"	83°42'53"	1850	2550	3090	3870	4530	5260	17	1943-59	1959	8130
				2470	4080	5270	6830	8020	9260				
				1880	2760	3550	4740	5710	6730				
03268300	Beaver Creek at Brighton	39°55'46"	83°34'04"	252	473	640	866	1040	1220	19	1959-77	1959	1000
				234	399	520	680	804	930				
				250	459	612	817	971	1130				

Table 3.--Flood-frequency data for streamflow-gaging stations--Continued

[ft^3/s, cubic feet per second. For each station the upper numbers are log-Pearson Type III estimates, the middle numbers are regression estimates, and the lower numbers are weighted estimates]

Station number	Station name	Latitude	Longitude	Flood-peak discharge in ft^3/s, for indicated recurrence interval, in years: 2	5	10	25	50	100	Record: Number of water years	Record: Period	Largest recorded discharge: Calendar year	Largest recorded discharge: Magnitude (ft^3/s)
03268500	Beaver Creek near Springfield	39°56'26"	83°44'56"	1850	2870	3590	4540	5280	6030	21	1943-59	1948	4980
				1590	2610	3360	4340	5090	5860		1973-76		
				1830	2830	3550	4500	5240	5980				
*03269000	Buck Creek at Springfield	39°55'57"	83°49'02"	3180	5440	7200	9730	11800	14100	56	1913	1929	13000
				4260	6880	8790	11300	13200	15200		1915-21		
				3210	5500	7290	9860	11900	14200		1924-56		
											1959-73		
*03269500	Mad River near Springfield	39°55'23"	83°52'13"	7770	12700	16400	21600	25900	30500	63	1904-05	1913	55400
				10300	15800	19800	25000	28900	33000		1913-73		
				7800	12700	16500	21800	26100	30700				
*03270500	Great Miami River at Dayton	39°45'55"	84°11'51"	36700	57200	70700	87200	99100	111000	29	1893-1921	1913	250000
				32400	47200	57700	71400	81300	92200				
				36600	56600	69800	85900	97500	109000				
03270800	Wolf Creek at Trotwood	39°47'39"	84°18'36"	1570	2410	2960	3650	4160	4670	25	1959	1959	3900
				1780	2810	3540	4460	5130	5790		1963-86		
				1590	2440	3030	3780	4330	4880				
03271000	Wolf Creek at Dayton	39°46'00"	84°14'10"	4730	7050	8740	11000	12900	14800	13	1939-50	1959	12500
				4220	6550	8200	10300	11800	13300		1959		
				4680	6950	8590	10800	12400	14200				
03271800	Twin Creek near Ingomar	39°42'28"	84°31'30"	7460	10700	13300	16900	20000	23400	26	1959	1959	30300
				8650	12900	15800	19400	22000	24700		1963-87		
				7500	10900	13600	17500	20500	23800				
03272695	Trippetts Branch at Camden	39°38'03"	84°39'08"	100	179	236	313	373	433	10	1978-87	1983	247
				80	146	196	260	309	355				
				95	167	219	288	340	394				
03272700	Sevenmile Creek at Camden	39°37'45"	84°38'40"	3240	4710	5650	6790	7600	8390	17	1971-87	1974	6210
				3580	5470	6790	8440	9620	10800				
				3270	4810	5830	7110	8040	8950				
03272800	Sevenmile Creek at Collinsville	39°31'23"	84°36'39"	6120	9790	12500	16400	19500	22800	17	1959	1968	16800
				6370	9750	12100	15100	17200	19400		1961-76		
				6140	9770	12400	16000	18800	21600				
03272900	Collins Creek at Collinsville	39°35'05"	84°36'53"	240	352	422	504	562	616	17	1966-82	1968	409
				203	365	488	645	765	881				
				234	355	438	543	619	695				

Table 3.--Flood-frequency data for streamflow-gaging stations--Continued

[ft^3/s, cubic feet per second. For each station the upper numbers are log-Pearson Type III estimates, the middle numbers are regression estimates, and the lower numbers are weighted estimates]

	Station number	Station name	Latitude	Longitude	Flood-peak discharge in ft^3/s, for indicated recurrence interval, in years: 2	5	10	25	50	100	Record: Number of water years	Record: Period	Largest recorded discharge: Calendar year	Largest recorded discharge: Magnitude (ft^3/s)
	03273500	Fourmile Creek near Hamilton	39°27'30"	84°32'50"	14500 12100 14400	21300 18000 21100	25400 22200 25200	30100 27400 29900	33200 31100 33000	36100 34900 36100	23	1938-60	1959	44500
*	03274000	Great Miami River at Hamilton	39°23'28"	84°34'20"	43400 66500 44300	60700 89800 63500	73800 106000 78500	92300 126000 99300	107000 139000 116000	124000 154000 133000	15	1907-21	1913	352000
	03274100	Blake Run near Reily	39°27'59"	84°45'22"	61 77 62	111 140 114	149 187 155	202 247 209	244 293 253	287 337 297	36	1939-40 1942-43 1947-78	1960	307
	03274880	Green Fork Tributary near Lynn, Ind.	40°01'14"	84°56'24"	97 146 105	168 251 190	220 329 254	290 427 340	345 501 405	401 572 471	10	1973-82	1979	240
	03275500	East Fork Whitewater River at Richmond, Ind.	39°48'24"	84°54'26"	5240 5360 5250	8980 8030 8890	11700 9870 11500	15400 12200 14900	18200 13800 17500	21100 15500 20000	29	1950-78	1969	15000
	03275600	East Fork Whitewater River at Abington, Ind.	39°43'57"	84°57'35"	6220 8190 6340	8610 12200 8930	10100 14900 10600	11900 18400 12800	13100 20900 14300	14300 23300 15800	20	1966-84 1986	1969	13400
	03275800	West Run near Liberty, Ind.	39°38'24"	84°57'18"	77 72 76	124 131 126	158 175 164	205 231 216	242 275 256	281 317 297	14	1973-86	1974	240
	03275900	Templeton Creek near Fairfield, Ind.	39°31'20"	84°56'51"	392 523 410	793 840 805	1150 1060 1110	1700 1340 1530	2180 1550 1860	2740 1750 2210	10	1973-82	1980	1900
*	03276000	East Fork Whitewater River at Brookville, Ind.	39°26'02"	85°00'12"	10100 13200 10300	17200 19200 17500	22900 23400 23000	31200 28600 30700	38300 32300 36700	46100 36000 43200	20	1954-73	1959	36100
*	03276500	Whitewater River at Brookville, Ind.	39°24'24"	85°00'46"	28700 33200 28800	43400 47400 43500	53300 57200 53500	66000 69400 66100	75400 77900 75500	84800 86800 84900	57	1916-20 1924-73 1983 1986	1959	81800
	03322500	Wabash River near New Corydon, Ind.	40°33'50"	84°48'10"	4190 3290 4160	5560 4680 5520	6310 5630 6270	7110 6860 7100	7620 7750 7640	8080 8670 8150	35	1952-86	1959	8720

Table 3.--Flood-frequency data for streamflow-gaging stations--Continued

[ft^3/s, cubic feet per second. For each station the upper numbers are log-Pearson Type III estimates, the middle numbers are regression estimates, and the lower numbers are weighted estimates]

Station number	Station name	Latitude	Longitude	Flood-peak discharge in ft^3/s, for indicated recurrence interval, in years: 2	5	10	25	50	100	Record: Number of water years	Record: Period	Largest recorded discharge: Calendar year	Largest recorded discharge: Magnitude (ft^3/s)
03325500	Mississinewa River near Ridgeville, Ind.	40°16'49"	84°59'44"	3650	5670	7100	8960	10400	11800	40	1947-86	1958	13900
				3160	4800	5950	7450	8570	9740				
				3630	5620	7010	8810	10200	11600				
04096515	Hog Creek near Allen, Mich.	41°56'55"	84°49'40"	244	360	446	566	664	768	17	1970-86	1985	664
				602	840	981	1150	1260	1360				
				259	406	521	681	805	931				
04099060	Pigeon Creek Tributary near Ellis, Ind.	41°37'43"	84°54'56"	46	77	99	130	154	178	10	1973-82	1981	110
				68	112	141	175	200	223			1982	
				49	85	112	147	173	198				
04175700	River Raisin near Tecumseh, Mich.	41°56'35"	83°56'45"	1130	1490	1740	2070	2330	2600	24	1957-80	1968	2920
				1820	2500	2900	3370	3670	3960				
				1150	1570	1870	2280	2580	2890				
04176000	River Raisin near Adrian, Mich.	41°54'15"	83°58'50"	2780	4000	4810	5830	6590	7340	33	1954-86	1982	6660
				3450	4750	5510	6420	7010	7600				
				2800	4030	4850	5870	6620	7360				
04176500	River Raisin near Monroe, Mich.	41°57'38"	83°31'52"	6290	9460	11500	14100	16000	17800	49	1938-86	1982	15300
				6940	9350	10800	12500	13600	14700				
				6300	9440	11500	14000	15800	17500				
04176900	Hill Ditch near Richards	41°39'54"	83°40'05"	81	161	230	334	425	527	35	1947-81	1972	340
				173	282	355	443	506	566				
				85	171	243	350	439	535				
04177400	Eagle Creek Tributary near Montpelier	41°35'10"	84°40'50"	71	111	138	175	202	230	26	1950-75	1956	195
				58	92	112	137	155	171				
				69	108	134	167	191	215				
04177720	Fish Creek at Hamilton, Ind.	41°31'55"	84°54'12"	324	448	527	625	696	766	17	1970-86	1985	654
				683	1040	1270	1540	1720	1900				
				346	506	621	771	883	991				
04178000	Saint Joseph River near Newville, Ind.	41°23'08"	84°48'06"	4250	6090	7350	8990	10200	11500	40	1947-86	1950	9710
				7670	11100	13300	15900	17600	19400				
				4330	6300	7690	9530	10900	12400				
04181500	Saint Marys River at Decatur, Ind.	40°50'55"	84°56'16"	5580	8090	9650	11500	12800	14000	55	1932-86	1943	12000
				5680	7740	8960	10400	11400	12400				
				5580	8070	9620	11400	12700	13900				

Table 3.--Flood-frequency data for streamflow-gaging stations--Continued

[ft^3/s, cubic feet per second. For each station the upper numbers are log-Pearson Type III estimates, the middle numbers are regression estimates, and the lower numbers are weighted estimates]

Station number	Station name	Latitude	Longitude	Flood-peak discharge in ft^3/s, for indicated recurrence interval, in years: 2	5	10	25	50	100	Record: Number of water years	Record: Period	Largest recorded discharge: Calendar year	Largest recorded discharge: Magnitude (ft^3/s)
04183500	Maumee River at Antwerp	41°11'56"	84°44'40"	14000	18300	21000	24600	27200	29800	71	1912-82	1913	40000
				15300	20300	23300	26900	29200	31700				
				14100	18300	21100	24700	27300	29900				
04183750	Racetrack Run at Hicksville	41°18'58"	84°46'00"	50	93	126	173	211	251	10	1978-87	1981	173
				31	54	70	89	104	117				
				46	79	102	131	153	175				
04184500	Bean Creek at Powers	41°40'39"	84°13'56"	2150	3080	3650	4340	4820	5280	42	1941-82	1982	4900
				3590	5330	6430	7760	8670	9580				
				2180	3160	3780	4540	5080	5610				
04184750	Spring Creek at Fayette	41°40'32"	84°19'47"	268	325	357	390	412	432	10	1978-87	1982	395
				143	238	302	380	436	489				
				240	301	340	386	421	454				
04184760	Bean Creek Tributary near Fayette	41°39'08"	84°17'34"	58	73	82	92	99	105	10	1978-87	1985	91
				38	64	81	103	118	133				
				53	70	81	96	107	117				
04185000	Tiffin River at Stryker	41°30'16"	84°25'47"	3410	4900	5830	6940	7730	8480	56	1913	1982	7800
				5920	8620	10300	12400	13700	15100		1922-28		
				3450	4990	5970	7180	8040	8850		1937		
											1941-87		
04185150	Beaver Creek Tributary near Montpelier	41°34'19"	84°31'03"	96	125	143	164	179	194	10	1978-87	1980	150
				30	52	67	85	99	111				
				75	94	107	123	135	148				
04185945	Auglaize River Tributary near Spencerville	40°42'27"	84°19'06"	87	135	168	210	241	272	10	1978-87	1986	180
				42	71	92	116	134	151				
				75	112	136	166	187	208				
04186500	Auglaize River near Fort Jennings	40°56'55"	84°15'58"	5050	7210	8510	9990	11000	11900	62	1922-36	1959	12000
				4650	6650	7880	9360	10400	11400		1941-87		
				5040	7190	8470	9950	11000	11900				
04186800	King Run near Harrod	40°43'56"	83°53'47"	94	126	145	168	184	199	21	1966-86	1982	167
				50	90	118	153	178	203				
				88	118	138	164	182	200				
04187500	Ottawa River at Allentown	40°45'18"	84°11'41"	3110	4470	5310	6290	6970	7620	52	1924-35	1959	7740
				2490	3590	4270	5090	5640	6200		1939		
				3100	4440	5250	6210	6870	7500		1943-81		

Table 3.--Flood-frequency data for streamflow-gaging stations--Continued

[ft^3/s, cubic feet per second. For each station the upper numbers are log-Pearson Type III estimates, the middle numbers are regression estimates, and the lower numbers are weighted estimates]

Station number	Station name	Latitude	Longitude	Flood-peak discharge in ft^3/s, for indicated recurrence interval, in years: 2	5	10	25	50	100	Record: Number of water years	Record: Period	Largest recorded discharge: Calendar year	Largest recorded discharge: Magnitude (ft^3/s)
04187945	Rattlesnake Creek	40°49'20"	84°04'16"	130	188	225	268	298	326	10	1978-87	1981	280
	near Cairo			81	132	165	205	234	262				
				120	173	206	245	273	300				
04188500	Eagle Creek near	40°59'35"	83°39'05"	2100	2880	3360	3920	4300	4670	13	1947-57	1981	6500
	Findlay			1350	2080	2550	3110	3510	3890		1959		
				2040	2800	3260	3790	4170	4520		1981		
04189000	Blanchard River near	41°03'21"	83°41'17"	5230	7760	9400	11400	12900	14300	61	1913	1913	22000
	Findlay			4870	6990	8300	9880	10900	12000		1924-36		
				5220	7730	9350	11300	12700	14100		1941-87		
04189100	Tiderishi Creek near	40°55'53"	83°43'39"	200	308	375	450	501	547	31	1947-77	1959	480
	Jenera			200	319	397	490	557	621				
				200	309	377	455	509	558				
04189500	Blanchard River at	41°02'40"	84°04'55"	8040	11300	13500	16300	18400	20500	13	1922-28	1959	17700
	Glandorf			7720	10900	12900	15200	16800	18500		1947-51		
				8020	11300	13400	16100	18100	20000		1959		
04190350	Little Auglaize	40°55'05"	84°20'47"	53	80	97	117	131	144	10	1978-87	1981	109
	River Tributary			60	97	120	149	170	189				
	at Ottoville			54	83	102	126	143	160				
04190500	Roller Creek at	40°46'16"	84°38'15"	211	310	378	466	534	603	31	1947-77	1959	890
	Ohio City			207	326	402	494	559	622				
				211	311	380	470	538	607				
04191480	Beetree Run near	41°13'21"	84°24'33"	95	132	154	180	198	214	11	1977-87	1985	165
	Junction			82	130	161	199	226	251				
				93	132	156	185	207	226				
04191500	Auglaize River near	41°14'15"	84°23'57"	25700	37300	45100	55000	62300	69500	74	1913	1913	120000
	Defiance			20400	28200	32900	38600	42300	46300		1915-87		
				25600	37200	44800	54200	61200	68100				
[ ]04192500	Maumee River near	41°17'30"	84°16'50"	45100	61000	71000	83400	92300	101000	58	1925-36	1982	104000
	Defiance			34000	44200	50200	57600	62200	67500		1939-75		
				44200	58800	67500	77600	84400	91100		1979-87		
04192900	Reitz Run at	41°29'50"	83°42'35"	34	65	92	135	173	217	21	1966-86	1969	165
	Waterville			64	107	136	170	195	219				
				36	71	101	144	180	217				

Table 3.--Flood-frequency data for streamflow-gaging stations--Continued

[ft^3/s, cubic feet per second. For each station the upper numbers are log-Pearson Type III estimates, the middle numbers are regression estimates, and the lower numbers are weighted estimates]

Station number	Station name	Latitude	Longitude	Flood-peak discharge in ft^3/s, for indicated recurrence interval, in years						Record		Largest recorded discharge	
				2	5	10	25	50	100	Number of water years	Period	Calendar year	Magnitude (ft^3/s)
04193500	Maumee River at Waterville	41°30′00″	83°42′46″	50900	69400	82300	99300	112000	126000	67	1900-01	1913	180000
				39500	51900	59300	68200	74000	80400		1913		
				50700	68900	81300	97300	110000	122000		1922-36		
											1939-87		
04195500	Portage River at Woodville	41°26′58″	83°21′41″	6340	8600	9990	11600	12800	13900	56	1913	1913	17000
				5480	7740	9130	10800	11900	13000		1929-35		
				6320	8570	9950	11600	12800	13900		1940-87		
04196000	Sandusky River near Bucyrus	40°48′13″	83°00′21″	2580	3910	4940	6410	7640	8990	43	1926-35	1959	13500
				1890	2860	3480	4220	4730	5240		1939-51		
				2560	3840	4780	6070	7100	8170		1959		
											1964-81		
											1987		
04196500	Sandusky River near Upper Sandusky	40°51′02″	83°15′23″	4830	6800	8030	9470	10500	11400	59	1922-36	1959	10000
				4790	7080	8530	10300	11500	12700		1938-81		
				4830	6810	8040	9510	10500	11500				
04196700	Saint James Run near Upper Sandusky	40°46′51″	83°18′12″	208	303	358	420	461	498	31	1947-77	1959	408
				231	373	466	578	659	736				
				209	308	367	437	484	528				
04196800	Tymochtee Creek at Crawford	40°55′22″	83°20′56″	3680	4910	5630	6460	7030	7550	27	1961-87	1978	6390
				2580	3550	4130	4820	5280	5740				
				3620	4810	5500	6280	6810	7290				
04197000	Sandusky River near Mexico	41°02′39″	83°11′42″	8700	12200	14500	17200	19100	20900	60	1922-37	1937	19000
				9380	13400	15900	18900	21000	23100		1939-82		
				8710	12300	14500	17300	19200	21100				
04197100	Honey Creek at Melmore	41°01′20″	83°06′35″	2600	3440	3940	4500	4890	5240	27	1961-87	1981	4440
				2160	3130	3720	4430	4910	5390				
				2580	3420	3920	4500	4900	5260				
04197300	Wolf Creek at Bettsville	41°14′58″	83°14′08″	1600	2060	2350	2720	2980	3250	21	1961-81	1962	4280
				1490	2260	2740	3330	3730	4130				
				1590	2070	2400	2810	3120	3430				
04197400	East Branch Wolf Creek at Fort Seneca	41°12′40″	83°10′50″	1760	2220	2500	2840	3080	3310	15	1961-75	1969	2780
				1560	2360	2860	3470	3890	4310				
				1740	2240	2560	2990	3300	3600				

Table 3.--Flood-frequency data for streamflow-gaging stations--Continued

[ft^3/s, cubic feet per second. For each station the upper numbers are log-Pearson Type III estimates, the middle numbers are regression estimates, and the lower numbers are weighted estimates]

Station number	Station name	Latitude	Longitude	Flood-peak discharge in ft^3/s, for indicated recurrence interval, in years: 2	5	10	25	50	100	Record: Number of water years	Record: Period	Largest recorded discharge: Calendar year	Largest recorded discharge: Magnitude (ft^3/s)
04197500	Havens Creek at Havens	41°17'36"	83°11'50"	140	207	249	298	333	365	31	1947-77	1956	312
				188	302	375	464	527	588				
				142	213	259	316	356	394				
04198000	Sandusky River near Fremont	41°18'28"	83°09'32"	15700	21500	25000	29000	31800	34400	62	1924-36	1978	36500
				13500	19100	22600	26800	29600	32500		1939-87		
				15700	21400	24900	28900	31700	34400				
04198100	Norwalk Creek near Norwalk	41°13'58"	82°32'28"	346	607	810	1100	1330	1580	36	1947-82	1969	1880
				341	589	775	1020	1210	1400				
				346	605	805	1080	1310	1550				
04198500	East Branch Huron River near Norwalk	41°14'58"	82°38'52"	2650	4350	5640	7460	8940	10500	13	1924-35	1969	22000
				2890	4690	6010	7720	9030	10400		1969		
				2670	4400	5700	7520	8970	10500				
04199000	Huron River at Milan	41°18'06"	82°36'25"	8000	11900	15000	19400	23200	27400	32	1950-81	1969	49600
				8180	12700	15900	20200	23300	26700				
				8000	12000	15100	19500	23200	27200				
04199500	Vermilion River near Vermilion	41°22'55"	82°19'01"	6170	10800	15000	22100	29000	37400	32	1950-81	1969	40800
				6100	9400	11800	14800	17100	19600				
				6170	10600	14500	20300	25400	31100				
04199800	Neff Run near Litchfield	41°12'33"	82°01'26"	71	97	115	139	157	176	17	1966-82	1969	152
				67	117	155	204	243	281				
				70	102	126	161	187	215				
04200000	East Branch Black River at Elyria	41°20'51"	82°05'40"	4620	7550	9900	13300	16300	19600	14	1923-35	1969	23100
				5240	8080	10100	12800	14700	16800		1969		
				4660	7620	9930	13200	15900	18700				
04200100	Plum Creek at Oberlin	41°17'15"	82°13'12"	298	501	652	861	1030	1200	31	1947-77	1969	1560
				246	405	521	671	787	902				
				295	491	635	830	982	1140				
04200500	Black River at Elyria	41°22'49"	82°06'17"	7230	10900	13900	18400	22300	26800	43	1945-87	1969	51700
				8360	12800	16000	20100	23200	26400				
				7260	11000	14100	18600	22500	26700				
04201500	Rocky River near Berea	41°24'24"	81°53'14"	7840	10900	12900	15600	17600	19600	56	1924-35	1959	21400
				6510	10200	12800	16300	18900	21600		1944-87		
				7820	10800	12900	15600	17700	19900				

Table 3.--Flood-frequency data for streamflow-gaging stations--Continued

[ft^3/s, cubic feet per second. For each station the upper numbers are log-Pearson Type III estimates, the middle numbers are regression estimates, and the lower numbers are weighted estimates]

Station number	Station name	Latitude	Longitude	Flood-peak discharge in ft^3/s, for indicated recurrence interval, in years: 2	5	10	25	50	100	Record: Number of water years	Record: Period	Largest recorded discharge: Calendar year	Largest recorded discharge: Magnitude (ft^3/s)
*04202000	Cuyahoga River at Hiram Rapids	41°20'26"	81°10'01"	1580 2700 1620	2310 4000 2400	2770 4910 2920	3320 6080 3560	3700 6940 4040	4070 7830 4490	24	1928-35 1945-60	1959	3670
04207200	Tinkers Creek at Bedford	41°23'04"	81°31'39"	2430 1710 2380	3340 2550 3230	4000 3140 3840	4910 3900 4650	5640 4470 5280	6410 5050 5960	25	1963-87	1969	7220
04208000	Cuyahoga River at Independence	41°23'43"	81°37'48"	8560 10100 8590	11400 15100 11500	13300 18600 13600	15800 23100 16300	17700 26400 18500	19600 29900 20700	59	1922-23 1928-36 1940-87	1959	24800
04209000	Chagrin River at Willoughby	41°37'51"	81°24'13"	8860 6410 8790	13500 10200 13200	17000 12900 16600	22100 16500 21300	26300 19100 25200	30900 22000 29300	56	1913 1926-35 1940-84	1948	28000
04210000	Phelps Creek near Windsor	41°30'56"	80°56'07"	1860 971 1780	2690 1600 2550	3190 2060 3030	3770 2650 3570	4160 3110 3960	4510 3570 4340	18	1942-59	1959	4600
04210090	Montville Ditch at Montville	41°36'04"	81°03'03"	28 48 ~~31~~	54 92 ~~64~~	76 126 ~~92~~	107 173 ~~132~~	132 211 ~~163~~	160 248 ~~197~~	12	1966-77	1977	95
04210100	Hoskins Creek at Hartsgrove	41°36'00"	80°57'12"	201 266 204	324 445 335	419 575 439	553 745 585	663 875 703	783 1010 830	36	1947-77 1982-86	1959	700
*04211000	Rock Creek near Rock Creek	41°45'10"	80°48'00"	2510 1960 2490	3670 3000 3610	4420 3740 4360	5340 4690 5260	6010 5400 5930	6670 6140 6590	25	1942-66	1959	8000
04211500	Mill Creek near Jefferson	41°45'11"	80°48'03"	3330 2490 3300	4620 3920 4560	5550 4940 5470	6800 6280 6710	7790 7280 7690	8840 8330 8730	33	1942-74	1959	9810
04212000	Grand River near Madison	41°44'26"	81°02'48"	8780 8620 8770	11600 12200 11600	13300 14600 13400	15500 17800 15700	17100 20100 17300	18700 22600 19000	51	1923-36 1938-74	1959	21100
04212500	Ashtabula River near Ashtabula	41°51'20"	80°45'44"	4520 3700 4500	6570 5930 6530	7960 7560 7930	9750 9680 9750	11100 11300 11100	12500 13000 12500	51	1925-36 1939-47 1950-79	1959	11600

Table 3.--Flood-frequency data for streamflow-gaging stations--Continued

[ft^3/s, cubic feet per second. For each station the upper numbers are log-Pearson Type III estimates, the middle numbers are regression estimates, and the lower numbers are weighted estimates]

Station number	Station name	Latitude	Longitude	Flood-peak discharge in ft^3/s, for indicated recurrence interval, in years: 2	5	10	25	50	100	Record: Number of water years	Record: Period	Largest recorded discharge: Calendar year	Largest recorded discharge: Magnitude (ft^3/s)
04212600	Hubbard Run Tributary at Ashtabula	41°50'38"	80°46'42"	104 93 103	143 175 152	171 237 195	208 321 255	238 388 303	269 455 351	17	1966-82	1969	270
04213000	Conneaut Creek at Conneaut	41°55'37"	80°36'15"	6360 4450 6300	9270 6890 9140	11200 8650 11000	13600 10900 13400	15400 12600 15100	17100 14400 16900	52	1923-36 1950-87	1959	17000
04213040	Raccoon Creek near West Springfield, Pa.	41°56'42"	80°26'51"	149 151 149	234 264 238	294 348 303	374 459 391	434 545 459	496 630 527	26	1961-86	1968	408

* Streamflow at the station location is now regulated. Only unregulated annual flood-peak discharges were used to compute the discharges shown in the table.

[] Station not used in regression analysis. Compared to the station Maumee River at Waterville (04193500), that was used in the regression analysis, contributing drainage area is less than 25 percent different and length of record is shorter.

Table 4.--Selected basin characteristics of streamflow-gaging stations

[mi^2, square mile; ft/mi, feet per mile]

Station number	Station name	Region	Contributing drainage area (mi^2)	Main-channel slope (ft/mi)	Storage area (percent)
03022500	French Creek at Saegerstown, Pa.	A	629	6.4	2.0
03023000	Cussewago Creek near Meadville, Pa.	A	90.2	7.1	.5
03086100	Big Sewickley Creek near Ambridge, Pa.	A	15.6	48.3	1.0
03086500	Mahoning River at Alliance	A	89.2	10.4	.9
03087000	Beech Creek near Bolton	A	17.4	27.0	.4
03088000	Deer Creek at Limaville	A	33.2	6.8	.5
03089500	Mill Creek near Berlin Center	A	19.1	11.1	2.0
03090500	Mahoning River near Berlin Center	A	248	28.2	2.4
03092000	Kale Creek near Pricetown	A	21.9	11.4	1.0
03092090	West Branch Mahoning River near Ravenna	A	21.8	19.0	1.0
03092100	Hinkley Creek near Charlestown	A	10.6	20.5	1.0
03092500	West Branch Mahoning River near Newton Falls	A	96.3	11.7	3.7
03092600	Ordnance Creek near Newton Falls	A	.163	110	0.0
03093000	Eagle Creek at Phalanx Station	A	97.6	10.7	.1
03094900	Walnut Creek at Cortland	A	8.45	15.8	1.0
03096000	Mosquito Creek at Niles	A	138	5.1	5.6
03098500	Mill Creek at Youngstown	A	66.3	7.7	.2
03098700	Crab Creek at Youngstown	A	14.0	51.0	1.0
03101000	Sugar Run at Pymatuning Dam, Pa.	A	9.34	41.3	0.0
03102500	Little Shenango River at Greenville, Pa.	A	104	9.9	1.1
03102900	Clear Creek at Dilworth	A	1.13	46.5	1.0
03102950	Pymatuning Creek at Kinsman	A	96.7	4.0	4.0
03104760	Harthegig Run near Greenfield, Pa.	A	2.26	63.8	0.0
03106000	Connoquenessing Creek near Zelienople, Pa.	A	356	4.5	1.2
03106500	Slippery Rock Creek at Wurtemburg, Pa.	A	398	8.1	1.0
03109000	Lisbon Creek at Lisbon	A	6.19	55.6	3.0
03109500	Little Beaver Creek near East Liverpool	A	496	8.3	1.1
03110000	Yellow Creek near Hammondsville	B	147	9.8	0.0
03110980	Consol Run at Bloomingdale	B	.040	500	0.0
03111450	Branson Run at Georgetown	B	1.31	95.2	.8
03111455	South Fork Short Creek at Georgetown	B	10.9	37.9	4.4
03111470	Little Piney Fork at Parlett	B	1.57	78.8	3.2
03111490	Piney Fork Tributary near Piney Fork	B	.440	130	.9
03111500	Short Creek near Dillonvale	B	123	14.4	0.0
03111540	Sloan Run Tributary near Harrisville	A	.340	254	0.0

Table 4.--Selected basin characteristics of streamflow-gaging stations--Continued

Station number	Station name	Region	Contributing drainage area (mi^2)	Main-channel slope (ft/mi)	Storage area (percent)
03114000	Captina Creek at Armstrongs Mills	A	134	16.0	0.0
03114240	Wood Run near Woodsfield	A	.530	246	0.0
03115280	Trail Run near Antioch	A	5.45	90.3	0.0
03115400	Little Muskingum River at Bloomfield	A	210	7.0	0.0
03115410	Graham Run near Bloomfield	A	.130	289	0.0
03115510	Moss Run near Wingett	A	1.52	114	0.0
03115600	Barnes Run near Summerfield	A	3.46	75.5	0.0
03115710	Buffalo Run Tributary near Dexter City	A	.190	366	0.0
03116000	Tuscarawas River at Clinton	B	174	6.2	1.4
03116100	Little Chippewa Creek near Smithville	B	16.4	6.5	0.0
03116200	Chippewa Creek at Easton	B	146	5.0	1.0
03117000	Tuscarawas River at Massillon	B	518	5.3	.7
03117500	Sandy Creek at Waynesburg	B	253	7.6	0.0
03118000	Middle Branch Nimishillen Creek at Canton	B	43.1	7.7	.4
03118500	Nimishillen Creek at North Industry	B	175	8.7	.2
03119000	Sandy Creek at Sandyville	B	481	7.3	0.0
03119700	Conotton Creek at Jewett	B	14.3	20.9	1.1
03122500	Tuscarawas River near Dover	B	1405	4.5	.6
03123400	Dundee Creek at Dundee	B	.740	116	2.0
03125000	Home Creek near New Philadelphia	B	1.64	62.0	0.0
03125300	West Branch Spencer Creek at Hendrysburg	B	2.26	84.5	.3
03125450	Robinson Run near Hendrysburg	B	1.97	95.6	.5
03127950	Clear Fork near Jewett	B	5.45	57.4	1.1
03128650	Mud Run Tributary at Wainwright	A	.550	101	1.8
03129000	Tuscarawas River at Newcomerstown	A	2443	1.9	.8
03129012	White Eyes Creek Tributary near Coshocton	A	.012	994	0.0
03129014	White Eyes Creek Tributary near Coshocton	A	.441	221	0.0
03129016	White Eyes Creek Tributary near Coshocton	A	.116	372	0.0
03129300	Whetstone Creek Tributary near Olivesburg	A	.240	47.7	0.0
03130500	Touby Run at Mansfield	A	5.44	39.6	0.0
03132000	Clear Fork at Butler	A	136	7.0	1.0
03134000	Jerome Fork at Jeromeville	A	120	9.6	0.0
03136000	Mohican River at Greer	A	948	2.9	.3
03136500	Kokosing River at Mount Vernon	A	202	10.1	0.0
03137000	Kokosing River at Millwood	A	455	7.6	0.0

Table 4.--Selected basin characteristics of streamflow-gaging stations--Continued

Station number	Station name	Region	Contributing drainage area (mi^2)	Main-channel slope (ft/mi)	Storage area (percent)
03138500	Walhonding River at Nellie	A	1505	3.0	.2
03138900	Jennings Ditch Tributary near Wooster	A	.900	153	0.0
03139000	Killbuck Creek at Killbuck	A	464	3.7	0.0
03139930	Little Mill Creek Tributary near Coshocton	A	.545	219	0.0
03139940	Little Mill Creek near Coshocton	A	1.44	151	0.0
03139960	Little Mill Creek near Coshocton	A	2.38	100	0.0
03139970	Little Mill Creek Tributary near Coshocton	A	.191	188	0.0
03139980	Little Mill Creek near Coshocton	A	4.02	77.8	0.0
03139990	Little Mill Creek near Coshocton	A	7.16	39.5	0.0
03140000	Mill Creek near Coshocton	A	27.2	21.1	0.0
03140010	Spoon Creek Tributary near Coshocton	A	.118	247	0.0
03140020	Spoon Creek Tributary near Coshocton	A	0.068	406	0.0
03140030	Spoon Creek Tributary near Coshocton	A	.049	375	0.0
03142200	Salt Fork near Cambridge	A	55.6	6.2	0.0
03144000	Wakatomika Creek near Frazeysburg	A	140	10.3	0.0
03144500	Muskingum River at Dresden	A	5993	2.0	.4
03144800	Etna Creek at Etna	A	1.10	37.0	1.0
03145500	Raccoon Creek at Granville	A	82.7	13.0	1.0
03145600	Otter Fork near Centerburg	A	3.17	17.7	2.0
03146000	North Fork Licking River at Utica	A	116	14.0	1.0
03146500	Licking River near Newark	A	537	10.7	.6
03147000	Licking River at Toboso	A	672	8.2	.8
03147900	Timber Run near Zanesville	A	10.1	35.7	1.0
03148300	Moxahala Creek at Roseville	A	80.6	8.0	3.2
03149500	Salt Creek near Chandlersville	A	75.7	9.0	0.0
03150000	Muskingum River at McConnelsville	A	7422	2.0	1.0
03150600	Tupper Creek at Devola	A	.990	58.0	0.0
03157000	Clear Creek near Rockbridge	A	89.0	9.2	0.0
03157500	Hocking River at Enterprise	A	459	10.6	0.0
03158100	Hayden Run near Haydenville	A	1.04	94.0	1.0
03158220	Glen Run near Doanville	A	1.09	94.4	.9
03159450	Mill Creek near Chauncey	A	1.48	80.4	.7
03159500	Hocking River at Athens	A	943	3.5	0.0
03159540	Shade River near Chester	A	156	4.0	.4
03201550	Starr Run near New Plymouth	A	.300	176	.7

Table 4.--Selected basin characteristics of streamflow-gaging stations--Continued

Station number	Station name	Re-gion	Contri-buting drainage area (mi^2)	Main-channel slope (ft/mi)	Storage area (percent)
03201600	Sandy Run above Big Four Hollow Creek near Lake Hope	A	.980	105	0.0
03201700	Big Four Hollow Creek near Lake Hope	A	1.01	103	0.0
03202000	Raccoon Creek at Adamsville	A	585	2.8	.1
03205995	Sandusky Creek near Burlington	A	.730	124	0.0
03217500	Scioto River at LaRue	A	257	2.5	0.0
03218000	Little Scioto River above Marion	A	72.4	4.3	0.0
03219500	Scioto River near Prospect	A	567	1.5	0.0
03220000	Mill Creek near Bellepoint	A	178	5.2	0.0
03221000	Scioto River below O'Shaughnessy Dam near Dublin	A	980	1.7	3.0
03223000	Olentangy River at Claridon	A	157	6.8	0.0
03224000	Shaw Creek at Shawtown	A	25.4	9.0	0.0
03224500	Whetstone Creek near Ashley	A	98.7	11.7	0.0
03225500	Olentangy River near Delaware	A	393	3.9	0.0
03226200	Delaware Run near Delaware	A	5.84	9.8	.4
03226850	Linworth Run near Linworth	A	.474	60.0	0.0
03228000	Scioto Big Run at Briggsdale	A	11.0	30.1	0.0
03228500	Big Walnut Creek at Central College	A	190	10.6	0.0
03228805	Alum Creek at Africa	A	122	9.0	0.0
03229000	Alum Creek at Columbus	A	189	6.9	0.0
03229500	Big Walnut Creek at Reese	A	544	8.1	0.0
03230500	Big Darby Creek at Darbyville	A	534	3.9	0.0
03230600	Hominy Creek at Circleville	A	5.66	58.3	0.0
03230800	Deer Creek at Mount Sterling	A	228	7.0	0.0
03231000	Deer Creek at Williamsport	A	333	5.9	0.0
03231500	Scioto River at Chillicothe	A	3849	2.7	0.0
03231600	East Fork Paint Creek near Sedalia	A	3.82	7.6	0.0
03232000	Paint Creek near Greenfield	A	249	4.1	0.0
03232300	Rattlesnake Creek at Centerfield	A	209	4.8	.1
03232500	Rocky Fork near Barretts MillS	A	140	21.3	0.0
03234000	Paint Creek near Bourneville	A	807	5.4	0.0
03234100	Indian Creek at Massieville	A	9.60	60.9	.1
03234500	Scioto River at Higby	A	5131	2.7	0.0
03235000	Salt Creek at Tarlton	A	11.5	28.6	0.0
03235080	Bull Creek near Adelphi	A	3.13	60.4	0.0
03235200	Little Blackjack Branch near South Bloomingville	A	.890	116	0.0

Table 4.--Selected basin characteristics of streamflow-gaging stations--Continued

Station number	Station name	Re-gion	Contri-buting drainage area (mi^2)	Main-channel slope (ft/mi)	Storage area (percent)
03235400	West Branch Tar Hollow Creek at Tar Hollow State Park	A	.300	213	0.0
03235500	Tar Hollow Creek at Tar Hollow State Park	A	1.35	140	0.0
03235995	Salt Creek near Londonderry	A	268	13.0	0.0
03236090	South Branch Little Salt Creek near Jackson	A	1.98	69.8	.4
03236100	South Branch Little Salt Creek at Jackson	A	3.76	36.7	.1
03237095	Devers Run at Lucasville	A	1.22	131	.4
03237210	Rose Run near Portsmouth	A	1.04	207	0.0
03237280	Upper Twin Creek at McGaw	C	12.2	67.0	0.0
03237300	West Branch Turkey Run near Winchester	C	.890	55.3	0.0
03237500	Ohio Brush Creek near West Union	C	387	8.3	0.0
03238400	Harwood Creek near Fayetteville	C	.880	26.0	0.0
03238500	Whiteoak Creek near Georgetown	C	218	7.9	0.0
03239000	Little Miami River near Selma	A	48.9	9.9	0.0
03239500	North Fork Little Miami River near Pitchin	A	28.9	9.4	0.0
03240000	Little Miami River near Oldtown	A	129	13.2	0.0
03240500	North Fork Massies Creek at Cedarville	A	28.9	7.0	0.0
03241000	South Fork Massies Creek near Cedarville	A	17.1	7.2	0.0
03241500	Massies Creek at Wilberforce	A	63.2	14.2	0.0
03241600	Shawnee Creek at Xenia	A	4.21	26.1	.1
03242050	Little Miami River near Spring Valley	A	366	10.0	0.0
03242100	Wayne Creek at Waynesville	A	1.01	98.0	0.0
03242150	Caesar Creek near Xenia	A	71.4	13.0	0.0
03242200	Anderson Fork near New Burlington	A	77.8	7.0	0.0
03242300	Caesar Creek at Harveysburg	A	209	11.0	0.0
03242500	Little Miami River near Fort Ancient	C	680	8.0	0.0
03244000	Todd Fork near Roachester	C	219	12.0	1.0
03245500	Little Miami River at Milford	C	1203	6.5	0.0
03246500	East Fork Little Miami River at Williamsburg	C	237	5.3	0.0
03247100	Patterson Run near Owensville	C	3.34	31.9	0.0
03247500	East Fork Little Miami River at Perintown	C	476	6.9	0.0
03255500	Mill Creek at Reading	C	73.0	7.6	.4
03258000	West Fork Mill Creek at Lockland	C	35.6	12.6	1.6
03260700	Bokengehalas Creek near De Graff	A	36.3	28.6	.2
03260800	Stony Creek near De Graff	A	59.1	22.8	.1
03261500	Great Miami River at Sidney	A	541	3.0	2.0

Table 4.--Selected basin characteristics of streamflow-gaging stations--Continued

Station number	Station name	Region	Contributing drainage area (mi^2)	Main-channel slope (ft/mi)	Storage area (percent)
03262750	Millers Ditch at Tipp City	A	.830	60.0	0.0
03263100	Poplar Creek near Vandalia	A	3.11	78.0	0.0
03263700	Bridge Creek near Greenville	A	4.83	11.6	0.0
03264000	Greenville Creek near Bradford	A	193	5.8	0.0
03265000	Stillwater River at Pleasant Hill	A	503	3.1	0.0
03265100	Hog Run Tributary at Laura	A	.460	12.9	0.0
03266500	Mad River at Zanesfield	A	7.31	49.8	0.0
03267000	Mad River near Urbana	A	162	11.0	0.0
03267900	Mad River at Saint Paris Pike at Eagle City	A	310	8.0	0.0
03268000	Buck Creek at New Moorefield	A	65.3	20.2	0.0
03268300	Beaver Creek at Brighton	A	3.33	17.0	0.0
03268500	Beaver Creek near Springfield	A	39.2	15.7	0.0
03269000	Buck Creek at Springfield	A	139	15.4	0.0
03269500	Mad River near Springfield	A	490	8.3	0.0
03270500	Great Miami River at Dayton	A	2511	4.0	0.0
03270800	Wolf Creek at Trotwood	C	22.7	19.0	0.0
03271000	Wolf Creek at Dayton	C	68.7	18.5	0.0
03271800	Twin Creek near Ingomar	C	197	10.0	0.0
03272695	Trippetts Branch at Camden	C	.330	145	.6
03272700	Sevenmile Creek at Camden	C	69.0	17.4	.7
03272800	Sevenmile Creek at Collinsville	C	120	16.0	0.0
03272900	Collins Creek at Collinsville	C	.940	120	0.0
03273500	Fourmile Creek near Hamilton	C	307	14.5	.3
03274000	Great Miami River at Hamilton	C	3630	3.4	.2
03274100	Blake Run near Reily	C	.290	93.0	0.0
03274880	Green Fork Tributary near Lynn, Ind.	C	.780	48.7	.1
03275500	East Fork Whitewater River at Richmond, Ind.	C	121	12.8	.6
03275600	East Fork Whitewater River at Abington, Ind.	C	200	12.1	.4
03275800	West Run near Liberty, Ind.	C	.260	100	0.0
03275900	Templeton Creek near Fairfield, Ind.	C	5.39	23.6	.6
03276000	East Fork Whitewater River at Brookville, Ind.	C	380	9.2	.3
03276500	Whitewater River at Brookville, Ind.	C	1224	7.3	.1
03322500	Wabash River near New Corydon, Ind.	A	262	3.2	4.1
03325500	Mississinewa River near Ridgeville, Ind.	A	133	4.6	.2
04096515	Hog Creek near Allen, Mich.	B	48.7	3.1	4.9

Table 4.--Selected basin characteristics of streamflow-gaging stations--Continued

Station number	Station name	Region	Contributing drainage area (mi^2)	Main-channel slope (ft/mi)	Storage area (percent)
04099060	Pigeon Creek Tributary near Ellis, Ind.	B	1.22	14.0	.3
04175700	River Raisin near Tecumseh, Mich.	B	249	5.2	13.0
04176000	River Raisin near Adrian, Mich.	B	463	4.9	7.1
04176500	River Raisin near Monroe, Mich.	B	1042	3.1	4.0
04176900	Hill Ditch near Richards	B	3.52	15.7	0.0
04177400	Eagle Creek Tributary near Montpelier	B	1.84	15.6	6.0
04177720	Fish Creek at Hamilton, Ind.	B	37.5	16.0	4.0
04178000	Saint Joseph River near Newville, Ind.	B	610	6.2	.3
04181500	Saint Marys River at Decatur, Ind.	B	621	2.1	1.0
04183500	Maumee River at Antwerp	B	2129	1.5	.5
04183750	Racetrack Run at Hicksville	B	.340	30.8	0.0
04184500	Bean Creek at Powers	B	206	6.6	0.0
04184750	Spring Creek at Fayette	B	2.58	21.5	0.0
04184760	Bean Creek Tributary near Fayette	B	.560	28.7	.9
04185000	Tiffin River at Stryker	B	410	5.3	0.0
04185150	Beaver Creek Tributary near Montpelier	B	.400	45.0	1.2
04185945	Auglaize River Tributary near Spencerville	B	.510	25.9	0.0
04186500	Auglaize River near Fort Jennings	B	332	3.4	0.0
04186800	King Run near Harrod	B	.530	65.0	0.0
04187500	Ottawa River at Allentown	B	160	3.9	.3
04187945	Rattlesnake Creek near Cairo	B	1.45	11.0	0.0
04188500	Eagle Creek near Findlay	B	55.0	9.3	0.0
04189000	Blanchard River near Findlay	B	346	3.7	0.0
04189100	Tiderishi Creek near Jenera	B	4.65	10.4	0.0
04189500	Blanchard River at Glandorf	B	644	3.2	0.0
04190350	Little Auglaize River Tributary at Ottoville	B	1.04	8.5	0.0
04190500	Roller Creek at Ohio City	B	5.14	8.0	0.0
04191480	Beetree Run near Junction	B	1.66	8.4	.2
04191500	Auglaize River near Defiance	B	2318	2.7	0.0
04192900	Reitz Run at Waterville	B	.980	16.7	0.0
04193500	Maumee River at Waterville	B	6330	1.3	0.0
04195500	Portage River at Woodville	B	428	2.8	0.0
04196000	Sandusky River near Bucyrus	B	88.8	7.4	0.0
04196500	Sandusky River near Upper Sandusky	B	298	6.6	0.0
04196700	Saint James Run near Upper Sandusky	B	5.29	13.4	0.0

Table 4.--Selected basin characteristics of streamflow-gaging stations--Continued

Station number	Station name	Region	Contributing drainage area (mi^2)	Main-channel slope (ft/mi)	Storage area (percent)
04196800	Tymochtee Creek at Crawford	B	229	2.0	1.0
04197000	Sandusky River near Mexico	B	774	4.3	0.0
04197100	Honey Creek at Melmore	B	149	5.0	1.0
04197300	Wolf Creek at Bettsville	B	66.2	7.0	0.0
04197400	East Branch Wolf Creek at Fort Seneca	B	70.1	7.0	0.0
04197500	Havens Creek at Havens	B	4.28	10.7	0.0
04198000	Sandusky River near Fremont	B	1251	4.0	0.0
04198100	Norwalk Creek near Norwalk	A	4.92	25.6	0.0
04198500	East Branch Huron River near Norwalk	A	85.5	14.8	0.0
04199000	Huron River at Milan	A	371	9.3	.1
04199500	Vermilion River near Vermilion	A	262	7.0	0.0
04199800	Neff Run near Litchfield	A	.760	31.0	1.0
04200000	East Branch Black River at Elyria	A	217	6.8	0.0
04200100	Plum Creek at Oberlin	A	4.83	13.8	1.0
04200500	Black River at Elyria	A	396	6.7	0.0
04201500	Rocky River near Berea	A	267	9.4	0.0
04202000	Cuyahoga River at Hiram Rapids	A	151	4.7	1.9
04207200	Tinkers Creek at Bedford	A	83.9	5.0	2.0
04208000	Cuyahoga River at Independence	A	707	7.1	1.5
04209000	Chagrin River at Willoughby	A	246	12.4	0.0
04210000	Phelps Creek near Windsor	A	25.6	20.7	1.0
04210090	Montville Ditch at Montville	A	.290	107	0.0
04210100	Hoskins Creek at Hartsgrove	A	5.42	21.8	1.7
04211000	Rock Creek near Rock Creek	A	69.2	4.1	0.0
04211500	Mill Creek near Jefferson	A	82.0	7.6	0.0
04212000	Grand River near Madison	A	581	1.4	0.0
04212500	Ashtabula River near Ashtabula	A	121	12.8	0.0
04212600	Hubbard Run Tributary at Ashtabula	A	.880	114	1.0
04213000	Conneaut Creek at Conneaut	A	175	7.0	0.0
04213040	Raccoon Creek near West Springfield, Pa.	A	2.53	57.5	3.3

APPENDIX A

Statistical Techniques for Determining Confidence Intervals and Testing for Extrapolation

This appendix provides an outline and example of the steps that must be followed to determine confidence intervals for the true t-year peak discharge and perform a more rigorous test for extrapolation than is covered in the body of the report.

Steps for Determining Confidence Intervals and Testing for Extrapolation

(1) Compute the regression estimate of the at-site population standard deviation:

$$\hat{\sigma} = \exp[\ln(\hat{s})],$$

where $\ln(\hat{s}) = -1.564 - 0.076(\log_{10}(\mathrm{CONTDA})) + 0.153(\log_{10}(\mathrm{SLOPE}))$,

$\hat{\sigma}$ is regression estimate of the at-site population standard deviation, and

$\hat{s}$ is regression estimate of the at-site sample standard deviation.

(2) Compute the estimated model error variance for the site of interest:

$$\hat{\gamma}^2 = \hat{\gamma}_m^2 + 2\hat{\rho}_{\mu\sigma}k\hat{\Delta}\hat{\gamma}_m + k^2\hat{\Delta}^2,$$

where $\hat{\Delta} = [\hat{\sigma}^2(\exp(\hat{\gamma}_s^2) - 1)]^{.5}$,

$\hat{\gamma}^2$ is estimated model error variance for the regression of peak discharge on basin characteristics at the site of interest,

$\hat{\gamma}_m^2$ is estimated model error variance for the regression of sample mean on basin characteristics (in this analysis, $\hat{\gamma}_m^2$ has been determined to have the numerical value 2.867×10^{-2}),

$\hat{\rho}_{\mu\sigma}$ is estimated correlation between the errors in the regressions for the mean and standard deviation (in this analysis, $\hat{\rho}_{\mu\sigma}$ has been determined to have the numerical values shown in table 5 for the tabulated recurrence intervals),

k is Pearson Type III frequency factor for the desired recurrence interval and skewness (the numerical values of k can be determined from tables published by Interagency Advisory Committee on Water Data, 1982), and

$\hat{\gamma}_s^2$ is estimated model error variance for the regression of ln(s) on basin characteristics (in this analysis, $\hat{\gamma}_s^2$ has been determined to have the numerical value 4.324×10^{-2}).

(3) Compute the estimated sampling error variance for the site of interest:

$$\hat{\Sigma} = \mathbf{x}\mathbf{U}\mathbf{x}^T,$$

where $\hat{\Sigma}$ is estimated sampling error variance for the site of interest,

$\mathbf{x}$ is a row vector of basin characteristics for the site of interest (table 6), and

$\mathbf{U}$ is the variance-covariance matrix, which was determined as follows:

$$\mathbf{U} = (\mathbf{X}^T \hat{\Psi}^{-1} \mathbf{X})^{-1},$$

where $\mathbf{X}$ is an n by p matrix of p-1 basin characteristics augmented on the left by a column of ones,

$\hat{\Psi}$ is the n by n GLS estimate of the covariance matrix, and

n is number of observations in the regression data set.

(4) Test for extrapolation:

If $\hat{\Sigma}$ is greater than Σ_{max}, then an estimate at the site of interest would constitute an extrapolation and consequently may suffer in accuracy. Σ_{max} is the maximum sampling error observed in the regression for the t-year peak discharge (table 5).

(5) Compute the regression estimate of the t-year peak discharge for the site of interest.

The regression equation for the desired region and recurrence interval should be selected from table 1 in the main body of the report.

(6) Compute the estimated variance of prediction at the site of interest:

where $\hat{V}_p$, the estimated variance of prediction at the site of interest, is defined as--

$$\hat{V}_p = \hat{\gamma}^2 + \hat{\Sigma}.$$

(7) Compute the 100(1-α) percent confidence interval for the true t-year peak discharge:

$$\hat{y}_u = (C)\hat{y}$$

$$\hat{y}_l = (\frac{1}{C})\hat{y}$$

$$C = 10^{[t_{(\alpha/2,n-p)}(\hat{V}_p)^{.5}]},$$

where $\hat{y}_u$ is upper confidence limit,

$\hat{y}_l$ is lower confidence limit, and

$t_{(\alpha/2,n-p)}$ is critical value of the Student's t distribution for n-p degrees of freedom.

Example

Estimate the 100-year peak discharge and the 90-percent confidence interval for an ungaged site with the following basin characteristics:

Contributing drainage area (CONTDA)	=	123 mi^2
Main-channel slope (SLOPE)	=	14.4 ft/mi
Storage area (STORAGE)	=	0.0 percent
Region	=	B

(1) Compute $\hat{\sigma}$:

$$\ln(\hat{s}) = -1.564 - 0.076(\log_{10}(\text{CONTDA})) + 0.153(\log_{10}(\text{SLOPE}))$$

$$= -1.564 - 0.076(\log_{10}(123)) + 0.153(\log_{10}(14.4))$$

$$= -1.546$$

$$\hat{\sigma} = \exp[\ln(\hat{s})]$$

$$= \exp[-1.546]$$

$$= 0.213.$$

(2) Compute $\hat{\gamma}^2$:

$$\hat{\Delta} = [\hat{\sigma}^2 (\exp(\hat{\gamma}_s^2) - 1)]^{.5}$$

$$= [(0.213)^2(\exp(4.324\text{x}10^{-2}) - 1)]^{.5}$$

$$= 4.48\text{x}10^{-2}.$$

$$\hat{\gamma}^2 = \hat{\gamma}_m^2 + 2\hat{\rho}_{\mu\sigma}k\hat{\Delta}\hat{\gamma}_m + k^2\hat{\Delta}^2$$

$$= 2.867\text{x}10^{-2}+(2)(-0.52)(2.326)(4.48\text{x}10^{-2})(2.867\text{x}10^{-2})^{0.5}+(2.326)^2(4.48\text{x}10^{-2})^2$$

$$= 2.118\text{x}10^{-2},$$

where k is determined from a table of published values and is based on a 100-year recurrence interval and 0 skew coefficient.

(3) Compute $\hat{\Sigma}$:

$$\hat{\Sigma} = \mathbf{xUx}^T$$

$$= 1.280\text{x}10^{-3},$$

where $\mathbf{x}$ $= [\ x(1)\ \ x(2)\ \ x(3)\ \ x(4)\ \ x(5)\ \ x(6)]$

$= [\ 1\ \ \log_{10}(\text{CONTDA})\ \ \log_{10}(\text{SLOPE})\ \ \log_{10}(\text{STORAGE+1})\ \ x(5)\ \ x(6)]$

$= [\ 1\ \ \log_{10}(123)\ \ \log_{10}(14.4)\ \ \log_{10}(0+1)\ \ 0\ \ 1].$

$\mathbf{U}$ = the variance-covariance matrix for the 100-year recurrence interval from table 7.

Note that the form of the $\mathbf{x}$-vector for Region B is obtained from table 6.

(4) Test for extrapolation:

$\hat{\Sigma}_{max} = 3.881\text{x}10^{-3}$ (from table 5 for the 100-year recurrence interval).

Because $\hat{\Sigma}$ is not greater than $\hat{\Sigma}_{max}$, the estimate will not be an extrapolation.

(5) Compute the regression estimate of the 100-year peak discharge. The equation for the 100-year peak discharge for region B is:

$$\hat{y} = 99.7(\text{CONTDA})^{0.756}(\text{SLOPE})^{0.285}(\text{STORAGE+1})^{-0.363}$$

$$= 99.7(123)^{0.756}(14.4)^{0.285}(0+1)^{-.0.363}$$

$$= 8{,}110 \text{ cubic feet per second.}$$

(6) Compute the estimated variance of prediction:

$$\hat{V}_p = \hat{\gamma}^2 + \hat{\Sigma}$$

$$= 2.118\text{x}10^{-2} + 1.280\text{x}10^{-3}$$

$$= 2.246\text{x}10^{-2}.$$

(7) Compute the 90-percent confidence interval:

$$C = 10^{[t_{\alpha/2,n-p}(\hat{V}_p)^{0.5}]}$$

$$= 10^{[(1.65)(2.246\text{x}10^{-2})^{0.5}]}$$

$$= 1.767.$$

$$\hat{y}_u = (C)\hat{y}$$

$$= 1.767(8110)$$

= 14,300 cubic feet per second.

$$\hat{y}_l = (\frac{1}{C})\hat{y}$$

$$= \frac{1}{1.767}(8110)$$

= 4,590 cubic feet per second.

The 90-percent confidence interval for $\hat{y}$ = 8,110 is (14,300, 4,590).

Table 5.—$\hat{\rho}_{\mu\sigma}$ *and* $\hat{\Sigma}_{max}$ *values, by recurrence interval*

Recurrence interval (years)	$\hat{\rho}_{\mu\sigma}$	$\hat{\Sigma}_{max}$
2	-1.0	3.519×10^{-3}
5	-.79	2.719×10^{-3}
10	-.65	2.820×10^{-3}
25	-.58	3.126×10^{-3}
50	-.55	3.489×10^{-3}
100	-.52	3.881×10^{-3}

Table 6.—*Regions and* ***x****-vectors*

[The row vector is augmented on the left by a 1 and on the right by two numbers which depend on the region in which the site of interest is located]

Region	x-vector					
	x(1)	x(2)	x(3)	x(4)	x(5)	x(6)
A	1	$\log_{10}$(CONTDA)	$\log_{10}$(SLOPE)	$\log_{10}$(STORAGE+1)	0	0
B	1	$\log_{10}$(CONTDA)	$\log_{10}$(SLOPE)	$\log_{10}$(STORAGE+1)	0	1
C	1	$\log_{10}$(CONTDA)	$\log_{10}$(SLOPE)	$\log_{10}$(STORAGE+1)	1	0

Table 7.--Variance-covariance (U) matrices

Recurrence interval (years)	U matrix					
	0.72376E-02	-0.16104E-02	-0.35153E-02	-0.64159E-03	0.21039E-03	-0.75259E-03
	-0.16104E-02	0.41537E-03	0.77063E-03	0.32677E-04	-0.10195E-03	0.11353E-03
2	-0.35153E-02	0.77063E-03	0.19792E-02	0.19911E-03	-0.23423E-03	0.32546E-03
	-0.64159E-03	0.32677E-04	0.19911E-03	0.28813E-02	0.40309E-04	-0.81374E-04
	0.21039E-03	-0.10195E-03	-0.23423E-03	0.40309E-04	0.15092E-02	0.13471E-03
	-0.75259E-03	0.11353E-03	0.32546E-03	-0.81374E-04	0.13471E-03	0.85058E-03
	0.54415E-02	-0.11930E-02	-0.26031E-02	-0.49141E-03	0.13794E-03	-0.56694E-03
	-0.11930E-02	0.30700E-03	0.56942E-03	0.24570E-04	-0.75937E-04	0.80239E-04
5	-0.26031E-02	0.56942E-03	0.14985E-02	0.15370E-03	-0.19294E-03	0.22620E-03
	-0.49141E-03	0.24570E-04	0.15370E-03	0.21538E-02	0.20611E-04	-0.42235E-04
	0.13794E-03	-0.75937E-04	-0.19294E-03	0.20611E-04	0.12312E-02	0.10560E-03
	-0.56694E-03	0.80239E-04	0.22620E-03	-0.42235E-04	0.10560E-03	0.67001E-03
	0.56240E-02	-0.12263E-02	-0.26830E-02	-0.52002E-03	0.14606E-03	-0.57941E-03
	-0.12263E-02	0.31535E-03	0.58542E-03	0.28838E-04	-0.82365E-04	0.78077E-04
10	-0.26830E-02	0.58542E-03	0.15617E-02	0.16173E-03	-0.21369E-03	0.22101E-03
	-0.52002E-03	0.28838E-04	0.16173E-03	0.22056E-02	0.20611E-04	-0.32747E-04
	0.14606E-03	-0.82365E-04	-0.21369E-03	0.20611E-04	0.13363E-02	0.11299E-03
	-0.57941E-03	0.78077E-04	0.22101E-03	-0.32747E-04	0.11299E-03	0.70937E-03
	0.61146E-02	-0.13275E-02	-0.29080E-02	-0.57970E-03	0.17049E-03	-0.61756E-03
	-0.13275E-02	0.34137E-03	0.63296E-03	0.35192E-04	-0.95738E-04	0.78223E-04
25	-0.29080E-02	0.63296E-03	0.17111E-02	0.17861E-03	-0.25067E-03	0.22484E-03
	-0.57970E-03	0.35192E-04	0.17861E-03	0.23731E-02	0.22831E-04	-0.21518E-04
	0.17049E-03	-0.95738E-04	-0.25067E-03	0.22831E-04	0.15250E-02	0.12740E-03
	-0.61756E-03	0.78223E-04	0.22484E-03	-0.21518E-04	0.12740E-03	0.78882E-03
	0.66006E-02	-0.14303E-02	-0.31343E-02	-0.63471E-03	0.19493E-03	-0.65759E-03
	-0.14303E-02	0.36797E-03	0.68133E-03	0.40066E-04	-0.10787E-03	0.79958E-04
50	-0.31343E-02	0.68133E-03	0.18555E-02	0.19447E-03	-0.28339E-03	0.23286E-03
	-0.63471E-03	0.40066E-04	0.19447E-03	0.25473E-02	0.25472E-04	-0.13326E-04
	0.19493E-03	-0.10787E-03	-0.28339E-03	0.25472E-04	0.16890E-02	0.14066E-03
	-0.65759E-03	0.79958E-04	0.23286E-03	-0.13326E-04	0.14066E-03	0.86136E-03
	0.71603E-02	-0.15500E-02	-0.33974E-02	-0.69600E-03	0.22322E-03	-0.70524E-03
	-0.15500E-02	0.39897E-03	0.73782E-03	0.44908E-04	-0.12125E-03	0.82790E-04
100	-0.33974E-02	0.73782E-03	0.20209E-02	0.21241E-03	-0.31960E-03	0.24406E-03
	-0.69600E-03	0.44908E-04	0.21241E-03	0.27526E-02	0.28671E-04	-0.51731E-05
	0.22322E-03	-0.12125E-03	-0.31960E-03	0.28671E-04	0.18663E-02	0.15559E-03
	-0.70524E-03	0.82790E-04	0.24406E-03	-0.51731E-05	0.15559E-03	0.94197E-03

APPENDIX B

Independent Variables Tested as Potential Regressor Variables

The following independent variables, which provide measures of basin characteristics, were tested as potential regressor variables. These variables were determined from U.S. Geological Survey 7.5-minute topographic quadrangle maps unless stated otherwise.

Contributing drainage area (in square miles).—the area, measured in a horizontal plane, that contributes surface runoff to a specified location on a stream. This area may be located inside or outside of the natural topographic divides of the basin.

Main-channel slope (in feet per mile).—computed as the difference in elevation at points 10 and 85 percent of the distance along the main channel from a specified location on the channel to the topographic divide, divided by the channel distance between the two points.

Main-channel length (in miles).—determined by measuring the distance along the main channel from a specified location to the topographic divide.

Mean basin elevation (in feet above sea level).— average of 20 to 80 ground-point elevations evenly distributed throughout the basin.

Basin elevation index (in thousands of feet above sea level).—determined by averaging main-channel elevations at points 10 and 85 percent of the distance from a specified location on the main channel to the topographic divide.

Basin shape index.—a dimensionless number computed by dividing the square of the main-channel length by the contributing drainage area.

Storage area.—the percentage of the contributing drainage area occupied by lakes, ponds, and swamps as explicitly shown on U.S. Geological Survey 7.5-minute topographic quadrangle maps. For the regression analysis, 1 was added to the storage-area percentage.

Forested area.—the percentage of the contributing drainage area occupied by forest cover. For the regression analysis, 1 was added to the forested-area percentage.

Surface-mined area.—the percentage of the contributing drainage area occupied by disturbed earth resulting from surface mining. For the regression analysis, 1 was added to the surface-mined-area percentage.

Mean annual precipitation (in inches).—determined from Ohio Department of Natural Resources, Ohio Water Plan Inventory Report 13 (Ohio Division of Water, 1962). For the regression analysis, 27 was subtracted from mean annual precipitation to account for annual evapotranspiration.

24-hour, 2-year rainfall (in inches).—the 24-hour rainfall expected to be equalled or exceeded an average of one time in a 2-year period, determined from Weather Bureau Technical Paper no. 40 (U.S. Department of Commerce, 1961).

Mean minimum January temperature (in degrees Fahrenheit).—determined from Weather Bureau, Climatography of the United States, no. 60-33 (U.S. Department of Commerce, 1959). Mean minimum January temperature was subtracted from 32 for the regression analysis to represent the number of degrees below freezing.