REGIONALIZATION OF WINTER LOW-FLOW CHARACTERISTICS OF TENNESSEE STREAMS

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Analyses and compilations used in this report are in inch-pound units of measurements. Factors for converting inch-pound units to metric (SI) units are listed below.

Multiply	By	To obtain
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.59	square kilometer (km^2)
cubic foot per second (ft^3/s)	0.0283	cubic meter per second (m^3/s)

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R. H. Bingham

ABSTRACT

Procedures for estimating winter (December-April) low flows at ungaged stream sites in Tennessee are based on surface geology and drainage area size. One set of equations applies to West Tennessee streams, and another set applies to Middle and East Tennessee streams. The equations do not apply to streams where flow is significantly altered by activities of man. Standard errors of estimate of equations for West Tennessee are 22 to 35 percent and for Middle and East Tennessee 31 to 36 percent. Statistical analyses indicate that summer low-flow characteristics are the same as annual low-flow characteristics, and that winter low flows are larger than annual low flows.

Streamflow-recession indexes, in days per log cycle of decrease in discharge, are used to account for effects of geology on low flow of streams. The indexes in Tennessee range from 32 days per log cycle for clay and shale to 350 days per log cycle for gravel and sand, indicating different aquifer characteristics of the geologic units that contribute to streamflows during periods of no surface runoff. Streamflow-recession rate depends primarily on transmissivity and storage characteristics of the aquifers, and the average distance from stream channels to basin divides. Geology and drainage basin size are the most significant variables affecting low flow in Tennessee streams according to regression analyses.

SUMMARY

Methods for estimating winter (December-April) low-flow characteristics in Tennessee consist of two sets of regression equations that use an index of streamflow recession and size of the drainage basin. One set of equations can be used to estimate winter low flow of streams in West Tennessee which have drainage areas between 25 and 1,940 square miles (mi^2). The other set of equations can be used to estimate winter low flow of streams in Middle and East Tennessee which have drainage areas between 2.68 and 2,557 mi^2. Areas where the separate sets of equations apply are shown on plate 1 (in pocket).

The following equations can be used for estimating winter low-flow characteristics in ungaged streams in West Tennessee.

	Standard error of estimate, in percent
$1Q_2 = 7.34 \times 10^{-3} A^{1.01} (G-30)^{0.75}$	34
$1Q_{10} = 5.10 \times 10^{-4} A^{1.02} (G-30)^{1.18}$	27
$1Q_{20} = 3.07 \times 10^{-4} A^{1.02} (G-30)^{1.26}$	23
$3Q_2 = 8.88 \times 10^{-3} A^{1.01} (G-30)^{0.72}$	35
$3Q_{10} = 5.82 \times 10^{-4} A^{1.02} (G-30)^{1.16}$	27
$3Q_{20} = 2.72 \times 10^{-4} A^{1.02} (G-30)^{1.29}$	25
$7Q_2 = 1.31 \times 10^{-2} A^{1.00} (G-30)^{0.67}$	35
$7Q_{10} = 9.20 \times 10^{-4} A^{1.01} (G-30)^{1.09}$	25
$7Q_{20} = 4.76 \times 10^{-4} A^{1.02} (G-30)^{1.19}$	22
$30Q_2 = 0.112 A^{1.02} (G-30)^{0.32}$	33
$30Q_{10} = 5.04 \times 10^{-3} A^{1.00} (G-30)^{0.82}$	31
$30Q_{20} = 2.23 \times 10^{-3} A^{1.00} (G-30)^{0.95}$	31

The following equations can be used for estimating winter low-flow characteristics in ungaged streams in Middle and East Tennessee.

	Standard error of estimate, in percent
$1Q_2 = 4.37 \times 10^{-3} A^{1.03} G^{0.97}$	35
$1Q_{10} = 1.41 \times 10^{-4} A^{1.01} G^{1.58}$	35
$1Q_{20} = 3.80 \times 10^{-5} A^{1.00} G^{1.83}$	35
$3Q_2 = 5.77 \times 10^{-3} A^{1.02} G^{0.93}$	34
$3Q_{10} = 1.96 \times 10^{-4} A^{1.01} G^{1.52}$	35
$3Q_{20} = 5.21 \times 10^{-5} A^{1.01} G^{1.77}$	33
$7Q_2 = 9.78 \times 10^{-3} A^{1.03} G^{0.84}$	34
$7Q_{10} = 4.07 \times 10^{-4} A^{1.00} G^{1.39}$	35
$7Q_{20} = 1.34 \times 10^{-4} A^{0.99} G^{1.60}$	34
$30Q_2 = 0.209 A^{1.02} G^{0.31}$	31
$30Q_{10} = 4.64 \times 10^{-3} A^{1.03} G^{0.93}$	36
$30Q_{20} = 1.33 \times 10^{-3} A^{1.02} G^{1.15}$	36

Definitions of the above variables are:

XQ_y = estimated winter low-flow characteristic for the indicated number of consecutive days (X) at the indicated recurrence interval (y);
A = contributing drainage area, in square miles; and
G = streamflow-recession index, in days per log cycle of decrease in discharge, determined from plate 1.

INTRODUCTION

Information on low flow characteristics in streams is essential to surface-water quality and water-supply management. The amount of available water in a stream for assimilation and transport of waste is the critical factor in determining the load capacity of the stream and withdrawal rates for water supply. With the current emphasis on reducing the cost of municipal waste-water treatment plants, the need for winter low-flow information is important to regulatory agencies concerned with this disposal into streams. The anticipated needs for low-flow estimates will increase throughout the State due to U.S. Environmental Protection Agency requirements for review of municipal effluent limits. Immediate applications of the results of this project are to: (1) update the low-flow characteristics of gaged streams, and (2) derive new methods with improved reliability for estimating low-flow characteristics at ungaged stream sites.

In response to the expected increase for low-flow information, the U.S. Geological Survey, in cooperation with the Tennessee Department of Health and Environment, began a study in 1981 to estimate low flow of streams in Tennessee. The study was divided into two phases. During the first phase, statistical analyses of daily streamflow data for continuous-record gaging stations were performed to calculate low flow for selected recurrence intervals and duration of streamflow (Bingham, 1985).

During the second phase of the study, equations were derived by multiple regression techniques to estimate annual low-flow characteristics of ungaged streams in Tennessee. Results of the second phase of the study are in a report by Bingham (1986).

In 1984, the study was extended to derive methods for estimating seasonal low-flow characteristics of ungaged streams, which this report describes. Seasonal low-flow characteristics for continuous-record gages are the discharges taken from a frequency curve of the seasonal values of the lowest mean discharge for a given number of consecutive days. The seasons for these analyses are winter (December 1 through April 30), and summer (May 1 through November 30). Statistical analyses indicate that summer low-flow characteristics are the same as annual low-flow characteristics, and that winter low flows are larger than annual low flows. Thus, for additional analyses in this study only winter low flows are considered. The winter low-flow frequency data for each gage were derived by an adaptation of the log-Pearson Type III flood-frequency program described in U.S. Water Resources Council Bulletin 17B (1981). Curves from the analyses were adjusted to the observed data for stations where significant differences in the plotting positions of observed and predicted values occurred (Riggs, 1972). Winter low-flow characteristics for partial-record stations were estimated by correlating measurements at the partial-record stations with concurrent discharges at continuous-record stations.

The purpose of this report is to describe procedures for estimating winter low-flow characteristics in ungaged streams in Tennessee and to summarize methods of analyses. This report is based on low-flow data collected as part of other programs with the Tennessee Department of Health and Environment and with other state and federal agencies.

LIMITATIONS AND ACCURACY OF EQUATIONS

Accuracy of the regression equations is expressed as standard error of estimate in percent. Standard error is computed from the difference between estimates of winter low flow from station data and estimates of winter low flow from the regression equations. Standard error of estimate is the range of error to be expected about two-thirds of the time. The standard error of estimate listed with each of the preceding equations is based on regression analyses using a streamflow-recession index determined from mapped values on plate 1.

The regression equations in this report are limited to estimating the indicated winter low-flow characteristics in natural flow streams in Tennessee. The equations are based on drainage areas ranging from 25 to 1,940 mi^2 for West Tennessee streams, and streamflow-recession indexes ranging from 32 to 350. The following table gives the range in winter low flows corresponding to each low-flow characteristic for stations used in the regressions for West Tennessee.

Low-flow characteristic	Range in winter low flow, in cubic feet per second	
	From	To
$1Q_2$	1.1	829
$1Q_{10}$	.4	466
$1Q_{20}$	.4	406
$3Q_2$	1.1	849
$3Q_{10}$	.4	474
$3Q_{20}$	.3	412
$7Q_2$	1.4	936
$7Q_{10}$	.5	502
$7Q_{20}$	.4	431
$30Q_2$	5.0	1540
$30Q_{10}$	.9	686
$30Q_{20}$	.6	551

Drainage areas ranged from 2.68 to 2,557 mi^2 for Middle and East Tennessee streams, and streamflow-recession indexes ranged from 32 to 175. The following table gives the range in winter low flows corresponding to each low-flow characteristic for stations used in the regressions for Middle and East Tennessee.

Low-flow characteristic	Range in winter low flow, in cubic feet per second	
	From	To
$1Q_2$	0.9	1340
$1Q_{10}$	.3	749
$1Q_{20}$	.2	628
$3Q_2$	1.0	1425
$3Q_{10}$	.3	818
$3Q_{20}$	.2	689
$7Q_2$	1.1	1604
$7Q_{10}$	.4	941
$7Q_{20}$	.3	794
$30Q_2$	1.8	2150
$30Q_{10}$	.6	1195
$30Q_{20}$	.3	1005

Use of the equations should be limited to the range in winter low flow, drainage area, and streamflow-recession indexes used to derive the equations.

The regression equations should not be used on streams where the low flow is significantly affected by regulation or other activities of man. Caution should be used when applying the equations to streams where a significant amount of the low flow is contributed by springs. Definition of the contributing drainage area, in such cases, is uncertain; some of the spring flow might be from adjacent basins. Caution also should be used in applying the equations to streams where most of the formation at or near land surface is limestone. Solution cavities in the limestone may alter the rate of flow considerably within short reaches of the stream channel. For example, a stream channel in limestone can have winter low flow of several cubic feet per second at one site and have zero flow at another site downstream. This commonly occurs in Overton, Putnam, White, Warren, Rutherford, and Williamson Counties of Middle Tennessee, and may occur locally in other counties.

Standard error of estimate listed for each regression equation applies only to the stations used in deriving the regression equation. The average errors associated with use of the equations to estimate winter low flows in ungaged streams are unknown, but are probably slightly larger than the standard errors of the equations.

ESTIMATES OF WINTER LOW-FLOW CHARACTERISTICS AT UNGAGED SITES

The following procedures can be used to estimate winter low flows for ungaged sites on streams with natural flow in Tennessee. From topographic maps, determine the size of drainage area upstream from the site. From plate 1, determine the streamflow-recession index for the stream basin. Winter low flows for the site can be estimated by substituting the values of drainage area size and streamflow-recession index into the appropriate regression equations and performing the indicated mathematical operations or by graphical determination using figures 1 through 24. Examples using the regression equations and graphs to estimate winter low flow in ungaged streams are given in Supplement A of this report.

The estimating methods are modified for a stream basin draining two or more areas of different streamflow-recession indexes. Drainage area is determined as described in the preceding paragraph. However, discharge from each of two or more streamflow-recession index areas must be computed separately using the equations, and the results weighted based on an estimate of the percentage of the basin draining each streamflow-recession index area.

VERIFICATION OF REGRESSION EQUATIONS AT PARTIAL-RECORD SITES

The regression equations were used to estimate winter $3Q_{20}$ for 238 low-flow partial-record stations within the State (plate 2) and the results were compared with low-flow estimates obtained from correlation methods. The 238 stations exclude those used in the regression analyses. Estimated winter low flows, drainage area, mapped streamflow-recession index (plate 1), and identification number for the stations are given in Supplement B for West Tennessee and in Supplement C for Middle and East Tennessee. The stations are the same as those used in previous low-flow regionalization work by Bingham (1986). Stations listed in Supplements B and C are assumed to represent flow unaffected by man's activity, and have drainage areas and low-flow values within the limitations of data used to derive the equations for winter $3Q_{20}$.

The regression equations were used to estimate winter $3Q_{20}$ low flow for partial-record stations and the results were compared withestimates obtained from correlation methods. The standard error of estimate was approximated by assuming the correlation values of winter $3Q_{20}$ low flow to be accurate. Residuals, in log units, were determined as the difference in logarithms of winter low flows from regression equations and from correlation methods. The error was computed by the root-mean-square procedure using the equation:

$$RMS = \sqrt{\bar{x}^2 + S^2},$$

where RMS = root mean square, in log units,
$\bar{x}$ = mean of the residuals, in log units, and
S = standard deviation of the residuals, in log units.

Computed RMS values, in log units, were converted to 36 percent for 33 partial-record stations in West Tennessee and to 44 percent for 205 partial-record stations in Middle and East Tennessee. A two-sided student's t test indicated insignificant bias in winter low flows determined by the regression equations.

Other comparisons of the winter low-flow estimates were made with graphical plots. The winter $3Q_{20}$ low flows from correlation methods for the

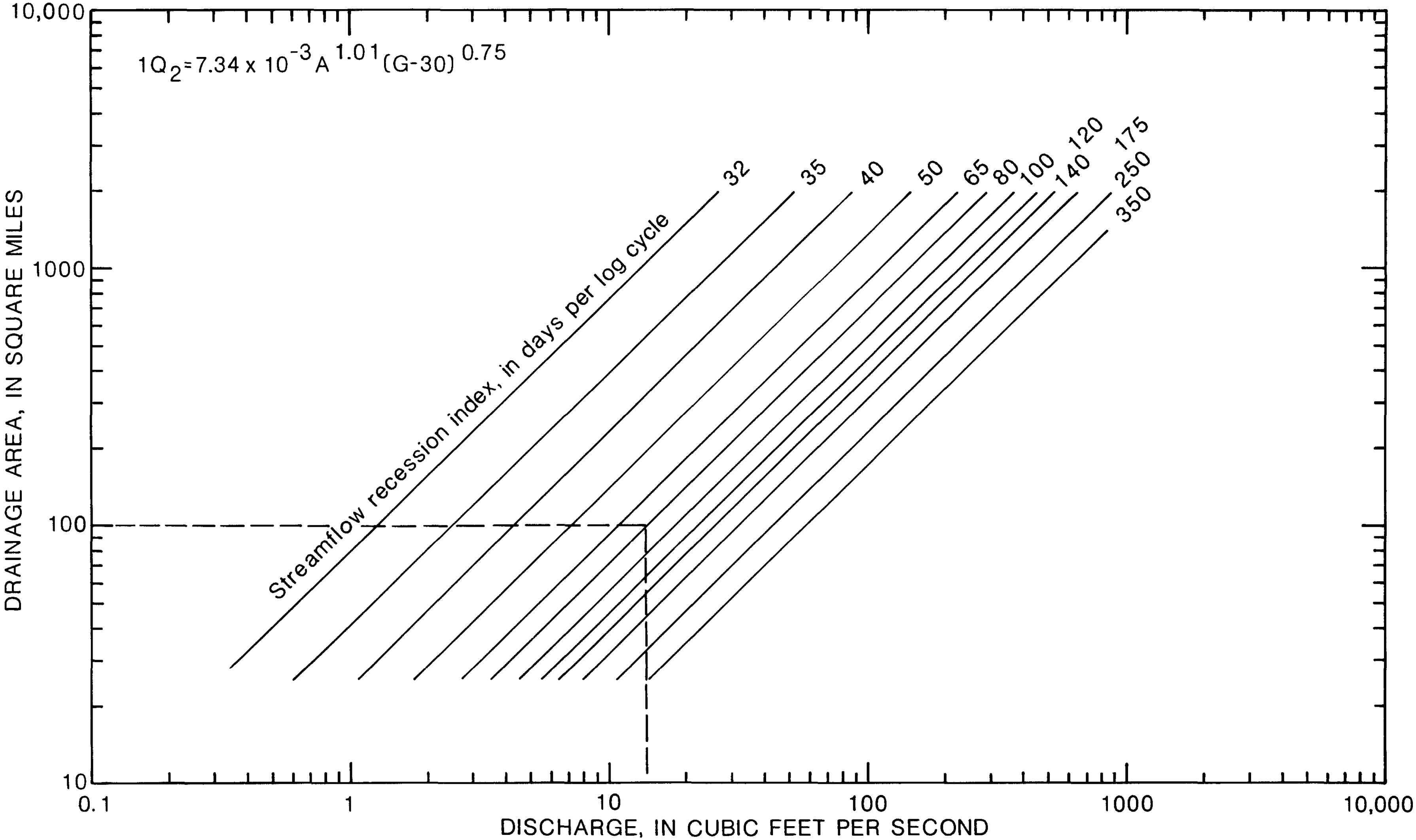

Figure 1.--Graphical solution of winter 1-day 2-year low-flow equation for West Tennessee.

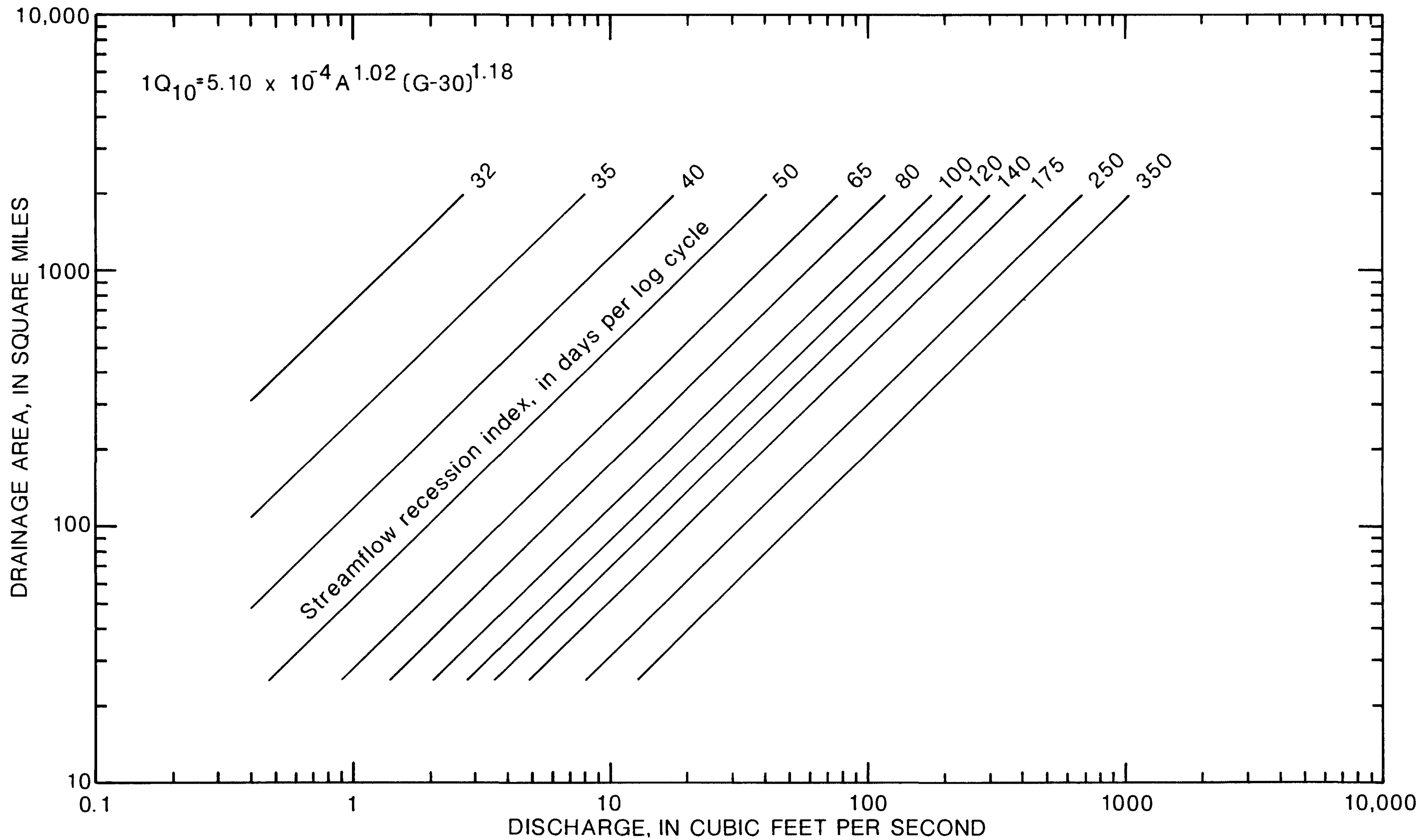

Figure 2.--Graphical solution of winter 1-day 10-year low-flow equation for West Tennessee.

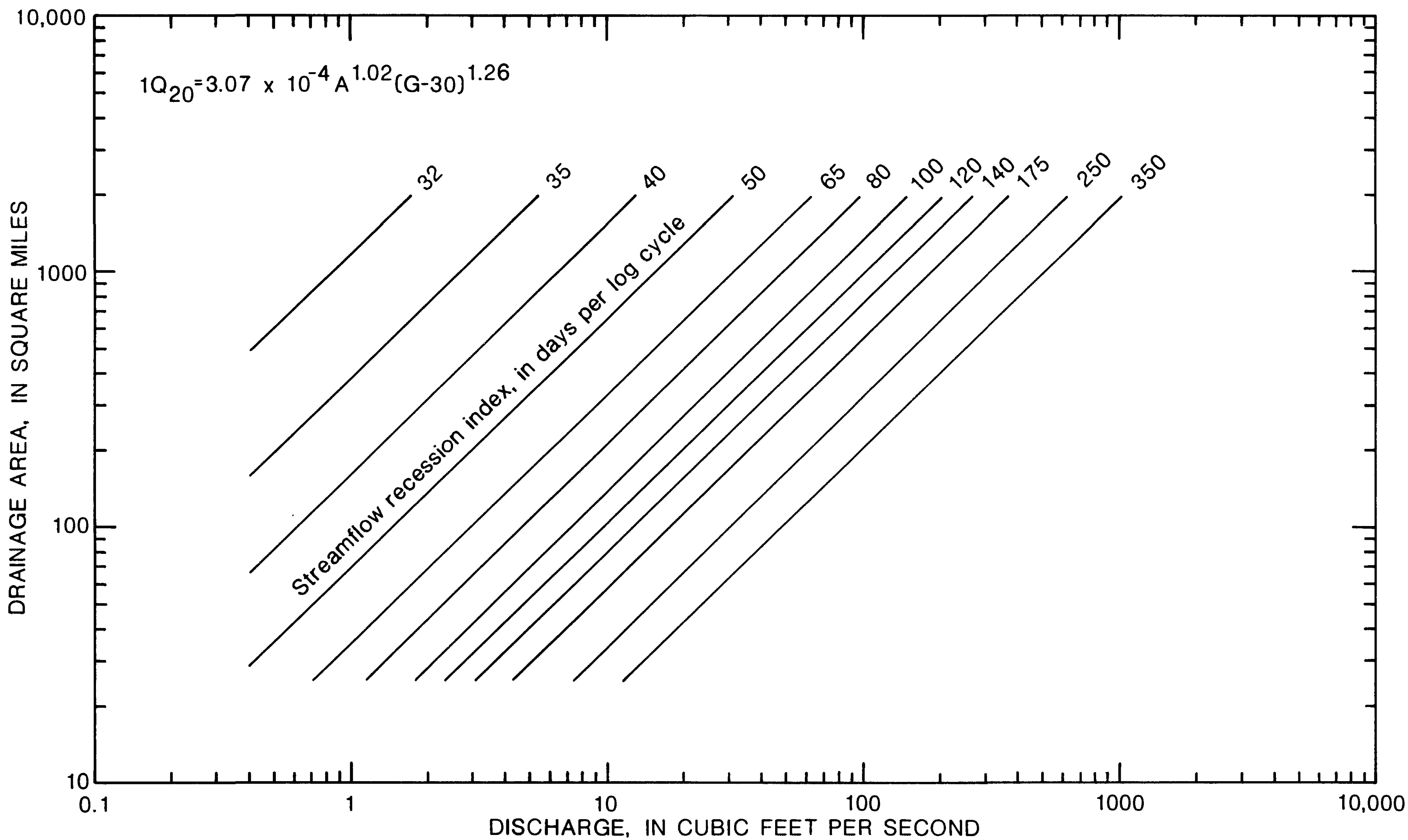

Figure 3.--Graphical solution of winter 1-day 20-year low-flow equation for West Tennessee.

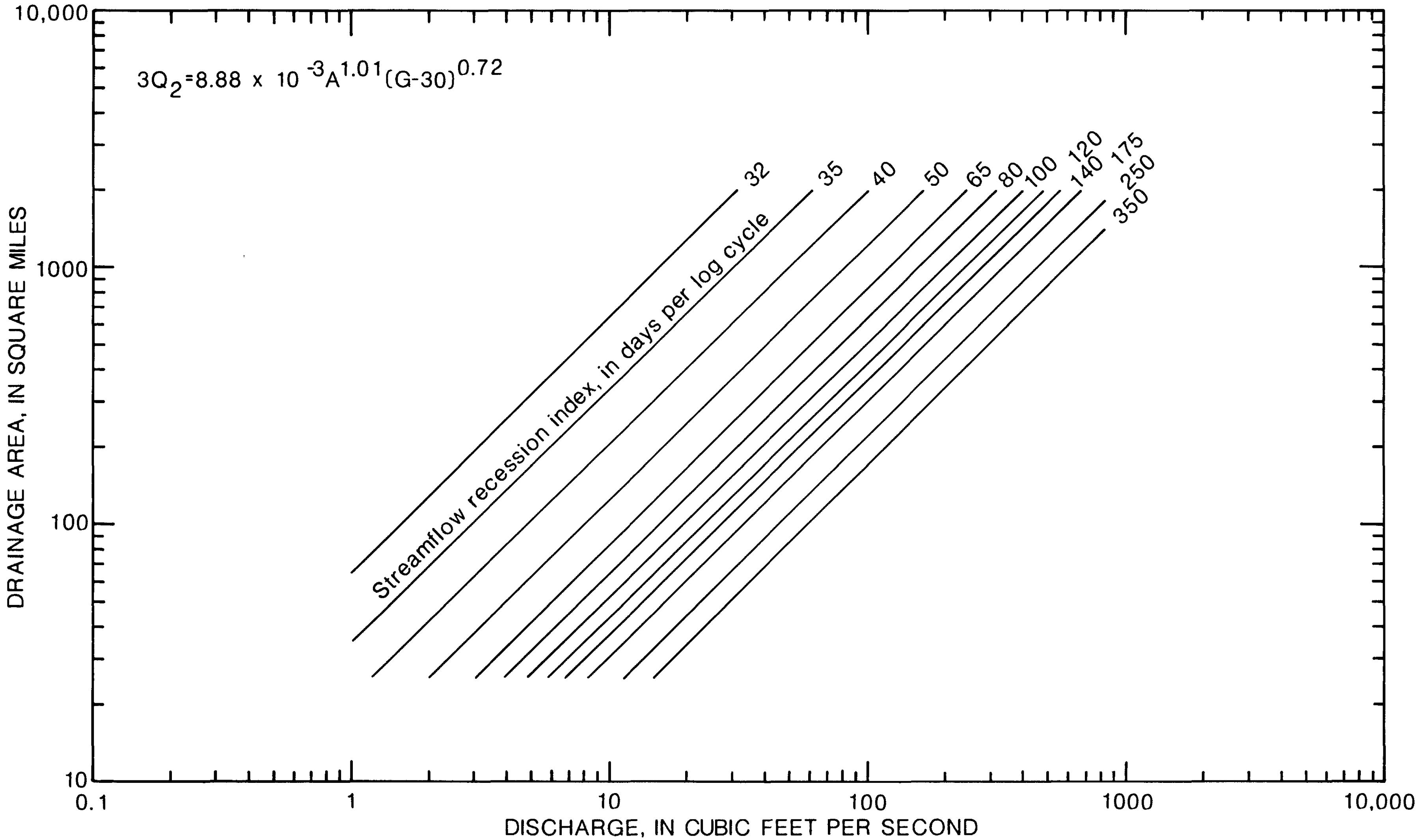

Figure 4.--Graphical solution of winter 3-day 2-year low-flow equation for West Tennessee.

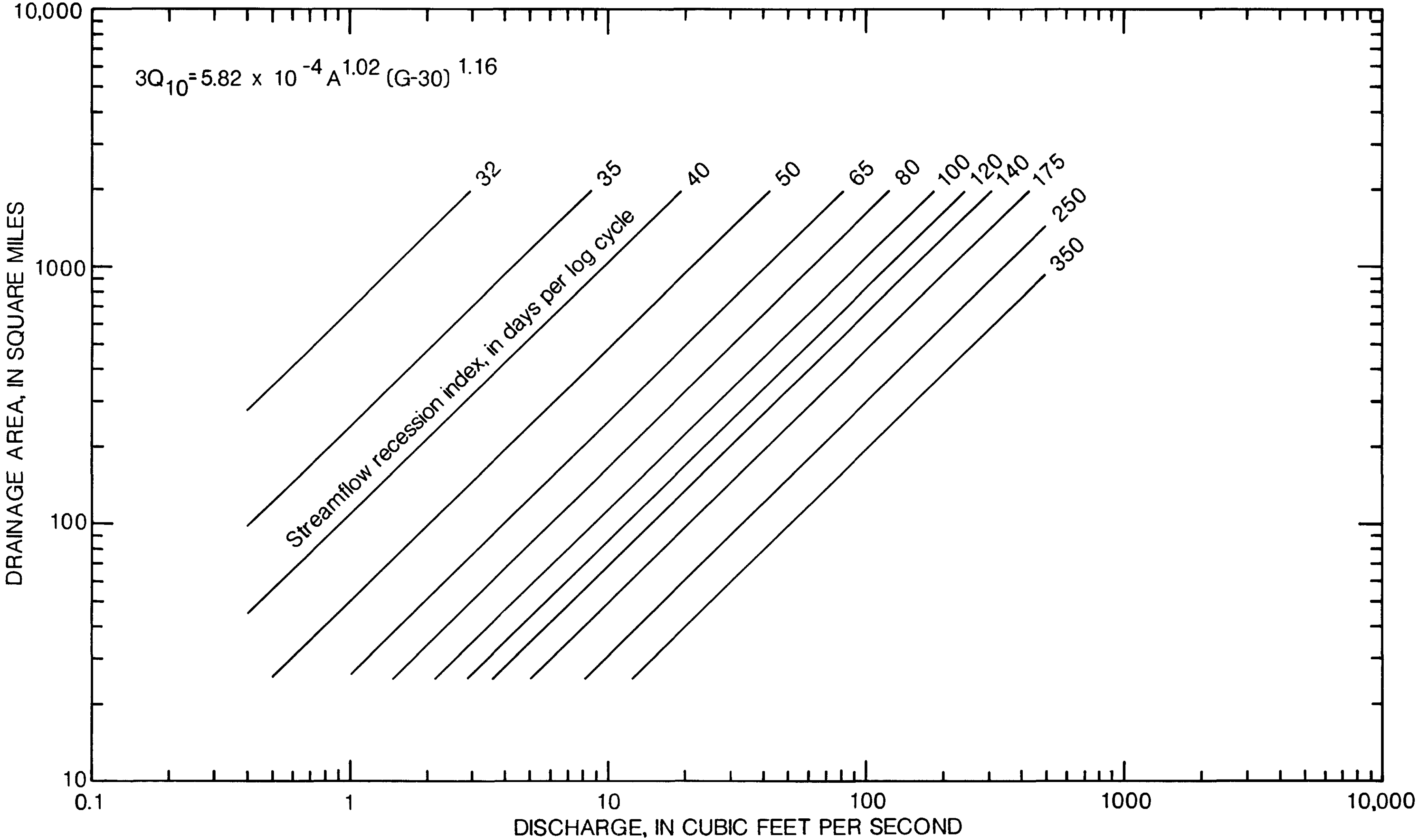

Figure 5.--Graphical solution of winter 3-day 10-year low-flow equation for West Tennessee.

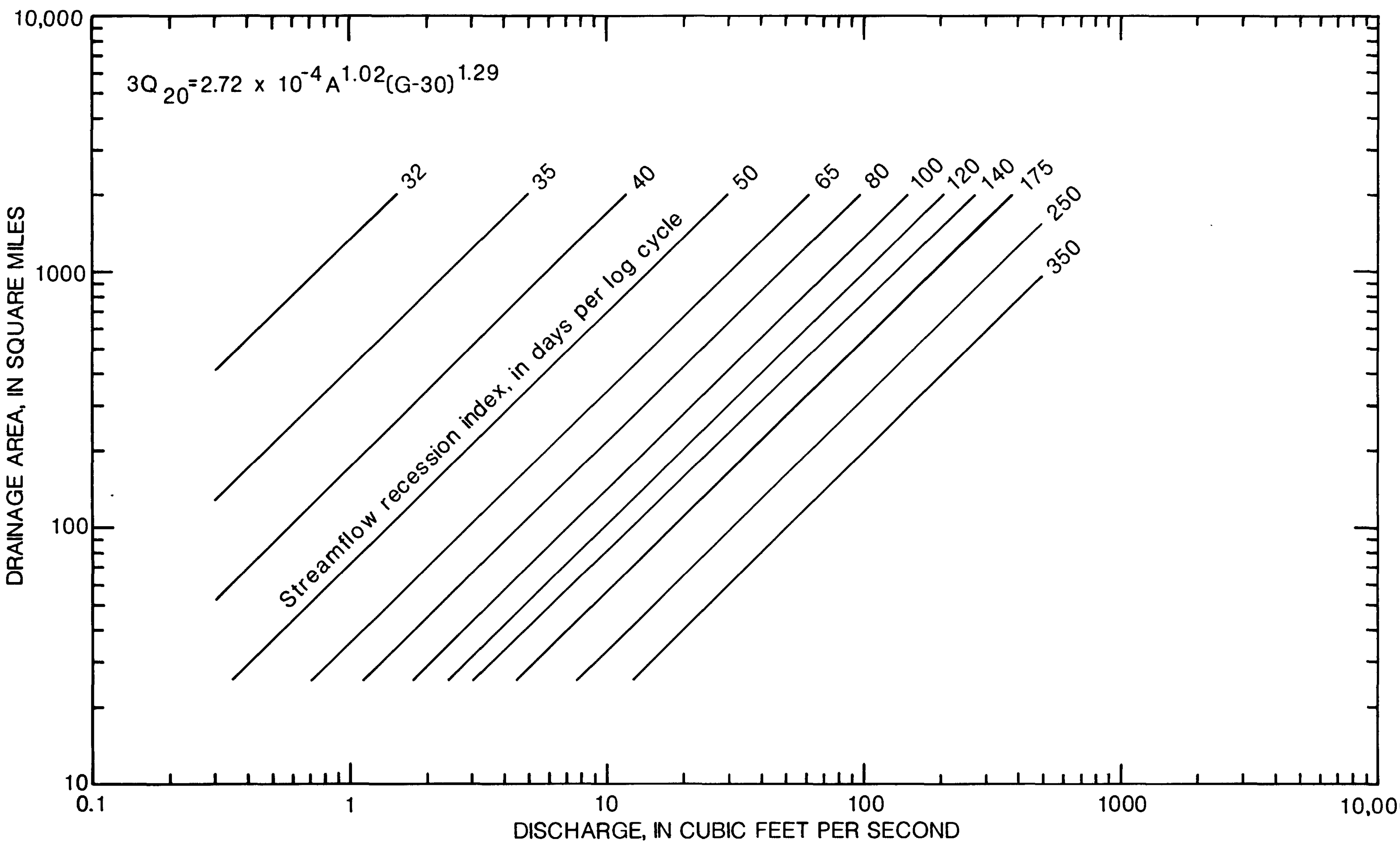

Figure 6.--Graphical solution of winter 3-day 20-year low-flow equation for West Tennessee.

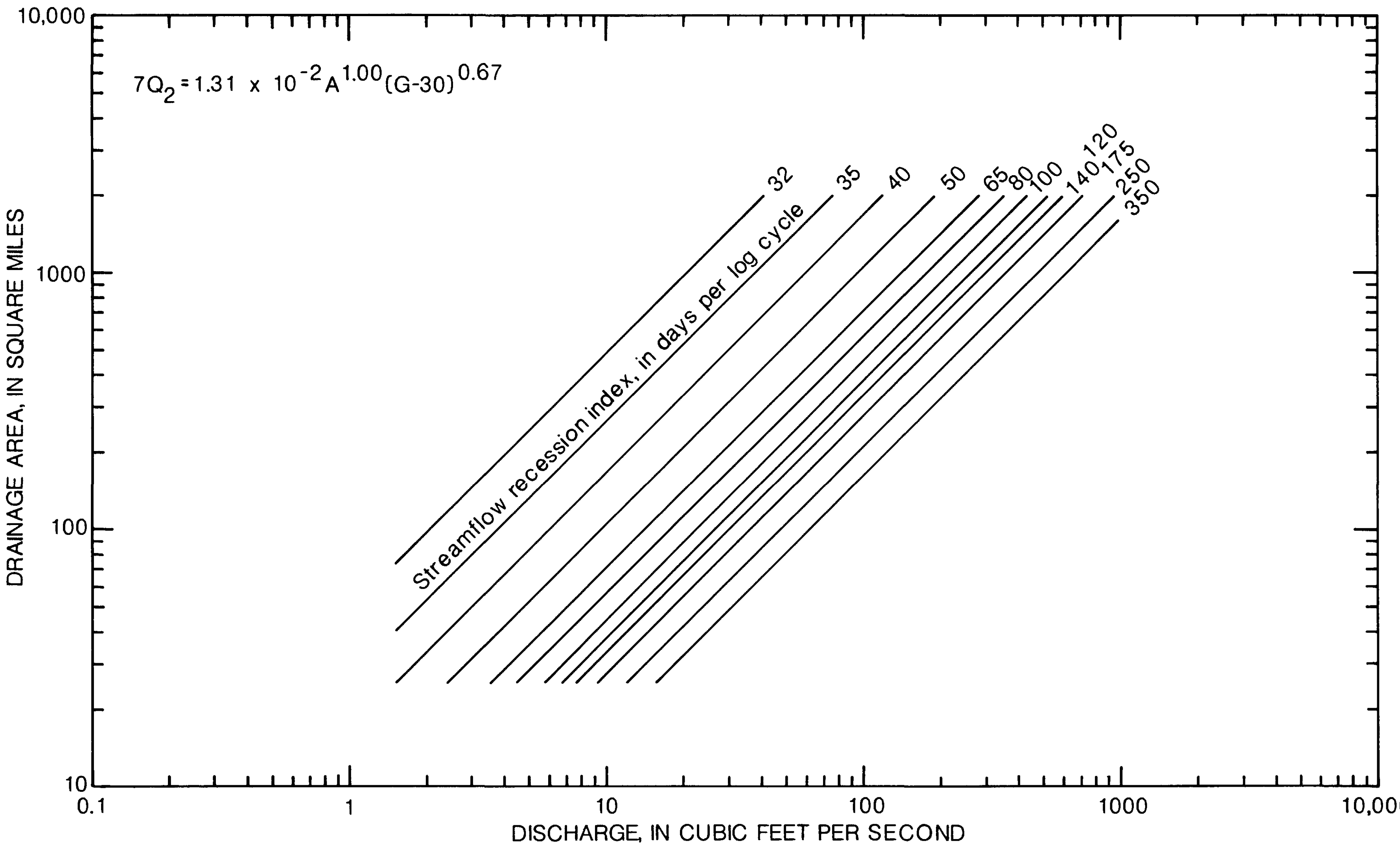

Figure 7.--Graphical solution of winter 7-day 2-year low-flow equation for West Tennessee.

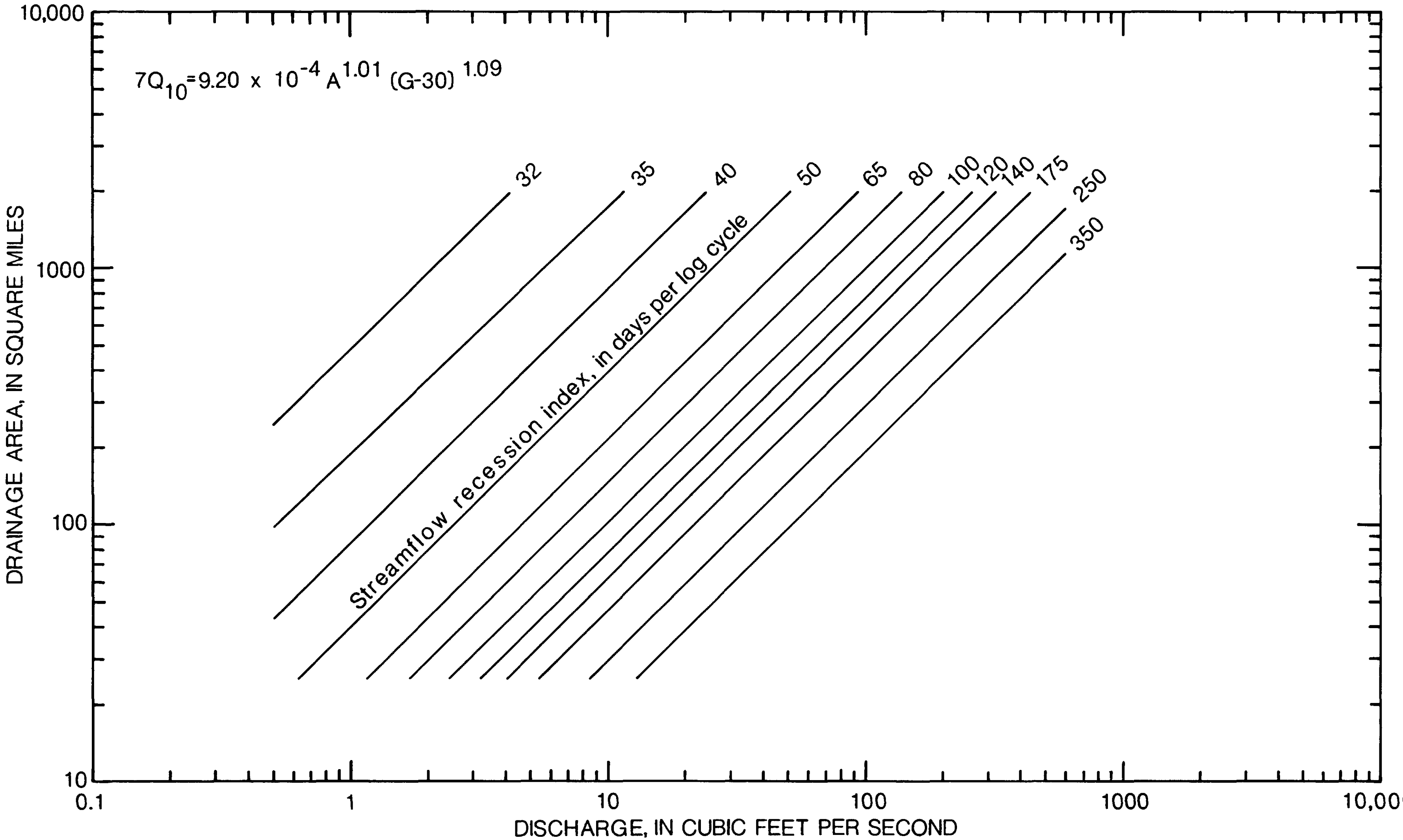

Figure 8.--Graphical solution of winter 7-day 10-year low-flow equation for West Tennessee.

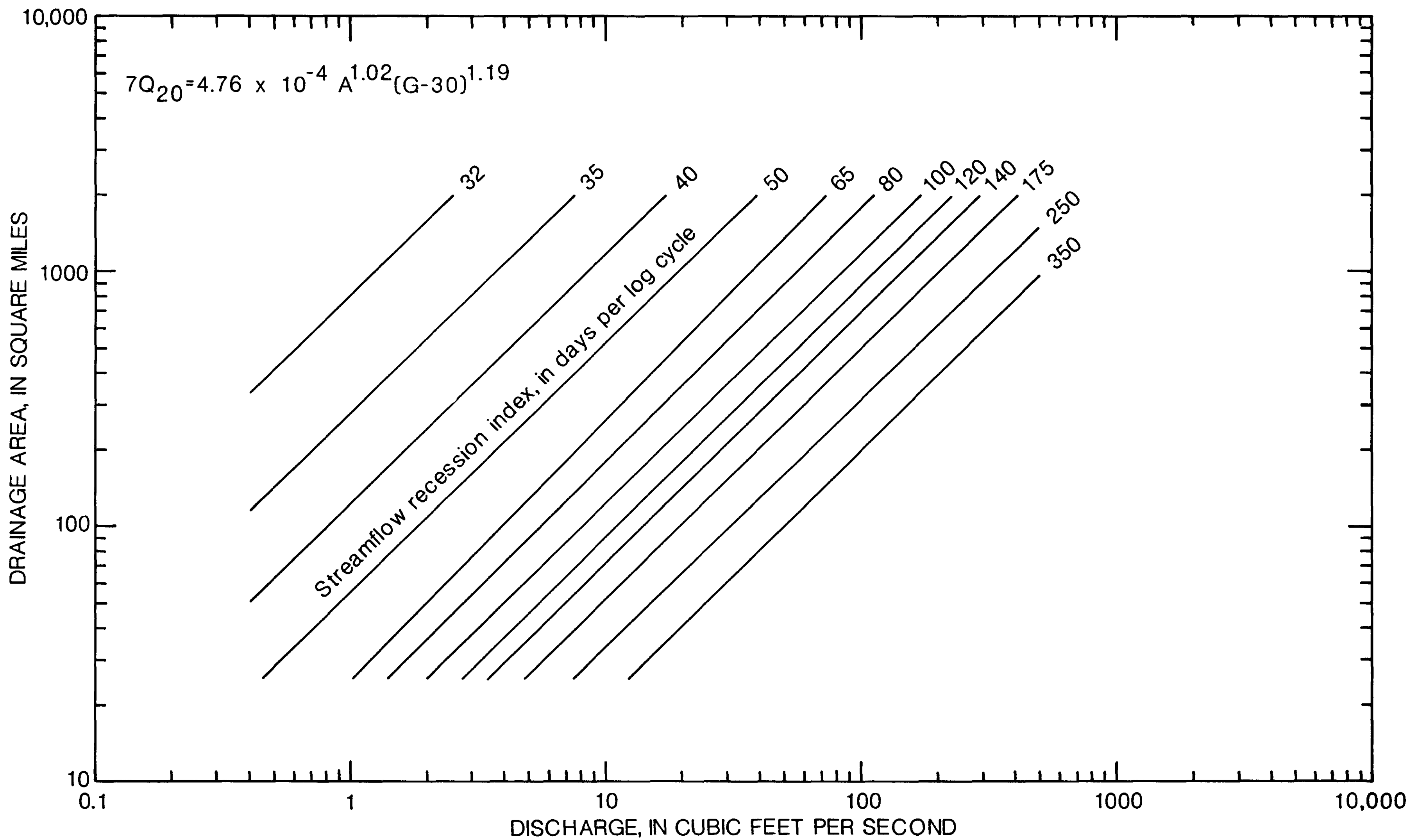

Figure 9.--Graphical solution of winter 7-day 20-year low-flow equation for West Tennessee.

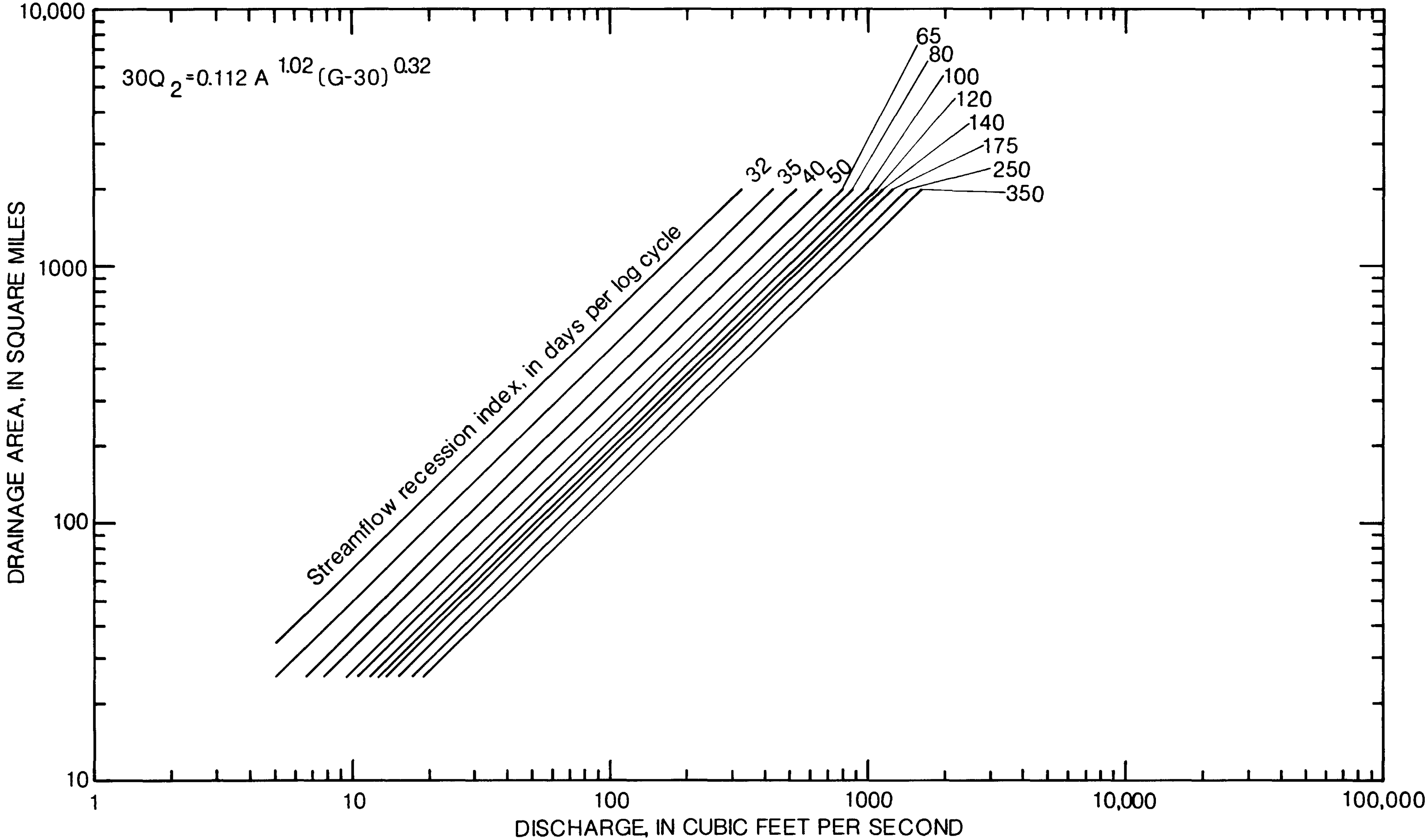

Figure 10.--Graphical solution of winter 30-day 2-year low-flow equation for West Tennessee.

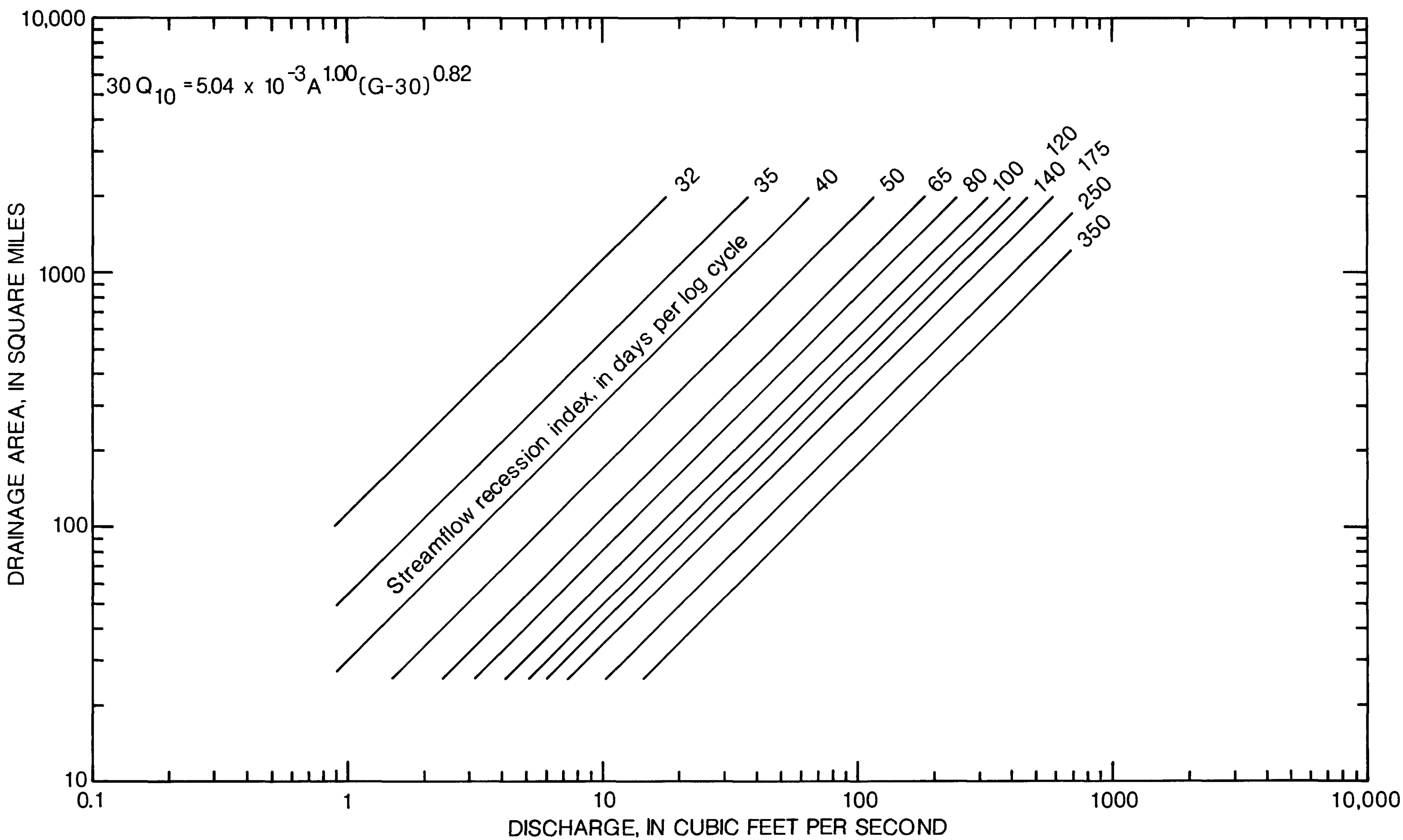

Figure 11.--Graphical solution of winter 30-day 10-year low-flow equation for West Tennessee.

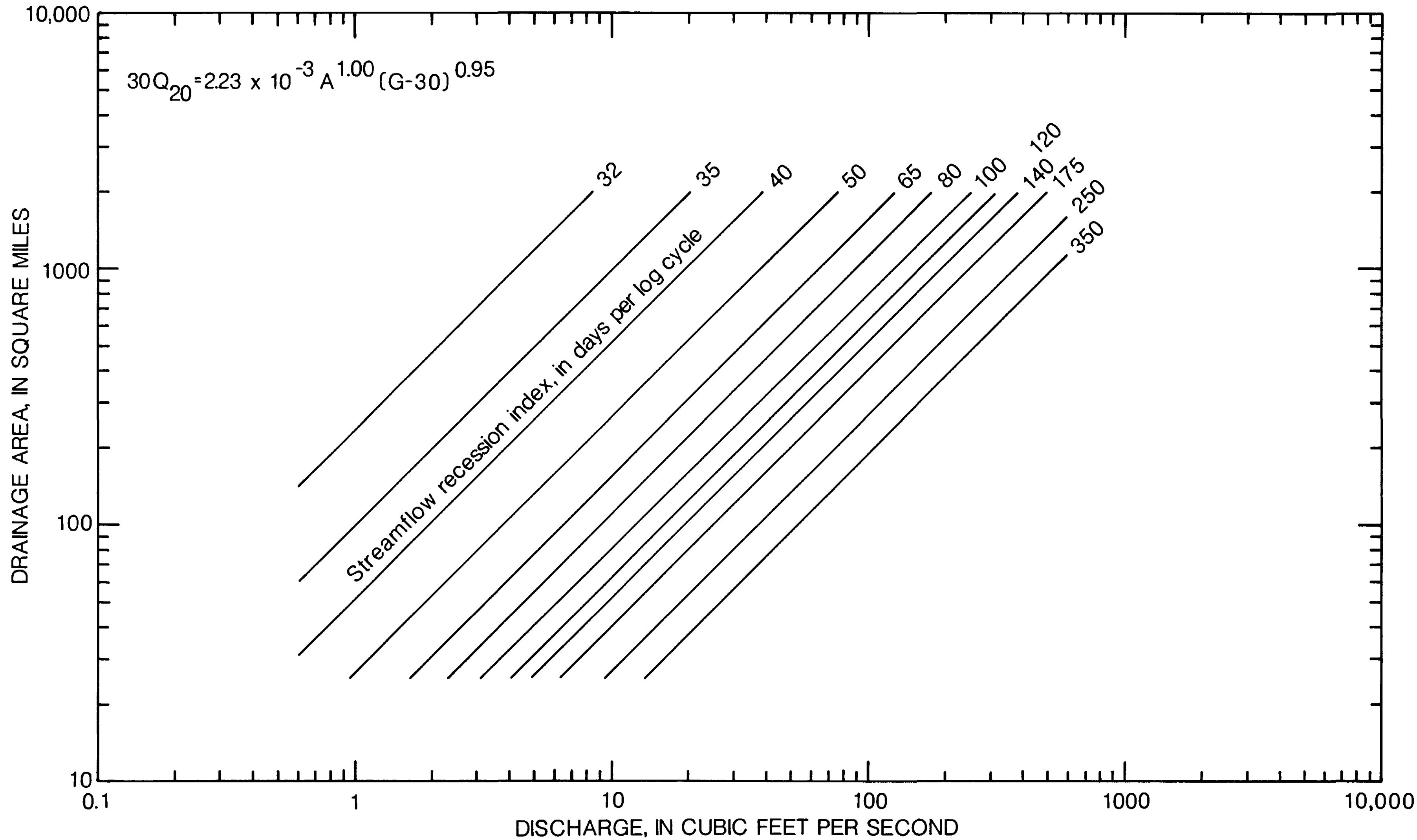

Figure 12.--Graphical solution of winter 30-day 20-year low-flow equation for West Tennessee.

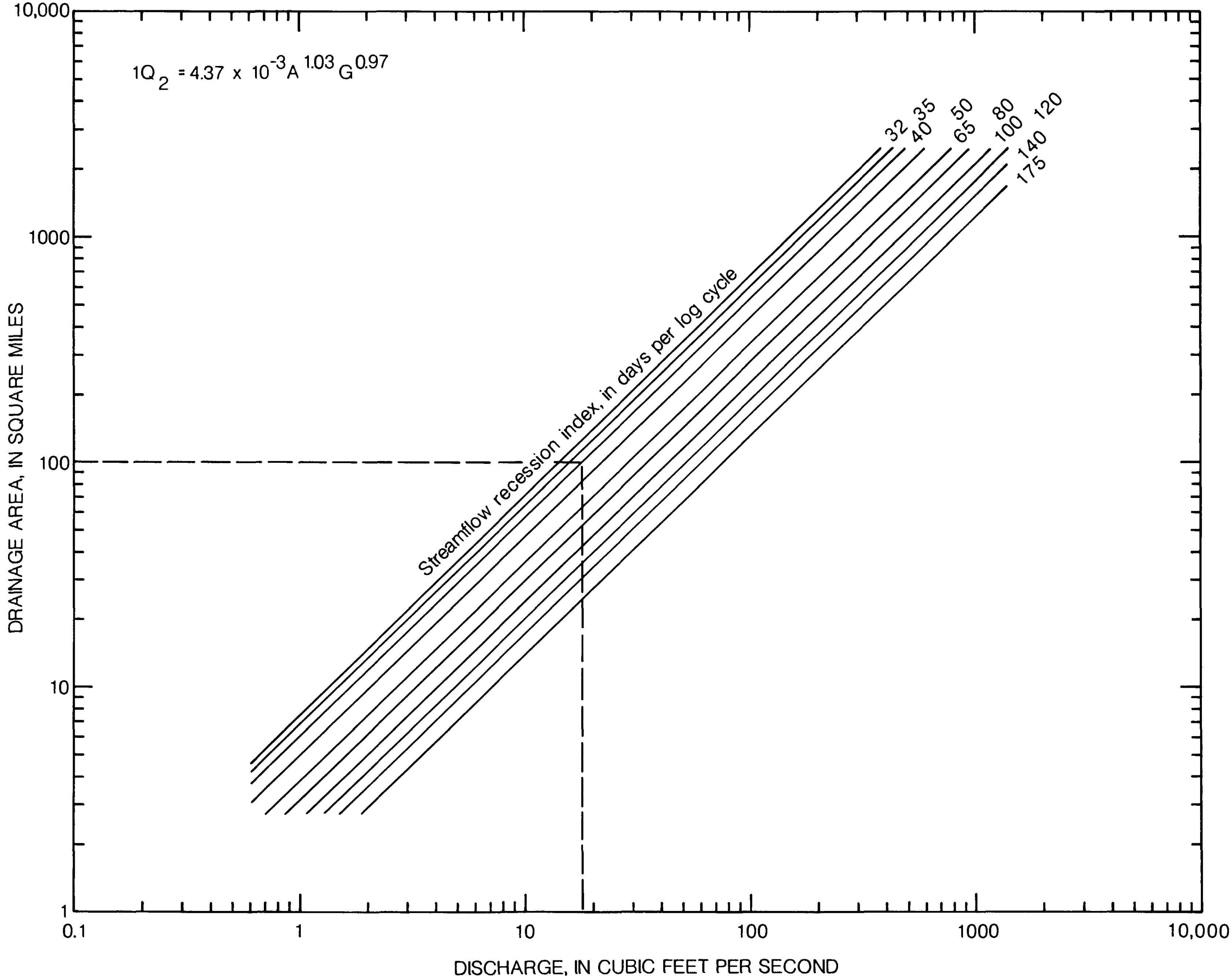

Figure 13.–Graphical solution of winter 1-day 2-year low-flow equation for Middle and East Tennessee.

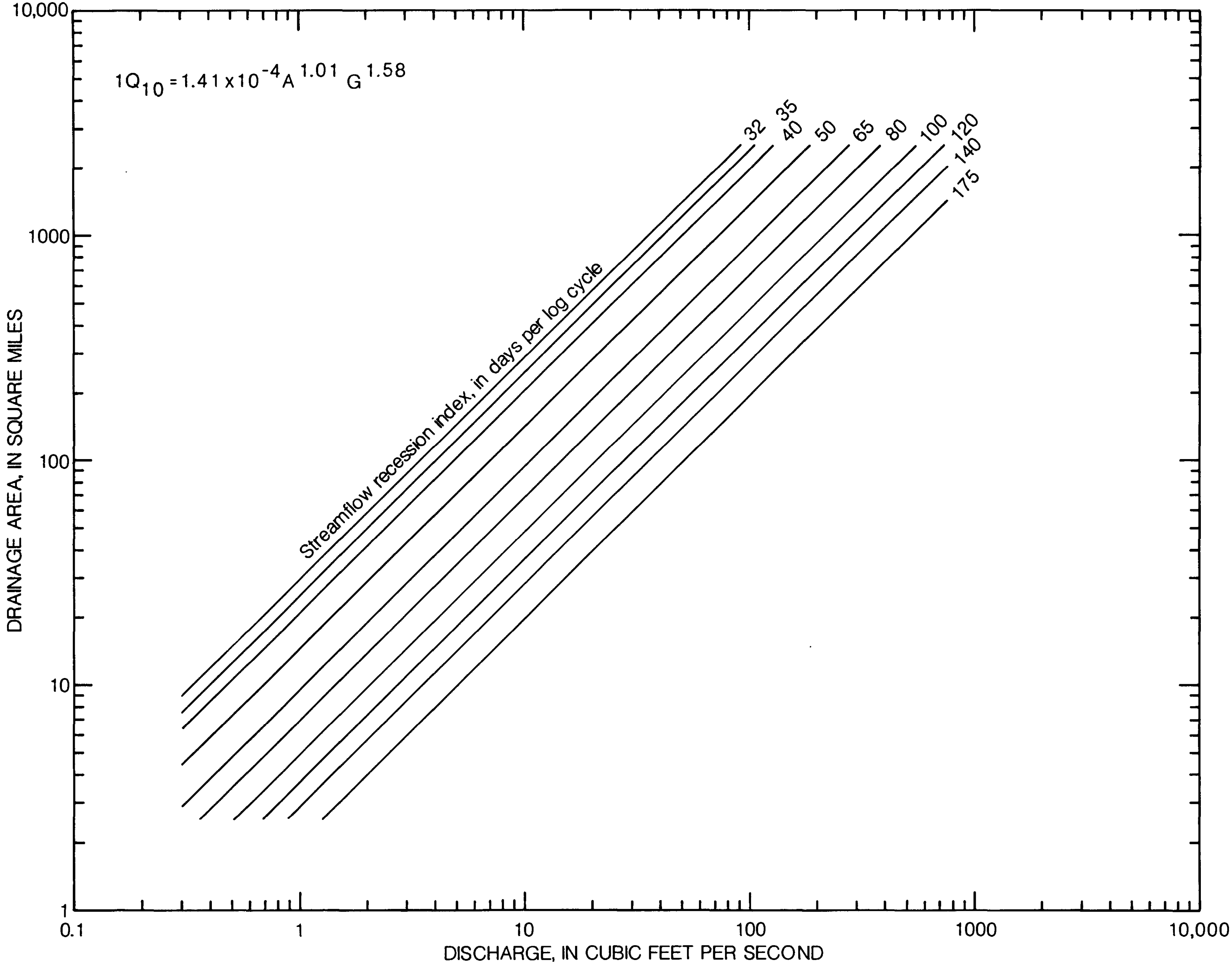

Figure 14.--Graphical solution of winter 1-day 10-year low-flow equation for Middle and East Tennessee.

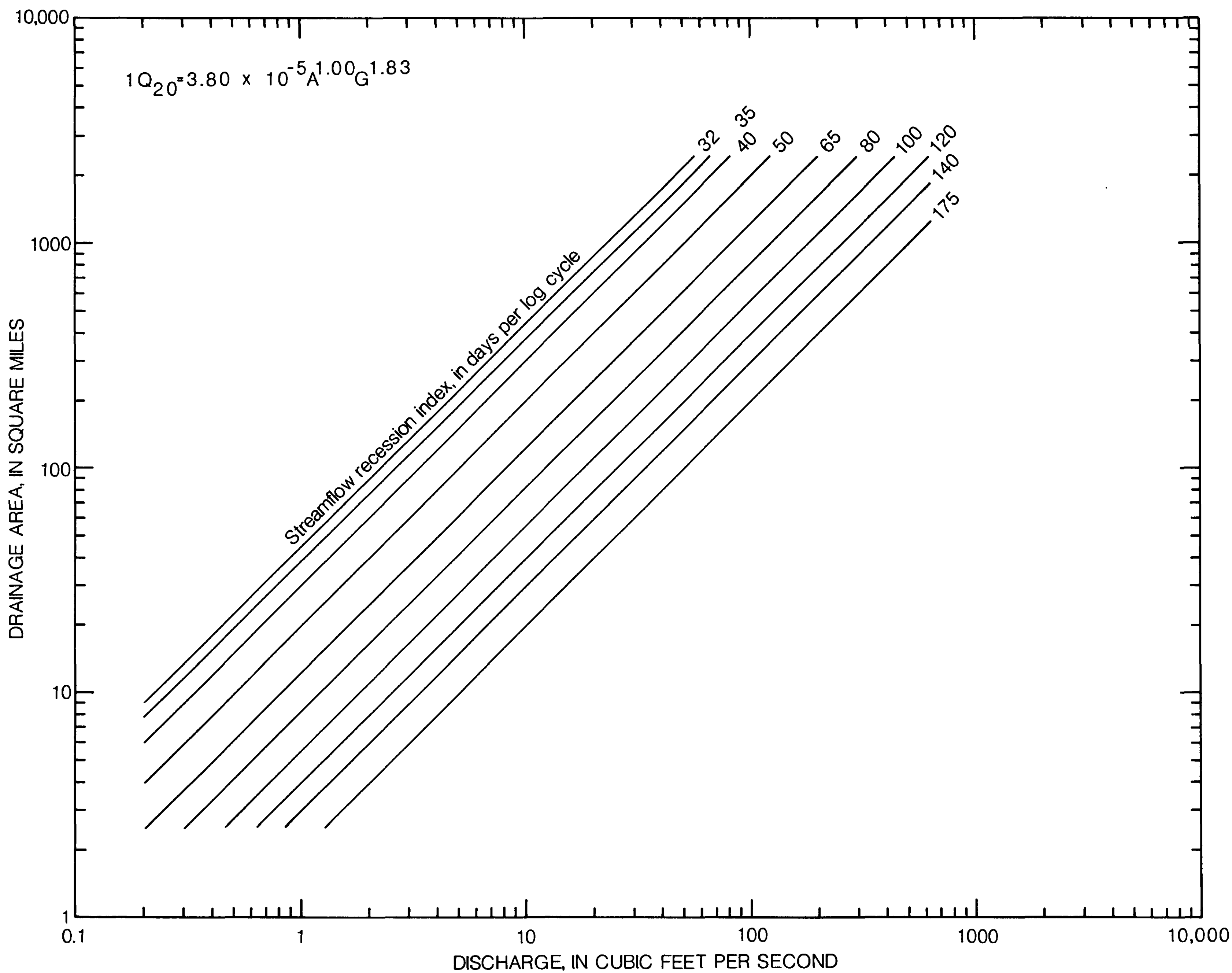

Figure 15.--Graphical solution of winter 1-day 20-year low-flow equation for Middle and East Tennessee.

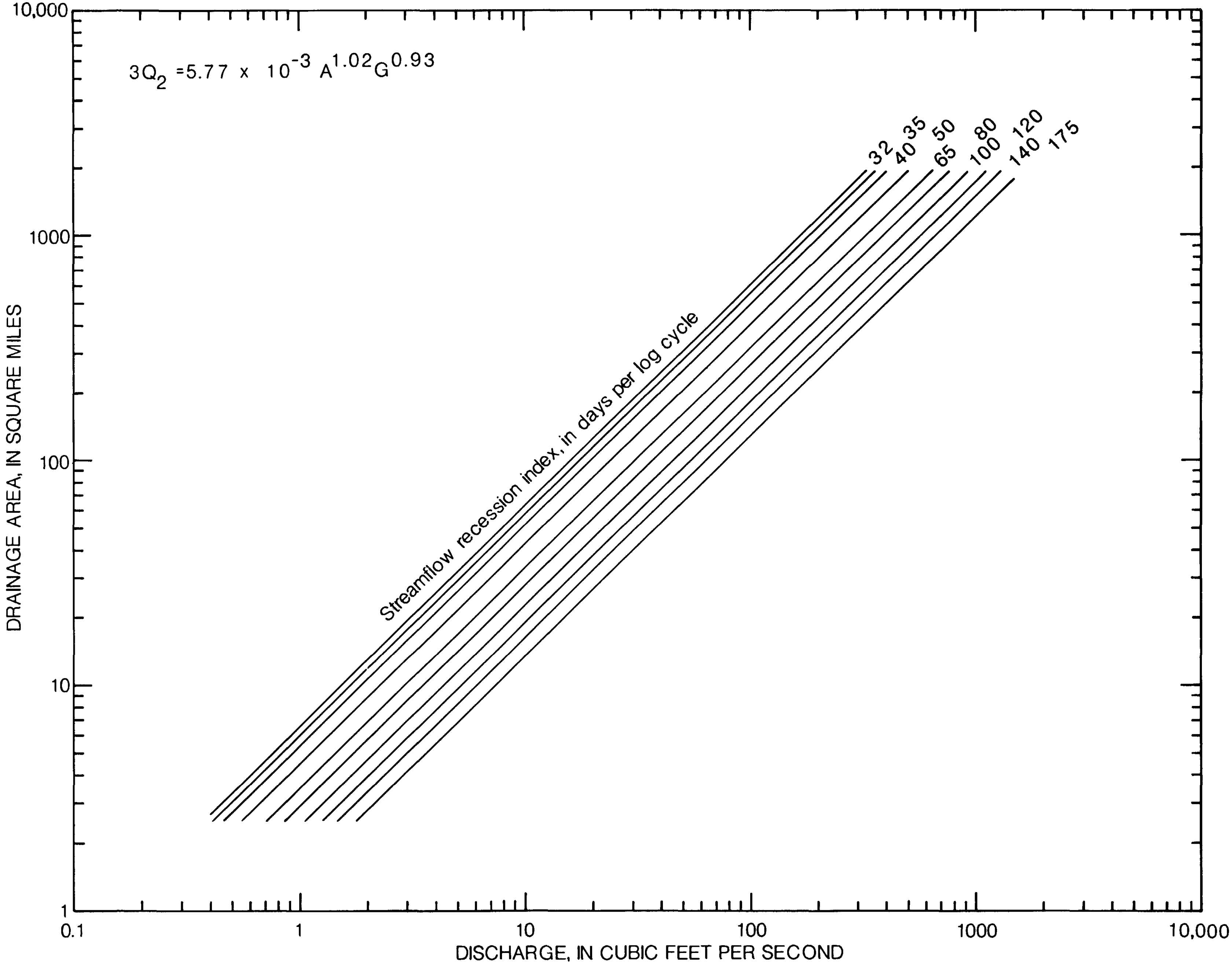

Figure 16.--Graphical solution of winter 3-day 2-year low-flow equation for Middle and East Tennessee.

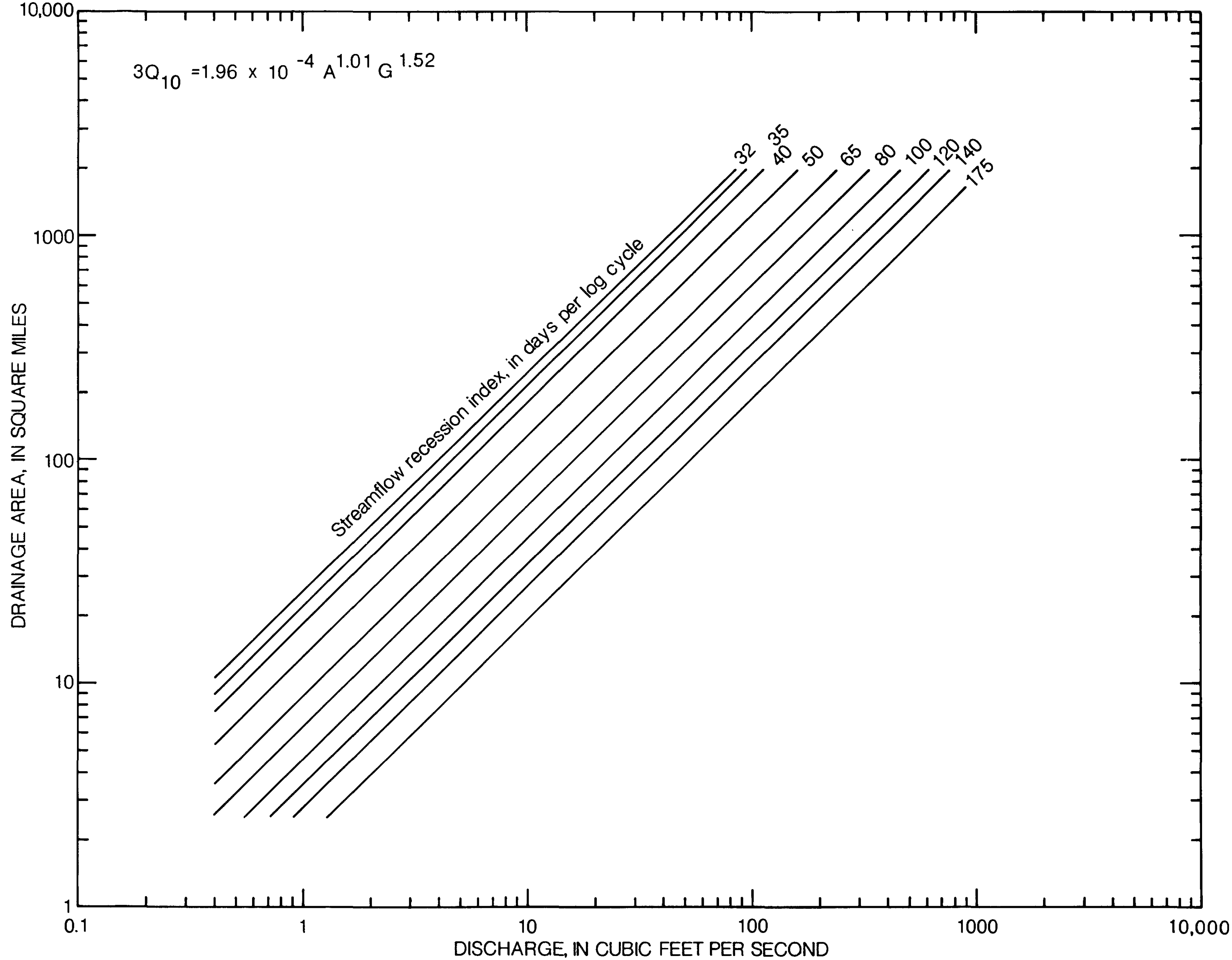

Figure 17.--Graphical solution of winter 3-day 10-year low-flow equation for Middle and East Tennessee.

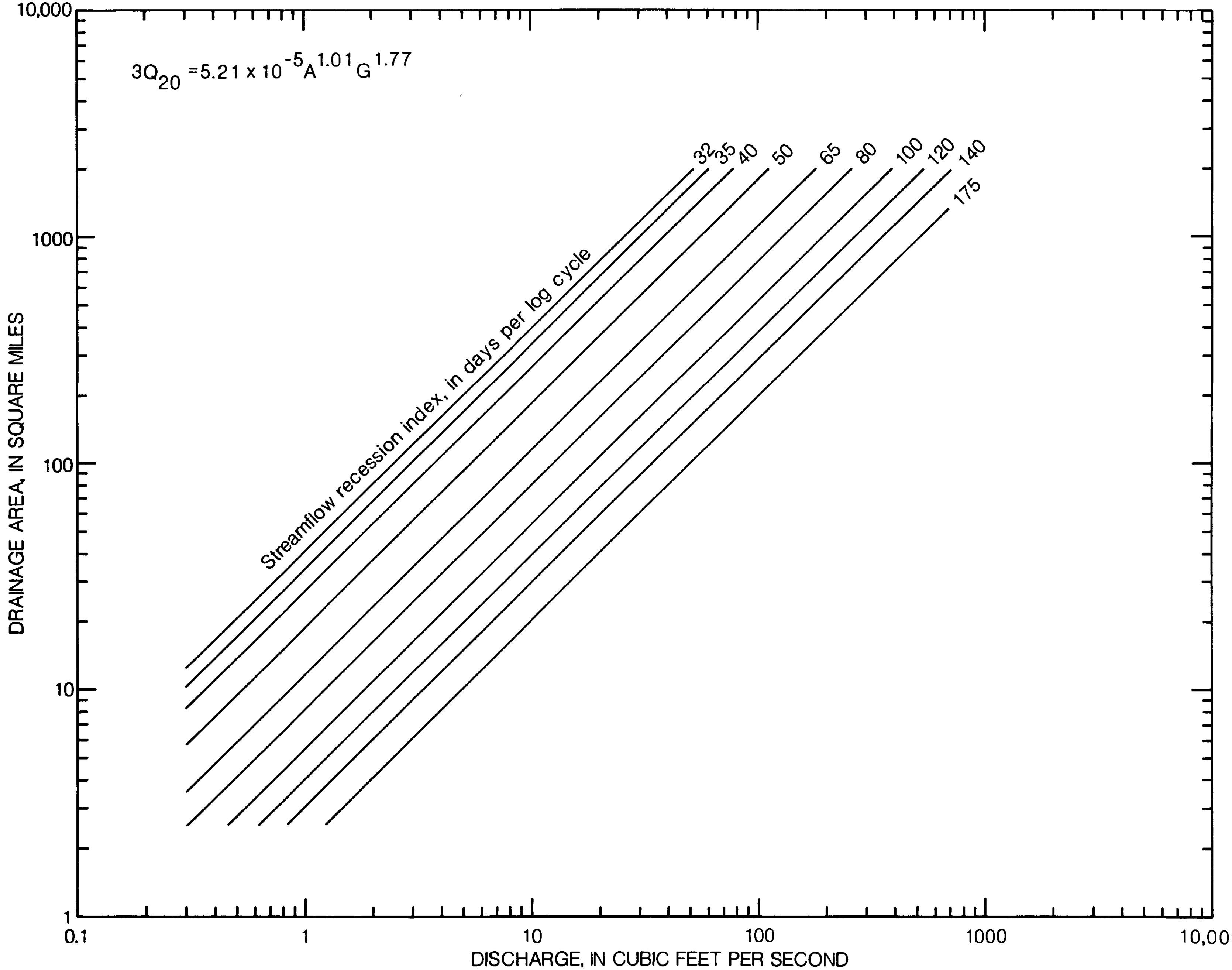

Figure 18.--Graphical solution of winter 3-day 20-year low-flow equation for Middle and East Tennessee.

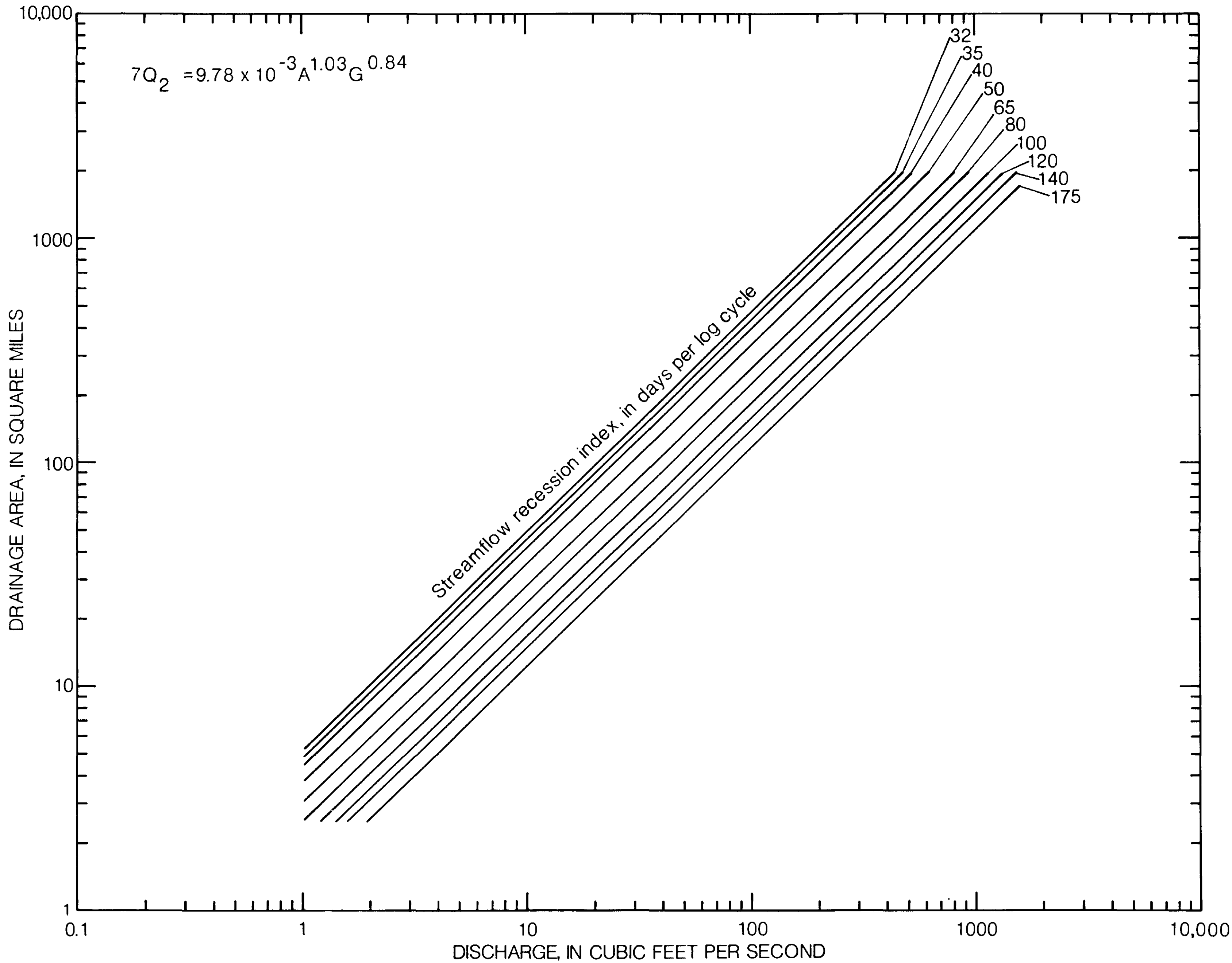

Figure 19.--Graphical solution of winter 7-day 2-year low-flow equation for Middle and East Tennessee.

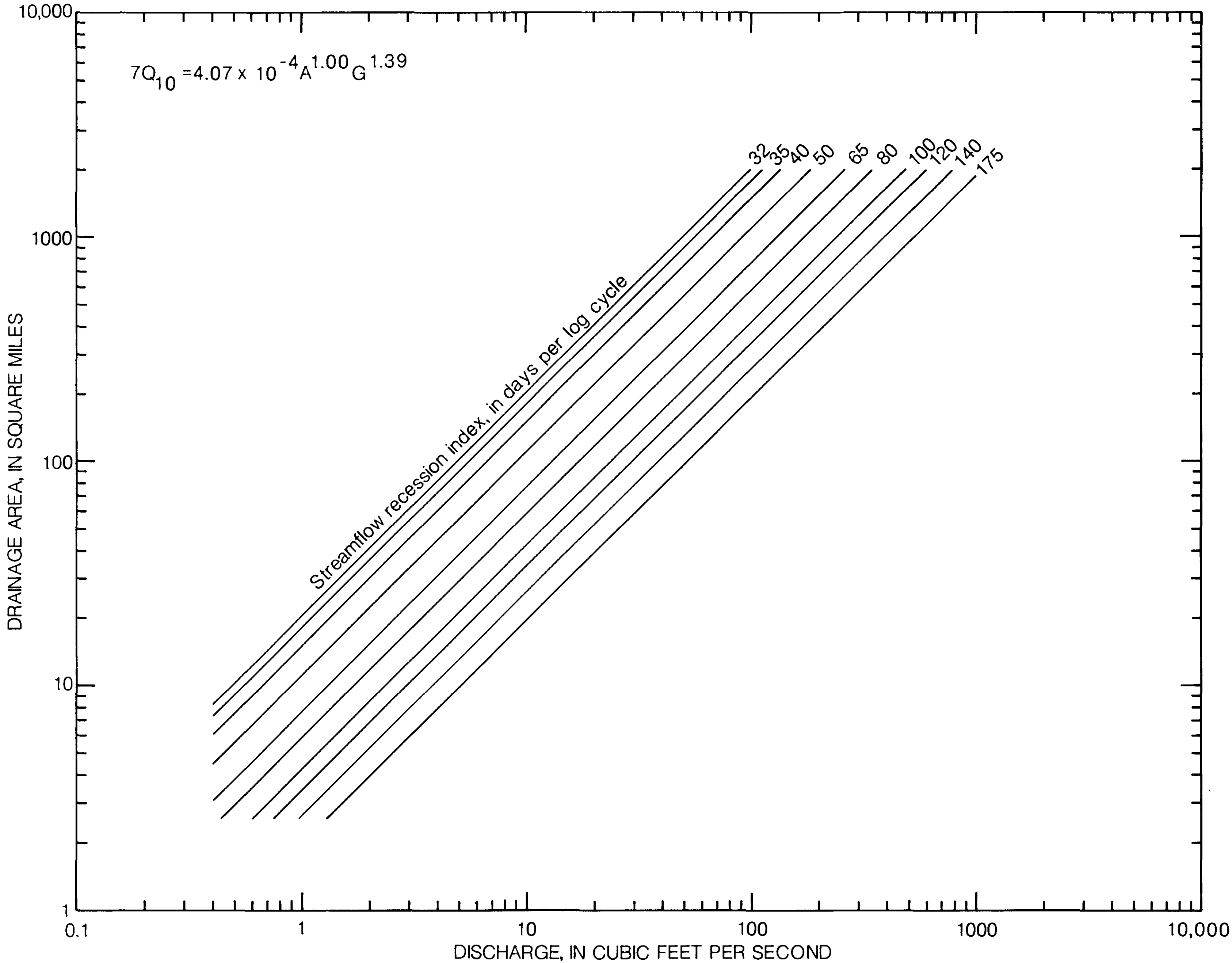

Figure 20.--Graphical solution of winter 7-day 10-year low-flow equation for Middle and East Tennessee.

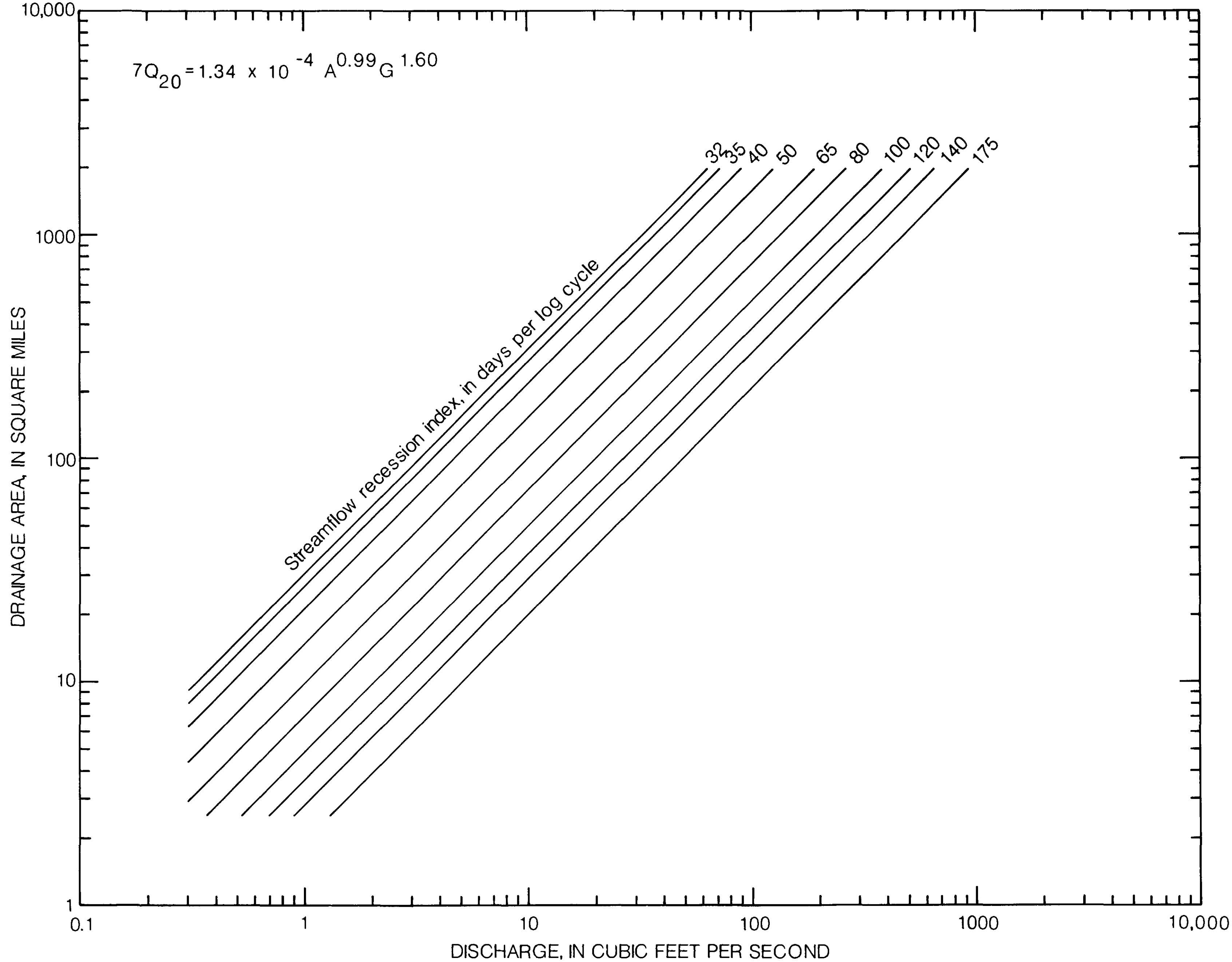

Figure 21.--Graphical solution of winter 7-day 20-year low-flow equation for Middle and East Tennessee.

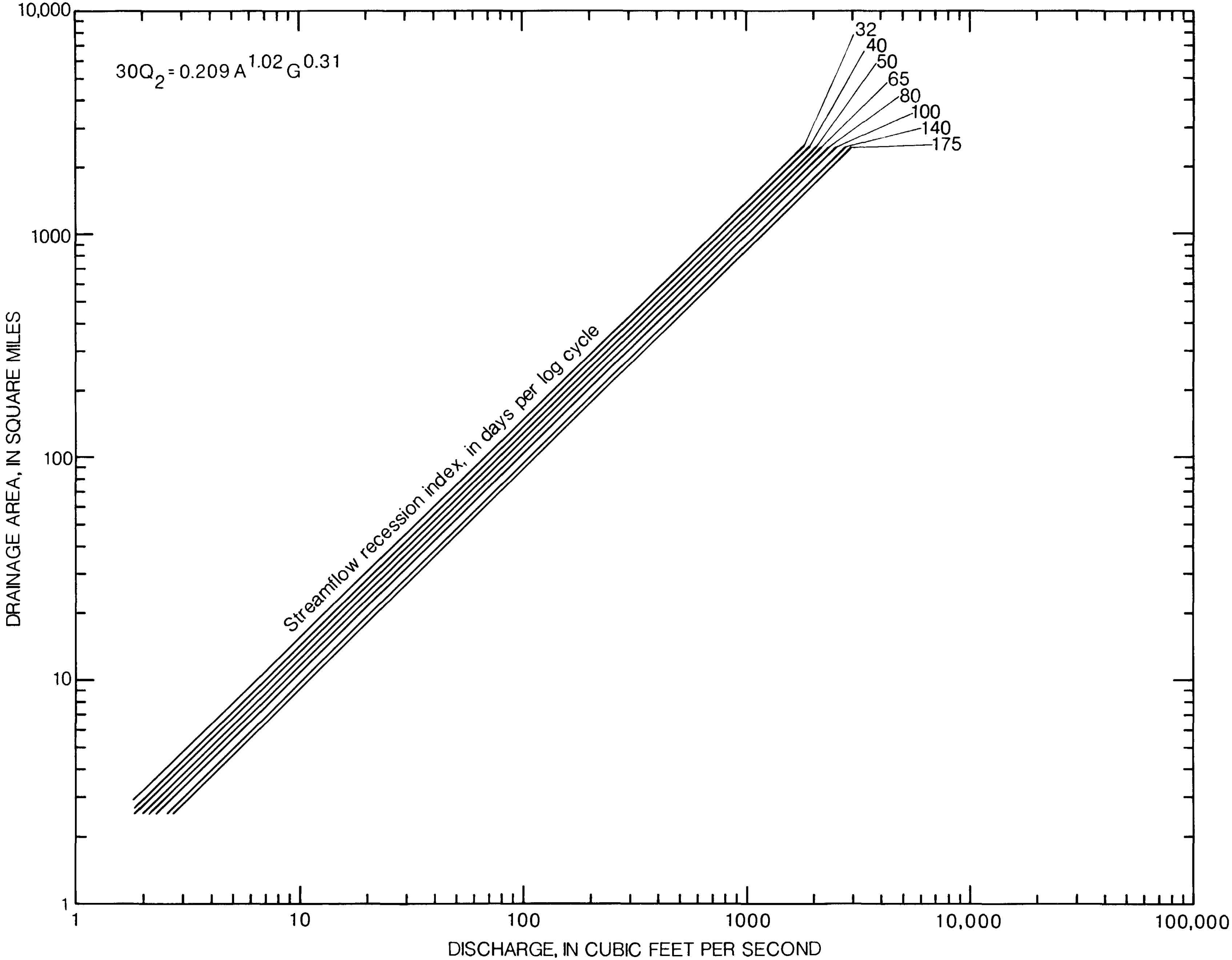

Figure 22.--Graphical solution of winter 30-day 2-year low-flow equation for Middle and East Tennessee.

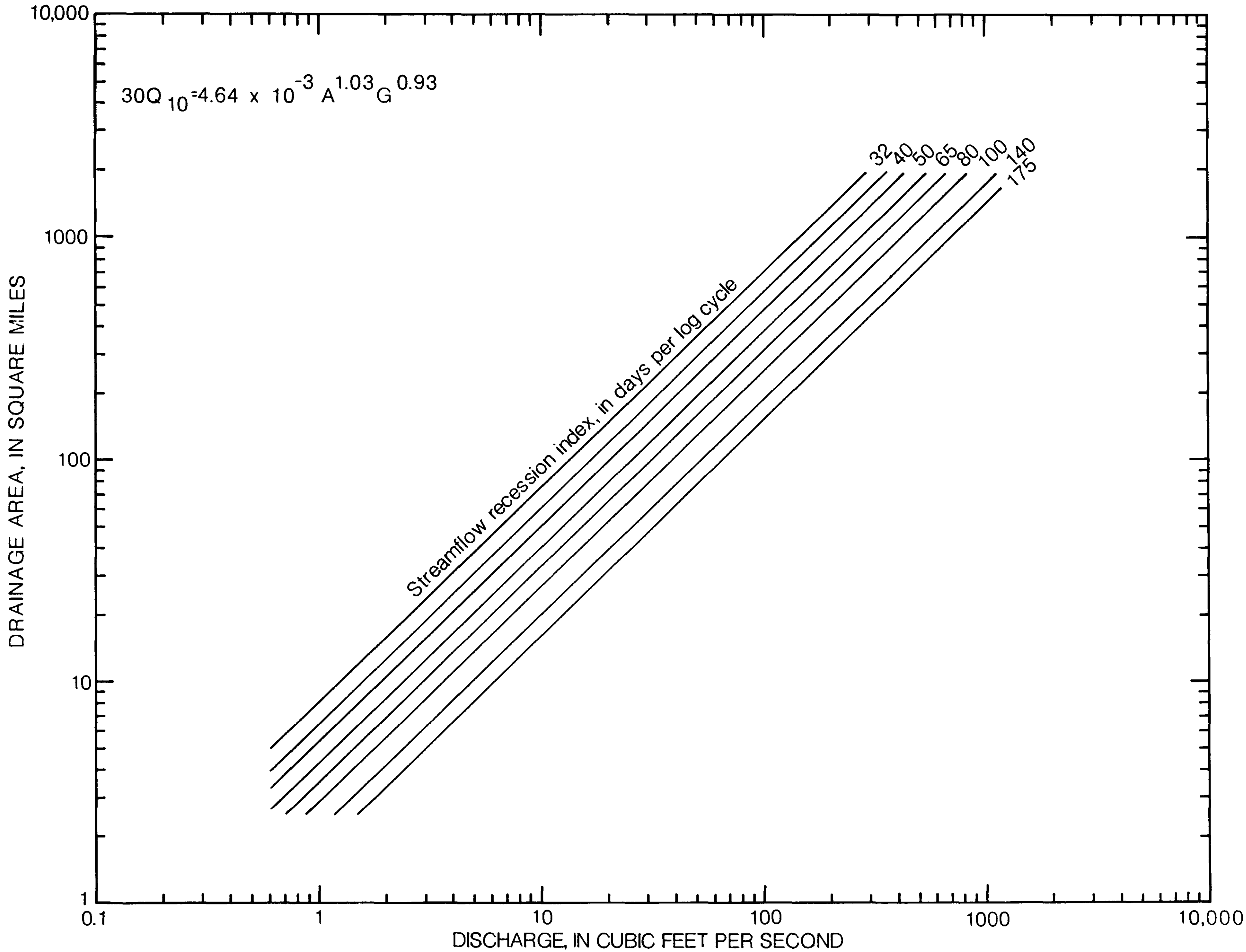

Figure 23.--Graphical solution of winter 30-day 10-year low-flow equation for Middle and East Tennessee.

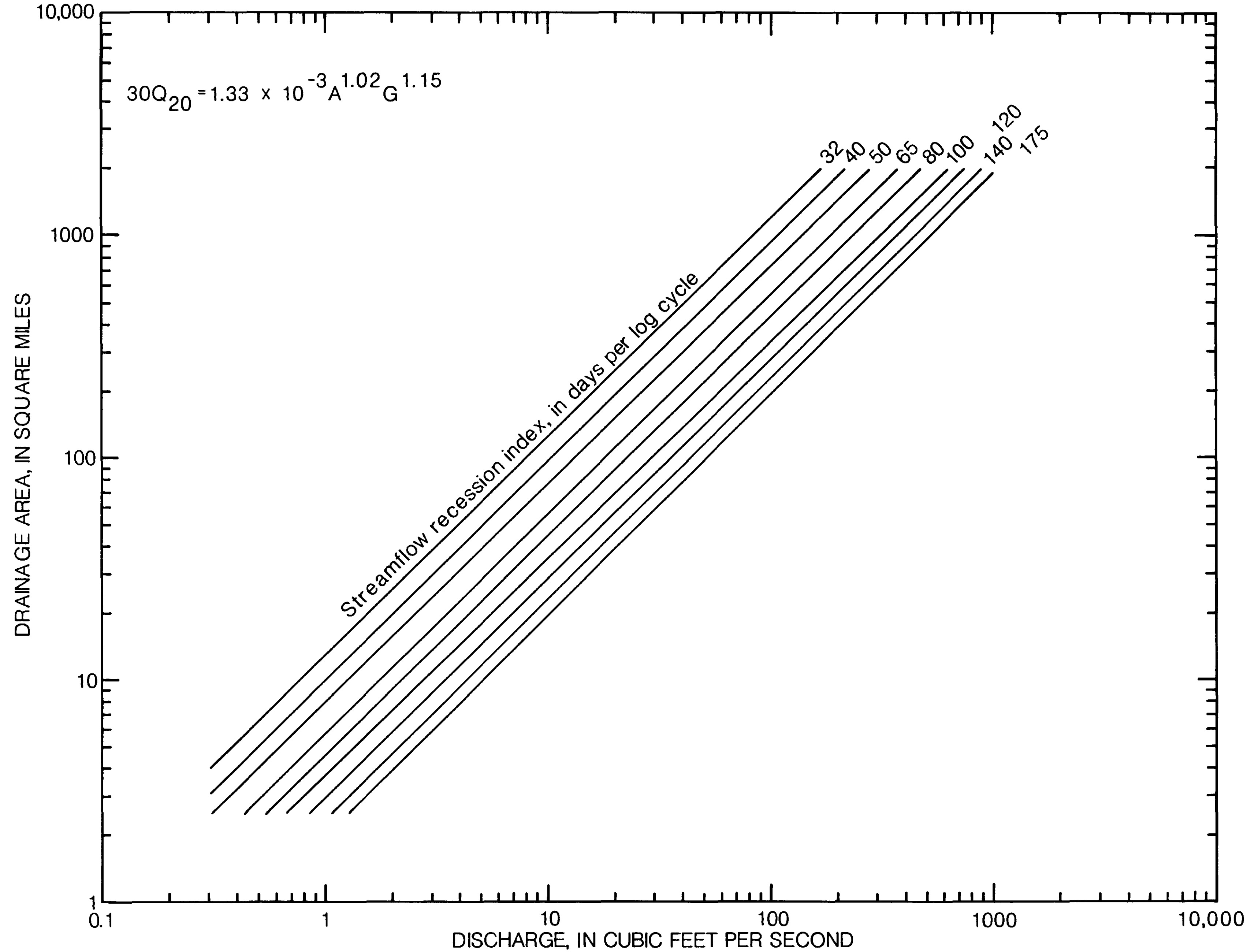

Figure 24.--Graphical solution of winter 30-day 20-year low-flow equation for Middle and East Tennessee.

partial-record stations were plotted against winter $3Q_{20}$ low flows estimated with the regression equations. Plots of the winter low-flow data for the 33 stations in West Tennessee are illustrated in figure 25. Plots for the 205 stations in Middle and East Tennessee are illustrated in figure 26. According to visual inspection, the plots indicate no bias, however, the largest errors appear to be associated with the smallest low-flow values used for the comparison. Although these comparisons between winter low-flow estimates from regression equations and from correlation are not completely independent, they do support confidence in the equations.

PROCEDURES FOR REGIONALIZING WINTER LOW-FLOW CHARACTERISTICS

Basin and climatic characteristics that influence the rate of low flow were analyzed to regionalize methods of estimating winter low flow in ungaged streams statewide. The most significant result of these analyses was to relate the effects of geology to the rate of winter low flow. Streamflow-recession indexes are strongly influenced by aquifers within the geologic framework underlying the stream basin. Thus, the streamflow-recession indexes used in these analyses were related to various rock types and combinations of rock types. Similar recession-index areas were then delineated based on geologic maps.

Ground Water-Surface Water Relations

Low flow in a stream is usually ground water discharged from the aquifer system to the stream. During the wet period in the winter and spring, most aquifers underlying the stream basin are recharged by precipitation in excess of the amount of water that can move through aquifers. During and after the wet season, water in the aquifers drains slowly into the adjacent stream and provides base flow during the year. A generalized cross section of a stream basin illustrating the movement of ground water from the aquifer system to the stream is shown in figure 27.

The interactions between the aquifer or groups of aquifers and the streams are extremely complex. The rate of ground-water discharge to a stream is a function of the capacity of the aquifer to store and transmit water, aquifer thickness and areal extent, slope of the ground-water table, amount of precipitation recharging the aquifer, size of the stream basin, and time. Most streams used in these analyses receive water from two or more rock types or geologic units each having different effects on low flow of the streams. For example, sand yields more water to a stream than does clay, and sandstone yields more water to a stream than does shale. Areal and vertical differences in the water yielding characteristics of an aquifer can also occur within a given rock type.

Rorabaugh and others (1966) investigated methods of relating ground water to surface water in the Columbia River basin. In their work, ground-water discharge to selected streams was related to the physical characteristics of the aquifer system as evidenced by the recession pattern of the water level in the

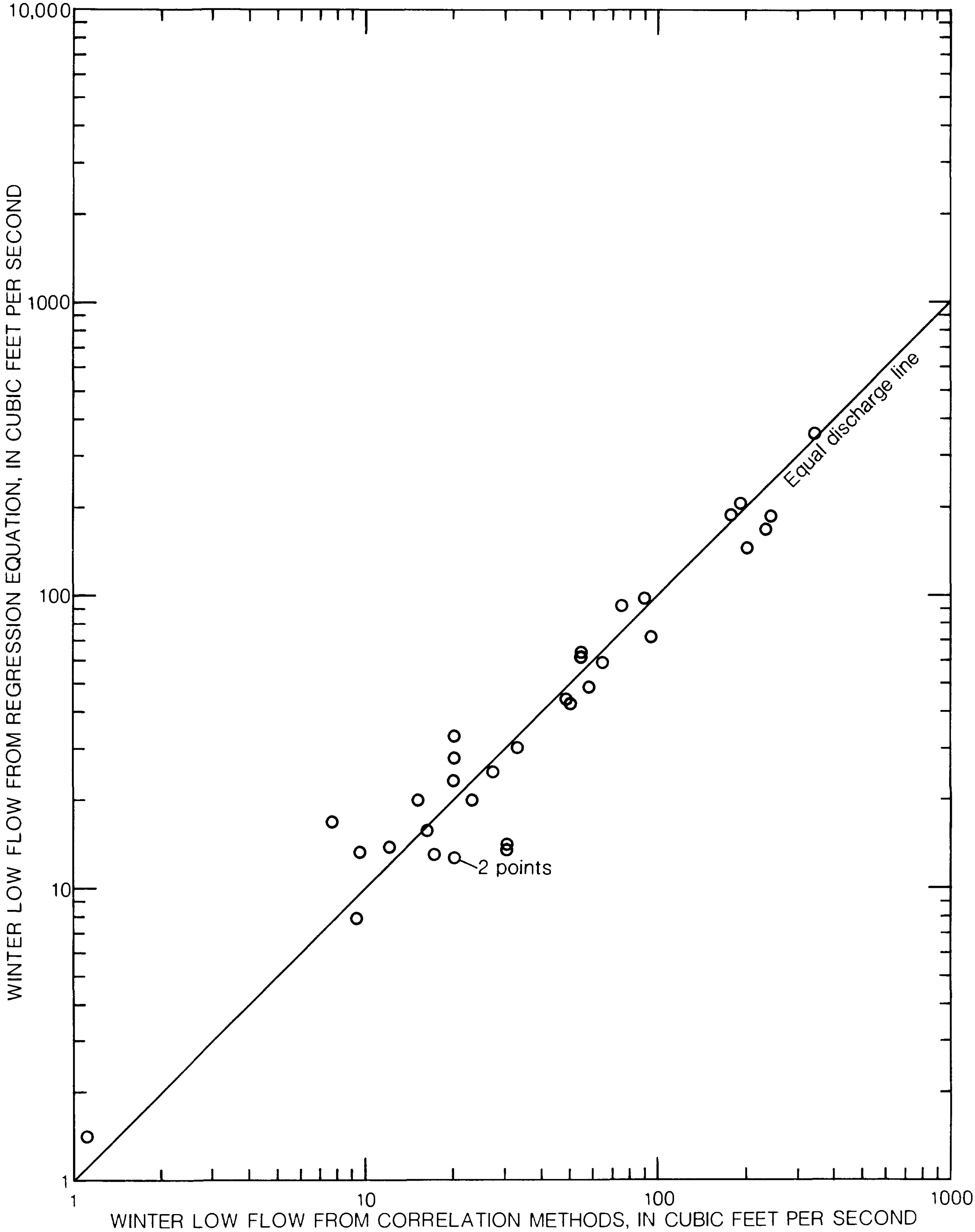

Figure 25.--Comparison of winter 3-day 20-year low flow from correlation methods with winter 3-day 20-year low flow from regression equation for partial-record stations in West Tennessee.

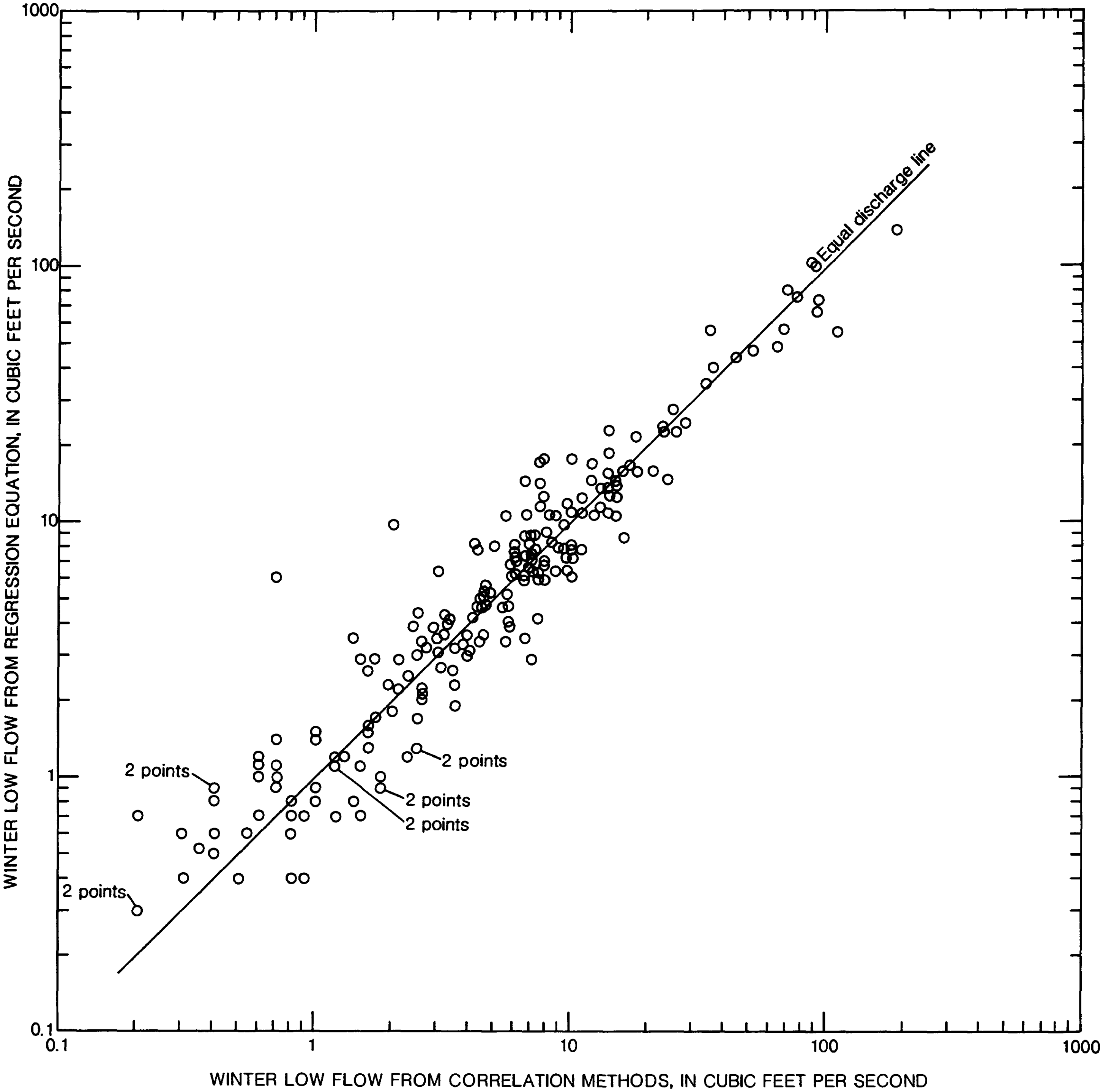

Figure 26.--Comparison of winter 3-day 20-year low-flow from correlation methods with winter 3-day 20-year low-flow from regression equation for partial-record stations in Middle and East Tennessee.

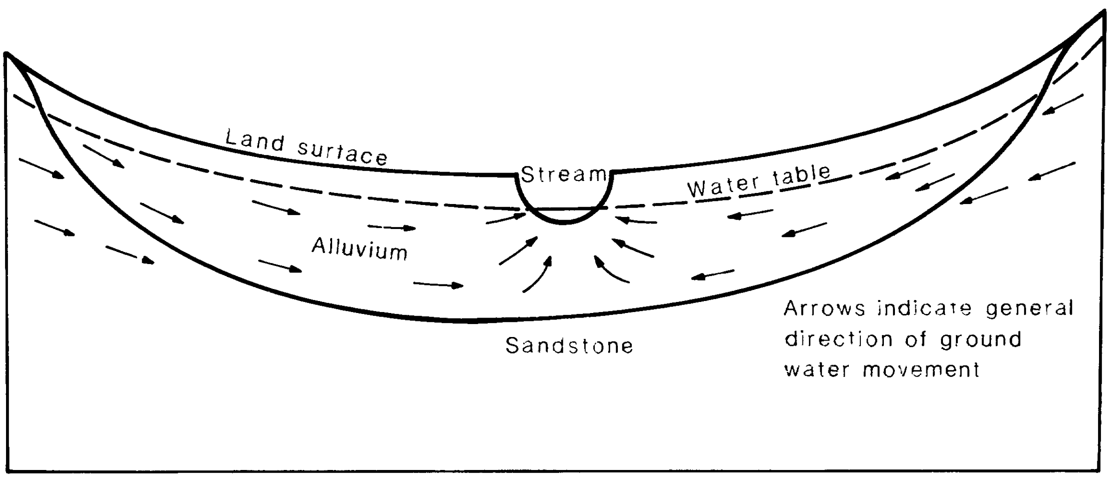

Figure 27.--Generalized cross section of a stream basin showing ground-water movement.

aquifer system during a period of no recharge. Rorabaugh also indicates that the streamflow recession for continuous-record gaging stations on unregulated streams can be used to estimate streamflow characteristics.

Trainer and Watkins (1975) used streamflow-recession indexes to estimate average values of aquifer transmissivity and storage in the upper Potomac River basin. Their work shows a direct relation between streamflow recession and the transmissivity of the aquifers. For example, stream basins underlain by aquifers with large transmissivity values had higher indexes of streamflow recession than basins underlain by aquifers with small transmissivity values. By applying that relation, Bingham (1982) used streamflow-recession indexes and surface geology to regionalize low-flow characteristics of unregulated streams in Alabama. For Tennessee, the same type of relation was used to regionalize low-flow characteristics statewide (Bingham, 1986).

Streamflow recession

The rate of streamflow recession during base flow is controlled by the hydraulic characteristics of the aquifers. The streamflow-recession index (t) can be estimated by the equation (Rorabaugh and others 1966):

$$t = \frac{a^2 S}{T},$$

Where t = time in days per log cycle;
a = distance from the stream to the hydrologic divide, in feet;
S = storage coefficient of the aquifer or aquifers; and
T = transmissivity of the aquifer or aquifers.

For this report, these characteristics are not necessary because streamflow data were used to estimate the streamflow-recession indexes graphically. However, according to Trainer and Watkins, (1975, p. 31-32) three factors which affect the streamflow-recession index complicate its definition and interpretation from a graph. Those factors are: (1) the brevity of most recession episodes in a humid region makes the recession curve difficult to establish precisely, (2) losses from ground water and from streamflow through evapotranspiration distort the ideal recession curve during much of the year, and (3) many recession curves are complex because of nonhomogeneity of the aquifers or the presence of multiple aquifers.

Records from approximately 150 continuous-record gaging stations were examined in an attempt to define the streamflow-recession index areas across Tennessee. Streamflow-recession indexes were defined for 109 of those sites. Streamflow at the remaining stations was significantly affected by activities of man, or the record was too short to define the streamflow-recession indexes. Approximately 6 to 10 recessions were plotted for each of the stations to assure consistency in the recession index definition. For some stations, however, only two to three recessions could be used for various reasons to estimate the index. The streamflow recessions, for each station, were plotted on semilog graph paper, daily streamflow on the log scale, and time, in days, on the arithmetic scale. The index of streamflow recession for each station was defined in days per log cycle, that is, the number of days required for the flow to decrease one complete log cycle. The base flow recession of a stream should approximate a straight line on a semilog plot.

Streamflow records for periods during November through March were generally used for defining the streamflow-recession indexes. During that time, interferences from evaporation and transpiration are minimal, and the recession probably reflects the geohydrologic control on base flow and low flow of streams. However, the recession slope is difficult to determine from streamflow in the winter because of interruptions from precipitation. Many of the interruptions are brief, and the recession slope may become nearly straight a few days after the streamflow peak.

The peak discharge during a period of rainfall is used as the first plotting point for the streamflow-recession curve. The plotting of stream discharge for each successive day is continued until the streamflow-recession curve approximates a straight line. The number of days required for the straight-line condition to occur after the peak discharge is a function of the basin geometry and the properties of the basin material (Rorabaugh and others, 1966) and is defined as the critical-time factor. The critical-time factor (tc) is expressed by the equation:

$$tc = \frac{0.2a^2S}{T}.$$

The variables a, S, and T are defined previously in this report. The straight-line part of the recession curve is used to define the index of streamflow recession. The streamflow recession for South Fork Forked Deer River at Jackson, Tennessee (station 209, pl. 1), is illustrated in figure 28. The straight-line part of the curve for South Fork Forked Deer River indicates a recession index of about 235 days per log cycle, which defines a critical-time factor of about 47 days.

Definition of the streamflow-recession index, for numerous stations, can be aided or verified by the critical-time factor. After the days per log cycle have been estimated from the recession plot, multiply the number of days by 0.2 to determine the number of days for the recession curve to become an apparent straight line following the peak. The critical-time procedure works fairly well when peak discharge represents medium to high flow. For low to medium discharge, the curves represent increments or additions to the composite of all past events, and, in many cases, the critical-time factor may be as low as 0.1 t and may not be conclusive (Daniel, 1976). In many Tennessee stream basins, the geometry and aquifer characteristics are such that the critical-time factor may represent weeks or months.

Great care is required in estimating the streamflow-recession index from hydrographs because of frequent precipitation during the winter, which interrupts the streamflow recession. Recession curves that become straight-line segments on semilog plots within 6 to 10 days after flood peaks can be determined readily through inspection of several years of hydrographs for each stream. By contrast, the recession curve that becomes linear after 50 days or more of uninterrupted recession can be determined only approximately because of frequent precipitation.

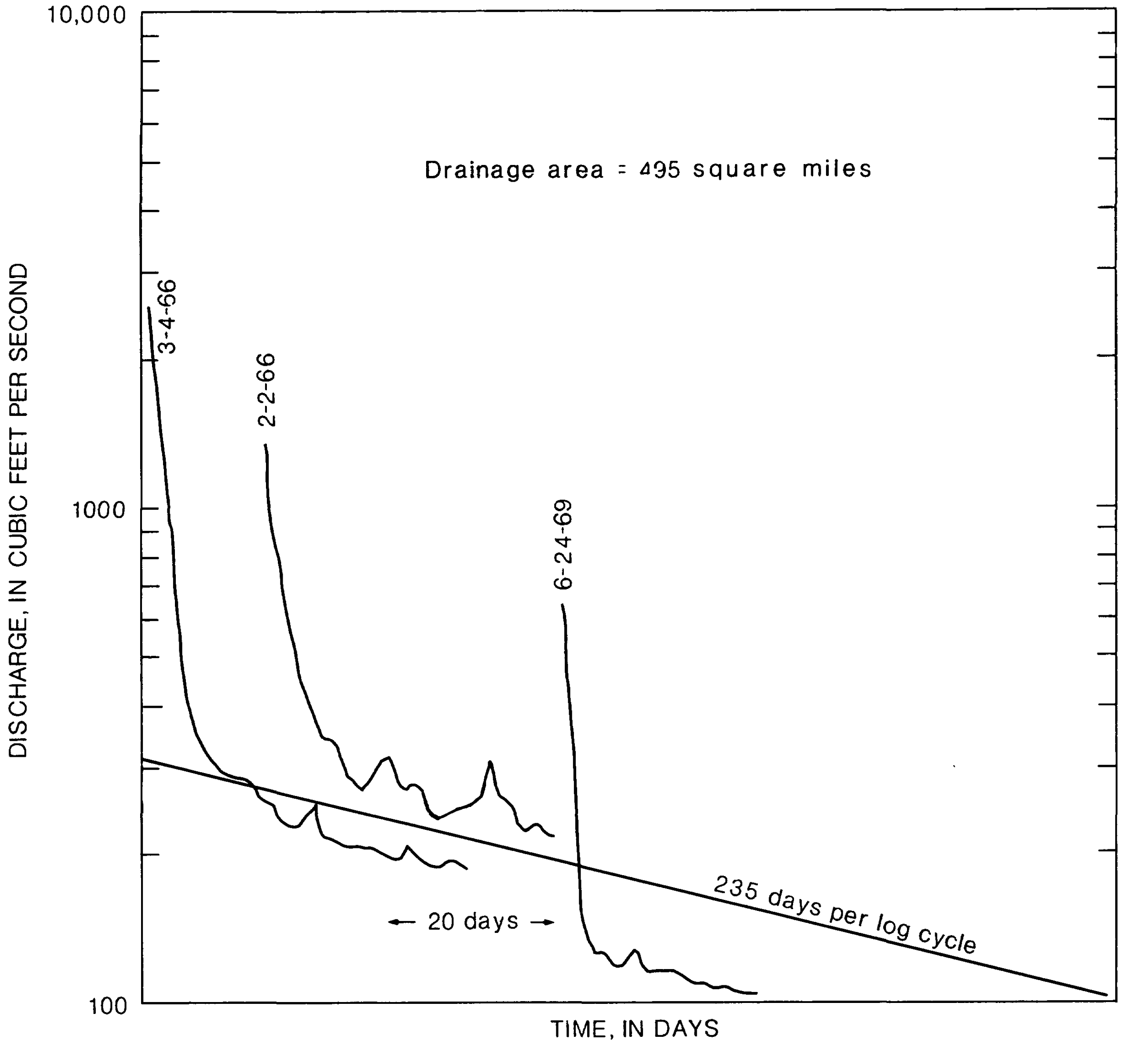

Figure 28.--Base flow recessions for South Fork Forked Deer River which drains mostly sand (station 209 on plate 1).

Multiple Aquifer Contributions To Streamflow

On a statewide basis, the variations of aquifer hydraulic characteristics and interaction of the aquifers and streamflow are extremely complex. Trainer and Watkins (1975, p. 34) indicate that both areal and vertical differences in hydraulic characteristics of aquifers probably contribute to the complexity of streamflow-recession curves. In many Tennessee streams the base flow represents the effects of several aquifers, each having different hydraulic characteristics.

For the purposes of developing the regression equations, no simple method exists for assigning fractions of low flows to parts of a basin draining two or more unlike aquifers. In the case of naturally integrated (combined) recessions, assigning fractions of low flows might not be possible while at the same time preserving the statistical validity of the data. Two methods were used, however, to determine a streamflow-recession index of each aquifer in basins where multiple aquifers contribute water to streamflow.

Graphical Computation Method

The streamflow-recession indexes, as determined graphically, for most of the streams in these analyses represent combined effects of the different aquifers within the basin. For example, flow of Sewee Creek near Decatur, in Meigs County (Station 115, pl. 1), represents the combined effects of two aquifers. One aquifer has a streamflow-recession index of 65 days per log cycle and the other aquifer has a streamflow-recession index of 120 days per log cycle (pl. 1). However, the combined effects of both aquifers define a streamflow-recession index of about 85 days per log cycle from the observed streamflow hydrograph (fig. 29).

Significantly different streamflow recessions were estimated for the same stream by separate straight-line segments for different periods of the recession curve. Riggs (1964, p. 353-354) describes how baseflow from two very unlike aquifers in the same drainage basin might produce two very different sloping straight-line segments in the streamflow-recession curve. When different streamflow-recession indexes are observed in a single basin, the resulting streamflow is the sum of the contributions from each part of the drainage area and the separate effects are relatively easily distinguished. The streamflow recessions for Sequatchie River near Whitwell, in Marion County (station 137, plate 1), illustrate two indexes representing two unlike aquifers (fig. 30). The recessions also indicate that the combined effects of the two unlike aquifers (32 and 100 days per log cycle) result in a streamflow-recession index of about 85 days per log cycle. However, for some streams where two or more only slightly different indexes might be expected on the basis of geologic formations, a single observed index can be a combined effect, and the separate effects from each part of the drainage area may be indistinguishable.

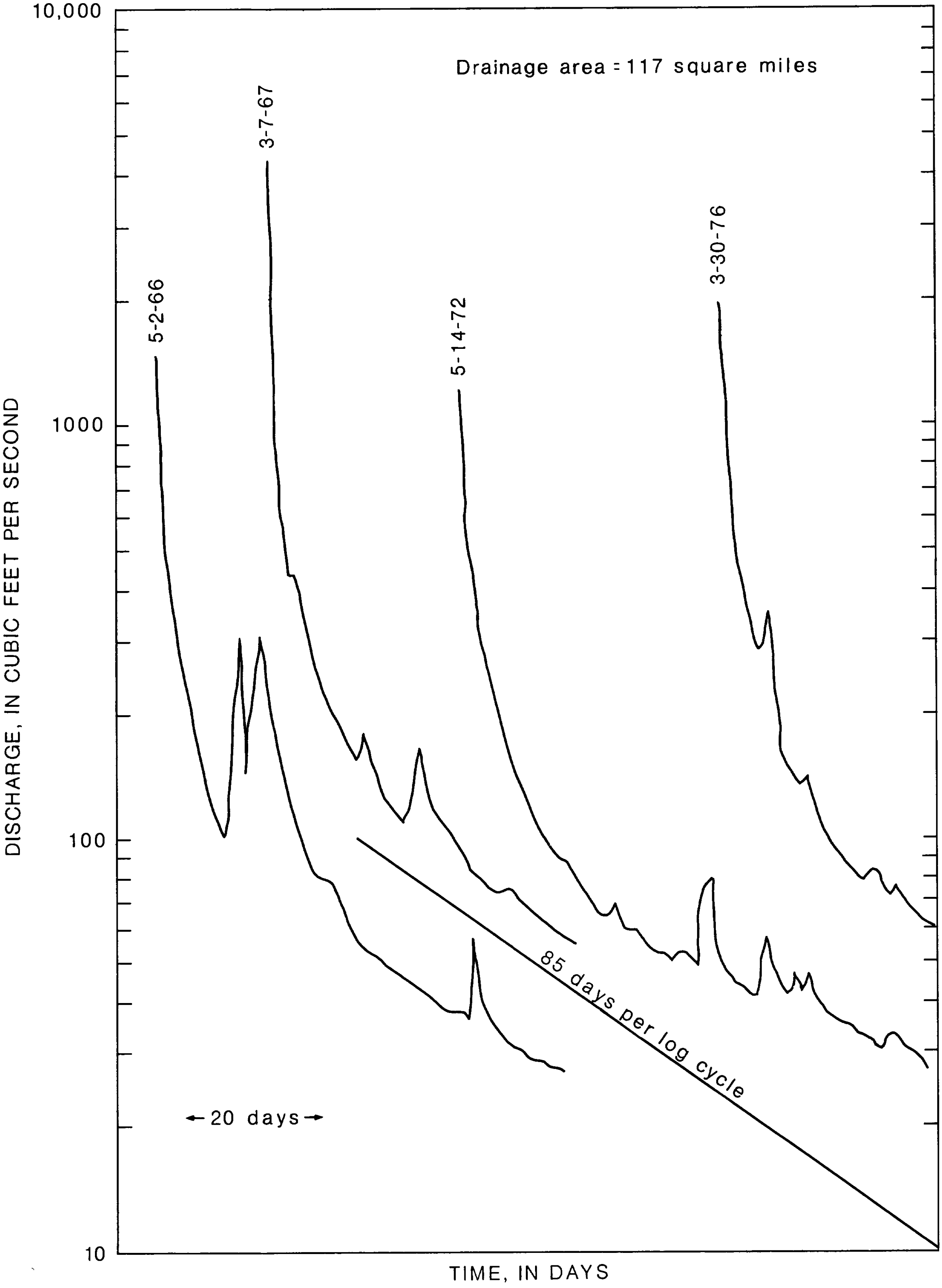

Figure 29.--Base flow recessions for Sewee Creek which drains mostly limestone and dolomite (station 115 on plate 1).

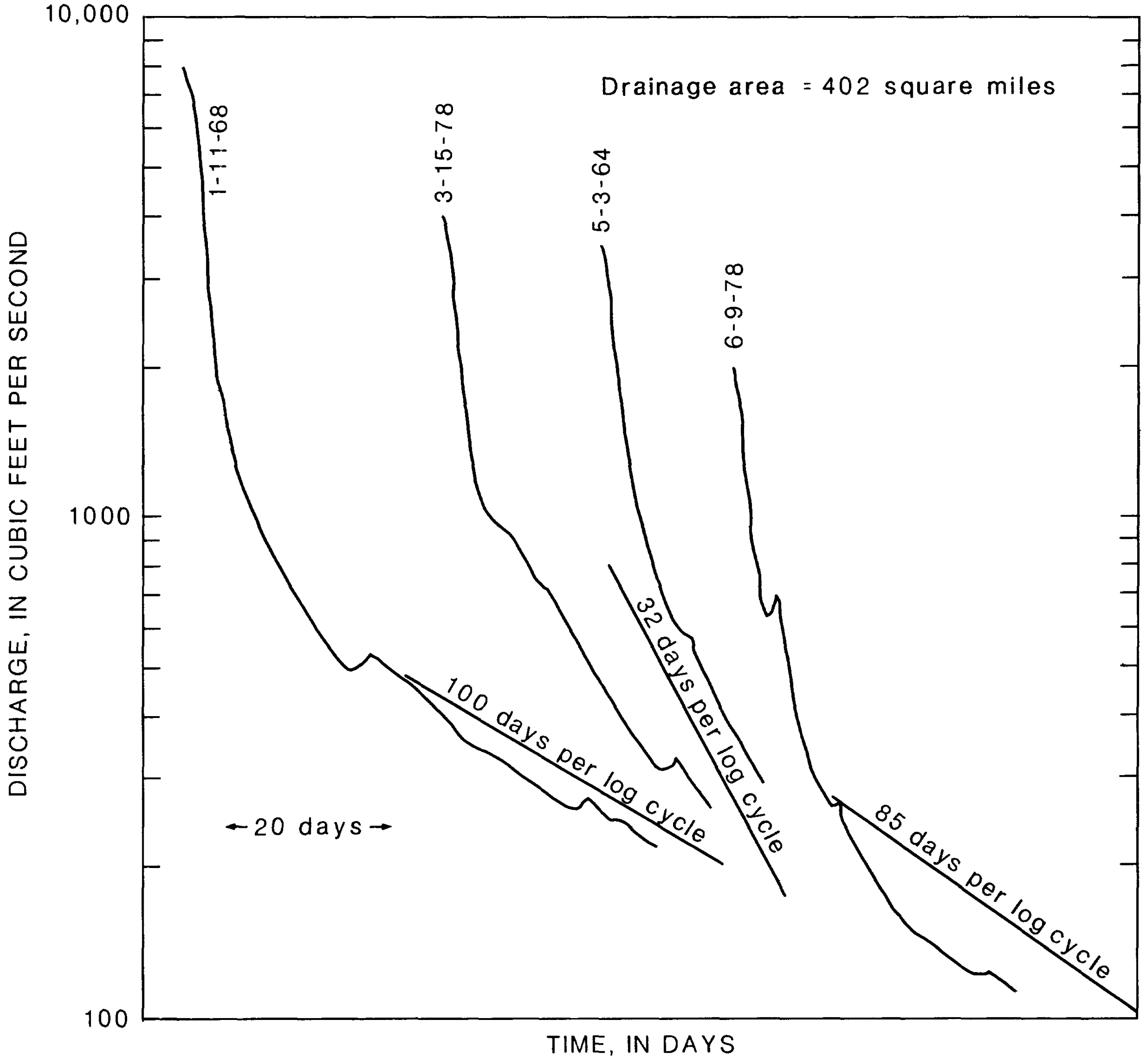

Figure 30.--Three rates of base flow recessions for Sequatchie River which drains mostly limestone and dolomite (station 137 on plate 1)

Weighted-Average Method

The weighted-average streamflow-recession index procedure was applied in mapping the index areas as shown on plate 1; thus the values shown may differ slightly from values obtained by the graphical computation method for the same stations. For the purposes of applying the regressions, however, the effect of contributions from different parts of a basin can be accounted for by the procedure described in Supplement A of this report.

The weighted-average procedure was based on an estimate of the percentage of a stream basin draining each of two or more different aquifers. Sequatchie River at station 137 on plate 1 provides an example of the averaging procedure. A generalized sketch of Sequatchie River basin is shown in figure 31. Approximately 75 percent of the basin drains a limestone and dolomite aquifer which has a streamflow-recession index of 100 days per log cycle (fig. 30). Twenty-five percent of the basin drains the overlying shale and sandstone aquifer which has a streamflow-recession index of 32 days per log cycle. The weighted-average streamflow-recession index is computed by summing 75 percent of 100 days per log cycle and 25 percent of 32 days per log cycle. Thus, the weighted-average streamflow-recession index of the two aquifers is 83 days per log cycle for Sequatchie River at station 137 (pl. 1) near Whitwell. This is in close agreement with the 85 days per log cycle estimated with the recession curves in figure 30. The weighted-average streamflow-recession index is considered the best estimate of the combined effects of the two aquifers on low flow of Sequatchie River at station 137.

Mapping Streamflow-Recession Indexes

Streamflow-recession index areas (plate 1) were delineated based on recession indexes derived from streamflow hydrographs, contacts between geologic formations, and the types of geologic formations at land surface in the basin. The types of formations include gravel, sand, clay, and silt in West Tennessee and limestone, chert, shale, sandstone, dolomite, and conglomerate in Middle and East Tennessee. In the mountainous areas of extreme East Tennessee, the surface formations also include siltstone, quartzite, and slate. Streamflow data have not been obtained for all the formations contributing water to streamflow within the State. However, the entire State was mapped based on the assumption that similar types of formations contribute similar amounts of water to streamflow and that ground-water divides of the shallow aquifers correspond to topographic divides.

Boundaries delineating areas of streamflow-recession indexes on plate 1 follow the same general pattern as contacts between formations or groups of formations with major differences in rock type and water-bearing properties. However, the quantitative significance of the several geologic factors that influence low flow in streams cannot be determined precisely.

The streamflow-recession indexes defined for each of the 109 continuous gaging stations were used to represent the relative effects of surface formations on low flow. These effects were evaluated by plotting gaging station locations and listing their respective streamflow-recession indexes on a map

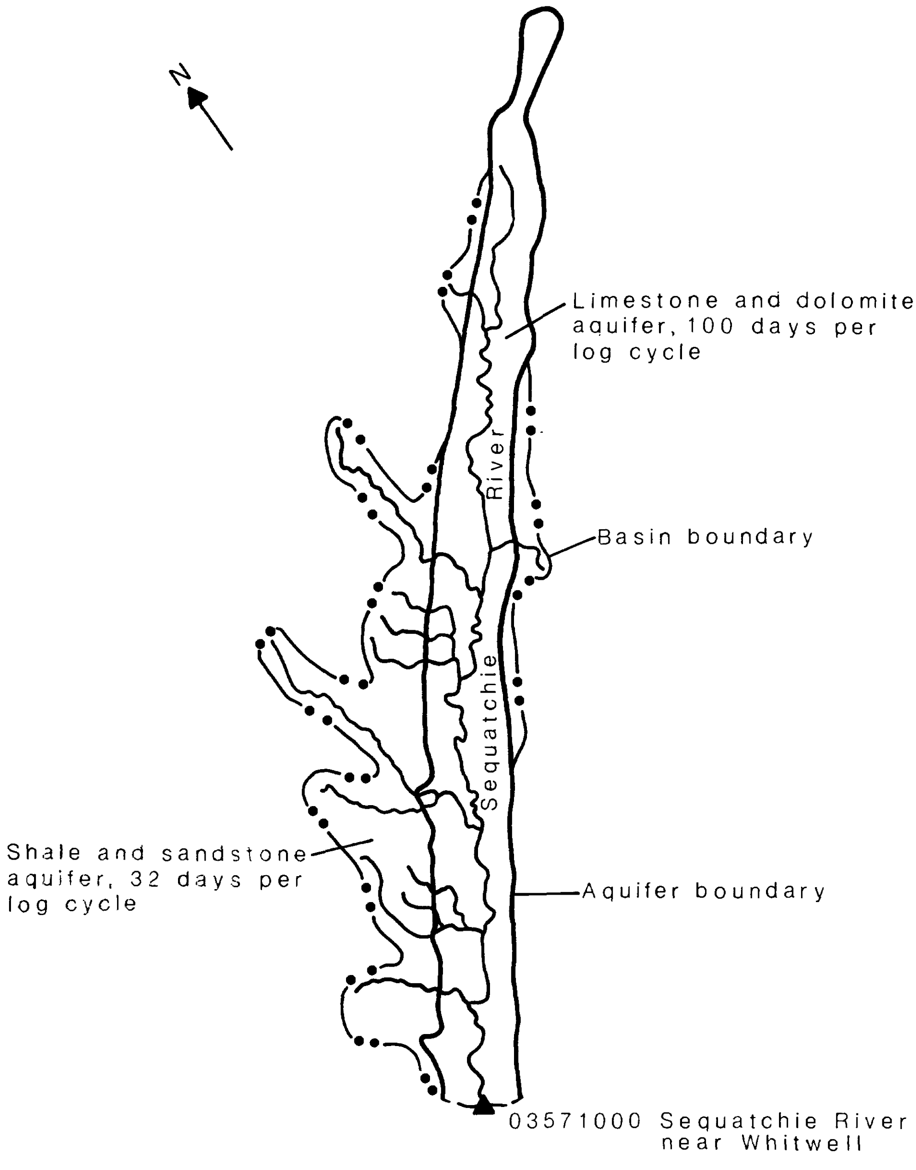

Figure 31.--Generalized sketch of Sequatchie River basin and aquifer boundaries (station 137 on plate 1).

of the State (pl. 1). The data on plate 1 were compared with that on a geologic map of Tennessee (Hardeman and others, 1966) to delineate areas where formation effects on low flow are similar.

Adequate descriptions of the surface formations are essential in determining the position of streamflow-recession index boundaries. In many areas, several formations with similar rock types and water-bearing properties were grouped together in a single streamflow-recession area. For example, in the Sequatchie River Valley near Chattanooga, several dolomite and limestone formations are at the surface along the floor and walls of the valley. Those formations have similar rock types and were assumed to have similar water-bearing properties within the Sequatchie Valley, consequently, they were mapped together as a single streamflow-recession index area for the entire length of the valley. Similarly, sand formations in West Tennessee which have essentially the same descriptions were assumed to have the same water-bearing properties and were mapped together as a single streamflow-recession index area.

Formations with contrasting rock types and water-bearing properties were separated on plate 1 by streamflow-recession index boundaries. For example, formations consisting primarily of clay were separated from formations consisting primarily of sand, and formations consisting primarily of shale were separated from formations consisting primarily of sandstone. The streamflow-recession index areas on plate 1 represent the relative capacity of the formations to release water to streams during low flow. A large number of days per log cycle (sustained base flow) represent slower depletion of water from the formations and a capacity of the formations to release large amounts of water, whereas, a small number of days per log cycle represent faster depletion of water from the formations and a capacity to release only small amounts of water.

The State geologic map (Hardeman and others, 1966) was inadequate in many areas to delineate streamflow-recession index boundaries. In those areas, 7½-minute geologic map quadrangles were used as an aid in delineating the boundaries. For example, the boundaries for Crooked Creek basin and for Beaver Creek basin (station number 200, pl. 1) near Huntingdon, in Carroll County, were based on a geologic map of the Huntingdon quadrangle (Ferguson, 1970) and the Palmer Shelter quadrangle (Parks, 1974). The maps were used to define areas of fluvial deposits in the Crooked Creek and Beaver Creek basins. Because of higher yielding fluvial deposits, the streamflow-recession index area of 350 days per log cycle was extended to include those stream basins. The fluvial deposits are not apparent on the state geologic map.

For three areas in West Tennessee, a mineral resources map of the Tennessee Valley Region (Tennessee Valley Authority, 1970) was used to delineate streamflow-recession index boundaries for local clay deposits near Lexington, Henderson, and Bolivar. Because the capacity of the clay to release water to streams is much smaller than the surrounding sand formation, the index values for the clay areas are significantly smaller than index values for the sand areas. Perhaps the effects of other clay deposits on low flow of West Tennessee streams should be accounted for, but streamflow records are not available to determine such effects.

The boundary between streamflow-recession index areas of 100 days and 175 days per log cycle in Polk, Monroe, Blount, and Sevier Counties in East Tennessee was delineated based on hydrological and geological information in reports by McMaster and Hubbard (1970) and King (1964).

Although descriptions of formations are some of the criteria used in delineating streamflow-recession index areas on plate 1, local variations in rock type may result in indexes considerably different than the areas indicate. The areas on plate 1 represent approximately average streamflow-recession indexes; the index may vary slightly from stream to stream within each area. The map is limited to 10 categories of index areas for practical application in estimating low flows. Approximately 15 to 20 categories could be delineated, but the map would be too cumbersome and difficult to use. The procedures used to delineate streamflow-recession index areas on plate 1 are highly subjective to interpretation of formation descriptions and to a lack of adequate information for precise positioning of the index boundaries.

Regression Analyses

Winter low flows at gaging stations were related to various basin and climatic characteristics by using regression techniques. Winter low-flow data used in the final regression analyses are tabulated in Supplement D. Characteristics tested were streamflow-recession index, drainage area, mean annual precipitation, and a sum of monthly normal precipitation for December through April. Streamflow-recession index and drainage area were the only characteristics significant at the 5 percent level of significance.

These regression analyses are similar to those used by Bingham (1986) to regionalize annual low-flow characteristics of streams in Tennessee. In those analyses, characteristics tested were streamflow-recession index, drainage area, main channel slope, length of main channel, mean elevation of the basin, percent forest cover within the basin, and mean annual precipitation. Streamflow-recession index and drainage area were also the only characteristics significant at the 5 percent level of significance in those analyses.

In Tennessee the most widely used low-flow data are the $3Q_{20}$. Thus, for this study the first regression analyses were performed for the winter $3Q_{20}$ low flow. Analyses for other winter low-flow characteristics were performed after completion of the analyses for the winter $3Q_{20}$. Low-flow values for other selected frequencies were substituted into the analyses. Estimating equations derived from the regression analyses are of the same general form for all the selected frequencies (see Summary).

To regionalize winter low flows for this study, it was assumed that separation of the State into two parts was necessary; attempts were not made to derive one set of equations to apply statewide. In the previous work by Bingham (1986) attempts were made to derive one set of equations to apply statewide. However, because of significant differences between hydraulic characteristics of aquifers in West Tennessee and hydraulic characteristics of aquifers in the rest of the State, the standard error of estimate of the regression was about 73 percent for the annual $3Q_{20}$ low flow. The equation over estimated the annual $3Q_{20}$ for all continuous-record stations in West Tennessee. For subsequent regressions the State was separated into (1) West Tennessee and (2) Middle and East Tennessee which reduced the standard error of estimate to 32 and 33 percent, respectively.

For the regression analyses of winter low flow for West Tennessee streams, 22 continuous-record stations were used to derive an equation to estimate winter $3Q_{20}$ low flow. Variables used in the equation were drainage area and streamflow-recession indexes determined from plate 1. Standard error of estimate for the regression was about 17 percent. In the final regression analyses to derive an equation to estimate winter $3Q_{20}$ low flow for West Tennessee streams, information for 15 low-flow partial-record stations was added to the data set. The partial-record stations were selected randomly for geographic and geologic distribution. The final regression analysis using 22 continuous-record stations and 15 partial-record stations has a standard error of estimate of about 25 percent.

Additional regression analyses were performed for West Tennessee streams to derive equations to estimate winter low-flow characteristics for 1, 3, 7, and 30 consecutive days for recurrence intervals of 2, 10, and 20 years. The standard error of estimates for those equations ranges from 22 to 35 percent. All the equations for West Tennessee streams have the same two independent variables (drainage area, A, and streamflow-recession index, G); the regression constant and variable exponents are different.

In regression analyses for Middle and East Tennessee streams, 82 continuous-record stations were used to derive an equation to estimate winter $3Q_{20}$ low flow. Variables used in the equation were drainage area and streamflow-recession indexes determined from plate 1. Standard error of estimate for the regression was about 30 percent. In the final regression analyses for Middle and East Tennessee streams, information for 109 low-flow partial-record stations was added to the data set and the regression rerun. The partial-record stations were selected randomly for geographic and geologic distribution. The final regression using 82 continuous-record stations and 109 partial-record stations has a standard error of estimate of about 33 percent.

Additional regression analyses were performed for streams in Middle and East Tennessee to derive equations to estimate winter low-flow characteristics for 1, 3, 7, and 30 consecutive days for recurrence intervals of 2, 10, and 20 years. Standard error of estimates for those equations range from 31 to 36 percent. All the equations for Middle and East Tennessee streams have the same two independent variables (A and G); the regression constant and variable exponents are different.

Equations were also derived to estimate low flows based on drainage area size as the only independent variable. Those equations are unacceptable because the standard errors of estimate associated with the equations are too large. For West Tennessee streams, the errors range from 100 percent for winter $3Q_2$ to 88 percent for winter $3Q_{20}$. For Middle and East Tennessee streams, the errors range from 51 percent for winter $3Q_2$ to 85 percent for winter $3Q_{20}$. These large errors indicate the importance of geologic effects on low flow, which are accounted for, to some extent, by the mapped streamflow-recession indexes. After adding the streamflow-recession index variable to the equation for estimating winter $3Q_{20}$ in West Tennessee streams, the standard error of estimate was decreased from 88 to 25 percent. For Middle and East Tennessee streams, the standard error of estimate was decreased from 85 to 33 percent.

In the regression analyses, values of 0, 10, 20, and 30 were subtracted from the streamflow-recession index to increase the equation constant and to reduce exponents of the variables. A value of 30 is the feasible maximum value that can be subtracted from the index because of logarithmic transformations used in the regression analyses. However, subtracting values from one of the variables in regression equations can increase the error of estimate and introduce unnecessary bias in results of using those equations.

Bias of the winter low-flow equations in this report was checked with graphical plots. The graphs include plots of regression residuals versus log of the streamflow-recession index, and residuals versus log of drainage area. According to visual inspection, the group of plotting points on each graph for the West Tennessee equations forms a straight line and are assumed to be unbiased. However, the groups of plotting points on the graph of streamflow-recession indexes and regression residuals do not form a straight line for the Middle and East Tennessee equation to estimate winter $3Q_{20}$ low flow. Subtracting values from the streamflow-recession index apparently caused results of the equation to be biased. Regression analyses indicated that the standard error and bias of the winter $3Q_{20}$ equation increased as the value subtracted became larger. Consequently, regression equations for estimating winter low flow in Middle and East Tennessee were derived without subtracting a value from the streamflow-recession index.

The winter $3Q_{20}$ low flows from observed streamflow data for gaging stations were plotted against predicted winter $3Q_{20}$ low flows estimated with the regression equations. Plots for stations used to derive the winter $3Q_{20}$ low-flow equation for West Tennessee streams are illustrated in figure 32. Plots for stations used to derive the winter $3Q_{20}$ low flow-equation for Middle and East Tennessee streams are illustrated in figure 33. Both illustrations indicate that the equations overestimate winter low-flow values of less than about 1 ft^3/s at nearly all sites.

Drainage areas for gaging stations used in the regression analyses for West Tennessee streams ranged from 25.0 to 1,940 mi^2. However, the distribution of drainage areas vary considerably within that range. For example, only four stations have a drainage area larger than 1,000 mi^2, and only two stations have a drainage area larger than 1,500 mi^2. The following table summarizes the distribution of drainage areas used in the regression analyses for West Tennessee streams.

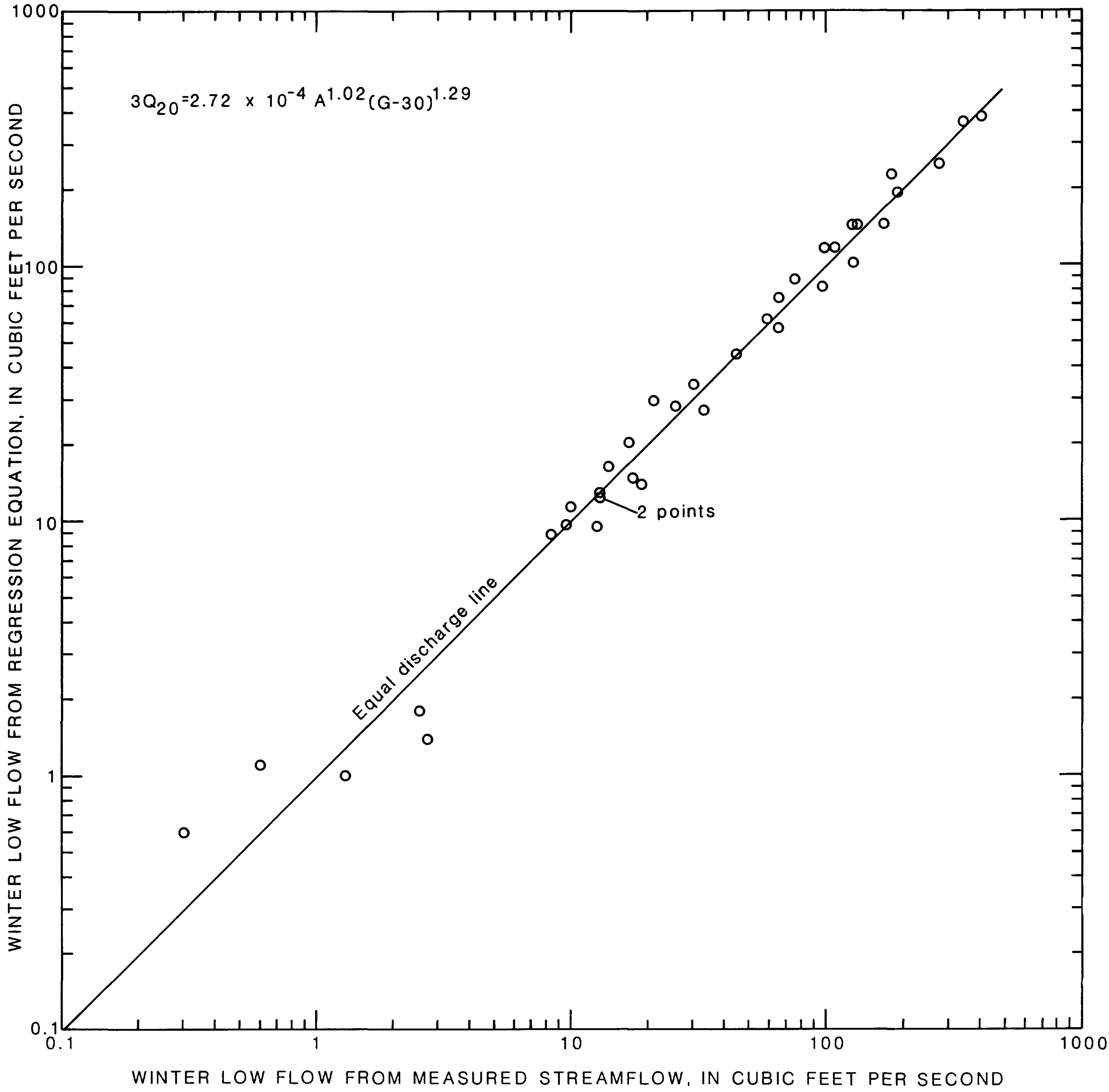

Figure 32.--Comparison of winter 3-day 20-year low flow from measured streamflow with winter 3-day 20-year low flow from regression equation for gaging stations in West Tennessee.

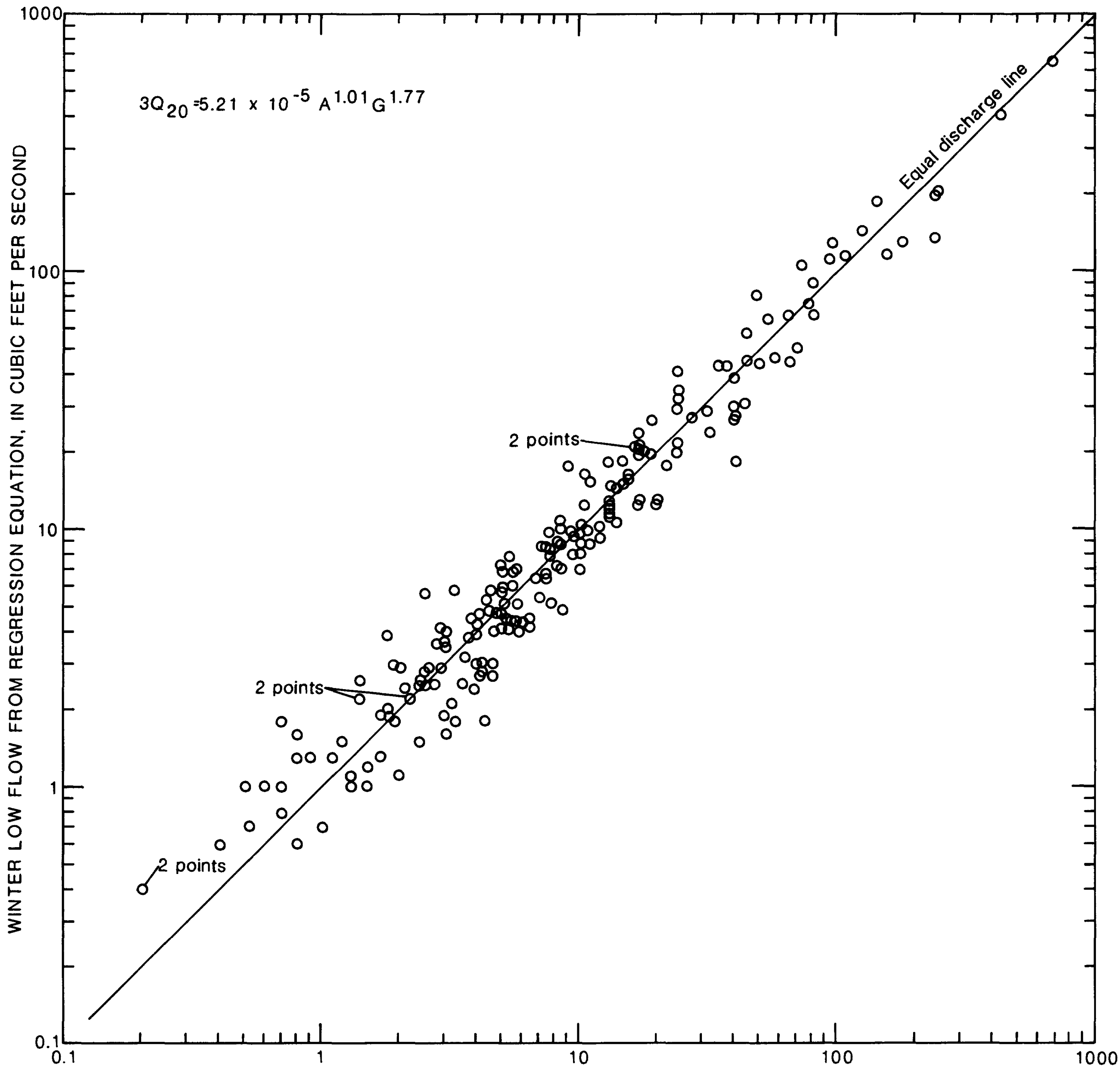

Figure 33.--Comparison of winter 3-day 20-year low flow from measured streamflow with winter 3-day 20-year low flow from regression equation for gaging stations in Middle and East Tennessee.

Range in drainage area (mi^2)	Number of stations in analyses
25-50	9
50.1-100	9
101-250	5
251-500	5
501-1000	5
1001-1500	2
1501-1940	2
Total stations	37

The streamflow-recession indexes used in the regression analyses for West Tennessee streams ranged from 55 to 350 days per log cycle. The following table summarizes distribution of indexes for gaging stations used in the regression analyses.

Range in streamflow-recession indexes	Number of stations in analyses
60-100	5
101-150	6
151-200	11
201-250	12
251-300	2
301-350	1
Total stations	37

Drainage areas for gaging stations used in the regression analyses for Middle and East Tennessee streams ranged from 2.68 to 2,557 mi^2. The following table summarizes the distribution of drainage areas used in the regression analyses.

Range in drainage area (mi^2)	Number of stations in analyses
2.68-10	9
10.1-25	50
25.1-50	33
50.1-100	35
101-250	31
251-500	11
501-1000	17
1001-2000	4
2001-2557	1
Total stations	191

Streamflow-recession indexes used in the regression analyses for Middle and East Tennessee streams ranged from 32 to 175 days per log cycle. The following table summarizes distribution of indexes for gaging stations used in the regression analyses.

Range in streamflow-recession indexes	Number of stations in analyses
32-40	11
41-50	23
51-65	30
66-80	31
81-100	38
101-120	29
121-140	28
141-175	1
Total stations	191

A partial analysis of the sensitivity of the winter $3Q_{20}$ regression equations to the streamflow-recession index G was performed for one set of conditions for the variable G. Results of sensitivity of the winter $3Q_{20}$ equation for West Tennessee streams for G equal to 50, 100, and 200 are as follows:

For G=50, a ±10 percent error in G results in -29 to +36 percent difference in winter $3Q_{20}$;
for G=100, a ±10 percent error in G results in -18 to +18 percent difference in winter $3Q_{20}$; and
for G=200, a ±10 percent error in G results in -15 to +16 percent difference in winter $3Q_{20}$.

Results for sensitivity of the equations for Middle and East Tennessee indicate that a ±10 percent error in G results in -17.0 to +18.4 percent difference in winter $3Q_{20}$.

The sensitivity analyses indicate that the sensitivity of the variable G in the equation decreases for West Tennessee as G increases, and remains about the same for Middle and East Tennessee regardless of the value of G.

CONCLUSIONS

Regression equations derived from observed streamflow data at 228 gaging stations can be used with streamflow-recession index and drainage area to estimate winter (December through April) low flow for 1, 3, 7, and 30 consecutive days for 2-, 10-, and 20-year recurrence intervals in ungaged streams in Tennessee. One set of equations applies to streams in West Tennessee, and one set applies to streams in Middle and East Tennessee. Standard errors of the regression estimates ranged from 22 to 35 percent for West Tennessee, and from 31 to 36 percent for Middle and East Tennessee. The standard errors apply only to the 228 stations used in the regression analyses. Statistical analyses indicate that summer low-flow characteristics are the same as annual low-flow characteristics, and that winter low flows are larger than annual low flows.

The relative effects of different rock types and geologic units on low flow were accounted for by a streamflow-recession index expressed in days per log cycle. Streamflow recession is controlled by the hydraulic characteristics of aquifers within the stream basin. The streamflow-recession index is defined as the number of days required for base flow of the stream to recede one complete log cycle. These indexes for gaging stations are related to the geology of the State. Areal distributions of the indexes are shown on plate 1.

REFERENCES CITED

Bingham, R. H., 1982, Low-flow characteristics of Alabama streams: U.S. Geological Survey Water-Supply Paper 2083, 27 p.

______ 1985, Low flows and flow duration of Tennessee streams through 1981: U.S. Geological Survey Water-Resources Investigations Report 84-4347, 325 p.

______ 1986, Regionalization of low-flow characteristics of Tennessee streams: U.S. Geological Survey Water-Resources Investigations Report 85-4191, 63 p.

Daniel, J. F., 1976, Estimating ground-water evapotranspiration from streamflow records: Water Resources Research, v. 12, no. 3, p. 360-364.

Ferguson, C. C., 1970, Geologic map of the Huntingdon quadrangle, Tennessee: Tennessee Department of Conservation, Division of Geology, Map GM 9-SW, scale 1:24,000.

Hardeman, W. D., Miller, R. A., and Swingle G. D., compilers, 1966, Geologic map of Tennessee: Tennessee Department of Conservation, Division of Geology, 4 sheets, scale 1:250,000.

King, P. B., 1964, Geology of the Central Great Smoky Mountains Tennessee: U.S. Geological Survey Professional Paper 349-C, 148 p., 13 Plates.

McMaster, W. M., and Hubbard, E.F., 1970, Water resources of the Great Smoky Mountains National Park, Tennessee and North Carolina: U.S. Geological Survey Hydrologic Investigations Atlas, HA-420, 2 sheets, Scale 1:125,000.

Parks, W. S., 1974, Geologic map of the Palmer Shelter quadrangle, Tennessee: Tennessee Department of Conservation, Division of Geology, Map GM 10-NW, scale 1:24,000.

Riggs, H. C., 1964, The base-flow recession curve as an indicator of ground water: International Association of Scientific Hydrology Publication 63, p. 352-363.

______ 1972, Low-flow investigations: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 4, Chapter B1, 18 p.

Rorabaugh, M. I., Simons, W. D., Garrett, A. A., and McMurtrey, R. G., 1966, Exploration of methods of relating ground water to surface water--Columbia River basin first phase, with a section on Direct computation of ground-water outflow by electric analog by B. H. Bermes: U.S. Geological Survey Open-File Report, 124 p.

Tennessee Valley Authority, 1970, Mineral resources of the Tennessee Valley Region: Tennessee Valley Authority, Division of Water Control Planning, Geologic Branch, map report.

Trainer, F. W., and Watkins, F. A., Jr., 1975, Geohydrologic reconnaissance of the upper Potomac River basin: U.S. Geological Survey Water-Supply Paper 2035, 68 p.

U.S. Water Resources Council, 1981, Guidelines for determining flood flow frequency: Washington, D. C., U.S. Water Resources Council Bulletin 17B, 183 p.

SUPPLEMENT A

Examples of Estimating Winter Low Flow for Ungaged Streams

The following computations demonstrate the application of regression equations for estimating winter low flow in ungaged streams in Tennessee. For the first example, assume a stream site is in West Tennessee and that the entire basin has a single streamflow-recession index. Assume a 30 mi^2 basin lying within a region having a streamflow-recession index (plate 1) of 140. Estimates of winter low flows for the site are computed in the following manner.

$$1Q_2 = 7.34 \times 10^{-3} A^{1.01} (G-30)^{0.75}$$
$$1Q_2 = .00734 (30)^{1.01} (140-30)^{0.75}$$
$$1Q_2 = .00734 (31.04) (33.97)$$
$$1Q_2 = 7.7 \text{ ft}^3/\text{s}$$

$$1Q_{10} = 5.10 \times 10^{-4} A^{1.02} (G-30)^{1.18}$$
$$1Q_{10} = .000510 (30)^{1.02} (140-30)^{1.18}$$
$$1Q_{10} = .000510 (32.11) (256.4)$$
$$1Q_{10} = 4.2 \text{ ft}^3/\text{s}$$

$$1Q_{20} = 3.07 \times 10^{-4} A^{1.02} (G-30)^{1.26}$$
$$1Q_{20} = .000307 (30)^{1.02} (140-30)^{1.26}$$
$$1Q_{20} = .000307 (32.11) (373.4)$$
$$1Q_{20} = 3.7 \text{ ft}^3/\text{s}$$

$$3Q_2 = 8.90 \times 10^{-3} A^{1.01} (G-30)^{0.72}$$
$$3Q_2 = .00890 (30)^{1.01} (140-30)^{0.72}$$
$$3Q_2 = .00890 (31.04) (29.50)$$
$$3Q_2 = 8.1 \text{ ft}^3/\text{s}$$

$$3Q_{10} = 5.81 \times 10^{-4} A^{1.02} (G-30)^{1.16}$$
$$3Q_{10} = .000581 (30)^{1.02} (140-30)^{1.16}$$
$$3Q_{10} = .000581 (32.11) (233.4)$$
$$3Q_{10} = 4.4 \text{ ft}^3/\text{s}$$

$$3Q_{20} = 2.72 \times 10^{-4} A^{1.02} (G-30)^{1.29}$$
$$3Q_{20} = .000272 (30)^{1.02} (140-30)^{1.29}$$
$$3Q_{20} = .000272 (32.11) (429.9)$$
$$3Q_{20} = 3.8 \text{ ft}^3/\text{s}$$

$$7Q_2 = 1.31 \times 10^{-2} A^{1.00} (G-30)^{0.67}$$
$$7Q_2 = .0131 (30)^{1.00} (140-30)^{0.67}$$
$$7Q_2 = .0131 (30) (23.32)$$
$$7Q_2 = 9.2 \text{ ft}^3/\text{s}$$

$$7Q_{10} = 9.20 \times 10^{-4} A^{1.01} (G-30)^{1.09}$$
$$7Q_{10} = .0009200 (30)^{1.01} (140-30)^{1.09}$$
$$7Q_{10} = .0009200 (31.04) (167.93)$$
$$7Q_{10} = 4.8 \text{ ft}^3/\text{s}$$

$$7Q_{20} = 4.76 \times 10^{-4} A^{1.02} (G-30)^{1.19}$$
$$7Q_{20} = .000476 (30)^{1.02} (140-30)^{1.19}$$
$$7Q_{20} = .000476 (32.11) (268.69)$$
$$7Q_{20} = 4.1 \text{ ft}^3/\text{s}$$

$$30Q_2 = 0.112 A^{1.02} (G-30)^{0.32}$$
$$30Q_2 = .112 (30)^{1.02} (140-30)^{0.32}$$
$$30Q_2 = .112 (32.11) (4.5)$$
$$30Q_2 = 16.2 \text{ ft}^3/\text{s}$$

$$30Q_{10}= 5.04 \times 10^{-3} A^{1.00} (G-30)^{0.82}$$
$$30Q_{10}= .00504 (30)^{1.00} (140-30)^{0.82}$$
$$30Q_{10}= .00504 (30) (47.2)$$
$$30Q_{10}= 7.1 \text{ ft}^3/\text{s}$$

$$30Q_{20}= 2.23 \times 10^{-3} A^{1.00} (G-30)^{0.95}$$
$$30Q_{20}= .00223 (30)^{1.00} (140-30)^{0.95}$$
$$30Q_{20}= .00223 (30) (86.96)$$
$$30Q_{20}= 5.8 \text{ ft}^3/\text{s}$$

For the second example, assume a stream site in Middle Tennessee is draining a basin having two streamflow-recession index areas. Seventy percent of the basin is in an area with an index of 50, and 30 percent of the basin has an index of 140. The entire basin has a drainage area of 80 mi^2. The estimating equations are used for the entire basin using each of the two streamflow-recession indexes, then a weighted-average winter low flow is computed based on the percentage of the basin draining each streamflow-recession index area on plate 1. Estimates of winter low flows are computed with the regression equations in the following manner. First, assume the entire basin is draining an area having a streamflow-recession index of 50.

$$3Q_2 = 5.77 \times 10^{-3} A^{1.02} G^{0.93}$$
$$3Q_2 = .00577 (80)^{1.02} (50)^{0.93}$$
$$3Q_2 = .00577 (87.33) (38.02)$$
$$3Q_2 = 19.2 \text{ ft}^3/\text{s}$$

Then assume the entire basin is draining an area having a streamflow-recession index of 140.

$$3Q_2 = 5.77 \times 10^{-3} A^{1.02} G^{0.93}$$
$$3Q_2 = .00577 (80)^{1.02} (140)^{0.93}$$
$$3Q_2 = .00577 (87.33) (99.06)$$
$$3Q_2 = 50 \text{ ft}^3/\text{s}$$

The estimated low flows of 19.2 ft^3/s and 50 ft^3/s for $3Q_2$ are weighted based on the 70 and 30 percent of the basin draining areas of each streamflow-recession index.

$$19.2 \text{ ft}^3/\text{s} (0.7) = 13.4 \text{ ft}^3/\text{s}$$
$$50 \text{ ft}^3/\text{s} (0.3) = \underline{15.0} \text{ ft}^3/\text{s}$$
$$\text{Weighted-average } 3Q_2 \text{ low flow} = 28.4 \text{ ft}^3/\text{s}$$

The 28.4 ft^3/s is rounded to the nearest whole number, thus, 28 ft^3/s is the estimated $3Q_2$ for the stream site in the second example.

The same procedure applies for estimating winter low flows using equations for the selected recurrence intervals for the stream site in the second example. The appropriate equation for estimating winter low flows for each recurrence interval is used for each index area and a weighted-average low flow is computed based on the percent of the basin draining each index area.

For the third example, assume a stream site in East Tennessee is draining a basin having three streamflow-recession index areas and 50 percent of the basin has an index of 65, 30 percent has an index of 100, and 20 percent has an index of 50. Drainage area of the basin is 125 mi^2. The estimating equations are used by applying each of the three streamflow-recession indexes to the entire basin, then a weighted-average winter low flow is computed based on the percent of the basin in each index area. Estimates of winter low flows for this example are computed in the following manner. First, assume the entire basin has a streamflow-recession index of 65.

$$3Q_2 = 5.77 \times 10^{-3} A^{1.02} G^{0.93}$$
$$3Q_2 = .00577 (125)^{1.02} (65)^{0.93}$$
$$3Q_2 = .00577 (137.7) (48.5)$$
$$3Q_2 = 38.5 \text{ ft}^3/\text{s}$$

Next, assume the entire basin has a streamflow-recession index of 100.

$$3Q_2 = 5.77 \times 10^{-3} A^{1.02} G^{0.93}$$
$$3Q_2 = .00577 (125)^{1.02} (100)^{0.93}$$
$$3Q_2 = .00577 (137.7) (72.4)$$
$$3Q_2 = 57.5 \text{ ft}^3/\text{s}$$

Finally, assume the entire basin has a streamflow-recession index of 50.

$$3Q_2 = 5.77 \times 10^{-3} A^{1.02} G^{0.93}$$
$$3Q_2 = .00577 (125)^{1.02} (50)^{0.93}$$
$$3Q_2 = .00577 (137.7) (38.0)$$
$$3Q_2 = 30.2 \text{ ft}^3/\text{s}$$

The estimated low flows of 38.5 ft^3/s, 57.5 ft^3/s, and 30.2 ft^3/s are weighted based on 50, 30, and 20 percent of the basin draining areas of each streamflow-recession index.

$$38.5 \text{ ft}^3/\text{s} (0.5) = 19.2 \text{ ft}^3/\text{s}$$
$$57.5 \text{ ft}^3/\text{s} (0.3) = 17.2 \text{ ft}^3/\text{s}$$
$$30.2 \text{ ft}^3/\text{s} (0.2) = \underline{6.0} \text{ ft}^3/\text{s}$$
$$\text{weighted-average low flow} = 42.4 \text{ ft}^3/\text{s}$$

The 42.4 ft^3/s is rounded to the nearest whole number, thus, 42 ft^3/s is the estimated $3Q_2$ for the stream site in the third example.

The weighted-average low flow procedure should be used for all ungaged stream sites within the State where the basin is draining more than one streamflow-recession index area.

Graphical solutions for the equations for estimating winter low flows in Tennessee streams are presented in figures 1 through 24. The dashed line and arrows on figure 1 indicate the procedure to follow for the following example.

$A = 100$ mi^2
$G = 80$, determined from plate 1

Enter the figure with drainage area (100 mi^2) along the vertical scale. Move horizontally to the line for a streamflow-recession index of 80, then move down to the discharge scale. An estimate of about 14 ft^3/s for winter $1Q_2$ was obtained from figure 1. The same procedure applies to figures 2 through 12 for winter low-flow estimates for West Tennessee streams. The following result for a stream in Middle or East Tennessee is obtained using the same method as described above except figure 13 is used for the following example:

$A = 100$ mi^2
$G = 40$
from figure 13, $1Q_2 = 18$ ft^3/s.

SUPPLEMENT B

Comparison of Winter Low-flow Estimates for Low-flow Partial-Record Stations in West Tennessee

[OBS = map index numbers which correspond to those on plate 2; STAN = downstream order station number; DA = drainage area, in square miles; INDEX = mapped (plate 1) streamflow-recession index number, in days per log cycle (index value is a weighted average for basin where the basin lies in multiple streamflow-recession index areas); COR3Q20 = estimated 3-day 20-year winter low flow, in cubic feet per second, from correlation method; and COM3Q20 = estimated 3-day 20-year winter low flow, in cubic feet per second, from regression equation]

OBS	STAN	DA	INDEX	COR3Q20	COM3Q20
153	03594422	49.5	250	16.0	15.3
207	03606300	88.2	230	27.0	24.4
208	07024200	26.5	350	9.5	13.1
209	07024350	204	315	74.0	90.6
210	07024400	55.7	245	7.6	16.8
211	07024700	67.6	320	33.0	30.0
212	07024730	156	245	57.0	47.9
213	07024750	34.2	300	12.0	13.7
214	07024760	93.4	190	15.0	19.4
215	07024770	286	210	94.0	70.7
216	07024800	752	175	200	143
217	07024900	110	215	20.0	27.6
218	07025050	238	145	20.0	32.9
219	07025100	268	135	20.0	33.0
220	07025900	1736	180	340	352
221	07027290	39.9	70	1.1	1.4
222	07027680	687	220	175	185
223	07028200	1048	175	190	201
224	07028920	173	210	50.0	42.3
225	07029275	310	175	64.0	58.1
226	07029350	329	90	23.0	19.8
227	07029370	44.1	240	17.0	12.8
228	07029373	55.9	200	20.0	12.4
229	07029374	56.0	200	20.0	12.4
230	07029480	121	350	54.0	61.8
231	07029490	122	350	54.0	62.3
232	07029675	51.4	155	9.2	7.7
233	07030050	2308	170	480	430
234	07030210	78.7	165	30.0	13.1
235	07030212	80.6	165	30.0	13.4
236	07030357	726	140	90.0	96.9
237	07030600	597	225	230	166
238	07031650	699	215	240	182

SUPPLEMENT C

Comparison of Winter Low-Flow Estimates for Low-Flow Partial-Record Stations in Middle and East Tennessee

[OBS = map index numbers which correspond to those on plate 2; STAN = downstream order station number; DA = drainage area, in square miles; INDEX = mapped (plate 1) streamflow-recession index number, in days per log cycle (index value is a weighted average for basin where the basin lies in multiple streamflow-recession index areas); COR3Q20 = estimated 3-day 20-year winter low flow, in cubic feet per second, from correlation method; and COM3Q20 = estimated 3-day 20-year winter low flow, in cubic feet per second, from regression equation]

OBS	STAN	DA	INDEX	COR3Q20	COM3Q20
1	03403750	240	32	0.7	6.1
2	03410050	712	35	18.0	21.4
3	03414680	70.8	50	2.4	3.9
4	03417695	15.3	65	2.5	1.3
5	03417850	40.3	65	6.6	3.5
6	03418030	13.8	65	2.3	1.2
7	03419270	37.7	60	7.0	2.9
8	03420880	297	140	88.0	103
9	03421200	31.1	120	10.0	8.0
10	03422620	3.01	120	1.2	.7
11	03422950	6.36	80	1.0	.8
12	03424520	29.8	60	3.5	2.3
13	03424750	227	43	9.4	9.7
14	03424900	26.9	35	.4	.8
15	03426700	7.03	55	.9	.4
16	03426900	125	51	9.5	7.2
17	03433720	80.2	90	6.8	12.6
18	03433810	27.2	80	5.5	3.4
19	03433910	66.2	100	14.0	12.5
20	03434580	727	55	64.0	48.7
21	03434585	5.05	80	.8	.6
22	03434640	107	90	12.0	16.8
23	03434700	843	60	91.0	66.0
24	03435044	78.4	52	5.4	4.6
25	03435110	19.7	50	1.2	1.1
26	03435120	69.2	53	4.1	4.2
27	03435300	547	70	35.0	56.0
28	03436130	20.5	80	1.6	2.6
29	03436300	69.3	80	7.2	8.8
30	03436460	179	80	14.0	22.9
31	03436490	455	77	110	55.0
32	03436655	52.2	120	13.0	13.5
33	03436930	55.7	120	6.6	14.5
34	03454790	32.6	100	5.8	6.1
35	03461260	5.22	100	.6	1.0
36	03465220	57.3	100	8.2	10.8
37	03465610	23.1	120	6.5	5.9
38	03465631	4.21	120	1.5	1.1
39	03466234	15.5	120	3.3	4.0
40	03467895	9.30	82	1.2	1.2

SUPPLEMENT C--Continued

OBS	STAN	DA	INDEX	COR3Q20	COM3Q20
41	03468050	30.8	70	3.0	3.1
42	03468196	3.48	120	1.0	.9
43	03469100	46.1	140	16.0	15.7
44	03469105	3.74	100	1.5	.7
45	03469119	18.0	100	3.8	3.3
46	03469130	110	105	26.0	22.7
47	03469230	20.0	135	7.4	6.3
48	03469253	31.8	125	7.0	8.8
49	03469282	7.23	130	2.6	2.1
50	03469400	59.9	125	17.0	16.7
51	03470330	28.3	80	3.9	3.6
52	03478550	48.0	120	15.0	12.4
53	03478590	8.32	115	2.6	2.0
54	03481700	6.77	75	.9	.7
55	03481800	24.4	75	3.1	2.7
56	03481815	70.0	75	8.9	7.9
57	03484200	57.8	105	9.6	11.9
58	03484797	32.6	100	10.0	6.1
59	03486230	39.0	100	5.6	7.3
60	03486488	6.78	70	.8	.7
61	03486860	9.06	120	1.9	2.3
62	03487100	20.3	120	4.8	5.2
63	03487548	36.3	110	5.0	8.0
64	03487562	43.2	100	6.0	8.1
65	03491800	32.3	50	2.0	1.8
66	03492005	3.13	100	.5	.6
67	03492995	30.6	80	5.7	3.9
68	03494800	58.8	50	2.7	3.2
69	03494955	3.62	80	.8	.4
70	03497113	6.36	80	1.4	.8
71	03497200	60.1	165	25.0	27.4
72	03498715	17.9	120	4.5	4.6
73	03499000	13.5	120	3.0	3.5
74	03499053	11.8	120	3.9	3.0
75	03499055	30.6	120	10.0	7.9
76	03499062	32.0	120	8.4	8.3
77	03499110	352	105	92.0	73.5
78	03499290	5.00	120	2.5	1.3
79	03499412	10.5	92	1.7	1.7
80	03518130	60.3	115	15.0	14.5

SUPPLEMENT C--Continued

OBS	STAN	DA	INDEX	COR3Q20	COM3Q20
81	03518456	59.9	105	11.0	12.3
82	03518470	21.7	175	11.0	10.9
83	03518750	25.2	57	2.5	1.7
84	03519000	271	105	68.0	56.4
85	03519600	11.2	120	1.5	2.9
86	03519660	43.4	120	13.0	11.2
87	03519700	30.7	110	5.8	6.8
88	03527700	4.83	50	.2	.3
89	03528200	21.7	50	.6	1.2
90	03531700	23.9	105	4.5	4.9
91	03531800	4.65	65	.5	.4
92	03534200	39.3	65	4.4	3.4
93	03534500	9.45	67	.4	.9
94	03535055	103	87	14.0	15.2
95	03535183	7.12	82	1.8	.9
96	03535187	36.4	70	4.5	3.6
97	03535195	52.5	76	6.5	6.1
98	03535200	56.1	79	6.0	7.0
99	03535400	86.8	82	7.6	11.5
100	03538215	18.4	35	.35	.5
101	03538244	12.4	70	1.3	1.2
102	03541995	11.8	62	1.8	.9
103	03542000	108	35	3.5	3.2
104	03543300	32.3	105	6.8	6.6
105	03544220	6.48	65	.3	.6
106	03556700	3.82	57	.2	.3
107	03557200	9.90	76	.6	1.1
108	03557300	101	90	21.0	15.9
109	03564920	7.40	110	1.6	1.6
110	03565087	33.5	120	6.6	8.7
111	03565410	24.3	140	4.1	8.2
112	03565437	22.1	140	6.8	7.5
113	03565444	26.8	140	8.0	9.1
114	03565730	69.3	140	23.0	23.7
115	03566050	15.6	100	2.1	2.9
116	03566102	21.2	100	2.9	3.9
117	03566117	2.87	120	.2	.7
118	03566123	2.81	120	.6	.7
119	03566128	42.1	120	10.0	10.9
120	03566137	11.6	120	2.5	3.0

SUPPLEMENT C--Continued

OBS	STAN	DA	INDEX	COR3Q20	COM3Q20
121	03566235	65.9	120	7.5	17.1
122	03566430	10.8	65	.4	.9
123	03566550	6.68	65	.4	.6
124	03566625	108	58	9.4	7.8
125	03567400	153	120	36.0	40.1
126	03567494	14.2	120	3.2	3.6
127	03567496	19.3	120	4.4	5.0
128	03567590	12.1	80	1.0	1.5
129	03568630	63.9	65	4.6	5.6
130	03568670	70.7	65	5.9	6.2
131	03570560	12.1	100	2.1	2.2
132	03570602	106	93	7.7	17.6
133	03570840	5.50	66	.4	.5
134	03571825	117	52	7.8	7.0
135	03572090	78.2	50	3.2	4.3
136	03578030	21.6	48	.7	1.1
137	03578500	41.3	80	5.6	5.2
138	03578504	50.5	92	6.8	8.2
139	03579700	41.2	140	15.0	14.0
140	03580500	77.1	60	7.8	5.9
141	03580700	24.6	95	7.4	4.2
142	03583330	28.9	105	7.4	5.9
143	03583400	86.6	70	16.0	8.7
144	03583480	22.9	50	1.6	1.3
145	03584050	8.10	50	.3	.4
146	03588200	18.6	140	7.4	6.3
147	03588260	53.6	140	14.0	18.3
148	03588340	31.5	140	12.5	10.7
149	03588515	8.58	140	1.7	2.9
150	03588600	46.6	140	18.0	15.9
151	03593585	21.7	130	9.6	6.4
152	03594140	84.4	95	12.0	14.6
154	03594484	251	150	90.0	98.2
155	03595100	13.0	140	2.5	4.4
156	03595500	40.4	120	6.7	10.5
157	03596130	30.6	140	15.0	10.4
158	03596700	16.8	50	.7	.9
159	03597200	80.1	51	4.3	4.6
160	03597220	85.5	50	4.6	4.7
161	03597787	17.2	52	1.8	1.0

OBS	STAN	DA	INDEX	COR3Q20	COM3Q20
162	03597900	49.6	34	1.0	1.4
163	03599250	916	62	77.0	76.0
164	03599418	1028	60	70.0	80.6
165	03599450	74.0	35	2.6	2.2
166	03600256	32.8	38	1.2	1.1
167	03601080	14.8	95	2.3	2.5
168	03601100	48.3	74	4.5	5.3
169	03601500	112	54	7.0	7.1
170	03601550	45.2	72	5.6	4.7
171	03601700	99.8	115	28.0	24.2
172	03601900	154	130	52.0	46.5
173	03601980	5.69	95	.7	1.0
174	03602110	9.00	95	1.6	1.5
175	03602192	21.2	140	6.0	7.2
176	03602200	6.21	80	.8	.8
177	03602229	6.31	110	.7	1.4
178	03602232	13.7	120	1.4	3.5
179	03602245	19.8	140	6.8	6.7
180	03602590	22.9	140	11.0	7.7
181	03602630	7.64	140	3.4	2.6
182	03602660	30.8	140	5.5	10.4
183	03602700	51.2	140	10.0	17.5
184	03603479	26.9	125	5.9	7.5
185	03603500	75.1	130	23.0	22.5
186	03603540	21.4	140	10.0	7.2
187	03603560	12.1	140	5.7	4.1
188	03603580	101	140	34.0	34.7
189	03603586	10.1	140	2.6	3.4
190	03603590	15.3	140	4.5	5.2
191	03603600	126	140	44.0	43.3
192	03603690	19.3	140	8.7	6.5
193	03603710	6.57	130	3.5	1.9
194	03603716	20.1	135	7.0	6.4
195	03603730	24.6	135	7.2	7.8
196	03603770	56.6	95	2.0	9.7
197	03603850	22.8	140	4.3	7.7
198	03603860	12.3	140	3.3	4.1
199	03603900	56.4	115	14.0	13.6
200	03604050	516	120	180	137
201	03604150	15.2	105	4.0	3.1
202	03604200	45.1	115	14.0	10.8
203	03604240	83.6	96	24.0	14.7
204	03604620	31.3	140	8.6	10.6
205	03605953	24.8	120	3.0	6.4
206	03605968	54.5	120	7.6	14.1

SUPPLEMENT D

Winter Low-Flow Values Estimated from Observed Streamflow Records and Regression Equations, and Data Used to Derive the Equations for Tennessee Streams

Map index numbers correspond to station identification numbers on plate 1; streamflow-recession index number from plate 1; *sites useo to derive low-flow equations for streams in West Tennessee; mi^2 = square miles; ft^3/s = cubic feet per second]

Map index No.	Station No.	Drainage area (mi^2)	Streamflow recession index	$1Q_2$		$1Q_{10}$		$1Q_{20}$	
				Observed (ft^3/s)	Regression (ft^3/s)	Observed (ft^3/s)	Regression (ft^3/s)	Observed (ft^3/s)	Regression (ft^3/s)
1	03408500	382	32	104	56.2	20.0	13.6	9.0	8.4
2	03409500	272	37	66.2	45.6	15.0	12.1	9.0	7.8
3	03414500	202	47	72.6	42.4	17.2	13.1	10.5	9.0
4	03415000	114	48	17.3	24.0	4.6	7.6	4.2	5.2
5	03415500	445	53	104	107	31.0	35.1	25.0	24.7
6	03416000	106	60	34.0	27.7	10.0	10.1	7.6	7.3
7	03416100	138	62	37.0	37.4	14.0	13.9	12.0	10.2
8	03417800	15.1	65	2.4	4.0	1.0	1.6	.8	1.2
9	03418000	78.7	65	17.3	22.0	6.2	8.5	4.7	6.3
10	03418020	22.5	65	5.4	6.1	2.0	2.4	1.5	1.8
11	03418050	50.3	65	17.0	13.9	6.0	5.4	4.5	4.0
12	03419300	16.7	75	5.4	5.1	1.9	2.2	1.4	1.7
13	03419500	157	75	66.0	51.4	25.0	21.3	21.0	16.4
14	03420000	175	76	63.5	58.2	20.4	24.3	14.6	18.7
15	03420120	78.8	67	30.0	22.7	6.7	8.9	3.2	6.7
16	03420200	174	37	29.0	28.8	5.0	7.7	3.5	5.0
17	03420500	126	140	60.3	74.9	40.4	45.9	36.7	41.1
18	03420800	132	60	40.0	34.6	11.0	12.6	7.2	9.1
19	03420900	303	110	155	146	77.0	75.9	61.0	63.8
20	03421000	642	85	248	247	98.8	107	74.8	84.6
21	03422800	15.8	60	--	--	--	--	--	--
22	03424670	137	35	--	--	--	--	4.1	3.5
23	03426600	25.5	90	10.0	9.5	4.6	4.6	3.6	3.7
24	03426800	39.1	104	15.1	16.9	6.5	8.8	5.0	7.4
25	03426850	24.5	50	4.5	5.1	1.4	1.7	.9	1.2
26	03426880	24.0	60	9.0	6.0	3.8	2.7	2.9	1.7
27	03427500	262	46	45.6	54.2	12.7	16.5	8.4	11.2
28	03427900	65.1	34	9.60	9.7	2.40	2.5	1.6	1.6
29	03429000	571	45	91.2	118	23.9	34.9	15.2	23.5
30	03430100	892	45	122	187	33.8	54.6	22.3	36.8
31	03431600	51.6	37	11.0	8.3	5.0	2.3	2.9	1.5
32	03431700	24.3	35	4.8	3.6	2.0	1.0	.9	.6
33	03431800	97.2	100	32.3	41.5	17.7	20.8	14.9	17.1
34	03433500	408	32	68.4	60.2	17.9	14.5	10.0	9.0
35	03433700	59.6	130	18.0	32.3	12.0	19.2	11.0	16.9
36	03434000	115	100	42.0	49.3	27.0	24.6	24.0	20.3
37	03434500	681	56	160	175	69.9	58.8	56.1	41.8
38	03434600	56.2	90	14.0	21.3	8.0	10.1	7.1	8.1
39	03435007	11.2	57	3.0	2.6	1.0	1.0	.7	.7
40	03435400	98.0	100	32.0	41.8	12.0	20.9	9.0	17.3

SUPPLEMENT D--Continued

Map index No.	Station No.	Drainage area (mi²)	Streamflow recession index	1Q2 Observed (ft³/s)	1Q2 Regression (ft³/s)	1Q10 Observed (ft³/s)	1Q10 Regression (ft³/s)	1Q20 Observed (ft³/s)	1Q20 Regression (ft³/s)
41	03435500	706	75	126	241	50.3	96.9	43.0	74.0
42	03435790	75.1	50	8.6	16.3	3.4	5.3	2.6	3.7
43	03435900	32.0	80	6.2	10.7	3.2	4.8	2.7	3.7
44	03436000	186	55	36.5	45.3	14.2	15.5	10.9	11.0
45	03436100	935	75	274	322	97.5	129	72.0	98.2
46	03436200	188	80	40.0	65.8	18.0	28.3	16.0	22.1
47	03436430	130	80	31.0	45.0	11.0	19.5	9.0	15.2
48	03436700	124	120	46.5	63.5	23.5	35.4	23.0	30.5
49	03436900	34.5	120	15.0	17.1	8.2	9.8	8.0	8.5
50	03436970	11.9	120	4.9	5.7	2.4	3.4	1.8	2.9
51	03455000	1858	140	1340	1190	749	690	628	613
52	03461200	10.2	100	9.8	4.1	4.3	2.2	3.0	1.8
53	03461300	55.3	94	26.0	21.9	14.0	10.7	12.0	8.7
54	03464815	81.0	100	31.0	34.4	14.0	17.3	10.0	14.3
55	03465000	15.9	100	8.0	6.5	3.1	3.4	2.0	2.8
56	03465500	805	100	567	1360	288	174	230	143
57	03466200	78.1	120	26.0	39.5	17.0	22.2	16.0	19.2
58	03466370	14.9	120	6.6	7.2	3.7	4.2	3.6	3.6
59	03466700	40.4	50	4.4	8.6	1.5	2.9	1.3	2.0
60	03466840	78.0	98	21.0	32.4	14.0	16.1	13.5	13.2
61	03466885	7.99	50	.6	1.6	.3	.6	.2	.4
62	03467000	220	68	30.0	66.1	17.0	25.7	16.0	19.2
63	03467490	41.2	65	5.4	11.3	3.0	4.4	2.7	3.3
64	03468250	10.4	50	1.4	2.1	.5	.7	.35	.5
65	03469112	11.2	100	6.8	4.5	3.6	2.4	3.0	2.0
66	03469160	64.1	72	18.0	19.7	8.8	8.1	7.0	6.2
67	03469238	24.0	111	14.0	10.9	8.0	6.0	6.7	5.1
68	03469500	76.2	95	48.0	30.7	24.0	15.0	19.0	12.2
69	03470000	353	80	150	126	77.4	53.4	63.0	41.6
70	03476980	18.4	50	1.9	3.8	.6	1.3	.4	.9
71	03478602	12.9	96	4.5	5.0	2.4	2.5	2.0	2.1
72	03481625	12.6	88	3.9	4.5	1.9	2.2	1.5	1.7
73	03482000	102	76	34.0	33.4	16.0	14.1	12.0	10.9
74	03484420	13.8	100	6.0	5.6	2.6	2.9	2.0	10.9
75	03484911	25.5	70	8.3	7.4	2.6	3.1	1.8	2.3
76	03485500	137	110	86.2	64.7	46.0	34.1	38.1	28.8
77	03486500	10.3	50	4.7	2.1	1.3	.7	.7	.5
78	03587520	44.5	65	--	--	--	--	1.7	3.6
79	03487550	36.3	100	12.0	15.1	5.5	7.7	4.6	6.4
80	03491000	47.3	70	12.5	14.0	4.6	5.7	3.8	4.3

Map index No.	Station No.	Drainage area (mi²)	Streamflow recession index	1Q2 Observed (ft³/s)	1Q2 Regression (ft³/s)	1Q10 Observed (ft³/s)	1Q10 Regression (ft³/s)	1Q20 Observed (ft³/s)	1Q20 Regression (ft³/s)
81	03491300	47.0	65	9.2	13.0	3.6	5.1	2.5	3.8
82	03494528	18.2	120	10.0	8.8	5.8	5.1	4.8	4.4
83	03494740	6.68	50	.9	1.4	.3	.5	.2	.3
84	03495000	61.4	65	12.0	17.0	4.7	6.6	4.1	4.9
85	03497300	106	145	115	64.9	59	40.8	39.0	36.9
86	03498000	192	90	117	75.4	56.0	34.9	39.0	28.0
87	03498500	269	100	178	118	86.0	57.9	69.0	47.6
88	03499200	13.2	135	9.8	7.1	6.6	4.5	5.9	4.0
89	03499300	11.2	120	7.5	5.4	3.2	3.2	2.5	2.7
90	03499620	9.62	120	5.0	4.6	2.8	2.7	2.3	2.3
91	03518410	67.1	87	33.5	24.8	14.0	11.8	9.0	9.2
92	03518500	118	112	102	56.5	53.4	30.2	39.0	25.6
93	03518800	27.9	100	11.0	11.5	5.8	5.9	4.9	4.9
94	03519640	16.0	120	12.3	7.7	6.4	4.5	4.8	3.9
95	03519732	47.2	140	37.0	27.3	18.0	17.1	15.0	15.3
96	03520043	23.3	120	13.0	27.3	6.6	6.6	5.4	5.7
97	03527600	85.8	60	23.0	22.3	8.3	8.2	7.0	5.9
98	03528000	1474	65	554	447	220	162	175	119
99	03528300	19.0	90	3.4	7.0	2.0	3.4	1.7	2.7
100	03528400	2.68	120	.96	1.2	.58	.7	.50	.7
101	03531815	19.9	115	9.7	9.3	5.3	5.3	4.5	4.5
102	03531900	62.5	75	22.0	19.9	9.6	8.4	8.0	6.5
103	03532000	685	100	268	308	110	148	90.0	122
104	03532100	31.2	90	12.0	11.6	5.0	5.6	4.2	4.5
105	03532200	24.0	42	3.2	4.3	.7	1.3	.5	.9
106	03534000	24.5	53	8.4	5.4	2.2	1.9	1.2	1.3
107	03534980	7.82	82	1.8	2.6	.8	1.2	.7	.9
108	03535000	68.5	80	20.5	23.3	8.1	10.3	6.6	8.0
109	03535050	93.3	75	32.0	30.1	16.0	12.6	13.0	9.7
110	03538180	10.2	70	4.8	2.9	1.7	1.2	1.3	.9
111	03538225	82.5	65	34.9	23.1	11.5	8.9	8.0	6.6
112	03539600	139	32	45.0	19.9	7.5	4.9	2.8	3.0
113	03539800	518.0	32	207	76.9	43.0	18.4	17.0	11.4
114	03543200	26.4	53	3.3	5.9	.8	2.1	.6	1.4
115	03543500	117	84	38.5	42.4	18.5	19.0	15.0	15.0
116	03544235	22.2	70	4.4	6.4	1.7	2.7	1.3	2.0
117	03557148	79.4	115	36.0	38.5	19.0	21.1	17.0	18.1
118	03561500	447	140	535	275	190	164	105	147
119	03565040	14.8	120	5.5	7.1	2.9	4.2	2.5	3.6
120	03565080	8.54	120	4.0	4.1	2.5	2.4	2.2	2.1

SUPPLEMENT D--Continued

Map index No.	Station No.	Drainage area (mi²)	Streamflow recession index	1Q2 Observed (ft³/s)	1Q2 Regression (ft³/s)	1Q10 Observed (ft³/s)	1Q10 Regression (ft³/s)	1Q20 Observed (ft³/s)	1Q20 Regression (ft³/s)
121	03565120	37.8	120	16.0	18.7	8.4	10.7	7.3	9.3
122	03565160	32.7	120	15.6	16.1	8.7	9.3	7.6	8.0
123	03565250	114	120	52.2	58.2	27.7	32.5	23.7	28.1
124	03565300	31.8	65	9.6	8.7	4.8	3.4	4.0	2.5
125	03565500	57.0	140	35.0	33.2	19.7	20.7	16.7	18.5
126	03566126	29.3	130	20.0	15.6	11.0	9.4	9.8	8.3
127	03566250	88.7	95	32.0	35.9	17.0	17.5	15.0	14.2
128	03566260	44.5	90	13.0	16.8	6.6	8.0	5.4	6.4
129	03566320	22.7	48	10.0	4.6	2.1	1.5	1.2	1.0
130	03566420	18.8	80	7.5	6.2	4.3	2.8	3.6	2.2
131	03566450	28.3	67	4.0	7.9	1.6	3.2	1.3	2.4
132	03566543	13.2	60	4.7	3.3	1.7	1.2	1.4	.9
133	03567500	428	120	175	227	104	123	90.3	106
134	03570580	23.7	72	8.6	7.1	3.1	3.0	2.5	2.3
135	03570600	86.2	80	29.0	29.5	9.8	12.9	7.8	10.1
136	03570835	274	80	102	96.9	28.0	41.4	21.0	32.2
137	03571000	402	85	142	152	51.5	67.0	42.0	52.9
138	03571500	116	65	41.0	32.8	13.0	12.5	12.0	9.3
139	03571835	28.2	65	8.2	7.7	2.5	3.0	2.0	2.2
140	03578000	65.6	50	21.7	14.2	3.0	4.7	1.8	3.2
141	03579100	275	90	88.6	109	36.8	50.1	28.9	40.1
142	03580300	55.9	50	9.5	12.0	4.7	4.0	3.9	2.8
143	03581200	49.4	50	11.0	10.6	4.7	3.5	3.7	2.4
144	03582000	827	110	323	411	168	208	144	175
145	03583300	47.5	37	4.7	7.6	2.5	2.1	2.1	1.4
146	03583360	20.2	50	5.8	4.2	2.8	1.4	2.2	1.0
147	03583500	24.4	100	9.1	10.0	5.5	5.2	4.9	4.3
148	03584000	366	60	99.0	98.8	47.5	35.1	39.0	25.5
149	03584500	1784	75	618	625	287	246	231	188
150	03585250	36.6	140	23.0	21.0	18.0	13.2	17.0	11.9
151	03585260	17.4	140	8.3	9.8	5.5	6.3	4.9	5.6
152	03587900	15.4	140	12.0	8.6	8.4	5.5	7.4	5.0
153	03588400	43.0	140	27.2	24.8	15.3	15.6	13.0	14.0
154	03588500	348	138	181	210	114	125	103	111
155	03590900	42.5	68	15.0	12.2	6.6	4.9	5.2	3.7
156 *	03593300	49.4	65	7.56	5.4	3.16	1.8	2.56	1.5
157	03593580	26.9	130	16.0	14.3	11.0	8.6	9.2	7.6
158	03593600	66.7	130	40.0	36.3	27.0	21.5	23.0	19.0
159	03593700	14.9	130	8.4	7.8	5.6	4.8	5.0	4.2
160	03593800	104	125	56.6	55.1	35.4	31.7	30.8	27.6

Map index No.	Station No.	Drainage area (mi²)	Streamflow recession index	1Q2 Observed (ft³/s)	1Q2 Regression (ft³/s)	1Q10 Observed (ft³/s)	1Q10 Regression (ft³/s)	1Q20 Observed (ft³/s)	1Q20 Regression (ft³/s)
161	03594040	53.7	66	23.6	15.1	12.3	5.9	8.8	4.4
162 *	03594120	45.5	75	13.9	6.0	4.0	2.3	2.4	1.8
163	03594150	25.8	77	10.0	8.2	4.8	3.6	3.8	2.8
164	03594160	201	66	82.0	58.5	46.6	22.4	40.8	16.6
165	03594180	50.7	64	12.0	13.4	6.6	5.3	5.8	3.9
166	03594260	24.7	95	6.9	9.7	4.3	4.8	3.8	3.9
167	03594400	16.8	60	3.8	4.2	1.9	1.6	1.6	1.2
168 *	03594445	115.0	205	67.0	42.4	38.0	29.1	32.0	26.1
169	03595300	35.3	60	9.2	8.9	4.9	3.3	4.2	2.4
170	03596000	107	100	38.0	45.8	20.4	24.9	17.1	18.9
171	03596500	208	105	110	95.0	62.0	48.3	50	40.2
172	03597000	66.3	45	12.2	12.9	5.3	4.0	4.4	2.7
173	03597700	130	44	22.0	25.3	6.8	7.6	5.0	5.1
174	03598000	481	90	156	194	85.7	87.9	74.4	70.3
175	03599500	1208	50	239	283	73.5	87.6	50.0	60.5
176	03600380	37.5	45	10.0	7.2	5.1	2.3	4.1	1.5
177	03600500	17.5	100	6.5	7.1	3.9	3.7	3.5	3.1
178	03601695	8.43	130	6.0	4.3	3.8	2.7	3.5	2.4
179	03601860	15.3	130	14.0	8.0	9.8	4.9	9.0	4.3
180	03601950	5.56	75	2.4	1.7	.9	.7	.8	.6
181	03602235	22.7	120	6.4	11.1	3.6	6.4	3.1	5.6
182	03602500	202	135	91.0	118	58.8	69.8	53.6	61.8
183	03602600	74.7	135	54.0	42.3	35.0	25.6	32.0	22.8
184	03603000	2557	90	887	1080	493	472	427	376
185	03603550	60.2	140	27.0	35.1	18.0	21.8	16.0	19.6
186	03603660	37.7	140	33.0	21.7	22.0	13.6	20.0	12.2
187	03603720	13.4	140	5.6	7.5	3.8	4.8	3.3	4.3
188	03603750	19.1	140	11.0	10.8	7.2	6.9	6.5	6.2
189	03604000	447	120	251	237	167	129	150	111
190	03604060	7.34	95	2.3	2.8	1.5	1.4	1.3	1.2
191	03604180	15.2	140	9.8	8.5	6.1	5.7	5.4	4.9
192	03604500	707	125	410	395	270	218	245	189
193	03604600	24.8	135	15.0	13.6	9.6	8.4	8.6	7.5
194	03605555	31.9	110	16.2	14.5	10.6	7.9	9.4	6.7
195 *	03606280	41.4	230	17.0	16.7	11.0	12.0	9.8	10.9
196 *	03606500	205	240	93.4	87.3	62.8	65.3	56.7	59.3
197 *	03607000	379	200	106	139	86.0	95.5	80.0	85.2
198 *	03607200	47.9	240	27.5	20.1	20.0	14.7	17.5	13.4
199 *	07024250	43.5	200	18.0	15.5	10.0	10.4	9.30	9.3
200 *	07024300	55.5	350	35.7	31.9	26.9	28.1	24.8	26.5

Map index No.	Station No.	Drainage area (mi²)	Streamflow recession index	1Q2 Observed (ft³/s)	1Q2 Regression (ft³/s)	1Q10 Observed (ft³/s)	1Q10 Regression (ft³/s)	1Q20 Observed (ft³/s)	1Q20 Regression (ft³/s)
201 *	07024500	383	235	151	161	106	120	96.9	109
202 *	07024720	137	300	85.0	70.1	67.0	58.1	62.0	53.9
203 *	07025000	203	150	33.4	56.9	22.6	33.4	20.8	29.0
204 *	07025300	83.7	300	35.0	42.6	29.0	35.1	28.0	32.5
205 *	07025350	36.7	65	3.2	4.0	.7	1.4	.6	1.1
206 *	07025500	480	205	140	180	113	126	108	113
207 *	07026000	1852	175	--	--	--	--	--	--
208 *	07027300	160	230	65.0	65.5	48.0	47.8	35.0	43.3
209 *	07027500	495	230	188	205	134	152	124	137
210 *	07027700	25.0	60	1.1	2.4	.42	.8	.38	.6
211 *	07028000	1003	195	286	363	197	250	178	222
212 *	07028500	73.4	140	15.0	19.0	12.9	10.6	12.5	9.2
213 *	07028900	88.2	120	17.0	19.7	9.4	10.1	8.0	8.6
214 *	07029000	369	195	126	132	101	89.7	96.2	79.8
215 *	07029100	867	160	268	262	151	162	130	142
216 *	07029380	94.8	140	44.2	24.7	16.5	13.8	12.5	11.9
217 *	07029400	837	130	278	208	147	115	122	98.3
218 *	07029410	47.6	250	23.0	20.6	18.0	15.4	17.0	14.1
219 *	07029440	40.4	60	5.0	3.9	1.6	1.2	1.2	1.0
220 *	07029500	1480	160	637	450	329	281	273	245
221 *	07029700	84.3	210	29.0	31.7	19.0	21.9	16.5	19.7
222 *	07030000	1940	175	829	642	466	422	406	371
223 *	07030020	92.0	170	20.5	28.7	15.0	17.8	14.0	15.7
224 *	07030209	76.9	165	18.0	23.3	14.0	14.2	13.0	12.5
225 *	07030280	505	150	93.9	143	69.0	84.9	61.9	73.7
226 *	07030400	71.9	170	18.0	22.3	14.0	13.8	13.0	12.2
227 *	07030500	503	230	229	209	179	155	168	140
228 *	07031700	770	210	295	297	218	211	192	189

SUPPLEMENT D--Continued

Map index No.	Station No.	Drainage area (mi^2)	Streamflow recession index	$3Q_2$ Observed (ft^3/s)	$3Q_2$ Regression (ft^3/s)	$3Q_{10}$ Observed (ft^3/s)	$3Q_{10}$ Regression (ft^3/s)	$3Q_{20}$ Observed (ft^3/s)	$3Q_{20}$ Regression (ft^3/s)
1	03408500	382	32	113	61.9	21.0	15.5	10.0	9.6
2	03409500	272	37	71.1	50.1	16.0	13.7	10.0	8.8
3	03414500	202	47	77.0	46.3	17.7	14.6	10.7	9.9
4	03415000	114	48	18.2	26.4	4.8	8.4	4.5	5.8
5	03415500	445	53	122	116	39.5	38.9	27.1	27.2
6	03416000	106	60	36.8	30.1	11.6	11.0	10.0	8.1
7	03416100	138	62	42.0	40.6	17.0	15.1	13.0	11.1
8	03417800	15.1	65	2.5	4.4	1.1	1.7	.9	1.3
9	03418000	78.7	65	18.2	23.9	6.6	9.2	5.5	6.8
10	03418020	22.5	65	5.3	6.7	2.1	2.6	1.8	2.0
11	03418050	50.3	65	17.0	15.2	6.4	5.8	5.4	4.4
12	03419300	16.7	75	5.7	5.6	2.0	2.4	1.7	1.9
13	03419500	157	75	76.0	55.2	30.0	23.0	22.0	17.7
14	03420000	175	76	66.1	62.5	21.4	26.2	17.0	20.2
15	03420120	78.8	67	16.0	24.6	6.4	9.6	4.9	7.2
16	03420200	174	37	31.0	31.8	6.0	8.7	2.5	5.6
17	03420500	126	140	62.1	78.9	41.2	47.5	37.4	42.8
18	03420800	132	60	36.0	37.6	13.0	13.7	8.5	10.0
19	03420900	303	110	162	154	80.0	80.0	65.0	67.5
20	03421000	642	85	262	261	105	116	80.2	90.9
21	03422800	16.8	60			.9	1.7	.8	1.3
22	03424670	137	35					4.7	4.0
23	03426600	25.5	90	10.0	10.3	5.0	4.8	4.0	3.9
24	03426800	39.1	104	16.3	18.1	7.0	9.3	5.34	7.8
25	03426850	24.5	50	4.7	5.7	1.6	1.9	1.1	1.3
26	03426880	24.0	60	9.2	6.6	4.2	2.4	3.3	1.8
27	03427500	262	46	48.3	59.1	14.7	18.4	10.1	12.4
28	03427900	65.1	34	9.0	10.8	2.7	2.8	1.9	1.8
29	03429000	571	45	97.3	128	28.3	39.0	19.0	26.2
30	03430100	892	45	129	202	35.7	61.3	23.7	41.0
31	03431600	51.6	37	13.0	9.2	5.4	2.5	3.0	1.6
32	03431700	24.3	35	5.4	4.1	2.3	1.1	1.0	.7
33	03431800	97.2	100	35.7	44.3	18.2	21.9	14.9	18.2
34	03433500	408	32	77.9	66.2	19.8	16.6	10.1	10.2
35	03433700	59.6	130	21.0	34.3	9.5	19.9	9.0	17.7
36	03434000	115	100	43.0	52.5	28.0	26.0	24.0	21.5
37	03434500	681	56	171	188	72.4	65.1	57.6	46.0
38	03434600	56.2	90	14.0	23.0	8.0	10.7	7.1	8.7
39	03435007	11.2	57	3.4	2.9	1.1	1.0	.7	.8
40	03435400	98.0	100	34.0	44.7	15.0	22.1	13.0	18.3

Map index No.	Station No.	Drainage area (mi^2)	Streamflow recession index	$3Q_2$ Observed (ft^3/s)	$3Q_2$ Regression (ft^3/s)	$3Q_{10}$ Observed (ft^3/s)	$3Q_{10}$ Regression (ft^3/s)	$3Q_{20}$ Observed (ft^3/s)	$3Q_{20}$ Regression (ft^3/s)
41	03435500	706	75	132	256	52.1	105	48.0	80.1
42	03435790	75.1	50	16.0	17.9	6.0	5.9	5.3	4.1
43	03435900	32.0	80	7.0	11.6	3.2	5.1	3.0	4.0
44	03436000	186	55	39.0	49.2	14.5	17.0	13.0	12.0
45	03436100	935	75	293	340	99.4	140	72.1	106
46	03436200	188	80	41.0	70.5	19.0	30.4	17.0	23.8
47	03436430	130	80	32.0	48.4	11.0	20.9	10.3	16.4
48	03436700	124	120	49.3	67.2	24.4	37.0	24.0	32.1
49	03436900	34.5	120	16.0	18.2	8.5	10.1	8.2	8.9
50	03436970	11.9	120	8.0	6.2	2.4	3.5	1.9	3.0
51	03455000	1858	140	1425	1220	818	722	689	641
52	03461200	10.2	100	10.0	4.5	4.5	2.2	3.0	1.9
53	03461300	55.3	94	29.0	23.5	16.0	11.3	12.0	9.2
54	03464815	81.0	100	36.0	36.8	18.0	18.2	11.0	15.1
55	03465000	15.9	100	8.4	7.0	3.8	3.5	2.9	2.9
56	03465500	805	100	616	382	337	186	240	134
57	03466200	78.1	120	28.0	42.0	18.0	23.2	17.0	20.1
58	03466370	14.9	120	7.0	7.8	4.0	4.3	3.7	3.8
59	03466700	40.4	50	5.5	9.5	1.7	3.1	1.4	2.2
60	03466840	78.0	98	22.0	34.7	15.0	17.0	14.0	14.1
61	03466885	7.99	50	1.2	1.8	.35	.6	.2	.4
62	03467000	220	68	31.7	71.1	18.0	27.9	17.0	20.9
63	03467490	41.2	65	6.5	12.4	3.2	4.8	3.0	3.6
64	03468250	10.4	50	1.6	2.4	.6	.8	.4	.6
65	03469112	11.2	100	7.4	4.9	4.0	2.5	3.2	2.1
66	03469160	64.1	72	20.0	21.3	10.0	8.7	7.4	6.7
67	03469238	24.0	111	15.0	11.7	8.8	6.2	7.0	5.4
68	03469500	76.2	95	54.0	32.9	27.0	15.8	20.0	13.0
69	03470000	353	80	164	134	86.3	57.5	66.0	44.7
70	03476980	18.4	50	2.4	4.3	.8	1.4	.5	1.0
71	03478602	12.9	96	5.2	5.4	2.5	2.7	2.2	2.2
72	03481625	12.6	88	4.5	4.9	2.0	2.3	1.8	1.9
73	03482000	102	76	37.0	36.0	17.0	15.2	13.0	11.7
74	03484420	13.8	100	7.0	6.1	3.2	3.0	2.4	2.6
75	03484911	25.5	70	10.0	8.1	3.5	3.3	2.4	2.5
76	03485500	137	110	97.0	68.6	54.0	35.8	44.0	30.4
77	03486500	10.3	50	5.0	2.4	1.3	.8	.7	1.8
78	03487520	44.5	65	--	--	--	--	1.8	3.9
79	03487550	36.3	100	12.2	16.2	5.6	8.1	5.0	6.8
80	03491000	47.3	70	13.2	15.3	4.7	6.1	4.1	4.7

SUPPLEMENT D--Continued

Map index No.	Station No.	Drainage area (mi^2)	Streamflow recession index	$3Q_2$ Observed (ft^3/s)	$3Q_2$ Regression (ft^3/s)	$3Q_{10}$ Observed (ft^3/s)	$3Q_{10}$ Regression (ft^3/s)	$3Q_{20}$ Observed (ft^3/s)	$3Q_{20}$ Regression (ft^3/s)
81	03491300	47.0	65	10.1	14.1	3.9	5.5	2.9	4.1
82	03494528	18.2	120	11.0	9.5	6.0	5.3	5.0	4.7
83	03494740	6.68	50	1.0	1.5	.3	.5	.2	.4
84	03495000	61.4	65	13.0	18.6	4.9	7.2	4.3	5.3
85	03497300	106	145	123	68.3	60.0	42.1	40.0	38.3
86	03498000	192	90	124	80.3	60.0	37.2	40.0	29.9
87	03498500	269	100	190	125	87.0	61.3	70.0	50.6
88	03499200	13.2	135	12.0	7.6	7.2	4.6	6.4	4.2
89	03499300	11.2	120	8.0	5.8	3.3	3.2	2.6	2.9
90	03499620	9.62	120	5.4	5.0	2.9	2.8	2.5	2.5
91	03518410	67.1	87	37.0	26.6	15.0	12.2	9.4	9.8
92	03518500	118	112	109	60	57.0	31.7	40.0	27.0
93	03518800	27.9	100	11.0	12.4	6.0	6.2	5.1	5.2
94	03519640	16.0	120	13.0	8.3	6.5	4.7	5.0	4.1
95	03519732	47.2	140	40.0	29.0	18.0	17.6	15.3	15.6
96	03520043	23.3	120	14.0	12.2	6.7	6.8	5.5	6.0
97	03527600	85.8	60	24.0	24.0	8.4	8.9	7.4	6.5
98	03528000	1474	65	580	474	225	178	180	130
99	03528300	19.0	90	3.5	7.6	2.2	3.6	2.0	2.9
100	03528400	2.68	120	1.0	1.3	.6	.8	.52	.7
101	03531815	19.9	115	10.0	10.0	5.8	5.4	4.8	4.7
102	03531900	62.5	75	24.0	21.6	11.0	9.1	8.5	7.0
103	03532000	685	100	287	324	112	158	97.4	129
104	03532100	31.2	90	13.0	12.6	5.0	5.9	4.5	4.8
105	03532200	24.0	42	3.6	4.8	.8	1.4	.6	1.0
106	03534000	24.5	53	8.7	6.0	2.3	2.1	1.2	1.5
107	03534980	7.82	82	1.9	2.8	.8	1.3	.7	1.0
108	03535000	68.5	80	22.7	25.2	9.6	11.0	7.4	8.6
109	03535050	93.3	75	35.0	32.5	19.0	13.6	14.0	10.5
110	03538180	10.2	70	5.4	3.9	1.8	1.3	1.3	1.0
111	03538225	82.5	65	38.5	25.1	12.0	9.6	8.2	7.2
112	03539600	139	32	48.0	22.1	8.0	5.6	3.0	3.5
113	03539800	518	32	221	84.5	46.0	21.1	17.0	13.0
114	03543200	26.4	53	3.8	6.5	1.0	2.2	.8	1.6
115	03543500	117	84	41.3	45.5	19.0	20.3	15.3	16.1
116	03544235	22.2	70	4.8	7.1	1.8	2.9	1.4	2.2
117	03557148	79.4	115	38.0	41.0	20.0	22.1	17.0	19.0
118	03561500	447	140	609	287	210	171	110	153
119	03565040	14.8	120	5.7	7.7	3.0	4.3	2.5	3.8
120	03565080	8.54	120	4.7	4.4	2.7	2.5	2.2	2.2

SUPPLEMENT D--Continued

Map index No.	Station No.	Drainage area (mi^2)	Streamflow recession index	$3Q_2$ Observed (ft^3/s)	$3Q_2$ Regression (ft^3/s)	$3Q_{10}$ Observed (ft^3/s)	$3Q_{10}$ Regression (ft^3/s)	$3Q_{20}$ Observed (ft^3/s)	$3Q_{20}$ Regression (ft^3/s)
121	03565120	37.8	120	16.7	20.0	8.7	11.1	7.5	9.7
122	03565160	32.7	120	16.0	17.3	8.8	9.6	7.7	8.4
123	03565250	114	120	54.0	61.7	28.0	34.0	23.9	29.5
124	03565300	31.8	65	10.8	9.5	5.2	3.7	4.2	2.8
125	03565500	57.0	140	36.9	35.1	20.2	21.3	19.0	19.3
126	03566126	29.3	130	21.0	16.6	12.0	9.7	11.0	8.7
127	03566250	88.7	95	36.0	38.5	18.0	18.5	15.0	15.1
128	03566260	44.5	90	14.0	18.1	7.0	8.5	5.6	6.9
129	03566320	22.7	48	10.0	5.1	2.2	1.6	1.3	1.1
130	03566420	18.8	80	8.1	6.7	4.6	3.0	3.9	2.4
131	03566450	28.3	67	4.4	8.7	1.8	3.4	1.4	2.6
132	03566543	13.2	60	5.5	3.6	1.7	1.3	1.5	1.0
133	03567500	428	120	185	238	108	130	93.3	111
134	03570580	23.7	72	9.8	7.8	3.1	3.2	2.7	2.5
135	03570600	86.2	80	34.0	31.8	10.0	13.8	8.4	10.8
136	03570835	274	80	110	104	28.0	44.5	24.0	34.7
137	03571000	402	85	164	162	52.0	72.0	45.0	56.8
138	03571500	116	65	47.0	35.5	13.0	13.6	12.0	10.1
139	03571835	28.2	65	9.8	8.4	2.5	3.3	2.1	2.4
140	03578000	65.6	50	23.9	15.6	4.9	5.1	2.8	3.6
141	03579100	275	90	113	116	44.8	53.5	34.3	42.9
142	03580300	55.9	50	10.0	13.2	4.8	4.4	4.0	3.0
143	03581200	49.4	50	12.0	11.7	5.0	3.9	4.1	2.7
144	03582000	827	110	344	429	173	221	146	185
145	03583300	47.5	37	5.2	8.5	2.8	2.3	2.4	1.5
146	03583360	20.2	50	6.2	4.7	2.8	1.6	2.0	1.1
147	03583500	24.4	100	9.4	10.8	5.7	5.4	5.2	4.5
148	03584000	366	60	105	106	50.0	38.5	40.5	27.9
149	03584500	1784	75	688	658	314	269	250	203
150	03585250	36.6	140	24.0	22.4	18.0	13.6	17.0	12.4
151	03585260	17.4	140	8.6	10.5	5.6	6.4	5.0	5.9
152	03587900	15.4	140	15.0	9.3	8.6	5.7	7.8	5.2
153	03588400	43.0	140	28.8	26.4	15.8	16.0	13.4	14.5
154	03588500	348	138	190	219	121	130	109	116
155	03590900	42.5	68	17.0	13.3	7.2	5.3	5.8	4.0
156 *	03593300	49.4	65	8.4	5.8	3.4	1.9	2.71	1.4
157	03593580	26.9	130	16.0	15.3	11.0	8.9	9.4	8.0
158	03593600	66.7	130	41.0	38.5	27.0	22.3	24.0	19.8
159	03593700	14.9	130	8.8	8.4	5.8	4.9	5.6	4.4
160	03593800	104	125	57.6	58.4	36.0	32.9	31.4	28.9

Map index No.	Station No.	Drainage area (mi^2)	Streamflow recession index	$3Q_2$ Observed (ft^3/s)	$3Q_2$ Regression (ft^3/s)	$3Q_{10}$ Observed (ft^3/s)	$3Q_{10}$ Regression (ft^3/s)	$3Q_{20}$ Observed (ft^3/s)	$3Q_{20}$ Regression (ft^3/s)
161	03594040	53.7	66	24.5	16.4	12.6	6.4	8.8	4.8
162 *	03594120	45.5	75	14.8	6.4	4.2	2.4	2.52	1.8
163	03594150	25.8	77	11.0	9.0	5.1	3.8	4.2	3.0
164	03594160	201	66	85.0	63.1	47.0	24.3	41.0	18.1
165	03594180	50.7	64	12.0	15.1	7.0	5.8	6.0	4.3
166	03594260	24.7	95	7.2	10.4	4.5	5.1	4.0	4.2
167	03594400	16.8	60	4.1	4.6	2.0	1.7	1.7	1.3
168 *	03594445	115	205	70.5	43.6	39.6	29.9	33.0	27.1
169	03595300	35.3	60	9.6	9.8	5.2	3.6	4.6	2.7
170	03596000	107	100	39.6	48.8	21.2	24.1	17.8	20.0
171	03596500	208	105	130	101	64.0	51.0	50.0	42.6
172	03597000	66.3	45	13.0	14.3	5.6	4.4	4.6	3.0
173	03597700	130	44	22.0	27.8	7.2	8.4	5.0	5.7
174	03598000	481	90	165	205	90.1	94.9	77.8	75.2
175	03599500	1208	50	282	303	108	97.8	80.5	67.0
176	03600380	37.5	45	11.0	8.0	5.2	2.5	4.3	1.7
177	03600500	17.5	100	7.0	7.7	4.1	3.9	3.6	3.2
178	03601695	8.43	130	6.2	4.7	3.8	2.8	3.5	2.5
179	03601860	15.3	130	14.0	8.6	9.8	5.0	6.4	4.5
180	03601950	5.56	75	2.7	1.8	.9	.8	.8	.6
181	03602235	22.7	120	6.8	12.0	3.6	6.6	3.2	5.8
182	03602500	202	135	94.8	123	59.5	72.4	53.8	64.5
183	03602600	74.7	135	56.0	44.7	35.0	26.5	32.0	23.7
184	03603000	2557	90	914	1120	505	510	436	404
185	03603550	60.2	140	28.0	37.1	18.5	22.5	16.5	20.4
186	03603660	37.7	140	34.0	23.1	23.0	14.0	20.0	12.7
187	03603720	13.4	140	6.0	8.0	4.0	4.9	3.8	4.5
188	03603750	19.1	140	11.0	11.5	7.4	7.0	6.8	6.4
189	03604000	447	120	261	248	174	135	157	116
190	03604060	7.34	95	2.5	3.0	1.7	1.5	1.5	1.2
191	03604180	15.2	140	10.0	9.1	6.4	5.6	5.7	5.1
192	03604500	707	125	422	412	272	229	245	198
193	03604600	24.8	135	12.0	14.5	7.4		8.7	7.8
194	03605555	31.9	110	17.0	16.4	11.0	8.2	10.0	7.0
195 *	03606280	41.4	230	18.0	17.1	10.0	12.3	10.0	11.3
196 *	03606500	205	240	98.0	89.0	65.0	66.8	58.1	61.8
197 *	03607000	379	200	110	142	91.0	97.7	86.0	88.2
198 *	03607200	47.9	240	28.0	20.5	21.0	15.2	19.0	14.0
199 *	07024250	43.5	200	19.0	16.0	11.0	10.7	9.5	9.6
200 *	07024300	55.5	350	36.9	32.2	27.5	28.7	25.5	28.0

SUPPLEMENT D--Continued

Map index No.	Station No.	Drainage area (mi^2)	Streamflow recession index	$3Q_2$ Observed (ft^3/s)	$3Q_2$ Regression (ft^3/s)	$3Q_{10}$ Observed (ft^3/s)	$3Q_{10}$ Regression (ft^3/s)	$3Q_{20}$ Observed (ft^3/s)	$3Q_{20}$ Regression (ft^3/s)
202 *	07024720	137	300	88.0	71.0	68.0	59.3	65.0	56.6
203 *	07025000	203	150	35.2	59.0	23.1	34.5	21.0	29.7
204 *	07025300	83.7	300	34.0	43.2	31.0	35.9	30.0	34.2
205 *	07025350	36.7	65	3.7	4.3	.7	1.4	.6	1.1
206 *	07025500	480	205	143	187	115	129	110	116
207 *	07026000	1852	175	595	630	393	410	352	364
208 *	07027300	160	230	68.0	67.0	50.0	49.0	45.0	45.0
209 *	07027500	495	230	197	210	138	155	127	143
210 *	07027700	25.0	60	1.1	2.6	.45	.8	.3	.6
211 *	07028000	1003	195	292	372	200	255	182	229
212 *	07028500	73.4	140	15.3	19.8	13.1	11.0	12.7	9.4
213 *	07028900	88.2	120	17.0	20.7	9.6	10.5	8.3	8.8
214 *	07029000	369	195	129	136	102	91.8	96.9	82.9
215 *	07029100	867	160	283	270	156	166	133	145
216 *	07029380	94.8	140	45.7	25.7	17.2	14.3	13.0	12.2
217 *	07029400	837	130	306	217	158	118	130	100
218 *	07029410	47.6	250	24.0	21.1	19.0	15.9	17.5	14.7
219 *	07029440	40.4	60	5.6	4.3	1.8	1.3	1.3	1.0
220 *	07029500	1480	160	668	465	341	287	282	251
221 *	07029700	84.3	210	26.5	32.5	20.0	22.5	17.0	20.4
222 *	07030000	1940	175	849	661	474	430	412	381
223 *	07030020	92.0	170	21.0	29.6	16.0	18.4	14.0	16.2
224 *	07030209	76.9	165	18.2	24.1	14.0	14.7	13.0	12.8
225 *	07030280	505	150	94.6	148	69.4	87.5	63.6	75.5
226 *	07030400	71.9	170	18.5	23.1	14.0	14.3	13.0	12.6
227 *	07030500	503	230	233	213	181	158	170	145
228 *	07031700	770	210	295	304	218	215	192	196

Map index No.	Station No.	Drainage area (mi²)	Streamflow recession index	7Q2 Observed (ft³/s)	7Q2 Regression (ft³/s)	7Q10 Observed (ft³/s)	7Q10 Regression (ft³/s)	7Q20 Observed (ft³/s)	7Q20 Regression (ft³/s)
1	03408500	382	32	145	79.8	31.0	19.7	17.0	12.7
2	03409500	272	37	92.7	63.6	19.0	17.2	11.0	11.4
3	03414500	202	47	93.6	57.3	20.5	17.8	12.1	12.5
4	03415000	114	48	22.9	32.4	5.2	10.3	5.0	7.3
5	03415500	445	53	179	143	50.0	46.4	35.0	33.1
6	03416000	106	60	43.0	36.2	13.0	13.1	10.0	9.7
7	03416100	138	62	56.0	48.8	21.0	17.9	16.0	13.3
8	03417800	15.1	65	3.0	5.2	1.2	2.1	1.0	1.6
9	03418000	78.7	65	22.9	28.5	8.2	10.9	6.1	8.2
10	03418020	22.5	65	7.1	7.9	2.6	3.1	1.9	2.4
11	03418050	50.3	65	22.0	18.0	8.0	6.9	6.0	5.3
12	03419300	16.7	75	6.6	6.6	2.1	2.8	1.7	2.2
13	03419500	157	75	102	65.4	47.0	26.5	26.0	20.5
14	03420000	175	76	78.0	73.9	22.0	30.1	17.6	23.4
15	03420120	78.8	67	19.0	29.3	7.6	11.4	5.6	8.7
16	03420200	174	37	36.0	40.2	11.0	11.0	4.0	7.3
17	03420500	126	140	68.8	88.0	44.7	50.7	40.4	44.9
18	03420800	132	60	58.0	45.4	15.0	16.3	9.8	12.1
19	03420900	303	110	190	177	92.0	87.4	73.0	72.9
20	03421000	642	85	325	308	126	130	93.5	102
21	03422800	16.8	60	--	--	--	--	--	--
22	03424670	137	35	--	--	--	--	--	--
23	03426600	25.5	90	12.0	11.8	5.3	5.5	4.2	4.5
24	03426800	39.1	104	18.9	20.6	8.0	10.4	6.0	8.7
25	03426850	24.5	50	6.2	6.9	1.7	2.3	1.2	1.7
26	03426880	24.0	60	11.0	7.9	4.4	3.0	3.5	2.2
27	03427500	262	46	65.9	73.4	16.0	22.4	11.0	15.6
28	03427900	65.1	34	12.0	13.7	3.0	3.6	2.0	2.4
29	03429000	571	45	119	161	31.0	47.5	21.0	32.6
30	03430100	892	45	155	254	37.0	74.2	28.0	50.7
31	03431600	51.6	37	16.0	11.5	6.2	3.2	3.2	2.2
32	03431700	24.3	35	6.9	5.1	2.7	1.4	1.3	1.0
33	03431800	97.2	100	40.4	50.8	19.8	24.5	16.0	20.3
34	03433500	408	32	98.1	85.4	24.5	21.1	15.6	13.5
35	03433700	59.6	130	21.0	38.3	13.0	21.6	12.0	19.0
36	03434000	115	100	47.0	60.4	30.0	29.0	26.0	23.9
37	03434500	681	56	201	231	83.8	76.8	65.7	55.1
38	03434600	56.2	90	15.0	26.5	8.5	12.2	7.4	9.9
39	03435007	11.2	57	4.3	3.5	1.2	1.3	.8	1.0
40	03435400	98.0	100	40.0	51.3	16.0	24.7	13.3	20.4

SUPPLEMENT D--Continued

Map index No.	Station No.	Drainage area (mi^2)	Streamflow recession index	$7Q_2$ Observed (ft^3/s)	$7Q_2$ Regression (ft^3/s)	$7Q_{10}$ Observed (ft^3/s)	$7Q_{10}$ Regression (ft^3/s)	$7Q_{20}$ Observed (ft^3/s)	$7Q_{20}$ Regression (ft^3/s)
41	03435500	706	75	166	306	59.6	120	49.0	91.2
42	03435790	75.1	50	18.0	21.8	6.5	7.2	6.2	5.2
43	03435900	32.0	80	7.2	13.5	3.4	5.9	3.3	4.7
44	03436000	186	55	44.4	60.0	15.9	20.4	12.0	14.8
45	03436100	935	75	335	408	102	159	72.1	121
46	03436200	188	80	52.0	83.0	21.0	34.7	18.0	27.2
47	03436430	130	80	42.0	56.9	13.0	24.0	10.5	18.9
48	03436700	124	120	54.9	76.1	25.9	40.3	26.0	34.5
49	03436900	34.5	120	17.0	20.5	9.5	11.2	9.0	9.7
50	03436970	11.9	120	8.8	6.9	2.7	3.8	2.2	3.4
51	03455000	1858	140	1604	1390	941	753	794	648
52	03461200	10.2	100	11.5	5.0	5.1	2.6	4.3	2.2
53	03461300	55.3	94	33.0	27.1	18.0	12.8	15.0	10.5
54	03464815	81.0	100	39.0	42.2	20.0	20.4	16.0	16.9
55	03465000	15.9	100	9.2	7.9	4.0	4.0	3.0	3.4
56	03465500	805	100	689	446	388	204	322	165
57	03466200	78.1	120	30.0	47.3	18.0	25.3	17.5	21.8
58	03466370	14.9	120	7.6	8.6	4.2	4.8	4.0	4.2
59	03466700	40.4	50	5.8	11.6	1.8	3.9	1.6	2.8
60	03466840	78.0	98	23.0	39.9	16.0	19.1	15.0	15.8
61	03466885	7.99	50	1.2	2.2	.7	.8	.6	.6
62	03467000	220	68	35.0	85.1	19.0	32.4	18.0	24.5
63	03467490	41.2	65	6.6	14.7	3.4	5.7	3.2	4.3
64	03468250	10.4	50	2.0	2.9	.7	1.0	.6	.7
65	03469112	11.2	100	8.4	5.5	4.6	2.8	3.9	2.4
66	03459160	64.1	72	24.0	25.2	11.0	10.2	9.4	7.9
67	03469238	24.0	111	17.0	13.2	10.0	7.0	8.4	6.0
68	03469500	76.2	95	62.0	37.9	31.0	17.9	25.0	14.7
69	03470000	353	80	189	159	99.4	65.3	81.7	50.9
70	93476980	18.4	50	2.9	5.2	1.1	1.8	.9	1.3
71	03478602	12.9	96	5.6	6.2	3.2	3.1	3.0	2.6
72	03481625	12.6	88	5.1	5.6	2.8	2.6	2.3	2.2
73	03482000	102	76	41.9	42.5	22.2	17.5	18.4	13.7
74	03484420	13.8	100	8.2	6.9	4.0	3.5	3.4	2.9
75	03484911	25.5	70	12.0	9.5	4.8	3.9	3.7	3.0
76	03485500	137	110	109	78.3	65.4	39.4	56.4	33.2
77	03486500	10.3	50	5.5	2.8	2.3	1.0	1.5	.7
78	03487520	44.5	65	--	--	--	--	--	--
79	03487550	36.3	100	15.1	18.5	6.0	9.1	5.4	7.6
80	03491000	47.3	70	15.0	18.0	5.0	7.2	4.25	5.6

SUPPLEMENT D--Continued

Map index No.	Station No.	Drainage area (mi²)	Streamflow recession index	7Q2 Observed (ft³/s)	7Q2 Regression (ft³/s)	7Q10 Observed (ft³/s)	7Q10 Regression (ft³/s)	7Q20 Observed (ft³/s)	7Q20 Regression (ft³/s)
81	03491300	47.0	65	11.8	16.8	4.0	6.5	3.0	4.9
82	03494528	18.2	120	13.0	10.6	6.4	5.9	5.2	5.2
83	03494740	6.68	50	1.3	1.8	.4	.6	.3	.5
84	03495000	61.4	65	20.0	22.1	6.5	8.5	5.5	6.4
85	03497300	106	145	136	75.9	70.0	44.8	48.0	40.0
86	03498000	192	90	140	93.6	65.9	41.8	52.3	33.6
87	03498500	269	100	212	145	100	67.9	88.0	55.6
88	03499200	13.2	135	11.0	8.4	7.3	5.0	6.5	4.5
89	03499300	11.2	120	9.0	6.4	3.9	3.6	3.3	3.2
90	03499620	9.62	120	6.4	5.5	3.1	3.1	2.6	2.7
91	03518410	67.1	87	48.0	30.9	19.0	13.9	15.0	11.2
92	03518500	118	112	125	68.2	67.5	34.8	56.1	29.4
93	03518800	27.9	100	13.0	14.1	6.5	7.0	5.2	5.9
94	03519640	16.0	120	15.0	9.3	7.3	5.2	6.0	4.5
95	03519732	47.2	140	37.0	32.1	20.0	19.0	16.0	17.0
96	03520043	23.3	120	16.0	13.7	7.4	7.5	5.8	6.6
97	03527600	85.8	60	27.0	29.2	9.0	10.6	7.6	7.9
98	03528000	1474	65	667	578	250	205	200	151
99	03528300	19.0	90	4.0	8.7	2.2	4.1	2.0	3.4
100	03528400	2.68	120	1.1	1.5	.62	.9	.55	.8
101	03531815	19.9	115	11.0	11.2	6.2	6.1	5.0	5.3
102	03531900	62.5	75	27.0	25.4	12.0	10.5	9.3	8.2
103	03532000	685	100	337	378	125	173	107	140
104	03532100	31.2	90	15.0	14.5	5.7	6.8	4.8	5.5
105	03532200	24.0	42	4.8	5.8	.85	1.8	.65	1.3
106	03534000	24.5	53	11.0	7.3	3.1	2.5	1.9	1.9
107	03534980	7.82	82	2.2	3.2	.9	1.5	.8	1.2
108	03535000	68.5	80	26.3	29.4	10.4	12.6	7.9	10.0
109	03535050	93.3	75	40.0	38.3	21.0	15.7	17.0	12.3
110	03538180	10.2	70	6.2	3.7	2.1	1.6	1.5	1.2
111	03538225	82.5	65	45.4	30.0	13.5	11.4	9.6	8.6
112	03539600	139	32	54.0	28.3	10.0	7.2	4.8	4.6
113	03539800	518	32	252	109	49.0	26.8	30.0	17.1
114	03543200	26.4	53	5.3	7.8	1.1	2.7	.8	2.0
115	03543500	117	84	50.0	53.2	21.2	23.1	16.3	18.4
116	03544235	22.2	70	6.2	8.3	2.1	3.4	1.5	2.6
117	03557148	79.4	115	43.0	46.4	21.0	24.3	17.0	20.7
118	03561500	447	140	708	323	255	181	125	158
119	03565040	14.8	120	7.0	8.6	3.3	4.8	2.7	4.2
120	03565080	8.54	120	5.4	4.9	2.8	2.8	2.3	2.4

SUPPLEMENT D--Continued

Map index No.	Station No.	Drainage area (mi^2)	Streamflow recession index	$7Q_2$ Observed (ft^3/s)	$7Q_2$ Regression (ft^3/s)	$7Q_{10}$ Observed (ft^3/s)	$7Q_{10}$ Regression (ft^3/s)	$7Q_{20}$ Observed (ft^3/s)	$7Q_{20}$ Regression (ft^3/s)
121	03565120	37.8	120	20.0	22.5	9.5	12.2	7.8	10.6
122	03565160	32.7	120	19.0	19.4	9.2	10.6	8.5	9.2
123	03565250	114	120	64.0	69.8	30.0	37.0	24.0	31.8
124	03565300	31.8	65	12.8	11.3	6.1	4.4	5.0	3.4
125	03565500	57.0	140	40.9	39.0	21.7	22.9	20.0	20.5
126	03566126	29.3	130	23.0	18.5	12.5	10.6	11.5	9.4
127	03566250	88.7	95	42.0	44.3	21.0	20.8	18.0	17.0
128	03566260	44.5	90	17.0	20.9	7.6	9.7	5.9	7.9
129	03566320	22.7	48			2.9	2.0	1.5	1.5
130	03566420	18.8	80	9.5	7.8	5.7	3.5	5.0	2.8
131	03566450	28.3	67	5.4	10.2	5.6	4.1	3.5	3.1
132	03566543	13.2	60	7.0	4.3	2.1	1.6	1.7	1.2
133	03567500	428	120	207	271	118	139	101	118
134	03570580	23.7	72	12.5	9.1	3.7	3.8	3.0	3.0
135	03570600	86.2	80	45.0	37.3	12.0	15.9	9.5	12.6
136	03570835	274	80	140	122	35.0	50.7	27.0	39.6
137	03571000	402	85	209	191	62.0	81.0	49.9	63.8
138	03571500	116	65	60.0	42.5	18.0	16.0	14.0	12.1
139	03571835	28.2	65	13.0	9.9	3.1	3.9	2.4	3.0
140	03578000	65.6	50	33.7	19.0	7.9	6.3	4.3	4.5
141	03579100	275	90	144	135	57.1	59.9	43.7	48.0
142	03580300	55.9	50	13.0	16.1	5.5	5.4	4.5	3.9
143	03581200	49.4	50	14.0	14.2	5.6	4.7	4.4	3.4
144	03582000	827	110	416	496	187	239	151	197
145	03583300	47.5	37	6.0	10.6	3.6	3.0	3.2	2.0
146	03583360	20.2	50	7.4	5.7	3.4	1.9	2.5	1.4
147	03583500	24.4	100	9.7	12.3	5.9	6.1	5.3	5.1
148	03584000	366	60	123	123	54.5	45.4	43.6	33.2
149	03584500	1784	75	843	793	370	303	287	229
150	03585250	36.6	140	27.0	24.7	19.0	14.7	18.0	13.2
151	03585260	17.4	140	10.0	11.5	6.0	7.0	5.2	6.3
152	03587900	15.4	140	17.0	10.2	9.4	6.2	8.2	5.6
153	03588400	43.0	140	32.6	29.2	16.9	17.3	14.0	15.5
154	03588500	348	138	215	247	128	138	112	120
155	03590900	42.5	68	20.0	15.7	8.2	6.2	6.4	4.8
156 *	03593300	49.4	65	10.2	7.0	3.8	2.3	2.9	1.8
157	03593580	26.9	130	17.0	16.9	11.0	9.7	9.5	8.6
158	03593600	66.7	130	43.0	43.0	28.0	24.2	25.0	21.2
159	03593700	14.9	130	13.0	9.2	6.2	5.4	5.6	4.8
160	03593800	104	125	62.0	65.7	37.1	35.7	32.2	31.0

SUPPLEMENT D--Continued

Map index No.	Station No.	Drainage area (mi^2)	Streamflow recession index	7Q2 Observed (ft^3/s)	7Q2 Regression (ft^3/s)	7Q10 Observed (ft^3/s)	7Q10 Regression (ft^3/s)	7Q20 Observed (ft^3/s)	7Q20 Regression (ft^3/s)
161	03594040	53.7	66	26.0	19.5	13.0	7.6	10.9	5.8
162 *	03594120	45.5	75	17.1	7.6	5.1	2.8	3.0	2.2
163	03594150	25.8	77	13.0	10.5	5.8	4.5	4.6	3.6
164	03594160	201	66	93.0	75.7	47.6	28.4	40.7	21.4
165	03594180	50.7	64	14.0	17.9	7.6	6.8	6.6	5.2
166	03594260	24.7	95	8.0	11.9	4.9	5.8	4.3	4.8
167	03594400	16.8	60	4.7	5.5	2.2	2.1	1.9	1.6
168 *	03594445	115	205	77.0	47.7	42.0	32.0	35.0	28.6
169	03595300	35.3	60	11.0	11.7	5.6	4.4	4.6	3.3
170	03596000	107	100	46.1	56.1	22.8	26.9	18.7	22.3
171	03596500	208	105	151	116	79.0	56.2	64.0	46.6
172	03597000	66.3	45	18.0	17.6	7.8	5.5	6.3	3.9
173	03597700	130	44	30.0	34.5	9.4	10.4	6.0	7.2
174	03598000	481	90	195	240	99.8	105	84.3	83.5
175	03599500	1208	50	363	378	144	117	109	81.1
176	03600380	37.5	45	15.0	9.8	5.8	3.1	4.6	2.2
177	03600500	17.5	100	8.0	8.7	4.5	4.4	3.9	3.7
178	03601695	8.43	130	6.5	5.1	4.0	3.0	3.6	2.7
179	03601860	15.3	130	15.0	9.5	10.0	5.5	9.3	4.9
180	03601950	5.56	75	2.8	2.1	1.0	.9	.8	.7
181	03602235	22.7	120	7.2	13.3	3.8	7.3	3.3	6.4
182	03602500	202	135	99.2	139	61.3	77.4	55.2	67.7
183	03602600	74.7	135	59.0	49.9	36.0	28.6	33.0	25.2
184	03603000	2557	90	1002	1340	550	560	474	438
185	03603550	60.2	140	30.0	41.2	20.0	24.2	18.0	21.6
186	03603660	37.7	140	37.0	25.5	24.0	15.1	22.0	13.6
187	03603720	13.4	140	6.4	8.8	5.6	5.4	4.0	4.9
188	03603750	19.1	140	12.0	12.7	8.0	7.7	7.0	6.9
189	03604000	447	120	282	284	184	146	166	123
190	03604060	7.34	95	2.5	3.4	1.6	1.7	1.5	1.4
191	03604180	15.2	140	10.5	10.0	6.8	6.1	6.1	5.5
192	03604500	707	125	442	470	281	244	253	207
193	03604600	24.8	135	16.0	16.1	7.7	9.5	7.0	8.5
194	03605555	31.9	110	18.0	17.5	12.0	9.1	10.3	7.8
195 *	03606280	41.4	230	20.0	18.7	12.0	13.2	11.0	11.8
196 *	03606500	205	240	106	96.1	68.8	70.2	61.2	64.0
197 *	03607000	379	200	118	155	95.0	104	90.0	92.9
198 *	03607200	47.9	240	30.0	22.4	22.0	16.1	20.0	14.6
199 *	07024250	43.5	200	22.0	17.6	12.0	11.6	10.0	10.3
200 *	07024300	55.5	350	41.2	34.3	30.1	29.6	27.4	28.0

SUPPLEMENT D--Continued

Map index No.	Station No.	Drainage area (mi²)	Streamflow recession index	7Q2 Observed (ft³/s)	7Q2 Regression (ft³/s)	7Q10 Observed (ft³/s)	7Q10 Regression (ft³/s)	7Q20 Observed (ft³/s)	7Q20 Regression (ft³/s)
201 *	07024500	383	235	172	177	116	129	105	117
202 *	07024720	137	300	92.0	75.8	71.0	61.4	66.0	57.3
203 *	07025000	203	150	40.1	65.6	24.3	37.7	21.5	32.4
204 *	07025300	83.7	300	36.0	46.3	31.5	37.3	30.5	34.7
205 *	07025350	36.7	65	4.5	5.2	1.2	1.7	.9	1.3
206 *	07025500	480	205	153	200	121	136	116	122
207 *	07026000	1852	175	650	683	431	435	387	386
208 *	07027300	160	230	74.0	72.5	53.0	51.8	48.0	46.9
209 *	07027500	495	230	218	225	147	162	132	148
210 *	07027700	25.0	60	1.4	3.2	.5	1.0	.42	.7
211 *	07028000	1003	195	327	402	215	269	192	241
212 *	07028500	73.4	140	16.1	22.3	13.4	12.2	12.9	10.4
213 *	07028900	88.2	120	18.0	23.5	10.0	11.8	9.0	9.8
214 *	07029000	369	195	137	148	106	97.7	99.8	87.2
215 *	07029100	867	160	310	297	168	179	142	157
216 *	07029380	94.8	140	50.1	28.8	18.6	15.8	14.1	13.5
217 *	07029400	837	130	338	240	173	130	145	110
218 *	07029410	47.6	250	26.0	22.9	19.5	16.8	17.0	15.3
219 *	07029440	40.4	60	6.8	5.2	2.0	1.6	1.5	1.2
220 *	07029500	1480	160	752	507	361	307	292	270
221 *	07029700	84.3	210	32.0	35.6	22.0	24.1	18.0	21.5
222 *	07030000	1940	175	936	715	502	456	431	405
223 *	07030020	92.0	170	22.0	32.8	16.0	20.0	15.0	17.4
224 *	07030209	76.9	165	19.0	26.8	14.5	16.0	13.5	13.9
225 *	07030280	505	150	101	164	82.1	94.8	78.8	82.0
226 *	07030400	71.9	170	21.0	25.6	15.0	15.6	13.5	13.6
227 *	07030500	503	230	243	229	187	165	174	150
228 *	07031700	770	210	312	327	225	226	200	205

SUPPLEMENT D--Continued

Map index No.	Station No.	Drainage area (mi^2)	Streamflow recession index	$30Q_2$		$30Q_{10}$		$30Q_{20}$	
				Observed (ft^3/s)	Regression (ft^3/s)	Observed (ft^3/s)	Regression (ft^3/s)	Observed (ft^3/s)	Regression (ft^3/s)
1	03408500	382	32	450	269	95.0	53.8	48.0	31.5
2	03409500	272	37	235	198	48.0	43.4	33.0	26.3
3	03414500	202	47	236	157	40.0	40.0	25.0	25.5
4	03415000	114	48	73.0	88.2	14.0	22.6	9.0	14.6
5	03415500	445	53	443	367	140	101	90.0	65.8
6	03416000	106	60	107	87.7	25.0	25.8	15.0	17.5
7	03416100	138	62	120	116	47.0	34.9	33.0	23.8
8	03417800	15.1	65	6.2	12.2	2.3	3.7	1.7	2.6
9	03418000	78.7	65	53.9	66.3	16.5	20.5	11.2	14.1
10	03418020	22.5	65	16.0	18.4	5.2	5.6	3.6	3.9
11	03418050	50.3	65	51.0	41.9	16.0	12.9	11.0	8.9
12	03419300	16.7	75	16.0	14.2	4.6	4.7	3.7	3.4
13	03419500	157	75	210	141	84.0	47.6	59.0	33.8
14	03420000	175	76	200	158	52.0	53.9	41.5	38.4
15	03420120	78.8	67	41.0	67.0	15.0	21.1	11.0	14.7
16	03420200	174	37	150	126	69.0	27.4	24.0	16.6
17	03420500	126	140	109	136	56.7	68.0	47.2	55.4
18	03420800	132	60	140	110	42.0	32.4	26.0	21.9
19	03420900	303	110	350	310	160	134	123	103
20	03421000	642	85	688	618	254	229	183	165
21	03422800	16.8	60	--	--	--	--	--	--
22	03424670	137	35	--	--	--	--	--	--
23	03426600	25.5	90	25.0	23.1	9.0	8.7	7.2	6.5
24	03426800	39.1	104	39.2	37.5	12.4	15.4	8.3	11.9
25	03426850	24.5	50	18.0	18.5	3.8	4.8	2.8	3.2
26	03426880	24.0	60	24.0	19.2	8.0	5.6	6.3	3.8
27	03427500	262	46	208	204	38.0	51.2	27.0	32.5
28	03427900	65.1	34	39.0	44.7	7.3	9.2	5.0	5.5
29	03429000	571	45	380	450	100	112	65.0	70.3
30	03430100	892	45	568	711	140	177	100	111
31	03431600	51.6	37	47.0	36.2	11.0	7.8	6.5	4.8
32	03431700	24.3	35	17.4	16.4	5.4	3.4	3.7	2.1
33	03431800	97.2	100	81.1	94.0	31.9	38.0	23.6	28.8
34	03433500	408	32	275	287	69.4	57.6	43.5	33.7
35	03433700	59.6	130	30.0	61.8	18.0	29.3	15.0	23.6
36	03434000	115	100	73.0	112	41.0	45.2	34.0	34.2
37	03434500	681	56	470	577	152	165	107	108
38	03434600	56.2	90	27.0	51.9	11.0	19.6	8.4	14.6
39	03435007	11.2	57	14	8.6	2.8	2.4	1.7	1.7
40	03435400	98.0	100	100	94.8	24.0	38.3	15.0	29.1

Map index No.	Station No.	Drainage area (mi²)	Streamflow recession index	$30Q_2$ Observed (ft³/s)	$30Q_2$ Regression (ft³/s)	$30Q_{10}$ Observed (ft³/s)	$30Q_{10}$ Regression (ft³/s)	$30Q_{20}$ Observed (ft³/s)	$30Q_{20}$ Regression (ft³/s)
41	03435500	706	75	343	655	93.7	224	63.6	157
42	03435790	75.1	50	44.0	58.3	11.0	15.3	7.2	10.0
43	03435900	32.0	80	15.0	28.1	5.2	9.8	4.0	7.2
44	03436000	186	55	108	152	27.1	42.5	17.6	28.1
45	03436100	935	75	781	874	155	300	88.0	210
46	03436200	188	80	110	172	30.0	60.9	22.0	43.8
47	03436430	130	80	97.0	118	22.0	41.6	15.0	30.0
48	03436700	124	120	111	128	29.0	57.9	26.1	45.6
49	03436900	34.5	120	32.0	34.4	10.0	15.5	8.8	12.3
50	03436970	11.9	120	12.0	11.6	4.2	5.2	2.7	4.2
51	03455000	1858	140	2110	2140	1195	1090	1005	869
52	03461200	10.2	100	18.2	9.4	11.0	3.7	7.0	2.9
53	03461300	55.3	94	56.0	51.8	29.0	20.1	18.5	15.1
54	03464815	81.0	100	59.0	78.0	29.0	31.5	23.0	23.9
55	03465000	15.9	100	13.0	14.7	5.6	5.9	4.0	4.5
56	03465500	805	100	952	819	533	336	444	251
57	03466200	78.1	120	74.0	79.5	33.0	36.0	25.0	28.4
58	03466370	14.9	120	24.0	14.6	8.6	6.5	6.2	5.2
59	03466700	40.4	50	21	30.9	7.4	8.1	3.6	5.3
60	03466840	78.0	98	51.0	74.6	25.0	29.7	20.0	22.5
61	03466885	7.99	50	3.2	5.9	1.4	1.5	1.0	1.0
62	03467000	220	68	112	193	39.6	61.6	27.8	42.6
63	03467490	41.2	65	21.0	34.2	7.5	10.5	5.0	7.3
64	03468250	10.4	50	5.2	7.7	1.6	2.0	.75	1.3
65	03469112	11.2	100	15	10.3	7.4	2.1	4.6	3.2
66	03469160	64.1	72	45.0	55.5	20.0	18.2	12	12.9
67	03469238	24.0	111	29.0	23.2	15	9.9	10	7.8
68	03469500	76.2	95	73.0	72.1	35.0	28.2	22.0	21.2
69	03470000	353	80	343	329	164	117	100	83.4
70	03476980	18.4	50	7.6	13.8	1.9	3.6	1.4	2.4
71	03478602	12.9	96	8.0	11.7	4.5	4.6	3.8	3.5
72	03481625	12.6	88	7.6	11.2	3.8	4.1	3.2	3.1
73	03482000	102	76	64.0	90.7	35.0	30.9	29.0	22.1
74	03484420	13.8	100	13	12.7	6.0	5.1	4.7	3.9
75	03484911	25.5	70	23.0	21.4	8.1	6.9	6.0	4.9
76	03485500	137	110	152	138	85.8	59.2	72.2	45.7
77	03486500	10.3	50	11	7.6	4.4	2.0	3.0	1.3
78	03487520	44.5	65	--	--	--	--	--	--
79	03487550	36.3	100	28.9	34.3	9.2	13.8	6.8	10.5
80	03491000	47.3	70	36.9	40.3	12.5	13.0	7.8	9.2

SUPPLEMENT D--Continued

Map index No.	Station No.	Drainage area (mi²)	Streamflow recession index	30Q2 Observed (ft³/s)	30Q2 Regression (ft³/s)	30Q10 Observed (ft³/s)	30Q10 Regression (ft³/s)	30Q20 Observed (ft³/s)	30Q20 Regression (ft³/s)
81	03491300	47.0	65	32.0	39.1	9.5	12.0	4.5	8.3
82	03494528	18.2	120	24.0	17.9	8.5	8.0	8.0	6.4
83	03494740	6.68	50	3.9	4.9	.60	1.3	.30	.80
84	03495000	61.4	65	48.0	51.4	16.0	15.8	10.0	11.0
85	03497300	106	145	221	115	96.0	58.8	56.0	48.3
86	03498000	192	90	237	183	104	69.5	79.2	51.2
87	03498500	269	100	376	267	175	109	100	81.7
88	03499200	13.2	135	17.0	13.4	8.6	6.4	8.2	5.3
89	03499300	11.2	120	16.0	10.9	7.4	4.9	4.7	3.9
90	03499620	9.62	120	12.0	9.3	4.2	4.2	3.9	3.3
91	03518410	67.1	87	86.0	61.6	35.0	22.8	26.0	16.8
92	03518500	118	112	199	119	103	51.6	83.3	40.0
93	03518800	27.9	100	26.0	26.2	8.8	10.5	8.2	8.0
94	03519640	16.0	120	24.0	15.7	10.0	7.0	8.0	5.6
95	03519732	47.2	140	66.0	49.8	26.0	24.7	24.0	20.3
96	03520043	23.3	120	32.0	23.0	10.0	10.3	9.5	8.2
97	03527600	85.8	60	67.0	70.7	23.0	20.8	14.0	14.1
98	03528000	1474	65	1307	1330	380	419	280	283
99	03528300	19.0	90	8.0	17.1	3.3	6.4	2.6	4.8
100	03528400	2.68	120	1.79	2.52	.78	1.1	.66	.90
101	03531815	19.9	115	18.0	19.3	8.0	8.4	6.0	6.7
102	03531900	62.5	75	56.0	54.7	16.0	18.4	10.0	13.2
103	03532000	685	100	719	694	190	284	150	213
104	03532100	31.2	90	36.0	28.4	8.8	10.7	6.8	8.0
105	03532200	24.0	42	18.0	17.2	2.0	4.0	1.2	2.5
106	03534000	24.5	53	32.0	18.8	7.7	5.1	4.5	3.4
107	03534980	7.82	82	4.5	6.7	1.3	2.4	1.1	1.7
108	03535000	68.5	80	60.2	61.3	14.5	21.5	9.0	15.6
109	03535050	93.3	75	72.0	82.5	35.0	27.9	21.0	19.8
110	03538180	10.2	70	14.0	8.4	2.8	2.7	1.7	1.9
111	03538225	82.5	65	112	69.6	19.0	21.5	12.0	14.8
112	03539600	139	32	112	95.4	21.0	19.0	8.5	11.2
113	03539800	518.0	32	572	367	80.0	73.7	43.0	43.0
114	03543200	26.4	53	22.0	20.3	2.2	5.5	1.8	3.7
115	03543500	117	84	109	108	30.0	39.1	27.9	28.5
116	03544235	22.2	70	17.0	18.6	3.2	6.0	2.9	4.2
117	03557148	79.4	115	78.0	79.8	35.0	35.2	27.0	27.5
118	03561500	447	140	872	497	340	251	180	202
119	03565040	14.8	120	14.0	14.5	6.6	6.5	5.0	5.2
120	03565080	8.54	120	8.0	8.2	4.4	3.7	3.5	3.0

SUPPLEMENT D--Continued

Map index No.	Station No.	Drainage area (mi²)	Streamflow recession index	30Q2		30Q10		30Q20	
				Observed (ft³/s)	Regression (ft³/s)	Observed (ft³/s)	Regression (ft³/s)	Observed (ft³/s)	Regression (ft³/s)
121	03565120	37.8	120	37.0	37.8	17.0	17.0	13.0	13.5
122	03565160	32.7	120	31.0	32.6	14.0	14.7	11.0	11.7
123	03565250	114	120	111	117	50.0	53.1	39.0	41.9
124	03565300	31.8	65	32.3	26.2	10.8	8.0	7.2	5.6
125	03565500	57.0	140	66.0	60.4	30.8	30.0	24.2	24.6
126	03566126	29.3	130	36.0	29.9	17.0	14.1	14.0	11.4
127	03566250	88.7	95	95.0	84.2	36.0	33.0	25.0	24.7
128	03566260	44.5	90	37.0	40.9	11.0	15.4	10.0	11.5
129	03566320	22.7	48	21.0	16.9	7.0	4.3	5.5	2.8
130	03566420	18.8	80	19.5	16.3	8.7	5.7	6.7	4.2
131	03566450	28.3	67	16.0	23.5	4.8	7.3	3.3	5.1
132	03566543	13.2	60	16.0	10.4	5.2	3.0	3.4	2.1
133	03567500	428	120	395	454	194	208	155	162
134	03570580	23.7	72	28.0	20.0	9.2	6.5	6.2	4.7
135	03570600	86.2	80	108	77.6	32.0	27.3	20.0	19.7
136	03570835	274	80	340	254	100	89.8	63.0	64.4
137	03571000	402	85	478	383	152	141	101	102
138	03571500	116	65	140	98.6	44.0	30.5	29.0	21.0
139	03571835	28.2	65	33.0	23.2	11.0	7.1	5.5	5.0
140	03578000	65.6	50	87.3	51	28.0	13.3	18.0	8.7
141	03579100	275	90	284	264	105	101	75.8	74.0
142	03580300	55.9	50	43.0	43.1	7.4	11.3	7.2	7.4
143	03581200	49.4	50	41.0	38.0	8.4	9.9	7.0	6.5
144	03582000	827	110	839	867	361	377	274	288
145	03583300	47.5	37	23.0	33.2	6.8	7.2	5.1	4.4
146	03583360	20.2	50	18.0	15.2	6.8	3.9	5.0	2.6
147	03583500	24.4	100	19.0	22.8	9.2	9.1	7.5	7.0
148	03584000	366	60	301	312	114	92.6	85.8	62.1
149	03584500	1784	75	1730	1690	769	583	593	406
150	03585250	36.6	140	34.0	38.4	25.0	19.0	22.0	15.6
151	03585260	17.4	140	15.0	17.9	9.0	8.8	7.5	7.3
152	03587900	15.4	140	24.0	15.8	12.0	7.8	10.0	6.5
153	03588400	43.0	140	52.0	45.2	22.0	22.4	20.1	18.4
154	03588500	348	138	366	383	176	191	144	154
155	03590900	42.5	68	48.0	35.8	13.0	11.3	9.0	7.9
156 *	03593300	49.4	65	22.3	18.6	7.2	4.7	5.2	3.2
157	03593580	26.9	130	23.0	27.4	14.0	12.9	12.0	10.5
158	03593600	66.7	130	57.0	69.3	35.0	32.9	31.0	26.5
159	03593700	14.9	130	16.0	14.9	16.0	7.0	6.5	5.7
160	03593800	104	125	90.2	108	49.2	50.2	42.0	39.9

SUPPLEMENT D--Continued

Map index No.	Station No.	Drainage area (mi^2)	Streamflow recession index	30Q2 Observed (ft^3/s)	30Q2 Regression (ft^3/s)	30Q10 Observed (ft^3/s)	30Q10 Regression (ft^3/s)	30Q20 Observed (ft^3/s)	30Q20 Regression (ft^3/s)
161	03594040	53.7	66	43.6	45.0	19.2	14.0	15.2	9.7
162 *	03594120	45.5	75	25.2	18.6	10.6	5.3	8.4	3.8
163	03594150	25.8	77	31.0	22.3	8.6	7.6	6.2	5.5
164	03594160	201	66	178	174	72.0	54.5	56.0	37.6
165	03594180	50.7	64	24.0	42.1	10.0	12.8	8.2	8.9
166	03594260	24.7	95	13.0	22.8	6.2	8.8	5.2	6.7
167	03594400	16.8	60	9.4	13.3	3.4	3.9	2.4	2.7
168	03594445	115	205	114	73.9	57.0	41.1	46.0	34.9
169	03595300	35.3	60	28.0	28.5	7.5	8.3	6.5	5.7
170	03596000	107	100	94.5	104	31.0	42.0	27.0	31.2
171	03596500	208	105	274	208	117	87.1	89.0	66.4
172	03597000	66.3	45	41.0	49.7	17.0	12.2	13.0	7.8
173	03597700	130	44	110	98.3	14.0	23.8	11.0	15.1
174	03598000	481	90	484	468	177	179	128	131
175	03599500	1208	50	997	1000	364	267	264	171
176	03600380	37.5	45	31.0	27.7	12.0	6.8	6.2	4.3
177	03600500	17.5	100	15.6	16.2	6.6	6.5	5.2	5.0
178	03601695	8.43	130	10.0	8.3	4.8	3.9	4.0	3.2
179	03601860	15.3	130	22.0	15.4	11.0	7.2	8.8	5.9
180	03601950	5.56	75	7.8	4.6	1.5	1.5	1.0	1.1
181	03602235	22.7	120	13.0	22.4	4.8	10.1	3.8	8.0
182	03602500	202	135	154	218	74.1	107	61.1	86.1
183	03602600	74.7	135	90.0	78.8	44.0	38.3	36.0	31.1
184	03603000	2557	90	2150	2590	920	1000	723	724
185	03603550	60.2	140	47.0	63.8	25.0	31.7	20.0	26.0
186	03603660	37.7	140	56.0	39.5	30.0	19.6	25.0	16.1
187	03603720	13.4	140	12.0	13.7	5.6	6.8	4.7	5.6
188	03603750	19.1	140	19.0	19.7	9.8	4.7	8.2	8.0
189	03604000	447	120	434	474	229	217	193	169
190	03604060	7.34	95	4.1	6.6	1.9	2.5	1.6	1.9
191	03604180	15.2	140	16.0	15.6	8.5	7.7	7.2	6.4
192	03604500	707	125	691	768	357	362	298	284
193	03604600	24.8	135	20.0	25.5	9.4	12.3	7.7	10.1
194	03605555	31.9	110	33.0	30.9	16.0	13.2	13.0	10.3
195 *	03606280	41.4	230	26.5	27.3	16.5	16.5	14.0	14.2
196 *	03606500	205	240	158	141	90.2	85.2	77.8	74.1
197 *	03607000	379	200	171	246	127	133	120	112
198 *	03607200	47.9	240	42.0	32.2	27.0	19.9	24.0	17.2
199 *	07024250	43.5	200	38.0	27.2	17.0	15.2	14.0	12.8
200 *	07024300	55.5	350	61.5	42.8	36.5	32.6	31.3	29.8

Map index No.	Station No.	Drainage area (mi²)	Streamflow recession index	30Q2 Observed (ft³/s)	30Q2 Regression (ft³/s)	30Q10 Observed (ft³/s)	30Q10 Regression (ft³/s)	30Q20 Observed (ft³/s)	30Q20 Regression (ft³/s)
201 *	07024500	383	235	283	264	143	156	119	136
202 *	07024720	137	300	118	102	84.0	70.0	76.0	62.8
203 *	07025000	203	150	71.6	117	32.0	53.2	26.3	43.2
204 *	07025300	83.7	300	45.0	61.5	38.0	42.7	31.0	38.3
205 *	07025350	36.7	65	16.0	13.8	2.9	3.5	1.8	2.4
206 *	07025500	480	205	238	316	132	172	115	146
207 *	07026000	1852	175	1160	1170	545	569	445	474
208 *	07027300	160	230	110	108	67.0	63.9	58.0	55.2
209 *	07027500	495	230	354	340	195	198	167	171
210 *	07027700	25.0	60	5.0	8.9	.90	2.1	.60	1.4
211 *	07028000	1003	195	589	656	284	343	235	288
212 *	07028500	73.4	140	25.3	40.3	14.6	17.9	13.0	14.3
213 *	07028900	88.2	120	65.0	45.5	16.0	18.2	11.0	14.2
214 *	07029000	369	195	206	237	123	126	108	106
215 *	07029100	867	160	595	524	216	243	162	200
216 *	07029380	94.8	140	80.0	52.3	28.2	23.1	20.9	18.5
217 *	07029400	837	130	688	464	301	189	239	150
218 *	07029410	47.6	250	36.0	32.4	24.0	20.5	21.5	17.9
219 *	07029440	40.4	60	18.0	14.4	4.8	3.4	3.2	2.3
220 *	07029500	1480	160	1350	902	581	416	458	341
221 *	07029700	84.3	210	58.0	54.4	28.0	30.8	23.0	26.3
222 *	07030000	1940	175	1540	1230	686	597	551	497
223 *	07030020	92.0	170	35.0	54.8	19.0	27.4	16.5	22.6
224 *	07030209	76.9	165	26.0	45.1	17.5	22.2	16.0	18.2
225 *	07030280	505	150	166	295	86.5	133	76.0	108
226 *	07030400	71.9	170	33.0	42.6	19.0	21.4	17.0	17.6
227 *	07030500	503	230	334	346	225	201	206	174
228 *	07031700	770	210	463	515	276	283	248	241

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