BASE-FLOW-FREQUENCY CHARACTERISTICS OF SELECTED PENNSYLVANIA STREAMS

By Kirk E. White and Ronald A. Sloto

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CONTENTS

ILLUSTRATIONS

Plate
[In pocket]

Figures

TABLES

CONVERSION FACTORS AND ABBREVIATIONS

Multiply inch-pound unit	By	To obtain metric unit
inch (in.)	25.40	millimeter (mm)
square mile (mi^2)	2.590	square kilometer (km^2)
gallon (gal)	3.785	liter (L)
	0.003785	cubic meter (m^3)
million gallons (Mgal)	3,785	cubic meter (m^3)
million gallons per day per square mile [$(Mgal/d)/mi^2$]	0.0169	cubic meters per second per square kilometer [$(m^3/s)/km^2$]
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)

BASE-FLOW-FREQUENCY CHARACTERISTICS OF SELECTED PENNSYLVANIA STREAMS

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ABSTRACT

Streamflow hydrographs of 309 streamflow stations in Pennsylvania were analyzed by using three computer-assisted empirical methods--local-minimum, fixed-interval, and sliding-interval--to separate the ground-water and surface-runoff components. The 2-, 5-, 10-, and 25-year base-flow-recurrence intervals were determined for each station. The 50- and 100-year recurrence intervals were determined for stations with minimums of 25 and 50 years of record, respectively. All active and inactive continuous-recording Pennsylvania streamflow stations with 10 or more years of record through water year 1986 were analyzed. Stations on the Delaware River in New York and New Jersey also were included. Hydrograph analysis by computer provides consistency of results by removing the subjectivity inherent in manual analyses and considerably reduces the time required to make the analyses. Estimates of the 25-year base-flow-recurrence interval made by using the local-minimum technique, which gives the most conservative estimate, range from 0.069 to 0.888 million gallons per day per square mile. Base flows estimated by using the three computer-assisted techniques compared well with published base flows estimated by using manual methods for three studies in southeastern Pennsylvania. Examples of the effects of geology, climate, regulation, and urbanization on base flow are provided.

INTRODUCTION

Increased development and water demand increase the potential for depletion of ground water caused by excessive withdrawals. Knowledge of the quantity of ground water discharged to streams helps water managers to assess the effect of ground-water withdrawals on streamflow.

Hydrograph analysis for base flow divides streamflow into its two component parts: overland runoff and ground-water discharge (base flow). Base-flow-hydrograph analysis techniques commonly are used to estimate ground-water contributions to streamflow and to define ground-water/surface-water relations. They also are used to calculate hydrologic budgets and to estimate recharge rates.

Two commonly used manual methods of analysis are fitting a curve under a streamflow hydrograph (Linsley and others, 1982, p. 210) and base-flow-recession methods (Olmsted and Hely, 1962; Riggs, 1963; Rorabaugh, 1963). Quick estimates of base flow are sometimes obtained by sketching a curve below the streamflow hydrograph. Such separation of a hydrograph into overland-runoff and ground-water components is difficult and inexact, however, and results derived from manual methods commonly cannot be replicated among investigators. The use of a computer program removes the subjectivity inherent in manual methods and substantially reduces the time required for hydrograph analysis of base flow. Analysis of a hydrograph for a streamflow station with 90 years of record can take weeks with completely manual methods, manual separation methods with the use of a plotter and digitizer take days, and computer methods take seconds.

Water resource managers need base flow information to manage ground-water withdrawals. To address this need, the U.S. Geological Survey (USGS), in cooperation with the Pennsylvania Department of Environmental Resources (PaDER), evaluated methods to obtain base-flow information accurately and efficiently.

The purpose of this report is to describe three computerized techniques of hydrograph analysis to determine base flow. Examples of the effects of physical factors on base flow are provided. The report provides managers with the base-flow information needed to manage ground-water withdrawals so that instream uses are preserved.

This report presents base flows for selected recurrence intervals determined by using automated hydrograph-separation techniques for all continuous-recording Pennsylvania streamflow stations (active and inactive) with a minimum of 10 years of record through the 1986 water year. The period of record for some stations includes the 1987 water year for 10 calendar years of record. A table of base-flow-recurrence intervals for 309 streamflow stations and a map showing annual base flow at the 25-year recurrence interval are provided.

DETERMINATION OF BASE FLOW USING COMPUTERIZED HYDROGRAPH-ANALYSIS TECHNIQUES

The hydrograph-analysis program, which is written in Fortran 77 (source code given in Appendix C), calculates the duration of overland runoff from the empirical relation:

$$N = A^{0.2}, \qquad (1)$$

where N is the number of days after which direct runoff ceases, and A is the drainage area in square miles (Linsley and others, 1982, p. 210). The interval used for base-flow separations in the program is approximately 2N; it is adjusted to the nearest odd integer from 3 to 11 (Pettyjohn and Henning, 1979, p. 31). For French Creek near Phoenixville, Pennsylvania, for example, the drainage area is 59.1 mi^2 (square miles), and N is equal to 2.26. The interval 2N, which is equal to 4.52, is adjusted to 5, the nearest odd integer.

Techniques

The hydrograph-analysis program uses three techniques to separate the ground-water and surface-runoff components of a streamflow hydrograph: fixed-interval, sliding-interval, and local-minimum. These three techniques can be described conceptually as three different algorithms to systematically draw connecting lines between the low points of the streamflow hydrograph. The sequence of these connecting lines defines the base-flow hydrograph. These techniques were developed by Pettyjohn and Henning (1979). Each technique is described below.

Fixed-Interval Technique

The fixed-interval technique assigns the lowest discharge in each interval to all days in that interval (fig. 1). The technique can be visualized as moving a bar 2N days wide upward until the bar intersects the hydrograph. The discharge at that point is assigned to all days in the interval. The bar is then moved 2N days horizontally, and the process is repeated. In figure 1, the interval (2N) is 5 days. For example, in the interval December 9 to 13, the lowest discharge, 85 ft^3/s (cubic feet per second), is assigned as the base-flow component for every day in that interval. The assigned daily values are connected to define the base-flow hydrograph.

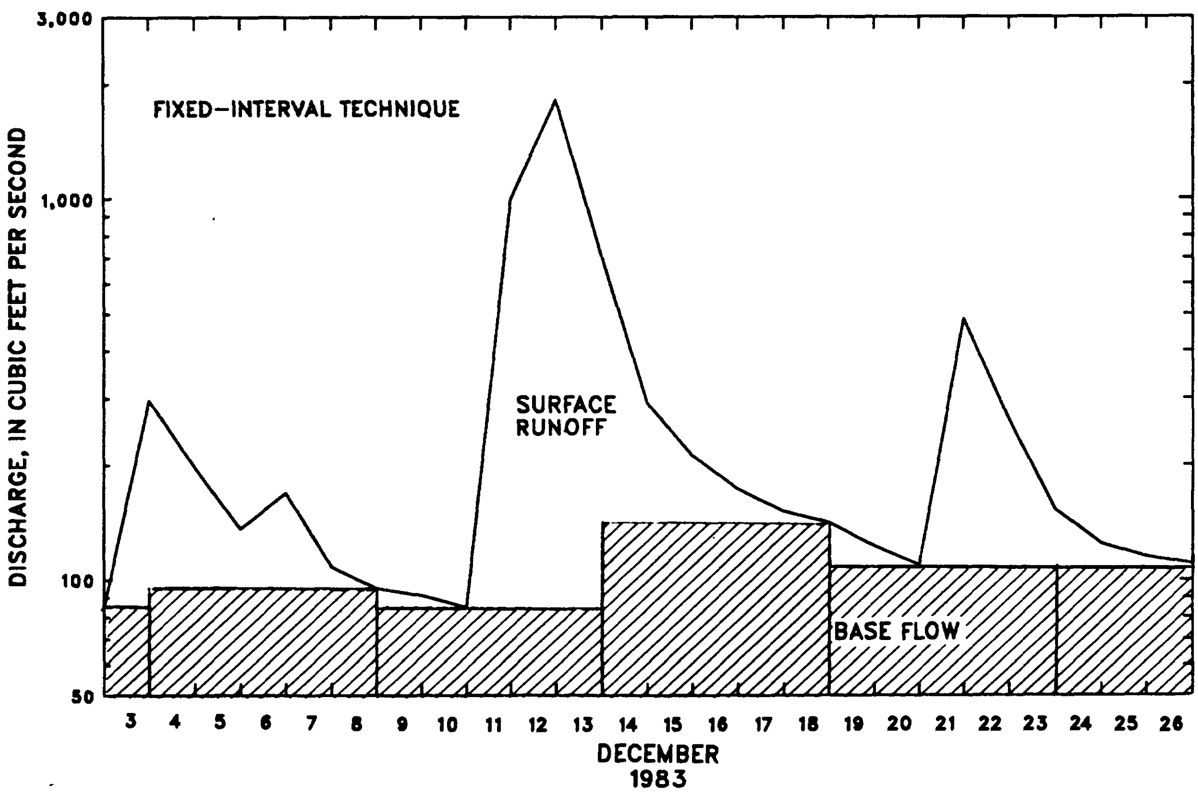

Figure 1.—Hydrograph analysis using the fixed-interval technique, French Creek near Phoenixville, December 3-27, 1983.

Sliding-Interval Technique

The sliding-interval technique finds the lowest discharge for the interval 2N-1 days and assigns it to the median day in the interval. The process is repeated by sliding the interval to the next day until a discharge has been assigned to each day (fig. 2). The technique can be visualized as moving a bar 2N-1 days wide upward until it intersects the hydrograph. The discharge at that point is assigned to the median day in the interval. The bar then slides over to the next day, and the process is repeated. For French Creek (fig. 2), the bar (2N-1) is 4 days wide. In the interval December 11 to 15, the lowest discharge, 85 ft^3/s, is assigned to December 13, the median day in that interval. The assigned daily values are then connected to define the base-flow hydrograph (dashed line in fig. 2).

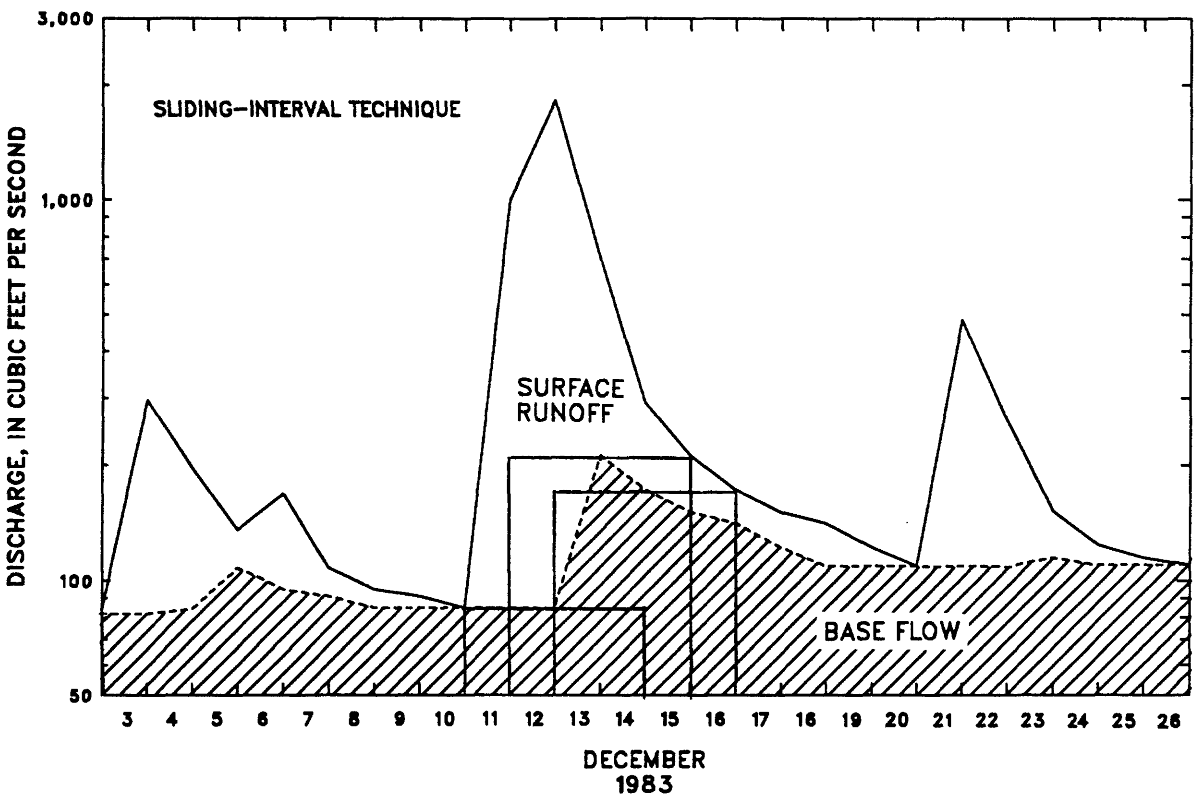

Figure 2.--Hydrograph analysis using the sliding-interval technique, French Creek near Phoenixville, December 3-27, 1983.

Local-Minimum Technique

The local-minimum technique is similar to the manual-straight-line method. Each day in an interval of 2N-1 days is checked to determine whether its discharge is the lowest in that interval, and whether the lowest discharge is a local minimum. If the day meets these criteria, it is connected by straight lines to adjacent local minimums (fig. 3). The discharge values for each day between local minimums are calculated by using the slope of the connecting line at each day. The technique can be visualized as connecting the lowest points on the hydrograph with straight lines to define the base-flow hydrograph. In figure 3, local minimums are on December 11, 21, and 27.

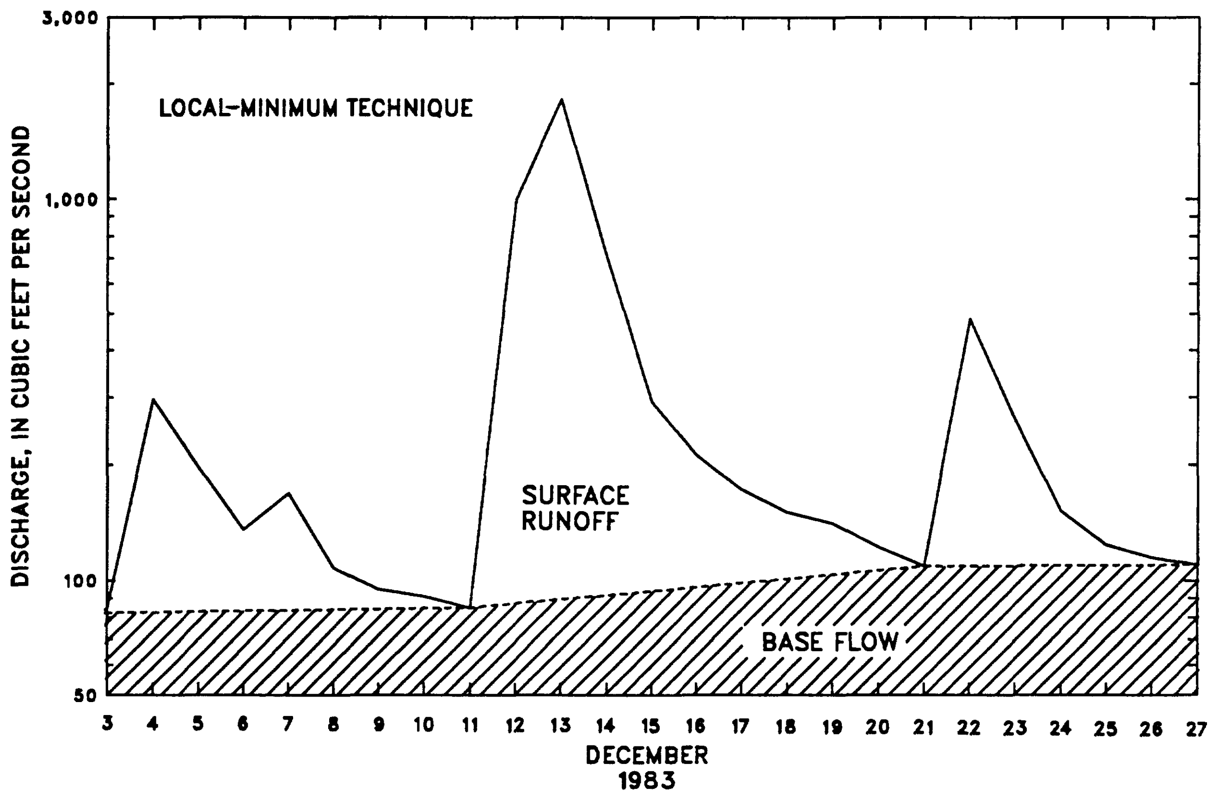

Figure 3.--Hydrograph analysis using the local-minimum technique, French Creek near Phoenixville, December 3-27, 1983.

Comparison of Computerized Hydrograph-Analysis Techniques

During execution of the program, the three techniques of hydrograph analysis are run simultaneously so that differences in base-flow estimates can be compared for the station under analysis. Figure 4 illustrates hydrograph analyses done by using the three techniques for French Creek near Phoenixville. Hydrographs were separated into base-flow and overland-runoff components for 1961-85 for three streamflow stations in southeastern Pennsylvania: West Branch Brandywine Creek near Honey Brook (18.7-mi^2 drainage area), Neshaminy Creek near Langhorne (210-mi^2 drainage area), and Schuylkill River at Pottstown (1,147-mi^2 drainage area). Annual base-flow estimates are given in table 1. The sliding-interval technique gave the highest median base flow for two of the three stations, and the fixed-interval technique gave the highest median base flow for one station. The local-minimum technique, which provides the most conservative estimate of base flow, gave the lowest median base flow for all three stations.

The computer program determines a cumulative probability distribution for each station. Mean annual base flows are arranged in order of magnitude beginning with the smallest as number one. The probability of base flows being less than a particular magnitude is calculated by using the formula for plotting position:

$$p = m / n + 1, \quad (2)$$

where m represents the order number and n represents the number of years of record. A cummulative probability curve of base flow for the period of record for West Branch Brandywine Creek near Honey Brook is shown in figure 5. The probability that a mean annual base flow, computed by using the local-minimum technique, will be less than 0.519 (Mgal/d)/mi^2 (million gallons per day per square mile) is 0.50.

For low flows, recurrence interval is defined as the average interval of time within which streamflow will be less than a particular value (W.O. Thomas, Jr., U.S. Geological Survey, oral commun., 1990). The recurrence interval is the inverse of the probability. At West Branch Brandywine Creek near Honey Brook, the mean annual base flow will be less than 0.519 (Mgal/d)/mi^2 at intervals averaging 2 years in length.

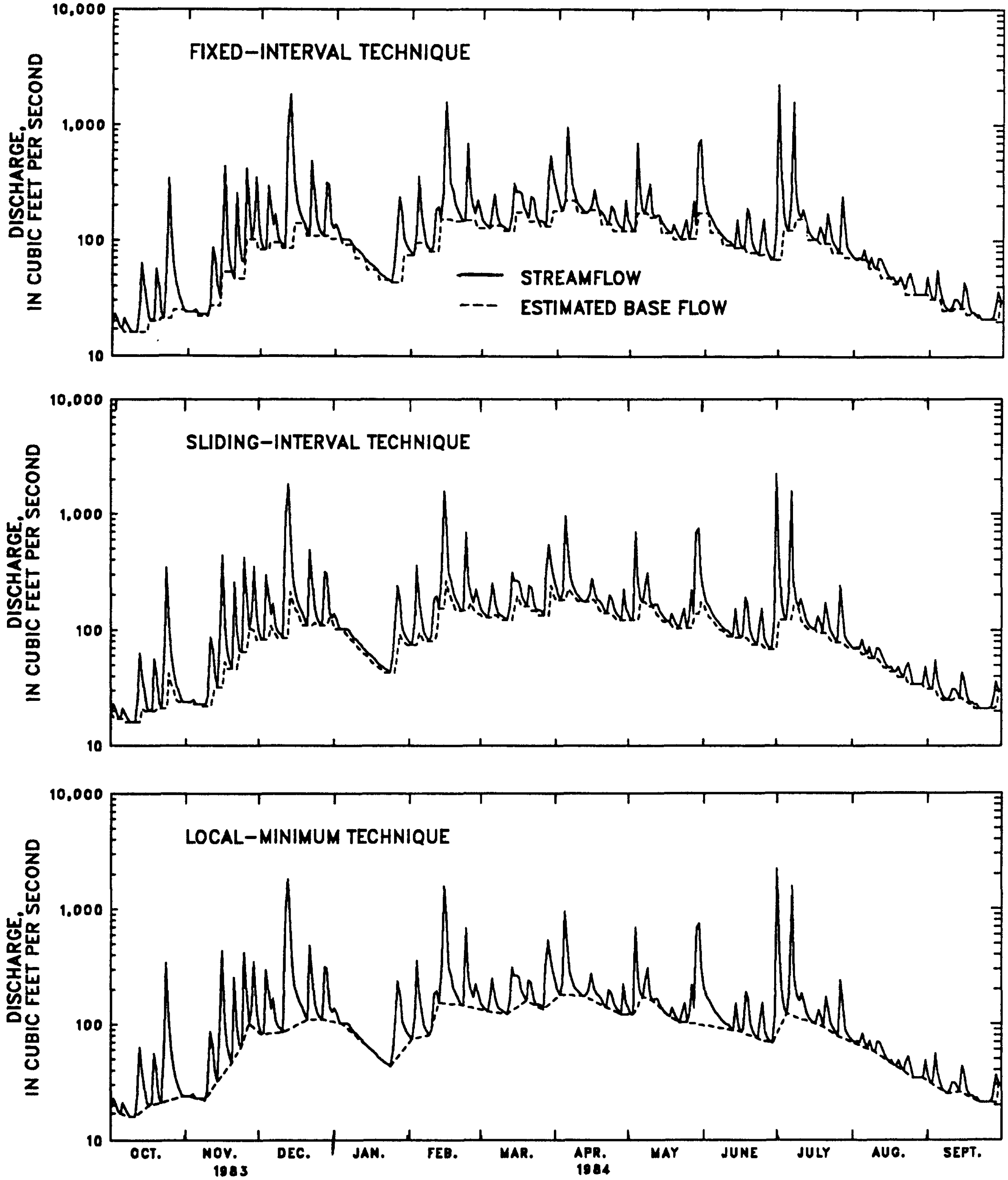

Figure 4.--Base-flow hydrographs produced by using the three hydrograph-analysis techniques, French Creek near Phoenixville, 1984 water year.

Table 1.--Base flows estimated by using three hydrograph-analysis techniques for three streamflow stations in southeastern Pennsylvania

[mi^2, square miles; (Mgal/d)/mi^2, million gallons per day per square mile]

Water year	Base flow [(Mgal/d)/mi^2] West Branch Brandywine Creek near Honey Brook (18.7 mi^2) Fixed interval	Sliding interval	Local minimum	Neshaminy Creek near Langhorne (210 mi^2) Fixed interval	Sliding interval	Local minimum	Schuylkill River at Pottstown (1,147 mi^2) Fixed interval	Sliding interval	Local minimum
1961	0.583	0.599	0.589	0.594	0.597	0.588	0.694	0.694	0.630
1962	.459	.471	.417	.325	.347	.312	.499	.486	.459
1963	.346	.342	.296	.242	.242	.233	.544	.556	.546
1964	.442	.432	.378	.347	.346	.314	.529	.548	.517
1965	.317	.313	.298	.265	.249	.217	.316	.322	.309
1966	.342	.342	.301	.211	.202	.188	.384	.372	.334
1967	.427	.418	.386	.524	.529	.503	.532	.554	.488
1968	.432	.431	.400	.380	.379	.345	.572	.567	.494
1969	.367	.370	.360	.328	.314	.294	.484	.502	.528
1970	.464	.466	.449	.443	.437	.424	.648	.643	.644
1971	.508	.516	.487	.492	.485	.406	.805	.778	.745
1972	.703	.720	.686	.703	.681	.636	.930	.950	.844
1973	.688	.700	.674	.692	.716	.702	1.069	1.112	1.106
1974	.558	.556	.537	.537	.546	.529	.828	.823	.753
1975	.721	.726	.657	.655	.644	.597	.889	.876	.811
1976	.683	.656	.619	.421	.439	.408	.958	.939	.840
1977	.556	.565	.548	.239	.245	.200	.651	.663	.658
1978	.779	.799	.729	.632	.623	.606	.934	.950	.863
1979	.743	.772	.666	.649	.655	.618	.804	.835	.779
1980	.670	.675	.647	.552	.547	.522	.678	.696	.629
1981	.308	.311	.300	.297	.296	.285	.377	.370	.357
1982	.428	.413	.393	.405	.402	.359	.617	.615	.562
1983	.674	.663	.617	.567	.567	.559	.753	.758	.759
1984	.835	.829	.739	.712	.693	.631	1.037	1.038	1.031
1985	.456	.459	.437	.193	.194	.173	.407	.403	.380
Median	.508	.516	.487	.443	.439	.408	.651	.663	.630

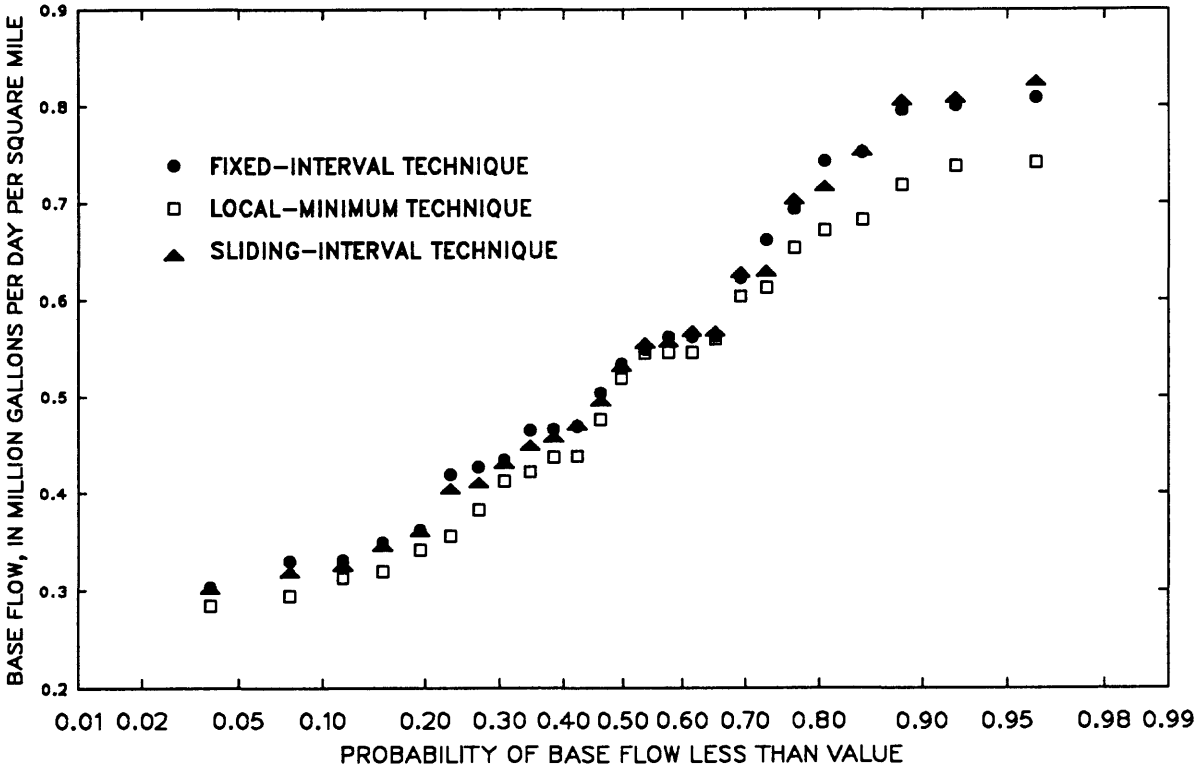

Figure 5.--Cumulative probability distribution of annual base flow estimated by three hydrograph-analysis techniques, West Branch Brandywine Creek near Honey Brook, 1961-85.

Comparison of Computerized and Manual Hydrograph-Analysis Techniques

Computerized hydrograph-analysis techniques were compared with those performed manually by base-flow-recession and graphical methods. Base flows estimated with the computer agree closely with those estimated by manual methods for selected streams in southeastern Pennsylvania.

A study by Olmsted and Hely (1962) investigated the relation between ground water and surface water in the 287-mi^2 Brandywine Creek basin in southeastern Pennsylvania. Olmsted and Hely (1962, p. 4-9) used base-flow-recession curves to estimate ground-water contribution to streamflow for 1928-31 and 1952-53. Annual base flows estimated by Olmsted and Hely (1962) and comparable estimates derived by computer are given in table 2. All three computerized techniques produced base-flow estimates similar to those of the manual base-flow-recession technique. The average base flow estimated by the sliding-interval technique was 1 percent higher, by the fixed-interval technique was less than 1 percent higher, and by the local-minimum technique was less than 1 percent lower than the average base flow estimated by the manual base-flow-recession method. Base flow estimated by the computerized techniques for individual years ranged from 5 percent lower to 5 percent higher than manually estimated base flow.

Table 2.--Base flow estimates by Olmsted and Hely[1] and by three computerized hydrograph-analysis techniques, Brandywine Creek at Chadds Ford, 1928-31 and 1952-53

Year	Base flow (million gallons per day per square mile)			
	Olmsted and Hely (1962)	Fixed-interval technique	Sliding-interval technique	Local-minimum technique
1928	0.868	0.840	0.837	0.821
1929	.559	.549	.568	.571
1930	.413	.398	.400	.393
1931	.293	.301	.306	.307
1952	.890	.915	.916	.906
1953	.791	.827	.832	.805
Average	.636	.638	.643	.634

[1]1962, p. 8-9

Base-flow hydrographs published by Olmsted and Hely (1962, p. 5) are compared with those estimated by the local-minimum technique in figure 6. The base-flow hydrographs are very similar to each other.

McGreevy and Sloto (1977, p. 38-39) used a graphical-separation technique to estimate basin ground-water yield in Chester County, Pennsylvania, for a dry (1966), near-average (1968), and wet (1973) water year. The analyses consisted of visual estimates that averaged base-flow runoff through storm periods. Estimates of base flow at four streamflow stations made by the fixed-interval, sliding-interval, and local-minimum techniques were 6, 7, and 4 percent higher, respectively, than the base flow estimated by the manual graphical technique. Base flow estimated by the three computerized techniques for individual years ranged from 7 percent lower to 19 percent higher than manually estimated base flow.

Biesecker and others (1968, p. 27-29) determined the contribution of ground water to total streamflow for seven stations in the Schuylkill River basin and for the station at Brandywine Creek at Chadds Ford in southeastern Pennsylvania for the 1952 and 1964 water years. They used a combination of manual-base-flow-recession and curve-fitting techniques. Average base flow at seven streamflow stations estimated by the fixed-interval and sliding-interval techniques was 9 percent lower, and the estimate by the local-minimum technique was 14 percent lower than manually estimated base flow. Base flow estimated by computer techniques for individual years ranged from 7 percent higher to 31 percent lower than manually estimated base flow.

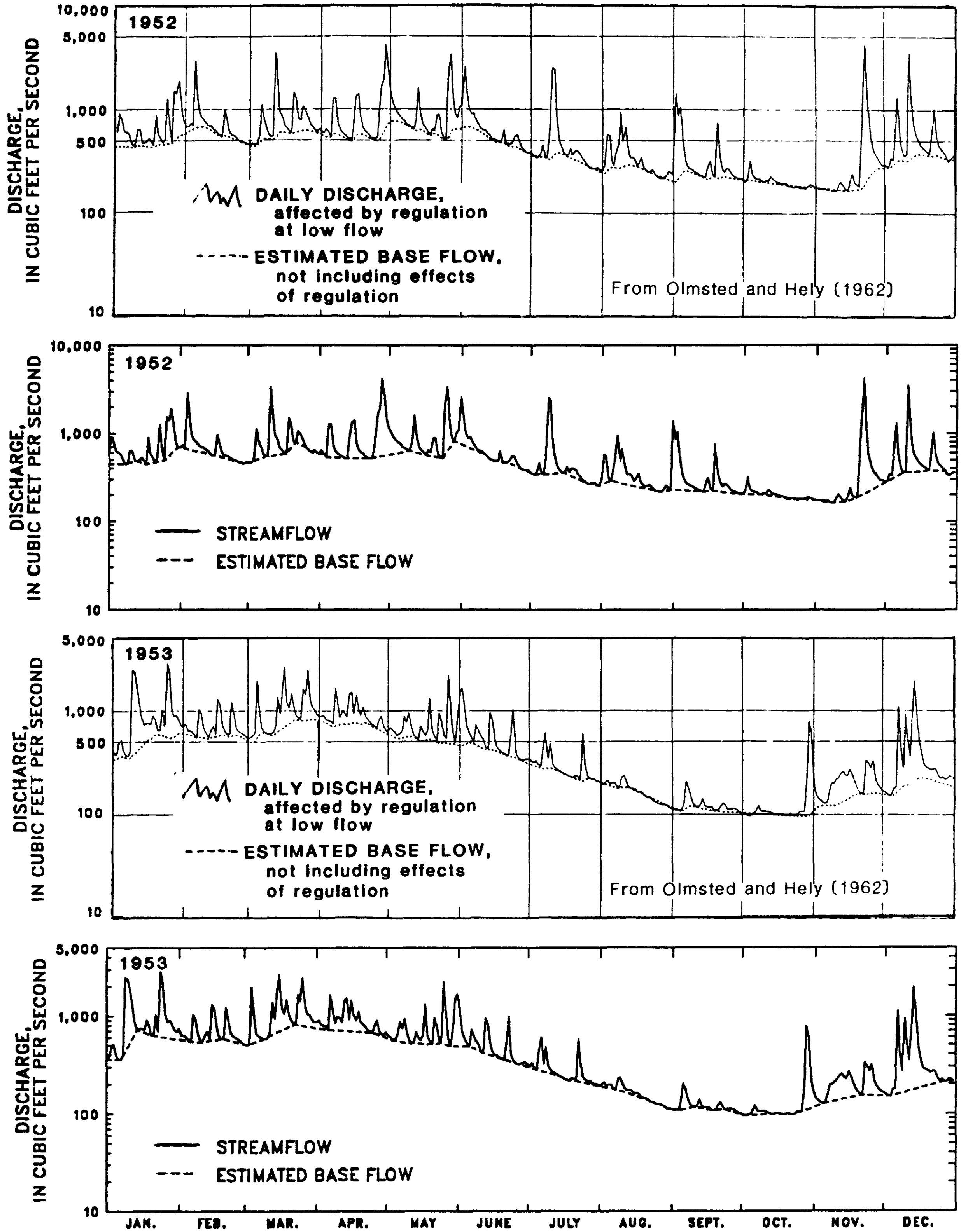

Figure 6.--Comparison of base-flow hydrographs determined by manual base-flow-recession technique and by computerized local-minimum technique, Brandywine Creek at Chadds Ford, 1952-53.

DETERMINATION OF BASE-FLOW-FREQUENCY CHARACTERISTICS OF PENNSYLVANIA STREAMS

Methods

Streamflow hydrographs were separated into overland runoff and base flow for all Pennsylvania streamflow stations, both active and inactive, with a minimum of 10 years of record through the 1986 water year. Stations on the Delaware River in New York and New Jersey also were included. An alphabetical listing of all stations is given in Appendix A.

Input to the computer program is mean daily discharge and output from the program is an annual series of base flows expressed in inches, cubic feet per second, and millions of gallons per day per square mile. Due to the limitations of the program, the annual base-flow values are regarded as independent without consideration for any serial correlation which may exist among annual base flows. Base flow also is given as percentage of streamflow for each of the three hydrograph-analysis techniques.

A cumulative probability distribution is provided for base flow in inches and millions of gallons per day per square mile. Recurrence intervals in millions of gallons per day per square mile are the inverse of the cumulative probability.

Annual minimum base flows at the 2-, 5-, 10-, and 25-year recurrence intervals for all stations in the study are listed by basin in Appendix B. The 50- and 100-year base-flow recurrence intervals were determined for stations with a minimum of 25 and 50 years of record, respectively. Each station is indicated (App. B, tables B1-B3) by its station-identification number, latitude and longitude, type and degree of regulation, and drainage area. At stations where flows were affected by a change in regulation during the period of record, base-flow estimates are shown for the periods before and after regulation, provided periods include 10 or more years of record. Plate 1 shows the values of annual base flow for the 25-year recurrence interval estimated by using the local-minimum technique for all stations included in the study.

Potential Sources of Error

Period of Record

The accuracy of the estimates of base-flow-frequency characteristics depends on the period of record used in the analysis. Records for a station that was operated during a period of extreme climatological conditions, such as the dry years of the 1960s, exhibit a bias toward low values in the computed base-flow characteristics. A long-term station with records representative of long-term climatological conditions provides more reliable estimates of base flows because extremes have less weight in the determination of base-flow frequencies.

Base-flow-frequency curves for two streamflow stations are given to demonstrate the effect of the period of record on base flow (figs. 7 and 8). Little Lehigh Creek near Allentown and Sinnemahoning Creek at Sinnemahoning were compared for 1960-69, 1970-79, and the entire period of record. Base-flow frequencies were estimated by using the local-minimum technique.

Correlating short-term stations to index stations with longer periods of record improves the accuracy of the base-flow-frequency estimates for the short-term stations. Searcy (1960, p. 68) noted that the magnitude and frequency of low flows from a long-term station often can be transferred directly to the short-term station through the curve defining this relationship. Such estimates represent a discharge that has the same probability of occurrence as that at the long-term station. The scope of this project, however, did not include correlation of short-term to long-term stations for the data presented in appendix B.

Figure 9 shows the relation between annual base flow at a short-term station, Raystown Branch Juniata River near Huntingdon (1947-70), and annual base flow at a long-term index station, Raystown Branch Juniata River at Saxton (1912-85). The coefficient of correlation (R) for the relation is 0.94 and is significant at the 99 percent level of confidence. The regression equation relating base flows at Raystown Branch Juniata River near Huntingdon to those of Raystown Branch Juniata River at Saxton is

$$Y = -0.032 + 0.971\ X, \qquad (3)$$

where Y is the adjusted base flow of Raystown Branch Juniata River near Huntingdon and X is the base flow of Raystown Branch Juniata River at Saxton. On the basis of this relation, base-flow values can be calculated for the 50- and 100-year recurrence intervals for Raystown Branch Juniata River near Huntingdon.

A similar correlation was done for Raystown Branch Juniata River below Raystown Dam near Huntingdon (1972-85), a moderately regulated stream. The coefficient of correlation of annual base flows for these two stations is 0.71 and is significant at the 99 percent level of confidence. The correlation coefficients indicate that base flows at Raystown Branch Juniata River at Saxton more strongly correlate with those at Raystown Branch Juniata River near Huntingdon than with those at Raystown Branch Juniata River below Raystown Dam near Huntingdon; however, the degree of confidence in both projections is good. The weaker correlation most likely is caused by the effects of regulation. The base-flow regression equation relating Raystown Branch Juniata River below Raystown Dam near Huntingdon to Raystown Branch Juniata River at Saxton is

$$Y = 0.07 + 0.834\ X, \qquad (4)$$

where Y is the adjusted base flow of Raystown Branch Juniata River below Raystown Dam near Huntingdon and X is the base flow of Raystown Branch Juniata River at Saxton.

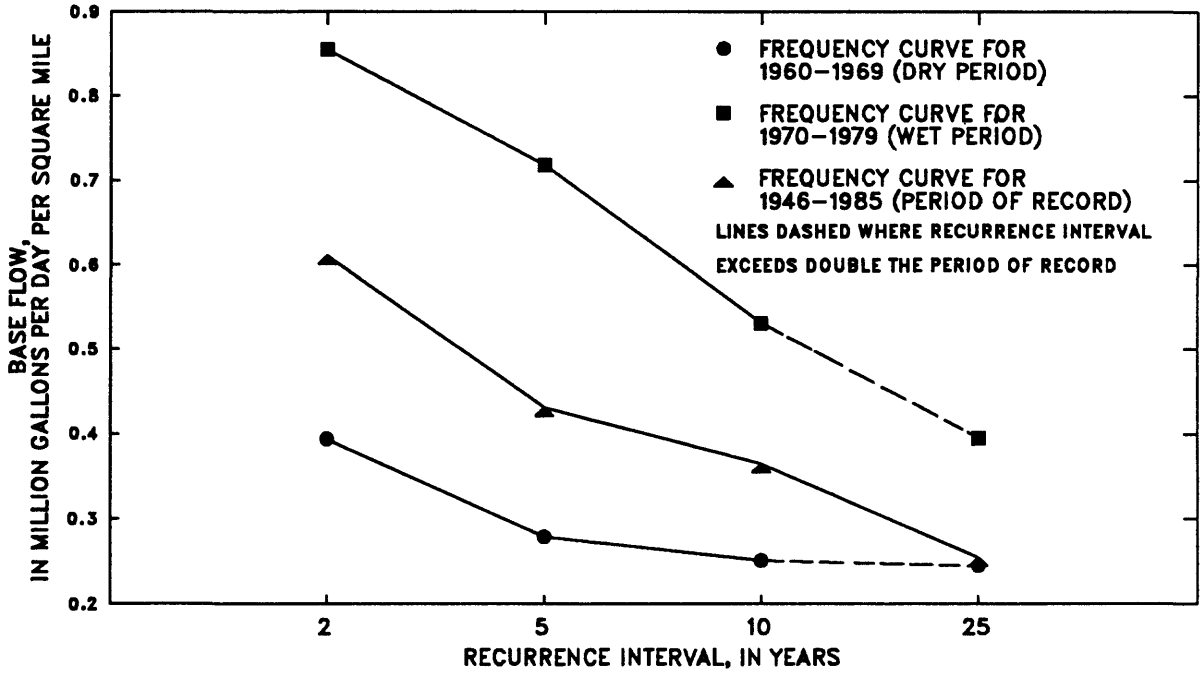

Figure 7.--Effect of period of record on base-flow-frequency distributions, Little Lehigh Creek near Allentown.

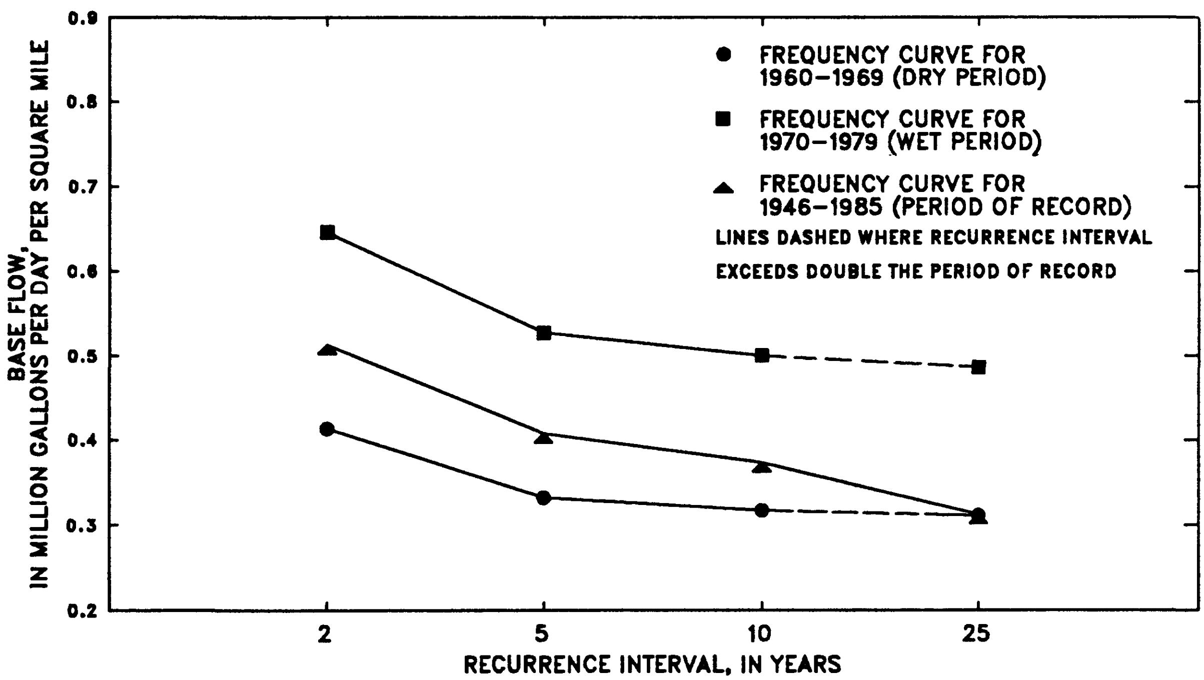

Figure 8.--Effect of period of record on base-flow-frequency distributions, Sinnemahoning Creek at Sinnemahoning.

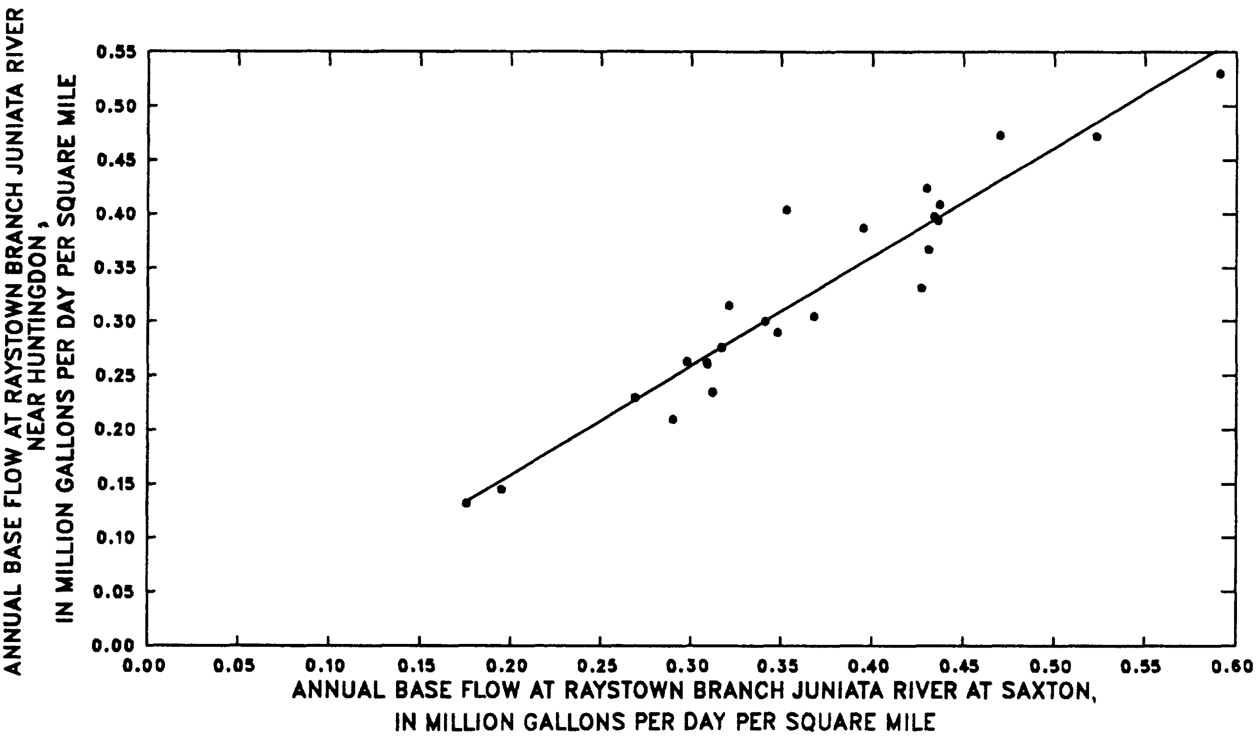

Figure 9.--Relation between base flow at Raystown Branch Juniata River near Huntingdon, 1947-70 and base flow at long-term index station Raystown Branch Juniata River at Saxton, 1912-85.

Table 3.--Unadjusted and adjusted annual base flows at selected recurrence intervals for gaging stations on the Raystown Branch Juniata River

[Base flow was estimated by using the local-minimum technique; --, period of record insufficient to calculate recurrence interval]

Period of record		Annual base flow at indicated recurrence intervals at indicated gaging stations (million gallons per day per square mile) 2-year	5-year	10-year	25-year	50-year	100-year
01562000	Raystown Branch Juniata River at Saxton						
1912-85	unadjusted	0.397	0.307	0.268	0.206	0.185	0.172
01563000	Raystown Branch Juniata River near Huntingdon						
1947-70	unadjusted	.310	.235	.178	.132	--	--
1947-70	adjusted to 1912-85	.353	.266	.228	.168	.148	.135
01563200	Raystown Branch Juniata River below Raystown Dam near Huntingdon						
1972-85	unadjusted	.468	.371	.252	.177	--	--
1972-85	adjusted to 1912-85	.401	.326	.294	.242	.224	.213

Table 3 shows unadjusted and adjusted base flows, for selected recurrence intervals for Raystown Branch Juniata River near Huntingdon and Raystown Branch Juniata River below Raystown Dam near Huntingdon.

Low-End Extrapolation and Interpolation

Extrapolation and interpolation by linear projection was used to determine cumulative probabilities that were not directly determined by the computer program. The slope of the projected line between the two nearest probability values was calculated. The intermediate probability value was calculated mathematically from its position on that line in relation to the two nearest points based on the calculated slope. Base-flow recurrence intervals are the inverse of the probability. If a straight line through adjacent points is not an accurate projection, error is introduced in the computed recurrence interval.

Annual base flows for five streamflow stations were plotted on a log-Gumbel distribution and the recurrence intervals were compared to those determined by extrapolation and interpolation. Differences in base-flow values were all less than 0.02 $(Mgal/d)/mi^2$. This comparison indicates that mathematical interpolation and extrapolation is an acceptable method for determining the intermediate probabilities, and in turn, the corresponding recurrence intervals.

PHYSICAL FACTORS THAT AFFECT BASE FLOW

Regulation

Regulation affects the natural flow of a stream and influences base flow. Appendix B contains information on regulation to inform the user of this report of factors that may affect estimates of base flow. The effect of regulation on base flow is designated as: N, no regulation; S, slight regulation that has little effect; M, regulation that has moderate effect; and H, regulation that has substantial effect. Because a quantitative determination of the effect of regulation at each streamflow station is beyond the scope of this report, the degree to which regulation affects base flow was determined subjectively by means of a relative comparison among regulated stations. The source of regulation is noted in appendix B as: P, mine pumpage; R, reservoir; and D, diversion for water supply.

A comparison of the base-flow data given in appendix B indicates that effects of regulation are site specific. Annual base flows of most of the streams in the Delaware River basin decreased subsequent to regulation, whereas annual base flows for most of the streams in the Susquehanna and Ohio River basins increased subsequent to regulation. The factors that resulted in an increase or decrease of annual base flow subsequent to regulation are unknown but appear to reflect reservoir-regulation criteria. As a result of the effect that regulation has on streamflow, the separation of regulated streamflow into base flow and surface runoff might yield results that do not represent the base flow of the stream under natural conditions but instead represent the base flow as determined solely by the regulation criteria at each individual site.

Geology

Geology strongly influences the infiltration-runoff relation in a basin. The permeability of the rock underlying a basin and the soil derived from that rock depends on geology.

Base flows of streams draining areas of different geology are compared to demonstrate the effect of geology on base flow. Little Lehigh Creek near Allentown and Monocacy Creek at Bethlehem are located in areas underlain predominantly by carbonate rocks. Tohickon Creek near Pipersville and Neshaminy Creek near Langhorne are located in areas underlain predominantly by Triassic sedimentary rocks. Annual base flow was estimated using the local-minimum technique for the period 1949-72. Three stations are not regulated; Neshaminy Creek near Langhorne is regulated by several flood-control reservoirs upstream, but the base flow is not substantially affected. Drainage areas range from 44.5 mi^2 for Monocacy Creek at Bethlehem to 210 mi^2 for Neshaminy Creek near Langhorne. Records of annual rainfall from the National Oceanic and Atmospheric Administration (NOAA) precipitation gages located near each station were compiled to determine differences in rainfall among stations.

Annual base flows and precipitation at the stations are given in table 4. Although the basins underlain by carbonate rocks received 9.1 percent less precipitation for the period of record than the basins underlain by Triassic sedimentary rocks, the estimated average base flow for the period of record was 50.3 percent greater for the carbonate-rock streams than for those that flow over Triassic sedimentary rocks. This indicates that the carbonate rocks are more permeable and(or) have more storage and allow more infiltration from precipitation; as a result, the base-flow component of the streams underlain by carbonate rock is much greater. The representative Triassic sedimentary rocks are less permeable or have less storage; therefore, more of the precipitation reaches the stream as overland runoff.

Table 4.--Annual base flows for two streams draining carbonate rocks and two streams draining Triassic sedimentary rocks

[Base flow was estimated using the local-minimum technique; $(Mgal/d)/mi^2$, million gallons per day per square mile; in., inches]

	Carbonate rock				Triassic sedimentary rock			
	Little Lehigh Creek near Allentown		Monocacy Creek at Bethlehem		Tohickon Creek near Pipersville		Neshaminy Creek near Langhorne	
Year	Base flow [(Mgal/d) /mi^2]	Precipitation (in.)	Base flow [(Mgal/d) /mi^2]	Precipitation (in.)	Base flow [(Mgal/d) /mi^2]	Precipitation (in.)	Base flow [(Mgal/d) /mi^2]	Precipitation (in.)
1959	0.425	41.62	0.430	44.85	0.218	45.01	0.325	43.57
1960	.569	46.81	.607	47.86	.282	46.33	.398	46.82
1961	.525	39.27	.590	37.43	.339	49.03	.554	50.70
1962	.452	41.58	.432	36.44	.178	40.43	.322	43.11
1963	.393	35.04	.366	28.75	.179	34.61	.206	35.94
1964	.375	34.74	.377	28.97	.189	35.19	.304	35.35
1965	.249	30.55	.185	26.62	.119	30.20	.211	33.31
1966	.258	38.28	.206	34.28	.188	40.45	.239	41.53
1967	.395	43.79	.437	41.50	.367	43.10	.507	56.15
1968	.464	38.43	.557	40.91	.245	34.90	.308	43.71
1969	.364	41.89	.399	41.28	.246	44.81	.322	49.86
1970	.510	41.59	.576	36.30	.326	43.45	.443	40.32
1971	.856	48.50	.831	48.30	.370	52.24	.484	59.95
1972	1.003	55.85	.974	49.91	.667	55.25	.656	57.98
Mean	.488	41.28	.498	38.81	.280	42.50	.377	45.59

Climate

Annual variations in climatic factors such as temperature, evapotranspiration, and rates and amounts of precipitation cause temporal differences in base flow. Figures 7 and 8 compare base-flow recurrence intervals for two streamflow stations to demonstrate the effect of precipitation on base flow. Little Lehigh Creek near Allentown and Sinnemahoning Creek at Sinnemahoning were compared for 1960-69, a dry period, and 1970-79, a wet period. Base-flow recurrence intervals were estimated by using the local-minimum technique.

Annual precipitation at the NOAA station at Allentown averaged 39.04 in. (inches) for 1960-69, or 11.9 percent less than the 1951-80 normal of 44.31 in. For 1970-79, the average precipitation was 48.30 in., or 9.0 percent greater than the 1951-80 normal. The 2- and 25-year base-flow recurrence intervals estimated by using the local-minimum technique for 1960-69 were 53.9 and 38.0 percent less, respectively, than those for 1970-79.

Average annual precipitation at Sinnemahoning for 1960-69 was 35.81 in., or 11.4 percent less than the 1951-80 normal of 40.43 in. For 1970-79, the average precipitation was 45.50 in., or 12.5 percent greater than the 1951-80 normal. The 2- and 25-year base-flow recurrence intervals estimated by using the local-minimum technique for 1960-69 were 36.1 and 36.0 percent less, respectively, than those for 1970-79.

Linear regression was used to determine the relation between average annual precipitation and annual percentages of base flow in streamflow. Figure 10 shows the relation for Little Lehigh Creek near Allentown, a stream located in a basin underlain by carbonate rocks. The percentage of base flow as streamflow increased as the average annual precipitation decreased. The relation for Sinnemahoning Creek at Sinnemahoning (fig. 11), a stream located in a basin underlain by sandstones, siltstones, and shales, cannot be clearly defined.

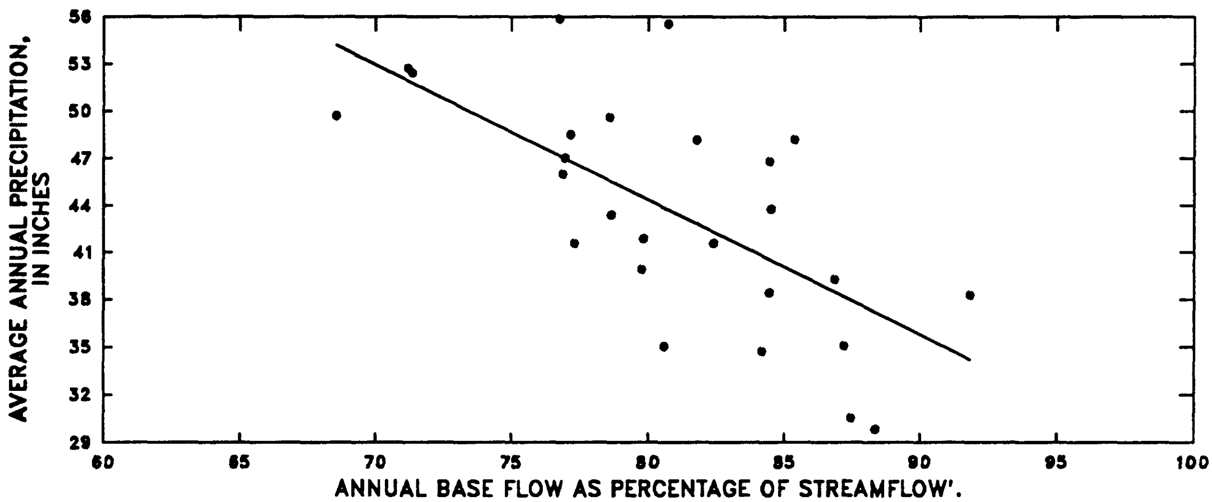

Figure 10.--Relation between average annual precipitation and base flow as a percentage of streamflow, Little Lehigh Creek near Allentown, 1960-85.

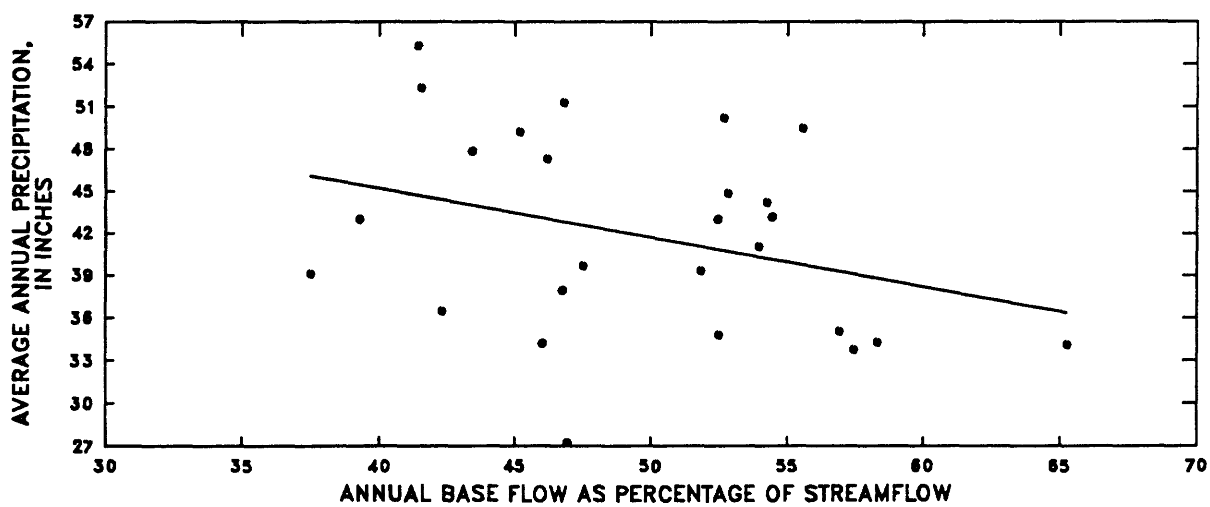

Figure 11.--Relation between average annual precipitation and base flow as a percentage of streamflow, Sinnemahoning Creek at Sinnemahoning, 1960-85.

Drainage Area

Wayne A. Pettyjohn (University of Oklahoma, oral commun., 1989) has suggested that computerized hydrograph-analysis techniques most likely do not give reliable results for drainage areas greater than 2,000 mi² in some geologic settings. Figure 12 shows the relation between drainage area and the 10-year base flow estimated by using the local-minimum technique for nonregulated and slightly regulated streams, for which the slope equals 0.0000018. Figure 13 shows a similar relation for moderately and heavily regulated streams, for which the slope equals -0.0000011. The low slope of the regression lines through the scattered data indicates that the size of the drainage area is not strongly related to base flows of streams in Pennsylvania.

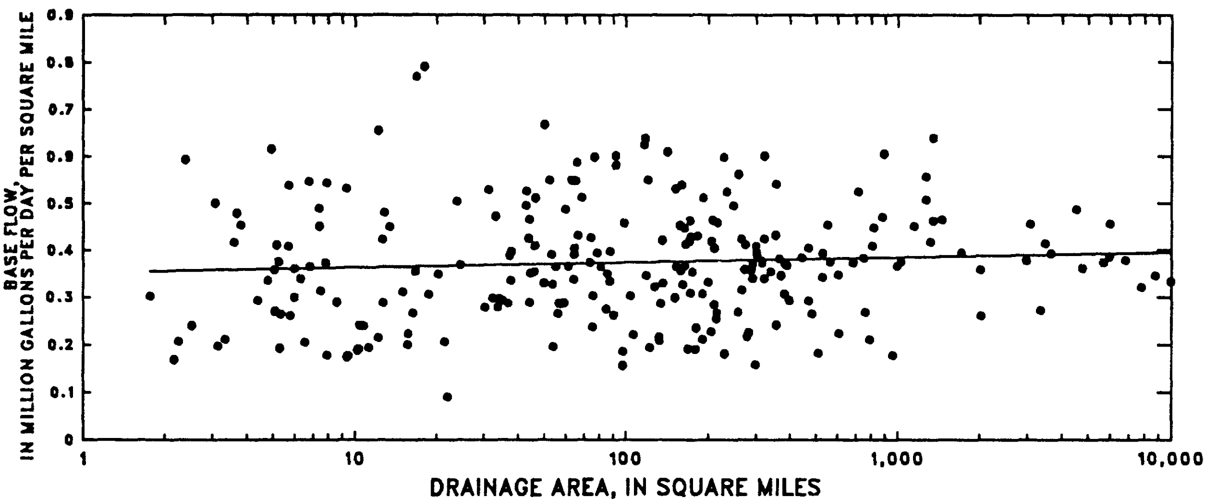

Figure 12.--Relation between base flow and drainage area for nonregulated and slightly regulated streams.

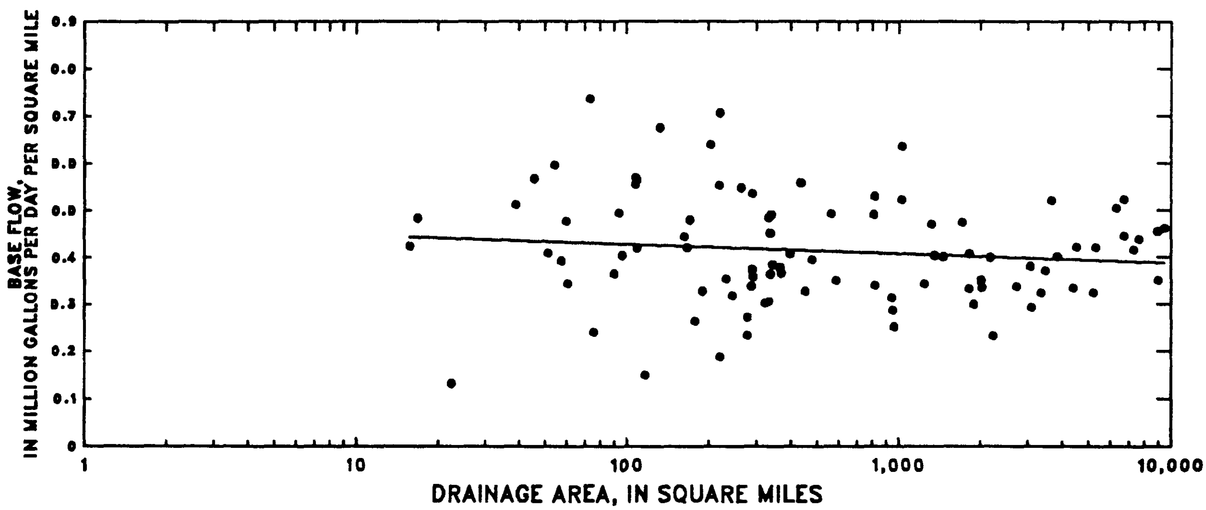

Figure 13.--Relation between base flow and drainage area for moderately and heavily regulated streams.

Urbanization

The degree of urbanization of an area affects base flow (Simmons and Reynolds, 1982). In rural areas, where impervious areas are small and no storm or sanitary sewers carry storm runoff, most precipitation infiltrates to the ground-water system and reaches the stream as base flow. In urbanized areas, however, where rooftops and pavement constitute large impervious areas and sewers carry storm runoff to streams, infiltration of precipitation decreases and the amount of water reaching the stream as surface runoff is increased. This reduction in ground-water recharge results in a decrease in the base flow of streams and increases the amount of direct runoff. In an analysis of the effect of urbanization on base flow, Simmons and Reynolds (1982) determined that urbanization and sanitary and storm sewering of a portion of Long Island caused approximately a 75-percent reduction in the base-flow contribution to total streamflow during 1948-69. In an adjacent urbanized, unsewered area, the base-flow component of streamflow decreased by about 11 percent during 1948-70. In a rural, unsewered area, the base-flow contribution to streamflow remained relatively constant during 1948-70.

SUMMARY

The use of computer analysis to separate streamflow hydrographs into overland-runoff and base-flow components removes much of the subjectivity inherent in manual analysis techniques and considerably reduces the time needed to estimate annual base flow. Manual analysis of one long-term record could take weeks. The computer program used in this study of the base flow of selected Pennsylvania streams performs three hydrograph-analysis techniques--local-minimum (which generally gives the lowest base-flow estimates), fixed-interval, and sliding-interval. Its use reduces the time required to estimate annual base flows for a long-term station to seconds. This computer program was used to analyze hydrographs from 309 streamflow stations in order to derive base-flow-frequency data that will aid water-resource managers. A map showing annual base flow for the 25-year base-flow recurrence interval, estimated by using the local-minimum technique, is included.

Correlating base-flow values of short-term stations to base-flow values of long-term stations reduces climatological bias in the record and improves the accuracy of base-flow recurrence interval estimates.

Factors that affect base-flow contributions to streamflow include geology, climate, regulation, and urbanization. A small sample of streams in areas underlain by carbonate rocks had higher base flows than streams underlain by Triassic sedimentary rocks. A comparison of two stations during a dry period (1960-69) and a wet period (1970-79) showed an average of 45.0 and 37.0 percent less base flow for the 2- and 25-year recurrence intervals, respectively, during 1960-69 than during 1970-79. The effect of regulation on base flow is site specific: annual base flows decreased for the majority of streams in the Delaware River basin and increased for the majority of streams in the Susquehanna and Ohio River basins subsequent to regulation. Other studies have shown that urbanization of an area generally causes a reduction of base flow in the local streams.

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Appendix A.--Alphabetical index of stations

[The table and page numbers given here indicate the section in this report that contains the base flows at selected recurrence intervals for the indicated station]

Station-identification number	Station name	Table number	Page number
03084000	Abers Creek near Murrysville, Pa.	B3	49
03010500	Allegheny River at Eldred, Pa.	B3	45
03025500	Allegheny River at Franklin, Pa.	B3	46
03012550	Allegheny River at Kinzua Dam, Pa.	B3	45
03036500	Allegheny River at Kittanning, Pa.	B3	47
03010000	Allegheny River at Larabee, Pa.	B3	45
03049500	Allegheny River at Natrona, Pa.	B3	48
03031500	Allegheny River at Parker, Pa.	B3	47
03007800	Allegheny River at Port Allegany, Pa.	B3	45
03016000	Allegheny River at West Hickory, Pa.	B3	45
01450500	Aquashicola Creek at Palmertown, Pa.	B1	34
01564500	Aughwick Creek near Three Springs, Pa.	B2	42
01547500	Bald Eagle Creek at Blanchard, Pa.	B2	40
01546000	Bald Eagle Creek at Milesburg, Pa.	B2	40
01557500	Bald Eagle Creek at Tyrone, Pa.	B2	41
01547200	Bald Eagle Creek below Spring Creek at Milesburg, Pa.	B2	40
01548005	Bald Eagle Creek near Beech Creek Station, Pa.	B2	40
03107500	Beaver River at Beaver Falls, Pa.	B3	51
03105500	Beaver River at Wampum, Pa.	B3	50
01573086	Beck Creek near Cleona, Pa.	B2	43
01547950	Beech Creek at Monument, Pa.	B2	40
03078500	Big Piney Run near Salisbury, Pa.	B3	49
03031950	Big Run near Sprankle Mills, Pa.	B3	47
03086100	Big Sewickley Creek near Ambridge, Pa.	B3	50
01567500	Bixler Run near Loysville, Pa.	B2	42
03043000	Blacklick Creek at Blacklick, Pa.	B3	48
03042000	Blacklick Creek at Josephine, Pa.	B3	48
01549500	Blockhouse Creek near English Center, Pa.	B2	40
01578400	Bowery Run near Quarryville, Pa.	B2	44
01541308	Bradley Run near Ashville, Pa.	B2	38
01481000	Brandywine Creek at Chadds Ford, Pa.	B1	37
01442500	Brodhead Creek at Minisink Hills, Pa.	B1	34
01440400	Brodhead Creek near Analomink, Pa.	B1	33
03015500	Brokenstraw Creek at Youngsville, Pa.	B3	45
01561000	Brush Creek at Gapsville, Pa.	B2	42
03111150	Brush Run near Buffalo, Pa.	B3	51
03049000	Buffalo Creek near Freeport, Pa.	B3	48
01559700	Buffalo Run Tributary near Mann's Choice, Pa.	B2	42
01439500	Bush Kill at Shoemakers, Pa.	B1	33
01465790	Byberry Creek at Chalfont Road, Philadelphia, Pa.	B1	35

Appendix A.--Alphabetical index of stations--Continued

Station-identification number	Station name	Table number	Page number
03079000	Casselman River at Markleton, Pa.	B3	49
03085500	Chartiers Creek at Carnegie, Pa.	B3	50
01477000	Chester Creek near Chester, Pa.	B1	37
03029500	Clarion River at Cooksburg, Pa.	B3	47
03028500	Clarion River at Johnsonburg, Pa.	B3	46
03029000	Clarion River at Ridgeway, Pa.	B3	47
03031000	Clarion River at St. Petersburg, Pa.	B3	47
03030500	Clarion River near Piney, Pa.	B3	47
01568500	Clark Creek near Carsonville, Pa.	B2	43
01541500	Clearfield Creek at Dimeling, Pa.	B2	39
03039200	Clear Run near Buckstown, Pa.	B3	47
01475550	Cobbs Creek at Darby, Pa.	B1	37
01475530	Cobbs Creek at U.S. No. 1 at Philadelphia, Pa.	B1	37
01566500	Cocolamus Creek near Millerstown, Pa.	B2	42
01574500	Codorus Creek at Spring Grove, Pa.	B2	43
01575500	Codorus Creek near York, Pa.	B2	43
03041500	Conemaugh River at Seward, Pa.	B3	48
03044000	Conemaugh River at Tunnelton, Pa.	B3	48
01576500	Conestoga River at Lancaster, Pa.	B2	44
03015000	Conewango Creek at Russell, Pa.	B3	45
03106000	Connoquenessing Creek near Zelienople, Pa.	B3	50
01614090	Conococheaque Creek near Fayetteville, Pa.	B2	44
01570000	Conodoguinet Creek near Hogestown, Pa.	B2	43
01516500	Corey Creek near Mainesburg, Pa.	B2	38
01520000	Cowanesque River near Lawrenceville, Pa.	B2	38
03039000	Crooked Creek at Crooked Creek Dam, Pa.	B3	47
03038000	Crooked Creek at Idaho, Pa.	B3	47
01518500	Crooked Creek at Tioga, Pa.	B2	38
03023000	Cussewago Creek near Meadville, Pa.	B3	46
01475300	Darby Creek at Waterloo Mills near Devon, Pa.	B1	37
01475510	Darby Creek near Darby, Pa.	B1	37
01446500	Delaware River at Belvidere, N.J.	B1	34
01427510	Delaware River at Callicoon, N.Y.	B1	33
01438500	Delaware River at Montague, N.J.	B1	33
01434000	Delaware River at Port Jervis, N.Y.	B1	33
01457500	Delaware River at Riegelsville, N.J.	B1	35
01463500	Delaware River at Trenton, N.J.	B1	35
01428500	Delaware River above Lackawaxen River near Barryville, N.Y.	B1	33
01440200	Delaware River below Tocks Island Damsite, near Delaware Water Gap, Pa.	B1	33
01448500	Dilldown Creek near Long Pond, Pa.	B1	34
01543000	Driftwood Branch Sinnemahoning Creek at Sterling Run, Pa.	B2	39
03072000	Dunkard Creek at Shannopin, Pa.	B3	48

Station-identification number	Station name	Table number	Page number
03048500	Kiskiminetas River at Vandergrift, Pa.	B3	48
01534500	Lackawanna River at Archbald, Pa.	B2	38
01535500	Lackawanna River at Moosic, Pa.	B2	38
01536000	Lackawanna River at Old Forge, Pa.	B2	38
01534300	Lackawanna River near Forest City, Pa.	B2	38
01431500	Lackawaxen River at Hawley, Pa.	B1	33
01430500	Lackawaxen River at West Hawley, Pa.	B1	33
01430000	Lackawaxen River near Honesdale, Pa.	B1	33
01549780	Larry's Creek at Cogan House, Pa.	B2	41
03080000	Laurel Hill Creek at Ursine, Pa.	B3	49
01453000	Lehigh River at Bethlehem, Pa.	B1	35
01454700	Lehigh River at Glendon, Pa.	B1	35
01447500	Lehigh River at Stoddartsville, Pa.	B1	34
01448000	Lehigh River at Tannery, Pa.	B1	34
01451000	Lehigh River at Walnutport, Pa.	B1	34
01447800	Lehigh River below Francis E. Walter Lake near White Haven, Pa.	B1	34
01569800	Letort Spring Run near Carlisle, Pa.	B2	43
03074300	Lick Run at Hopwood, Pa.	B3	49
03041000	Little Conemaugh River at East Conemaugh, Pa.	B3	47
03021700	Little Conneauttee Creek near McKean, Pa.	B3	46
01539500	Little Fishing Creek at Eyers Grove, Pa.	B2	39
01558000	Little Juniata River at Spruce Creek, Pa.	B2	41
01556500	Little Juniata River at Tipton, Pa.	B2	41
01451500	Little Lehigh Creek near Allentown, Pa.	B1	34
01565700	Little Lost Creek near Oakland Mills, Pa.	B2	42
03034500	Little Mahoning Creek at McCormick, Pa.	B3	47
03049800	Little Pine Creek near Etna, Pa.	B3	48
01469500	Little Schuylkill River at Tamaqua, Pa.	B1	36
03102500	Little Shenango River at Greenville, Pa.	B3	50
03042200	Little Yellow Creek near Strongstown, Pa.	B3	48
01572000	Lower Little Swatara Creek at Pine Grove, Pa.	B2	43
03045000	Loyalhanna Creek at Kingston, Pa.	B3	48
03047000	Loyalhanna Creek at Loyalhanna Dam, Pa.	B3	48
03045500	Loyalhanna Creek at New Alexandria, Pa.	B3	48
01552000	Loyalsock Creek at Loyalsockville, Pa.	B2	41
01550000	Lycoming Creek near Trout Run, Pa.	B2	41
03036000	Mahoning Creek at Mahoning Creek Dam, Pa.	B3	47
03034000	Mahoning Creek at Punxsutawney, Pa.	B3	47
03035000	Mahoning Creek near Dayton, Pa.	B3	47
01470756	Maiden Creek at Virginville, Pa.	B1	36
01470720	Maiden Creek Tributary at Lenhartsville, Pa.	B1	36
01573500	Manada Creek at Manada Gap, Pa.	B2	43
01471980	Manatawny Creek near Pottstown, Pa.	B1	36
01547700	Marsh Creek at Blanchard, Pa.	B2	40

Appendix A.--Alphabetical index of stations--Continued

Station-identification number	Station name	Table number	Page number
03025000	Sugar Creek at Sugar Creek, Pa.	B3	46
03101000	Sugar Run at Pymatuning Dam, Pa.	B3	50
01540500	Susquehanna River at Danville, Pa.	B2	39
01570500	Susquehanna River at Harrisburg, Pa.	B2	43
01576000	Susquehanna River at Marietta, Pa.	B2	43
01533400	Susquehanna River at Meshoppen, Pa.	B2	38
01554000	Susquehanna River at Sunbury, Pa.	B2	41
01531500	Susquehanna River at Towanda, Pa.	B2	38
01536500	Susquehanna River at Wilkes-Barre, Pa.	B2	39
01515000	Susquehanna River near Waverly, N.Y.	B2	38
01573000	Swatara Creek at Harper Tavern, Pa.	B2	43
01573560	Swatara Creek near Hershey, Pa.	B2	43
01467086	Tacony Creek above Adams Avenue, Philadelphia, Pa.	B1	35
03072840	Tenmile Creek near Clarksville, Pa.	B3	49
01518000	Tioga River at Tioga, Pa.	B2	38
01516350	Tioga River near Mansfield, Pa.	B2	38
03017500	Tionesta Creek at Lynch, Pa.	B3	45
03019000	Tionesta Creek at Nebraska, Pa.	B3	45
03020000	Tionesta Creek at Tionesta Dam, Pa.	B3	45
01537000	Toby Creek at Luzerne, Pa.	B2	39
01447720	Tobyhanna Creek near Blakeslee, Pa.	B1	34
01460000	Tohickon Creek at Point Pleasant, Pa.	B1	35
01459500	Tohickon Creek near Pipersville, Pa.	B1	35
03029400	Toms River at Cooksburg, Pa.	B3	47
01613050	Tonoloway Creek near Needmore, Pa.	B2	44
01532000	Towanda Creek near Monroeton, Pa.	B2	38
01540200	Trexler Run near Ringstown, Pa.	B2	39
01470960	Tulpehocken Creek at Blue Marsh Dam near Reading, Pa.	B1	36
01470779	Tulpehocken Creek near Bernville	B1	36
01471000	Tulpehocken Creek near Reading	B1	36
01447680	Tunkhannock Creek near Long Pond, Pa.	B1	34
01534000	Tunkhannock Creek near Tunkhannock, Pa.	B2	38
03084500	Turtle Creek at Trafford, Pa.	B3	49
01566000	Tuscarora Creek near Port Royal, Pa.	B2	42
03042500	Two Lick Creek at Graceton, Pa.	B3	48
01542810	Waldy Run near Emporium, Pa.	B2	38
01432000	Wallenpaupack Creek at Wilsonville, Pa.	B1	33
01465785	Walton Run at Philadelphia, Pa.	B1	35
01538000	Wapwallopen Creek near Wapwallopen, Pa.	B2	39
01480500	West Branch Brandywine Creek at Coatesville, Pa.	B1	37
01480617	West Branch Brandywine Creek at Modena, Pa.	B1	37
01480300	West Branch Brandywine Creek near Honey Brook, Pa.	B1	37

Appendix B.--Base flows at selected recurrence intervals

The station-identification number is assigned in downstream order. Gaps are left in the series of numbers to allow for new stations that may be established; hence, the numbers are not consecutive. A station number can be from 8 to 15 digits and normally appears to the left of the station name. For example, an 8-digit number for a station such as 01431500 includes a 2-digit part number "01" plus a 6-digit downstream order number "431500." The part number designates major river basins; for example, part "01" is the North Atlantic Slope basin.

Table B1.--Base flows at selected recurrence intervals in the Delaware River basin

[--, period of record too short to estimate recurrence interval. Degree of regulation: N, no known regulation; S, slight regulation that does not significantly affect base flow; M, regulation that has a moderate effect on base flow; H, regulation that has a substantial effect on base flow; P, regulation by mine pumpage; R, regulation by reservoir releases; D, regulation by diversion for water supply]

Regulation	Period of record	Drainage area (square miles)	Annual base flow at indicated recurrence interval in million gallons per day per square mile — Recurrence interval determined by local-minimum method (years): 2	5	10	25	50	100	Recurrence interval determined by fixed-interval method (years): 2	5	10	25	50	100
01427510 Delaware River at Callicoon, N.Y. (Latitude 41 45 24N Longitude 75 03 30)														
HRD	1976-85	1,820	0.494	0.356	0.334	0.227	--	--	0.571	0.374	0.354	0.352	--	--
01428500 Delaware River above Lackawaxen River near Barryville, N.Y. (Latitude 41 30 31N Longitude 74 59 11)														
N	1941-53	2,020	.652	.494	.359	.262	--	--	.703	.552	.431	.424	--	--
HRD	1964-85	2,020	.522	.381	.352	.249	--	--	.573	.417	.369	.290	--	--
01429000 West Branch Lackawaxen River at Prompton, Pa. (Latitude 41 35 14N Longitude 75 19 38)														
N	1945-59	59.7	.713	.594	.489	.378	--	--	.784	.638	.578	.478	--	--
MR	1961-85	59.7	.664	.539	.477	.447	0.447	--	.736	.586	.556	.476	0.438	--
01429500 Dyberry Creek near Honesdale, Pa. (Latitude 41 36 25N Longitude 75 16 00)														
N	1944-58	64.6	.597	.434	.391	.341	--	--	.645	.517	.451	.428	--	--
SR	1960-85	64.6	.590	.470	.405	.393	.390	--	.646	.519	.455	.440	.435	--
01430000 Lackawaxen River near Honesdale, Pa. (Latitude 41 33 43N Longitude 75 14 54)														
N	1949-59	164	.678	.569	.447	.345	--	--	.784	.624	.510	.414	--	--
MR	1961-68, 86-87	164	.558	.479	.444	.357	--	--	.610	.521	.500	.417	--	--
01430500 Lackawaxen River at West Hawley, Pa. (Latitude 41 28 10N Longitude 75 11 15)														
N	1922-37	206	.611	.555	.419	.392	--	--	.656	.609	.499	.357	--	--
01431000 Middle Creek near Hawley, Pa. (Latitude 41 29 05N Longitude 75 13 20)														
N	1945-59	78.4	.529	.437	.394	.345	--	--	.593	.473	.441	.391	--	--
01431500 Lackawaxen River at Hawley, Pa. (Latitude 41 28 34N Longitude 75 10 21)														
N	1909-16, 39-58	290	.517	.454	.370	.349	.348	--	.596	.522	.423	.384	.369	--
MR	1961-85	290	.537	.461	.374	.352	.348	--	.590	.460	.432	.385	.369	--
01432000 Wallenpaupack Creek at Wilsonville, Pa. (Latitude 41 27 33N Longitude 75 11 08)														
N[1]	1910-24	228	.710	.618	.598	.588	--	--	.760	.702	.675	.659	--	--
01434000 Delaware River at Port Jervis, N.Y. (Latitude 41 22 14N Longitude 74 41 52)														
N	1905-53	3,070	.659	.569	.457	.434	.336	--	.681	.603	.523	.442	.442	--
HRD	1964-85	3,070	.592	.421	.381	.280	--	--	.638	.454	.421	.310	--	--
01438500 Delaware River at Montague, N.J. (Latitude 41 18 33N Longitude 74 47 44)														
N	1940-53	3,480	.667	.549	.415	.334	--	--	.769	.576	.485	.476	--	--
HRD	1964-85	3,480	.566	.410	.372	.262	--	--	.626	.441	.386	.309	--	--
01439500 Bush Kill at Shoemakers, Pa. (Latitude 41 05 17N Longitude 75 02 17)														
N	1909-85	117	.888	.689	.625	.520	.450	0.413	.947	.755	.668	.601	.546	0.479
01440200 Delaware R blw Tocks Isl Damsite, nr Delaware Water Gap, Pa. (Latitude 41 00 42N Longitude 75 05 09)														
HR	1965-85	3,850	.617	.446	.402	.262	--	--	.661	.474	.405	.314	--	--
01440400 Brodhead Creek near Analomink, Pa. (Latitude 41 05 05N Longitude 75 12 54)														
N	1958-85	65.9	.832	.649	.588	.492	.482	--	.887	.702	.621	.585	.579	--
01441000 McMichaels Creek at Stroudsburg, Pa. (Latitude 40 58 45N Longitude 75 12 05)														
N	1912-37	65.3	.800	.606	.548	.459	.417	--	.848	.654	.562	.490	.464	--

Table B1.--Base flows at selected recurrence intervals in the Delaware River basin--Continued

Regulation	Period of record	Drainage area (square miles)	Annual base flow at indicated recurrence interval in million gallons per day per square mile											
			Recurrence interval determined by local-minimum method (years)						Recurrence interval determined by fixed-interval method (years)					
			2	5	10	25	50	100	2	5	10	25	50	100
01442500 Brodhead Creek at Minisink Hills, Pa. (Latitude 40 59 55N Longitude 75 08 35)														
N	1951-85	259	0.822	0.626	0.562	0.510	0.455	--	0.930	0.674	0.630	0.539	0.484	--
01446500 Delaware River at Belvidere, N.J. (Latitude 40 49 36N Longitude 75 05 02)														
N	1923-53	4,535	.649	.569	.487	.420	.345	--	.704	.599	.526	.493	.479	--
HRD	1964-85	4,535	.646	.456	.422	.264	--	--	.722	.486	.440	.310	--	--
01446600 Martins Creek near East Bangor, Pa. (Latitude 40 54 00 Longitude 75 12 08)														
SD	1962-77	10.4	.530	.344	.240	.190	--	--	.658	.464	.315	.250	--	--
01447500 Lehigh River at Stoddartsville, Pa. (Latitude 41 07 49N Longitude 75 37 33)														
N	1944-85	91.7	.870	.695	.601	.509	.454	--	.956	.742	.668	.566	.529	--
01447680 Tunkhannock Creek near Long Pond, Pa. (Latitude 41 03 55N Longitude 75 31 14)														
SD	1966-85	18.0	1.199	.872	.790	.620	--	--	1.380	.986	.872	.670	--	--
01447720 Tobyhanna Creek near Blakeslee, Pa. (Latitude 41 05 05N Longitude 75 36 21)														
SD	1962-85	118	.893	.713	.638	.563	--	--	.970	.730	.690	.641	--	--
01447800 Lehigh River blw Francis E. Walter Lake near White Haven, Pa. (Latitude 41 06 17N Longitude 75 43 57)														
HR	1962-85	290	.787	.550	.537	.527	--	--	.831	.603	.569	.537	--	--
01448000 Lehigh River at Tannery, Pa. (Latitude 41 02 25N Longitude 75 45 45)														
N	1919-58	322	.844	.702	.601	.528	.495	--	.908	.733	.637	.562	.518	--
01448500 Dilldown Creek near Long Pond, Pa. (Latitude 41 02 08N Longitude 75 32 37)														
N	1950-85	2.39	.933	.689	.594	.539	.537	--	1.002	.743	.631	.585	.551	--
01449360 Pohopoco Creek at Kresgeville, Pa. (Latitude 40 53 51N Longitude 75 30 10)														
N	1967-85	49.9	.987	.763	.668	.646	--	--	1.106	.873	.687	.649	--	--
01449500 Wild Creek at Hatchery, Pa. (Latitude 40 55 22N Longitude 75 33 32)														
N	1941-57	16.8	1.111	.841	.770	.737	--	--	1.197	.932	.802	.772	--	--
HR	1959-78	16.8	1.114	.758	.485	.445	--	--	1.210	.861	.550	.527	--	--
01449800 Pohopoco Creek below Beltzville Dam near Parryville, Pa. (Latitude 40 50 44N Longitude 75 38 46)														
HRD	1968-85	96.4	.738	.555	.405	.395	--	--	.895	.626	.422	.417	--	--
01450000 Pohopoco Creek near Parryville, Pa. (Latitude 40 49 54N Longitude 75 40 53)														
MDR	1941-57	109	.776	.586	.564	.562	--	--	.839	.660	.613	.612	--	--
HDR	1959-69	109	.607	.480	.420	.369	--	--	.634	.506	.463	.434	--	--
01450500 Aquashicola Creek at Palmerton, Pa. (Latitude 40 48 22N Longitude 75 35 54)														
SD	1940-85	76.7	.815	.624	.599	.495	.460	--	.935	.689	.658	.541	.537	--
01451000 Lehigh River at Walnutport, Pa. (Latitude 40 45 25N Longitude 75 36 12)														
SRD	1947-85	889	.859	.678	.606	.567	.524	--	.940	.717	.664	.573	.558	--
01451500 Little Lehigh Creek near Allentown, Pa. (Latitude 40 34 56N Longitude 75 29 00)														
N	1946-85	80.8	.611	.431	.365	.255	.248	--	.614	.433	.373	.257	.252	--
01451800 Jordan Creek near Schnecksville, Pa. (Latitude 40 39 42N Longitude 75 37 38)														
N	1967-85	53.0	.605	.422	.391	.291	--	--	.675	.467	.440	.356	--	--
01452000 Jordan Creek at Allentown, Pa. (Latitude 40 37 23N Longitude 75 28 58)														
N	1945-85	75.8	.506	.364	.303	.209	.166	--	.616	.415	.334	.284	.233	--

Table B1.--Base flows at selected recurrence intervals in the Delaware River basin--Continued

Regulation	Period of record	Drainage area (square miles)	Annual base flow at indicated recurrence interval in million gallons per day per square mile: Recurrence interval determined by local-minimum method (years) 2	5	10	25	50	100	Recurrence interval determined by fixed-interval method (years) 2	5	10	25	50	100
01452500 Monocacy Creek at Bethlehem, Pa. (Latitude 40 38 28N Longitude 75 22 47)														
N	1949-85	44.5	0.557	0.417	0.351	0.196	0.180	--	0.576	0.418	0.364	0.197	0.182	--
01453000 Lehigh River at Bethlehem, Pa. (Latitude 40 36 55N Longitude 75 22 45)														
N	1903, 1910-40	1,279	.678	.600	.507	.431	.405	--	.690	.639	.547	.475	.449	--
SR	1942-85	1,279	.735	.605	.557	.522	.474	--	.814	.624	.576	.536	.479	--
01454700 Lehigh River at Glendon, Pa. (Latitude 40 40 09N Longitude 75 14 12)														
SR	1967-85	1,359	.939	.654	.638	.568	--	--	.993	.721	.669	.613	--	--
01457500 Delaware River at Riegelsville, N.J. (Latitude 40 35 36 Longitude 75 11 17)														
MRD	1907-53	6,328	.671	.594	.504	.456	.415	--	.695	.617	.540	.509	.485	--
01459500 Tohickon Creek near Pipersville, Pa. (Latitude 40 26 01N Longitude 75 07 01)														
N	1936-72	97.4	.257	.209	.186	.149	.105	--	.293	.227	.217	.180	.145	--
SR	1974-85	97.4	.330	.218	.156	.094	--	--	.402	.246	.203	.168	--	--
01460000 Tohickon Creek at Point Pleasant, Pa. (Latitude 40 25 25N Longitude 75 04 00)														
N	1884-98, 1901-12	107	.333	.242	.222	.183	.172	--	.365	.277	.230	.222	.219	--
01463500 Delaware River at Trenton, N.J. (Latitude 40 13 18N Longitude 74 46 42)														
MRD	1913-53	6,780	.661	.571	.523	.438	.410	--	.719	.624	.524	.505	.491	--
HRD	1964-85	6,780	.684	.493	.446	.307	--	--	.770	.506	.446	.345	--	--
01465000 Neshaminy Creek at Rushland, Pa. (Latitude 40 15 18N Longitude 75 01 59)														
N	1885-1912, 1932-33	134	.428	.324	.286	.243	.230	--	.454	.356	.278	.257	.252	--
01465500 Neshaminy Creek near Langhorne, Pa. (Latitude 40 10 26N Longitude 74 57 26)														
SR	1935-85	210	.374	.306	.284	.214	.206	0.204	.398	.330	.279	.258	.219	0.198
01465770 Poquessing Creek at Trevose Road, Philadelphia, Pa. (Latitude 40 07 55N Longitude 74 59 40)														
N	1965-80	5.08	.404	.287	.270	.253	--	--	.432	.294	.280	.271	--	--
01465785 Walton Run at Philadelphia, Pa. (Latitude 40 05 22N Longitude 74 59 37)														
N	1965-77	2.17	.296	.213	.169	.117	--	--	.313	.236	.185	.130	--	--
01465790 Byberry Creek at Chalfont Road, Philadelphia, Pa. (Latitude 40 05 01N Longitude 74 58 57)														
N	1966-77	5.34	.372	.274	.264	.261	--	--	.400	.299	.275	.265	--	--
01465798 Poquessing Creek at Grant Avenue, Philadelphia, Pa. (Latitude 40 03 25N Longitude 74 59 08)														
N	1966-85	21.4	.358	.284	.207	.198	--	--	.394	.292	.216	.194	--	--
01467042 Pennypack Creek at Pine Road, Philadelphia, Pa. (Latitude 40 05 23N Longitude 75 04 10)														
N	1965-80	37.9	.663	.462	.397	.346	--	--	.674	.473	.404	.367	--	--
01467048 Pennypack Creek at Lower Rhawn St. Bridge, Philadelphia, Pa. (Latitude 40 03 00N Longitude 75 01 59)														
N	1966-85	49.8	.574	.406	.330	.317	--	--	.589	.423	.350	.339	--	--
01467050 Wooden Bridge Run at Philadelphia, Pa. (Latitude 40 03 19N Longitude 75 01 22)														
N	1966-80	3.35	.291	.238	.211	.210	--	--	.320	.270	.225	.222	--	--
01467086 Tacony Creek above Adams Avenue, Philadelphia, Pa. (Latitude 40 02 33N Longitude 75 06 47)														
N	1966-85	16.7	.586	.434	.355	.339	--	--	.605	.447	.362	.352	--	--
01467089 Frankford Creek at Torresdale Avenue, Philadelphia, Pa. (Latitude 40 00 25N Longitude 75 05 33)														
N	1967-80	33.8	.383	.301	.278	.237	--	--	.395	.307	.281	.232	--	

Table B1.--Base flows at selected recurrence intervals in the Delaware River basin--Continued

Regulation	Period of record	Drainage area (square miles)	Annual base flow at indicated recurrence interval in million gallons per day per square mile											
			Recurrence interval determined by local-minimum method (years)						Recurrence interval determined by fixed-interval method (years)					
			2	5	10	25	50	100	2	5	10	25	50	100
01468500 Schuylkill River at Landingville, Pa. (Latitude 40 37 45N Longitude 76 07 30)														
MP	1948-51, 1964, 1974-85	133	1.071	0.736	0.675	0.602	--	--	1.138	0.774	0.720	0.616	--	--
01469500 Little Schuylkill River at Tamaqua, Pa. (Latitude 40 48 25N Longitude 75 58 20)														
N	1920-31	42.9	.890	.650	.526	.455	--	--	.982	.689	.524	.437	--	--
SR	1933-85	42.9	.803	.579	.496	.441	0.392	0.368	.866	.662	.547	.487	0.427	0.397
01470500 Schuylkill River at Berne, Pa. (Latitude 40 31 21N Longitude 75 59 55)														
SPR	1948-85	355	.808	.599	.541	.445	.399	--	.858	.637	.568	.466	.414	--
01470720 Maiden Creek Tributary at Lenhartsville, Pa. (Latitude 40 34 23N Longitude 75 52 34)														
N	1966-79	7.46	.579	.403	.314	.193	--	--	.754	.519	.438	.313	--	--
01470756 Maiden Creek at Virginville, Pa. (Latitude 40 30 51N Longitude 75 53 00)														
N	1974-85	159	.606	.420	.356	.296	--	--	.670	.451	.386	.339	--	--
01470779 Tulpehocken Creek near Bernville, Pa. (Latitude 40 24 48N Longitude 76 10 19)														
N	1975-85	66.5	.865	.574	.432	.337	--	--	.895	.577	.451	.369	--	--
01470960 Tulpehocken Creek at Blue Marsh Damsite near Reading, Pa. (Latitude 40 22 14N Longitude 76 01 32)														
N	1966-77	175	.659	.478	.353	.218	--	--	.735	.525	.396	.268	--	--
01471000 Tulpehocken Creek near Reading, Pa. (Latitude 40 22 08N Longitude 75 58 46)														
N	1951-77	211	.664	.488	.404	.305	.300	--	.713	.515	.460	.349	.349	--
01471510 Schuylkill River at Reading, Pa. (Latitude 40 19 52N Longitude 75 56 22)														
SPR	1920-29	880	.630	.492	.470	.457	--	--	.672	.520	.464	.435	--	--
01471980 Manatawny Creek near Pottstown, Pa. (Latitude 40 16 22N Longitude 75 40 49)														
N	1975-85	85.5	.570	.458	.350	.280	--	--	.586	.462	.344	.267	--	--
01472000 Schuylkill River at Pottstown, Pa. (Latitude 40 14 30N Longitude 75 39 07)														
SPR	1933-85	1,147	.657	.508	.452	.340	.323	.317	.692	.523	.456	.385	.333	.305
01472157 French Creek near Phoenixville, Pa. (Latitude 40 09 05N Longitude 75 36 06)														
N	1969-85	59.1	.589	.455	.288	.254	--	--	.595	.459	.299	.264	--	--
01472174 Pickering Creek near Chester Springs, Pa. (Latitude 40 05 22N Longitude 75 37 50)														
N	1967-82	5.98	.639	.554	.361	.305	--	--	.673	.583	.380	.313	--	--
01472500 Perkiomen Creek near Frederick, Pa. (Latitude 40 16 30N Longitude 75 27 20)														
N	1885-1912	152	.429	.319	.298	.272	.265	--	.457	.371	.318	.299	.296	--
01473000 Perkiomen Creek at Graterford, Pa. (Latitude 40 13 46N Longitude 75 27 07)														
N	1915-55	279	.330	.277	.221	.199	.153	--	.339	.285	.259	.205	.161	--
HR	1957-85	279	.338	.265	.233	.184	.164	--	.364	.282	.259	.197	.169	--
01473120 Skippack Creek near Collegeville, Pa. (Latitude 40 09 52N Longitude 75 26 01)														
N	1967-85	53.7	.312	.216	.196	.159	--	--	.358	.249	.221	.177	--	--
01473950 Wissahickon Creek at Bells Mill Road, Philadelphia, Pa. (Latitude 40 04 50N Longitude 75 13 35)														
N	1966-80	53.6	.537	.386	.327	.291	--	--	.538	.389	.346	.320	--	--
01474000 Wissahickon Creek at Mouth, Philadelphia, Pa. (Latitude 40 00 54N Longitude 75 12 24)														
N	1966-85	64.0	.548	.375	.338	.312	--	--	.562	.377	.348	.340	--	--

Table B1.--Base flows at selected recurrence intervals in the Delaware River basin--Continued

Regulation	Period of record	Drainage area (square miles)	Annual base flow at indicated recurrence interval in million gallons per day per square mile: Recurrence interval determined by local-minimum method (years)						Recurrence interval determined by fixed-interval method (years)					
			2	5	10	25	50	100	2	5	10	25	50	100
01474500 Schuylkill River at Philadelphia, Pa. (Latitude 39 58 00N Longitude 75 11 20)														
MDR	1933-85	1,893	0.468	0.346	0.300	0.205	0.176	0.166	0.509	0.369	0.309	0.250	0.185	0.153
01475300 Darby Creek at Waterloo Mills near Devon, Pa. (Latitude 40 01 21N Longitude 75 25 20)														
N	1973-85	5.15	.706	.543	.412	.333	--	--	.754	.549	.419	.331	--	--
01475510 Darby Creek near Darby, Pa. (Latitude 39 55 44N Longitude 75 16 22)														
N	1965-85	37.4	.761	.521	.389	.361	--	--	.759	.534	.398	.360	--	--
01475530 Cobbs Creek at U.S. Highway No. 1 at Philadelphia, Pa. (Latitude 39 59 29N Longitude 75 16 49)														
N	1965-80	4.78	.560	.437	.336	.314	--	--	.570	.453	.345	.326	--	--
01475550 Cobbs Creek at Darby, Pa. (Latitude 39 55 02N Longitude 75 14 52)														
N	1965-85	22.0	.381	.150	.091	.069	--	--	.387	.181	.106	.092	--	--
01477000 Chester Creek near Chester, Pa. (Latitude 39 52 08N Longitude 75 24 31)														
N	1932-85	61.1	.574	.427	.366	.312	.306	.305	.580	.435	.376	.325	.318	.313
01480300 West Branch Brandywine Creek near Honey Brook, Pa. (Latitude 40 04 22N Longitude 75 51 40)														
N	1961-85	18.7	.519	.345	.306	.286	.280	--	.534	.374	.331	.304	.290	--
01480500 West Branch Brandywine Creek at Coatesville, Pa. (Latitude 39 59 08N Longitude 75 49 40)														
SD	1944-50, 1971-85	45.8	.562	.440	.354	.248	--	--	.572	.436	.349	.250	--	--
01480617 West Branch Brandywine Creek at Modena, Pa. (Latitude 39 57 42N Longitude 75 48 06)														
SD	1971-85	55.0	.726	.528	.365	.323	--	--	.742	.537	.370	.320	--	--
01480675 Marsh Creek near Glenmoore, Pa. (Latitude 40 05 52N Longitude 75 44 31)														
N	1967-85	8.57	.542	.439	.289	.213	--	--	.596	.507	.344	.249	--	--
01480685 Marsh Creek near Downingtown, Pa. (Latitude 40 03 19N Longitude 75 43 00)														
HR	1974-85	20.3	.626	.437	.349	.302	--	--	.734	.500	.375	.320	--	--
01480700 East Branch Brandywine Creek near Downingtown, Pa. (Latitude 40 02 05N Longitude 75 42 32)														
MR	1974-85	60.6	.586	.487	.344	.271	--	--	.608	.500	.351	.264	--	--
01480870 East Branch Brandywine Creek below Downingtown, Pa. (Latitude 39 58 07N Longitude 75 40 25)														
MR	1974-85	89.9	.624	.519	.366	.287	--	--	.636	.536	.369	.286	--	--
01481000 Brandywine Creek at Chadds Ford, Pa. (Latitude 39 52 11N Longitude 75 35 37)														
N	1912-52, 1963-72	287	.564	.404	.356	.317	.307	.304	.570	.414	.368	.325	.302	.290
MR	1974-85	287	.625	.467	.338	.285	--	--	.632	.464	.335	.288	--	--

[1]Flow totally regulated after 1925.

Table B2.--Base flows at selected recurrence intervals in the Susquehanna and Potomac River basins

[--, period of record too short to estimate recurrence interval. Degree of regulation: N, no known regulation; S, slight regulation that does not significantly affect base flow; M, regulation that has a moderate effect on base flow; H, regulation that has a substantial effect on base flow; P, regulation by mine pumpage; R, regulation by reservoir releases; D, regulation by diversion for water supply]

			Annual base flow at indicated recurrence interval in million gallons per day per square mile											
			Recurrence interval determined by local-minimum method (years)						Recurrence interval determined by fixed-interval method (years)					
Regulation	Period of record	Drainage area (square miles)	2	5	10	25	50	100	2	5	10	25	50	100
01515000 Susquehanna River near Waverly, N.Y. (Latitude 41 59 05N Longitude 76 30 05)														
N	1938-61	4,780	0.514	0.416	0.361	0.255	--	--	0.541	0.472	0.432	0.390	--	--
01516350 Tioga River near Mansfield, Pa. (Latitude 41 47 34N Longitude 77 04 44)														
N	1977-86	153	.459	.413	.365	.332	--	--	.527	.417	.410	.408	--	--
01516500 Corey Creek near Mainesburg, Pa. (Latitude 41 47 27N Longitude 77 00 54)														
N	1955-85	12.2	.341	.229	.215	.162	0.144	--	.393	.292	.256	.201	0.152	--
01517000 Elk Run near Mainesburg, Pa. (Latitude 41 48 54N Longitude 76 57 55)														
N	1955-77	10.2	.332	.231	.188	.146	--	--	.407	.284	.234	.214	--	--
01518000 Tioga River at Tioga, Pa. (Latitude 41 54 30N Longitude 77 07 47)														
N	1939-78	282	.365	.274	.225	.172	.147	--	.387	.304	.253	.204	.203	--
01518500 Crooked Creek at Tioga, Pa. (Latitude 41 54 08N Longitude 77 08 55)														
N	1954-73	122	.269	.214	.195	.142	--	--	.300	.239	.225	.168	--	--
01520000 Cowanesque River near Lawrenceville, Pa. (Latitude 41 59 48N Longitude 77 08 25)														
N	1952-78	298	.245	.194	.159	.132	.120	--	.282	.216	.193	.168	.168	--
01531500 Susquehanna River at Towanda, Pa. (Latitude 41 45 55N Longitude 76 26 28)														
SR	1914-85	7,797	.427	.348	.320	.285	.261	0.251	.462	.384	.336	.307	.304	0.302
01532000 Towanda Creek near Monroeton, Pa. (Latitude 41 42 25N Longitude 76 29 06)														
N	1915-85	215	.389	.319	.266	.243	.207	.167	.463	.351	.306	.263	.253	.243
01532850 Middle Branch Wyalusing Creek Trib. near Birchardville, Pa. (Latitude 41 51 45N Longitude 76 00 26)														
N	1966-78	5.67	.533	.429	.410	.387	--	--	.672	.522	.485	.469	--	--
01533400 Susquehanna River at Meshoppen, Pa. (Latitude 41 36 26N Longitude 76 03 02)														
SR	1977-86	8,720	.435	.359	.346	.337	--	--	.507	.376	.347	.327	--	--
01533500 North Branch Mehoopany Creek near Lovelton, Pa. (Latitude 41 31 50N Longitude 76 09 20)														
N	1941-57	35.2	.390	.339	.293	.172	--	--	.468	.388	.342	.271	--	--
01533950 South Branch Tunkhannock Creek near Montdale, Pa. (Latitude 41 34 29N Longitude 75 38 32)														
N	1961-77	12.6	.452	.304	.289	.246	--	--	.554	.355	.335	.304	--	--
01534000 Tunkhannock Creek near Tunkhannock, Pa. (Latitude 41 33 30N Longitude 75 53 42)														
N	1915-85	383	.433	.365	.306	.255	.252	.252	.464	.387	.335	.292	.282	.27
01534300 Lackawanna River near Forest City, Pa. (Latitude 41 40 47N Longitude 75 28 20)														
HR	1960-85	38.8	.614	.559	.513	.424	.423	--	.764	.610	.583	.519	.486	--
01534500 Lackawanna River at Archbald, Pa. (Latitude 41 30 16N Longitude 75 32 33)														
HP	1941-59	108	.749	.586	.556	.441	--	--	.843	.713	.625	.553	--	--
HR	1960-85	108	.723	.615	.570	.528	.514	--	.864	.675	.646	.564	.529	--
01535500 Lackawanna River at Moosic, Pa. (Latitude 41 21 30N Longitude 75 43 50)														
HP	1914-27	264	.678	.615	.549	.547	--	--	.740	.642	.576	.570	--	--

Table B2.--Base flows at selected recurrence intervals in the Susquehanna and Potomac River basins--Continued

Regulation	Period of record	Drainage area (square miles)	Annual base flow at indicated recurrence interval in million gallons per day per square mile: Recurrence interval determined by local-minimum method (years) 2	5	10	25	50	100	Recurrence interval determined by fixed-interval method (years) 2	5	10	25	50	100
01536000 Lackawanna River at Old Forge, Pa. (Latitude 41 21 33N Longitude 75 44 41)														
HP	1939-58	332	0.678	0.574	0.485	0.425	--	--	0.742	0.598	0.497	0.465	--	--
MR	1960-85	332	.470	.343	.306	.282	0.269	--	.514	.383	.350	.318	0.304	--
01536500 Susquehanna River at Wilkes Barre, Pa. (Latitude 41 15 03N Longitude 75 52 52)														
SR	1900-85	9,960	.434	.369	.333	.288	.274	0.268	.467	.402	.362	.318	.309	0.302
01537000 Toby Creek at Luzerne, Pa. (Latitude 41 16 57N Longitude 75 53 46)														
SR	1942-85	32.4	.454	.332	.298	.246	.176	--	.496	.352	.336	.279	.195	--
01537500 Solomon Creek at Wilkes Barre, Pa. (Latitude 41 13 39N Longitude 75 54 17)														
HP	1941-62	15.7	.628	.532	.425	.370	--	--	.710	.605	.479	.338	--	--
SP	1963-85	15.7	.390	.289	.223	.174	--	--	.465	.371	.285	.206	--	--
01538000 Wapwallopen Creek near Wapwallopen, Pa. (Latitude 41 03 33N Longitude 76 05 38)														
N	1920-85	43.8	.572	.456	.426	.383	.342	.320	.638	.510	.441	.417	.385	.353
01539000 Fishing Creek near Bloomsburg, Pa. (Latitude 41 04 41N Longitude 76 25 53)														
S	1939-85	274	.584	.493	.412	.382	.357	--	.649	.518	.459	.420	.405	--
01539500 Little Fishing Creek at Eyers Grove, Pa. (Latitude 41 04 50N Longitude 76 30 40)														
SD	1941-57	56.5	.401	.351	.287	.263	--	--	.473	.410	.321	.315	--	--
01540000 Fishing Creek at Bloomsburg, Pa. (Latitude 41 00 10N Longitude 76 27 50)														
N	1915-27	355	.688	.493	.433	.419	--	--	.709	.579	.525	.519	--	--
01540200 Trexler Run near Ringtown, Pa. (Latitude 40 51 10N Longitude 76 16 48)														
N	1964-79	1.77	.616	.382	.302	.227	--	--	.694	.458	.324	.228	--	--
01540500 Susquehanna River at Danville, Pa. (Latitude 40 57 29N Longitude 76 37 10)														
SR	1906-85	11,220	.458	.366	.339	.299	.268	.240	.483	.406	.364	.333	.325	.322
01541000 West Branch Susquehanna River at Bower, Pa. (Latitude 40 53 49N Longitude 78 40 38)														
N	1914-85	315	.519	.439	.372	.364	.351	.344	.586	.464	.416	.396	.375	.367
01541200 West Branch Susquehanna River at Curwensville, Pa. (Latitude 40 57 41N Longitude 78 31 10)														
N	1956-65	367	.496	.443	.381	.339	--	--	.518	.468	.434	.416	--	--
MR	1966-85	367	.593	.475	.378	.299	--	--	.672	.560	.466	.354	--	--
01541308 Bradley Run near Ashville, Pa. (Latitude 40 30 33N Longitude 78 35 02)														
N	1968-78	6.77	.781	.671	.547	.476	--	--	.921	.767	.596	.447	--	--
01541500 Clearfield Creek at Dimeling, Pa. (Latitude 40 58 18N Longitude 78 24 22)														
N	1914-59	371	.466	.394	.345	.312	.306	--	.535	.428	.368	.356	.349	--
MR	1961-85	371	.572	.439	.366	.323	.302	--	.611	.468	.413	.349	.338	
01542000 Moshannon Creek at Osceola Mills, Pa. (Latitude 40 50 58N Longitude 78 16 05)														
N	1941-85	68.8	.680	.540	.513	.472	.412	--	.738	.639	.571	.531	.483	--
01542500 West Branch Susquehanna River at Karthaus, Pa. (Latitude 41 07 03N Longitude 78 06 33)														
N	1941-59	1,462	.554	.472	.465	.352	--	--	.602	.525	.475	.362	--	--
MR	1961-85	1,462	.627	.480	.401	.377	.365	--	.669	.534	.453	.431	.422	--
01542810 Waldy Run near Emporium, Pa. (Latitude 41 34 44N Longitude 78 17 34)														
N	1965-85	5.24	.535	.418	.376	.355	--	--	.711	.544	.509	.462	--	--
01543000 Driftwood Branch Sinnemahoning Creek at Sterling Run, Pa. (Latitude 41 24 48N Longitude 78 11 50)														
N	1964-85	272	.482	.385	.359	.351	--	--	.538	.411	.403	.306	--	--

Table B2.--Base flows at selected recurrence intervals in the Susquehanna and Potomac River basins--Continued

Regulation	Period of record	Drainage area (square miles)	Annual base flow at indicated recurrence interval in million gallons per day per square mile: Recurrence interval determined by local-minimum method (years)						Recurrence interval determined by fixed-interval method (years)					
			2	5	10	25	50	100	2	5	10	25	50	100
01543500 Sinnemahoning Creek at Sinnemahoning, Pa. (Latitude 41 19 02N Longitude 78 06 12)														
N	1939-85	685	0.513	0.407	0.373	0.312	0.267	--	0.572	0.460	0.427	0.398	0.333	--
01544000 First Fork Sinnemahoning Creek near Sinnemahoning, Pa. (Latitude 41 24 06N Longitude 78 01 28)														
MR	1956-85	245	.472	.370	.319	.210	.160	--	.535	.417	.362	.342	.335	--
01544500 Kettle Creek at Cross Fork, Pa. (Latitude 41 28 33N Longitude 77 49 34)														
N	1941-85	136	.556	.453	.421	.340	.259	--	.674	.560	.517	.455	.363	--
01545000 Kettle Creek near Westport, Pa. (Latitude 41 19 12N Longitude 77 52 27)														
MR	1962-85	233	.529	.412	.354	.343	--	--	.614	.466	.430	.409	--	--
01545500 West Branch Susquehanna River at Renovo, Pa. (Latitude 41 19 28N Longitude 77 45 03)														
SR	1908-85	2,975	.539	.434	.378	.349	.308	0.267	.598	.464	.407	.376	.365	0.348
01545600 Young Womans Creek near Renovo, Pa. (Latitude 41 23 22N Longitude 77 41 28)														
N	1965-85	46.2	.594	.456	.410	.383	--	--	.654	.553	.515	.507	--	--
01546000 Bald Eagle Creek at Milesburg, Pa. (Latitude 40 56 30N Longitude 77 47 40)														
SD	1912-27	119	.422	.368	.346	.295	--	--	.498	.423	.383	.339	--	--
01546500 Spring Creek near Axemann, Pa. (Latitude 40 53 23N Longitude 77 47 40)														
SD	1941-85	87.2	.563	.470	.334	.289	.288	--	.596	.478	.344	.298	.291	--
01547100 Spring Creek at Milesburg, Pa. (Latitude 40 55 54N Longitude 77 47 13)														
SD	1968-85	142	.934	.784	.609	.487	--	--	.962	.815	.639	.494	--	--
01547200 Bald Eagle Creek below Spring Creek at Milesburg, Pa. (Latitude 40 56 35N Longitude 77 47 12)														
N	1956-85	265	.658	.519	.424	.392	.387	--	.681	.522	.411	.400	.395	--
01547500 Bald Eagle Creek at Blanchard, Pa. (Latitude 41 03 06N Longitude 77 36 17)														
N	1955-70	339	.502	.403	.354	.345	--	--	.525	.395	.364	.352	--	--
MR	1972-85	339	.623	.529	.491	.456	--	--	.650	.563	.549	.547	--	--
01547700 Marsh Creek at Blanchard, Pa. (Latitude 41 03 34N Longitude 77 36 22)														
N	1956-85	44.1	.438	.374	.289	.264	.258	--	.501	.432	.372	.327	.317	--
01547800 South Fork Beech Creek near Snow Shoe, Pa. (Latitude 41 01 30N Longitude 77 54 15)														
N	1970-79	12.2	.892	.751	.655	.596	--	--	1.047	.927	.789	.689	--	--
01547950 Beech Creek at Monument, Pa. (Latitude 41 06 42N Longitude 77 42 09)														
N	1969-85	152	.799	.605	.531	.475	--	--	.862	.745	.623	.547	--	--
01548005 Bald Eagle Creek near Beech Creek Station, Pa. (Latitude 41 04 51N Longitude 77 32 59)														
N	1911-70	562	.531	.426	.375	.361	.314	.281	.556	.453	.407	.384	.374	.368
MR	1972-85	562	.681	.533	.494	.469	--	--	.725	.639	.583	.536	--	--
01548500 Pine Creek at Cedar Run, Pa. (Latitude 41 31 18N Longitude 77 26 52)														
N	1919-85	604	.451	.376	.347	.309	.247	.197	.505	.414	.387	.362	.293	.243
01549000 Pine Creek near Waterville, Pa. (Latitude 41 18 45N Longitude 77 22 45)														
N	1909-19	750	.492	.390	.383	.378	--	--	.566	.431	.391	.364	--	--
01549500 Blockhouse Creek near English Center, Pa. (Latitude 41 28 25N Longitude 77 13 52)														
N	1941-85	37.7	.503	.400	.336	.294	.232	--	.592	.464	.418	.359	.310	--

Table B2.--Base flows at selected recurrence intervals in the Susquehanna and Potomac River basins--Continued

Regulation	Period of record	Drainage area (square miles)	Annual base flow at indicated recurrence interval in million gallons per day per square mile: Recurrence interval determined by local-minimum method (years) 2	5	10	25	50	100	Recurrence interval determined by fixed-interval method (years) 2	5	10	25	50	100
01549700 Pine Creek below Litlte Pine Creek near Waterville, Pa. (Latitude 41 16 25N Longitude 77 19 28)														
MR	1958-85	944	0.450	0.371	0.314	0.307	0.304	--	0.512	0.443	0.397	0.371	0.357	--
01549780 Larrys Creek at Cogan House, Pa. (Latitude 41 25 04N Longitude 77 09 46)														
N	1961-77	6.80	.618	.394	.365	.293	--	--	.763	.493	.457	.441	--	--
01550000 Lycoming Creek near Trout Run, Pa. (Latitude 41 25 06N Longitude 77 01 59)														
N	1914-85	173	.576	.456	.429	.382	.319	0.279	.655	.510	.482	.450	.405	0.377
01551000 Grafius Run at Williamsport, Pa. (Latitude 41 15 15N Longitude 77 00 40)														
N	1941-52	3.14	.327	.231	.196	.177	--	--	.456	.349	.299	.267	--	--
01551500 West Branch Susquehanna River at Williamsport, Pa. (Latitude 41 14 10N Longitude 76 59 49)														
SR	1896-1985	5,682	.496	.406	.373	.338	.273	.232	.544	.445	.402	.375	.327	.320
01552000 Loyalsock Creek at Loyalsockville, Pa. (Latitude 41 19 31N Longitude 76 54 43)														
N	1926-73, 1976-85	443	.550	.437	.384	.341	.316	.300	.594	.493	.413	.381	.362	.351
01552500 Muncy Creek near Sonestown, Pa. (Latitude 41 21 25N Longitude 76 32 06)														
N	1941-85	23.8	.738	.557	.504	.435	.426	--	.909	.688	.615	.595	.559	--
01553130 Sand Spring Run near White Deer, Pa. (Latitude 41 03 31N Longitude 77 04 37)														
N	1969-79	4.93	.958	.807	.617	.468	--	--	1.054	.845	.643	.477	--	--
01553500 West Branch Susquehanna River at Lewisburg, Pa. (Latitude 40 58 05N Longitude 76 52 25)														
SR	1940-85	6,847	.525	.413	.379	.347	.334	--	.548	.460	.408	.369	.338	--
01553600 East Branch Chillisquaque Creek near Washingtonville, Pa. (Latitude 41 04 57N Longitude 76 39 17)														
N	1961-77	9.48	.325	.212	.176	.158	--	--	.415	.305	.251	.226	--	--
01554000 Susquehanna River at Sunbury, Pa. (Latitude 40 50 04N Longitude 76 49 37)														
SR	1938-85	18,300	.506	.412	.372	.350	.308	--	.526	.435	.393	.368	.335	--
01554500 Shamokin Creek near Shamokin, Pa. (Latitude 40 48 37N Longitude 76 35 04)														
MP	1940-85	54.2	.813	.652	.596	.482	.408	--	.850	.671	.612	.497	.413	--
01555000 Penns Creek at Penns Creek, Pa. (Latitude 40 52 00N Longitude 77 02 55)														
N	1930-85	301	.579	.463	.396	.349	.316	.297	.622	.504	.418	.382	.357	.342
01555500 East Mahantango Creek near Dalmatia, Pa. (Latitude 40 36 40N Longitude 76 54 44)														
N	1930-85	162	.496	.366	.327	.228	.189	.171	.578	.410	.371	.281	.212	.176
01556000 Frankstown Branch Juniata River at Williamsburg, Pa. (Latitude 40 27 47N Longitude 78 12 00)														
SR	1917-85	291	.476	.379	.339	.286	.262	.247	.521	.404	.366	.322	.286	.251
01556500 Little Juniata River at Tipton, Pa. (Latitude 40 37 40N Longitude 78 17 38)														
HR	1946-59	93.7	.618	.501	.495	.486	--	--	.712	.581	.564	.536	--	--
01557500 Bald Eagle Creek at Tyrone, Pa. (Latitude 40 41 01N Longitude 78 14 02)														
SD	1945-85	44.1	.637	.513	.466	.425	.420	--	.719	.588	.549	.507	.463	--
01558000 Little Juniata River at Spruce Creek, Pa. (Latitude 40 36 45N Longitude 78 08 27)														
MR	1939-85	220	.714	.608	.554	.503	.492	--	.768	.668	.609	.541	.528	--
01559000 Juniata River at Huntingdon, Pa. (Latitude 40 29 05N Longitude 78 01 09)														
MR	1942-71	816	.475	.405	.341	.278	.253	--	.529	.432	.331	.299	.280	--
SR	1973-85	816	.577	.521	.449	.371	--	--	.616	.571	.486	.405	--	--

Table B2.--Base flows at selected recurrence intervals in the Susquehanna and Potomac River basins--Continued

Regulation	Period of record	Drainage area (square miles)	Annual base flow at indicated recurrence interval in million gallons per day per square mile: Recurrence interval determined by local-minimum method (years) 2	5	10	25	50	100	Recurrence interval determined by fixed-interval method (years) 2	5	10	25	50	100
01559500 Standing Stone Creek near Huntingdon, Pa. (Latitude 40 31 25N Longitude 77 58 15)														
N	1930-57	128	0.422	0.345	0.322	0.263	0.262	--	0.443	0.391	0.323	0.282	0.273	--
01559700 Buffalo Run Tributary near Manns Choice, Pa. (Latitude 39 58 40N Longitude 78 37 08)														
N	1962-77	5.28	.380	.247	.192	.117	--	--	.436	.313	.241	.159	--	--
01560000 Dunning Creek at Belden, Pa. (Latitude 40 04 18N Longitude 78 29 34)														
N	1940-85	172	.424	.366	.309	.276	.217	--	.492	.404	.378	.298	.239	--
01560500 Dunning Creek at Yount, Pa. (Latitude 40 03 30N Longitude 78 28 30)														
N	1930-38	191	.313	.257	.211	.183	--	--	.380	.316	.221	.164	--	--
01561000 Brush Creek at Gapsville, Pa. (Latitude 39 57 20N Longitude 78 15 15)														
N	1932-57	36.8	.448	.316	.287	.266	.262	--	.527	.389	.355	.313	.291	--
01562000 Raystown Branch Juniata River at Saxton, Pa. (Latitude 40 12 57N Longitude 78 15 56)														
N	1912-85	756	.397	.307	.268	.206	.185	0.172	.438	.332	.295	.245	.214	0.207
01562500 Great Trough Creek near Marklesburg, Pa. (Latitude 40 21 00N Longitude 78 07 50)														
N	1930-56	84.6	.391	.285	.275	.264	.260	--	.441	.330	.292	.286	.285	--
01563000 Raystown Branch Juniata River near Huntingdon, Pa. (Latitude 40 25 35N Longitude 78 01 47)														
N	1947-70	957	.310	.235	.178	.132	--	--	.392	.283	.206	.178	--	--
01563200 Raystown Branch Juniata R. blw Raystown Dam nr Huntingdon, Pa. (Latitude 40 25 44N Longitude 77 59 29)														
MR	1972-85	960	.468	.371	.252	.177	--	--	.510	.388	.268	.167	--	--
01563500 Juniata River at Mapleton Depot, Pa. (Latitude 40 23 32N Longitude 77 56 07)														
SR	1938-70	2,030	.398	.311	.261	.225	.218	--	.423	.328	.279	.252	.239	--
MR	1972-85	2,030	.490	.451	.335	.322	--	--	.546	.477	.384	.365	--	--
01564500 Aughwick Creek near Three Springs, Pa. (Latitude 40 12 45N Longitude 77 55 32)														
N	1939-85	205	.370	.282	.227	.189	.135	--	.418	.314	.276	.224	.209	--
01565000 Kishacoquillas Creek at Reedsville, Pa. (Latitude 40 39 17N Longitude 77 35 00)														
N	1940-69, 1984	164	.526	.463	.366	.305	.290	--	.623	.504	.401	.334	.318	--
01565700 Little Lost Creek near Oakland Mills, Pa. (Latitude 40 36 19N Longitude 77 18 42)														
N	1964-79	6.52	.438	.291	.205	.165	--	--	.526	.330	.239	.195	--	--
01566000 Tuscarora Creek near Port Royal, Pa. (Latitude 40 30 55 Longitude 77 25 10)														
N	1912-57	214	.390	.308	.254	.226	.185	--	.435	.354	.292	.237	.209	--
01566500 Cocolamus Creek near Millerstown, Pa. (Latitude 40 33 55N Longitude 77 07 05)														
N	1931-57	57.2	.439	.322	.286	.171	.111	--	.493	.373	.335	.201	.144	--
01567000 Juniata River at Newport, Pa. (Latitude 40 28 42N Longitude 77 07 46)														
N	1900-70	3,354	.408	.311	.273	.221	.205	.203	.432	.345	.298	.246	.234	.229
MR	1973-85	3,354	.470	.384	.324	.246	--	--	.502	.417	.352	.285	--	--
01567500 Bixler Run near Loysville, Pa. (Latitude 40 22 15N Longitude 77 24 09)														
N	1955-85	15.0	.485	.344	.312	.236	.183	--	.539	.391	.344	.266	.199	--
01568000 Sherman Creek at Shermans Dale, Pa. (Latitude 40 19 24N Longitude 77 10 09)														
N	1930-85	200	.510	.395	.331	.268	.228	.208	.552	.430	.355	.299	.246	.214

Table B2.--Base flows at selected recurrence intervals in the Susquehanna and Potomac River basins--Continued

Regulation	Period of record	Drainage area (square miles)	Annual base flow at indicated recurrence interval in million gallons per day per square mile: Recurrence interval determined by local-minimum method (years) 2	5	10	25	50	100	Recurrence interval determined by fixed-interval method (years) 2	5	10	25	50	100
01568500 Clark Creek near Carsonville, Pa. (Latitude 40 27 37N Longitude 76 45 06)														
HD	1941-85	22.5	0.384	0.176	0.132	0.120	0.110	--	0.422	0.178	0.131	0.121	0.113	--
01569000 Stony Creek near Dauphin, Pa. (Latitude 40 22 46N Longitude 76 54 31)														
N	1938-44, 1968-73	33.2	.674	.539	.473	.391	--	--	.751	.599	.525	.426	--	--
01569800 Letort Spring Run near Carlisle, Pa. (Latitude 40 14 05N Longitude 77 08 23)														
N	1977-86	21.6	1.199	.943	.905	.888	--	--	1.224	.956	.920	.901	--	--
01570000 Conodoguinet Creek near Hogestown, Pa. (Latitude 40 15 08N Longitude 77 01 17)														
N	1912-16, 1930-57, 1968-85	470	.460	.343	.293	.223	.181	0.159	.484	.388	.302	.244	.187	0.158
01570500 Susquehanna River at Harrisburg, Pa. (Latitude 40 15 17N Longitude 76 53 11)														
SR	1891-1985	24,100	.504	.410	.385	.341	.290	.280	.537	.441	.390	.365	.350	.343
01571000 Paxton Creek near Penbrook, Pa. (Latitude 40 18 30N Longitude 76 51 00)														
N	1941-49	11.2	.473	.399	.194	.071	--	--	.548	.442	.226	.096	--	--
01571500 Yellow Breeches Creek near Camp Hill, Pa. (Latitude 40 13 29N Longitude 76 53 54)														
SD	1910-18, 1955-85	216	.662	.537	.459	.422	.406	--	.692	.558	.478	.447	.408	--
01572000 Lower Little Swatara Creek at Pine Grove, Pa. (Latitude 40 32 15N Longitude 76 22 40)														
SD	1921-31	34.3	.580	.388	.296	.254	--	--	.606	.442	.318	.268	--	--
01573000 Swatara Creek at Harper Tavern, Pa. (Latitude 40 24 09N Longitude 76 34 39)														
MD	1920-85	337	.586	.424	.364	.273	.192	.128	.634	.454	.390	.302	.230	.180
01573086 Beck Creek near Cleona, Pa. (Latitude 40 19 24N Longitude 76 29 00)														
N	1964-79	7.87	.598	.376	.178	.178	--	--	.610	.385	.186	.186	--	--
01573160 Quittapahilla Creek near Bellegrove, Pa. (Latitude 40 20 34N Longitude 76 33 46)														
SP	1976-85	74.2	.803	.545	.428	.343	--	--	.820	.550	.428	.341	--	--
01573500 Manada Creek at Manada Gap, Pa. (Latitude 40 23 50N Longitude 76 42 35)														
N	1938-57	13.5	.670	.592	.451	.386	--	--	.820	.698	.566	.468	--	--
01573560 Swatara Creek near Hershey, Pa. (Latitude 40 17 54N Longitude 76 40 05)														
N[1]	1976-85	483	.610	.356	.265	.204	--	--	.666	.384	.306	.253	--	--
01574000 West Conewago Creek near Manchester, Pa. (Latitude 40 04 56N Longitude 76 43 13)														
SR	1929-85	510	.307	.212	.182	.145	.096	.063	.325	.231	.194	.157	.099	.058
01574500 Codorus Creek at Spring Grove, Pa. (Latitude 39 52 43N Longitude 76 51 13)														
N	1930-63	75.5	.386	.289	.237	.167	.145	--	.407	.301	.254	.174	.156	--
MR	1967-85	75.5	.498	.297	.239	.220	--	--	.527	.291	.248	.216	--	--
01575000 South Branch Codorus Creek near York, Pa. (Latitude 39 55 14N Longitude 76 44 57)														
MDR	1928-85	117	.390	.251	.149	.120	.098	.085	.414	.272	.164	.131	.122	.119
01575500 Codorus Creek near York, Pa. (Latitude 39 56 46N Longitude 76 45 20)														
MDR	1941-85	222	.402	.268	.187	.156	.134	--	.428	.290	.208	.165	.162	--
01576000 Susquehanna River at Marietta, Pa. (Latitude 40 03 16N Longitude 76 31 52)														
SR	1932-85	25,990	.512	.406	.370	.356	.330	.315	.550	.444	.396	.371	.352	.343

Table B2.--Base flows at selected recurrence intervals in the Susquehanna and Potomac River basins--Continued

Regulation	Period of record	Drainage area (square miles)	Annual base flow at indicated recurrence interval in million gallons per day per square mile: Recurrence interval determined by local-minimum method (years)						Recurrence interval determined by fixed-interval method (years)					
			2	5	10	25	50	100	2	5	10	25	50	100
01576500 Conestoga River at Lancaster, Pa. (Latitude 40 03 00N Longitude 76 16 39)														
MD	1929-30, 1934-85	324	0.499	0.368	0.303	0.208	0.178	0.163	0.518	0.370	0.314	0.220	0.190	0.175
01577500 Muddy Creek at Castle Fin, Pa. (Latitude 39 46 21N Longitude 76 18 58)														
SR	1929-37	133	.563	.368	.208	.112	--	--	.590	.376	.212	.114	--	--
01578400 Bowery Run near Quarryville, Pa. (Latitude 39 53 41N Longitude 76 06 50)														
N	1963-79	5.98	.574	.357	.300	.274	--	--	.589	.370	.326	.323	--	--
01603500 Evitts Creek near Centerville, Pa. (Latitude 39 47 23N Longitude 78 38 48)														
N	1933-81	30.2	.432	.322	.279	.242	.211	--	.486	.390	.326	.255	.251	--
01613050 Tonoloway Creek near Needmore, Pa. (Latitude 39 53 54N Longitude 78 07 57)														
N	1966-85	10.7	.382	.260	.239	.186	--	--	.490	.368	.319	.223	--	--
01614090 Conococheaque Creek near Fayetteville, Pa. (Latitude 39 55 48N Longitude 77 26 23)														
N	1961-79	5.05	.672	.527	.358	.354	--	--	.736	.547	.389	.372	--	--

[1]Records have been adjusted for diversion.

Table B3.--Base flows at selected recurrence intervals in the Ohio and St. Lawrence River basins

[--, period of record too short to estimate recurrence interval. Degree of regulation: N, no known regulation; S, slight regulation that does not significantly affect base flow; M, regulation that has a moderate effect on base flow; H, regulation that has a substantial effect on base flow; P, regulation by mine pumpage; R, regulation by reservoir releases; D, regulation by diversion for water supply]

			Annual base flow at indicated recurrence interval in million gallons per day per square mile											
			Recurrence interval determined by local minimum method (years)						Recurrence interval determined by fixed interval method (years)					
Regulation	Period of record	Drainage area (square miles)	2	5	10	25	50	100	2	5	10	25	50	100
03007800 Allegheny River at Port Allegany, Pa. (Latitude 41 49 07N Longitude 78 17 35)														
N	1975-85	248	0.568	0.518	0.496	0.479	--	--	0.704	0.596	0.553	0.546	--	--
03008000 Newell Creek near Port Allegany, Pa. (Latitude 41 53 40 Longitude 78 20 57)														
N	1967-77	7.79	.486	.394	.373	.367	--	--	.633	.483	.469	.458	--	--
03009680 Potato Creek at Smethport, Pa. (Latitude 41 48 35N Longitude 78 25 50)														
N	1975-85	160	.691	.569	.539	.521	--	--	.795	.690	.656	.631	--	--
03010000 Allegheny River at Larabee, Pa. (Latitude 41 54 05N Longitude 78 23 05)														
N	1926-38	530	.580	.447	.393	.353	--	--	.615	.485	.432	.385	--	--
03010500 Allegheny River at Eldred, Pa. (Latitude 41 57 48N Longitude 78 23 11)														
N	1940-85	550	.560	.490	.454	.366	0.316	--	.666	.530	.502	.477	0.381	--
03010655 Oswayo Creek at Shinglehouse, Pa. (Latitude 41 57 42N Longitude 78 11 54)														
N	1975-85	98.7	.529	.488	.458	.443	--	--	.702	.588	.523	.481	--	--
03011800 Kinzua Creek near Guffey, Pa. (Latitude 41 45 59N Longitude 78 43 08)														
N	1966-85	46.4	.650	.538	.512	.485	--	--	.745	.587	.560	.556	--	--
03012550 Allegheny River at Kinzua Dam, Pa. (Latitude 41 50 29N Longitude 79 00 44)														
HR	1936-85	2,180	.578	.435	.400	.359	.346	--	.668	.533	.500	.415	.363	--
03015000 Conewango Creek at Russell, Pa. (Latitude 41 56 17N Longitude 79 08 00)														
MR	1949-85	816	.681	.593	.531	.483	.479	--	.807	.643	.620	.530	.489	--
03015280 Jackson Run near North Warren, Pa. (Latitude 41 54 10N Longitude 79 14 18)														
N	1963-78	12.8	.708	.539	.482	.374	--	--	.770	.632	.547	.474	--	--
03015500 Brokenstraw Creek at Youngsville, Pa. (Latitude 41 51 09N Longitude 79 19 03)														
N	1910-85	321	.563	.472	.424	.357	.323	0.289	.610	.506	.434	.379	.344	0.288
03016000 Allegheny River at West Hickory, Pa. (Latitude 41 34 15N Longitude 79 24 29)														
SR	1942-64	3,660	.535	.452	.393	.349	--	--	.574	.484	.452	.427	--	--
HR	1966-85	3,660	.701	.553	.521	.466	--	--	.807	.684	.602	.516	--	--
03017500 Tionesta Creek at Lynch, Pa. (Latitude 41 36 07N Longitude 79 03 01)														
N	1939-78	233	.681	.569	.525	.404	.370	--	.762	.626	.585	.519	.514	--
03019000 Tionesta Creek at Nebraska, Pa. (Latitude 41 28 25N Longitude 79 23 05)														
N	1910, 1924-39	469	.579	.473	.405	.386	--	--	.586	.500	.437	.379	--	--
03020000 Tionesta Creek at Tionesta Dam, Pa. (Latitude 41 28 44N Longitude 79 26 26)														
MR	1941-85	479	.543	.436	.396	.340	.332	--	.679	.506	.461	.433	.394	--
03020500 Oil Creek at Rouseville, Pa. (Latitude 41 28 54N Longitude 79 41 44)														
N	1933-85	300	.545	.484	.409	.363	.350	.346	.584	.508	.429	.383	.342	.322
03021000 Oil Creek near Rouseville, Pa. (Latitude 41 27 35N Longitude 79 41 25)														
N	1910-31	315	.508	.421	.377	.372	--	--	.539	.409	.393	.361	--	--

Table B3.--Base flows at selected recurrence intervals in the Ohio and St. Lawrence River basins--Continued

Regulation	Period of record	Drainage area (square miles)	Annual base flow at indicated recurrence interval in million gallons per day per square mile: Recurrence interval determined by local minimum method (years) 2	5	10	25	50	100	Recurrence interval determined by fixed interval method (years) 2	5	10	25	50	100
03021350 French Creek near Wattsburg, Pa. (Latitude 42 00 55N Longitude 79 46 58)														
N	1975-85	92.0	0.737	0.620	0.581	0.567	--	--	0.800	0.652	0.612	0.599	--	--
03021410 West Branch French Creek near Lowville, Pa. (Latitude 42 04 54N Longitude 79 51 02)														
N	1975-85	52.3	.700	.582	.550	.537	--	--	.764	.613	.554	.538	--	--
03021500 French Creek at Carters Corners, Pa. (Latitude 41 57 23N Longitude 79 52 38)														
N	1910-70	208	.617	.517	.464	.432	0.385	0.350	.659	.551	.496	.446	0.401	0.389
03021520 French Creek near Union City, Pa. (Latitude 41 54 28N Longitude 79 53 49)														
MR	1972-85	221	.856	.750	.707	.689	--	--	1.114	1.045	.873	.819	--	--
03021700 Little Conneauttee Creek near McKean, Pa. (Latitude 41 55 53N Longitude 80 05 02)														
N	1961-77	3.6	.556	.442	.418	.370	--	--	.658	.557	.531	.484	--	--
03022500 French Creek at Saegerstown, Pa. (Latitude 41 42 50N Longitude 80 08 50)														
N	1922-38	629	.549	.421	.339	.315	--	--	.525	.456	.353	.333	--	--
03022540 Woodcock Creek at Blooming Valley, Pa. (Latitude 41 41 26N Longitude 80 02 54)														
N	1975-85	31.1	.605	.536	.530	.526	--	--	.721	.669	.600	.548	--	--
03022554 Woodcock Creek at Woodcock Creek Dam, Pa. (Latitude 41 41 45N Longitude 80 06 30)														
MR	1975-85	45.6	.667	.618	.569	.527	--	--	.902	.769	.657	.600	--	--
03023000 Cussewago Creek near Meadville, Pa. (Latitude 41 40 20N Longitude 80 12 55)														
N	1911-37	90.2	.405	.343	.262	.239	.231	--	.459	.373	.340	.305	.286	--
03023500 French Creek at Carlton, Pa. (Latitude 41 28 15N Longitude 80 01 05)														
N	1909-23	998	.531	.501	.366	.233	--	--	.605	.556	.397	.238	--	--
03024000 French Creek at Utica, Pa. (Latitude 41 21 15N Longitude 79 57 22)														
N	1933-69	1,028	.508	.413	.374	.329	.268	--	.546	.459	.389	.338	.300	--
MR	1971-85	1,028	.721	.644	.636	.628	--	--	.796	.708	.657	.596	--	--
03025000 Sugar Creek at Sugar Creek, Pa. (Latitude 41 25 43N Longitude 79 52 48)														
N	1933-78	166	.574	.505	.413	.347	.331	--	.649	.557	.437	.383	.350	--
03025200 Patchel Run near Franklin, Pa. (Latitude 41 25 20N Longitude 79 50 59)														
N	1965-77	5.69	.751	.599	.539	.521	--	--	.820	.676	.639	.610	--	--
03025500 Allegheny River at Franklin, Pa. (Latitude 41 23 22N Longitude 79 49 14)														
N	1915-38	5,982	.538	.424	.386	.363	--	--	.578	.501	.449	.362	--	--
SR	1940-85	5,982	.629	.508	.456	.369	.354	--	.696	.524	.489	.448	.398	--
03026500 Sevenmile Run near Rasselas, Pa. (Latitude 41 37 52N Longitude 78 34 37)														
N	1952-85	7.84	.717	.587	.544	.448	.390	--	.864	.672	.660	.643	.639	--
03027500 East Branch Clarion River at East Branch Clarion R. Dam, Pa. (Latitude 41 33 11N Longitude 78 35 47)														
MR	1953-85	73.2	.896	.774	.737	.478	.220	--	.970	.808	.775	.524	.291	--
03028000 West Branch Clarion River at Wilcox, Pa. (Latitude 41 34 31N Longitude 78 41 33)														
N	1954-85	63.0	.734	.610	.550	.432	.404	--	.857	.682	.655	.610	.592	--
03028500 Clarion River at Johnsonburg, Pa. (Latitude 41 29 10N Longitude 78 40 43)														
MRD	1953-85	204	.835	.677	.640	.546	.513	--	.904	.742	.681	.583	.503	--

Table B3.--Base flows at selected recurrence intervals in the Ohio and St. Lawrence River basins--Continued

Regulation	Period of record	Drainage area (square miles)	Annual base flow at indicated recurrence interval in million gallons per day per square mile: Recurrence interval determined by local minimum method (years) 2	5	10	25	50	100	Recurrence interval determined by fixed interval method (years) 2	5	10	25	50	100
03029000 Clarion River at Ridgeway, Pa. (Latitude 41 25 15N Longitude 78 44 10)														
N	1941-52	303	0.610	0.499	0.387	0.314	--	--	0.680	0.543	0.458	0.389	--	--
03029400 Toms River at Cooksburg, Pa. (Latitude 41 20 16N Longitude 79 12 50)														
N	1960-77	12.6	.568	.462	.424	.382	--	--	.652	.588	.535	.508	--	--
03029500 Clarion River at Cooksburg, Pa. (Latitude 41 19 50N Longitude 79 12 33)														
N	1939-51	807	.655	.487	.409	.384	--	--	.724	.550	.477	.457	--	--
MRD	1953-85	807	.676	.586	.492	.455	0.421	--	.732	.597	.552	.535	0.529	--
03030500 Clarion River near Piney, Pa. (Latitude 41 11 33N Longitude 79 26 25)														
HR	1949-85	951	.432	.343	.286	.236	.223	--	.567	.413	.384	.348	.306	--
03031000 Clarion River at St. Petersburg, Pa. (Latitude 41 08 57N Longitude 79 39 37)														
MR	1942-52	1,246	.530	.392	.344	.309	--	--	.603	.456	.371	.301	--	--
03031500 Allegheny River at Parker, Pa. (Latitude 41 06 02N Longitude 79 40 53)														
MR	1933-85	7,671	.610	.488	.439	.363	.321	0.299	.668	.519	.474	.418	.358	0.326
03031950 Big Run near Sprankle Mills, Pa. (Latitude 40 59 30N Longitude 79 05 26)														
N	1964-79	7.38	.642	.543	.490	.348	--	--	.770	.663	.546	.438	--	--
03032500 Redbank Creek at St. Charles, Pa. (Latitude 40 59 40N Longitude 79 23 40)														
N	1919, 1922-85	528	.508	.419	.342	.320	.302	.290	.577	.449	.403	.370	.330	.302
03034000 Mahoning Creek at Punxsutawney, Pa. (Latitude 40 56 21N Longitude 79 00 31)														
SP	1939-85	158	.618	.516	.453	.422	.400	--	.697	.600	.515	.488	.484	--
03034500 Little Mahoning Creek at McCormick, Pa. (Latitude 40 50 10N Longitude 79 06 37)														
N	1940-85	87.4	.502	.429	.398	.348	.317	--	.566	.497	.460	.436	.397	--
03035000 Mahoning Creek near Dayton, Pa. (Latitude 40 54 05N Longitude 79 13 35)														
N	1921-39	321	.517	.381	.339	.287	--	--	.606	.434	.406	.290	--	--
03036000 Mahoning Creek at Mahoning Creek Dam, Pa. (Latitude 40 55 39N Longitude 79 17 29)														
HR	1941-85	344	.516	.423	.384	.347	.329	--	.579	.496	.432	.388	.386	--
03036500 Allegheny River at Kittanning, Pa. (Latitude 40 49 13N Longitude 79 31 54)														
N	1905-22	8,973	.522	.440	.351	.346	--	--	.552	.488	.423	.356	--	--
MR	1924-27, 1935-85	8,973	.611	.488	.455	.372	.334	.317	.648	.530	.483	.428	.405	.396
03038000 Crooked Creek at Idaho, Pa. (Latitude 40 39 17N Longitude 79 20 56)														
N	1938-66	191	.400	.353	.306	.292	.286	--	.465	.410	.393	.336	.304	--
MRD	1968-85	191	.482	.386	.328	.210	--	--	.583	.464	.397	.308	--	--
03039000 Crooked Creek at Crooked Creek Dam, Pa. (Latitude 40 43 13N Longitude 79 30 42)														
N	1919-38	278	.344	.251	.216	.102	--	--	.391	.275	.237	.184	--	--
MRD	1940-85	278	.392	.316	.271	.240	.239	--	.472	.358	.329	.290	.267	--
03039200 Clear Run near Buckstown, Pa. (Latitude 40 02 49N Longitude 78 50 00)														
N	1965-77	3.68	.669	.532	.479	.413	--	--	.716	.599	.522	.451	--	--
03040000 Stony Creek River at Ferndale, Pa. (Latitude 40 17 08N Longitude 78 55 15)														
MRDP	1914-34, 1939-85	451	.453	.363	.327	.276	.268	.268	.496	.398	.366	.316	.311	.306
03041000 Little Conemaugh River at East Conemaugh, Pa. (Latitude 40 20 37N Longitude 78 53 07)														
SRD	1940-85	183	.588	.471	.430	.389	.355	--	.650	.548	.490	.423	.417	--

Table B3.--Base flows at selected recurrence intervals in the Ohio and St. Lawrence River basins--Continued

Regulation	Period of record	Drainage area (square miles)	Annual base flow at indicated recurrence interval in million gallons per day per square mile: Recurrence interval determined by local minimum method (years) 2	5	10	25	50	100	Recurrence interval determined by fixed interval method (years) 2	5	10	25	50	100
03041500 Conemaugh River at Seward, Pa. (Latitude 40 25 09N Longitude 79 01 35)														
SRD	1939-85	715	0.638	0.570	0.524	0.491	0.480	--	0.684	0.609	0.560	0.514	0.504	--
03042000 Blacklick Creek at Josephine, Pa. (Latitude 40 28 24N Longitude 79 11 01)														
SP	1953-85	192	.690	.570	.512	.440	.420	--	.771	.630	.568	.526	.497	--
03042200 Little Yellow Creek near Strongstown, Pa. (Latitude 40 33 45N Longitude 78 56 44)														
N	1965-77	7.36	.681	.542	.452	.444	--	--	.850	.600	.544	.473	--	--
03042280 Yellow Creek near Homer City, Pa. (Latitude 40 34 18N Longitude 79 06 13)														
HR	1971-85	57.4	.630	.489	.394	.355	--	--	.813	.663	.630	.574	--	--
03042500 Two Lick Creek at Graceton, Pa. (Latitude 40 31 02N Longitude 79 10 19)														
N	1952-67	171	.498	.439	.419	.374	--	--	.552	.522	.478	.437	--	--
HRP	1969-85	171	.678	.576	.480	.354	--	--	.765	.643	.584	.402	--	--
03043000 Blacklick Creek at Blacklick, Pa. (Latitude 40 28 25N Longitude 79 12 15)														
N	1908-50	390	.477	.403	.367	.320	.316	--	.521	.450	.394	.368	.348	--
03044000 Conemaugh River at Tunnelton, Pa. (Latitude 40 27 16N Longitude 79 23 28)														
N	1940-50	1,358	.551	.502	.462	.445	--	--	.586	.523	.466	.427	--	--
MRDP	1952-85	1,358	.554	.444	.404	.395	.389	--	.593	.489	.471	.392	.334	--
03045000 Loyalhanna Creek at Kingston, Pa. (Latitude 40 17 33N Longitude 79 20 27)														
SRD	1940-85	172	.542	.471	.463	.443	.378	--	.596	.527	.515	.494	.488	--
03045500 Loyalhanna Creek at New Alexandria, Pa. (Latitude 40 23 40N Longitude 79 25 55)														
N	1920-39	265	.505	.363	.315	.268	--	--	.549	.419	.362	.343	--	--
03047000 Loyalhanna Creek at Loyalhanna Dam, Pa. (Latitude 40 27 53N Longitude 79 27 05)														
HR	1942-85	292	.451	.391	.359	.310	.310	--	.518	.431	.406	.355	.349	--
03047500 Kiskiminetas River at Avonmore, Pa. (Latitude 40 32 05N Longitude 79 27 55)														
N	1908-35	1,723	.510	.426	.394	.371	.369	--	.562	.450	.407	.404	.403	--
03048500 Kiskiminetas River at Vandergrift, Pa. (Latitude 40 36 16N Longitude 79 33 08)														
MRD	1942-85	1,825	.546	.464	.408	.375	.371	--	.592	.497	.465	.423	.359	--
03049000 Buffalo Creek near Freeport, Pa. (Latitude 40 42 57N Longitude 79 41 59)														
N	1941-85	137	.440	.360	.329	.273	.267	--	.488	.417	.382	.348	.345	--
03049500 Allegheny River at Natrona, Pa. (Latitude 40 36 55N Longitude 79 43 07)														
MR	1939-85	11,410	.620	.509	.455	.374	.355	--	.678	.523	.494	.435	.417	--
03049800 Little Pine Creek near Etna, Pa. (Latitude 40 31 13N Longitude 79 56 18)														
N	1963-85	5.78	.342	.300	.261	.155	--	--	.434	.376	.323	.213	--	--
03063000 Monongahela River at Lock and Dam 8, at Point Marion, Pa. (Latitude 39 43 57N Longitude 79 54 42)														
HR	1938-54	2,720	.466	.364	.338	.324	--	--	.523	.419	.350	.349	--	--
03072000 Dunkard Creek at Shannopin, Pa. (Latitude 39 45 33N Longitude 79 58 15)														
SP	1941-85	229	.286	.230	.181	.166	.163	--	.335	.254	.228	.198	.181	--
03072500 Monongahela River at Greensboro, Pa. (Latitude 39 47 15N Longitude 79 55 26)														
HR	1939-85	4,407	.466	.376	.334	.309	.248	--	.513	.443	.368	.339	.333	--

Table B3.--Base flows at selected recurrence intervals in the Ohio and St. Lawrence River basins--Continued

Regulation	Period of record	Drainage area (square miles)	Annual base flow at indicated recurrence interval in million gallons per day per square mile — Recurrence interval determined by local minimum method (years): 2	5	10	25	50	100	Recurrence interval determined by fixed interval method (years): 2	5	10	25	50	100
03072590 Georges Creek at Smithfield, Pa. (Latitude 39 47 44N Longitude 79 47 47)														
SD	1964-77	16.3	0.378	0.293	0.267	0.254	--	--	0.512	0.352	0.294	0.292	--	--
03072840 Tenmile Creek near Clarksville, Pa. (Latitude 39 59 51N Longitude 80 02 31)														
N	1969-78	133	.370	.308	.216	.150	--	--	.420	.372	.256	.176	--	--
03073000 South Fork Tenmile Creek at Jefferson, Pa. (Latitude 39 55 23N Longitude 80 04 22)														
SRD	1932-85	180	.268	.227	.190	.151	0.147	0.147	.314	.250	.208	.171	0.163	0.161
03074300 Lick Run at Hopwood, Pa. (Latitude 39 52 04N Longitude 79 41 40)														
N	1967-77	3.80	.555	.507	.454	.415	--	--	.712	.664	.555	.460	--	--
03074500 Redstone Creek at Waltersburg, Pa. (Latitude 39 58 48N Longitude 79 45 52)														
SP	1943-85	73.7	.506	.432	.374	.340	.309	--	.543	.448	.403	.345	.336	--
03075000 Monongahela River at Charleroi, Pa. (Latitude 40 08 58N Longitude 79 54 06)														
HR	1934-75	5,213	.436	.360	.324	.271	.262	--	.484	.409	.372	.323	.272	--
03075070 Monongahela River at Elizabeth, Pa. (Latitude 40 15 44N Longitude 79 54 05)														
HR	1977-86	5,340	.467	.445	.421	.403	--	--	.532	.482	.467	.458	--	--
03077500 Youghiogheny River at Youghiogheny River Dam, Pa. (Latitude 39 48 19N Longitude 79 21 52)														
HR	1941-85	436	.811	.632	.559	.496	.471	--	.863	.679	.602	.542	.492	--
03078500 Big Piney Run near Salisbury, Pa. (Latitude 39 43 34N Longitude 79 02 55)														
SRD	1933-69	24.5	.495	.400	.369	.350	.324	--	.648	.538	.452	.430	.428	--
03079000 Casselman River at Markleton, Pa. (Latitude 39 51 35N Longitude 79 13 40)														
SD	1921-85	382	.527	.429	.371	.347	.320	.302	.588	.481	.427	.391	.367	.357
03080000 Laurel Hill Creek at Ursina, Pa. (Latitude 39 49 13N Longitude 79 19 18)														
N	1919-85	121	.706	.597	.550	.517	.440	.364	.812	.704	.664	.592	.524	.522
03081000 Youghiogheny River below Confluence, Pa. (Latitude 39 49 39N Longitude 79 22 22)														
HR	1941-85	1,029	.748	.635	.522	.462	.451	--	.790	.661	.570	.496	.490	--
03082200 Poplar Run near Normalville, Pa. (Latitude 40 00 59N Longitude 79 25 33)														
N	1962-77	9.27	.622	.539	.532	.529	--	--	.808	.699	.624	.566	--	--
03082500 Youghiogheny River at Connellsville, Pa. (Latitude 40 01 03N Longitude 79 35 38)														
N	1909-17, 1920-23	1,326	.503	.425	.418	.416	--	--	.574	.466	.444	.428	--	--
HR	1925-85	1,326	.700	.574	.471	.398	.376	.372	.739	.596	.505	.457	.393	.359
03083000 Green Lick Run at Green Lick Reservoir, Pa. (Latitude 40 06 18N Longitude 79 30 01)														
N	1942-78	3.07	.574	.510	.501	.458	.445	--	.719	.606	.587	.530	.526	--
03083500 Youghiogheny River at Sutersville, Pa. (Latitude 40 14 24N Longitude 79 48 24)														
HR	1927-28, 1932-35, 1940-85	1,715	.636	.549	.475	.439	.399	.378	.681	.589	.530	.464	.427	.407
03084000 Abers Creek near Murrysville, Pa. (Latitude 40 27 01N Longitude 79 42 50)														
N	1949-85	4.39	.396	.325	.293	.242	.210	--	.463	.396	.343	.297	.239	--
03084500 Turtle Creek at Trafford, Pa. (Latitude 40 23 09N Longitude 79 45 55)														
N	1921-51	55.9	.398	.298	.265	.250	.248	--	.438	.343	.321	.257	.208	--

Table B3.--Base flows at selected recurrence intervals in the Ohio and St. Lawrence River basins--Continued

Regulation	Period of record	Drainage area (square miles)	Annual base flow at indicated recurrence interval in million gallons per day per square mile: Recurrence interval determined by local minimum method (years) 2	5	10	25	50	100	Recurrence interval determined by fixed interval method (years) 2	5	10	25	50	100
03085000 Monongahela River at Braddock, Pa. (Latitude 40 23 28N Longitude 79 51 30)														
HR	1939-85	7,337	0.507	0.436	0.416	0.351	0.320	--	0.580	0.476	0.453	0.379	0.373	--
03085500 Chartiers Creek at Carnegie, Pa. (Latitude 40 24 02N Longitude 80 05 48)														
SRDP	1920-32, 1941-70, 1976-85	257	.376	.307	.268	.235	.208	0.192	.393	.323	.289	.246	.216	0.200
03086000 Ohio River at Sewickley, Pa. (Latitude 40 32 57N Longitude 80 12 21)														
MR	1934-85	19,500	.592	.505	.462	.392	.346	.320	.646	.525	.486	.439	.349	.300
03086100 Big Sewickley Creek near Ambridge, Pa. (Latitude 40 36 27N Longitude 80 09 49)														
N	1968-77	15.6	.336	.281	.200	.145	--	--	.424	.361	.233	.147	--	--
03100000 Shenango River near Turnersville, Pa. (Latitude 41 30 45N Longitude 80 28 15)														
N	1913-21	152	.384	.306	.301	.298	--	--	.497	.403	.353	.323	--	--
03101000 Sugar Run at Pymatuning Dam, Pa. (Latitude 41 29 50N Longitude 80 27 55)														
N	1935-54	9.34	.243	.190	.174	.124	--	--	.294	.235	.222	.188	--	--
03101500 Shenango River at Pymatuning Dam, Pa. (Latitude 41 29 53N Longitude 80 27 37)														
MR	1936-85	167	.656	.546	.421	.347	.345	.344	.694	.533	.438	.357	.351	.348
03102000 Shenango River near Jamestown, Pa. (Latitude 41 37 30N Longitude 80 25 30)														
N	1920-31	181	.417	.284	.235	.194	--	--	.538	.376	.336	.295	--	--
03102500 Little Shenango River at Greenville, Pa. (Latitude 41 25 19N Longitude 80 22 35)														
N	1915-17, 1920-22, 1926-85	104	.412	.350	.303	.246	.228	.214	.457	.371	.302	.259	.256	.254
03102850 Shenango River near Transfer, Pa. (Latitude 41 21 13N Longitude 80 23 53)														
MR	1966-85	337	.608	.483	.452	.441	--	--	.617	.533	.472	.423	--	--
03103000 Pymatuning Creek near Orangeville Pa. (Latitude 41 18 40N Longitude 80 28 40)														
N	1915-22, 1926-62	169	.328	.238	.191	.169	.133	--	.428	.330	.270	.223	.195	--
03103500 Shenango River at Sharpsville, Pa. (Latitude 41 15 58N Longitude 80 28 22)														
MR	1939-85	584	.471	.367	.351	.269	.257	--	.557	.408	.371	.279	.275	--
03104000 Shenango River at Sharon, Pa. (Latitude 41 13 55N Longitude 80 30 35)														
N	1911-31	608	.329	.273	.224	.172	--	--	.410	.316	.264	.229	--	--
03104500 Shenango River at New Castle, Pa. (Latitude 41 00 00N Longitude 80 21 05)														
N	1913-31	792	.353	.274	.210	.170	--	--	.401	.322	.235	.200	--	--
03104760 Harthegig Run near Greenfield, Pa. (Latitude 41 11 10N Longitude 80 19 38)														
N	1969-79	2.26	.330	.255	.206	.170	--	--	.401	.331	.247	.194	--	--
03105500 Beaver River at Wampum, Pa. (Latitude 40 53 19N Longitude 80 20 14)														
MR	1916-17, 33-70, 1982-85	2,235	.351	.275	.232	.200	.132	--	.372	.289	.248	.223	.141	--
03106000 Connoquenessing Creek near Zelienople, Pa. (Latitude 40 49 01N Longitude 80 14 33)														
N	1920-85	356	.368	.297	.241	.217	.204	.198	.399	.319	.283	.260	.242	.230
03106300 Muddy Creek near Portersville, Pa. (Latitude 40 57 47N Longitude 80 07 31)														
HR	1970-85	51.2	.645	.443	.410	.388	--	--	.803	.573	.523	.394	--	--

Table B3.--Base flows at selected recurrence intervals in the Ohio and St. Lawrence River basins--Continued

			Annual base flow at indicated recurrence interval in million gallons per day per square mile											
			Recurrence interval determined by local minimum method (years)						Recurrence interval determined by fixed interval method (years)					
Regulation	Period of record	Drainage area (square miles)	2	5	10	25	50	100	2	5	10	25	50	100
03106500 Slippery Rock Creek at Wurtemburg, Pa. (Latitude 40 53 02N Longitude 80 14 02)														
N	1912-67	398	0.414	0.320	0.293	0.242	0.201	0.182	0.447	0.342	0.304	0.259	0.211	0.183
HR	1970-85	398	.561	.450	.408	.346	--	--	.584	.496	.444	.407	--	--
03107500 Beaver River at Beaver Falls, Pa. (Latitude 40 45 48N Longitude 80 18 55)														
MR	1957-85	3,106	.459	.344	.293	.244	.221	--	.499	.381	.308	.255	.232	--
03108000 Raccoon Creek at Moffatts Mill, Pa. (Latitude 40 37 40N Longitude 80 20 16)														
MD	1942-85	178	.364	.299	.264	.236	.190	--	.402	.348	.291	.256	.232	--
03111150 Brush Run near Buffalo, Pa. (Latitude 40 11 54N Longitude 80 24 28)														
N	1961-84	10.3	.306	.244	.191	.187	--	--	.351	.282	.279	.214	--	--
04213040 Raccoon Creek near West Springfield, Pa. (Latitude 41 56 42N Longitude 80 26 51)														
N	1969-85	2.53	.387	.286	.239	.226	--	--	.467	.378	.336	.288	--	--

```
C                      **********************************
C                      *        HYSEP2.F77              *
C                      * HYDROGRAPH SEPARATION PROGRAM  *
C                      *        R. A. SLOTO             *
C                      *        VERSION 3.0             *
C                      *        REV 12/12/89            *
C                      **********************************
C
C    INPUT TO PROGRAM IS DAILY VALUES CARD IMAGES FROM WATSTORE OR ADAPS.
C    PROGRAM OPTIONS ARE SPECIFIED ON FIRST LINE OF INPUT - "OPTION CARD
C    A BLANK LINE PRODUCES THE DEFAULT INPUT/OUTPUT:
C          WATER YEAR INPUT
C          SHORT PRINTOUT
C
C    INPUT MAY BE WATER OR CALENDAR YEAR CARD IMAGES (NCFLAG).
C    INPUT MAY BE 1 YEAR OR PERIOD OF RECORD.  GAPS IN RECORD ARE ACCOUNTED
C    FOR, BUT RECORD MUST BE COMPLETE WATER OR CALENDAR YEARS.  THE PROGRAM
C    DOES NOT CHECK INPUT; THE USER MUST DO THIS BEFORE RUNNING PROGRAM.
C
C    NPFLAG IS USED TO SELECT SHORT OR LONG PRINTOUT.
C    FIXED, SLIDE AND LOCMIN ARE HYDROGRAPH SERARATION TECHNIQUES.  ALL THREE
C      WILL BE RUN FOR PRINTED OUTPUT.
C
C******************************************************************************
C
C                 OPTION CARD INSTRUCTIONS
C
C        Variable            Field
C        name      Format   (column)  Explanation
C        ---------  ------  --------  -----------
C        Printout format
C        NPFLAG      I1         2      NPFLAG=0  short printout format
C                                      NPFLAG=1  long printout format
C
C        Input data
C        NCFLAG      I1         4      NCFLAG=0  water year input
C                                      NCFLAG=1  calendar year input
C
C******************************************************************************
C
C.....DECLARATIONS
      CHARACTER*32 INFILE, OUTFILE, CARDFILE,      /* FILE NAMES
     *             STA*50                          /* STATION NAME
      CHARACTER*8 STAID                            /* STATION ID
      CHARACTER*1 METH1, METH2, METH3              /* SEP METHOD FOR PLOTTING
      INTEGER IREC,                                /* YEARS OF RECORD
     *        IWY,                                 /* WATER YEAR
     *        NDFLAG,                              /* END OF DATA FLAG
     *        NPFLAG,                      /* SHORT/LONG PRINTOUT FLAG
     *        NCFLAG,                      /* WATER/CALENDAR YEAR INPUT FLAG
     *        IWR(100)                     /* WATER YR ARRAY
      REAL DIS(365),GDIS(365),ABFW(100,30),ABFC(100,3),
     * AQW(100,3),AQC(100,3),FREQC(100),FREQW(100),CFI(100,3),
     * WFI(100,3)
C
C.....READ FORMATION FROM TERMINAL
C
      WRITE (1,50) '*** BASEFLOW SEPARATION PROGRAM ***'
      WRITE (1,50) 'ENTER STATION NAME : '
      READ (1,50) STA
      WRITE (1,50) 'ENTER DRAINAGE AREA (MI2) : '
      READ (1,55) DRAIN
      WRITE (1,50) 'ENTER INPUT FILE NAME : '
      READ (1,50) INFILE
      WRITE (1,50) 'ENTER OUTPUT FILE NAME : '
      READ (1,50) OUTFILE
      IF (OUTFILE.EQ.'Q') GOTO 100
      WRITE (1,50) '*** PLEASE WAIT! PROGAM IS RUNNING ***'
C
C.....OPEN INPUT/OUTPUT FILES
      OPEN (UNIT=5,FILE=INFILE)
      OPEN (UNIT=6,STATUS='NEW',FILE=OUTFILE)
C
C.....READ PROGRAM OPTIONS - FIRST LINE OF INPUT
      READ (5,500) NPFLAG,NCFLAG
C
C.....INITIALIZE PROGRAM VARIABLES
 4    NDFLAG=0
      IREC=0
C
C.....READ DISCHARGE CARDS
 10   IREC=IREC+1
      CALL READIN(DIS,DRAIN,STA,STAID,INTRVL,TEXT1,TEXT2,
     * NPFLAG,NDFLAG,NCFLAG,IREC,IWY)
      IF (NDFLAG.EQ.1) GOTO 20
```

```
      IWR(IREC)=IWY
C
C     **********************
C     HYDROGRAPH SEPARATION
C     **********************
C
C.....FIXED INTERVAL METHOD
      CALL FIXED(DIS,GDIS,INTRVL,NPFLAG,METH)
      CALL MONTH(DIS,GDIS,ABFC,AQC,ABFW,AQW,DRAIN,IREC,NPFLAG,IWR,
     * IWY,METH)
      IF (NPFLAG.EQ.1) CALL STAT(DIS,GDIS,DRAIN,NPFLAG)
C
C.....SLIDING INTERVAL METHOD
      CALL SLIDE(DIS,GDIS,INTRVL,NPFLAG,METH)
      CALL MONTH(DIS,GDIS,ABFC,AQC,ABFW,AQW,DRAIN,IREC,NPFLAG,IWR,
     * IWY,METH)
      IF (NPFLAG.EQ.1) CALL STAT(DIS,GDIS,DRAIN,NPFLAG)
C
C.....LOCAL MINIMUM METHOD
      CALL LOCMIN(DIS,GDIS,INTRVL,NPFLAG,METH)
      CALL MONTH(DIS,GDIS,ABFC,AQC,ABFW,AQW,DRAIN,IREC,NPFLAG,IWR,
     * IWY,METH)
      IF (NPFLAG.EQ.1) CALL STAT(DIS,GDIS,DRAIN,NPFLAG)
C
 20   CONTINUE
      IF (NDFLAG.EQ.0) GOTO 10
C
C.....PERIOD OF RECORD SUMMARY
      IREC=IREC-1
      CALL ANNUAL(ABFC,AQC,ABFW,AQW,IREC,KREC,DRAIN,STA,STAID,
     * FREQC,FREQW,CFI,WFI,IWR)
C
C.....CLOSE INPUT/OUTPUT FILES & END PROGRAM
 100  CLOSE (UNIT=5,STATUS='KEEP')
      CLOSE (UNIT=6,STATUS='KEEP')
      STOP
C
 50   FORMAT (A)
 55   FORMAT (F7.0)
 500  FORMAT (8(1X,I1),1X,A1,1X,I1,1X,A1,1X,I1,1X,A1)
C
      END
C-----------------------------------------------------------------------
      SUBROUTINE READIN (DIS,DRAIN,STA,STAID,INTRVL,TEXT1,TEXT2,
     * NPFLAG,NDFLAG,NCFLAG,IREC,IWY)
C     12/12/89  3.0
C-----------------------------------------------------------------------
C.....DECLARATIONS
      CHARACTER*50 STA                         /* STATION NAME
      CHARACTER*8 STAID                        /* STATION ID NUMBER
      CHARACTER TEXT1*12, TEXT2*4              /* BASEFLOW CARD HEADER
      REAL DRAIN,                              /* DRAINAGE AREA
     *     DIS(365),                           /* STREAMFLOW
     *     DMAX                                /* MAXIMUM DISCHARGE
      INTEGER INTRVL,                          /* HYSEP METHOD INTERVAL
     *        NMISS,                           /* NO OF ZERO DATA VALUES
     *        IWY,                             /* WATER YEAR
     *        NDFLAG,                          /* END OF DATA FLAG
     *        NPFLAG,                          /* SHORT/LONG PRINTOUT FLAG
     *        NCFLAG                           /* WATER/CALENDAR YEAR INPUT
C
      NMISS=0
      IWY=0
      DMAX=0.0
C
C.....READ WATER YEAR DISCHARGE CARDS
      IF (NCFLAG.EQ.1) GOTO 11
      READ (5,500,END=100) STAID, TEXT1, TEXT2
      READ (5,520) IWY,(DIS(I),I=1,8)
      READ  (5,540) (DIS(I),I=9,365)
      GOTO 12
C.....READ CALENDAR YEAR DISCHARGE CARDS
 11   READ (5,500,END=100) STAID, TEXT1, TEXT2
      READ (5,520) IWY,(DIS(I),I=1,8)
      READ  (5,545) (DIS(I),I=9,365)
 12   IWY=IWY+1
C
C.....PRINTOUT HEADING
      IF (NPFLAG.EQ.0.AND.IREC.NE.1) GOTO 15
      WRITE (6,580)
      IF (NPFLAG.EQ.1) WRITE (6,600) STAID,STA,IWY
      IF (NPFLAG.EQ.0) WRITE (6,605) STAID,STA
      WRITE (6,620) DRAIN
      WRITE (6,603)
C
C.....CHECK FOR ZERO VALUES & ISSUE WARNING
 15   CONTINUE
```

```
      DO 20 I=1,365
      IF (DMAX.LT.DIS(I)) DMAX=DIS(I)
      IF (DIS(I).EQ.0.0) NMISS=NMISS+1
 20   CONTINUE
      IF (NMISS.EQ.0)  GO TO 30
      IF (NPFLAG.EQ.0) WRITE (6,670) IWY
      IF (NPFLAG.EQ.0) WRITE (6,685) NMISS
      IF (NPFLAG.EQ.1) WRITE (6,680) NMISS
C
  30  CONTINUE
      IF (DMAX/DRAIN.LT.100.0) GO TO 40
      IF (NPFLAG.EQ.0) WRITE (6,670) IWY
      IF (NPFLAG.EQ.0) WRITE (6,705) DMAX,DRAIN
      IF (NPFLAG.EQ.1) WRITE (6,700) DMAX,DRAIN
C
 40   RINTR=DRAIN**0.2
      RINTR = RINTR*2.0
      IF (RINTR.LE.4.0) INTRVL=3
      IF (RINTR.LE.6.0.AND.RINTR.GT.4.0) INTRVL=5
      IF (RINTR.LE.8.0.AND.RINTR.GT.6.0) INTRVL=7
      IF (RINTR.LE.10.0.AND.RINTR.GT.8.0) INTRVL=9
      IF (RINTR.GT.10.0) INTRVL=11
      IFLAG=1
C
      RETURN
 100  NDFLAG=1
      RETURN
C
 500  FORMAT (2X,A8,18X,A12,14X,A4)
 520  FORMAT (16X,I4,4X,8F7.0)
 540  FORMAT (2(24X,8F7.0/)24X,7F7.0/3(24X,8F7.0/)24X,6F7.0/
     13(24X,8F7.0/)24X,7F7.0/3(24X,8F7.0/)24X,7F7.0/
     23(24X,8F7.0/)24X,4F7.0/3(24X,8F7.0/)24X,7F7.0/
     33(24X,8F7.0/)24X,6F7.0/3(24X,8F7.0/)24X,7F7.0/
     43(24X,8F7.0/)24X,6F7.0/3(24X,8F7.0/)24X,7F7.0/
     53(24X,8F7.0/)24X,7F7.0/3(24X,8F7.0/)24X,6F7.0)
 545  FORMAT (2(24X,8F7.0/)24X,7F7.0/
     13(24X,8F7.0/)24X,4F7.0/3(24X,8F7.0/)24X,7F7.0/
     23(24X,8F7.0/)24X,6F7.0/3(24X,8F7.0/)24X,7F7.0/
     33(24X,8F7.0/)24X,6F7.0/3(24X,8F7.0/)24X,7F7.0/
     43(24X,8F7.0/)24X,7F7.0/3(24X,8F7.0/)24X,6F7.0/
     53(24X,8F7.0/)24X,7F7.0/3(24X,8F7.0/)24X,6F7.0/
     63(24X,8F7.0/)24X,7F7.0)
 580  FORMAT ('1',95('*')/)
 600  FORMAT (1X,A8,1X,A50,1X,I4,1X,'WATER YEAR'/)
 603  FORMAT (1X,95('*'))
 605  FORMAT (1X,A8,1X,A50/)
 620  FORMAT (1X,'DRAINAGE AREA = ',F8.2,' SQUARE MILES'/)
 670  FORMAT ('0',I4,' WATER YEAR:')
 680  FORMAT ('0',' *** WARNING **** THERE ARE ',I3,' DAYS THAT HAVE ZER
     1O DATA VALUES'/)
 685  FORMAT (' *** WARNING **** THERE ARE ',I3,' DAYS THAT HAVE ZERO DA
     1TA VALUES'/)
 700  FORMAT ('0','**** WARNING ****  MAXIMUM DISCHARGE IS ',F10.0,'  DR
     1AINAGE AREA IS ',F8.2,'.  '/' ','             THE RATIO DISCHARGE/DR
     2AINAGE AREA EXCEEDS 100 CFS/SQ.MI.'/)
 705  FORMAT (' **** WARNING ****  MAXIMUM DISCHARGE IS ',F10.0,'  DRAIN
     1AGE AREA IS ',F8.2,'.  '/' ','             THE RATIO DISCHARGE/DRAIN
     2AGE AREA EXCEEDS 100 CFS/SQ.MI.'/)
C
      END
C-----------------------------------------------------------------------
      SUBROUTINE FIXED(DIS,GDIS,INTRVL,NPFLAG,METH)
C-----------------------------------------------------------------------
C
C     HYDROGRAPH SEPARATION BY THE FIXED-INTERVAL METHOD
C     ADAPTED FROM PETTYJOHN AND HENNING (1979)
C     BY R. A. SLOTO
C     12/12/89   3.3
C
C.....DECLARATIONS
      REAL DIS(365),                            /* STREAMFLOW
     *     GDIS(365),                           /* BASEFLOW
     *     PMIN                                 /* MINIMUM DISCHARGE
      INTEGER INTRVL,                           /* INTERVAL
     *        NPFLAG                            /* SHORT/LONG PRINTOUT FLAG
C
      IF (NPFLAG.EQ.0) GOTO 1
      WRITE (6,500)
      WRITE (6,540) INTRVL
C
 1    METH=1
C
      K=365/INTRVL
      DO 4 I=1,K
      PMIN=100000.
      L1=((I-1)*INTRVL)+1
```

```
      L2=I*INTRVL
      DO 2 J=L1,L2
      IF(DIS(J).LT.PMIN) PMIN=DIS(J)
 2    CONTINUE
      DO 3 J=L1,L2
      GDIS(J)=PMIN
 3    CONTINUE
 4    CONTINUE
      M1=(K*INTRVL)+1
      IF(K*INTRVL.EQ.365) GO TO 7
      PMIN=100000.
      DO 5 J=M1,365
      IF(DIS(J).LT.PMIN) PMIN=DIS(J)
 5    CONTINUE
      DO 6 J=M1,365
      GDIS(J)=PMIN
 6    CONTINUE
 7    RETURN
C
 500  FORMAT ('0',50('*')/1X,'HYDROGRAPH SEPARATION BY THE FIXED ',
     1'INTERVAL METHOD'/1X,50('*'))
 540  FORMAT (1X,'INTERVAL=',I3,' DAYS')
      END
C-----------------------------------------------------------------------
      SUBROUTINE SLIDE(DIS,GDIS,INTRVL,NPFLAG,METH)
C-----------------------------------------------------------------------
C     HYDROGRAPH SERARATION BY THE SLIDING INTERVAL METHOD
C     ADAPTED FROM PETTYJOHN AND HENNING (1979)
C     BY R. A. SLOTO
C     12/12/89   3.2
C
C     DECLARATIONS
C
      REAL DIS(365),                           /* STREAMFLOW
     *     GDIS(365),                          /* BASEFLOW
     *     PMIN                                /* MINIMUM DISCHARGE PEAK
      INTEGER INTRVL,                          /* INTERVAL
     *        NPFLAG                           /* SHORT/LONG PRINTOUT FLAG
C
      IF (NPFLAG.EQ.0) GOTO 1
      WRITE (6,500)
      WRITE (6,520) INTRVL
C
 1    METH=2
C
      INT=INTRVL
      INT=(INTRVL-1)/2
      DO 9 I=1,365
      IF(DIS(I).LT.0.0) GO TO 9
      IF(I-(INT+1)) 5,2,2
 2    IF((365-I)-(INT+1)) 7,3,3
 3    PMIN=100000.
      K1=I-INT
      K2=I+INT
      DO 4 J=K1,K2
      IF(DIS(J).LT.PMIN) PMIN=DIS(J)
 4    CONTINUE
      GDIS(I)=PMIN
      GO TO 9
 5    PMIN=100000.
      K2=I+INT
      DO 6 J=1,K2
      IF(DIS(J).LT.PMIN) PMIN=DIS(J)
 6    CONTINUE
      GDIS(I)=PMIN
      GO TO 9
 7    PMIN=100000.
      K1=I-INT
      DO 8 J=K1,365
      IF(DIS(J).LT.PMIN) PMIN=DIS(J)
 8    CONTINUE
      GDIS(I)=PMIN
 9    CONTINUE
      RETURN
C
 500  FORMAT (/'0',52('*')/1X,'HYDROGRAPH SERARATION BY THE SLIDING ',
     1'INTERVAL METHOD'/1X,52('*'))
 520  FORMAT (1X,'INTERVAL=',I3,' DAYS')
      END
C-----------------------------------------------------------------------
      SUBROUTINE LOCMIN(DIS,GDIS,INTRVL,NPFLAG,METH)
C-----------------------------------------------------------------------
C     HYDROGRAPH SEPARATION BY THE LOCAL MINIMUM METHOD
C     ADAPTED FROM PETTYJOHN AND HENNING (1979)
C     BY R. A. SLOTO
C     12/12/89   2.2
C
```

```
C.....DECLARATIONS
      REAL DIS(365),                                  /* STREAMFLOW
     *     GDIS(365)                                  /* BASEFLOW
      INTEGER INTRVL,                                 /* INTERVAL
     *        IPOINT(400),                            /* LOC OF LOW POINTS
     *        METH,                                   /* HYSEP METHOD
     *        NPFLAG                                  /* SHORT/LONG PRINTOUT FLAG
C
      IF (NPFLAG.EQ.0) GOTO 1
      WRITE (6,500)
C
 1    NUMPT=0
      METH=3
C
      INT=INTRVL
      IF(INTRVL.EQ.3) GO TO 2
      IF(INTRVL.EQ.5) GO TO 5
      IF(INTRVL.EQ.7) GO TO 8
      IF(INTRVL.EQ.9) GO TO 11
      IF(INTRVL.GE.11) GO TO 14
 2    L=365-1
      DO 4 I=2,L
      IF(DIS(I).LE.DIS(I+1).AND.DIS(I).LE.DIS(I-1)) GO TO 3
      GO TO 4
 3    NUMPT=NUMPT+1
      IPOINT(NUMPT)=I
 4    CONTINUE
      GO TO 17
 5    L=365-2
      DO 7 I=3,L
      IF(DIS(I).LE.DIS(I+1).AND.DIS(I).LE.DIS(I-1).AND.DIS(I).LE.DIS(I+2
     1).AND.DIS(I).LE.DIS(I-2)) GO TO 6
      GO TO 7
 6    NUMPT=NUMPT+1
      IPOINT(NUMPT)=I
 7    CONTINUE
      GO TO 17
 8    L=365-3
      DO 10 I=4,L
      IF(DIS(I).LE.DIS(I+1).AND.DIS(I).LE.DIS(I+2).AND.DIS(I).LE.DIS(I+3
     1).AND.DIS(I).LE.DIS(I-1).AND.DIS(I).LE.DIS(I-2).AND.DIS(I).LE.DIS(
     2I-3)) GO TO 9
      GO TO 10
 9    NUMPT=NUMPT+1
      IPOINT(NUMPT)=I
 10   CONTINUE
      GO TO 17
 11   L=365-4
      DO 13 I=5,L
      IF(DIS(I).LE.DIS(I+1).AND.DIS(I).LE.DIS(I+2).AND.DIS(I).LE.DIS(I+3
     1).AND.DIS(I).LE.DIS(I-1).AND.DIS(I).LE.DIS(I-2).AND.DIS(I).LE.DIS(
     2I-3).AND.DIS(I).LE.DIS(I-4).AND.DIS(I).LE.DIS(I+4)) GO TO 12
      GO TO 13
 12   NUMPT=NUMPT+1
      IPOINT(NUMPT)=I
 13   CONTINUE
      GO TO 17
 14   L=365-5
      DO 16 I=6,L
      IF(DIS(I).LE.DIS(I+1).AND.DIS(I).LE.DIS(I+2).AND.DIS(I).LE.DIS(I+3
     1).AND.DIS(I).LE.DIS(I-1).AND.DIS(I).LE.DIS(I-2).AND.DIS(I).LE.DIS(
     2I-3).AND.DIS(I).LE.DIS(I-4).AND.DIS(I).LE.DIS(I+4).AND.DIS(I).LE.D
     3IS(I-5).AND.DIS(I).LE.DIS(I+5)) GO TO 15
      GO TO 16
 15   NUMPT=NUMPT+1
      IPOINT(NUMPT)=I
 16   CONTINUE
 17   K=NUMPT-1
      J=IPOINT(1)
      L=IPOINT(NUMPT)
      DO 18 IJ=1,J
      GDIS(IJ)=DIS(J)
 18   CONTINUE
      DO 19 IJ=L,365
      GDIS(IJ)=DIS(L)
 19   CONTINUE
      DO 21 I=1,K
      IP1=IPOINT(I)
      IP2=IPOINT(I+1)
      GDIS(IP1)=DIS(IP1)
      GDIS(IP2)=DIS(IP2)
      ISTART=IP1
      IEND=IP2
      DO 20 J=ISTART,IEND
      X=J-IP1
      Y=IP2-IP1
      IF(GDIS(IP1).EQ.0.0) GDIS(IP1)=0.01
```

```
      IF(GDIS(IP2).EQ.0.0) GDIS(IP2)=0.01
      GDIS(J)=10.**((X/Y)*(ALOG10(GDIS(IP2))-ALOG10(GDIS(IP1)))+ALOG10(G
     1DIS(IP1)))
 20   CONTINUE
 21   CONTINUE
      DO 22 IJK=1,365
      IF(GDIS(IJK).GT.DIS(IJK)) GDIS(IJK)=DIS(IJK)
 22   CONTINUE
      RETURN
C
 500  FORMAT (/'0',49('*')/1X,'HYDROGRAPH SEPARATION BY THE LOCAL '
     1'MINIMUM METHOD',/1X,49('*'))
      END
C-----------------------------------------------------------------------
      SUBROUTINE MONTH(DIS,GDIS,ABFC,AQC,ABFW,AQW,DRAIN,IREC,NPFLAG,IWR,
     * IWY,METH)
C-----------------------------------------------------------------------
C     THIS SUBROUTINE CALCULATES INFORMATION ABOUT THE HYDROGRAPH
C     SEPARATION ON A MONTHLY BASIS.
C     ADAPTED FROM PETTYJOHN AND HENNING (1979)
C     BY R. A. SLOTO
C     12/12/89   3.1
C
C.....DECLARATIONS
      REAL MONTH(12,6),                      /* STATISTICS ARRAYS
     *     DIS(365),                         /* STREAM DISCHARGE
     *     GDIS(365),                        /* GW DISCHARGE
     *     TOTALQ,                           /* MONTHLY STREAM DISCHARGE
     *     TOTLGW,                           /* MONTHLY GW DISCHARGE
     *     RECH,                             /* GW DISCHARGE IN MDG/MI2
     *     DRAIN,                            /* DRAINAGE AREA
     *     CALBF1,                           /* GW OCT-DEC
     *     CALBF2,                           /* GW JAN-SEPT
     *     CALQ1,                            /* SF OCT-DEC
     *     CALQ2,                            /* SF JAN-SEPT
     *     ABFC(100,3),                      /* CY BF ARRAY
     *     AQC(100,3),                       /* CY SF ARRAY
     *     ABFW(100,3),                      /* WY BF ARRAY
     *     AQW(100,3)                        /* WY SF ARRAY
      INTEGER NPFLAG,                        /* SHORT/LONG PRINTOUT FLAG
     *        IWR(100),                      /* WY ARRAY
     *        METH,                          /* HYSEP METHOD
     *        IWY                            /* WATER YEAR
C
C.....INITIALIZE VARIABLES
      TOTALQ=0.0
      TOTLGW=0.0
      CALBF1=0.0
      CALBF2=0.0
      CALQ1=0.0
      CALQ2=0.0
C     DO 2 I=1,12
C     DO 1 J=1,6
C     MONTH(I,J)=0.0
C1    CONTINUE
C2    CONTINUE
C
C.....OCTOBER
      DO 3 I=1,31
      TOTALQ=TOTALQ+DIS(I)
      TOTLGW=TOTLGW+GDIS(I)
 3    CONTINUE
      MONTH(1,1)=TOTALQ/31.
      MONTH(1,2)=0.03719*(TOTALQ/DRAIN)
      MONTH(1,3)=TOTLGW/31.
      MONTH(1,4)=0.03719*(TOTLGW/DRAIN)
      MONTH(1,5)=0.
      IF (TOTALQ.EQ.0.) GOTO 20
      MONTH(1,5)=(TOTLGW/TOTALQ)*100.
 20   RECH=(TOTLGW/DRAIN)*0.02085
      MONTH(1,6)=RECH
      CALQ1=CALQ1+TOTALQ
      CALBF1=CALBF1+TOTLGW
C.....NOVEMBER
      TOTALQ=0.0
      TOTLGW=0.0
      DO 4 I=32,61
      TOTALQ=TOTALQ+DIS(I)
      TOTLGW=TOTLGW+GDIS(I)
 4    CONTINUE
      MONTH(2,1)=TOTALQ/30.
      MONTH(2,2)=0.03719*(TOTALQ/DRAIN)
      MONTH(2,3)=TOTLGW/30.
      MONTH(2,4)=0.03719*(TOTLGW/DRAIN)
      MONTH(2,5)=0.
      IF (TOTALQ.EQ.0.) GOTO 30
      MONTH(2,5)=(TOTLGW/TOTALQ)*100.
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 30    RECH=(TOTLGW/DRAIN)*0.02154
       MONTH(2,6)=RECH
       CALQ1=CALQ1+TOTALQ
       CALBF1=CALBF1+TOTLGW
C.....DECEMBER
       TOTALQ=0.00
       TOTLGW=0.0
       DO 5 I=62,92
       TOTALQ=TOTALQ+DIS(I)
       TOTLGW=TOTLGW+GDIS(I)
 5     CONTINUE
       MONTH(3,1)=TOTALQ/31.
       MONTH(3,2)=0.03719*(TOTALQ/DRAIN)
       MONTH(3,4)=0.03719*(TOTLGW/DRAIN)
       MONTH(3,3)=TOTLGW/31.
       MONTH(3,5)=0.
       IF (TOTALQ.EQ.0.) GOTO 40
       MONTH(3,5)=(TOTLGW/TOTALQ)*100.
 40    RECH=(TOTLGW/DRAIN)*0.02085
       MONTH(3,6)=RECH
       CALQ1=CALQ1+TOTALQ
       CALBF1=CALBF1+TOTLGW
C.....JANUARY
       TOTALQ=0.00
       TOTLGW=0.0
       DO 6 I=93,123
       TOTALQ=TOTALQ+DIS(I)
       TOTLGW=TOTLGW+GDIS(I)
 6     CONTINUE
       MONTH(4,1)=TOTALQ/31.
       MONTH(4,3)=TOTLGW/31.
       MONTH(4,2)=0.03719*(TOTALQ/DRAIN)
       MONTH(4,4)=0.03719*(TOTLGW/DRAIN)
       MONTH(4,5)=0.
       IF (TOTALQ.EQ.0.) GOTO 50
       MONTH(4,5)=(TOTLGW/TOTALQ)*100.
 50    RECH=(TOTLGW/DRAIN)*0.02085
       MONTH(4,6)=RECH
       CALQ2=CALQ2+TOTALQ
       CALBF2=CALBF2+TOTLGW
C.....FEBRUARY
       TOTALQ=0.0
       TOTLGW=0.0
       DO 7 I=124,151
       TOTALQ=TOTALQ+DIS(I)
       TOTLGW=TOTLGW+GDIS(I)
     7 CONTINUE
       MONTH(5,1)=TOTALQ/28.
       MONTH(5,2)=0.03719*(TOTALQ/DRAIN)
       MONTH(5,3)=TOTLGW/28.
       MONTH(5,4)=0.03719*(TOTLGW/DRAIN)
       MONTH(5,5)=0.
       IF (TOTALQ.EQ.0.) GOTO 60
       MONTH(5,5)=(TOTLGW/TOTALQ)*100.
 60    RECH=(TOTLGW/DRAIN)*0.02308
       MONTH(5,6)=RECH
       CALQ2=CALQ2+TOTALQ
       CALBF2=CALBF2+TOTLGW
C.....MARCH
       TOTALQ=0.00
       TOTLGW=0.0
       DO 8 I=152,182
       TOTALQ=TOTALQ+DIS(I)
       TOTLGW=TOTLGW+GDIS(I)
     8 CONTINUE
       MONTH(6,1)=TOTALQ/31.
       MONTH(6,2)=0.03719*(TOTALQ/DRAIN)
       MONTH(6,3)=TOTLGW/31.
       MONTH(6,4)=0.03719*(TOTLGW/DRAIN)
       MONTH(6,5)=0.
       IF (TOTALQ.EQ.0.) GOTO 70
       MONTH(6,5)=(TOTLGW/TOTALQ)*100.
 70    RECH=(TOTLGW/DRAIN)*0.02085
       MONTH(6,6)=RECH
       CALQ2=CALQ2+TOTALQ
       CALBF2=CALBF2+TOTLGW
C.....APRIL
       TOTALQ=0.00
       TOTLGW=0.0
       DO 9 I=183,212
       TOTALQ=TOTALQ+DIS(I)
       TOTLGW=TOTLGW+GDIS(I)
     9 CONTINUE
       MONTH(7,1)=TOTALQ/30.
       MONTH(7,2)=0.03719*(TOTALQ/DRAIN)
       MONTH(7,3)=TOTLGW/30.
       MONTH(7,4)=0.03719*(TOTLGW/DRAIN)
```

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      MONTH(7,5)=0.
      IF (TOTALQ.EQ.0.) GOTO 80
      MONTH(7,5)=(TOTLGW/TOTALQ)*100.
 80   RECH=(TOTLGW/DRAIN)*0.02154
      MONTH(7,6)=RECH
      CALQ2=CALQ2+TOTALQ
      CALBF2=CALBF2+TOTLGW
C.....MAY
      TOTALQ=0.0
      TOTLGW=0.0
      DO 10 I=213,243
      TOTALQ=TOTALQ+DIS(I)
      TOTLGW=TOTLGW+GDIS(I)
   10 CONTINUE
      MONTH(8,1)=TOTALQ/31.
      MONTH(8,2)=0.03719*(TOTALQ/DRAIN)
      MONTH(8,3)=TOTLGW/31.
      MONTH(8,5)=0.
      IF (TOTALQ.EQ.0.) GOTO 90
      MONTH(8,5)=(TOTLGW/TOTALQ)*100.
  90  MONTH(8,4)=0.03719*(TOTLGW/DRAIN)
      RECH=(TOTLGW/DRAIN)*0.02085
      MONTH(8,6)=RECH
      CALQ2=CALQ2+TOTALQ
      CALBF2=CALBF2+TOTLGW
C.....JUNE
      TOTLGW=0.0
      TOTALQ=0.00
      DO 11 I=244,273
      TOTALQ=TOTALQ+DIS(I)
      TOTLGW=TOTLGW+GDIS(I)
   11 CONTINUE
      MONTH(9,1)=TOTALQ/30.
      MONTH(9,2)=0.03719*(TOTALQ/DRAIN)
      MONTH(9,3)=TOTLGW/30.
      MONTH(9,4)=0.03719*(TOTLGW/DRAIN)
      MONTH(9,5)=0.
      IF (TOTALQ.EQ.0.) GOTO 100
      MONTH(9,5)=(TOTLGW/TOTALQ)*100.
      RECH=(TOTLGW/DRAIN)*0.02154
 100  MONTH(9,6)=RECH
      CALQ2=CALQ2+TOTALQ
      CALBF2=CALBF2+TOTLGW
C.....JULY
      TOTALQ=0.0
      TOTLGW=0.0
      DO 12 I=274,304
      TOTALQ=TOTALQ+DIS(I)
      TOTLGW=TOTLGW+GDIS(I)
   12 CONTINUE
      MONTH(10,1)=TOTALQ/31.
      MONTH(10,2)=0.03719*(TOTALQ/DRAIN)
      MONTH(10,3)=TOTLGW/31.
      MONTH(10,4)=0.03719 *(TOTLGW/DRAIN)
      MONTH(10,5)=0.
      IF (TOTALQ.EQ.0.) GOTO 110
      MONTH(10,5)=(TOTLGW/TOTALQ)*100.
 110  RECH=(TOTLGW/DRAIN)*0.02085
      MONTH(10,6)=RECH
      CALQ2=CALQ2+TOTALQ
      CALBF2=CALBF2+TOTLGW
C.....AUGUST
      TOTALQ=0.00
      TOTLGW=0.0
      DO 13 I=305,335
      TOTALQ=TOTALQ+DIS(I)
      TOTLGW=TOTLGW+GDIS(I)
   13 CONTINUE
      MONTH(11,1)=TOTALQ/31.
      MONTH(11,2)=0.03719*(TOTALQ/DRAIN)
      MONTH(11,3)=TOTLGW/31.
      MONTH(11,4)=0.03719 *(TOTLGW/DRAIN)
      MONTH(11,5)=0.
      IF (TOTALQ.EQ.0.) GOTO 120
      MONTH(11,5)=(TOTLGW/TOTALQ)*100.
 120  RECH=(TOTLGW/DRAIN)*0.02085
      MONTH(11,6)=RECH
      CALQ2=CALQ2+TOTALQ
      CALBF2=CALBF2+TOTLGW
C.....SEPTEMBER
      TOTALQ=0.00
      TOTLGW=0.0
      DO 14 I=336,365
      TOTALQ=TOTALQ+DIS(I)
      TOTLGW=TOTLGW+GDIS(I)
   14 CONTINUE
      MONTH(12,1)=TOTALQ/30.
```

```
      MONTH(12,2)=0.03719*(TOTALQ/DRAIN)
      MONTH(12,3)=TOTLGW/30.
      MONTH(12,4)=0.03719 *(TOTLGW/DRAIN)
      MONTH(12,5)=0.
      IF (TOTALQ.EQ.0.) GOTO 130
      MONTH(12,5)=(TOTLGW/TOTALQ)*100.
 130  RECH=(TOTLGW/DRAIN)*0.02154
      MONTH(12,6)=RECH
      CALQ2=CALQ2+TOTALQ
      CALBF2=CALBF2+TOTLGW
C
C.....LOAD WATER AND CALENDAR YEAR ARRAYS
      JREC=IREC-1
      IF (IREC.EQ.1) GOTO 200
      NYR=IWY-1
      IF (IWR(JREC).EQ.NYR) GOTO 180
      ABFC(JREC,METH)=0.0
      AQC(JREC,METH)=0.0
      GOTO 200
 180  ABFC(JREC,METH)=ABFC(JREC,METH)+CALBF1
      AQC(JREC,METH)=AQC(JREC,METH)+CALQ1
 200  ABFC(IREC,METH)=CALBF2
      AQC(IREC,METH)=CALQ2
      AQW(IREC,METH)=CALQ1+CALQ2
      ABFW(IREC,METH)=CALBF1+CALBF2
C
      IF (NPFLAG.EQ.0) GOTO 300
C.....PRINT RESULTS
      WRITE (6,500)
      WRITE (6,520)
      WRITE (6,540) (MONTH(I,1),I=1,12)
      WRITE (6,560) (MONTH(I,2),I=1,12)
      WRITE (6,580) (MONTH(I,3),I=1,12)
      WRITE (6,600) (MONTH(I,4),I=1,12)
      WRITE (6,620) (MONTH(I,5),I=1,12)
      WRITE (6,640) (MONTH(I,6),I=1,12)
 300  CONTINUE
      RETURN
C
 500  FORMAT ('0','MONTHLY SUMMARY'/1X,15('-'))
 520  FORMAT (19X,'OCT',7X,'NOV',7X,'DEC',7X,'JAN',7X,'FEB',7X,'MAR'
     1,7X,'APR',7X,'MAY',7X,'JUN',7X,'JUL',7X,'AUG',7X,'SEP')
 540  FORMAT (1X,'MEAN Q (CFS)',12(F10.3))
 560  FORMAT (1X,'TOTAL Q (IN)',12(F10.3))
 580  FORMAT (1X,'MEAN GW(CFS)',12(F10.3))
 600  FORMAT (1X,'TOTAL GW(IN)',12(F10.3))
 620  FORMAT (1X,'% AS GW     ',12(F10.2))
 640  FORMAT (1X,'RECH MGD/MI2',12(F10.3))
      END
C-----------------------------------------------------------------------
      SUBROUTINE STAT(DIS,GDIS,DRAIN,NPFLAG)
C-----------------------------------------------------------------------
C     SUBROUTINE TO CALCULATE AND PRINT OUT SUMMARY INFORMATION ABOUT
C     THE HYDROGRAPH SEPARATION.
C     ADAPTED FROM PETTYJOHN AND HENNING (1979)
C     BY R. A. SLOTO
C     12/12/89   4.1
C
C.....DECLARATIONS
      REAL MDSS,                                 /* MEAN Q
     *     DIS(365),                             /* STREAM DISCHARGE
     *     GDIS(365),                            /* GW DISCHARGE
     *     DRAIN,                                /* DRAINAGE AREA
     *     LMIN,                                 /* MINIMUM Q
     *     LMAX,                                 /* MAXIMUM Q
     *     TOQUAN,                               /* MEAN Q IN CFS
     *     TOQUGW,                               /* MEAN GW IN CFS
     *     TOTGWI,                               /* TOTAL GW IN INCHES
     *     TOTQIN,                               /* TOTAL Q IN INCHES
     *     TDMISSI,                              /* TOTAL Q IN CFS/MI2
     *     TDGWSM,                               /* TOTAL GW IN CFS/MI2
     *     PERCEN,                               /* % OF Q THAT IS GW
     *     RECHM                                 /* RECHARGE RATE IN MGD/MI2
      INTEGER NPFLAG                             /* SHORT/LONG PRINTOUT FLAG
C
      IF (NPFLAG.EQ.0) GOTO 100
C.....INITIALIZE VARIABLES
      LMIN=100000.
      LMAX=.0
      TOTDIS=.0
      TOTGW=0.0
C
C.....CALCULATE AND SUM STATISTICS
      DO 1 I=1,365
      TOTDIS=TOTDIS+DIS(I)
      TOTGW=TOTGW+GDIS(I)
      IF(DIS(I).LT.LMIN) LMIN=DIS(I)
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      IF(DIS(I).GT.LMAX) LMAX=DIS(I)
  1   CONTINUE
      TOQUAN=TOTDIS/365.
      TOQUGW=TOTGW/365.
      TOTGWI=0.03719*(TOTGW/DRAIN)
      TOTQIN=0.03719*(TOTDIS/DRAIN)
      MDSS=TOTDIS/365.
      TDSSMI=(TOTDIS*86400.)/DRAIN
      TDGWSM=(TOTGW*86400.)/DRAIN
      PERCEN=(TOQUGW/TOQUAN)*100.
      RECHM=TDGWSM*2.0493E-08
C
C.....PRINT RESULTS
      WRITE (6,500)
      WRITE (6,530) TOQUAN,TOTQIN
C     WRITE (6,540) LMIN
C     WRITE (6,550) MDSS
C     WRITE (6,560) LMAX
C     WRITE (6,570) TDSSMI
      WRITE (6,580) TOQUGW,TOTGWI
C     WRITE (6,590) TDGWSM
      WRITE (6,600) PERCEN
      WRITE (6,610) RECHM
 100  CONTINUE
      RETURN
C
 500  FORMAT('0','SUMMARY INFORMATION ON THE HYDROGRAPH SEPARATION'/
     11X,48('-'))
 530  FORMAT  (1X,'MEAN DISCHARGE FOR THE WATER YEAR',13X,F10.3,1X,
     1'CFS OR 'F7.2,' INCHES')
 540  FORMAT (1X,'MINIMUM DISCHARGE',30X,F8.2,1X,'CFS')
 550  FORMAT (1X,'MEAN DISCHARGE',33X,F8.2,1X,'CFS')
 560  FORMAT (1X,'MAXIMUM DISCHARGE',30X,F8.2,1X,'CFS')
 570  FORMAT (1X,'TOTAL DISCHARGE/YR/BASIN AREA',16X,1PE10.3,1X,'CF/SQ.
     1MI')
 580  FORMAT (1X,'MEAN GROUND-WATER DISCHARGE FOR THE WATER YEAR',1X,
     1F9.3,1X,'CFS OR ',F7.2,' INCHES')
 590  FORMAT (1X,'TOTAL GROUND-WATER DISCHARGE/YR/BASIN AREA',3X,1PE10.
     13,1X,'CF/SQ.MI.')
 600  FORMAT (1X,'% OF TOTAL DISCHARGE DUE TO GROUND-WATER RUNOFF',F9.2
     1)
 610  FORMAT (1X,'THE RECHARGE RATE  = ',F10.3,'   MGD/SQ.MI.')
      END
C---------------------------------------------------------------------------
      SUBROUTINE ANNUAL(ABFC,AQC,ABFW,AQW,IREC,KREC,DRAIN,STA,STAID,
     * FREQC,FREQW,CFI,WFI,IWR)
C---------------------------------------------------------------------------
C     THIS SUBROUTINE CALCULATES AND PRINTS A SUMMARY OF THE HYDROGRAPH
C     SEPARATION ON AN ANNUAL BASIS.
C     WRITTEN BY R. A. SLOTO
C     12/12/89   5.6
C
C.....DECLARATIONS
      CHARACTER STA*50,                         /* STATION NAME
     *          STAID*8                         /* STATION ID
      REAL DRAIN,                               /* DRAINAGE AREA
     *     ABFC(100,3),                         /* CY BF ARRAY
     *     AQC(100,3),                          /* CY SF ARRAY
     *     ABFW(100,3),                         /* WY BF ARRAY
     *     AQW(100,3),                          /* WY SF ARRAY
     *     REC1,                                /* MEDIAN LOCATOR
     *     REC2,                                /* MEDIAN LOCATOR
     *     WBFI(100,3),                         /* WY BF INCHES
     *     CBFI(100,3),                         /* CY BF INCHES
     *     WBFC(100,3),                         /* WY MEAN BF CFS
     *     CBFC(100,3),                         /* CY MEAN BF CFS
     *     WBFM(100,3),                         /* WY RECHARGE MGD/MI2
     *     CBFM(100,3),                         /* CY RECHARGE MGD/MI2
     *     WBFP(100,3),                         /* WY % BF
     *     CBFP(100,3),                         /* CY % BF
     *     WFI(100,3),                /* WY BF INCHES SORTED BY FREQUECY
     *     WFC(100,3),                /* WY BF CFS SORTED BY FREQ
     *     WFP(100,3),                /* WY BF % SORTED BY FREQ
     *     WFM(100,3),                /* WY BF MGD/MI2 SORTED BY FREQ
     *     CFI(110,3),                /* CY BF INCHES SORTED BY FREQ
     *     CFC(100,3),                /* CY BF CFS SORTED BY FREQ
     *     CFP(100,3),                /* CY BF % SORTED BY FREQ
     *     CFM(100,3),                /* CY BF MGD/MI2 SORTED BY FREQ
     *     W(100,3),                  /* TEMPORARY WY ARRAY
     *     C(100,3),                  /* TEMPORARY CY ARRAY
     *     WMI(3),                              /* MEDIAN INCHES WY
     *     WMC(3),                              /* MEDIAN CFS WY
     *     WMM(3),                              /* MEDIAN RECH WY
     *     WMP(3),                              /* MEDIAN PERCENTAGE WY
     *     CMI(3),                              /* MEDIAN INCHES CY
     *     CMC(3),                              /* MEDIAN CFS CY
     *     CMM(3),                              /* MEDIAN RECH CY
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     *     CMP(3),                          /* MEDIAN PERCENTAGE CY
     *     WIM(3),                          /* MEAN INCHES WY
     *     WCM(3),                          /* MEAN CFS WY
     *     WRM(3),                          /* MEAN RECH WY
     *     WPM(3),                          /* MEAN PERCENTAGE WY
     *     CIM(3),                          /* MEAN INCHES CY
     *     CCM(3),                          /* MEAN CFS CY
     *     CRM(3),                          /* MEAN RECH CY
     *     CPM(3),                          /* MEAN PERCENTAGE CY
     *     FREQC(100),                      /* BF FREQUENCY BY CY
     *     FREQW(100)                       /* BF FREQUENCY BY WY
      INTEGER IWW(100,3),                   /* WY SORTED BY FREQ
     *        IWC(100,3),                   /* CY SORTED BY FREQ
     *        ICR(100),                     /* CY ARRAY
     *        IWR(100)                      /* WY ARRAY
C
C.....INITIALIZE VARIABLES
C     DO 11 J=1,3
C     DO 10 I=1,100
C     WBFI(I,J)=0.0
C     WBFC(I,J)=0.0
C     WBFM(I,J)=0.0
C     WBFP(I,J)=0.0
C     CBFI(I,J)=0.0
C     CBFC(I,J)=0.0
C     CBFM(I,J)=0.0
C     CBFP(I,J)=0.0
C     WFP(I,J)=0.0
C     CFP(I,J)=0.0
C     WFC(I,J)=0.0
C     CFC(I,J)=0.0
C     WFI(I,J)=0.0
C     CFI(I,J)=0.0
C     WFM(I,J)=0.0
C     CFM(I,J)=0.0
C     IWW(I,J)=0
C     IWC(I,J)=0
C     C(I,J)=0.0
C     W(I,J)=0.0
C10   CONTINUE
C11   CONTINUE
C     DO 15 I=1,100
C     FREQC(I)=0.0
C     FREQW(I)=0.0
C     ICR(I)=0
C15   CONTINUE
C     DO 20 I=1,3
C     WMI(I)=0.0
C     WMC(I)=0.0
C     WMM(I)=0.0
C     WMP(I)=0.0
C     CMI(I)=0.0
C     CMC(I)=0.0
C     CMM(I)=0.0
C     CMP(I)=0.0
C  20 CONTINUE
C
C.....CALCULATE WATER YEAR STATISTICS
      DO 26 J=1,3
      DO 25 I=1,IREC
      W(I,J)=ABFW(I,J)
      WBFI(I,J)=(ABFW(I,J)/DRAIN)*0.03719
      WBFC(I,J)=ABFW(I,J)/365.
      WBFM(I,J)=(ABFW(I,J)/DRAIN)*1.7706E-03
      IF (AQW(I,J).EQ.0.0) GOTO 25
      WBFP(I,J)=(ABFW(I,J)/AQW(I,J))*100.0
      WFP(I,J)=WBFP(I,J)
 25   CONTINUE
 26   CONTINUE
C
C.....REMOVE YEARS OF MISSING CALENDAR DATA
      ICR(1)=IWR(1)
      KREC=IREC-1
      M=0
      L=KREC
C
      DO 35 I=2,L
      IF (ABFC(I,1).EQ.0.0) GOTO 30
      N=I-M
      ABFC(N,1)=ABFC(I,1)
      AQC(N,1)=AQC(I,1)
      ABFC(N,2)=ABFC(I,2)
      AQC(N,2)=AQC(I,2)
      ABFC(N,3)=ABFC(I,3)
      AQC(N,3)=AQC(I,3)
      ICR(N)=IWR(I)
      GOTO 35
```

```
C
 30   M=M+1
      N=I-M
      KREC=KREC-1
 35   CONTINUE
C
C.....CALCULATE CALENDAR YEAR STATISTICS
      DO 41 J=1,3
      DO 40 I=1,KREC
      C(I,J)=ABFC(I,J)
      CBFI(I,J)=(ABFC(I,J)/DRAIN)*0.03719
      CBFC(I,J)=ABFC(I,J)/365.
      CBFM(I,J)=(ABFC(I,J)/DRAIN)*1.7706E-03
      IF (AQC(I,J).EQ.0.0) GOTO 40
      CBFP(I,J)=(ABFC(I,J)/AQC(I,J))*100.0
      CFP(I,J)=CBFP(I,J)
 40   CONTINUE
 41   CONTINUE
C
C.....SORT WATER YEAR BASEFLOWS
      CALL DATASORT(W,IREC)
C
C.....SORT CALENDAR YEAR BASE FLOWS
      CALL DATASORT(C,KREC)
C
C.....SORT WATER YEAR PERCENTAGES
      CALL DATASORT(WFP,IREC)
C
C.....SORT CALENDAR YEAR PERCENTAGES
      CALL  DATASORT(CFP,KREC)
C
C.....SORT WATER YEARS
      DO 122 J=1,3
      DO 121 I=1,IREC
      DO 120 K=1,IREC
      IF (W(I,J).NE.ABFW(K,J)) GOTO 120
      IWW(I,J)=IWR(K)
 120  CONTINUE
 121  CONTINUE
 122  CONTINUE
C
C.....SORT CALENDAR YEARS
      DO 132 J=1,3
      DO 131 I=1,KREC
      DO 130 K=1,KREC
      IF (C(I,J).NE.ABFC(K,J)) GOTO 130
      IWC(I,J)=IWR(K)
 130  CONTINUE
 131  CONTINUE
 132  CONTINUE
C
C.....CALCULATE WATER YEAR FREQUENCY DISTRIBUTION
      NUM=IREC+1
      XNUM=FLOAT(NUM)
      DO 140 I=1,IREC
      XI=FLOAT(I)
      FREQW(I)=(XI/XNUM)*100.0
 140  CONTINUE
C
C.....CALCULATE CALENDAR YEAR FREQUENCY DISTRIBUTION
      NUM=KREC+1
      XNUM=FLOAT(NUM)
      DO 145 I=1,KREC
      XI=FLOAT(I)
      FREQC(I)=(XI/XNUM)*100.0
 145  CONTINUE
C
C.....CALCULATE WATER YEAR FREQUENCY STATISTICS
      DO 411 J=1,3
      DO 410 I=1,IREC
      BASIN=W(I,J)/DRAIN
      WFI(I,J)=BASIN*0.03719
      WFM(I,J)=BASIN*1.7706E-03
      WFC(I,J)=W(I,J)/365.
 410  CONTINUE
 411  CONTINUE
C
C.....CALCULATE CALENDAR YEAR FREQUENCY STATISTICS
      DO 421 J=1,3
      DO 420 I=1,KREC
      BASIN=C(I,J)/DRAIN
      CFI(I,J)=BASIN*0.03719
      CFM(I,J)=BASIN*1.7706E-03
      CFC(I,J)=C(I,J)/365.
 420  CONTINUE
 421  CONTINUE
C
```

```
C.....CALCULATE WATER YEAR MEDIANS
      JJ=IREC+1
      REC1=FLOAT(JJ)/2.0
      KK=JJ/2
      REC2=FLOAT(KK)
      II=INT(REC1)
      IF (REC1.NE.REC2) GOTO 152
C.....ODD NUMBER OF YEARS
      DO 150 J=1,3
      WMI(J)=WFI(II,J)
      WMC(J)=WFC(II,J)
      WMM(J)=WFM(II,J)
      WMP(J)=WFP(II,J)
 150  CONTINUE
      GOTO 156
C.....EVEN NUMBER OF YEARS
 152  III=II+1
      DO 155 J=1,3
      WMI(J)=(WFI(II,J)+WFI(III,J))/2.0
      WMC(J)=(WFC(II,J)+WFC(III,J))/2.0
      WMM(J)=(WFM(II,J)+WFM(III,J))/2.0
      WMP(J)=(WFP(II,J)+WFP(III,J))/2.0
 155  CONTINUE
 156  CONTINUE
C
C.....CALCULATE CALENDAR YEAR MEDIANS
      JJ=KREC+1
      REC1=FLOAT(JJ)/2.0
      KK=JJ/2
      REC2=FLOAT(KK)
      II=INT(REC1)
      IF (REC1.NE.REC2) GOTO 162
C.....ODD NUMBER OF YEARS
      DO 160 J=1,3
      CMI(J)=CFI(II,J)
      CMC(J)=CFC(II,J)
      CMM(J)=CFM(II,J)
      CMP(J)=CFP(II,J)
 160  CONTINUE
      GOTO 166
C.....EVEN NUMBER OF YEARS
 162  III=II+1
      DO 165 J=1,3
      CMI(J)=(CFI(II,J)+CFI(III,J))/2.0
      CMC(J)=(CFC(II,J)+CFC(III,J))/2.0
      CMM(J)=(CFM(II,J)+CFM(III,J))/2.0
      CMP(J)=(CFP(II,J)+CFP(III,J))/2.0
 165  CONTINUE
 166  CONTINUE
C
C.....CALCULATE WATER YEAR MEANS
      NI=FLOAT(IREC)
      SUMI=0.0
      SUMC=0.0
      SUMR=0.0
      SUMP=0.0
      DO 210 J=1,3
      DO 200 I=1,IREC
      SUMI=SUMI+WBFI(I,J)
      SUMC=SUMC+WBFC(I,J)
      SUMR=SUMR+WBFM(I,J)
      SUMP=SUMP+WBFP(I,J)
 200  CONTINUE
      WIM(J)=SUMI/NI
      WCM(J)=SUMC/NI
      WRM(J)=SUMR/NI
      WPM(J)=SUMP/NI
      SUMI=0.0
      SUMC=0.0
      SUMR=0.0
      SUMP=0.0
 210  CONTINUE
C
C.....CALCULATE CALENDAR YEAR MEANS
      NK=FLOAT(KREC)
      DO 230 J=1,3
      DO 220 I=1,KREC
      SUMI=SUMI+CBFI(I,J)
      SUMC=SUMC+CBFC(I,J)
      SUMR=SUMR+CBFM(I,J)
      SUMP=SUMP+CBFP(I,J)
 220  CONTINUE
      CIM(J)=SUMI/NK
      CCM(J)=SUMC/NK
      CRM(J)=SUMR/NK
      CPM(J)=SUMP/NK
      SUMI=0.0
```

```
      SUMC=0.0
      SUMR=0.0
      SUMP=0.0
  230 CONTINUE
C
C.....PRINT PAGE 1 -- SUMMARY BY WATER YEAR
      WRITE (6,500) STA, STAID
      WRITE (6,505) DRAIN
      WRITE (6,520)
      WRITE (6,530)
      DO 300 I=1,IREC
      WRITE (6,540) IWR(I),
     1WBFI(I,1),WBFC(I,1),WBFM(I,1),WBFP(I,1),
     2WBFI(I,2),WBFC(I,2),WBFM(I,2),WBFP(I,2),
     3WBFI(I,3),WBFC(I,3),WBFM(I,3),WBFP(I,3)
  300 CONTINUE
      WRITE (6,560)
     1WMI(1),WMC(1),WMM(1),WMP(1),
     2WMI(2),WMC(2),WMM(2),WMP(2),
     3WMI(3),WMC(3),WMM(3),WMP(3)
      WRITE (6,570)
     1WIM(1),WCM(1),WRM(1),WPM(1),
     2WIM(2),WCM(2),WRM(2),WPM(2),
     3WIM(3),WCM(3),WRM(3),WPM(3)
C
C.....PRINT PAGE 2 -- SUMMARY BY CALENDAR YEAR
      WRITE (6,600) STA, STAID
      WRITE (6,605) DRAIN
      WRITE (6,620)
      WRITE (6,530)
      DO 350 I=1,KREC
      WRITE (6,540) ICR(I),
     1CBFI(I,1),CBFC(I,1),CBFM(I,1),CBFP(I,1),
     2CBFI(I,2),CBFC(I,2),CBFM(I,2),CBFP(I,2),
     3CBFI(I,3),CBFC(I,3),CBFM(I,3),CBFP(I,3)
  350 CONTINUE
      WRITE (6,560)
     1CMI(1),CMC(1),CMM(1),CMP(1),
     2CMI(2),CMC(2),CMM(2),CMP(2),
     3CMI(3),CMC(3),CMM(3),CMP(3)
      WRITE (6,570)
     1CIM(1),CCM(1),CRM(1),CPM(1),
     2CIM(2),CCM(2),CRM(2),CPM(2),
     3CIM(3),CCM(3),CRM(3),CPM(3)
C
C.....PRINT PAGE 3 -- WATER YEAR SUMMARY ORDERED BY FREQUENCY
      WRITE (6,500) STA, STAID
      WRITE (6,505) DRAIN
      WRITE (6,610)
      WRITE (6,630)
      DO 460 I=1,IREC
      WRITE (6,640)
     1FREQW(I),WFI(I,1),WFM(I,1),IWW(I,1),
     2FREQW(I),WFI(I,2),WFM(I,2),IWW(I,2),
     3FREQW(I),WFI(I,3),WFM(I,3),IWW(I,3)
  460 CONTINUE
C
C.....PRINT PAGE 4 -- CALENDAR YEAR SUMMARY ORDERED BY FREQUENCY
      WRITE (6,600) STA, STAID
      WRITE (6,605) DRAIN
      WRITE (6,610)
      WRITE (6,630)
      DO 480 I=1,KREC
      WRITE (6,640)
     1FREQC(I),CFI(I,1),CFM(I,1),IWC(I,1),
     2FREQC(I),CFI(I,2),CFM(I,2),IWC(I,2),
     3FREQC(I),CFI(I,3),CFM(I,3),IWC(I,3)
  480 CONTINUE
C
      RETURN
C
  500 FORMAT ('1',94('*')//1X,'WATER YEAR BASEFLOW SUMMARY FOR ',
     1A50,3X,A8/)
  505 FORMAT (1X,'DRAINAGE AREA = ',F8.2,' SQUARE MILES'//1X,94('*'))
  520 FORMAT ('0','WATER',3X,'**** FIXED-INTERVAL METHOD *****',11X,
     1'*** SLIDING-INTERVAL METHOD ****',11X,
     2'***** LOCAL-MINIMUM METHOD ******')
  530 FORMAT (1X,'YEAR',6X,
     1'IN',7X,'CFS',3X,'MGD/MI2',2X,'% OF SF',11X,
     2'IN',7X,'CFS',3X,'MGD/MI2',2X,'% OF SF',11X,
     3'IN',7X,'CFS',3X,'MGD/MI2',2X,'% OF SF'/)
  540 FORMAT (1X,I4,4X,3(F5.2,F10.2,F8.3,F10.2,9X))
  560 FORMAT (/' MEDIAN',2X,3(F5.2,F10.2,F8.3,F10.2,9X))
  570 FORMAT (' MEAN  ',2X,3(F5.2,F10.2,F8.3,F10.2,9X))
  600 FORMAT ('1',96('*')//1X,'CALENDAR YEAR BASEFLOW SUMMARY FOR ',
     1A50,3X,A8/)
  605 FORMAT (1X,'DRAINAGE AREA = ',F8.2,' SQUARE MILES'//1X,96('*'))
```

```
 610  FORMAT ('0','**** FIXED-INTERVAL METHOD ****',11X,
     1'*** SLIDING-INTERVAL METHOD ***',11X,
     2'***** LOCAL MINIMUM METHOD *****')
 620  FORMAT ('0','CALNDR',1X,'**** FIXED-INTERVAL METHOD *****',11X,
     1'*** SLIDING-INTERVAL METHOD ****',11X,
     2'***** LOCAL-MINIMUM METHOD ******')
 630  FORMAT (1X,
     1'FREQ',6X,'IN',5X,'MGD/MI2',3X,'YEAR',11X,
     2'FREQ',6X,'IN',5X,'MGD/MI2',3X,'YEAR',11X,
     3'FREQ',6X,'IN',5X,'MGD/MI2',3X,'YEAR'/)
 640  FORMAT (1X,3(F4.1,F9.2,F9.3,5X,I4,11X))
C
      END
C---------------------------------------------------------------------------
-
      SUBROUTINE DATASORT(X,IREC)
C---------------------------------------------------------------------------
-
      REAL X(100,3)
C
      DO 70 K=1,3
      M=IREC
 10   M=INT(M/2)
      IF (M.EQ.0) GOTO 60
      DO 50 S=1,M
 20   I=S
      J=S+M
      Z=0
 30   IF (X(I,K).LE.X(J,K)) GOTO 40
      Z=1
      R=X(I,K)
      X(I,K)=X(J,K)
      X(J,K)=R
 40   I=J
      J=J+M
      IF (J.LT.(IREC+1)) GOTO 30
      IF (Z.EQ.1) GOTO 20
 50   CONTINUE
      GOTO 10
 60   CONTINUE
 70   CONTINUE
C
      RETURN
      END
```

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