A METHOD FOR ESTIMATING MAGNITUDE AND FREQUENCY OF FLOODS IN SOUTH DAKOTA

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations 35-74

Prepared for the
South Dakota Department of Transportation
in cooperation with
United States Department of Transportation,
Federal Highway Administration

UNITED STATES DEPARTMENT OF THE INTERIOR

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by Lawrence D. Becker

ABSTRACT

A general flood-frequency analysis has provided a method for estimating flood magnitudes and frequencies on South Dakota streams. Related flood data useful in planning and design also are included in the report.

Two distinct hydrologic regions are delineated within the State. The divisional boundary for these regions is, in general, the western divide of the James River basin. For each region, the 2-, 5-, 10-, 25-, 50-, and 100-year floods are related to basin and climatic characteristics by regression equations. Indices based on contributing drainage area size, elevation, and mean annual precipitation were found to be the most useful variables in estimation of South Dakota floods. Regional relationships based on these variables can be used to estimate floods of selected frequency at most ungaged sites where peak flows are not significantly affected by regulation or other manmade works. Equations and graphs presented are applicable to drainage basins with areas approximately from 0.1 to 4,000 square miles (0.3 to 10,400 square kilometres) in the Eastern Region and from 0.1 to 9,000 square miles (0.3 to 23,300 square kilometres) in the Western Region. Limitations on use of these equations are given and the accuracy of resulting estimates is discussed.

Flood characteristics are tabulated for 130 gaging stations having 10 or more years of record. These frequency data may provide the best estimates of floods at these gaged sites. Also, maximum flood peaks determined at 188 gaging stations and 52 miscellaneous sites are compared with regional flood relationships.

Individual relationships are presented for the main-stem portions of selected streams where significant regulation is a factor or where drainage areas exceed the limits of applicability of the regional relationships.

INTRODUCTION

The purpose of this report is to provide planners and designers with improved estimates of the magnitude and frequency of floods in South Dakota. Tables, equations, and graphs are presented for estimating the magnitudes of the 2-, 5-, 10-, 25-, 50-, and 100-year floods for many gaged sites and most ungaged natural flow sites in South Dakota. An individual analysis is also provided for selected reaches of major rivers. Other flood data that may be useful in planning and designing are also presented.

Frequency relations presented herein are based upon more data, analyzed by a more rigorous technique, than relations in earlier studies. Considerable flood data that were not available to earlier investigators of floods in South Dakota have been included in the analyses upon which these relations are based. In particular, many small-streams records resulting from operation of a crest-stage gaging program are now of sufficient length to be useful in defining the flood frequencies. Also, the length of records available for larger streams within the State has been materially increased since earlier frequency studies were made.

Tabular material presented in an appendix includes maximum floods recorded at selected gaging stations and miscellaneous ungaged sites in South Dakota. These floods are graphically related to drainage areas and thereby may provide a rough guide to design flood magnitudes. Basin and climatic characteristics and flood characteristics for selected gaging stations in the State also appear in the appendix. Estimating techniques presented herein includes as a first step a search for such gaged record frequency data.

Flood estimating relations for South Dakota streams presented in earlier U.S. Geological Survey reports are superseded and the relationships presented herein are presently the most reliable methods of estimating flood magnitudes for design purposes.

Previous Reports

The need for a comprehensive study of flood frequency in South Dakota was shown by Larimer (1970) in a streamflow evaluation study. Previous reports have also defined flood-estimating techniques applicable to South Dakota streams. These include reports by McCabe and Crosby (1959), Patterson (1966), and Patterson and Gamble (1968), which were based on the index-flood method described by Dalrymple (1960).

Cooperation

This report is based on data collected and published by the U.S. Geological Survey as part of cooperative programs with various State and Federal agencies. Most of the small streams data have been collected as a direct result of cooperative agreements with the South Dakota Department of Transportation. The opinions, findings, and conclusions herein are those of the U.S. Geological Survey and not necessarily those of any cooperating agency.

Use of Metric Units of Measurement

The analyses and data compilations in this report are based on English units of measurements. The equivalent metric units are given in the text and illustrations where appropriate. English units only are shown in tables where, because of space limitations, the dual system of English and metric units would not be practicable. To convert English units to metric units, the following conversion factors should be used:

English units		Conversion factor		Metric units
Length in inches (in)	x	2.54	=	centimetres (cm)
in feet (ft)	x	.3048	=	metres (m)
in miles (mi)	x	1.609	=	kilometres (km)
Area in square miles (sq mi)	x	2.590	=	square kilometres (sq km)
Runoff rate in cubic feet second (cfs)	x	.02832	=	cubic metres per second (cu m/s)
Unit runoff in cubic feet per second per square mile (cfs/sq mi)	x	.01093	=	cubic metres per second per square kilometre (cu m/s/sq km)

FLOOD FREQUENCY ANALYSIS

Data Used

Flood-frequency curves were defined for more than 200 gaging sites in South Dakota and adjoining States for which records of at least 5 years' duration were available.

Final regression equations, however, are based on 162 streamflow records with unregulated periods of at least 10 years in length. Peak data through the 1971 water year were considered for 90 continuous-record gaging stations. Data for the 72 partial-record stations also included the 1972 annual maximums. Average length of record is about 19 years. The location of 128 selected stations, including some of the main-stem stations used in individual analyses for large streams, are shown in the appendix, figure A-1. As most of the streamflow records used in the final analyses are for stations located in South Dakota, locations of stations in adjacent States are not shown. Flood characteristics derived from these data are listed for selected stations in table A-1 of the appendix.

Analytical Technique

Analysis of station data was based on use of the log-Pearson Type III method for fitting flood-frequency curves. However, graphical adjustments were made to some computed frequency curves which did not reasonably fit the station data. Details of the log-Pearson Type III method and calculations are given by the U.S. Water Resources Council (1967). These frequency analyses, in general, are the most reliable estimators of future floods and form the basis for regression relations that transfer information to ungaged sites.

The U.S. Geological Survey currently uses certain limits for frequency curve definition. Listed below are the minimum number of years of record used to define floods of selected recurrence interval.

Recurrence interval-	10	25	50	100
Minimum years of record-	10	15	20	25

Magnitudes of floods for these recurrence intervals will have about equal reliability (Hardison, 1969). These limits were observed in listing the flood characteristics in table A-1. The 50- and 100-year floods are shown only for stations having relatively long records. Because of the lack of long-term records for small streams, frequency curves for selected partial-record stations were extended beyond these limitations and estimates were made of the higher-recurrence interval floods for use in regionalization of the flood-frequency data.

Regionalization of the flood-frequency data was based on multiple-regression techniques as described by Benson (1962). The relations of flood peaks to drainage basin and climatic characteristics were determined from a regression model of the form $Q = aA^bB^cC^d$ ..., where the dependent variable (Q) is the peak discharge and the independent variables (A, B, and C) are basin or climatic characteristics. In the equation, the constant of regression and regression coefficients are indicated respectively by "a" and by "b,c, and d". The analysis defines the regression constant and regression coefficients, evaluates the statistical significance of each basin or climatic characteristic, and provides a standard error of estimate.

Residual values (differences between "observed" peak discharges and estimates obtained from the initial regression equations) were plotted on a State map. Geographic bias indicated by residuals defined two flood-frequency regions in South Dakota. An Eastern Region and a Western Region were defined with the State being divided along the western divide of the James River basin (fig. 1). Separate equations for each of these regions satisfactorily remove geographic bias. However, a small "sandhills" area along the Nebraska border within the Western Region was identified as a sector where floods will be overestimated by as much as two or three times. Available data are insufficient to define an independent set of relations for the sandhills area, so use of an adjustment factor of 0.4 times an estimate from the Western Region relation is suggested.

Numerous basin and climatic characteristics were considered in the model; however, only those of both statistical and practical significance were retained in the estimating relations. Several variables, although statistically significant for some relations, were omitted because they did not sufficiently improve accuracy of the estimating relations. To further simplify the estimating relations and facilitate their use, a uniform set of variables was used for all flood equations defined in each region. Variables based on drainage area size, elevation, and mean annual precipitation proved most significant and useful in estimation of flood peaks at ungaged sites in South Dakota. Area and precipitation are significant in all relations for the Eastern Region while area and elevation are of practical significance in the Western Region. The three variables used are defined in the following section and values for these are listed for selected stations in the appendix, table I.

METHOD OF ESTIMATING

The most reliable estimators of future floods generally are the frequency analyses of gaging station records. Streamflow characteristics listed in table A-1 may provide satisfactory estimates for planning and design purposes at or near gaged sites, particularly where long-term records are available. Therefore, the estimating technique includes a search for available flood-frequency data for the desired site.

The method presented herein for estimating flood magnitudes at ungaged or short-record sites where floodflow is virtually natural requires solving mathematical equations relating flow magnitude to basin characteristics. The equations are of the form $Q_t = aA^bP^c$ (Eastern Region) and $Q_t = aA^bE^c$ (Western Region and sandhills area).

Where:

- Q is the peak flood discharge, in cubic feet per second,
- t is the flood-recurrence interval, in years,
- a, b, and c are regression constant and coefficients,
- A is the contributing drainage area above the site, in square miles,
- P is the mean annual precipitation, in inches, minus 11 inches, and
- E is the mean basin elevation, in thousands of feet above mean sea level.

Because this method of estimating is based on regional analyses of past streamflow records, it provides a means of transferring the streamflow data which have been collected at the individual gaged sites within a region to most ungaged sites within that region where flood estimates may be required. Further, these regionalized relationships may, in some cases, provide better estimates of the larger floods than do flood characteristics determined from actual streamflow records at short-term gaging stations having records of less than about 17 years duration.

Flood-frequency Equations

Estimates of peak discharges for the 2-, 5-, 10-, 25-, 50-, and 100-year recurrence interval floods can be computed for natural-flow sites in South Dakota by using the following relations. Due regard must be given to applicability and limitations of these equations as discussed in the following section. Equations are:

Eastern Region

$$Q_2 = 0.030\ A^{0.47}\ P^{2.93} \quad (1)$$

$$Q_5 = 0.458\ A^{0.49}\ P^{2.26} \quad (2)$$

$$Q_{10} = 1.78\ A^{0.50}\ P^{1.92} \quad (3)$$

$$Q_{25} = 7.52\ A^{0.51}\ P^{1.54} \quad (4)$$

$$Q_{50} = 30.3\ A^{0.52}\ P^{1.09} \quad (5)$$

$$Q_{100} = 78.4\ A^{0.52}\ P^{0.84} \quad (6)$$

Western Region (For sandhills area multiply Q by 0.4)

$$Q_2 = 110\ A^{0.54}\ E^{-1.16} \quad (7)$$

$$Q_5 = 320\ A^{0.49}\ E^{-0.84} \quad (8)$$

$$Q_{10} = 528\ A^{0.48}\ E^{-0.79} \quad (9)$$

$$Q_{25} = 1{,}020\ A^{0.48}\ E^{-0.91} \quad (10)$$

$$Q_{50} = 1{,}640\ A^{0.46}\ E^{-0.84} \quad (11)$$

$$Q_{100} = 2{,}080\ A^{0.45}\ E^{-0.74} \quad (12)$$

The above equations are based on English units of measurements. To convert the final answers of discharge from cubic feet per second to the metric equivalent of cubic metres per second, multiply by the factor 0.02832. Note that substitution of values using metric units for the variables A, P, and E will not provide correct answers because the conversion of units would also be involved in the constants derived for these equations.

Values for the variables A, P, and E used in developing equations 1 through 12 were determined in the manner described below. Insofar as possible, required variables for an ungaged site for which flood estimates are to be made should be determined in like manner.

1) Contributing drainage area (A), in square miles, for a gaged site is that reported in the latest Geological Survey streamflow data publications. For any ungaged site, determine by outlining the drainage basin on the best maps available and planimetering the area within the outline. Area can be roughly determined by laying a transparent grid, having squares of known size, over a map and counting the number of squares within the basin outline.

2) Mean annual precipitation, in inches, is the basin average as determined from isohyetal maps adapted from those published by the U.S. Weather Bureau (1959). The average is determined by weighing the values of precipitation lines within the basin with the drainage area between each of these lines using a grid-sampling method as explained above. Variation of the mean annual precipitation in South Dakota is shown in figure 2. See Charts and Examples. The variable P is obtained by subtracting 11 inches from the basin average.

3) Mean basin elevation (E), in thousands of feet above mean sea level, is measured on U.S. Geological Survey maps or best available map by laying a grid over the map, determining

elevation at each grid intersection, averaging these elevations, and dividing by 1,000. Grid spacing should be selected to give at least 25 intersections within the basin boundary.

Preceding equations (1 - 12) for Q_2, Q_5, Q_{10}, Q_{25}, Q_{50}, and Q_{100} are reduced to graphical form in figures 3 through 14. See Charts and Examples.

Estimates of peak discharge for recurrence intervals other than those for which equations are given may be obtained by interpolation from a frequency curve (discharge versus recurrence interval). Discharges for the frequency curve are computed using equations 1 though 6 or 7 through 12, as applicable. However, extrapolation of discharges corresponding to recurrence intervals greater than 100 years is not recommended.

Flood Frequency for Large Streams

Estimating relations (flood-frequency equations) given previously do not apply to drainage areas exceeding about 4,000 sq mi (10,400 sq km) in the Eastern Region and about 9,000 sq mi (23,300 sq km) in the Western Region. Further, the equations are not applicable to several of the major streams because of main-stem regulation. To provide flood estimating techniques for some of the large streams, some of which have major regulation, individual relations between flood magnitude and contributing drainage area were prepared based on interpolation between gaged sites on the main stems. Flood-frequencies indicated for the regulated streams are based on an assumption that past records had homogeneous regulation patterns and are applicable only if regulation patterns are unchanged in the future. The main-stem reaches of streams for which separate relations are shown are:

(a) Grand River downstream from Shadehill Reservoir,
(b) Belle Fourche River downstream from Wyoming-South Dakota State line,
(c) Cheyenne River downstream from Angostura Reservoir,
(d) White River for contributing drainage areas greater than 5,000 sq mi (13,000 sq km),
(e) James River downstream from North Dakota-South Dakota State line, and
(f) Big Sioux River for contributing drainage areas greater than 4,000 sq mi (10,400 sq km).

Graphs showing the magnitude of floods of selected recurrence intervals versus contributing drainage area for these streams are presented in figures 17 through 22. See Charts and Examples.

Flood-frequency relations for the Missouri River main stem are beyond the scope of this report because the complex regulation patterns have not been homogeneous during the period of record. Such estimates would require a complete systems analysis.

ACCURACY AND LIMITATIONS

Accuracy of Estimates

The reliability of flood estimates at ungaged sites is indirectly indicated by the standard errors of estimate of the regression equations. The standard error, given in percent, is the range of error to be expected about two-thirds of the time. That is, the difference between the computed and the true discharge for two-thirds of the estimates made will be within plus or minus one standard error of estimate. Because the analyses used logarithims of variables, standard errors are larger in the positive direction.

Approximate standard errors of estimate for defined relations are:

	Flood relation	Standard error of estimate, in percent	
		Average	Range
Eastern Region			
	Q_2	100	(+142, -58)
	Q_5	81	(+110, -52)
	Q_{10}	74	(+ 98, -50)
	Q_{25}	73	(+ 97, -49)
	Q_{50}	74	(+ 98, -50)
	Q_{100}	82	(+111, -53)
Western Region			
	Q_2	134	(+201, -67)
	Q_5	84	(+115, -53)
	Q_{10}	77	(+103, -51)
	Q_{25}	75	(+100, -50)
	Q_{50}	63	(+ 81, -45)
	Q_{100}	65	(+ 85, -45)

The accuracy of estimates may also be indicated by converting standard error to equivalent years of record (Hardison, 1969). That is, the number of years of actual streamflow records needed at a site to provide an estimate of equal accuracy is equated to the accuracy obtained by using estimating relations. For South Dakota streams, relations developed for Q_{10} will give estimates equivalent to 7 to 10 years actual streamflow records while relations developed for Q_{50} give estimates comparable in accuracy to that obtained by operation of a gaging station for about 17 years.

At or near gaged sites, the designer may use flood magnitudes based on estimating relations or he may choose to use streamflow characteristics based on actual records collected at that site. In making the decision, the equivalent years of record concept should be considered. For gaged sites with short records, the estimating relations will possibly provide the best answer while for sites with relatively long records the streamflow characteristics at the site may provide a more accurate answer. For a desired site located between two gaged sites, each having relatively long records; an interpolation of flood magnitudes might be considered as an alternate method to the use of estimating relations. Such an interpolation based on drainage area is suggested by the equations. The equivalent years of record concept should again be considered in determining relative accuracy of flood estimates.

Limitations of Estimating Relations

The following limitations should be observed when using the estimating relations (equations 1 through 12 and figures 3 through 14):

(1) The relations are applicable only to sites where floodflows are virtually natural. Therefore, they should not be used where peak discharges are significantly affected by manmade works (major dams, reservoirs, diversions, or urbanization).

(2) Estimating relations are considered applicable to a range of contributing drainage areas of from about 0.1 to 4,000 sq mi (0.3 to 10,400 sq km) in the Eastern Region and from about 0.1 to 9,000 sq mi (0.3 to 23,300 sq km) in the Western Region.

(3) The streamflow records for small streams having drainage areas of less than about 100 sq mi (260 sq km) are of insufficient length, generally 17 years, to accurately define 50- and 100-year recurrence-interval floods. However, until more streamflow data are available, these equations will give rough estimates of high recurrence-interval floods for small streams. In future years, estimating relations presented herein may require redefinition as additional or new hydrologic data become available (Becker, 1973).

(4) Flood magnitudes will be grossly overestimated by the Western Region equations for the small "sandhills" area along the Nebraska border (fig. 1). Available data are insufficient for defining reliable estimates for that area, but flood magnitudes should be reduced to about 0.4 of that estimated by the Western Region relations.

MAXIMUM FLOODS AND FLOOD-PRONE AREAS

Floods of Record

Designers and planners sometimes either are required to or desire to consider the magnitude of maximum observed floods. This section provides data on the maximum flood discharges observed in South Dakota. Maximum flood peaks determined at 114 continuous-record gaging stations, 74 crest-stage gages, and 52 miscellaneous sites are tabulated in the appendix; tables A-2, A-3, and A-4. The ratio of discharge to contributing drainage area has been computed and tabulated for each flood. These ratios, expressed as cubic feet per second per square mile (cfs/sq mi), may also be of value in design considerations.

Maximum floods in South Dakota may result from either snowmelt or rainfall peaks. The severe floods of 1969 in the James and Big Sioux River basins (Anderson and Schwob, 1970) resulted from spring snowmelt. The Rapid City flood (Larimer, 1973) and floods in that vicinity in 1972 are of particular note because of their severity and were the result of summer rainfall.

Maximum flood peaks given in the appendix are related to drainage area in figures 15 and 16. See Charts and Examples. Regional curves based on equations using the single variable of drainage area for the 50- and 100-year floods are shown for comparison. A comparison of South Dakota floods with maximum known floods in the United States is also made. As may be seen from these figures, a significant number of past floods have exceeded the 100-year flood. Significance of the extreme floods of 1969 and 1972 is shown by the fact that 42 of about 70 floods plotted in figure 15 occurred in 1969 and that 22 of 51 floods exceeding the 100-year flood in figure 16 are associated with the Rapid City area flood.

Extent of Flooding

The areal extent of flooding (flood-plain inundation) expected as a result of floods of rare recurrence interval may be determined for many streams by consulting flood-prone area maps. As a part of a national program for managing flood losses, the U.S. Geological Survey has recently prepared approximately 300 flood-prone area maps (7½-minute quadrangles) relating to South Dakota streams. This program of flood-prone area mapping is based on reconnaissance-level accuracy. Flood boundaries outlined on these maps are generally for a "flood with a 1 in 100 chance on the average of occurring in any year." These maps are available from the South Dakota District Office, U.S. Geological Survey.

CHARTS AND EXAMPLES

Charts

For convenience, the figures which need to be referred to most often in making flood estimates are grouped in this section of the report. Related flood data useful in planning and design, are tabulated in the appendix. The user, however, should be familiar with the limitations placed on the use of these figures and tables as discussed in preceding sections of the report.

Hydrologic regions are shown on figure 1 and mean annual precipitation may be determined from figure 2. Graphical solutions for the estimating relations (equations 1 through 12) are given in figures 3 through 14. Refer to figures 3 through 8 for the Eastern Region and to figures 9 through 14 for the Western Region. However, refer to table A-1 for basin and flood characteristics of gaged sites. Floods of record listed in tables A-2, A-3, and A-4 are shown for each region on figures 15 and 16. Refer to figures 17 through 22 for flood-frequency relations applicable to main-stem reaches of selected large streams.

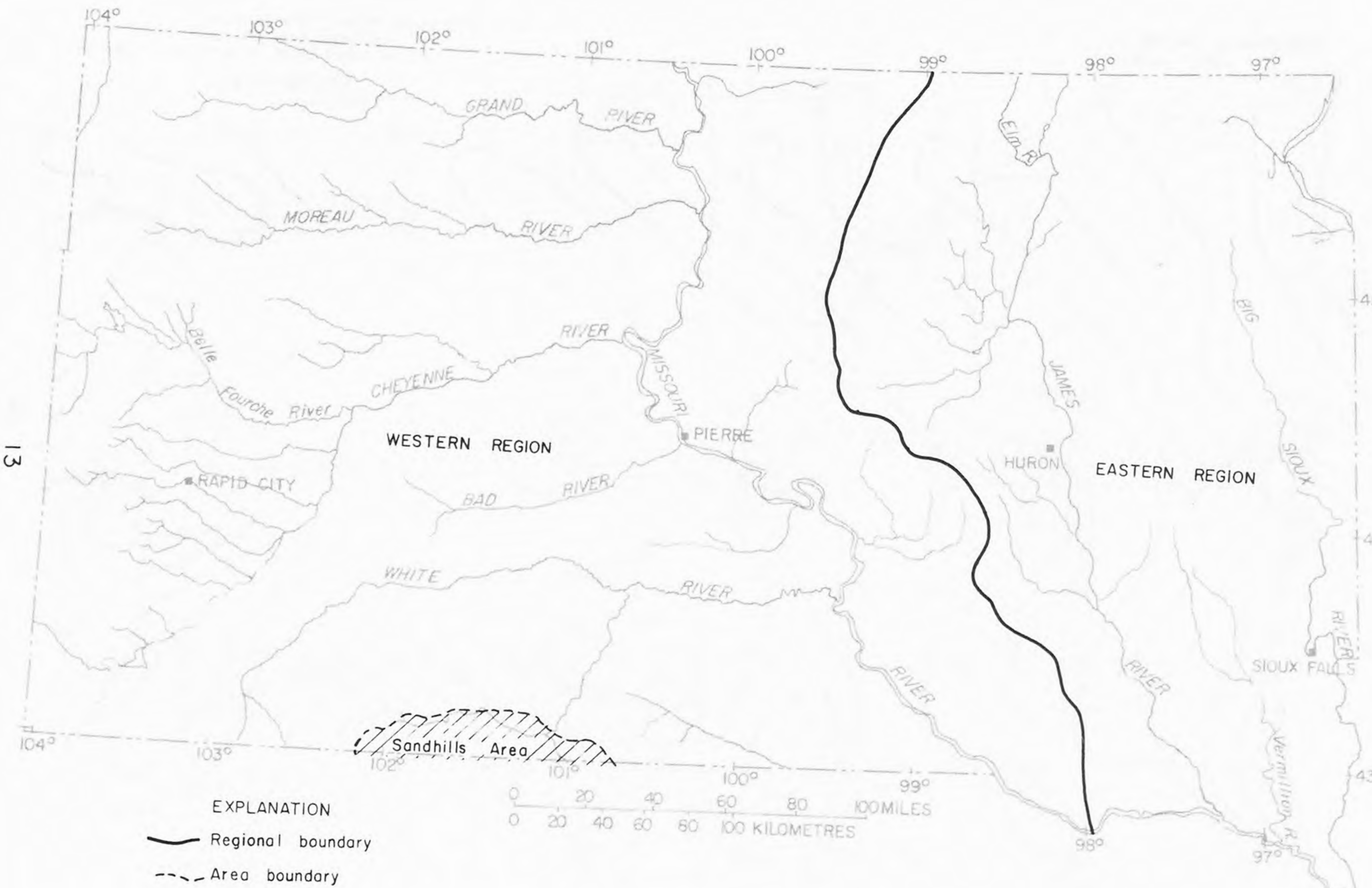

Figure 1.--Hydrologic regions in South Dakota.

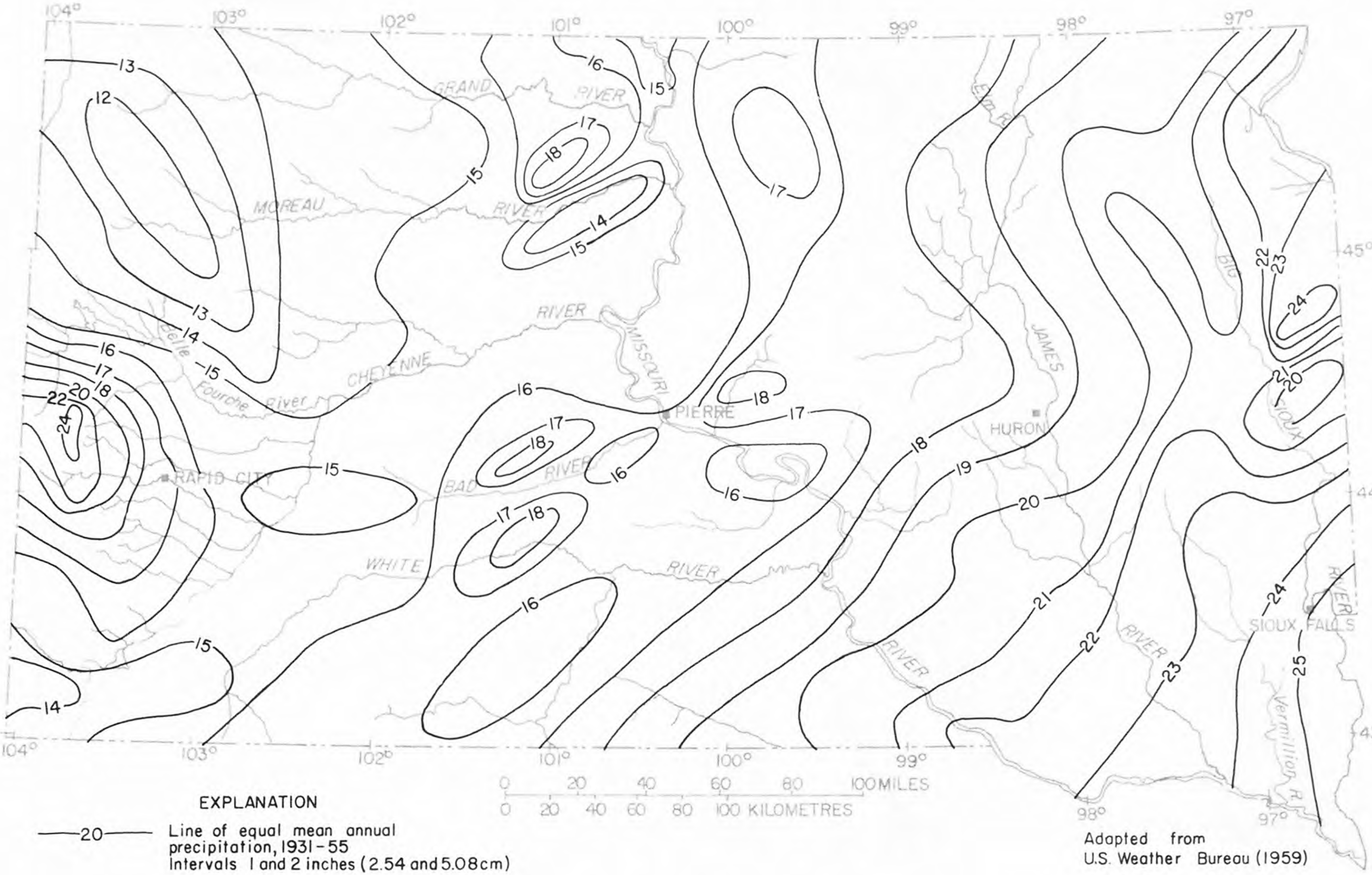

Figure 2.-- Mean annual precipitation.

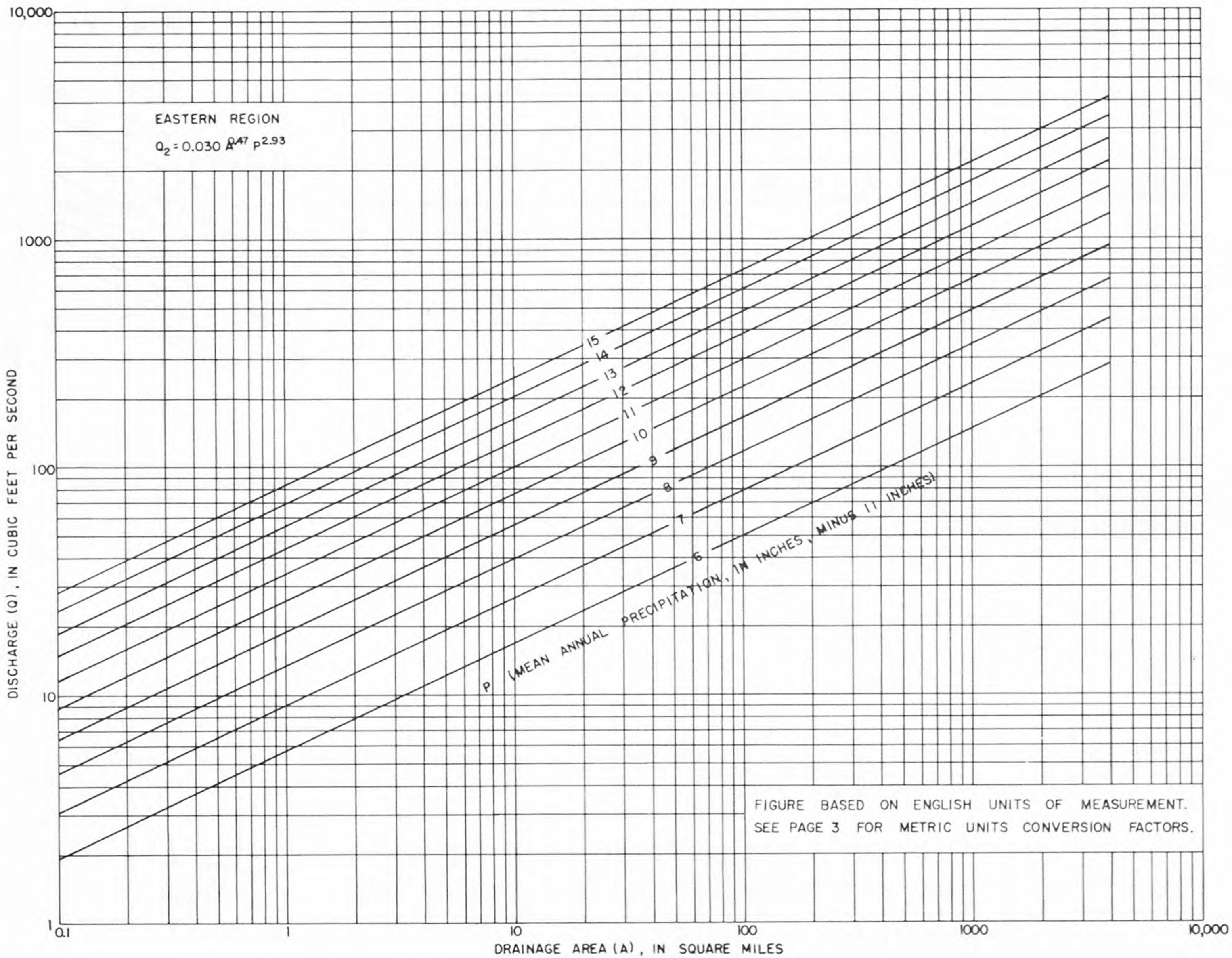

Figure 3.--Relation of 2-year flood to drainage area and precipitation, Eastern Region.

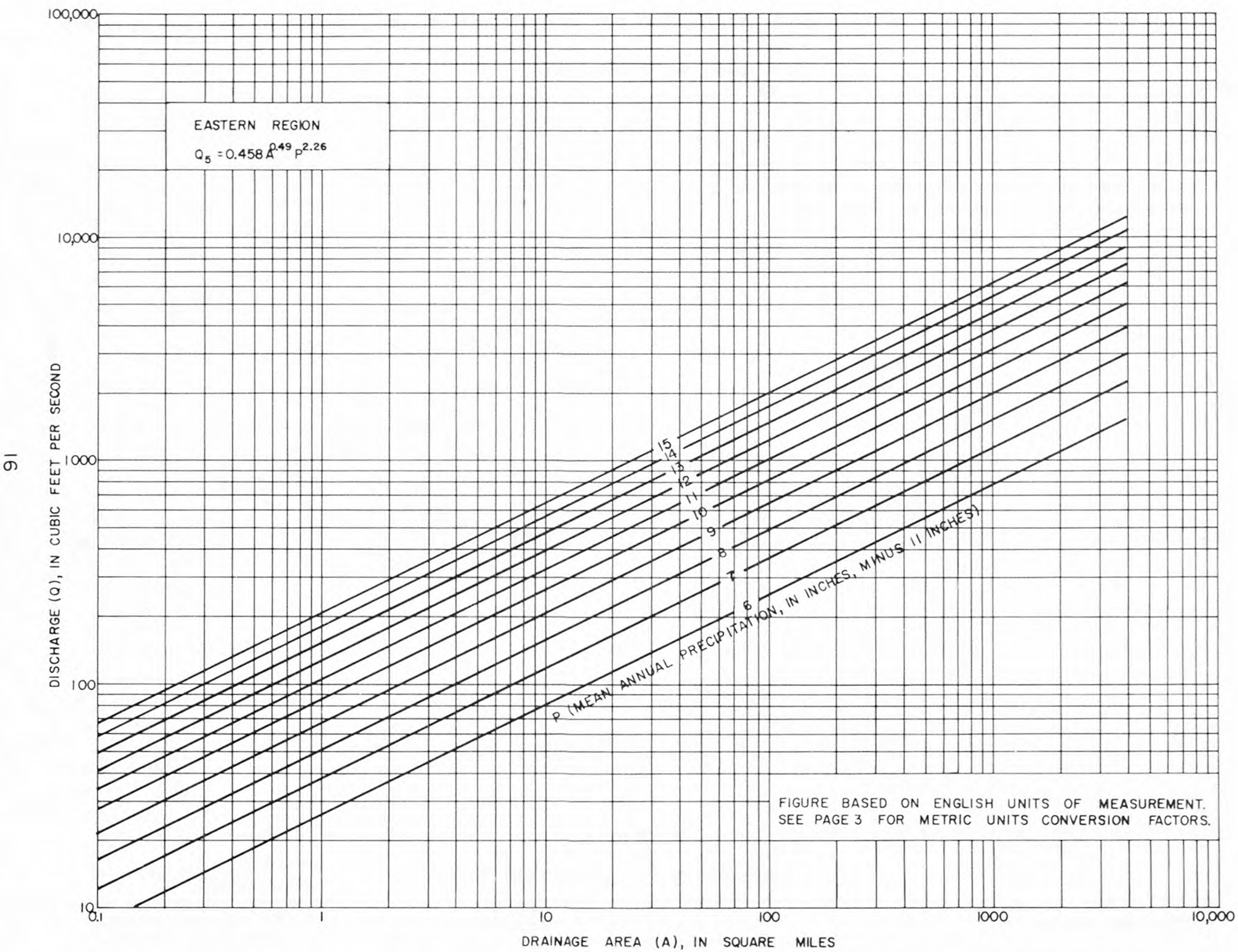

Figure 4.-- Relation of 5-year flood to drainage area and precipitation, Eastern Region.

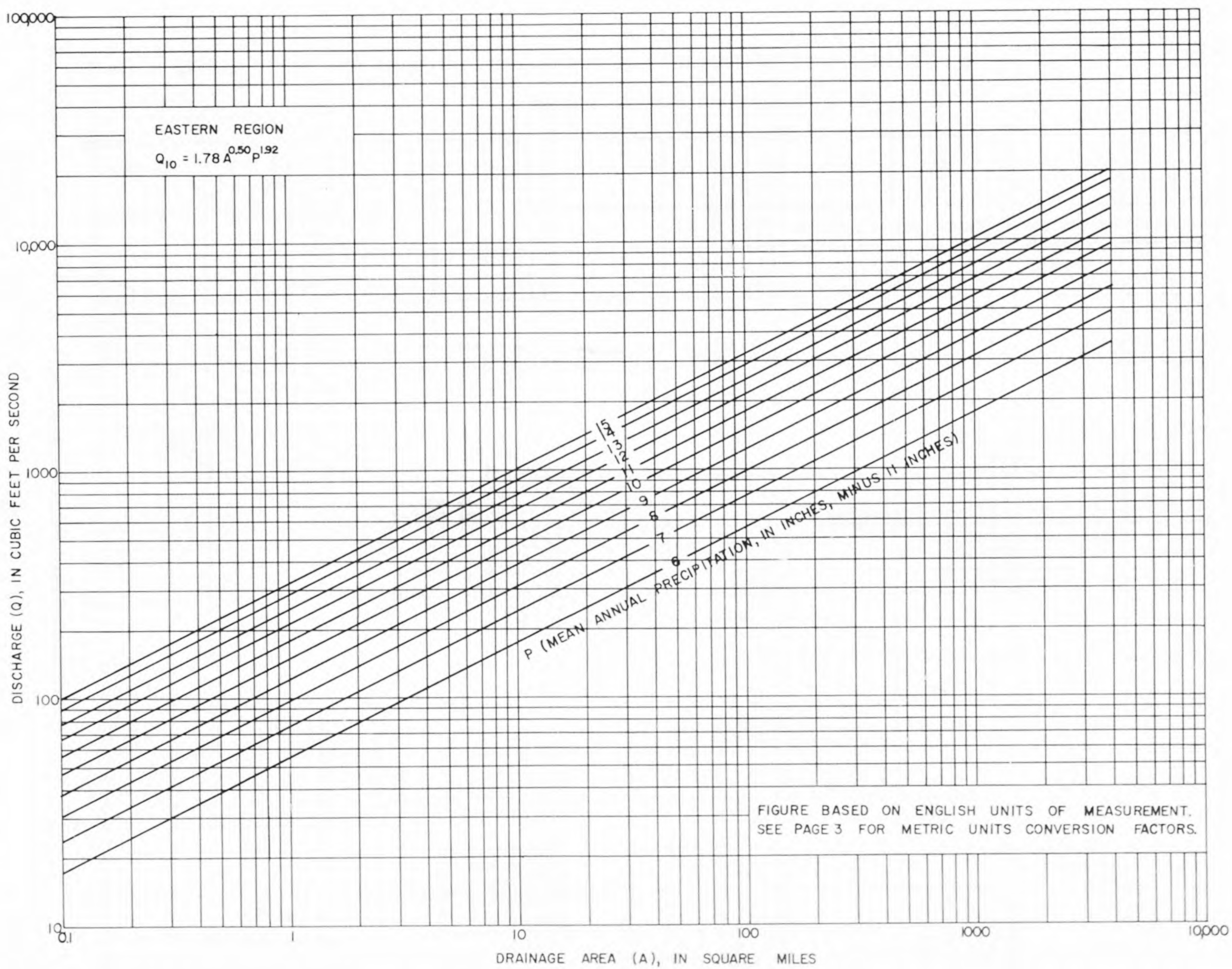

Figure 5.-- Relation of 10-year flood to drainage area and precipitation, Eastern Region.

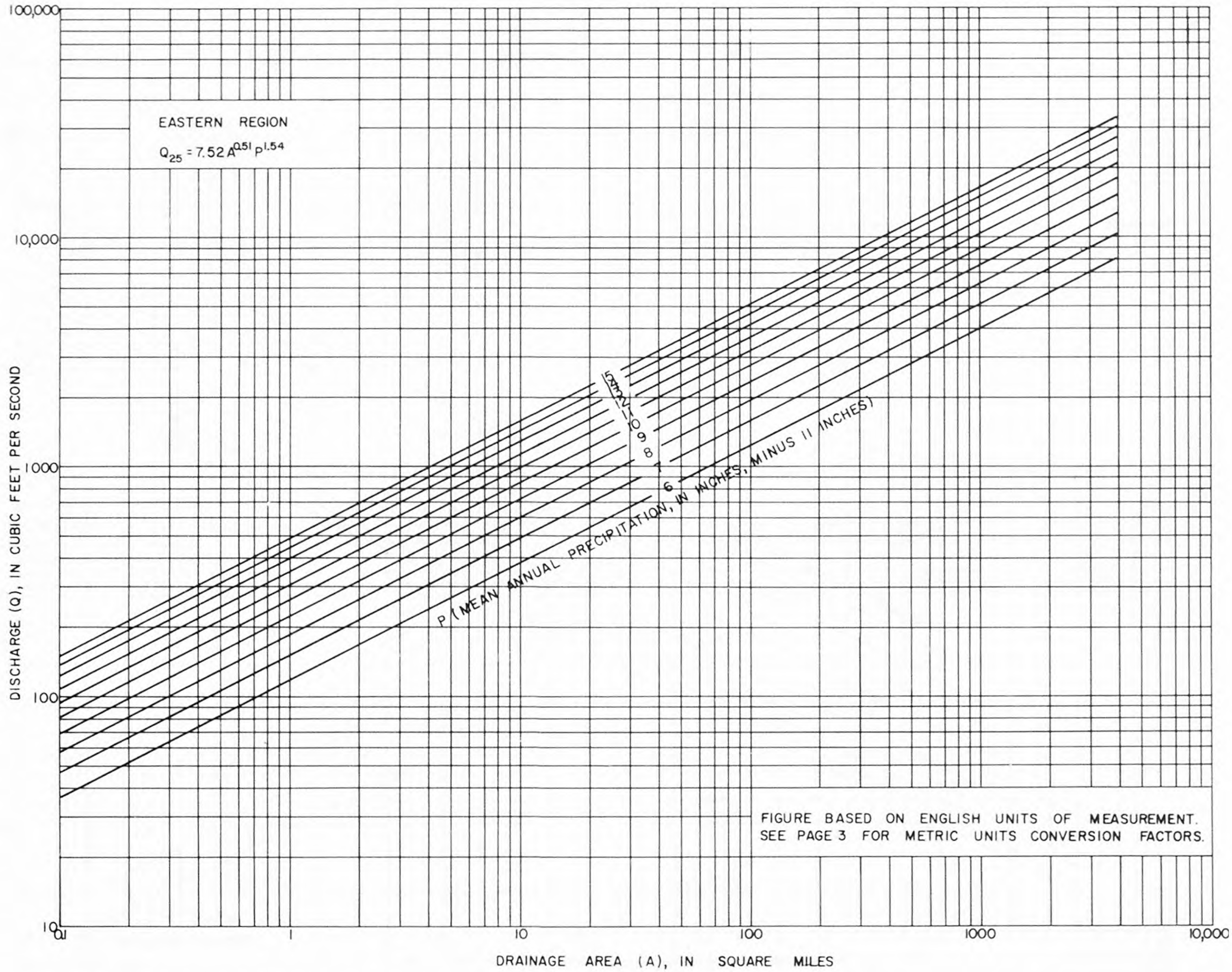

Figure 6.-- Relation of 25-year flood to drainage area and precipitation, Eastern Region.

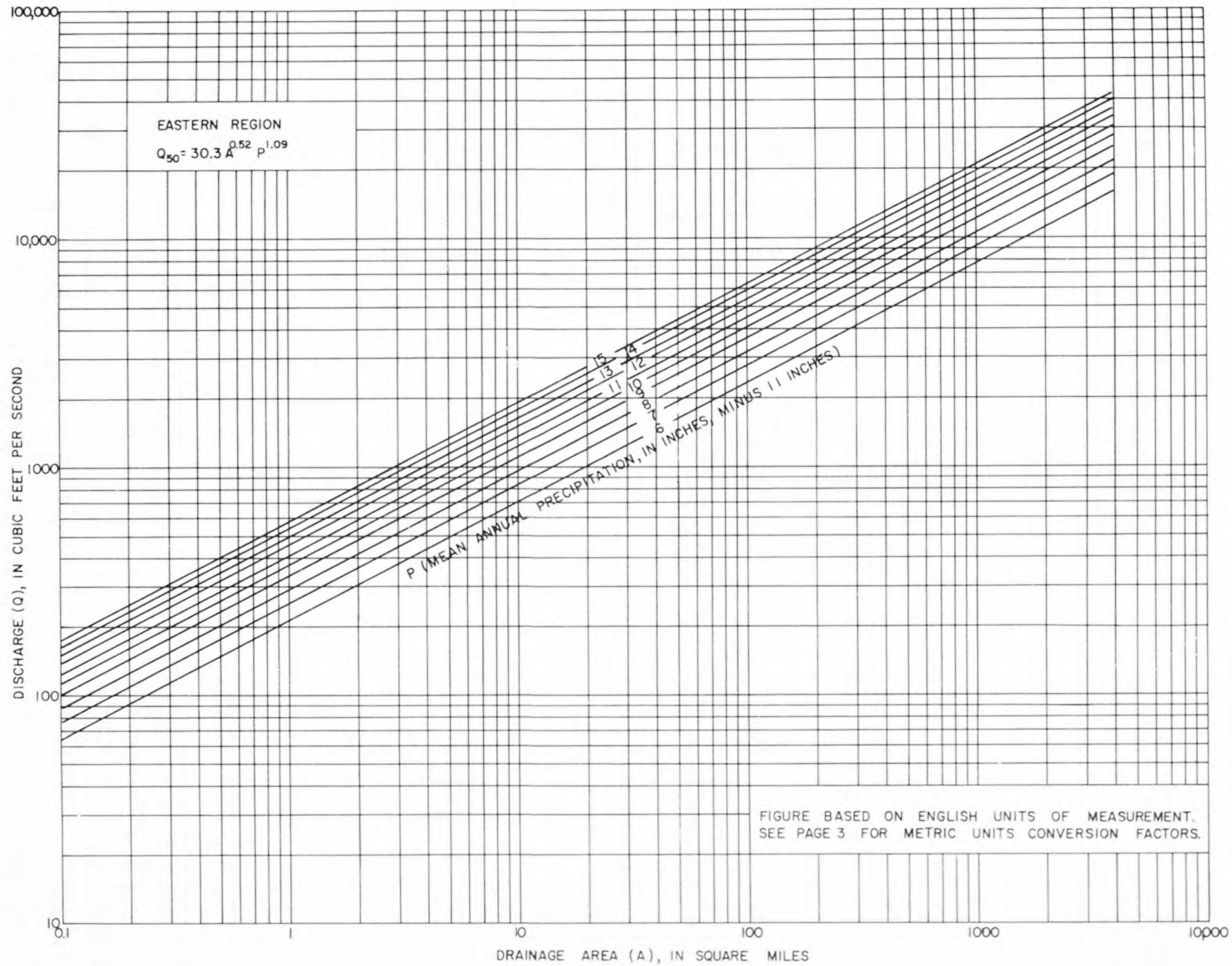

Figure 7.-- Relation of 50-year flood to drainage area and precipitation, Eastern Region.

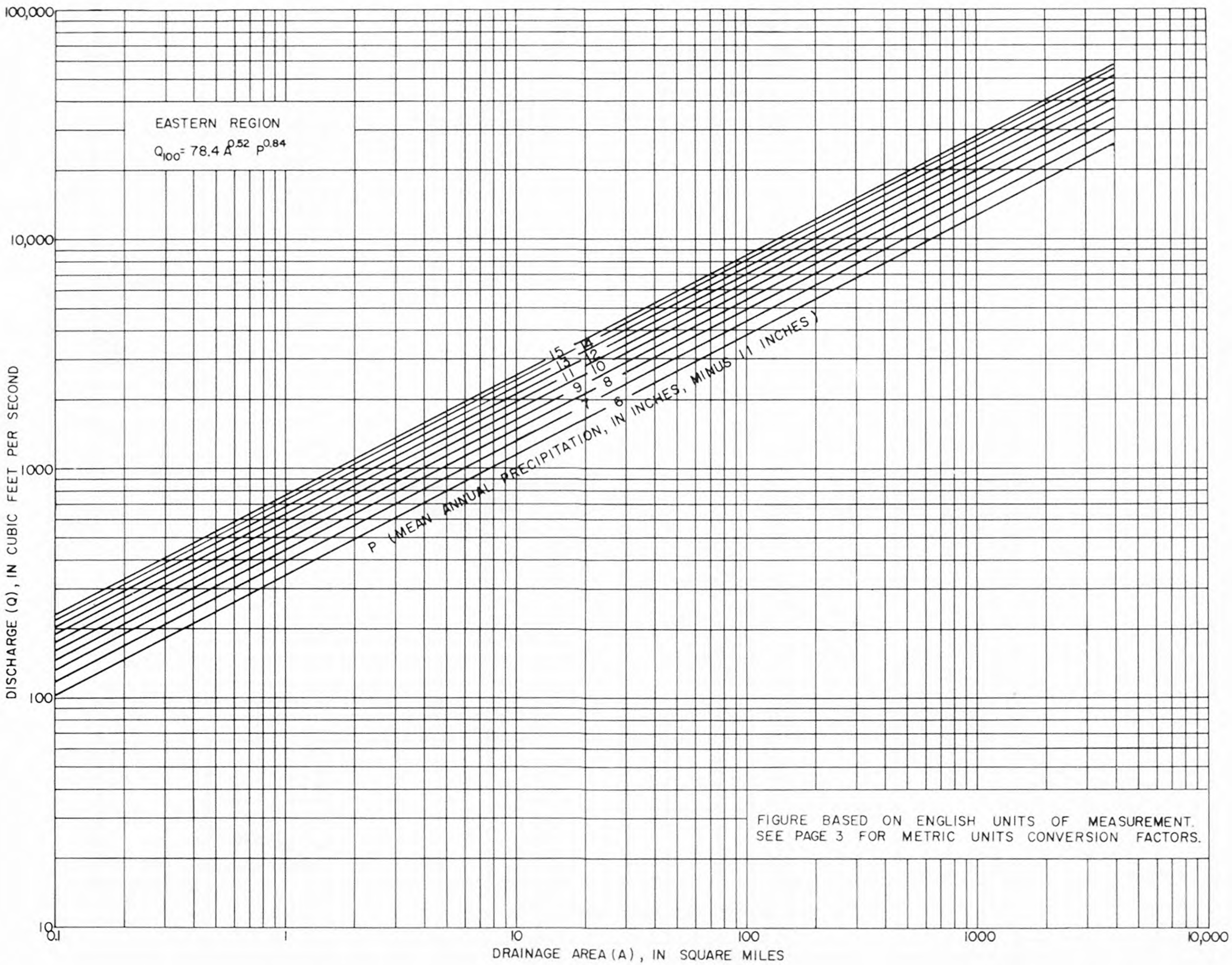

Figure 8.--Relation of 100-year flood to drainage area and precipitation, Eastern Region.

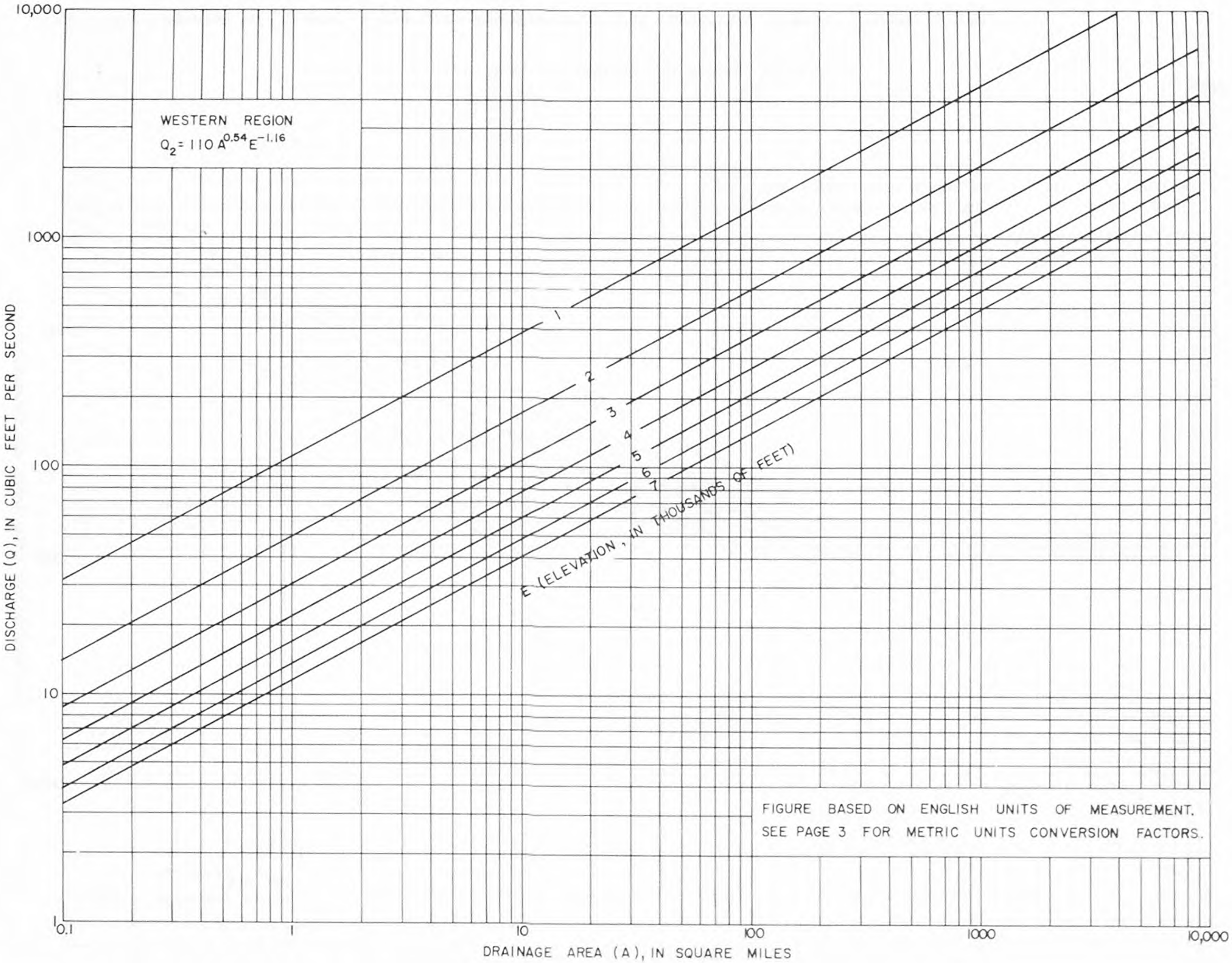

Figure 9-- Relation of 2-year flood to drainage area and elevation, Western Region.

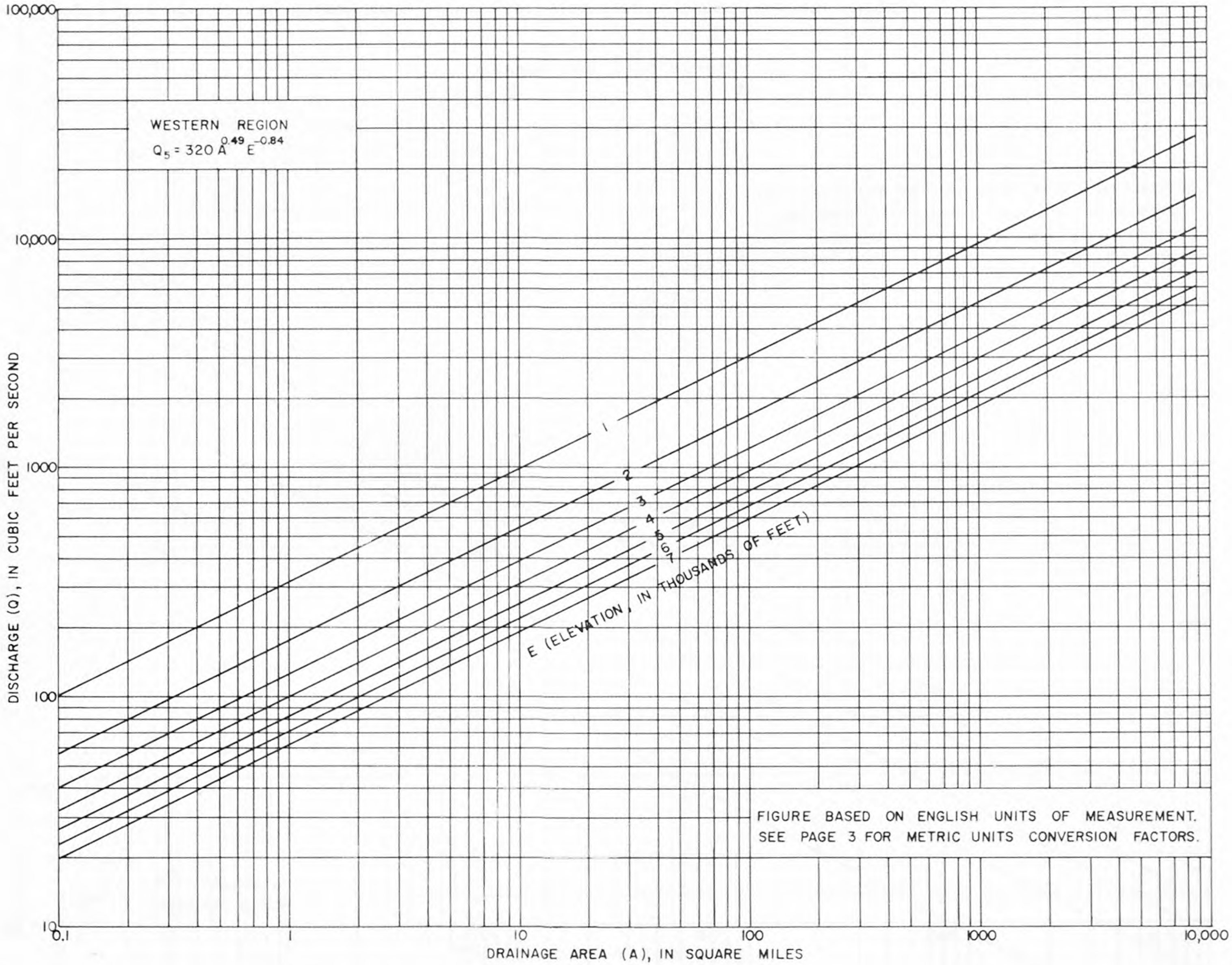

Figure 10.—Relation of 5-year flood to drainage area and elevation, Western Region.

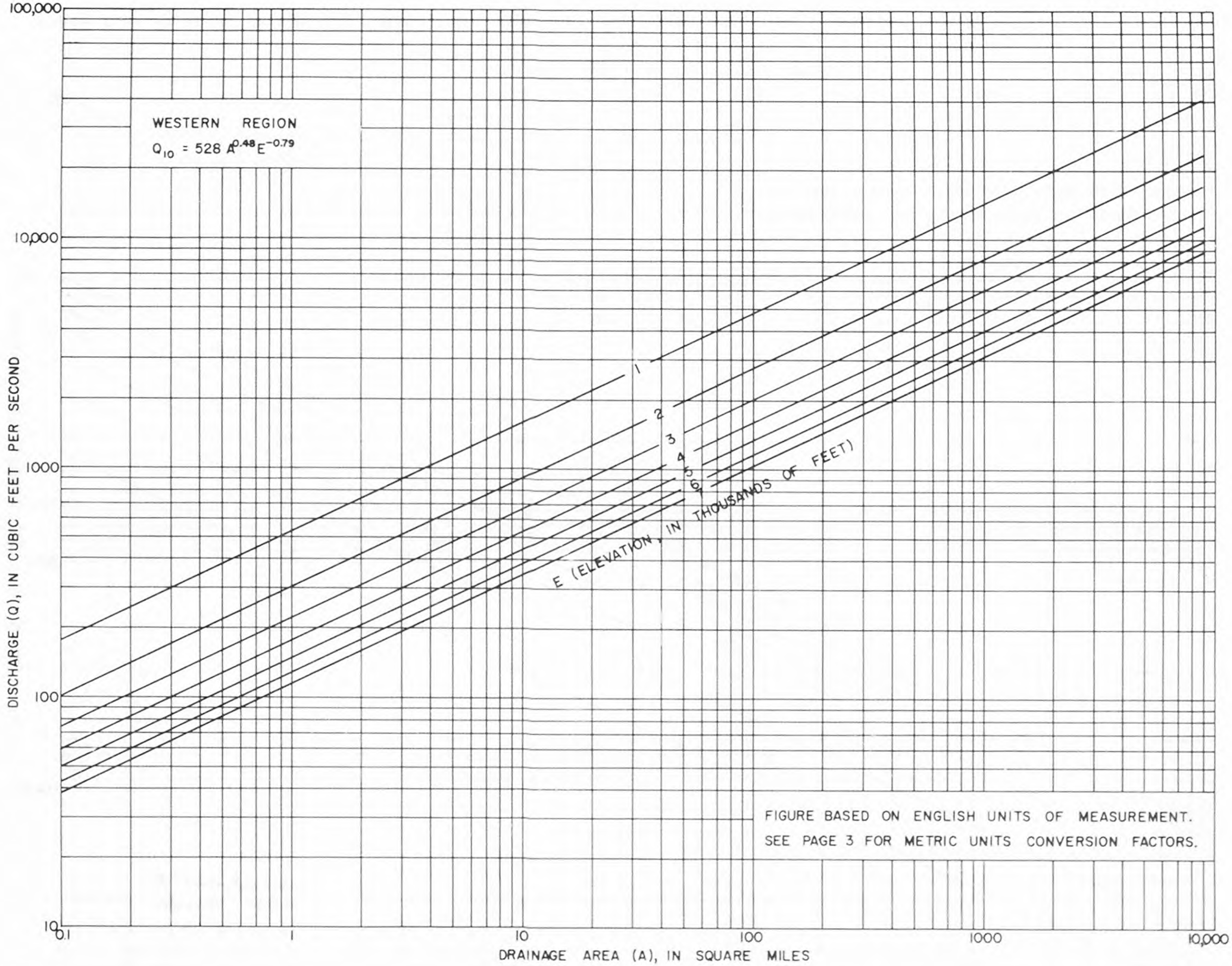

Figure 11.--Relation of 10-year flood to drainage area and elevation, Western Region.

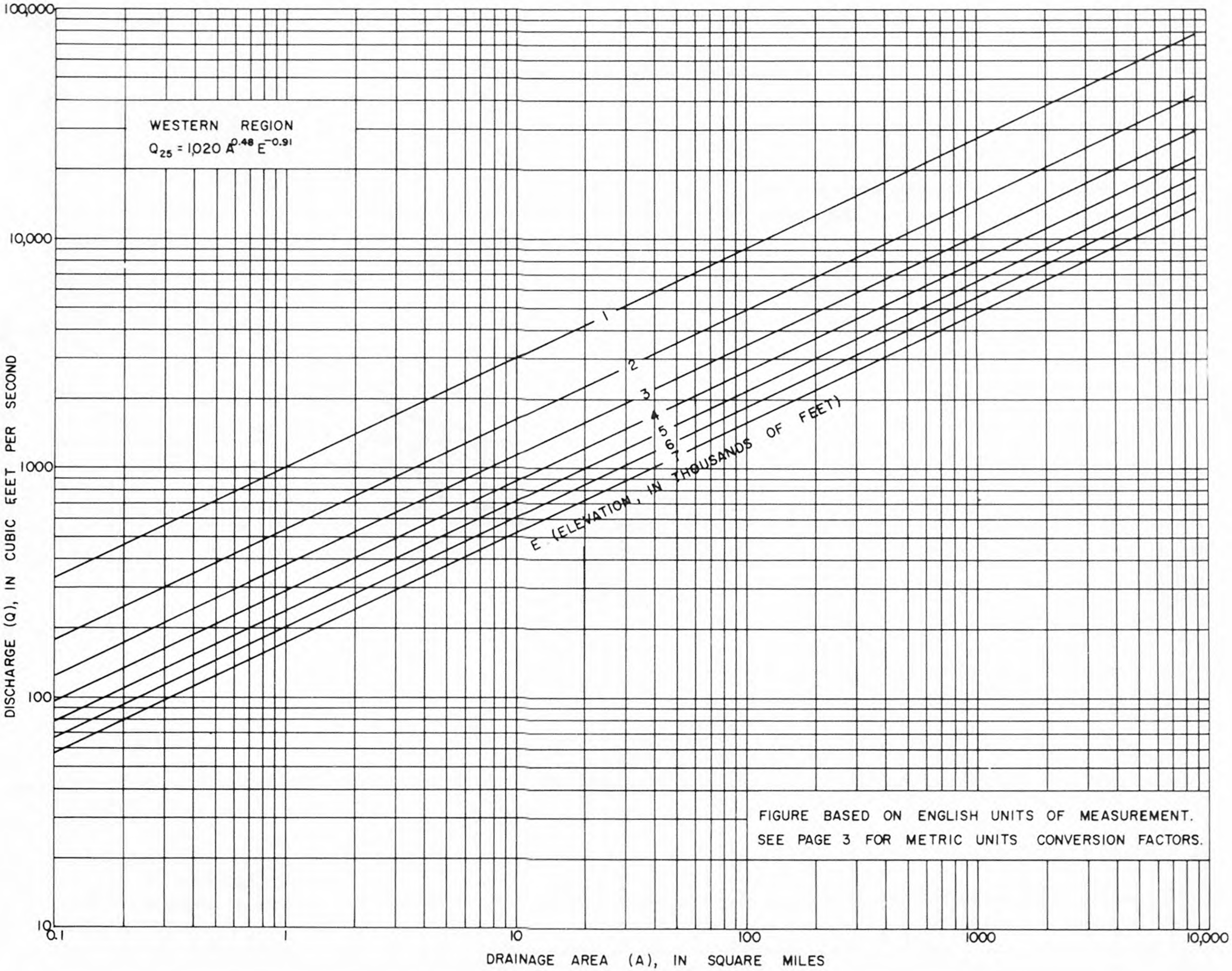

Figure 12.--Relation of 25-year flood to drainage area and elevation, Western Region.

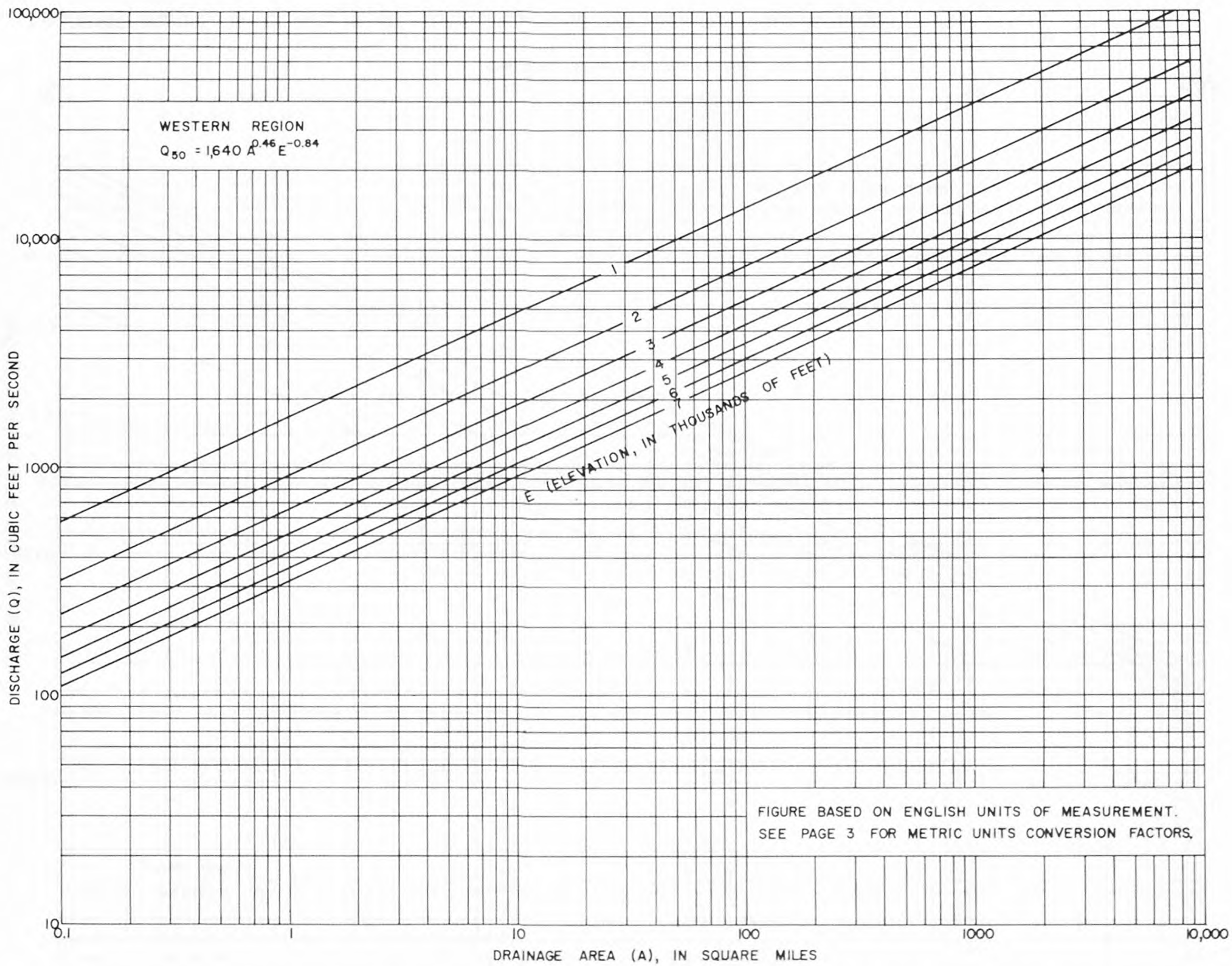

Figure 13.--Relation of 50-year flood to drainage area and elevation, Western Region.

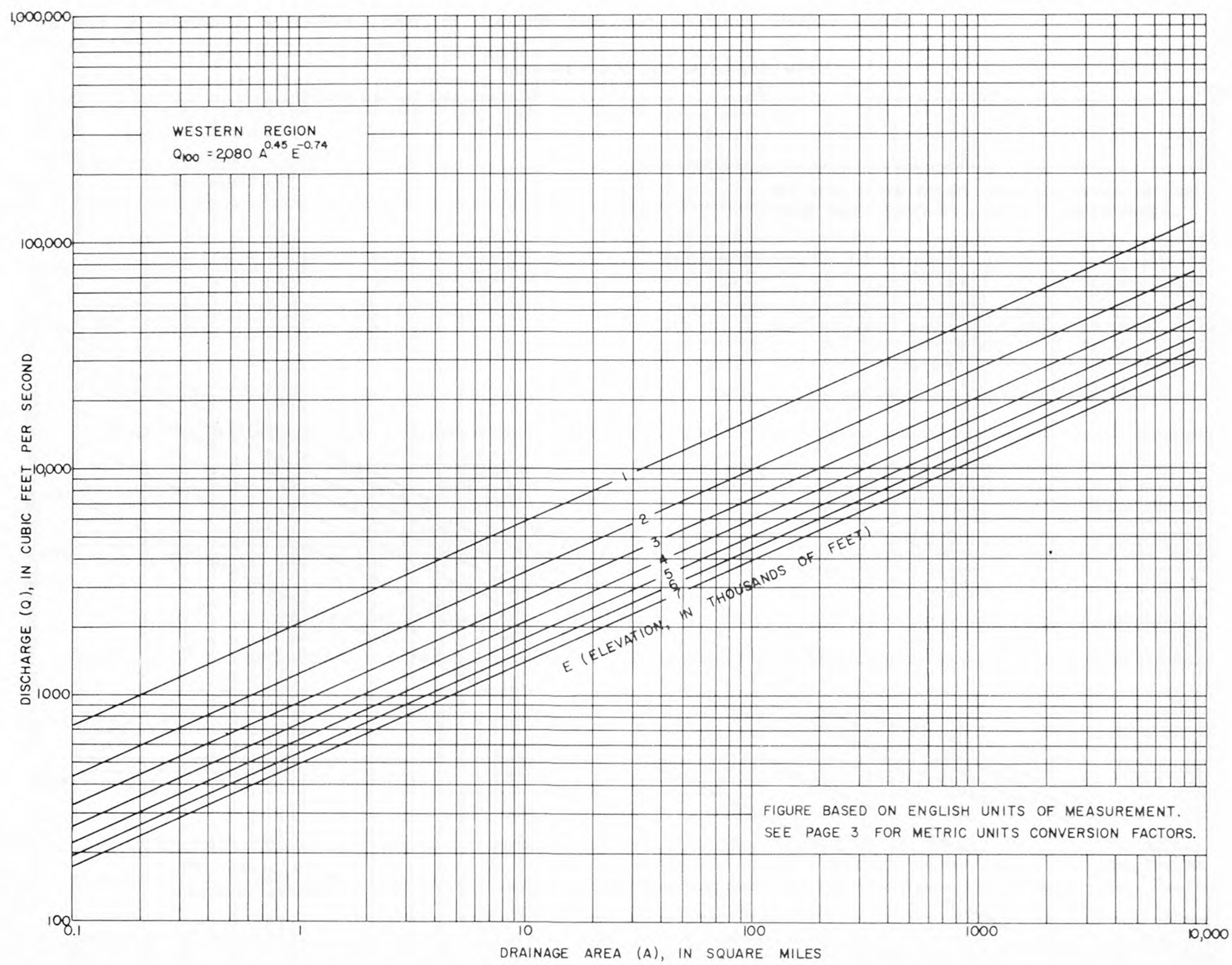

Figure 14.--Relation of 100-year flood to drainage area and elevation, Western Region.

FIGURE BASED ON ENGLISH UNITS OF MEASUREMENT. SEE PAGE 3 FOR METRIC UNITS CONVERSION FACTORS.

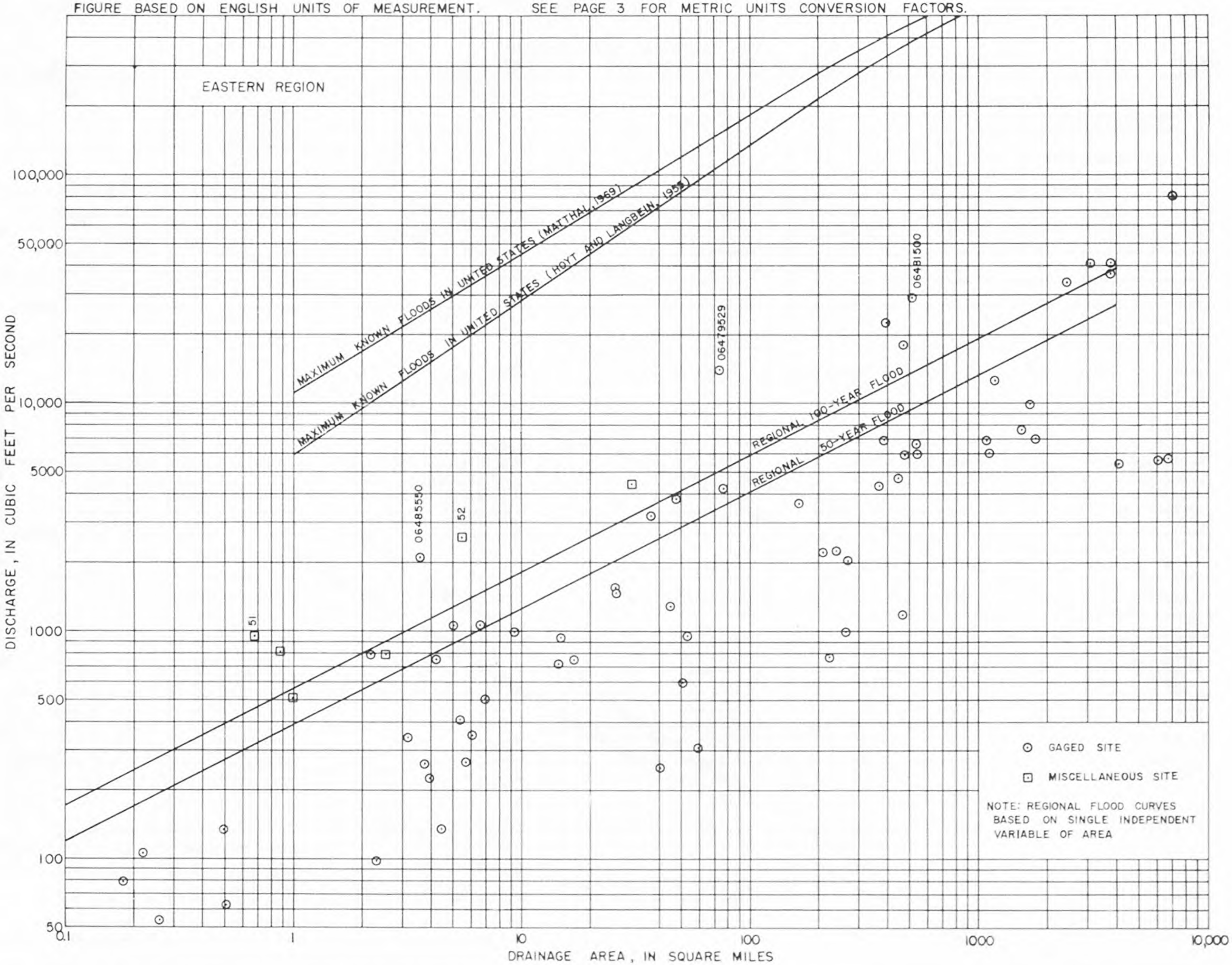

Figure 15.--Relation of floods of record in Eastern Region to drainage area.

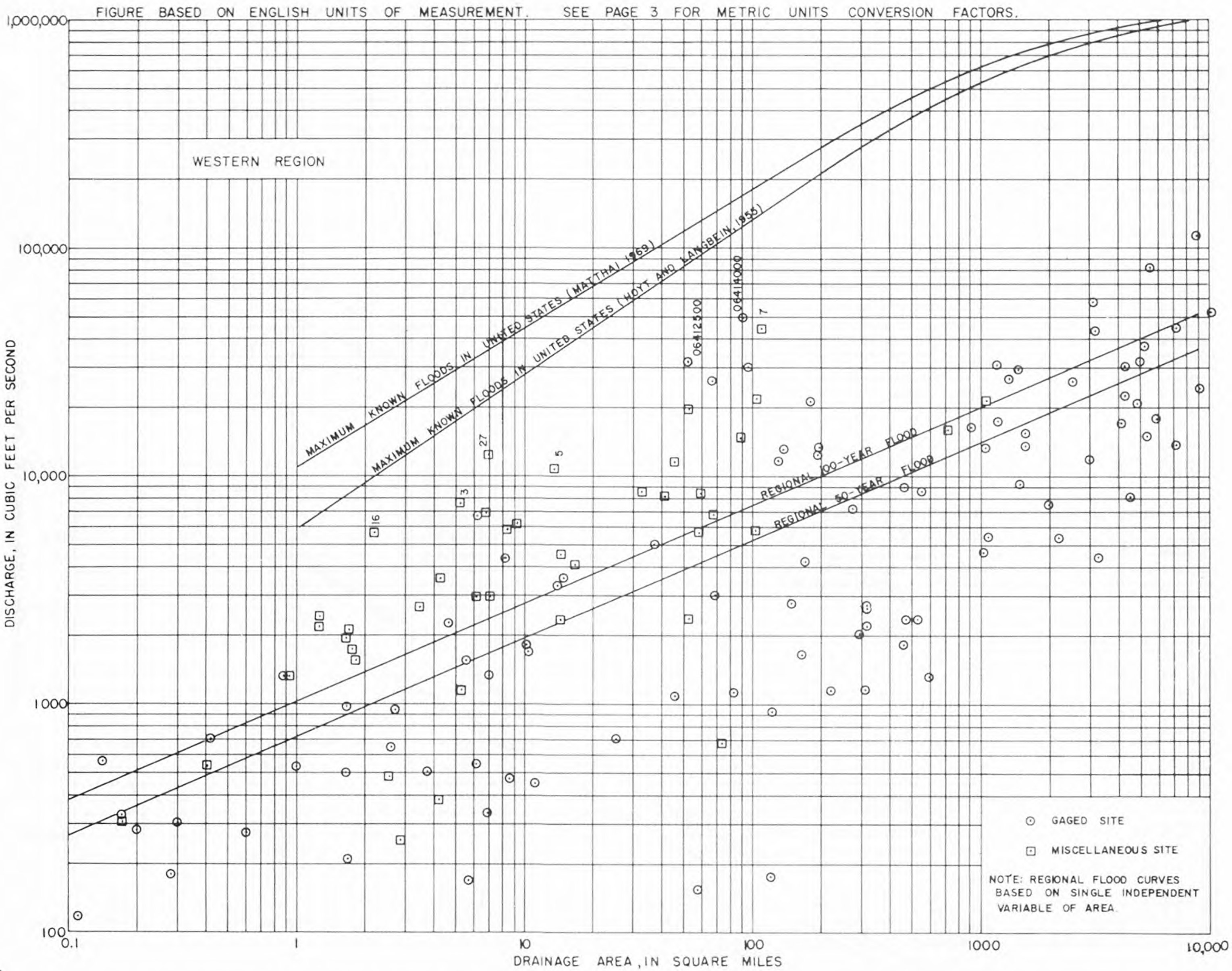

Figure 16.-- Relation of floods of record in Western Region to drainage area.

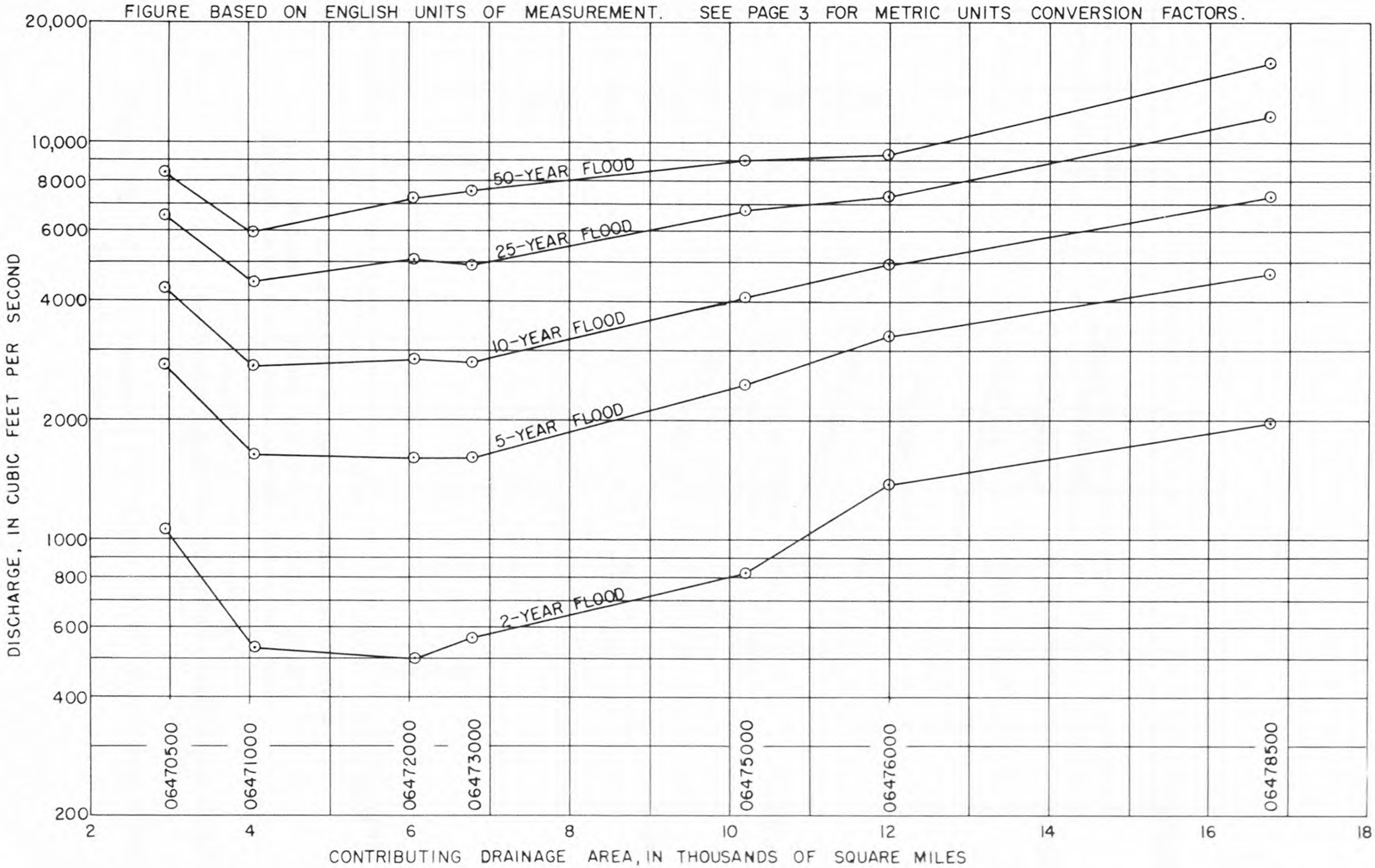

Figure 17.-- Flood frequency for James River downstream from North Dakota-South Dakota State line.

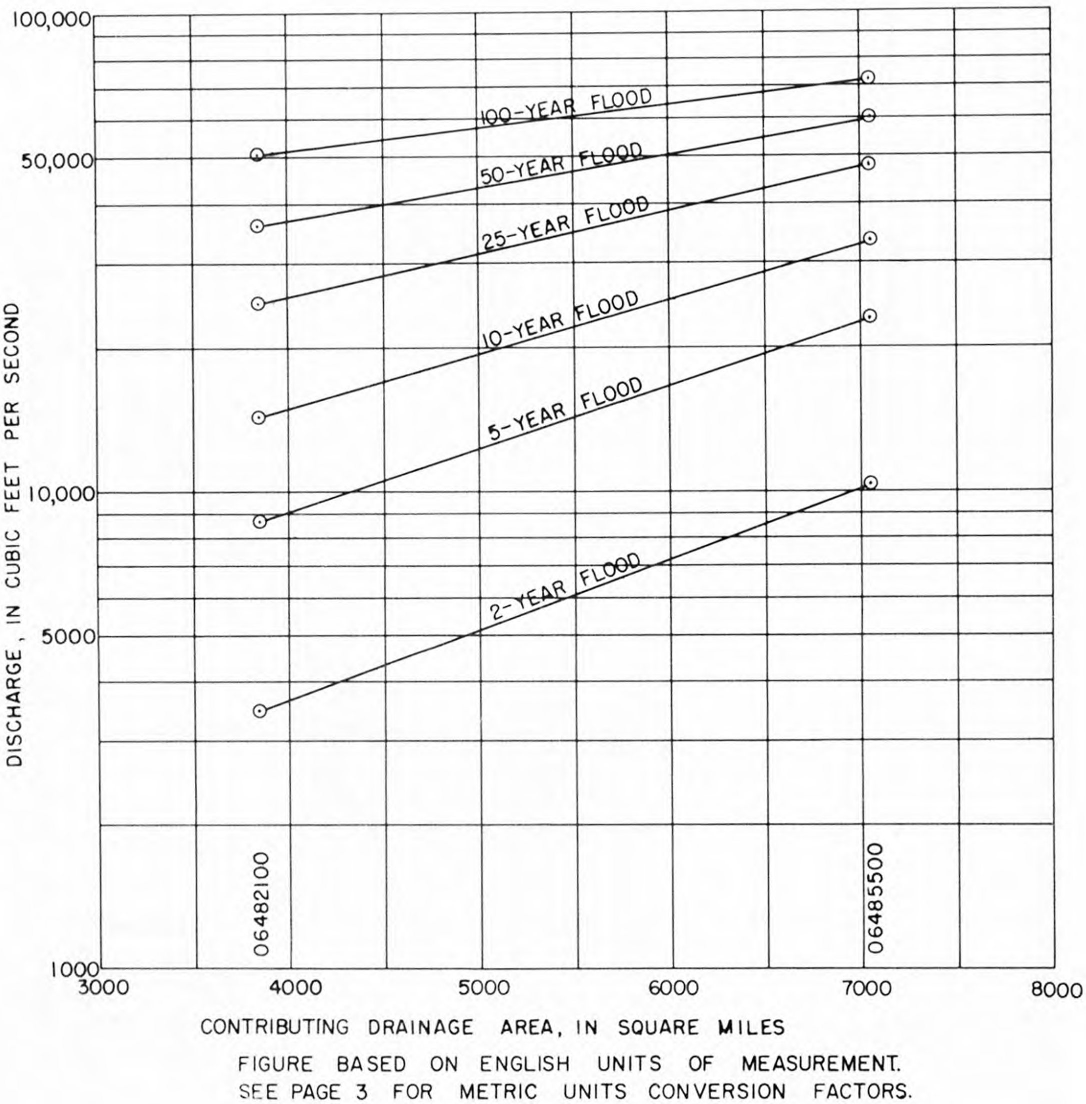

Figure 18.-- Flood frequency for Big Sioux River.

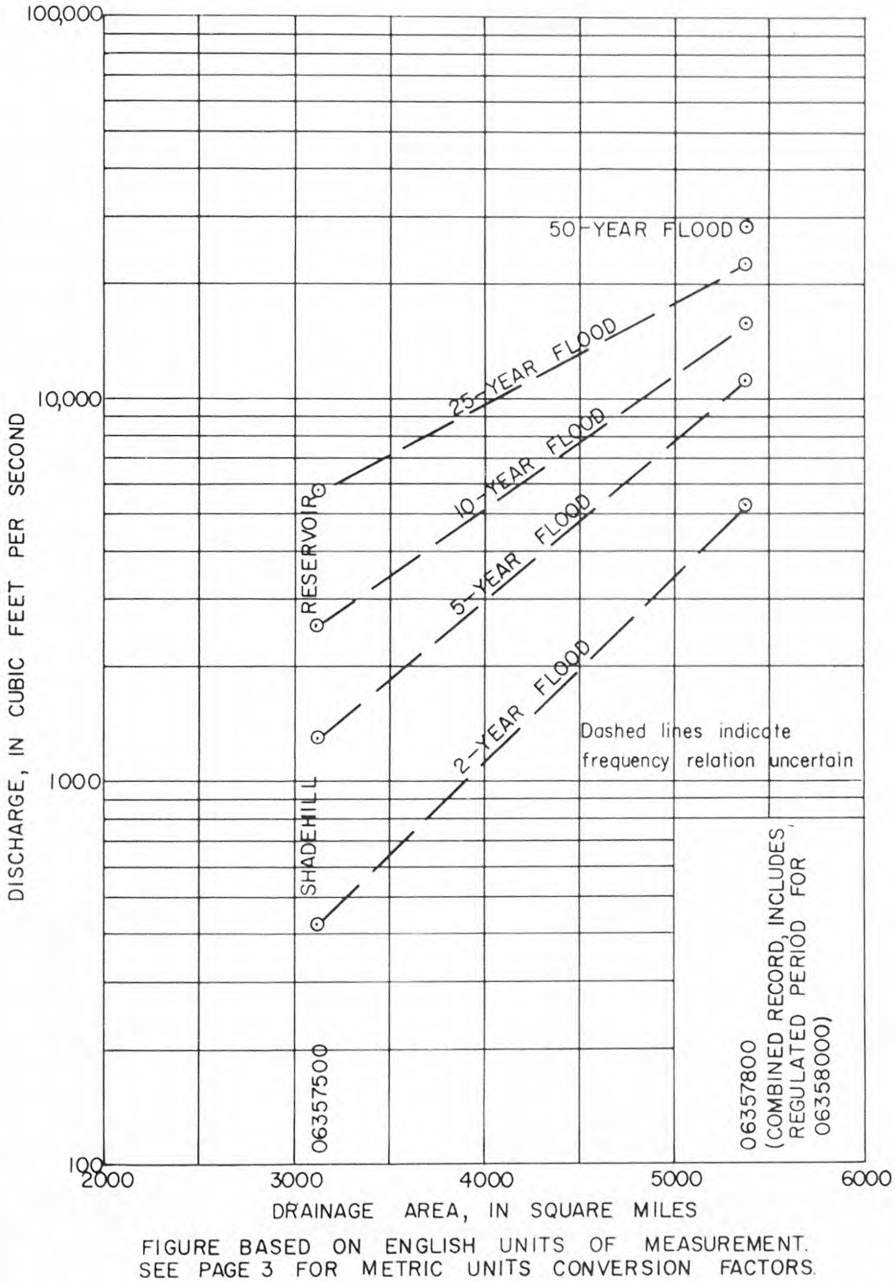

Figure 19.--Flood frequency for Grand River downstream from Shadehill Reservoir.

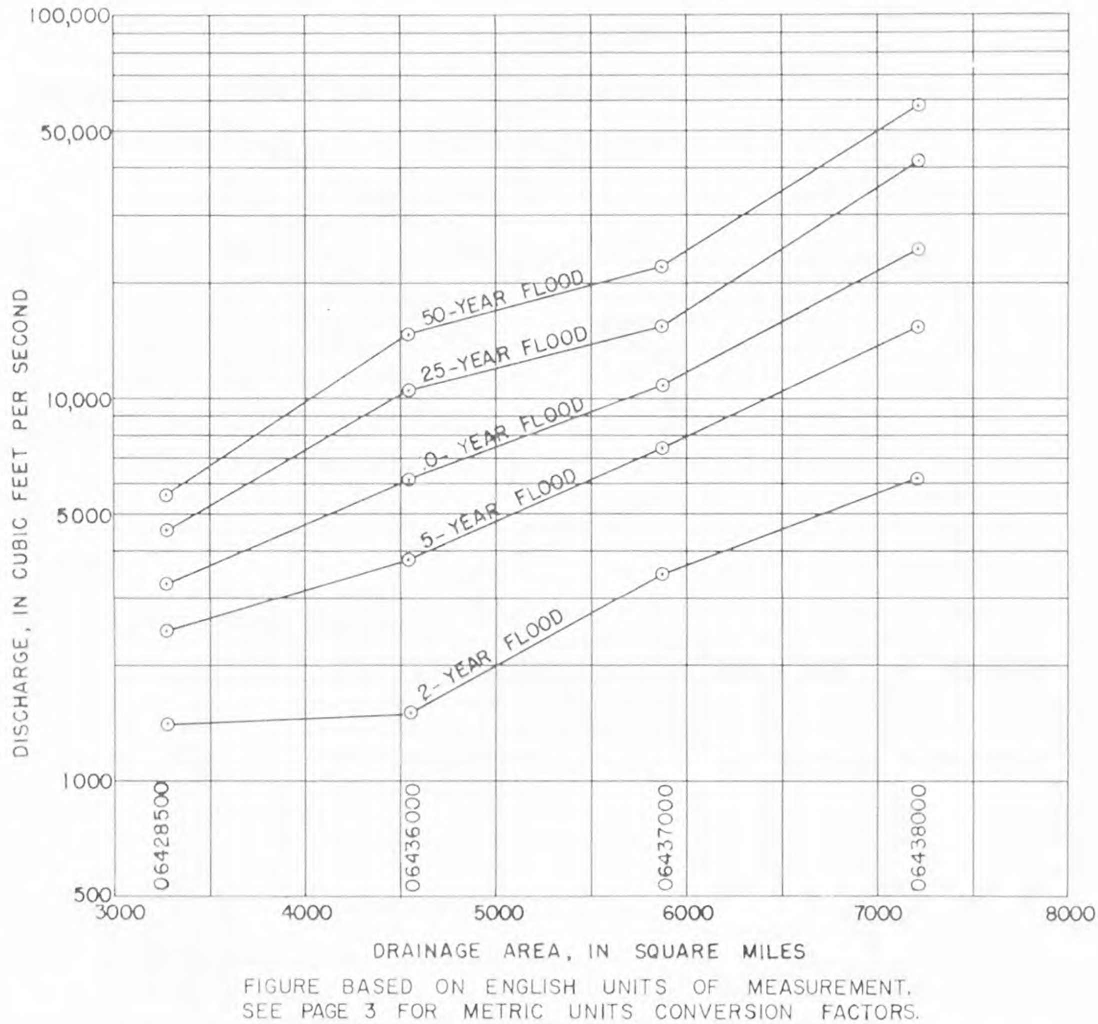

Figure 20.-- Flood frequency for Belle Fourche River downstream from Wyoming - South Dakota State line.

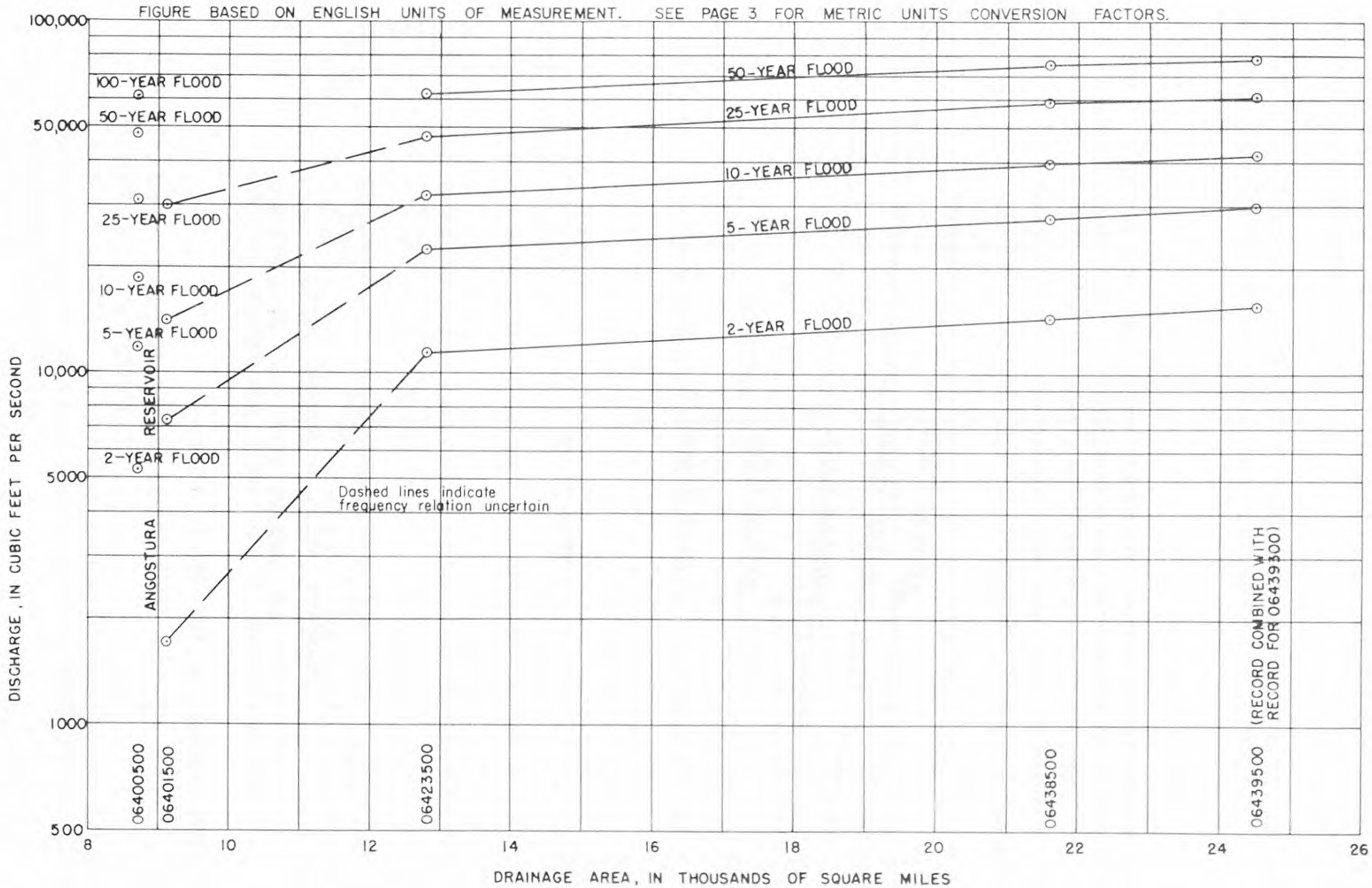

Figure 21.-- Flood frequency for Cheyenne River downstream from Angostura Reservoir.

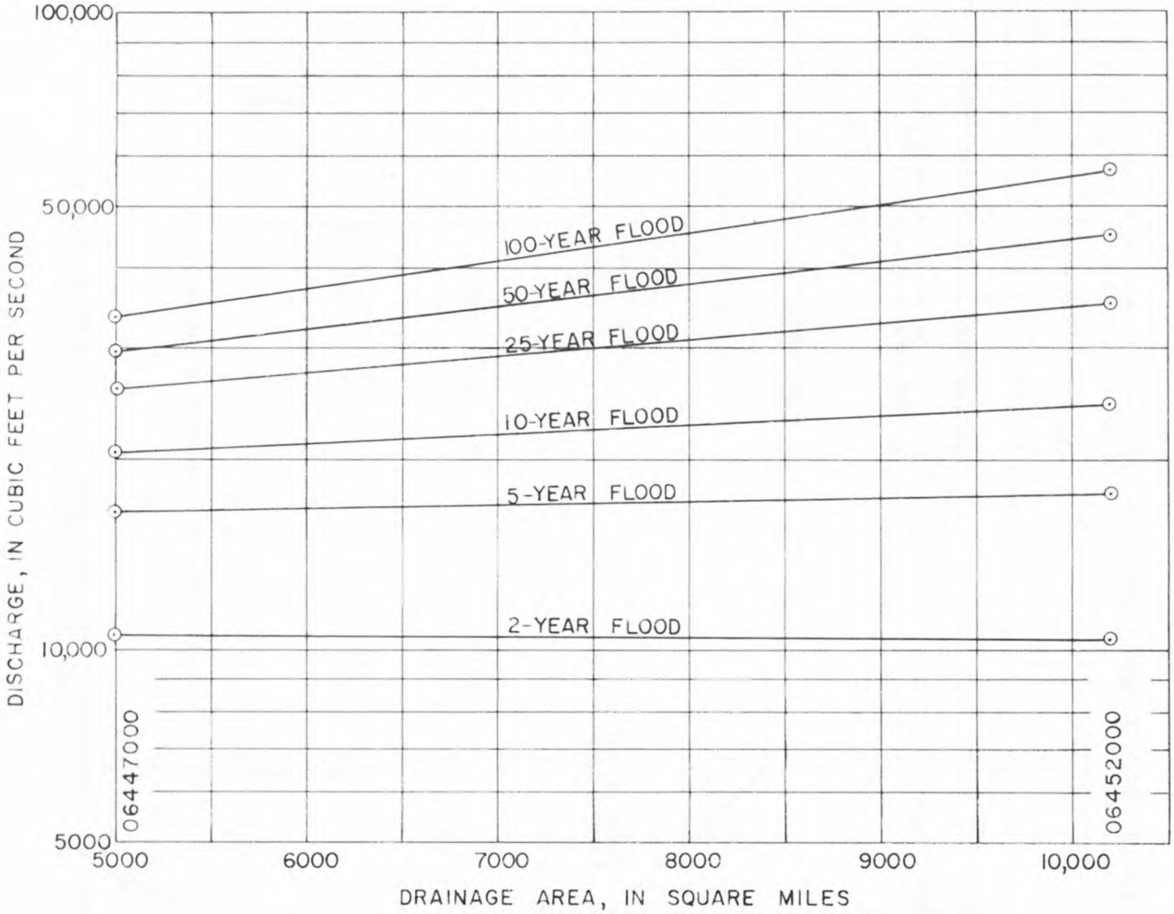

FIGURE BASED ON ENGLISH UNITS OF MEASUREMENT.
SEE PAGE 3 FOR METRIC UNITS CONVERSION FACTORS.

Figure 22.-- Flood-frequency for White River.

Illustrative Examples

To illustrate use of the estimating relations the following examples are given.

Example 1.--Estimate 25-year and 50-year floods on Sand Creek at a proposed highway crossing in Sanborn County.

Solution:

1) Search for gaging-station records (figure A-1 and table A-1). If flood-characteristics not found for desired site, use estimating relations.
2) Drainage basin located in Eastern Region, figure 1. Therefore, equations 1 through 6 and figures 3 through 8 are applicable.
3) Contributing drainage area determined as 300 sq mi; use A=300.
4) Mean annual precipitation for drainage basin determined as 18.8 inches using figure 2. Subtract 11 inches; use P=7.8.
5) Compute Q_{25} and Q_{50} by substitution in equations 4 and 5. If results are desired in metric units, multiply answers by 0.02832.

$$Q_{25} = 7.52(300)^{0.51}(7.8)^{1.54} = 3{,}260 \text{ cfs}$$

$$= 3{,}260(0.02832) = 92.3 \text{ cu m/s}$$

$$Q_{50} = 30.3(300)^{0.52}(7.8)^{1.09} = 5{,}520 \text{ cfs}$$

$$= 5{,}520(0.02832) = 156 \text{ cu m/s}$$

6) Results may be quickly verified from curves given in figures 6 and 7.

Example 2.--Determine data required to plot a flood-frequency curve for an ungaged site on a tributary of the Moreau River. Assume contributing drainage area is 500 sq mi and mean elevation of drainage basin is 3,000 feet.

Solution:

1) Western Region equations and curves apply, use figures 9 through 14.
2) Enter figures with drainage area, move to point of intersection with proper curve for mean elevation, and read discharge.

For A=500 and E=3.0;

from figure 9, Q_2=880 cfs (24.9 cu m/s),

from figure 10, Q_5= 2,650 cfs (75.0 cu m/s),

from figure 11, Q_{10}=4,400 cfs (125 cu m/s),

from figure 12, Q_{25}=7,400 cfs (210 cu m/s),

from figure 13, Q_{50}=11,400 cfs (323 cu m/s), and

from figure 14, Q_{100}=15,000 cfs (424 cu m/s).

3) Discharges would then be plotted versus respective recurrence intervals of 2, 5, 10, 25, 50, and 100 years on log-probability paper and a smooth curve drawn (plot not shown).

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APPENDIX

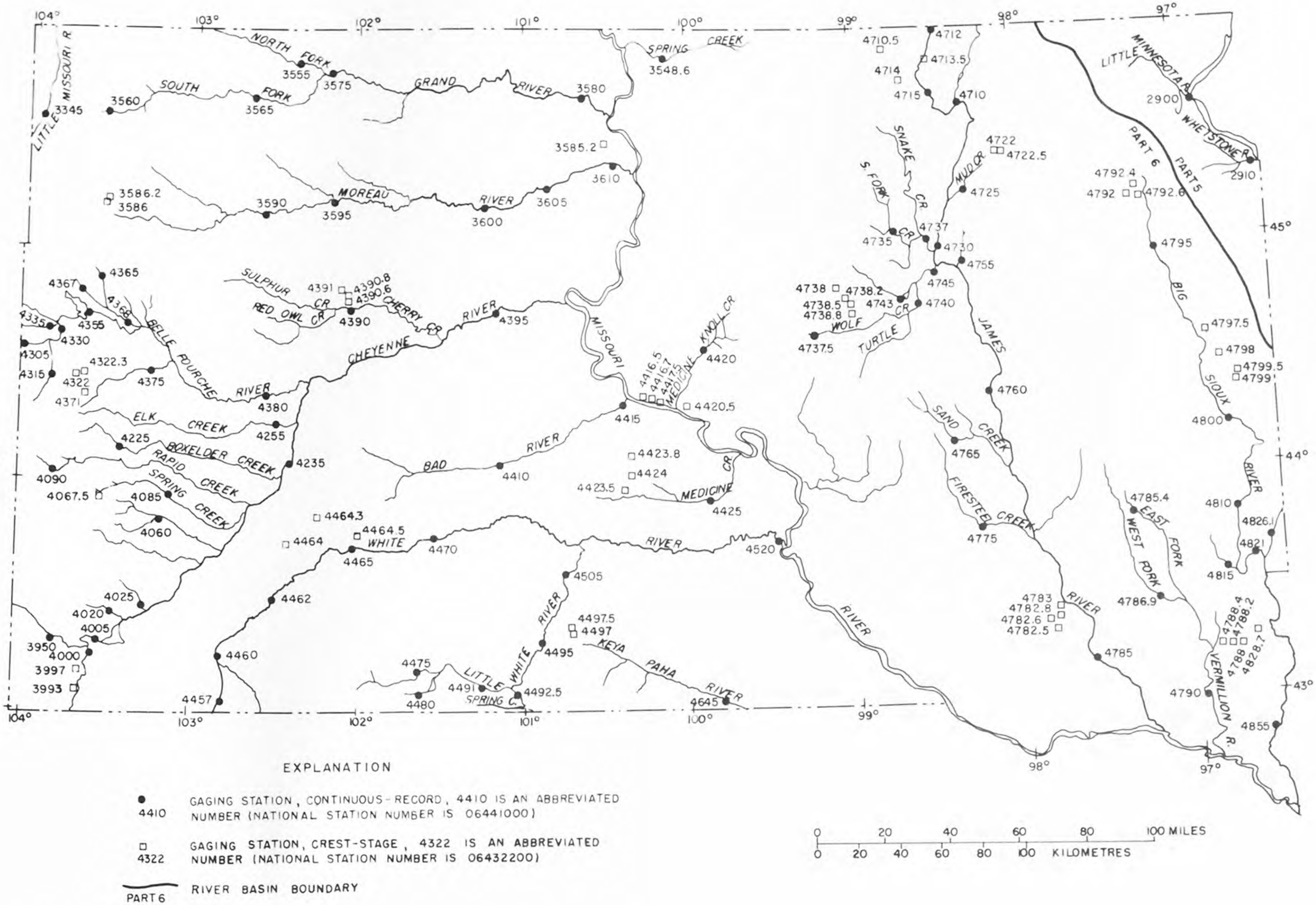

Figure A-1.-- Map of South Dakota showing location of gaging stations used in regression analyses.

Table A-1.--Drainage-basin and flood-frequency characteristics for selected gaging stations in South Dakota.

Station number and name	Basin characteristics			Flood characteristics					
	Drainage area (sq mi)	Mean basin elevation (ft)	Mean annual precipitation (in)	Discharge, in cfs, for indicated recurrence intervals					
				Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
05290000 Little Minnesota R nr Peever	447	1,100	21.5	807	2,000	3,150	5,050	6,780	8,800
05291000 Whetstone R nr Big Stone City	389	1,200	21.0	1,060	2,810	4,360	6,620	8,440	10,300
06334500 Little Missouri R at Camp Crook	1,970	3,700	15.2	2,690	4,320	5,580	7,360	--	--
06354860 Spring Cr nr Herreid	440	2,000	17.0	308	822	1,370	--	--	--
06355500 [a]North Fork Grand R nr White Butte	1,190	2,900	14.0	1,510	6,140	11,700	21,700	--	--
06356000 South Fork Grand R at Buffalo	148	3,000	12.0	734	1,490	2,030	2,720	--	--
06356500 South Fork Grand R nr Cash	1,350	2,800	12.7	1,670	4,250	7,350	13,800	21,400	32,100
06357500 Grand R at Shadehill	3,120	2,800	13.5	420	1,300	2,550	5,700	--	--
06357800 Grand R at Little Eagle	5,370	2,600	14.4	5,290	11,100	15,800	22,700	28,200	--
06358520 Deadman Cr trib nr Mobridge	.28	1,900	15.0	10	33	59	109	--	--

Table A-1.--Drainage-basin and flood-frequency characteristics for selected gaging stations in South Dakota.--cont.

Station number and name	Basin characteristics: Drainage area (sq mi)	Basin characteristics: Mean basin elevation (ft)	Basin characteristics: Mean annual precipitation (in)	Flood characteristics, discharge, in cfs, for indicated recurrence intervals: Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
06358600 South Fork Moreau R trib nr Redig	11.3	3,100	12.5	62	160	275	480	--	--
06358620 Sand Cr trib nr Redig	.06	3,100	12.5	21	37	49	65	--	--
06359000 Moreau R at Bixby	1,570	3,000	12.9	2,730	5,650	8,240	12,300	15,900	--
06359500 Moreau R nr Faith	2,660	2,900	13.2	3,650	8,850	14,400	24,600	35,100	48,600
06360000 Moreau R nr Eagle Butte	4,320	2,700	13.9	6,450	16,400	25,900	40,900	--	--
06360500 Moreau R nr Whitehorse	4,880	2,700	14.1	5,900	11,000	15,000	21,200	--	--
06361000 Moreau R at Promise	5,223	2,500	14.2	6,070	14,900	23,100	36,300	48,100	61,400
06395000 Cheyenne R at Edgemont	7,143	4,800	14.3	3,400	6,700	10,200	16,800	23,500	33,000
06399300 Hat Cr trib nr Ardmore	3.74	3,600	14.0	51	308	676	1,400	--	--

Table A-1.--Drainage-basin and flood-frequency characteristics for selected gaging stations in South Dakota.--cont.

Station number and name	Basin characteristics			Flood characteristics: Discharge, in cfs, for indicated recurrence intervals					
	Drainage area (sq mi)	Mean basin elevation (ft)	Mean annual precipitation (in)	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
06399700 Pine Cr nr Ardmore	5.47	3,500	14.0	820	1,450	1,900	2,500	--	--
06400000 Hat Cr nr Edgemont	1,044	3,900	14.0	1,140	3,160	5,550	10,400	15,800	--
06400500 Cheyenne R nr Hot Springs	8,710	4,700	14.3	5,300	11,800	18,500	30,800	47,500	60,100
06402000 Fall R at Hot Springs	137	4,400	16.5	414	1,880	4,730	14,000	--	--
06402500 Beaver Cr nr Buffalo Gap	130	4,300	16.5	122	690	1,900	5,600	10,200	14,200
06406000 Battle Cr at Hermosa	178	4,500	17.0	340	980	1,750	3,100	4,700	--
06406750 Sunday Gulch nr Hill City	5.72	6,100	18.0	11	40	76	151	--	--
06408500 Spring Cr nr Hermosa	199	4,900	17.4	45	308	788	2,040	3,690	--
06409000 Castle Cr abv Deerfield Reservoir nr Hill City	83.0	6,600	19.5	54	138	266	610	1,130	--

Table A-1.--Drainage-basin and flood-frequency characteristics for selected gaging stations in South Dakota.--cont.

Station number and name	Basin characteristics			Flood characteristics					
	Drainage area (sq mi)	Mean basin elevation (ft)	Mean annual precipitation (in)	Discharge, in cfs, for indicated recurrence intervals					
				Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
06422500 Boxelder Cr nr Nemo	96	5,400	19.0	279	772	--	--	--	--
06423500 Cheyenne R nr Wasta	12,800	4,400	15.0	11,500	22,500	32,000	47,000	62,000	--
06425500 Elk Cr nr Elm Springs	540	3,500	16.9	1,300	4,000	6,100	8,800	10,100	--
06428500 Belle Fourche R at Wyoming-South Dakota State line	3,280	4,700	15.5	1,400	2,450	3,250	4,500	5,600	--
06430500 Redwater Cr at Wyoming-South Dakota State line	471	5,000	20.0	258	712	1,220	2,190	3,210	--
06431500 Spearfish Cr at Spearfish	168	5,700	22.0	277	735	1,340	2,720	4,460	7,150
06432200 Polo Cr nr Whitewood	10.6	4,400	21.0	189	544	905	1,510	--	--
06432230 Miller Cr nr Whitewood	6.72	4,200	21.0	13	157	310	541	--	--
06433000 Redwater R abv Belle Fourche	920	4,800	20.0	706	1,910	3,630	7,910	13,800	23,600
06433500 Hay Cr at Belle Fourche	121	3,700	18.5	51	144	236	385	--	--

Table A-1.--Drainage-basin and flood-frequency characteristics for selected gaging stations in South Dakota.--cont.

Station number and name	Basin characteristics			Flood characteristics					
	Drainage area (sq mi)	Mean basin elev-ation (ft)	Mean annual precip-itation (in)	Discharge, in cfs, for indicated recurrence intervals					
				Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
06436000 Belle Fourche R nr Fruitdale	4,540	4,590	16.4	1,500	3,800	6,100	10,500	14,800	--
06436500 Horse Cr nr Newell	65	3,100	14.2	406	1,910	--	--	--	--
06436700 Indian Cr nr Arpan	315	3,300	14.2	887	2,150	2,890	--	--	--
06436800 Horse Cr nr Vale	530	3,100	14.2	1,090	2,020	2,660	--	--	--
06437000 Belle Fourche R nr Sturgis	5,870	4,300	16.1	3,500	7,400	10,800	15,300	22,000	--
06437100 Boulder Cr nr Deadwood	1.69	4,900	21.0	39	145	250	430	--	--
06437500 Bear Butte Cr nr Sturgis	192	4,200	17.8	422	1,660	3,420	7,370	12,500	19,400
06438000 Belle Fourche R nr Elm Springs	7,210	4,000	15.7	6,190	15,300	24,600	41,300	57,800	--
06438500 Cheyenne R nr Plainview	21,600	4,200	15.3	14,200	27,900	39,900	58,700	75,400	--
06439000 Cherry Cr nr Plainview	1,190	2,700	13.3	1,640	4,050	6,470	10,600	14,600	19,500

Table A-1.--Drainage-basin and flood-frequency characteristics for selected gaging stations in South Dakota.--cont.

Station number and name	Basin characteristics			Flood characteristics: Discharge, in cfs, for indicated recurrence intervals					
	Drainage area (sq mi)	Mean basin elevation (ft)	Mean annual precipitation (in)	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
06439060 Cherry Cr trib No. 2 nr Avance	.11	2,100	15.0	6.4	23	48	105	--	--
06439080 Cherry Cr trib No 3 nr Avance	4.58	2,400	15.0	69	436	995	2,150	--	--
06439100 Beaver Cr nr Faith	37.1	2,500	15.0	285	1,260	2,380	4,250	--	--
06439500 [a]Cheyenne R nr Eagle Butte	24,500	3,900	15.2	25,200	52,300	73,200	101,000	123,000	--
06441000 Bad R nr Midland	1,460	2,400	15.9	2,740	5,680	8,950	15,400	22,500	32,400
06441500 Bad R nr Fort Pierre	3,107	2,200	16.3	6,410	14,300	21,700	34,100	45,800	59,700
06441650 Mush Cr nr Pierre	14.6	1,700	16.5	699	2,160	3,510	5,490	--	--
06441670 Missouri R trib nr Pierre	.42	1,700	16.5	68	201	353	640	--	--
06441750 Missouri R trib nr Canning	.20	1,600	16.5	84	155	210	285	--	--

Table A-1.--Drainage-basin and flood-frequency characteristics for selected gaging stations in South Dakota.--cont.

Station number and name	Basin characteristics			Flood characteristics: Discharge, in cfs, for indicated recurrence intervals					
	Drainage area (sq mi)	Mean basin elevation (ft)	Mean annual precipitation (in)	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
06442000 Medicine Knoll Cr nr Blunt	455	1,800	17.4	88	510	1,300	3,620	7,050	--
06442050 Missour R trib nr DeGrey	1.64	1,500	16.0	233	589	886	1,300	--	--
06442350 North Fork Medicine Cr nr Vivian	45.9	2,100	17.0	107	321	567	1,020	--	--
06442380 Medicine Cr trib nr Vivian	.30	2,100	16.5	36	106	182	320	--	--
06442400 Medicine Cr trib No. 2 nr Vivian	8.62	2,000	17.0	111	233	331	470	--	--
06442500 Medicine Cr nr Kennebec	465	1,900	17.5	635	1,890	3,510	7,000	--	--
06445700 White R at Slim Butte	1,500	3,700	15.9	807	2,170	3,820	--	--	--
06446000 White R nr Oglala	2,200	3,500	15.9	1,050	1,940	2,710	3,900	4,950	6,160
06446200 White R nr Rockyford	3,000	3,400	15.9	3,600	6,600	9,470	--	--	--
06446400 Cain Cr trib at Imlay	14.0	2,800	15.5	807	1,610	2,260	3,230	--	--

Table A-1.--Drainage-basin and flood-frequency characteristics for selected gaging stations in South Dakota.--cont.

Station number and name	Basin characteristics			Flood characteristics: Discharge, in cfs, for indicated recurrence intervals					
	Drainage area (sq mi)	Mean basin elev-ation (ft)	Mean annual precip-itation (in)	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
06446430 White R trib nr Conata	.17	2,800	15.0	114	207	286	408	--	--
06446500 White R nr Interior	4,120	3,420	15.6	7,050	11,500	14,600	18,600	--	--
06446550 White R trib nr Interior	.14	2,400	15.5	177	332	440	575	--	--
06447000 White R nr Kadoka	5,000	3,100	15.9	10,600	16,600	20,600	25,800	29,700	33,600
06447500 Little White R nr Martin	310	3,300	16.0	205	500	834	--	--	--
06448000 Lake Cr abv refuge, nr Tuthill	58	3,100	16.0	80	117	137	--	--	--
06449100 Little White R nr Vetal	590	3,100	16.1	410	725	1,010	--	--	--
06449250 Spring Cr nr St. Francis	57	2,900	17.0	42	59	70	--	--	--
06449500 Little White R nr Rosebud	1,020	2,900	16.2	809	1,780	2,830	4,850	7,040	10,000

Table A-1.--Drainage-basin and flood-frequency characteristics for selected gaging stations in South Dakota.--cont.

Station number and name	Basin characteristics: Drainage area (sq mi)	Basin characteristics: Mean basin elevation (ft)	Basin characteristics: Mean annual precipitation (in)	Flood characteristics: Discharge, in cfs, for indicated recurrence intervals: Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
06449700 Little Oak Cr nr Mission	2.62	2,600	17.8	33	144	312	712	--	--
06449750 West Branch Horse Cr nr Mission	6.05	2,500	17.5	29	124	268	610	--	--
06450500 Little White R blw White River	1,570	2,700	16.3	2,030	4,660	7,550	13,100	19,200	27,300
06452000 White R nr Oacoma	10,200	2,600	17.0	10,400	17,800	24,400	35,200	45,100	57,000
06464500 Keya Paha R at Wewela	1,070	2,400	19.0	760	1,810	2,960	5,120	7,420	--
06464900 Keya Paha R nr Naper, Nebr.	1,630	2,390	19.5	2,520	4,730	6,600	9,430	--	--
06471000 James R at Columbia	4,050	1,500	17.4	527	1,630	2,720	4,440	5,940	--
06471050 Elm R trib nr Leola	14.7	1,700	18.0	62	177	308	559	--	--
06471200 Maple R at North Dakota-South Dakota State line	480	1,600	18.0	279	1,080	2,320	5,340	--	--

Table A-1.--Drainage-basin and flood-frequency characteristics for selected gaging stations in South Dakota.--cont.

Station number and name	Basin characteristics			Flood characteristics: Discharge, in cfs, for indicated recurrence intervals					
	Drainage area (sq mi)	Mean basin elevation (ft)	Mean annual precipitation (in)	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
06471350 Maple R at Frederick	552	1,600	18.0	272	1,230	2,790	6,790	--	--
06471400 Willow Cr trib nr Leola	3.74	1,500	18.0	16	38	68	134	--	--
06471500 Elm R at Westport	1,170	1,600	18.0	755	2,730	5,140	9,770	14,500	20,600
06472200 Mud Cr trib nr Groton	41.0	1,500	20.0	50	188	328	--	--	--
06472250 Mud Cr trib No. 2 nr Groton	60.0	1,500	20.0	55	172	295	--	--	--
06472500 Mud Cr nr Stratford	460	1,400	20.0	59	293	652	1,480	--	--
06473000 James R at Ashton	6,810	1,500	18.2	560	1,600	2,800	4,900	7,500	--
06473500 South Fork Snake Cr nr Athol	1,090	1,600	17.4	91	603	1,650	4,790	9,790	--
06473700 Snake Cr nr Ashton	1,770	1,600	17.6	134	788	1,940	4,910	--	--

Table A-1.--Drainage-basin and flood-frequency characteristics for selected gaging stations in South Dakota.--cont.

Station number and name	Basin characteristics			Flood characteristics: Discharge, in cfs, for indicated recurrence intervals					
	Drainage area (sq mi)	Mean basin elevation (ft)	Mean annual precipitation (in)	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
06473750 Wolf Cr nr Ree Heights	265	1,700	17.0	30	226	641	--	--	--
06473800 Matter Cr trib nr Orient	5.41	1,600	17.6	15	102	245	564	--	--
06473820 Shaefer Cr nr Orient	45.1	1,600	17.5	82	334	694	1,490	--	--
06473850 Shaefer Cr trib nr Orient	6.08	1,500	17.5	37	117	190	295	--	--
06473880 Shaefer Cr trib nr Miller	5.75	1,500	17.5	17	65	130	266	--	--
06474000 Turtle Cr nr Tulare	1,120	1,600	17.5	101	846	2,820	--	--	--
06474300 Medicine Cr nr Zell	210	1,500	18.0	166	642	1,280	--	--	--
06474500 Turtle Cr at Redfield	1,540	1,600	17.5	190	1,090	2,780	7,710	15,000	27,600
06475500 Dry Run nr Frankfort	225	1,300	19.3	14	110	302	806	--	--

Table A-1.--Drainage-basin and flood-frequency characteristics for selected gaging stations in South Dakota.--cont.

Station number and name	Basin characteristics			Flood characteristics: Discharge, in cfs, for indicated recurrence intervals					
	Drainage area (sq mi)	Mean basin elevation (ft)	Mean annual precipitation (in)	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
06476000 James R at Huron	12,010	1,500	17.8	1,370	3,260	4,900	7,330	9,350	--
06476500 Sand Cr nr Alpena	240	1,500	18.7	435	1,260	1,790	2,280	--	--
06477500 Firesteel Cr nr Mount Vernon	540	1,500	20.3	426	2,150	4,150	7,390	--	--
06478250 North Branch Dry Cr trib nr Parkston	3.19	1,400	21.5	23	130	274	--	--	--
06478260 North Branch Dry Cr nr Parkston	37.0	1,400	21.5	109	578	1,290	2,870	--	--
06478280 South Branch Dry Cr nr Parkston	17.1	1,400	21.5	93	304	559	1,050	--	--
06478300 Dry Cr nr Parkston	76.8	1,400	21.5	197	724	1,540	3,680	--	--
06478500 James R nr Scotland	16,760	1,500	19.3	1,990	4,670	7,290	11,700	15,840	--
06478690 West Fork Vermillion R nr Parker	370	1,500	22.6	557	1,920	3,660	--	--	--

Table A-1.--Drainage-basin and flood-frequency characteristics for selected gaging stations in South Dakota.--cont.

Station number and name	Basin characteristics			Flood characteristics: Discharge, in cfs, for indicated recurrence intervals					
	Drainage area (sq mi)	Mean basin elevation (ft)	Mean annual precipitation (in)	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
06478800 Saddlerock Cr nr Canton	14.8	1,400	25.0	84	309	626	1,350	--	--
06478820 Saddlerock Cr trib nr Beresford	2.32	1,400	25.0	16	49	78	121	--	--
06478840 Saddlerock Cr nr Beresford	26.3	1,400	25.0	46	237	638	2,040	--	--
06479000 Vermillion R nr Wakonda	1,680	1,500	23.2	1,550	3,730	5,690	8,700	11,300	14,100
06479200 Big Sioux R nr Ortley	53.8	1,800	21.5	136	391	674	--	--	--
06479240 Big Sioux R trib No. 2 nr Summit	.26	1,900	21.5	9.5	27	44	74	--	--
06479260 Big Sioux R trib No. 3 nr Summit	6.60	2,000	21.5	145	447	704	1,040	--	--
06479500 Big Sioux R at Watertown	400	1,800	21.4	340	934	1,360	1,840	2,140	2,380
06479750 Peg Munky Run nr Estelline	25.4	1,800	21.5	364	874	1,350	2,090	--	--

Table A-1.--Drainage-basin and flood-frequency characteristics for selected gaging stations in South Dakota.--cont.

Station number and name	Basin characteristics			Flood characteristics					
	Drainage area (sq mi)	Mean basin elev-ation (ft)	Mean annual precip-itation (in)	Discharge, in cfs, for indicated recurrence intervals					
				Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
06479800 North Deer Cr nr Estelline	48.3	1,800	20.0	173	772	1,720	4,100	--	--
06479900 Sixmile Cr trib nr Brookings	9.42	1,800	20.0	146	571	1,060	1,910	--	--
06479950 Deer Cr nr Brookings	4.21	1,800	20.0	85	311	517	795	--	--
06480000 Big Sioux R nr Brookings	2,450	1,800	21.4	1,980	6,540	12,300	24,300	--	--
06481000 Big Sioux R nr Dell Rapids	3,090	1,800	21.7	2,970	9,120	16,600	31,800	48,600	--
06481500 Skunk Cr nr Sioux Falls	520	1,600	23.9	1,430	4,410	8,330	17,000	27,600	--
06482100 Big Sioux R nr Brandon	3,840	1,700	22.2	3,450	8,620	14,200	24,800	35,900	50,500
06482870 Little Beaver Cr trib nr Canton	.22	1,400	25.5	14	24	44	61	--	--
06485500 Big Sioux R at Akron, Ia.	7,060	1,600	23.7	10,300	23,000	33,300	47,900	59,400	71,300

a Flood characteristics based on unregulated period.

Table A-2.--Maximum observed discharges at selected continuous-record gaging stations in South Dakota.

Station number	Station name	Contributing drainage area (sq mi)	Period of record, water years	Peak discharge Date	Peak discharge cfs	Peak discharge cfs per sq mi
	Little Minnesota River basin					
05290000	Little Minnesota R nr Peever	447	1940-72	4- 8-52	4,730	10.6
05290500	Whetstone R nr Corona	170	1953-57	5-21-57	1,140	6.71
05291000	Whetstone R nr Big Stone City	389	1910-12 1931-72	4- 8-69	6,870	17.7
	Little Missouri River basin					
06334500	Little Missouri R at Camp Crook	1,970	1956-72	5-28-62	7,600	3.86
	Spring Creek basin					
06354860	Spring Cr nr Herreid	220	1963-72	3-17-66	1,160	5.27
06354880	Spring Cr nr Pollock	1,310	1960-62	4- 2-60	606	.46
	Grand River basin					
06355500	North Fork Grand R nr White Butte	1,190	1946-72	4-16-50	30,900	26.0
06356000	South Fork Grand R at Buffalo	148	1956-72	6-14-63	2,780	18.8
06356500	South Fork Grand R nr Cash	1,350	1946-72	4-15-50	27,000	20.0
06357500	Grand R at Shadehill	3,120	1943-72	4-16-50	58,000	18.6

Table A-2.--Maximum observed discharges at selected continuous-record gaging stations in South Dakota.--cont.

Station number	Station name	Contributing drainage area (sq mi)	Period of record, water years	Peak discharge Date	Peak discharge cfs	Peak discharge cfs per sq mi
	Grand River basin - cont.					
06357800	Grand R at Little Eagle	5,370	1959-72	3-12-72	15,000	2.79
06358000	Grand River near Wakpala	5,510	1914-16, 1929-64	4-18-50	82,200	14.9
	Moreau River basin					
06359000	Moreau R at Bixby	1,570	1948-72	4- 1-52	15,300	9.75
06359500	Moreau River nr Faith	2,660	1944-72	4- 9-44	26,000	9.77
06360000	Moreau R nr Eagle Butte	4,320	1944-58	6-15-53	30,300	7.01
06360500	Moreau R nr Whitehorse	4,880	1955-72	3-14-72	21,000	4.30
06361000	Moreau R at Promise	5,223	1929-58	4- 5-52	36,900	7.06
	Cheyenne River basin					
06395000	Cheyenne R at Edgemont	7,143	1905, 1929-32, 1947-72	5-25-71	13,800	1.93
06400000	Hat Cr nr Edgemont	1,044	1905, 1951-72	6-16-67	13,300	12.7
06400500	Cheyenne River nr Hot Springs	8,710	1915-20, 1943-72	5-12-20	114,000	13.1

Table A-2.--Maximum observed discharges at selected continuous-record gaging stations in South Dakota.--cont.

Station number	Station name	Contributing drainage area (sq mi)	Period of record, water years	Peak discharge Date	Peak discharge cfs	Peak discharge cfs per sq mi
	Cheyenne River basin - cont.					
06401500	Cheyenne R blw Angostura Dam	9,100	1946-72	6-18-62	24,300	2.67
06402000	Fall R at Hot Springs	137	1938-72	9- 4-38	13,100	95.6
06402500	Beaver Cr nr Buffalo Gap	130	1938-72	9- 4-38	11,700	90.0
06402600	Cheyenne R nr Buffalo Gap	9,810	1969-72	5-25-71	17,600	1.79
06404000	Battle Cr nr Keystone	66	1946-47, 1962-72	6- 9-72	26,200	397
06405000	Grace Coolidge Cr nr Custer	25.3	1946-47, 1967-72	6-10-72	709	28.0
06406000	Battle Cr at Hermosa	178	1950-72	6-10-72	21,400	120
06408500	Spring Cr nr Hermosa	199	1950-72	6-10-72	13,400	67.3
06409000	Castle Cr abv Deerfield Reservoir, nr Hill City	83	1949-72	5-22-52	1,120	13.5
06410000	Castle Cr blw Deerfield Dam	96	1947-72	5-22-52	200	2.08
06410500	Rapid Cr abv Pactola Reservoir, at Silver City	292	1954-72	5-15-65	2,060	7.05
06411500	Rapid Cr blw Pactola Dam	320	1929-32, 1947-72	5-22-52	2,170	6.78

Table A-2.--Maximum observed discharges at selected continuous-record gaging stations in South Dakota.--cont.

Station number	Station name	Contributing drainage area (sq mi)	Period of record, water years	Peak discharge Date	Peak discharge cfs	Peak discharge cfs per sq mi
	Cheyenne River basin - cont.					
06412500	Rapid Cr abv Canyon Lake, nr Rapid City	371	1947-72	6- 9-72	a31,200	b600
06414000	Rapid Cr at Rapid City	410	1905-06, 1943-72	6- 9-72	a50,000	c549
06421500	Rapid Cr nr Farmingdale	602	1947-72	6-10-72	a7,320	d25.9
06422500	Boxelder Cr nr Nemo	96	1946-47, 1966-72	6- 9-72	30,100	314
06423500	Cheyenne R nr Wasta	12,800	1915, 1929-32, 1934-72	5- 6-32	46,300	3.62
06425500	Elk Cr nr Elm Springs	540	1950-72	3-29-52	8,540	15.8
06428500	Belle Fourche R at Wyoming-South Dakota State line	3,280	1947-72	6-18-62	4,400	1.34
06430500	Redwater Cr at Wyoming-South Dakota State line	471	1929-31, 1936-37, 1955-72	6-16-62	2,340	4.97
06431500	Spearfish Cr at Spearfish	168	1947-72	5-15-65	4,240	25.2
06433000	Redwater Cr abv Belle Fourche	920	1946-72	6-16-62	16,400	17.8

Table A-2.--Maximum observed discharges at selected continuous-record gaging stations in South Dakota.--cont.

Station number	Station name	Contributing drainage area (sq mi)	Period of record, water years	Peak discharge Date	Peak discharge cfs	Peak discharge cfs per sq mi
	Cheyenne River basin - cont.					
06433500	Hay Cr at Belle Fourche	121	1954-72	6-19-72	930	7.69
06435500	Belle Fourche R nr Belle Fourche	4,310	1924, 1927-43	4- 9-24	22,400	5.20
06436000	Belle Fourche R nr Fruitdale	4,540	1946-72	5-15-65	8,100	1.78
06436500	Horse Cr nr Newell	67	1962-69	5-25-65	3,070	45.8
06436700	Indian Cr nr Arpan	315	1962-72	5- 8-67	2,690	8.54
06436800	Horse Cr nr Vale	530	1962-72	5-26-65	2,380	4.49
06437000	Belle Fourche R nr Sturgis	5,870	1946-72	5-24-46	17,900	3.05
06437200	Bear Butte Cr nr Galena	47.6	1966-69	6-13-67	1,000	21.0
06437500	Bear Butte Cr nr Sturgis	192	1946-72	6-16-62	12,700	66.1
06438000	Belle Fourche R nr Elm Springs	7,210	1929-32, 1934-72	6- 8-64	45,100	6.26
06438500	Cheyenne R nr Plainview	21,600	1951-72	5-26-57	41,700	1.93
06439000	Cherry Cr nr Plainview	1,190	1946-72	4- 1-52	17,500	14.7
06439300	Cheyenne R at Cherry Creek	23,900	1961-72	6-16-67	43,800	1.83

Table A-2.--Maximum observed discharges at selected continuous-record gaging stations in South Dakota.--cont.

Station number	Station name	Contributing drainage area (sq mi)	Period of record, water years	Peak discharge Date	cfs	cfs per sq mi
	Cheyenne River basin - cont.					
06439500	Cheyenne R nr Eagle Butte	24,500	1929-67	5-24-33	104,000	4.24
	Bad River basin					
06440500	North Fork Bad R at Philip	164	1939-44	6- 4-42	1,640	10.0
06441000	Bad R nr Midland	1,460	1946-72	6-15-67	29,400	20.1
06441500	Bad R nr Fort Pierre	3,107	1929-72	6-18-67	43,800	14.1
	Medicine Knoll Creek basin					
06442000	Medicine Knoll Cr nr Blunt	455	1950-72	4- 5-52	1,830	4.02
	Medicine Creek basin					
06442500	Medicine Cr at Kennebec	465	1955-72	3-28-60	8,970	19.3
	White River basin					
06445700	White R at Slim Butte	1,500	1962-72	6-16-67	9,240	6.16
06445980	White Clay Cr nr Oglala	340	1966-72	6-16-67	659	1.94
06446000	White R nr Oglala	2,200	1944-72	6-21-47	5,200	2.36
06446200	White R nr Rockyford	3,000	1965-72	6-17-67	11,800	3.93

Table A-2.--Maximum observed discharges at selected continuous-record gaging stations in South Dakota.--cont.

Station number	Station name	Contributing drainage area (sq mi)	Period of record, water years	Peak discharge		
				Date	cfs	cfs per sq mi
	White River basin - cont.					
06446500	White R nr Interior	4,120	1905-06, 1912-18, 1929-32, 1940-42	5- 1-42	17,100	4.15
06447000	White R nr Kadoka	5,000	1942-72	6- 4-42	32,000	4.34
06447500	Little White R nr Martin	310	1938-40, 1963-72	7-19-65	1,190	3.84
06448000	Lake Cr abv refuge, nr Tuthill	58	1938-40, 1963-72	3- 9-66	154	2.66
06449000	Lake Cr blw refuge, nr Tuthill	120	1938-40, 1963-72	6-18-67	178	1.48
06449100	Little White R nr Vetal	590	1960-72	3-13-66	1,330	2.25
06449250	Spring Cr nr St. Francis	57	1960-72	6-21-62	65	1.14
06449500	Little White R nr Rosebud	1,020	1944-72	6-11-67	4,640	4.55
06450500	Little White R blw White River	1,570	1950-72	6-12-67	13,700	8.73
06451500	White R at Westover	7,850	1913-18	4- 4-15	15,200	1.94
06452000	White R nr Oacoma	10,200	1929-72	3-30-52	51,900	5.09

Table A-2.--Maximum observed discharges at selected continuous-record gaging stations in South Dakota.--cont.

Station number	Station name	Contributing drainage area (sq mi)	Period of record, water years	Peak discharge: Date	Peak discharge: cfs	Peak discharge: cfs per sq mi
	Niobrara River basin					
06464000	Keya Paha R nr Hidden Timber	320	1948-53	3-30-52	2,710	8.47
06464500	Keya Paha R at Wewela	1,070	1939-40, 1950-72	3-31-52	5,430	5.07
	James River basin					
06471000	James R at Columbia	4,050	1946-72	5-24-50	5,420	1.34
06471200	Maple R at North Dakota-South Dakota State line	480	1957-72	4-11-69	5,930	12.4
06471500	Elm R at Westport	1,170	1947-72	4-10-69	12,600	10.8
06472000	James R nr Stratford	6,070	1950-72	5-14-50	5,580	.92
06472500	Mud Cr nr Stratford	470	1956-72	4-10-69	1,180	2.51
06473000	James R at Ashton	6,810	1946-72	4-24-69	5,680	.83
06473500	South Fork Snake Cr nr Athol	1,090	1950-72	4- 7-69	6,810	6.25
06473700	Snake Cr nr Ashton	1,770	1956-72	4-10-69	6,980	3.94
06473750	Wolf Cr nr Ree Heights	265	1960-72	4- 5-69	990	3.74
06474000	Turtle Cr nr Tulare	1,120	1954-56, 1966-72	4- 5-69	6,000	5.36
06474300	Medicine Cr nr Zell	210	1960-72	4- 5-69	2,210	10.5

Table A-2.--Maximum observed discharges at selected continuous-record gaging stations in South Dakota.--cont.

Station number	Station name	Contributing drainage area (sq mi)	Period of record, water years	Peak discharge		
				Date	cfs	cfs per sq mi
	James River basin - cont.					
06474500	Turtle Cr at Redfield	1,540	1946-72	4- 7-69	7,660	4.97
06475000	James R nr Redfield	10,200	1950-72	4-13-69	7,310	.72
06475500	Dry Run nr Frankfort	225	1956-72	3-29-62	772	3.43
06476000	James R at Huron	12,010	1929-32, 1944-72	4-13-69	9,000	.75
06476500	Sand Cr nr Alpena	240	1950-72	3-28-60	2,240	9.33
06477000	James R nr Forestburg	13,810	1950-72	4- 9-69	12,500	.90
06477150	Rock Cr nr Fulton	270	1967-72	4- 7-69	2,040	7.56
06477500	Firesteel Cr nr Mount Vernon	540	1956-72	4- 4-69	6,610	12.2
06478000	James R nr Mitchell	15,010	1954-58, 1966-72	4-11-69	13,800	.92
06478500	James R nr Scotland	16,760	1929-72	4- 3-62	15,200	.91
	Vermillion River basin					
06478540	Little Vermillion R nr Salem	51.0	1967-72	4- 7-69	596	11.7
06478690	West Fork Vermillion R nr Parker	370	1962-72	3-28-62	4,340	11.7
06479000	Vermillion R nr Wakonda	1,680	1946-72	4- 8-69	9,880	5.88

Table A-2.--Maximum observed discharges at selected continuous-record gaging stations in South Dakota.--cont.

Station number	Station name	Contributing drainage area (sq mi)	Period of record, water years	Peak discharge		
				Date	cfs	cfs per sq mi
	Big Sioux River basin					
06479500	Big Sioux R at Watertown	400	1946-72	4- 9-52	2,220	5.55
06479529	Stray Horse Cr nr Castlewood	73.7	1969-72	4- 7-69	14,000	190
06479640	Hidewood Cr nr Estelline	164	1969-72	4- 7-69	3,630	22.1
06480000	Big Sioux R nr Brookings	2,450	1954-72	4- 9-69	33,900	13.8
06480500	Big Sioux R nr Flandreau	2,610	1929-32	3-15-29	5,200	1.99
06481000	Big Sioux R nr Dell Rapids	3,090	1949-72	4- 9-69	41,300	13.4
06481500	Skunk Cr nr Sioux Falls	520	1949-72	6-17-57	29,400	56.5
06482000	Big Sioux R at Sioux Falls	3,780	1944-60	6-17-57	16,200	4.29
06482020	Big Sioux R at North Cliff Ave., at Sioux Falls	3,800	1969, 1972	4-10-69	40,700	10.7
06482100	Big Sioux R nr Brandon	3,840	1960-72	4-10-69	36,800	9.58
06482610	Split Rock Cr at Corson	475	1966-72	4- 8-69	17,800	37.5
06485500	Big Sioux R at Akron, Ia.	7,060	1929-72	4- 9-69	80,800	11.4

a None of drainage area above Pactola Reservoir (319 sq mi) contributed to flood.
b Based on contributing drainage area of 52 sq mi.
c Based on contributing drainage area of 91 sq mi.
d Based on contributing drainage area of 283 sq mi.

Table A-3.--Maximum observed discharges at selected crest-stage gages in South Dakota.

Station number	Station name	Contributing drainage area (sq mi)	Period of record, water years	Peak discharge		
				Date	cfs	cfs per sq mi
	Minnesota River basin					
05289950	Little Minnesota R trib at Sisseton	4.0	1970-72	6-29-71	228	57.0
05292600	North Fork Yellow Bank R trib nr Stockholm	7.0	1970-72	6-29-71	510	72.9
	Deadman Creek basin					
06358520	Deadman Cr trib nr Mobridge	.28	1956-72	6-17-64	180	643
	Moreau River basin					
06358550	Battle Cr trib nr Castle Rock	1.0	1969-72	6-25-72	536	536
06358600	South Fork Moreau R trib nr Redig	11.3	1956-72	7- 8-69	450	39.8
06358620	Sand Cr trib nr Redig	.06	1956-72	7- 8-69	64	107
	Cheyenne River basin					
06396200	Fiddle Cr nr Edgemont	1.97	1956-72	8- 4-61	68	34.5
06396300	Cottonwood Cr trib nr Edgemont	.20	1956-72	7-19-65	86	430
06396350	Red Canyon Cr trib nr Pringle	.2	1970-72	5- 3-71	30	150
06399300	Hat Cr trib nr Ardmore	3.74	1956-72	3-16-63	510	136

Table A-3.--Maximum observed discharges at selected crest-stage gages in South Dakota.--cont.

Station number	Station name	Contributing drainage area (sq mi)	Period of record, water years	Peak discharge		
				Date	cfs	cfs per sq mi
	Cheyenne River basin - cont.					
06399700	Pine Cr nr Ardmore	5.47	1956-72	6- 9-68	1,550	283
06403800	Battle Cr trib nr Keystone	.88	1956-71	6- 9-72	1,330	1,510
06406750	Sunday Gulch nr Hill City	5.72	1956-69	7-19-65	170	29.7
06406900	Palmer Cr nr Hill City	8.24	1956-72	6- 9-72	4,370	530
06406950	Horse Cr at Highway 385, nr Hill City	10.1	1972	6- 9-72	1,830	181
06422395	Boxelder Cr at Benchmark, nr Nemo	37.2	1972	6- 9-72	1,180	31.7
06422400	Estes Cr nr Nemo	6.15	1969-72	6- 9-72	6,620	1,080
06432200	Polo Cr nr Whitewood	10.6	1956-72	4-14-67	1,700	160
06432230	Miller Cr nr Whitewood	6.72	1956-67	5-14-65	330	49.1
06432250	Polo Cr trib nr Whitewood	.06	1956-67	6-15-62	137	2,280
06437100	Boulder Cr nr Deadwood	1.69	1956-72	6-15-62	210	124
06439050	Cherry Cr trib nr Avance	.60	1956-72	6-13-67	275	458
06439060	Cherry Cr trib No. 2 nr Avance	.11	1956-72	5-21-62	119	1,080
06439080	Cherry Cr trib No. 3 nr Avance	4.58	1956-72	5-21-62	2,280	498
06439100	Beaver Cr nr Faith	37.1	1956-72	6- 2-65	5,000	135

Table A-3.--Maximum observed discharges at selected crest-stage gages in South Dakota.--cont.

Station number	Station name	Contributing drainage area (sq mi)	Period of record, water years	Peak discharge: Date	Peak discharge: cfs	Peak discharge: cfs per sq mi
	Bad River basin					
06441200	Powell Cr trib nr Fort Pierre	.4	1970-72	8-10-70	211	528
	Hilgers Gulch basin					
06441530	Hilgers Gulch trib nr Pierre	1.25	1968-72	6- 9-71	244	195
06441580	Hilgers Gulch at Pierre	7.0	1967-72	6-18-67	1,320	189
	Mush Creek basin					
06441650	Mush Cr nr Pierre	14.6	1956-72	8-10-56	3,620	248
	Unnamed Missouri River tributaries					
06441670	Missouri R trib nr Pierre	.42	1956-72	8-10-56	705	1,680
06441750	Missouri R trib nr Canning	.20	1956-72	5-18-60	284	1,420
06442050	Missouri R trib nr DeGrey	1.64	1956-72	8- 7-56	976	595
	Medicine Creek basin					
06442350	North Fork Medicine Cr nr Vivian	45.9	1956-72	4- 3-60	1,080	23.5
06442380	Medicine Cr trib nr Vivian	.30	1956-72	6-15-62	302	1,010
06442400	Medicine Cr trib No. 2 nr Vivian	8.62	1956-72	3-26-60	475	55.1

Table A-3.--Maximum observed discharges at selected crest-stage gages in South Dakota.--cont.

Station number	Station name	Contributing drainage area (sq mi)	Period of record, water years	Peak discharge		
				Date	cfs	cfs per sq mi
	White River basin					
06446250	Porcupine Cr trib nr Rockyford	1.66	1968, 1970-72	6- -68	500	301
06446300	Big Hollow Cr trib nr Scenic	2.67	1968, 1970-72	7-24-72	939	352
06446400	Cain Cr trib at Imlay	14.0	1956-72	6-15-62	3,300	236
06446430	White R trib nr Conata	.17	1956-72	6-17-64	329	1,940
06446550	White R trib nr Interior	.14	1956-72	6- 8-64	558	3,990
06449700	Little Oak Cr nr Mission	2.62	1956-71	6- -62	646	247
06449750	West Branch Horse Cr nr Mission	6.05	1956-70	6- 7-68	548	90.6
	Choteau Creek basin					
06453150	Choteau Cr trib nr Tripp	.3	1970-72	5-22-72	177	590
	James River basin					
06471050	Elm R trib nr Leola	14.7	1956-72	4- 8-69	720	49.0
06471350	Maple R at Fredrick	552	1956-69	4-11-69	6,000	10.9
06471400	Willow Cr trib nr Leola	3.74	1956-72	4- 9-69	260	69.5
06471450	Willow Cr trib nr Barnard	.18	1956-72	4- 9-69	78	433

Table A-3.--Maximum observed discharges at selected crest-stage gages in South Dakota.--cont.

Station number	Station name	Contributing drainage area (sq mi)	Period of record, water years	Peak discharge		
				Date	cfs	cfs per sq mi
	James River basin - cont.					
06472200	Mud Cr trib nr Groton	41.0	1960-69	4- 8-69	250	6.10
06472250	Mud Cr trib No. 2 nr Groton	60.0	1960-72	4- 8-69	310	5.17
06473800	Matter Cr trib nr Orient	5.41	1956-71	4- 3-69	410	75.8
06473820	Shaefer Cr nr Orient	45.1	1956-72	4- 3-69	1,280	28.4
06473850	Shaefer Cr trib nr Orient	6.08	1956-72	4- 3-69	350	57.6
06473880	Shaefer Cr trib nr Miller	5.75	1956-72	4- 3-69	265	46.1
06475550	Dry Run trib nr Frankfort	4.5	1967-72	6- -67	135	30.0
06478200	Coffee Cr trib nr Parkston	.5	1968-72	4- 3-69	62	124
06478250	North Branch Dry Cr trib nr Parkston	3.19	1956-67	3-27-60	340	107
06478260	North Branch Dry Cr nr Parkston	37.0	1956-72	4- 8-69	3,200	86.5
06478280	South Branch Dry Cr nr Parkston	17.1	1956-72	7-14-62	750	43.9
06478300	Dry Cr nr Parkston	76.8	1956-72	3-27-60	4,210	54.8
	Vermillion River basin					
06478800	Saddlerock Cr nr Canton	14.8	1956-72	6-12-65	945	63.9
06478820	Saddlerock Cr trib nr Beresford	2.32	1956-70	6-12-65	97	41.8

Table A-3.--Maximum observed discharges at selected crest-stage gages in South Dakota.--cont.

Station number	Station name	Contributing drainage area (sq mi)	Period of record, water years	Peak discharge		
				Date	cfs	cfs per sq mi
	Vermillion River basin - cont.					
06478840	Saddlerock Cr nr Beresford	26.3	1956-72	6-12-65	1,480	56.3
06478950	Ash Cr nr Beresford	5.1	1969-72	6- 6-71	1,050	206
	Big Sioux River basin					
06479200	Big Sioux R nr Ortley	53.8	1956-68	7- 1-62	a950	17.7
06479240	Big Sioux R trib No. 2 nr Summit	.26	1956-72	7- 1-62	53	204
06479260	Big Sioux R trib No. 3 nr Summit	6.60	1956-72	7- 1-62	1,050	159
06479750	Peg Munky Run nr Estelline	25.4	1956-72	5-24-65	1,540	60.6
06479800	North Deer Cr nr Estelline	48.3	1956-71	6-16-70	3,800	78.7
06479810	North Deer Cr trib nr Brookings	.5	1969-72	6-15-70	134	268
06479900	Sixmile Cr trib nr Brookings	9.42	1956-72	4- 8-69	1,000	106
06479950	Deer Cr nr Brookings	4.21	1956-72	4- 8-69	750	178
06482600	West Pipestone Cr trib nr Garretson	2.20	1969-72	5-28-70	792	360
06482870	Little Beaver Cr trib nr Canton	.22	1956-72	7-10-71	104	473
06485550	West Union Cr nr Alcester	3.62	1969-72	6-27-69	2,100	580

a Flood exceeded in 1969, discharge not determined.

Table A-4.--Peak discharge at selected miscellaneous sites in South Dakota.

No.	Stream and place of determination	Contributing drainage area (sq mi)	Peak discharge cfs	Peak discharge Date	Peak discharge cfs per sq mi
	Grand River basin				
1	Crooked Cr in sec.33, T.23 N., R.6 E., at bridge on U.S. Highway 85, 5 miles north of Ludlow.	67.4	6,800	7-28-51	101
2	North Fork Grand R in sec.8, T.22 N., R.12 E., at bridge on Hettinger-Lodgepole road, 5 miles south of North Dakota-South Dakota State line.	1,060	21,300	4- 7-52	20.1
3	Camel (Middle) Cr in sec.26, T.22 N., R.4 E., 6 miles east and 1.5 miles north of Ladner.	5.2	7,500	7-28-51	1,440
	Moreau River basin				
4	Little Moreau R in sec.20, T.16 N., R.25 E., 6.5 miles south of Timberlake.	--	10,600	6-19-60	--
	Cheyenne River basin				
5	Battle Cr in NW¼NE¼ sec.8, T.2 S., R.6 E., 100 ft upstream from U.S. Highway 16A and 0.4 mile southwest of Keystone.	13.6	10,800	6- 9-72	794
6	Grizzly Bear Cr in SE¼ sec.8, T.2 S., R.6 E., at Hugo Mine about 1 mile upstream from Keystone.	9.22	6,230	6- 9-72	676
7	Battle Cr in SW¼ sec.36, T.2 S., R.7 E., at canyon mouth, 1.0 mile upstream from Grace Coolidge Cr and 2.5 miles southwest of Hermosa.	110	44,100	6-10-72	401

Table A-4.--Peak discharge at selected miscellaneous sites in South Dakota.--cont.

No.	Stream and place of determination	Contributing drainage area (sq mi)	Peak discharge cfs	Peak discharge Date	Peak discharge cfs per sq mi
	Cheyenne River basin - cont.				
8	Grace Coolidge Cr trib in NW¼NE¼ sec.10, T.3 S., R.7 E., 4.5 miles southwest of Hermosa.	3.44	2,660	7-28-57	773
9	Dry Cr in SW¼SW¼ sec.32, T.2 S., R.8 E., 0.8 mile upstream from mouth and 1 mile south of Hermosa.	5.25	1,150	7-28-57	219
10	Spring Cr in SE¼ sec.14, T.1 S., R.5 E., 0.3 mile upstream from Sheridan Lake, and 6.2 miles northeast of Hill City.	58.0	5,630	6- 9-72	97.1
11	Spring Cr in SE¼ sec.4, T.1 S., R.6 E., 0.1 mile downstream from Bitter Cr and 9.3 miles northeast of Hill City.	88.9	14,900	6- 9-72	168
12	Rockerville Gulch in SW¼ sec.13, T.1 S., R.6 E., at east edge of town of Rockerville.	1.79	1,560	6- 9-72	872
13	Spring Cr in SE¼ sec.4, T.1 S., R.7 E., 2.0 miles upstream from Rockerville Gulch, and 8.0 miles south of Rapid City.	103	21,800	6-10-72	212
14	Castle Cr trib No. 1 in NE¼ sec.18, T.1 N., R.3 E., at road 1.4 miles upstream from Castle Cr and 6.5 miles southwest of Rochford.	1.25	2,190	7-28-55	1,750
15	Castle Cr trib No. 1, 1.1 miles upstream from mouth and 6.4 miles southwest of Rochford.	1.75	1,720	7-28-55	983

Table A-4.--Peak discharge at selected miscellaneous sites in South Dakota.--cont.

No.	Stream and place of determination	Contributing drainage area (sq mi)	Peak discharge		
			cfs	Date	cfs per sq mi
	Cheyenne River basin - cont.				
16	Castle Cr trib No. 1 in SW¼NE¼ sec.17, T.1 N., R.3 E., 0.4 mile upstream from mouth and 6.2 miles southwest of Rochford.	2.20	5,620	7-28-55	2,550
17	Castle Cr trib No. 2 in NE¼NE¼ sec.7, T.1 N., R.3 E., at culvert 5.8 miles southwest of Rochford.	.019	98.9	7-28-55	5,200
18	Iron Cr in sec.4, T.1 N., R.3 E., 300 ft upstream from mouth and 4.2 miles southwest of Rochford.	1.25	2,410	7-28-55	1,930
19	North Fork Castle Cr in SE¼ sec.4, T.1 N., R.3 E., 0.5 mile upstream from mouth and 4 miles southwest of Rochford.	14.6	4,490	7-28-55	308
20	Castle Cr in NW¼ sec.2, T.1 N., R.3 E., 2 miles downstream from North Fork Castle Cr and 3 miles south of Rochford.	b32.6	8,500	7-28-55	261
21	Castle Cr in NW¼SE¼ sec.4, T.1 N., R.4 E., at Chicago, Burlington, and Quincy RR. bridge, 0.4 mile south of Mystic.	b52.2	2,360	7-28-55	45.2
22	Rapid Cr in NW¼ sec.5, T.1 N., R.6 E., 2.5 miles east of Pactola Dam and 8.0 miles west of Rapid City.	a8.35	5,750	6- 9-72	689
23	Deer Cr in SW¼ sec.27, T.2 N., R.5 E., at Deer Cr Campground on State Highway 40, 13 miles west of Rapid City.	4.28	3,530	6- 9-72	825

Table A-4.--Peak discharge at selected miscellaneous sites in South Dakota.--cont.

No.	Stream and place of determination	Contributing drainage area (sq mi)	Peak discharge cfs	Date	cfs per sq mi
	Cheyenne River basin - cont.				
24	Victoria Cr in SW¼NW¼ sec.27, T.1 N., R.6 E., 1,000 ft downstream from Victoria Dam, 5.4 miles southwest of city limits of Rapid City.	6.71	6,860	6- 9-72	1,020
25	Rapid Cr trib in NE¼NW¼ sec.18, T.1 N., R.7 E., on road to Nameless Cave, 2 miles southwest of city limits of Rapid City.	1.67	2,130	7-13-62	1,280
26	Cleghorn Canyon in NE¼SW¼ sec.8, T.1 N., R.7 E., 900 ft upstream from mouth and 1 mile southwest of city limits of Rapid City.	6.96	2,920	7-13-62	420
27	Cleghorn Canyon in SE¼ sec.7, T.1 N., R.7 E., 0.5 mile upstream from mouth, 1.1 miles west of city limits of Rapid City.	6.95	12,600	6- 9-72	1,810
28	South Canyon in SW¼NW¼ sec.36, T.2 N., R.6 E., 300 ft upstream from small tributary and 2 miles west of city limits of Rapid City.	.92	1,310	7-13-62	1,420
29	South Canyon in NE¼NW¼ sec.4, T.1 N., R.7 E., near intersection of Nordbye Lane and Hall Street in Rapid City.	6.06	2,960	7-13-62	488
30	Lime Cr in NE¼ sec.4, T.2 N., R.7 E., at intersection of 36th Street and West Main Street in Rapid City.	2.51	481	6- 9-72	192

Table A-4.--Peak discharge at selected miscellaneous sites in South Dakota.--cont.

No.	Stream and place of determination	Contributing drainage area (sq mi)	Peak discharge cfs	Peak discharge Date	Peak discharge cfs per sq mi
	Cheyenne River basin - cont.				
31	Rapid Cr trib in NW¼NE¼ sec.7, T.1 N., R.8 E., in Rapid City, 1 mile upstream from mouth.	2.84	256	7-14-57	90.1
32	Elk Cr in SW¼ sec.29, T.4 N., R.6 E., in canyon mouth 0.8 mile upstream from Interstate Highway 90, and 3.4 miles northwest of Piedmont.	45.5	11,600	6- 9-72	255
33	Stagebarn Canyon in NE¼SE¼ sec.22, T.3 N., R.6 E., 0.5 mile downstream from South Stagebarn Canyon and 2.0 miles southeast of Piedmont.	16.8	4,100	6- 9-72	244
34	Rapid Cr, at highway bridge at Creston, about 4 miles upstream from mouth.	710	16,000	5- 6-32	22.5
35	Spearfish Cr in SW¼NW¼ sec.9, T.4 N., R.2 E., 0.4 mile upstream from Annie Cr and 2 miles northwest of Cheyenne Crossing.	73.6	673	5-14-65	9.14
36	False Bottom Cr in SE¼ sec.19, T.6 N., R.3 E., 0.8 mile upstream from U.S. Highway 14 and 3.5 miles southeast of Spearfish.	14.3	2,310	5-14-65	162
37	Whitewood Cr in NW¼NE¼ sec.23, T.5 N., R.3 E., at rodeo grounds in Deadwood, 0.5 mile upstream from Spruce Gulch.	41.4	8,030	5-14-65	194

Table A-4.--Peak discharge at selected miscellaneous sites in South Dakota.--cont.

No.	Stream and place of determination	Contributing drainage area (sq mi)	Peak discharge cfs	Peak discharge Date	Peak discharge cfs per sq mi
	Cheyenne River basin - cont.				
38	Whitewood Cr in NE¼NW¼ sec.27, T.6 N., R.4 E., at Chicago and Northwestern Railway bridge, 1 mile east of Whitewood.	59.0	8,460	7-15-62	143
39	Bear Butte Cr trib in NW¼NE¼ sec.14, T.5 N., R.4 E., 0.8 mile upstream from mouth and 4 miles southwest of Sturgis.	1.63	1,940	6-15-62	1,190
40	Bear Butte Cr in sec.7, T.5 N., R.5 E., 150 ft above mouth of dry creek and 1.5 miles southwest of Sturgis.	53.0	19,500	6- 9-72	368
41	Deadman Gulch in NE¼ sec.16, T.5 N., R.5 E., about 1,500 ft upstream from bridge on Interstate Highway 90, 1 mile south of Sturgis.	--	4,740	6- 9-72	--
42	Bear Butte Cr in NE¼NW¼ sec.6, T.5 N., R.6 E., at State Highway 79, 3.5 miles northeast of Sturgis.	101	5,980	6-16-62	59.2
	Medicine Creek basin				
43	Medicine Cr trib No. 1 in sec. 9, T.105 N., R.74 W., 3.2 miles northeast of Lyman and 5.8 miles northwest of Reliance.	4.2	377	7- 9-55	89.8
44	Medicine Cr trib No. 2 in NE¼ sec.14, T.105 N., R.74 W., 3.5 miles northeast of Lyman and 4.2 miles northwest of Reliance.	.4	530	7- 9-55	1,320

Table A-4.--Peak discharge at selected miscellaneous sites in South Dakota.--cont.

No.	Stream and place of determination	Contributing drainage area (sq mi)	Peak discharge cfs	Peak discharge Date	Peak discharge cfs per sq mi
	White River basin				
45	White Clay Cr in sec.12, T.35 N., R.45 W., 0.2 mile upstream from Wolf Cr and 0.5 mile west of Pine Ridge.	--	1,880	5-20-62	--
46	White R trib in N½ sec.28, T.2 S., R.16 E., at culvert on U.S. Highway 16A, 8.2 miles northwest of Conata.	.17	305	9-20-55	1,790
	Marne Creek basin				
47	Marne Cr in SE¼SE¼ sec.12, T.93 N., R.56 W., 400 ft downstream from 12th Street Bridge in Yankton.	30.7	4,450	6-16-57	145
48	Marne Cr trib in SW¼ sec.11, T.93 N., R.56 W., 80 ft downstream from culvert on State Highway 50 and 2 miles northwest of Yankton.	1	510	5-30-59	510
	Vermillion River basin				
49	West Fork Vermillion R trib in SW¼ sec.36, T.109 N., R.56 W., 13.5 miles north of Howard.	.87	817	6- 4-56	939
50	West Fork Vermillion R trib in NW¼ sec.12, T.108 N., R.56 W., at culvert on highway, 12 miles north of Howard.	2.56	780	6- 4-56	305

Table A-4.--Peak discharge at selected miscellaneous sites in South Dakota.--cont.

No.	Stream and place of determination	Contributing drainage area (sq mi)	Peak discharge: cfs	Peak discharge: Date	Peak discharge: cfs per sq mi
	Big Sioux River basin				
51	Big Sioux R trib in SE¼SE¼ sec.19, T.104 N., R.49 W., at culvert on highway, 3.5 miles southwest of Dell Rapids.	.68	948	6-16-57	1,390
52	Skunk Cr trib in SE¼ sec.25, T.104 N., R.51 W., at culvert on highway, 2 miles southeast of Colton.	5.80	2,550	6-16-57	440

a Excludes drainage area above Pactola Dam.
b Excludes drainage area above Deerfield Dam.

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