A Synthesis of Post-Fire Road Treatments for BAER Teams: Methods, Treatment Effectiveness, and Decision-Making Tools for Rehabilitation

Appendix C: USGS Regression Methods

Final Report to the Joint Fire Sciences Program

JFSP Project # 06-3-4-03

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October 31, 2008

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Appendix C—USGS Regression Methods

The USGS regression methods were developed to estimate peak flow discharge for gaged and ungaged natural flow streams, which were categorized into (1) a gaged site, (2) a site near a gaged site near the same stream, and (3) an ungaged site. StreamStats are available for many states (figure 1), which is a web-based tool to obtain streamflow information (http://water.usgs.gov/osw/streamstats/index.html), to estimate peak flow in a given location. For most other western US, two USGS regression methods for ungaged sites are available. Thomas and others (1997) developed the USGS regression methods in the southwestern United States (figure C.1). Additionally each state has one or more publications of USGS regression methods of its own. This report summarizes USGS regression methods by Thomas and others (1997) and other state-by-state USGS regression methods for ungaged sites in western United States. Peak flow discharge for gaged sites and sites near gaged site near stream are estimated by the following methods.

Gaged Sites

Weighted estimates were considered to be the best estimates of flood frequency at a gaged site, and the following equation was used for the weighted estimate (Sauer, 1974):

$$Q_{T(w)} = \frac{Q_{T(s)}N + Q_{T(r)}E}{N + E} \qquad \text{(Equation C.1)}$$

where

$Q_{T(w)}$ = weighted discharge, in cubic feet per second, for T-year recurrence interval;

$Q_{T(s)}$ = station value of the discharge, in cubic feet per second, for T-year recurrence interval;

$Q_{T(r)}$ = regression value of the discharge, in cubic feet per second, for T-year recurrence interval;

N = number of years of station data used to compute $Q_{T(s)}$; and

E = equivalent years of record for $Q_{T(r)}$.

Sites Near Gaged Sites on the Same Stream

Flood-frequency relations at sites near gaged sites on the same stream can be estimated using a ratio of drainage area for the ungaged and gaged sites. The drainage-area ratio should be approximately between 0.5 and 1.5. If ungaged and gaged basins have similar characteristics in topography, geology, and vegetation, and the drainage-area ratio requirement, the following equations can be used for peak flow:

$$Q_{T(u)} = Q_{T(g)}(A_u / A_g)^x \qquad \text{(Equation C.2)}$$

where

$Q_{T(u)}$ = peak flow, in cubic feet per second, at ungaged site for *T*-year recurrence interval;
$Q_{T(g)}$ = peak flow, in cubic feet per second, at gaged site for *T*-year recurrence interval;
A_u = drainage area, in square miles, at ungaged site;
A_g = drainage area, in square miles, at gaged site; and
x = exponent for each flood region as follows:

Flood region		Exponent, *x*
Name	**Number**	
High-Elevation	1	0.8
Northwest	2	0.7
South-Central Idaho	3	0.7
Northeast	4	0.7
Eastern Sierra	5	0.8
Northern Great Basin	6	0.6
South-Central Utah	7	0.5
Four Corners	8	0.4
Western Colorado	9	0.5
Southern Great Basin	10	0.6
Northeastern Arizona	11	0.6
Central Arizona	12	0.6
Southern Arizona	13	0.5
Upper Gila Basin	14	0.5
Upper Rio Grande Basin	15	0.5
Southeast	16	0.4

Applicable when the drainage area ratio (A_u/A_g) is between 0.5 and 1.5.

Ungaged Sites

Flood-frequency relations at ungaged sites were estimated using the regional models that were regression equations and developed using basin and climate characteristics as explanatory variables in the flowing section. There are three models to express the relation between peak flow and basin and climate characteristics in equation C.3–C.8. The most common relation is in the following form:

$$Q_T = a\ \mathrm{A}^b\ \mathrm{B}^c. \qquad \text{(Equation C.3)}$$

The following linear relation is obtained by logarithmic transformation:

$$\log Q_T = \log a + b \log A + c \log B + \ldots , \qquad \text{(Equation C.4)}$$

where
Q_T = peak flow, in cubic feet per second, for *T*-year recurrence interval;
A and *B* = explanatory variables; and
a, b, c = regression coefficients.

Drainage area is the most significant explanatory variable, and in some cases the relation between the logarithm of Q_T and the logarithm of drainage area is not linear. The following form of equations is used in such cases:

$$Q_T = 10^{(a+bAREA^x)} B^c , \qquad \text{(Equation C.5)}$$

or the logarithmic transformation:

$$\log Q_T = a + b\ \mathrm{AREA}^x + c \log B + \ldots , \qquad \text{(Equation C.6)}$$

where

AREA = drainage area;
B = other basin or climatic characteristic; and
x = exponent for AREA for which the relation is made linear.

The third form of equations is another method to account for a nonlinear relation between the logarithm of Q_T and the logarithm of drainage area.

$$Q_T = a\ \mathrm{AREA}^b (B\text{-}d)^c, \qquad \text{(Equation C.7)}$$

or the logarithmic transformation:

$$\log Q_T = \log a + b \log \mathrm{AREA} + c \log(B\text{-}d) + \ldots , \qquad \text{(Equation C.8)}$$

where

d = a constant, which is less than the minimum value of B, for which the relation is made linear.

Explanatory Variables

For the purpose of the report by Thomas and others (1997), six basin and climate characteristics are referred to as explanatory variables and are used as terms in the model equations. The abbreviation for each variable and method of measuring the variable are as follows:

1. AREA is the drainage area, in square miles, and is determined by planimetering the contributing drainage area on the largest scale topographic map available;
2. ELEV is the mean basin elevation, in feet above sea level, and is determined by placing a transparent grid over the drainage-basin area, which is drawn on the largest scale topographic map available. The elevations of a minimum of 20 equally spaced points are determined, and the average of the points is taken. As many as 100 points may be needed for large basins;
3. PREC is the mean annual precipitation, in inches, and is determined by placing a transparent grid over an isohyetal map of mean annual precipitation. The

drainage-area boundary is drawn on the map, the mean annual precipitation is determined at each grid intersection, and the values are averaged for the basin.

4. EVAP is the mean annual free water-surface evaporation, in inches, and was determined for gages sites by linear interpolation between the isolines of map 3 from Farnsworth and others (1982). The value used for the regression equations was the value at the gaged-site location; therefore, in the application of the regression equations, the study-site location should be used. To use the methods from the report by Thomas and others (1997), EVAP should be estimated for the study site by linear interpolation between the isolines of EVAP shown in figures C.2 to C.4.
5. LAT is the latitude of the gaged site, in decimal degree, and is determined using the largest scale topographic map available. The value used for the regression equations was the value at the gaged-site location; therefore, in the application of the regression equations, the study-site location should be used. Decimal degrees are the minutes and seconds of the latitude converted to a decimal.
6. LONG is the longitude of the gaged site, in decimal degrees, and is determined using the largest scale topographic map available. The value used for the regression equations was the value at the gaged-site location; therefore, in the application of the regression equations, the study-site location should be used. Decimal degrees are the minutes and seconds of the longitude converted to a decimal.

Table C.1. Generalized least-squares regression equations for estimating regional flood-frequency relations for the High-Elevation Region 1 (Thomas and others, 1997)

Recurrence interval, in years	**Equation**	**Average standard error of prediction, in percent**	**Equivalent years of record**
2	$Q = 0.124\ \mathrm{AREA}^{0.845}\mathrm{PREC}^{1.44}$	59	0.16
5	$Q = 0.629\ \mathrm{AREA}^{0.807}\mathrm{PREC}^{1.12}$	52	0.62
10	$Q = 1.43\ \mathrm{AREA}^{0.786}\mathrm{PREC}^{0.958}$	48	1.34
25	$Q = 3.08\ \mathrm{AREA}^{0.768}\mathrm{PREC}^{0.811}$	46	2.50
50	$Q = 4.75\ \mathrm{AREA}^{0.758}\mathrm{PREC}^{0.732}$	46	3.37
100	$Q = 6.78\ \mathrm{AREA}^{0.750}\mathrm{PREC}^{0.668}$	46	4.19

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; PREC, mean annual precipitation, in inches.
Data were based on 165 stations.
Average number of years of systematic record is 28.

Table C.2. Generalized least-squares regression equations for estimating regional flood-frequency relations for the Northwest Region 2 (Thomas and others, 1997)

Recurrence interval, in years	**Equation**	**Average standard error of prediction, in percent**	**Equivalent years of record**
2	$Q = 13.1\ \mathrm{AREA}^{0.713}$	72	0.96
5	$Q = 22.4\ \mathrm{AREA}^{0.723}$	66	1.80
10	$Q = 55.7\ \mathrm{AREA}^{0.727}(\mathrm{ELEV}/1{,}000)^{-0.353}$	61	3.07
25	$Q = 84.7\ \mathrm{AREA}^{0.737}(\mathrm{ELEV}/1{,}000)^{-0.438}$	61	4.64
50	$Q = 113\ \mathrm{AREA}^{0.746}(\mathrm{ELEV}/1{,}000)^{-0.511}$	64	5.47
100	$Q = 148\ \mathrm{AREA}^{0.752}(\mathrm{ELEV}/1{,}000)^{-0.584}$	68	6.05

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; ELEV, mean basin elevation, in feet.
Data were based on 108 stations.
Average number of years of systematic record is 26.

Table C.3. Generalized least-squares regression equations for estimating regional flood-frequency relations for the South-Central Idaho Region 3 (Thomas and others, 1997)

Recurrence interval, in years	Equation	Average standard error of prediction, in percent	Equivalent years of record
2	$Q = 0.444\ \mathrm{AREA}^{0.649}\mathrm{PREC}^{1.15}$	86	0.29
5	$Q = 1.21\ \mathrm{AREA}^{0.639}\mathrm{PREC}^{0.995}$	83	0.49
10	$Q = 1.99\ \mathrm{AREA}^{0.633}\mathrm{PREC}^{0.924}$	80	0.77
25	$Q = 3.37\ \mathrm{AREA}^{0.627}\mathrm{PREC}^{0.849}$	78	1.23
50	$Q = 4.70\ \mathrm{AREA}^{0.625}\mathrm{PREC}^{0.802}$	77	1.57
100	$Q = 6.42\ \mathrm{AREA}^{0.621}\mathrm{PREC}^{0.757}$	78	1.92

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; PREC, mean annual precipitation, in inches.
Data were based on 35 stations.
Average number of years of systematic record is 32.

Table C.4. Generalized least-squares regression equations for estimating regional flood-frequency relations for the Northeast Region 4 (Thomas and others, 1997)

Recurrence interval, in years	Equation	Average standard error of prediction, in percent	Equivalent years of record
2	$Q = 0.0405\ \mathrm{AREA}^{0.701}(\mathrm{ELEV}/1{,}000)^{2.91}$	64	0.39
5	$Q = 0.408\ \mathrm{AREA}^{0.683}(\mathrm{ELEV}/1{,}000)^{2.05}$	57	0.95
10	$Q = 1.26\ \mathrm{AREA}^{0.674}(\mathrm{ELEV}/1{,}000)^{1.64}$	53	1.76
25	$Q = 3.74\ \mathrm{AREA}^{0.667}(\mathrm{ELEV}/1{,}000)^{1.24}$	51	3.02
50	$Q = 7.04\ \mathrm{AREA}^{0.664}(\mathrm{ELEV}/1{,}000)^{1.02}$	52	3.89
100	$Q = 11.8\ \mathrm{AREA}^{0.662}(\mathrm{ELEV}/1{,}000)^{0.835}$	53	4.65

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; ELEV, mean basin elevation, in feet.
Data were based on 108 stations.
Average number of years of systematic record is 28.

Table C.5. Generalized least-squares regression equations for estimating regional flood-frequency relations for the Eastern Sierras Region 5 (Thomas and others, 1997)

Recurrence interval, in years	Equation	Average standard error of prediction, in percent	Equivalent years of record
2	$Q = 0.0333\ \mathrm{AREA}^{0.853}(\mathrm{ELEV}/1{,}000)^{2.68}[(\mathrm{LAT}-28)/10]^{4.1}$	135	0.21
5	$Q = 2.42\ \mathrm{AREA}^{0.823}(\mathrm{ELEV}/1{,}000)^{1.01}[(\mathrm{LAT}-28)/10]^{4.1}$	101	0.73
10	$Q = 28.0\ \mathrm{AREA}^{0.826}[(\mathrm{LAT}-28)/10]^{4.3}$	84	1.69
25	$Q = 426\ \mathrm{AREA}^{0.812}(\mathrm{ELEV}/1{,}000)^{-1.10}[(\mathrm{LAT}-28)/10]^{4.3}$	87	2.62
50	$Q = 2{,}030\ \mathrm{AREA}^{0.798}(\mathrm{ELEV}/1{,}000)^{-1.71}[(\mathrm{LAT}-28)/10]^{4.4}$	91	3.26
100	$Q = 7{,}000\ \mathrm{AREA}^{0.782}(\mathrm{ELEV}/1{,}000)^{-2.18}[(\mathrm{LAT}-28)/10]^{4.6}$	95	3.80

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; ELEV, mean basin elevation, in feet; LAT, latitude of site, in decimal degrees.
Data were based on 37 stations.
Average number of years of systematic record is 31.

Table C.6. Hybrid equations for estimating regional flood-frequency relations for the Northern Great Basin Region 6 (Thomas and others, 1997)

Recurrence interval, in years	Equation	Estimated average standard error of regression, in log units	Equivalent years of record
2	$Q = 0$	--	--
5	$Q = 32\ \mathrm{AREA}^{0.80}(\mathrm{ELEV}/1{,}000)^{-0.66}$	1.47	0.233
10	$Q = 590\ \mathrm{AREA}^{0.62}(\mathrm{ELEV}/1{,}000)^{-1.6}$	1.12	0.748
25	$Q = 3{,}200\ \mathrm{AREA}^{0.62}(\mathrm{ELEV}/1{,}000)^{-2.1}$	0.796	2.52
50	$Q = 5{,}300\ \mathrm{AREA}^{0.64}(\mathrm{ELEV}/1{,}000)^{-2.1}$	1.10	1.75
100	$Q = 20{,}000\ \mathrm{AREA}^{0.51}(\mathrm{ELEV}/1{,}000)^{-2.3}$	1.84	0.794

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; ELEV, mean basin elevation, in feet.
Data were based on 80 stations.
Dashes indicate no data.
Average number of years of systematic record is 19. Estimated average standard error of regression for the hybrid method includes much of the within-station residual variance and therefore is not comparable to standard error of estimate from an ordinary least-squares regression.

Table C.7. Generalized least-squares regression equations for estimating regional flood-frequency relations for the South-Central Utah Region 7 (Thomas and others, 1997)

Recurrence interval, in years	**Equation**	**Average standard error of prediction, in percent**	**Equivalent years of record**
2	$Q = 0.0150\ \mathrm{AREA}^{0.697}(\mathrm{ELEV}/1{,}000)^{-3.16}$	56	0.25
5	$Q = 0.306\ \mathrm{AREA}^{0.590}(\mathrm{ELEV}/1{,}000)^{-2.22}$	45	1.56
10	$Q = 1.25\ \mathrm{AREA}^{0.526}(\mathrm{ELEV}/1{,}000)^{-1.83}$	45	3.07
25	$Q = 122\ \mathrm{AREA}^{0.440}$	49	4.60
50	$Q = 183\ \mathrm{AREA}^{0.390}$	53	5.27
100	$Q = 264\ \mathrm{AREA}^{0.344}$	59	5.68

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; ELEV, mean basin elevation, in feet.
Data were based on 28 stations.
Average number of years of systematic record is 23.

Table C.8. Generalized least-squares regression equations for estimating regional flood-frequency relations for the Four Corners Region 8 (Thomas and others, 1997)

Recurrence interval, in years	**Equation**	**Average standard error of prediction, in percent**	**Equivalent years of record**
2	$Q = 598\ \mathrm{AREA}^{0.501}(\mathrm{ELEV}/1{,}000)^{-1.02}$	72	0.37
5	$Q = 2{,}620\ \mathrm{AREA}^{0.449}(\mathrm{ELEV}/1{,}000)^{-1.28}$	62	1.35
10	$Q = 5{,}310\ \mathrm{AREA}^{0.425}(\mathrm{ELEV}/1{,}000)^{-1.40}$	57	2.88
25	$Q = 10{,}500\ \mathrm{AREA}^{0.403}(\mathrm{ELEV}/1{,}000)^{-1.49}$	54	5.45
50	$Q = 16{,}000\ \mathrm{AREA}^{0.390}(\mathrm{ELEV}/1{,}000)^{-1.54}$	53	7.45
100	$Q = 23{,}300\ \mathrm{AREA}^{0.377}(\mathrm{ELEV}/1{,}000)^{-1.59}$	53	9.28

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; ELEV, mean basin elevation, in feet.
Data were based on 108 stations.
Average number of years of systematic record is 27.

Table C.9. Generalized least-squares regression equations for estimating regional flood-frequency relations for the Western Colorado Region 9 (Thomas and others, 1997)

Recurrence interval, in years	**Equation**	**Average standard error of prediction, in percent**	**Equivalent years of record**
2	$Q = 0.0204\ \mathrm{AREA}^{0.606}(\mathrm{ELEV}/1{,}000)^{-3.5}$	68	0.14
5	$Q = 0.181\ \mathrm{AREA}^{0.515}(\mathrm{ELEV}/1{,}000)^{-2.9}$	55	0.77
10	$Q = 1.18\ \mathrm{AREA}^{0.488}(\mathrm{ELEV}/1{,}000)^{-2.2}$	52	1.70
25	$Q = 18.2\ \mathrm{AREA}^{0.465}(\mathrm{ELEV}/1{,}000)^{-1.1}$	53	2.81
50	$Q = 248\ \mathrm{AREA}^{0.449}$	57	3.36
100	$Q = 292\ \mathrm{AREA}^{0.444}$	59	3.94

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; ELEV, mean basin elevation, in feet.
Data were based on 43 stations.
Average number of years of systematic record is 28.

Table C.10. Hybrid equations for estimating regional flood-frequency relations for the Southern Great Basin Region 10 (Thomas and others, 1997)

Recurrence interval, in years	**Equation**	**Estimated average standard error of regression, in log units**	**Equivalent years of record**
2	$Q = 12\ \mathrm{AREA}^{0.58}$	1.14	0.618
5	$Q = 85\ \mathrm{AREA}^{0.59}$	0.602	3.13
10	$Q = 200\ \mathrm{AREA}^{0.62}$	0.675	3.45
25	$Q = 400\ \mathrm{AREA}^{0.65}$	0.949	2.49
50	$Q = 590\ \mathrm{AREA}^{0.67}$	0.928	3.22
100	$Q = 850\ \mathrm{AREA}^{0.69}$	1.23	2.22

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles.
Data were based on 104 stations.
Average number of years of systematic record is 21.
Estimated average standard error of regression for the hybrid method includes much of the within-station residual variance and therefore is not comparable to standard error of estimate from an ordinary least-squares regression.

Table C.11. Hybrid equations for estimating regional flood-frequency relations for the Northeastern Arizona Region 11 (Thomas and others, 1997)

Recurrence interval, in years	Equation	Estimated average standard error of regression, in log units	Equivalent years of record
2	$Q = 26\ \mathrm{AREA}^{0.62}$	0.609	0.428
5	$Q = 130\ \mathrm{AREA}^{0.56}$	0.309	2.79
10	$Q = 0.10\ \mathrm{AREA}^{0.52}\mathrm{EVAP}^{2.0}$	0.296	4.63
25	$Q = 0.17\ \mathrm{AREA}^{0.52}\mathrm{EVAP}^{2.0}$	0.191	17.1
50	$Q = 0.24\ \mathrm{AREA}^{0.54}\mathrm{EVAP}^{2.0}$	0.294	9.20
100	$Q = 0.27\ \mathrm{AREA}^{0.58}\mathrm{EVAP}^{2.0}$	0.863	1.32

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; EVAP, mean annual evaporation, in inches.

Data were based on 46 stations.

Average number of years of systematic record is 20. Estimated average standard error of regression for the hybrid method includes much of the within-station residual variance and therefore is not comparable to standard error of estimate from an ordinary least-squares regression.

Table C.12. Generalized least-squares regression equations for estimating regional flood-frequency relations for the Central Arizona Region 12 (Thomas and others, 1997)

Recurrence interval, in years	Equation	Average standard error of prediction, in percent	Equivalent years of record
2	$Q = 41.1\ \mathrm{AREA}^{0.629}$	105	0.23
5	$Q = 238\ \mathrm{AREA}^{0.687}(\mathrm{ELEV}/1{,}000)^{-0.358}$	68	1.90
10	$Q = 479\ \mathrm{AREA}^{0.661}(\mathrm{ELEV}/1{,}000)^{-0.398}$	52	6.24
25	$Q = 942\ \mathrm{AREA}^{0.630}(\mathrm{ELEV}/1{,}000)^{-0.383}$	40	17.8
50	$Q = 10^{(7.36-4.17\,AREA^{-0.08})}(\mathrm{ELEV}/1{,}000)^{-0.440}$	37	27.5
100	$Q = 10^{(6.55-3.17\,AREA^{-0.11})}(\mathrm{ELEV}/1{,}000)^{-0.454}$	39	32.1

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; ELEV, mean basin elevation, in feet.

Data were based on 68 stations.

Average number of years of systematic record is 21.

Table C.13. Generalized least-squares regression equations for estimating regional flood-frequency relations for the Southern Arizona Region 13 (Thomas and others, 1997)

Recurrence interval, in years	Equation	Average standard error of prediction, in percent	Equivalent years of record
2	$Q = 10^{(6.38-4.29\,AREA^{-0.06})}$	57	2.0
5	$Q = 10^{(5.78-3.31\,AREA^{-0.08})}$	40	6.25
10	$Q = 10^{(5.68-3.02\,AREA^{-0.09})}$	37	11.1
25	$Q = 10^{(5.64-2.78\,AREA^{-0.10})}$	39	15.0
50	$Q = 10^{(5.57-2.59\,AREA^{-0.11})}$	43	15.9
100	$Q = 10^{(5.52-2.42\,AREA^{-0.12})}$	48	16.1

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles.
Data were based on 73 stations.
Average number of years of systematic record is 21.

Table C.14. Generalized least-squares regression equations for estimating regional flood-frequency relations for the Upper Gila Basin Region 14 (Thomas and others, 1997)

Recurrence interval, in years	Equation	Average standard error of prediction, in percent	Equivalent years of record
2	$Q = 583\ \mathrm{AREA}^{0.588}(\mathrm{ELEV}/1{,}000)^{-1.3}$	74	1.69
5	$Q = 618\ \mathrm{AREA}^{0.524}(\mathrm{ELEV}/1{,}000)^{-0.70}$	63	3.54
10	$Q = 361\ \mathrm{AREA}^{0.464}$	65	4.95
25	$Q = 581\ \mathrm{AREA}^{0.462}$	63	7.75
50	$Q = 779\ \mathrm{AREA}^{0.462}$	64	9.65
100	$Q = 1{,}010\ \mathrm{AREA}^{0.463}$	66	11.2

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; ELEV, mean basin elevation, in feet.
Data were based on 22 stations.
Average number of years of systematic record is 26.

Table C.15. Generalized least-squares regression equations for estimating regional flood-frequency relations for the Upper Rio Grande Basin Region 15 (Thomas and others, 1997)

Recurrence interval, in years	Equation	Average standard error of prediction, in percent	Equivalent years of record
2	$Q = 18{,}700\ \mathrm{AREA}^{0.730}(\mathrm{ELEV}/1{,}000)^{-2.86}[(\mathrm{LONG}-99)/10]^{2.8}$	64	0.13
5	$Q = 31{,}700\ \mathrm{AREA}^{0.646}(\mathrm{ELEV}/1{,}000)^{-2.67}[(\mathrm{LONG}-99)/10]^{2.7}$	66	0.64
10	$Q = 26{,}000\ \mathrm{AREA}^{0.582}(\mathrm{ELEV}/1{,}000)^{-2.27}[(\mathrm{LONG}-99)/10]^{2.7}$	68	1.24
25	$Q = 34{,}800\ \mathrm{AREA}^{0.532}(\mathrm{ELEV}/1{,}000)^{-2.15}[(\mathrm{LONG}-99)/10]^{2.6}$	71	2.04
50	$Q = 44{,}200\ \mathrm{AREA}^{0.501}(\mathrm{ELEV}/1{,}000)^{-2.11}[(\mathrm{LONG}-99)/10]^{2.5}$	73	2.60
100	$Q = 91{,}800\ \mathrm{AREA}^{0.439}(\mathrm{ELEV}/1{,}000)^{-2.22}[(\mathrm{LONG}-99)/10]^{2.5}$	76	3.12

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; ELEV, mean basin elevation, in feet; LONG, longitude of site, in decimal degrees.
Data were based on 17 stations.
Average number of years of systematic record is 35.

Table C.16. Hybrid equations for estimating regional flood-frequency relations for the Southeast Region 16 (Thomas and others, 1997)

Recurrence interval, in years	Equation	Estimated average standard error of regression, in log units	Equivalent years of record
2	$Q = 14\ \mathrm{AREA}^{0.51}(\mathrm{EVAP}-32)^{0.55}$	0.664	0.410
5	$Q = 37\ \mathrm{AREA}^{0.48}(\mathrm{EVAP}-32)^{0.63}$	0.269	3.77
10	$Q = 52\ \mathrm{AREA}^{0.47}(\mathrm{EVAP}-32)^{0.67}$	0.177	12.6
25	$Q = 70\ \mathrm{AREA}^{0.48}(\mathrm{EVAP}-32)^{0.74}$	0.425	3.20
50	$Q = 110\ \mathrm{AREA}^{0.47}(\mathrm{EVAP}-34)^{0.74}$	0.367	5.38
100	$Q = 400\ \mathrm{AREA}^{0.50}(\mathrm{EVAP}-37)^{0.45}$	0.442	4.54

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; EVAP, mean annual evaporation, in inches.
Data were based on 120 stations.
Average number of years of systematic record is 30.
Estimated average standard error of regression for the hybrid method includes much of the within-station residual variance and therefore is not comparable to standard error of estimate from an ordinary least-squares regression.

Table C.17. Exponent coefficients for estimation of peak flow of ungaged sites near gaged sites on the same stream in Montana (Omang, 1992)

T, in years	Hydrologic regions of Montana							
	West Region	Northwest Region	Southwest Region	Upper Yellowstone Central Mountain Region	Northwest Foothills Region	Northeast Plains Region	East-Central Plains Region	Southeast Plains Region
2	0.94	0.94	0.87	0.85	0.49	0.69	0.55	0.55
5	0.90	0.87	0.82	0.79	0.48	0.65	0.53	0.53
10	0.89	0.84	0.78	0.77	0.47	0.63	0.52	0.52
25	0.87	0.81	0.72	0.74	0.46	0.61	0.50	0.51
50	0.86	0.79	0.70	0.72	0.47	0.60	0.49	0.50
100	0.85	0.74	0.68	0.70	0.48	0.59	0.49	0.50
500	0.83	0.67	0.64	0.65	0.50	0.57	0.47	0.49

T: Recurrence interval.

Applicable when the drainage area ratio (A_u/A_g) is between 0.5 and 1.5.

Table C.18. Regional flood-frequency equations for Montana based on drainage-basin characteristics (Omang, 1992)

Recurrence interval, in years	Equation	Average SEP, in percent	Equivalent years of record
	West Region		
2	$Q = 0.042\ \mathrm{AREA}^{0.94}\mathrm{PREC}^{1.49}$	52	1
5	$Q = 0.140\ \mathrm{AREA}^{0.90}\mathrm{PREC}^{1.31}$	47	2
10	$Q = 0.235\ \mathrm{AREA}^{0.89}\mathrm{PREC}^{1.25}$	45	2
25	$Q = 0.379\ \mathrm{AREA}^{0.87}\mathrm{PREC}^{1.19}$	45	3
50	$Q = 0.496\ \mathrm{AREA}^{0.86}\mathrm{PREC}^{1.17}$	46	3
100	$Q = 0.615\ \mathrm{AREA}^{0.85}\mathrm{PREC}^{1.15}$	48	4
500	$Q = 0.874\ \mathrm{AREA}^{0.83}\mathrm{PREC}^{1.14}$	55	4
	Northwest Region		
2	$Q = 0.266\ \mathrm{AREA}^{0.94}\mathrm{PREC}^{1.12}$	44	2
5	$Q = 2.34\ \mathrm{AREA}^{0.87}\mathrm{PREC}^{0.75}$	34	8
10	$Q = 7.84\ \mathrm{AREA}^{0.84}\mathrm{PREC}^{0.54}$	31	13
25	$Q = 23.1\ \mathrm{AREA}^{0.81}\mathrm{PREC}^{0.40}$	27	26
50	$Q = 25.4\ \mathrm{AREA}^{0.79}\mathrm{PREC}^{0.46}$	26	39
100	$Q = 38.9\ \mathrm{AREA}^{0.74}\mathrm{PREC}^{0.50}$	38	24
500	$Q = 87.1\ \mathrm{AREA}^{0.67}\mathrm{PREC}^{0.49}$	59	18
	Southwest Region		
2	$Q = 2.48\ \mathrm{AREA}^{0.87}(\mathrm{HE}+10)^{0.19}$	88	1
5	$Q = 24.8\ \mathrm{AREA}^{0.82}(\mathrm{HE}+10)^{-0.16}$	69	2
10	$Q = 81.5\ \mathrm{AREA}^{0.78}(\mathrm{HE}+10)^{-0.32}$	63	3
25	$Q = 297\ \mathrm{AREA}^{0.72}(\mathrm{HE}+10)^{-0.49}$	60	4
50	$Q = 695\ \mathrm{AREA}^{0.70}(\mathrm{HE}+10)^{-0.62}$	63	5
100	$Q = 1{,}520\ \mathrm{AREA}^{0.68}(\mathrm{HE}+10)^{-0.74}$	66	5
500	$Q = 7{,}460\ \mathrm{AREA}^{0.64}(\mathrm{HE}+10)^{-0.99}$	80	5

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; PREC, mean annual precipitation, in inches; ELEV, mean basin elevation, in feet; HE, percentage of basin above 6,000 feet elevation.

SEP: Standard error of prediction

Table C.19. Regional flood-frequency equations for Montana based on drainage-basin characteristics (Omang, 1992)—Continued

Recurrence interval, in years	Equation	Average SEP, in percent	Equivalent years of record
	Upper Yellowstone–Central Mountain Region		
2	$Q = 0.117\ \mathrm{AREA}^{0.85}(\mathrm{ELEV}/1{,}000)^{3.57}(\mathrm{HE}+10)^{-0.57}$	72	2
5	$Q = 0.960\ \mathrm{AREA}^{0.79}(\mathrm{ELEV}/1{,}000)^{3.44}(\mathrm{HE}+10)^{-0.82}$	53	7
10	$Q = 2.71\ \mathrm{AREA}^{0.77}(\mathrm{ELEV}/1{,}000)^{3.36}(\mathrm{HE}+10)^{-0.94}$	46	12
25	$Q = 8.54\ \mathrm{AREA}^{0.74}(\mathrm{ELEV}/1{,}000)^{3.16}(\mathrm{HE}+10)^{-1.03}$	44	14
50	$Q = 19.0\ \mathrm{AREA}^{0.72}(\mathrm{ELEV}/1{,}000)^{2.95}(\mathrm{HE}+10)^{-1.05}$	46	14
100	$Q = 41.6\ \mathrm{AREA}^{0.70}(\mathrm{ELEV}/1{,}000)^{2.72}(\mathrm{HE}+10)^{-1.07}$	50	14
500	$Q = 205\ \mathrm{AREA}^{0.65}(\mathrm{ELEV}/1{,}000)^{2.17}(\mathrm{HE}+10)^{-1.07}$	63	15
	Northwest Foothills Region		
2	$Q = 0.653\ \mathrm{AREA}^{0.49}(\mathrm{ELEV}/1{,}000)^{2.60}$	88	4
5	$Q = 3.70\ \mathrm{AREA}^{0.48}(\mathrm{ELEV}/1{,}000)^{2.22}$	52	13
10	$Q = 8.30\ \mathrm{AREA}^{0.47}(\mathrm{ELEV}/1{,}000)^{2.10}$	48	19
25	$Q = 20.3\ \mathrm{AREA}^{0.46}(\mathrm{ELEV}/1{,}000)^{1.95}$	50	25
50	$Q = 47.7\ \mathrm{AREA}^{0.47}(\mathrm{ELEV}/1{,}000)^{1.62}$	54	28
100	$Q = 79.8\ \mathrm{AREA}^{0.48}(\mathrm{ELEV}/1{,}000)^{1.40}$	62	28
500	$Q = 344\ \mathrm{AREA}^{0.50}(\mathrm{ELEV}/1{,}000)^{0.98}$	75	31
	Northeast Plains Region		
2	$Q = 15.4\ \mathrm{AREA}^{0.69}(\mathrm{ELEV}/1{,}000)^{-0.39}$	85	3
5	$Q = 77.0\ \mathrm{AREA}^{0.65}(\mathrm{ELEV}/1{,}000)^{-0.71}$	63	6
10	$Q = 161\ \mathrm{AREA}^{0.63}(\mathrm{ELEV}/1{,}000)^{-0.84}$	56	10
25	$Q = 343\ \mathrm{AREA}^{0.61}(\mathrm{ELEV}/1{,}000)^{-1.00}$	53	14
50	$Q = 543\ \mathrm{AREA}^{0.60}(\mathrm{ELEV}/1{,}000)^{-1.09}$	53	17
100	$Q = 818\ \mathrm{AREA}^{0.59}(\mathrm{ELEV}/1{,}000)^{-1.19}$	56	18
500	$Q = 1{,}720\ \mathrm{AREA}^{0.57}(\mathrm{ELEV}/1{,}000)^{-1.37}$	68	18

Equation: Q, peak flow, in cubic feet per second; AREA, drainage area, in square miles; PREC, mean annual precipitation, in inches; ELEV, mean basin elevation, in feet; HE, percentage of basin above 6,000 feet elevation.

SEP: Standard error of prediction

Table C.20. Regional flood-frequency equations for Montana based on drainage-basin characteristics (Omang, 1992)—Continued

Recurrence interval, in years	Equation	Average SEP, in percent	Equivalent years of record
	East–Central Plains Region		
2	$Q = 141\ \mathrm{AREA}^{0.55}(\mathrm{ELEV}/1{,}000)^{-1.88}$	99	3
5	$Q = 509\ \mathrm{AREA}^{0.53}(\mathrm{ELEV}/1{,}000)^{-1.92}$	75	5
10	$Q = 911\ \mathrm{AREA}^{0.52}(\mathrm{ELEV}/1{,}000)^{-1.88}$	66	8
25	$Q = 1{,}545\ \mathrm{AREA}^{0.50}(\mathrm{ELEV}/1{,}000)^{-1.79}$	62	11
50	$Q = 2{,}100\ \mathrm{AREA}^{0.49}(\mathrm{ELEV}/1{,}000)^{-1.72}$	62	14
100	$Q = 2{,}620\ \mathrm{AREA}^{0.49}(\mathrm{ELEV}/1{,}000)^{-1.62}$	65	15
500	$Q = 3{,}930\ \mathrm{AREA}^{0.47}(\mathrm{ELEV}/1{,}000)^{-1.44}$	75	16
	Southeast Plains Region		
2	$Q = 537\ \mathrm{AREA}^{0.55}(\mathrm{ELEV}/1{,}000)^{-2.91}$	134	1
5	$Q = 1{,}350\ \mathrm{AREA}^{0.53}(\mathrm{ELEV}/1{,}000)^{-2.75}$	88	3
10	$Q = 2{,}050\ \mathrm{AREA}^{0.52}(\mathrm{ELEV}/1{,}000)^{-2.64}$	73	5
25	$Q = 3{,}240\ \mathrm{AREA}^{0.51}(\mathrm{ELEV}/1{,}000)^{-2.55}$	63	9
50	$Q = 4{,}160\ \mathrm{AREA}^{0.50}(\mathrm{ELEV}/1{,}000)^{-2.47}$	59	12
100	$Q = 5{,}850\ \mathrm{AREA}^{0.50}(\mathrm{ELEV}/1{,}000)^{-2.51}$	62	13
500	$Q = 8{,}250\ \mathrm{AREA}^{0.49}(\mathrm{ELEV}/1{,}000)^{-2.33}$	67	15

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; PREC, mean annual precipitation, in inches; ELEV, mean basin elevation, in feet; HE, percentage of basin above 6,000 feet elevation.

Equation is not valid if the ungaged stream originates in the Northwest region.

SEP: Standard error of prediction

Table C.21. Exponent coefficients for estimation of peak flow of ungaged sites near gaged sites on the same stream in Montana (Parrett and Johnson, 2004)

T, in years	Hydrologic regions of Montana							
	West Region	**Northwest Region**	**Northwest Foothills Region**	**Northeast Plains Region**	**East-Central Plains Region**	**Southeast Plains Region**	**Upper Yellowstone Central Mountain Region**	**Southwest Region**
2	0.851	0.884	0.609	0.620	0.464	0.516	0.877	0.894
5	0.818	0.822	0.587	0.564	0.459	0.478	0.768	0.776
10	0.798	0.789	0.577	0.536	0.454	0.458	0.712	0.720
25	0.776	0.747	0.566	0.506	0.446	0.433	0.656	0.661
50	0.761	0.722	0.560	0.486	0.439	0.418	0.618	0.622
100	0.747	0.700	0.555	0.469	0.432	0.403	0.587	0.585
200	0.734	0.685	0.551	0.453	0.426	0.389	0.557	0.550
500	0.717	0.665	0.547	0.433	0.417	0.371	0.523	0.510

T: Recurrence interval.

Applicable when the drainage area ratio (A_u/A_g) is between 0.5 and 1.5.

Table C.22. Regression equations for Montana based on basin characteristics (Parrett and Johnson, 2004)

Recurrence interval, in years	Equation	Average SEP, in percent	Equivalent years of record
	West Region (n = 96)		
2	$Q = 0.268\ \mathrm{AREA}^{0.927}\mathrm{PREC}^{1.60}(\mathrm{F}+1)^{-0.508}$	60.5	0.9
5	$Q = 1.54\ \mathrm{AREA}^{0.884}\mathrm{PREC}^{1.36}(\mathrm{F}+1)^{-0.577}$	55.4	1.4
10	$Q = 3.63\ \mathrm{AREA}^{0.860}\mathrm{PREC}^{1.25}(\mathrm{F}+1)^{-0.605}$	54.3	1.9
25	$Q = 8.50\ \mathrm{AREA}^{0.835}\mathrm{PREC}^{1.14}(\mathrm{F}+1)^{-0.639}$	54.6	2.7
50	$Q = 13.2\ \mathrm{AREA}^{0.823}\mathrm{PREC}^{1.09}(\mathrm{F}+1)^{-0.652}$	56.0	3.1
100	$Q = 18.7\ \mathrm{AREA}^{0.812}\mathrm{PREC}^{1.06}(\mathrm{F}+1)^{-0.664}$	58.5	3.4
200	$Q = 24.7\ \mathrm{AREA}^{0.804}\mathrm{PREC}^{1.04}(\mathrm{F}+1)^{-0.674}$	62.2	3.6
500	$Q = 35.4\ \mathrm{AREA}^{0.792}\mathrm{PREC}^{1.02}(\mathrm{F}+1)^{-0.690}$	67.9	3.7
	Northwest Region (n = 35)		
2	$Q = 0.128\ \mathrm{AREA}^{0.918}\mathrm{PREC}^{1.33}$	49.2	--
5	$Q = 1.19\ \mathrm{AREA}^{0.846}\mathrm{PREC}^{0.954}$	39.2	--
10	$Q = 4.10\ \mathrm{AREA}^{0.807}\mathrm{PREC}^{0.720}$	38.4	--
25	$Q = 15.8\ \mathrm{AREA}^{0.760}\mathrm{PREC}^{0.510}$	38.4	--
50	$Q = 31.2\ \mathrm{AREA}^{0.733}\mathrm{PREC}^{0.445}$	37.4	--
100	$Q = 56.4\ \mathrm{AREA}^{0.710}\mathrm{PREC}^{0.403}$	40.2	--
200	$Q = 97.0\ \mathrm{AREA}^{0.694}\mathrm{PREC}^{0.364}$	46.0	--
500	$Q = 175\ \mathrm{AREA}^{0.674}\mathrm{PREC}^{0.374}$	56.9	--
	Northwest Foothills Region (n = 24)		
2	$Q = 14.2\ \mathrm{AREA}^{0.598}$	99.5	2.7
5	$Q = 53.6\ \mathrm{AREA}^{0.546}$	59.6	8.7
10	$Q = 105\ \mathrm{AREA}^{0.546}$	51.3	15.5
25	$Q = 208\ \mathrm{AREA}^{0.538}$	50.8	22.2
50	$Q = 318\ \mathrm{AREA}^{0.536}$	55.0	23.8
100	$Q = 462\ \mathrm{AREA}^{0.537}$	61.0	23.8
200	$Q = 649\ \mathrm{AREA}^{0.540}$	68.2	23.1
500	$Q = 977\ \mathrm{AREA}^{0.544}$	79.0	21.8

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; PREC, mean annual precipitation, in inches; ELEV, mean basin elevation, in feet; HE, percentage of basin above 6,000 feet elevation; F, percentage of basin covered by forest.

SEP: Standard error of prediction; n: number of stations used in the regression analysis; --: not applicable.

Table C.23. Regression equations for Montana based on basin characteristics (Parrett and Johnson, 2004)—Continued

Recurrence interval, in years	Equation	Average SEP, in percent	Equivalent years of record
	Northeast Plains Region (n = 57)		
2	$Q = 30.5\ \mathrm{AREA}^{0.601}(\mathrm{ELEV}/1{,}000)^{-0.913}$	91.0	3.0
5	$Q = 143\ \mathrm{AREA}^{0.547}(\mathrm{ELEV}/1{,}000)^{-1.12}$	80.3	4.3
10	$Q = 293\ \mathrm{AREA}^{0.520}(\mathrm{ELEV}/1{,}000)^{-1.19}$	81.3	5.5
25	$Q = 579\ \mathrm{AREA}^{0.493}(\mathrm{ELEV}/1{,}000)^{-1.21}$	87.2	6.6
50	$Q = 860\ \mathrm{AREA}^{0.477}(\mathrm{ELEV}/1{,}000)^{-1.21}$	93.9	7.2
100	$Q = 1{,}190\ \mathrm{AREA}^{0.462}(\mathrm{ELEV}/1{,}000)^{-1.20}$	101.4	7.5
200	$Q = 1{,}570\ \mathrm{AREA}^{0.450}(\mathrm{ELEV}/1{,}000)^{-1.17}$	109.9	7.7
500	$Q = 2{,}130\ \mathrm{AREA}^{0.435}(\mathrm{ELEV}/1{,}000)^{-1.13}$	123.2	7.7
	East–Central Plains Region (n = 85)		
2	$Q = 141\ \mathrm{AREA}^{0.495}(\mathrm{ELEV}/1{,}000)^{-1.85}$	99.9	3.1
5	$Q = 661\ \mathrm{AREA}^{0.490}(\mathrm{ELEV}/1{,}000)^{-2.09}$	76.0	5.7
10	$Q = 1{,}300\ \mathrm{AREA}^{0.482}(\mathrm{ELEV}/1{,}000)^{-2.11}$	71.4	8.3
25	$Q = 2{,}360\ \mathrm{AREA}^{0.470}(\mathrm{ELEV}/1{,}000)^{-2.05}$	73.4	10.7
50	$Q = 3{,}240\ \mathrm{AREA}^{0.462}(\mathrm{ELEV}/1{,}000)^{-1.96}$	78.6	11.6
100	$Q = 4{,}120\ \mathrm{AREA}^{0.454}(\mathrm{ELEV}/1{,}000)^{-1.84}$	85.7	12.0
200	$Q = 4{,}950\ \mathrm{AREA}^{0.446}(\mathrm{ELEV}/1{,}000)^{-1.72}$	94.3	11.9
500	$Q = 5{,}940\ \mathrm{AREA}^{0.435}(\mathrm{ELEV}/1{,}000)^{-1.53}$	107.8	11.6
	Southeast Plains Region (n = 69)		
2	$Q = 29.0\ \mathrm{AREA}^{0.600}(\mathrm{F}+1)^{-0.424}$	134.1	1.5
5	$Q = 83.1\ \mathrm{AREA}^{0.547}(\mathrm{F}+1)^{-0.352}$	103.9	2.6
10	$Q = 142\ \mathrm{AREA}^{0.517}(\mathrm{F}+1)^{-0.309}$	94.3	4.0
25	$Q = 249\ \mathrm{AREA}^{0.483}(\mathrm{F}+1)^{-0.264}$	88.9	6.0
50	$Q = 355\ \mathrm{AREA}^{0.461}(\mathrm{F}+1)^{-0.236}$	89.1	7.3
100	$Q = 486\ \mathrm{AREA}^{0.441}(\mathrm{F}+1)^{-0.212}$	91.6	8.3
200	$Q = 645\ \mathrm{AREA}^{0.422}(\mathrm{F}+1)^{-0.190}$	96.1	9.0
500	$Q = 905\ \mathrm{AREA}^{0.401}(\mathrm{F}+1)^{-0.166}$	105.5	9.3

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; PREC, mean annual precipitation, in inches; ELEV, mean basin elevation, in feet; HE, percentage of basin above 6,000 feet elevation; F, percentage of basin covered by forest.

SEP: Standard error of prediction; n: number of stations used in the regression analysis.

Table C.24. Regression equations for Montana based on basin characteristics (Parrett and Johnson, 2004)—Continued

Recurrence interval, in years	Equation	Average SEP, in percent	Equivalent years of record
	Upper Yellowstone–Central Mountain Region (n = 92)		
2	$Q = 5.84\ \mathrm{AREA}^{0.832}(\mathrm{HE}+1)^{0.098}$	94.9	1.5
5	$Q = 21.7\ \mathrm{AREA}^{0.782}(\mathrm{HE}+1)^{-0.0295}$	72.7	3.2
10	$Q = 42.3\ \mathrm{AREA}^{0.758}(\mathrm{HE}+1)^{0.0915}$	63.4	5.6
25	$Q = 82.6\ \mathrm{AREA}^{0.733}(\mathrm{HE}+1)^{-0.148}$	57.1	9.5
50	$Q = 126\ \mathrm{AREA}^{0.716}(\mathrm{HE}+1)^{-0.182}$	55.9	12.2
100	$Q = 181\ \mathrm{AREA}^{0.702}(\mathrm{HE}+1)^{-0.211}$	56.8	14.2
200	$Q = 252\ \mathrm{AREA}^{0.689}(\mathrm{HE}+1)^{-0.238}$	59.5	15.4
500	$Q = 375\ \mathrm{AREA}^{0.674}(\mathrm{HE}+1)^{-0.271}$	65.2	15.9
	Southwest Region (n = 44)		
2	$Q = 3.02\ \mathrm{AREA}^{0.881}(\mathrm{HE}+1)^{0.0981}$	94.4	0.9
5	$Q = 17.1\ \mathrm{AREA}^{0.800}(\mathrm{HE}+1)^{-0.104}$	79.0	1.7
10	$Q = 41.9\ \mathrm{AREA}^{0.765}(\mathrm{HE}+1)^{-0.214}$	75.9	2.4
25	$Q = 109\ \mathrm{AREA}^{0.728}(\mathrm{HE}+1)^{-0.332}$	75.6	3.4
50	$Q = 201\ \mathrm{AREA}^{0.704}(\mathrm{HE}+1)^{-0.408}$	77.4	4.0
100	$Q = 351\ \mathrm{AREA}^{0.682}(\mathrm{HE}+1)^{-0.476}$	80.3	4.5
200	$Q = 582\ \mathrm{AREA}^{0.660}(\mathrm{HE}+1)^{-0.537}$	83.8	4.9
500	$Q = 1{,}060\ \mathrm{AREA}^{0.636}(\mathrm{HE}+1)^{-0.611}$	89.9	5.3

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; PREC, mean annual precipitation, in inches; ELEV, mean basin elevation, in feet; HE, percentage of basin above 6,000 feet elevation; F, percentage of basin covered by forest.

SEP: Standard error of prediction; n: number of stations used in the regression analysis.

Table C.25. Exponent coefficients for estimation of peak flow of ungaged sites near gaged sites on the same stream in Colorado (Vaill, 2000)

Hydrologic region	**Exponent, *x***
Mountains	0.69
Rio Grande	0.88
Southwest	0.71
Northwest	0.64
Plains	0.40

Applicable when the drainage area ratio (A_u/A_g) is between 0.5 and 1.5.

Table C.26. Regional flood-frequency equations for Colorado (Vaill, 2000)

Recurrence interval, in years	Equation	Average SEP, in percent
	Mountain Region	
2	$Q = 11.0\ \mathrm{AREA}^{0.663}(\mathrm{BS}+1.0)^{3.465}$	52
5	$Q = 17.9\ \mathrm{AREA}^{0.677}(\mathrm{BS}+1.0)^{2.739}$	47
10	$Q = 23.0\ \mathrm{AREA}^{0.685}(\mathrm{BS}+1.0)^{2.364}$	45
25	$Q = 29.4\ \mathrm{AREA}^{0.695}(\mathrm{BS}+1.0)^{2.004}$	44
50	$Q = 34.5\ \mathrm{AREA}^{0.700}(\mathrm{BS}+1.0)^{1.768}$	44
100	$Q = 39.5\ \mathrm{AREA}^{0.706}(\mathrm{BS}+1.0)^{1.577}$	44
200	$Q = 44.6\ \mathrm{AREA}^{0.710}(\mathrm{BS}+1.0)^{1.408}$	45
500	$Q = 51.5\ \mathrm{AREA}^{0.715}(\mathrm{BS}+1.0)^{1.209}$	47
	Rio Grande Region	
2	$Q = 0.03\ \mathrm{AREA}^{0.979}\mathrm{PREC}^{1.615}$	61
5	$Q = 0.12\ \mathrm{AREA}^{0.940}\mathrm{PREC}^{1.384}$	55
10	$Q = 0.25\ \mathrm{AREA}^{0.914}\mathrm{PREC}^{1.277}$	53
25	$Q = 0.52\ \mathrm{AREA}^{0.884}\mathrm{PREC}^{1.117}$	51
50	$Q = 0.81\ \mathrm{AREA}^{0.864}\mathrm{PREC}^{1.121}$	50
100	$Q = 1.19\ \mathrm{AREA}^{0.846}\mathrm{PREC}^{1.074}$	49
200	$Q = 1.67\ \mathrm{AREA}^{0.828}\mathrm{PREC}^{1.036}$	49
500	$Q = 2.48\ \mathrm{AREA}^{0.808}\mathrm{PREC}^{0.995}$	49
	Southwest Region	
2	$Q = 28.7\ \mathrm{AREA}^{0.699}$	62
5	$Q = 50.5\ \mathrm{AREA}^{0.693}$	58
10	$Q = 66.0\ \mathrm{AREA}^{0.697}$	57
25	$Q = 86.3\ \mathrm{AREA}^{0.704}$	57
50	$Q = 102.0\ \mathrm{AREA}^{0.709}$	58
100	$Q = 118.4\ \mathrm{AREA}^{0.715}$	59
200	$Q = 135.5\ \mathrm{AREA}^{0.720}$	60
500	$Q = 159.4\ \mathrm{AREA}^{0.728}$	62

Equation: Q, peak flow, in cubic feet per second; AREA, drainage area, in square miles; PREC, mean annual precipitation, in inches; BS, mean drainage-basin slope, in foot per foot.
SEP: Standard error of prediction.

Table C.27. Regional flood-frequency equations for Colorado (Vaill, 2000)—Continued

Recurrence interval, in years	Equation	Average SEP, in percent
	Northwest Region	
2	$Q = 0.39\ \mathrm{AREA}^{0.684}\mathrm{PREC}^{1.304}$	62
5	$Q = 2.84\ \mathrm{AREA}^{0.674}\mathrm{PREC}^{0.833}$	58
10	$Q = 7.56\ \mathrm{AREA}^{0.671}\mathrm{PREC}^{0.601}$	56
25	$Q = 20.6\ \mathrm{AREA}^{0.669}\mathrm{PREC}^{0.362}$	56
50	$Q = 38.8\ \mathrm{AREA}^{0.667}\mathrm{PREC}^{0.210}$	56
100	$Q = 104.7\ \mathrm{AREA}^{0.624}$	59
200	$Q = 118.5\ \mathrm{AREA}^{0.624}$	60
500	$Q = 137.6\ \mathrm{AREA}^{0.623}$	61
	Plains Region	
2	$Q = 39.0\ \mathrm{AREA}^{0.486}$	93
5	$Q = 195.8\ \mathrm{AREA}^{0.399}$	89
10	$Q = 364.6\ \mathrm{AREA}^{0.400}$	90
25	$Q = 725.3\ \mathrm{AREA}^{0.395}$	92
50	$Q = 1116\ \mathrm{AREA}^{0.392}$	95
100	$Q = 1640\ \mathrm{AREA}^{0.388}$	96
200	$Q = 2324\ \mathrm{AREA}^{0.385}$	98
500	$Q = 3534\ \mathrm{AREA}^{0.380}$	100

Equation: Q, peak flow, in cubic feet per second; AREA, drainage area, in square miles; PREC, mean annual precipitation, in inches.

SEP: Standard error of prediction.

Table C.28. Exponent coefficients and description of hydrologic sub-regions for estimation of peak flow of ungaged sites near gaged sites on the same stream in South Dakota (Sando, 1998)

Sub-region	Description	Exponent, *x*
A	Minnesota-Red River Lowland, Coteau des Prairies, and eastern part of the Southern Plateaus physical divisions of Flint (1955).	0.529
B	Lake Dakota Plain, James River Lowland and Highlands, and Coteau du Missouri physical divisions of Flint (1955); part of the Coteau du Missouri in central South Dakota that has topography typical of Great Plains "breaks" sites was excluded from this sub-region.	0.615
C	Great Plains physiographic division of Fenneman (1946), excluding the Sand Hills influenced area in south-central South Dakota, and areas with topography typical of "breaks" sites, primarily in Cheyenne, Bad, and White River basins.	0.569
D	Includes areas in the Great Plains physiographic division of Fenneman (1946) with topography typical of "breaks" sites.	0.545
E	Generally corresponds to the Sand Hills physical division of Flint (1955)	0.691
F	Generally corresponds to the northeast exterior part of the Black Hills physical division of Flint (1955)	0.654
G	Generally corresponds to the southwest interior part of the Black Hills physical division of Flint (1955)	0.689

Applicable when the drainage area ratio (A_u/A_g) is between 0.75 and 1.5.

Table C.29. Regional regression equations for South Dakota based on basin and climate characteristics (Sando, 1998)

Recurrence interval, in years	Equation	Average SEP, in percent	Equivalent years of record
	Sub-region A (n = 55)		
2	$Q = 30.9\ \mathrm{AREA}^{0.513} I_2^{6.14}$	59	4.5
5	$Q = 85.5\ \mathrm{AREA}^{0.509} I_2^{5.45}$	54	6.1
10	$Q = 137\ \mathrm{AREA}^{0.510} I_2^{5.12}$	54	7.8
25	$Q = 218\ \mathrm{AREA}^{0.513} I_2^{4.80}$	56	9.8
50	$Q = 287\ \mathrm{AREA}^{0.517} I_2^{4.62}$	58	11.0
100	$Q = 362\ \mathrm{AREA}^{0.521} I_2^{4.47}$	61	11.9
500	$Q = 553\ \mathrm{AREA}^{0.531} I_2^{4.22}$	69	13.0
	Sub-region B (n = 43)		
2	$Q = 18.6\ \mathrm{AREA}^{0.425} I_2^{1.10}$	67	5.4
5	$Q = 51.6\ \mathrm{AREA}^{0.508} I_2^{0.835}$	64	7.1
10	$Q = 86.8\ \mathrm{AREA}^{0.546} I_2^{0.764}$	67	8.7
25	$Q = 148\ \mathrm{AREA}^{0.584} I_2^{0.730}$	72	10.6
50	$Q = 206\ \mathrm{AREA}^{0.606} I_2^{0.728}$	76	11.6
100	$Q = 275\ \mathrm{AREA}^{0.625} I_2^{0.742}$	81	12.4
500	$Q = 480\ \mathrm{AREA}^{0.661} I_2^{0.811}$	93	13.6
	Sub-region C (n = 48 or 46)		
2	$Q = 25.0\ \mathrm{AREA}^{0.569}$	108	1.8
5	$Q = 72.5\ \mathrm{AREA}^{0.578}$	67	4.8
10	$Q = 125\ \mathrm{AREA}^{0.579}$	58	8.3
25	$Q = 207\ \mathrm{AREA}^{0.573}$	53	12.0
50	$Q = 286\ \mathrm{AREA}^{0.570}$	53	14.9
100	$Q = 379\ \mathrm{AREA}^{0.566}$	55	16.5
500	$Q = 664\ \mathrm{AREA}^{0.556}$	65	16.6

Equation: Q, peak flow, in cubic feet per second; AREA, drainage area, in square miles; I_2, precipitation intensity index, 24-hour precipitation intensity, in inches, with a recurrence interval of 2 years (figure C.8; estimated from U.S. Weather Bureau, 1961).

SEP: Standard error of prediction; n: number of stations used in the regression analysis.

Table C.30. Regional regression equations for South Dakota based on basin and climate characteristics (Sando, 1998)—Continued

Recurrence interval, in years	Equation	Average SEP, in percent	Equivalent years of record
	Sub-region D (n = 17)		
2	$Q = 78.5\ \mathrm{AREA}^{0.357}$	109	2.3
5	$Q = 230\ \mathrm{AREA}^{0.455}$	61	7.4
10	$Q = 395\ \mathrm{AREA}^{0.515}$	44	17.9
25	$Q = 676\ \mathrm{AREA}^{0.585}$	34	39.1
50	$Q = 944\ \mathrm{AREA}^{0.627}$	33	52.5
100	$Q = 1{,}270\ \mathrm{AREA}^{0.663}$	34	59.2
500	$Q = 2{,}300\ \mathrm{AREA}^{0.732}$	41	57.5
	Sub-region E (n = 10)		
2	$Q = 12.1\ \mathrm{AREA}^{0.555}$	44	4.3
5	$Q = 18.9\ \mathrm{AREA}^{0.611}$	28	16.0
10	$Q = 22.6\ \mathrm{AREA}^{0.653}$	26	27.0
25	$Q = 27.0\ \mathrm{AREA}^{0.702}$	30	30.2
50	$Q = 30.3\ \mathrm{AREA}^{0.737}$	36	27.4
100	$Q = 33.6\ \mathrm{AREA}^{0.769}$	42	24.2
500	$Q = 41.4\ \mathrm{AREA}^{0.840}$	60	18.5
	Sub-region F (n = 17)		
2	$Q = 0.937\ \mathrm{AREA}^{0.676}\mathrm{CS}^{0.447}$	107	2.6
5	$Q = 0.591\ \mathrm{AREA}^{0.779}\mathrm{CS}^{0.745}$	83	6.0
10	$Q = 0.471\ \mathrm{AREA}^{0.832}\mathrm{CS}^{0.907}$	73	10.5
25	$Q = 0.406\ \mathrm{AREA}^{0.888}\mathrm{CS}^{1.06}$	66	18.4
50	$Q = 0.381\ \mathrm{AREA}^{0.925}\mathrm{CS}^{1.16}$	64	24.6
100	$Q = 0.352\ \mathrm{AREA}^{0.960}\mathrm{CS}^{1.25}$	64	29.4
500	$Q = 0.243\ \mathrm{AREA}^{1.04}\mathrm{CS}^{1.47}$	78	31.2

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; CS, main-channel slope, in feet per mile, measured at points 10 and 85 percent of stream length upstream from gage.

SEP: Standard error of prediction; n: number of stations used in the regression analysis.

Table C.31. Regional regression equations for South Dakota based on basin and climate characteristics (Sando, 1998)—Continued

Recurrence interval, in years	Equation	Average SEP, in percent	Equivalent years of record
	Sub-region G (n = 7)		
2	$Q = 3.46\ \mathrm{AREA}^{0.650}$	51	3.9
5	$Q = 7.70\ \mathrm{AREA}^{0.654}$	71	3.2
10	$Q = 11.3\ \mathrm{AREA}^{0.673}$	87	3.2
25	$Q = 16.5\ \mathrm{AREA}^{0.704}$	108	3.3
50	$Q = 21.0\ \mathrm{AREA}^{0.731}$	126	3.3
100	$Q = 25.8\ \mathrm{AREA}^{0.759}$	144	3.4
500	$Q = 38.5\ \mathrm{AREA}^{0.826}$	193	3.5

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles.
SEP: Standard error of prediction; n: number of stations used in the regression analysis.

Table C.32. Exponent coefficients for estimation of peak flow of ungaged sites near gaged sites on the same stream in Wyoming (Miller, 2003)

Recurrence interval, in years	Hydrologic regions of Wyoming					
	Region 1	**Region 2**	**Region 3**	**Region 4**	**Region 5**	**Region 6**
	Rocky Mountains	**Central Basins and Northern Plains**	**Eastern Basins and Eastern Plains**	**Eastern Mountains**	**Overthrust Belt**	**High Desert**
1.5	0.885	0.486	0.401	0.518	0.871	0.626
2	0.866	0.475	0.402	0.506	0.869	0.608
2.33	0.858	0.470	0.403	0.503	0.868	0.600
5	0.829	0.455	0.407	0.506	0.864	0.567
10	0.810	0.447	0.410	0.518	0.861	0.544
25	0.790	0.439	0.416	0.536	0.857	0.520
50	0.776	0.434	0.423	0.549	0.853	0.504
100	0.764	0.430	0.432	0.562	0.850	0.489
200	0.752	0.427	0.441	0.573	0.847	0.476
500	0.738	0.425	0.454	0.585	0.842	0.459

Applicable when the drainage area ratio (A_u/A_g) is between 0.75 and 1.5.

Table C.33. Regression equations for Wyoming based on basin characteristics (Miller, 2003)

Recurrence interval, in years	Equation	Average SEP, in percent	Equivalent years of record
	Rocky Mountains (Region 1)		
1.5	$Q = 0.126\ \text{AREA}^{0.885}\left(\frac{ELEV-3{,}000}{1{,}000}\right)^{2.56}(\text{LONG-100})^{0.032}$	56	1.0
2	$Q = 0.313\ \text{AREA}^{0.866}\left(\frac{ELEV-3{,}000}{1{,}000}\right)^{2.32}(\text{LONG-100})^{-0.069}$	50	1.2
2.33	$Q = 0.458\ \text{AREA}^{0.858}\left(\frac{ELEV-3{,}000}{1{,}000}\right)^{2.22}(\text{LONG-100})^{-0.110}$	47	1.3
5	$Q = 1.89\ \text{AREA}^{0.829}\left(\frac{ELEV-3{,}000}{1{,}000}\right)^{1.85}(\text{LONG-100})^{-0.262}$	39	2.4
10	$Q = 4.71\ \text{AREA}^{0.810}\left(\frac{ELEV-3{,}000}{1{,}000}\right)^{1.60}(\text{LONG-100})^{-0.357}$	36	3.8
25	$Q = 12.1\ \text{AREA}^{0.790}\left(\frac{ELEV-3{,}000}{1{,}000}\right)^{1.34}(\text{LONG-100})^{-0.451}$	35	5.4
50	$Q = 22.3\ \text{AREA}^{0.776}\left(\frac{ELEV-3{,}000}{1{,}000}\right)^{1.16}(\text{LONG-100})^{-0.510}$	36	6.3
100	$Q = 38.6\ \text{AREA}^{0.764}\left(\frac{ELEV-3{,}000}{1{,}000}\right)^{1.00}(\text{LONG-100})^{-0.562}$	38	6.9
200	$Q = 64.3\ \text{AREA}^{0.752}\left(\frac{ELEV-3{,}000}{1{,}000}\right)^{0.857}(\text{LONG-100})^{-0.611}$	40	7.2
500	$Q = 120\ \text{AREA}^{0.738}\left(\frac{ELEV-3{,}000}{1{,}000}\right)^{0.674}(\text{LONG-100})^{-0.670}$	43	7.3

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; ELEV, mean basin elevation, in feet; LONG, longitude of basin outlet location, in decimal degrees.
SEP: Standard error of prediction.

Table C.34. Regression equations for Wyoming based on basin characteristics (Miller, 2003)—Continued

Recurrence interval, in years	Equation	Average SEP, in percent	Equivalent years of record
Central Basins and Northern Plains (Hydrologic Region 2 in Wyoming)			
1.5	$Q = 17.8\ \mathrm{AREA}^{0.486}$	135	1.4
2	$Q = 29.9\ \mathrm{AREA}^{0.475}$	113	1.6
2.33	$Q = 37.1\ \mathrm{AREA}^{0.470}$	105	1.7
5	$Q = 80.9\ \mathrm{AREA}^{0.455}$	81	3.4
10	$Q = 134\ \mathrm{AREA}^{0.447}$	69	5.9
25	$Q = 225\ \mathrm{AREA}^{0.439}$	60	10.4
50	$Q = 311\ \mathrm{AREA}^{0.434}$	57	13.9
100	$Q = 415\ \mathrm{AREA}^{0.430}$	56	16.9
200	$Q = 536\ \mathrm{AREA}^{0.427}$	57	19.0
500	$Q = 728\ \mathrm{AREA}^{0.425}$	61	20.1
Eastern Basins and Eastern Plains (Hydrologic Region 3 in Wyoming)			
1.5	$Q = 1.12\ \mathrm{AREA}^{0.401}\mathrm{SHI}^{3.01}$	127	2.0
2	$Q = 2.28\ \mathrm{AREA}^{0.402}\mathrm{SHI}^{2.90}$	98	2.6
2.33	$Q = 3.10\ \mathrm{AREA}^{0.403}\mathrm{SHI}^{2.84}$	89	3.1
5	$Q = 10.1\ \mathrm{AREA}^{0.407}\mathrm{SHI}^{2.60}$	61	7.7
10	$Q = 21.9\ \mathrm{AREA}^{0.410}\mathrm{SHI}^{2.44}$	51	14.4
25	$Q = 48.8\ \mathrm{AREA}^{0.416}\mathrm{SHI}^{2.27}$	46	23.6
50	$Q = 80.9\ \mathrm{AREA}^{0.423}\mathrm{SHI}^{2.16}$	48	28.0
100	$Q = 127\ \mathrm{AREA}^{0.432}\mathrm{SHI}^{2.05}$	51	29.5
200	$Q = 193\ \mathrm{AREA}^{0.441}\mathrm{SHI}^{1.94}$	56	28.9
500	$Q = 323\ \mathrm{AREA}^{0.454}\mathrm{SHI}^{1.80}$	66	26.6

Equation: Q, peak flow, in cubic feet per second; AREA, drainage area, in square miles; SHI, mean basin soils hydrologic index (figure C.10), unitless.

SEP: Standard error of prediction

Table C.35. Regression equations for Wyoming based on basin characteristics (Miller, 2003)—Continued

Recurrence interval, in years	Equation	Average SEP, in percent	Equivalent years of record
	Eastern Mountains (Hydrologic Region 4 in Wyoming)		
1.5	$Q = 4.27\ \mathrm{AREA}^{0.518}\mathrm{MAR}^{1.42}(\mathrm{LAT}\text{-}40)^{-0.435}$	53	3.4
2	$Q = 6.26\ \mathrm{AREA}^{0.506}\mathrm{MAR}^{1.33}(\mathrm{LAT}\text{-}40)^{-0.315}$	53	3.2
2.33	$Q = 7.27\ \mathrm{AREA}^{0.503}\mathrm{MAR}^{1.30}(\mathrm{LAT}\text{-}40)^{-0.262}$	53	3.3
5	$Q = 12.2\ \mathrm{AREA}^{0.506}\mathrm{MAR}^{1.19}(\mathrm{LAT}\text{-}40)^{-0.048}$	53	4.6
10	$Q = 16.9\ \mathrm{AREA}^{0.518}\mathrm{MAR}^{1.12}(\mathrm{LAT}\text{-}40)^{0.107}$	54	6.3
25	$Q = 23.5\ \mathrm{AREA}^{0.536}\mathrm{MAR}^{1.05}(\mathrm{LAT}\text{-}40)^{0.283}$	54	8.9
50	$Q = 29.1\ \mathrm{AREA}^{0.549}\mathrm{MAR}^{1.01}(\mathrm{LAT}\text{-}40)^{0.403}$	54	11.0
100	$Q = 35.3\ \mathrm{AREA}^{0.562}\mathrm{MAR}^{0.963}(\mathrm{LAT}\text{-}40)^{0.517}$	54	13.1
200	$Q = 42.2\ \mathrm{AREA}^{0.573}\mathrm{MAR}^{0.922}(\mathrm{LAT}\text{-}40)^{0.626}$	55	15.1
500	$Q = 52.5\ \mathrm{AREA}^{0.585}\mathrm{MAR}^{0.873}(\mathrm{LAT}\text{-}40)^{0.766}$	56	17.5
	Overthrust Belt (Hydrologic Region 5 in Wyoming)		
1.5	$Q = 2.08\ \mathrm{AREA}^{0.871}\mathrm{JAN}^{1.02}$	63	0.8
2	$Q = 3.07\ \mathrm{AREA}^{0.869}\mathrm{JAN}^{0.884}$	61	0.7
2.33	$Q = 3.58\ \mathrm{AREA}^{0.868}\mathrm{JAN}^{0.831}$	61	0.6
5	$Q = 6.19\ \mathrm{AREA}^{0.864}\mathrm{JAN}^{0.643}$	61	0.8
10	$Q = 8.71\ \mathrm{AREA}^{0.861}\mathrm{JAN}^{0.529}$	62	1.0
25	$Q = 12.3\ \mathrm{AREA}^{0.857}\mathrm{JAN}^{0.415}$	64	1.2
50	$Q = 15.2\ \mathrm{AREA}^{0.853}\mathrm{JAN}^{0.346}$	66	1.4
100	$Q = 18.3\ \mathrm{AREA}^{0.850}\mathrm{JAN}^{0.287}$	68	1.6
200	$Q = 21.6\ \mathrm{AREA}^{0.847}\mathrm{JAN}^{0.235}$	69	1.7
500	$Q = 26.2\ \mathrm{AREA}^{0.842}\mathrm{JAN}^{0.176}$	72	1.9

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; JAN, mean January precipitation, in inches; MAR, mean March precipitation, in inches; LAT, latitude of basin outlet location, in decimal degrees.

SEP: Standard error of prediction

Table C.36. Regression equations for Wyoming based on basin characteristics (Miller, 2003)—Continued

Recurrence interval, in years	Equation	Average SEP, in percent	Equivalent years of record
	High Desert (Hydrologic Region 6 in Wyoming)		
1.5	$Q = 12.7\ \mathrm{AREA}^{0.626}(\mathrm{LAT}-40)^{-1.18}$	72	3.2
2	$Q = 22.2\ \mathrm{AREA}^{0.608}(\mathrm{LAT}-40)^{-1.24}$	66	3.2
2.33	$Q = 28.1\ \mathrm{AREA}^{0.600}(\mathrm{LAT}-40)^{-1.26}$	64	3.3
5	$Q = 66.4\ \mathrm{AREA}^{0.567}(\mathrm{LAT}-40)^{-1.35}$	59	4.7
10	$Q = 116\ \mathrm{AREA}^{0.544}(\mathrm{LAT}-40)^{-1.40}$	57	6.4
25	$Q = 204\ \mathrm{AREA}^{0.520}(\mathrm{LAT}-40)^{-1.44}$	58	8.5
50	$Q = 290\ \mathrm{AREA}^{0.504}(\mathrm{LAT}-40)^{-1.46}$	60	9.7
100	$Q = 394\ \mathrm{AREA}^{0.489}(\mathrm{LAT}-40)^{-1.47}$	63	10.4
200	$Q = 519\ \mathrm{AREA}^{0.476}(\mathrm{LAT}-40)^{-1.48}$	67	10.9
500	$Q = 719\ \mathrm{AREA}^{0.459}(\mathrm{LAT}-40)^{-1.49}$	73	11.1

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; LAT, latitude of basin outlet location, in decimal degrees.

SEP: Standard error of prediction

Table C.37. Exponent coefficients for estimation of peak flow of ungaged sites near gaged sites on the same stream in New Mexico (Waltemeyer, 1996; Mason and others, 2000)

Recurrence interval, in years	Hydrologic regions of New Mexico								
	Region 1	**Region 2**	**Region 3**	**Region 4**	**Region 5**	**Region 6**	**Region 7**	**Region 8**	**Statewide small basin**
	Northeast Plains	**Northwest Plateau**	**Southeast Mountain**	**Southeast Plains**	**Northern Mountain**	**Central Mountain Valley**	**Southwest Desert**	**Southwest Mountain**	
2	0.53	0.47	0.60	0.51	0.83	0.50	0.46	0.19	0.39
5	0.50	0.46	0.67	0.54	0.81	0.47	0.48	0.23	0.42
10	0.49	0.46	0.70	0.55	0.81	0.46	0.49	0.25	0.43
25	0.48	0.45	0.75	0.57	0.80	0.44	0.50	0.27	0.44
50	0.48	0.45	0.78	0.58	0.80	0.43	0.51	0.29	0.45
100	0.48	0.45	0.81	0.59	0.80	0.42	0.52	0.30	0.46
500	0.48	0.45	0.87	0.62	0.80	0.40	0.55	0.32	0.47

Applicable when the drainage area ratio (A_u/A_g) is between 0.5 and 1.5.
Statewide small basin has basin size of 10 square miles or less, and mean basin elevation of less than 7,500 feet.

Table C.38. Flood-peak flow regression equations and associated statistics for streams that drain rural areas in New Mexico (Waltemeyer, 1996; Mason and others, 2000)

Recurrence interval, in years	**Equation**	**Average SEP, in percent**
	Northeast Plains Region (1)	
2	$Q = 114\ \mathrm{AREA}^{0.53}$	96
5	$Q = 307\ \mathrm{AREA}^{0.50}$	78
10	$Q = 508\ \mathrm{AREA}^{0.49}$	75
25	$Q = 853\ \mathrm{AREA}^{0.48}$	72
50	$Q = 1{,}180\ \mathrm{AREA}^{0.48}$	72
100	$Q = 1{,}580\ \mathrm{AREA}^{0.48}$	75
500	$Q = 2{,}800\ \mathrm{AREA}^{0.48}$	82
	Northwest Plateau Region (2)	
2	$Q = 84.7\ \mathrm{AREA}^{0.47}$	111
5	$Q = 197\ \mathrm{AREA}^{0.46}$	82
10	$Q = 306\ \mathrm{AREA}^{0.46}$	72
25	$Q = 486\ \mathrm{AREA}^{0.45}$	66
50	$Q = 654\ \mathrm{AREA}^{0.45}$	63
100	$Q = 853\ \mathrm{AREA}^{0.45}$	63
500	$Q = 1{,}450\ \mathrm{AREA}^{0.45}$	66
	Southeast Mountain Region (3)	
2	$Q = 8{,}540{,}000\ \mathrm{AREA}^{0.60}(\mathrm{ELEV}/1{,}000)^{-5.96}$	36
5	$Q = 71{,}400{,}000\ \mathrm{AREA}^{0.67}(\mathrm{ELEV}/1{,}000)^{-6.69}$	38
10	$Q = 160{,}000{,}000\ \mathrm{AREA}^{0.70}(\mathrm{ELEV}/1{,}000)^{-6.94}$	41
25	$Q = 304{,}000{,}000\ \mathrm{AREA}^{0.75}(\mathrm{ELEV}/1{,}000)^{-7.10}$	43
50	$Q = 415{,}000{,}000\ \mathrm{AREA}^{0.78}(\mathrm{ELEV}/1{,}000)^{-7.16}$	46
100	$Q = 521{,}000{,}000\ \mathrm{AREA}^{0.81}(\mathrm{ELEV}/1{,}000)^{-7.19}$	49
500	$Q = 711{,}000{,}000\ \mathrm{AREA}^{0.87}(\mathrm{ELEV}/1{,}000)^{-7.20}$	60

Equation: Q, peak flow, in cubic feet per second; AREA, drainage area, in square miles; ELEV, mean basin elevation, in feet.

SEP: Standard error of prediction; n: number of stations used in the regression analysis.

Table C.39. Flood-peak flow regression equations and associated statistics for streams that drain rural areas in New Mexico (Waltemeyer, 1996; Mason and others, 2000)—Continued

Recurrence interval, in years	Equation	Average SEP, in percent
	Southeast Plains Region (4)	
2	$Q = 81.7\ \mathrm{AREA}^{0.51}$	192
5	$Q = 236\ \mathrm{AREA}^{0.54}$	124
10	$Q = 407\ \mathrm{AREA}^{0.55}$	103
25	$Q = 721\ \mathrm{AREA}^{0.57}$	88
50	$Q = 1{,}040\ \mathrm{AREA}^{0.58}$	78
100	$Q = 1{,}430\ \mathrm{AREA}^{0.59}$	72
500	$Q = 2{,}720\ \mathrm{AREA}^{0.62}$	66
	Northern Mountain Region (5)	
2	$Q = 854\ \mathrm{AREA}^{0.83}(\mathrm{ELEV}/1{,}000)^{-2.22}I_{25}^{0.31}$	92
5	$Q = 7{,}390\ \mathrm{AREA}^{0.81}(\mathrm{ELEV}/1{,}000)^{-3.01}I_{25}^{0.63}$	82
10	$Q = 21{,}900\ \mathrm{AREA}^{0.81}(\mathrm{ELEV}/1{,}000)^{-3.41}I_{25}^{0.81}$	78
25	$Q = 69{,}000\ \mathrm{AREA}^{0.80}(\mathrm{ELEV}/1{,}000)^{-3.85}I_{25}^{1.03}$	75
50	$Q = 144{,}000\ \mathrm{AREA}^{0.80}(\mathrm{ELEV}/1{,}000)^{-4.13}I_{25}^{1.18}$	78
100	$Q = 280{,}000\ \mathrm{AREA}^{0.80}(\mathrm{ELEV}/1{,}000)^{-4.40}I_{25}^{1.33}$	82
500	$Q = 1{,}100{,}000\ \mathrm{AREA}^{0.80}(\mathrm{ELEV}/1{,}000)^{-4.95}I_{25}^{1.64}$	92
	Central Mountain Valley Region (6)	
2	$Q = 747{,}000\ \mathrm{AREA}^{0.50}(\mathrm{CE}/1{,}000)^{-5.28}I_{10}^{1.18}$	103
5	$Q = 257{,}000\ \mathrm{AREA}^{0.47}(\mathrm{CE}/1{,}000)^{-4.49}I_{10}^{1.76}$	69
10	$Q = 153{,}000\ \mathrm{AREA}^{0.46}(\mathrm{CE}/1{,}000)^{-4.09}I_{10}^{2.06}$	57
25	$Q = 88{,}900\ \mathrm{AREA}^{0.44}(\mathrm{CE}/1{,}000)^{-3.67}I_{10}^{2.37}$	46
50	$Q = 61{,}100\ \mathrm{AREA}^{0.43}(\mathrm{CE}/1{,}000)^{-3.38}I_{10}^{2.57}$	43
100	$Q = 41{,}800\ \mathrm{AREA}^{0.42}(\mathrm{CE}/1{,}000)^{-3.09}I_{10}^{2.74}$	41
500	$Q = 17{,}800\ \mathrm{AREA}^{0.40}(\mathrm{CE}/1{,}000)^{-2.45}I_{10}^{3.03}$	43

Equation: Q, peak flow, in cubic feet per second; AREA, drainage area, in square miles; ELEV, mean basin elevation, in feet; CE, average channel elevation, in feet above sea level; I_{10}, maximum precipitation intensity, 24-hour precipitation intensity, in inches, with a recurrence interval of 10 years; I_{25}, maximum precipitation intensity, 24-hour precipitation intensity, in inches, with a recurrence interval of 25 years.

SEP: Standard error of prediction; n: number of stations used in the regression analysis.

Table C.40 Flood-peak flow regression equations and associated statistics for streams that drain rural areas in New Mexico (Waltemeyer, 1996; Mason and others, 2000)—Continued

Recurrence interval, in years	Equation	Average SEP, in percent
	Southwest Desert Region (7)	
2	$Q = 128\ \mathrm{AREA}^{0.46}$	57
5	$Q = 246\ \mathrm{AREA}^{0.48}$	51
10	$Q = 345\ \mathrm{AREA}^{0.49}$	51
25	$Q = 491\ \mathrm{AREA}^{0.50}$	54
50	$Q = 615\ \mathrm{AREA}^{0.51}$	57
100	$Q = 751\ \mathrm{AREA}^{0.52}$	60
500	$Q = 1{,}120\ \mathrm{AREA}^{0.55}$	72
	Southwest Mountain Region (8)	
2	$Q = 25{,}800{,}000\ \mathrm{AREA}^{0.19}(\mathrm{CE}/1{,}000)^{-6.10}$	88
5	$Q = 14{,}900{,}000\ \mathrm{AREA}^{0.23}(\mathrm{CE}/1{,}000)^{-5.53}$	85
10	$Q = 10{,}300{,}000\ \mathrm{AREA}^{0.25}(\mathrm{CE}/1{,}000)^{-5.19}$	85
25	$Q = 6{,}530{,}000\ \mathrm{AREA}^{0.27}(\mathrm{CE}/1{,}000)^{-4.80}$	88
50	$Q = 4{,}690{,}000\ \mathrm{AREA}^{0.29}(\mathrm{CE}/1{,}000)^{-4.52}$	92
100	$Q = 3{,}400{,}000\ \mathrm{AREA}^{0.30}(\mathrm{CE}/1{,}000)^{-4.25}$	96
500	$Q = 1{,}660{,}000\ \mathrm{AREA}^{0.32}(\mathrm{CE}/1{,}000)^{-3.68}$	116
Statewide small basin, less than 10 square miles and less than 7,500 feet mean basin elevation		
2	$Q = 107\ \mathrm{AREA}^{0.39}$	120
5	$Q = 243\ \mathrm{AREA}^{0.42}$	88
10	$Q = 374\ \mathrm{AREA}^{0.43}$	75
25	$Q = 591\ \mathrm{AREA}^{0.44}$	69
50	$Q = 792\ \mathrm{AREA}^{0.45}$	66
100	$Q = 1{,}030\ \mathrm{AREA}^{0.46}$	63
500	$Q = 1{,}730\ \mathrm{AREA}^{0.47}$	63

Equation: Q, peak flow, in cubic feet per second; AREA, drainage area, in square miles; ELEV, mean basin elevation, in feet; CE, average channel elevation, in feet above sea level.
SEP: Standard error of prediction; n: number of stations used in the regression analysis.

Table C.41. Exponent coefficients for estimation of peak flow of ungaged sites near gaged sites on the same stream in Idaho (Berenbrock, 2002)

Hydrologic region	**Exponent, *x***
1	0.65
2	0.88
3	0.84
4	0.85
5	0.94
6	0.80
7a	0.77
7b	0.65
8	0.90

Applicable when the drainage area ratio (A_u/A_g) is between 0.5 and 1.5.

Table C.42. Flood-peak flow regression equations and associated statistics for ungaged sites on unregulated and undiverted streams in Idaho (Berenbrock, 2002)

Recurrence interval, in years	Equation	SEP, in percent
	Region 1 (n = 21)	
2	$Q = 2.52\ \mathrm{AREA}^{0.775}(\mathrm{ELEV}/1{,}000)^{3.32}(\mathrm{F}+1)^{-0.504}$	+78.4 to -43.9
5	$Q = 23.0\ \mathrm{AREA}^{0.720}(\mathrm{ELEV}/1{,}000)^{3.36}(\mathrm{F}+1)^{-0.885}$	+61.1 to -37.9
10	$Q = 81.5\ \mathrm{AREA}^{0.687}(\mathrm{ELEV}/1{,}000)^{3.40}(\mathrm{F}+1)^{-1.10}$	+56.8 to -36.2
25	$Q = 339\ \mathrm{AREA}^{0.649}(\mathrm{ELEV}/1{,}000)^{3.44}(\mathrm{F}+1)^{-1.36}$	+57.1 to -36.3
50	$Q = 876\ \mathrm{AREA}^{0.623}(\mathrm{ELEV}/1{,}000)^{3.47}(\mathrm{F}+1)^{-1.53}$	+60.1 to -37.6
100	$Q = 2{,}080\ \mathrm{AREA}^{0.597}(\mathrm{ELEV}/1{,}000)^{3.49}(\mathrm{F}+1)^{-1.68}$	+64.8 to -39.3
200	$Q = 4{,}660\ \mathrm{AREA}^{0.572}(\mathrm{ELEV}/1{,}000)^{3.52}(\mathrm{F}+1)^{-1.82}$	+70.8 to -41.4
500	$Q = 12{,}600\ \mathrm{AREA}^{0.540}(\mathrm{ELEV}/1{,}000)^{3.56}(\mathrm{F}+1)^{-2.00}$	+80.1 to -44.5
	Region 2 (n = 44)	
2	$Q = 0.742\ \mathrm{AREA}^{0.897}\mathrm{PREC}^{0.935}$	+64.2 to -39.1
5	$Q = 1.50\ \mathrm{AREA}^{0.888}(\mathrm{ELEV}/1{,}000)^{-0.330}\mathrm{PREC}^{0.992}$	+64.3 to -39.1
10	$Q = 2.17\ \mathrm{AREA}^{0.884}(\mathrm{ELEV}/1{,}000)^{-0.538}\mathrm{PREC}^{1.04}$	+65.8 to -39.7
25	$Q = 3.24\ \mathrm{AREA}^{0.879}(\mathrm{ELEV}/1{,}000)^{-0.788}\mathrm{PREC}^{1.10}$	+68.7 to -40.7
50	$Q = 4.22\ \mathrm{AREA}^{0.876}(\mathrm{ELEV}/1{,}000)^{-0.962}\mathrm{PREC}^{1.14}$	+71.4 to -41.6
100	$Q = 5.39\ \mathrm{AREA}^{0.874}(\mathrm{ELEV}/1{,}000)^{-1.13}\mathrm{PREC}^{1.18}$	+74.1 to -42.6
200	$Q = 6.75\ \mathrm{AREA}^{0.872}(\mathrm{ELEV}/1{,}000)^{-1.29}\mathrm{PREC}^{1.21}$	+77.1 to -43.5
500	$Q = 8.90\ \mathrm{AREA}^{0.869}(\mathrm{ELEV}/1{,}000)^{-1.49}\mathrm{PREC}^{1.26}$	+81.3 to -44.8
	Region 3 (n = 26)	
2	$Q = 26.3\ \mathrm{AREA}^{0.864}(\mathrm{ELEV}/1{,}000)^{-0.502}$	+86.4 to -46.4
5	$Q = 127\ \mathrm{AREA}^{0.842}(\mathrm{ELEV}/1{,}000)^{-1.31}$	+58.6 to -36.9
10	$Q = 265\ \mathrm{AREA}^{0.837}(\mathrm{ELEV}/1{,}000)^{-1.68}$	+51.8 to -34.1
25	$Q = 504\ \mathrm{AREA}^{0.833}(\mathrm{ELEV}/1{,}000)^{-1.95}$	+50.3 to -33.5
50	$Q = 719\ \mathrm{AREA}^{0.832}(\mathrm{ELEV}/1{,}000)^{-2.08}$	+51.9 to -34.2
100	$Q = 965\ \mathrm{AREA}^{0.831}(\mathrm{ELEV}/1{,}000)^{-2.18}$	+55.1 to -35.5
200	$Q = 1{,}240\ \mathrm{AREA}^{0.831}(\mathrm{ELEV}/1{,}000)^{-2.26}$	+59.4 to -37.3
500	$Q = 1{,}660\ \mathrm{AREA}^{0.832}(\mathrm{ELEV}/1{,}000)^{-2.35}$	+66.2 to -39.8

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; ELEV, mean basin elevation, in feet; F, percentage of basin covered by forest; PREC, mean annual precipitation, in inches.

SEP: Standard error of prediction; n: number of stations used in the regression analysis.

Table C.43. Flood-peak flow regression equations and associated statistics for ungaged sites on unregulated and undiverted streams in Idaho (Berenbrock, 2002)—Continued

Recurrence interval, in years	Equation	SEP, in percent
	Region 3 (n = 60)	
2	$Q = 16.3\ \mathrm{AREA}^{0.893}(\mathrm{ELEV}/1{,}000)^{-0.121}$	+83.5 to -45.5
5	$Q = 46.3\ \mathrm{AREA}^{0.874}(\mathrm{ELEV}/1{,}000)^{-0.459}$	+69.1 to -40.9
10	$Q = 79.2\ \mathrm{AREA}^{0.863}(\mathrm{ELEV}/1{,}000)^{-0.628}$	+63.6 to -38.9
25	$Q = 139\ \mathrm{AREA}^{0.852}(\mathrm{ELEV}/1{,}000)^{-0.801}$	+59.5 to -37.3
50	$Q = 198\ \mathrm{AREA}^{0.844}(\mathrm{ELEV}/1{,}000)^{-0.910}$	+57.7 to -36.6
100	$Q = 273\ \mathrm{AREA}^{0.837}(\mathrm{ELEV}/1{,}000)^{-1.01}$	+56.9 to -36.3
200	$Q = 365\ \mathrm{AREA}^{0.831}(\mathrm{ELEV}/1{,}000)^{-1.10}$	+56.6 to -36.1
500	$Q = 521\ \mathrm{AREA}^{0.822}(\mathrm{ELEV}/1{,}000)^{-1.20}$	+56.9 to -36.3
	Region 5 (n = 46)	
2	$Q = 0.0297\ \mathrm{AREA}^{0.995}\mathrm{PREC}^{2.20}(\mathrm{NS}_{30}+1)^{-0.664}$	+46.7 to -31.8
5	$Q = 0.0992\ \mathrm{AREA}^{0.970}\mathrm{PREC}^{1.92}(\mathrm{NS}_{30}+1)^{-0.602}$	+44.8 to -30.9
10	$Q = 0.178\ \mathrm{AREA}^{0.957}\mathrm{PREC}^{1.79}(\mathrm{NS}_{30}+1)^{-0.571}$	+45.0 to -31.1
25	$Q = 0.319\ \mathrm{AREA}^{0.943}\mathrm{PREC}^{1.66}(\mathrm{NS}_{30}+1)^{-0.538}$	+46.0 to -31.5
50	$Q = 0.456\ \mathrm{AREA}^{0.934}\mathrm{PREC}^{1.58}(\mathrm{NS}_{30}+1)^{-0.517}$	+47.1 to -32.0
100	$Q = 0.620\ \mathrm{AREA}^{0.926}\mathrm{PREC}^{1.52}(\mathrm{NS}_{30}+1)^{-0.499}$	+48.4 to -32.6
200	$Q = 0.813\ \mathrm{AREA}^{0.919}\mathrm{PREC}^{1.46}(\mathrm{NS}_{30}+1)^{-0.483}$	+49.8 to -33.2
500	$Q = 1.12\ \mathrm{AREA}^{0.911}\mathrm{PREC}^{1.39}(\mathrm{NS}_{30}+1)^{-0.464}$	+51.9 to -34.2
	Region 6 (n = 31)	
2	$Q = 0.000258\ \mathrm{AREA}^{0.893}\mathrm{PREC}^{3.15}$	+76.5 to -43.4
5	$Q = 0.00223\ \mathrm{AREA}^{0.846}\mathrm{PREC}^{2.68}$	+68.8 to -40.8
10	$Q = 0.00632\ \mathrm{AREA}^{0.824}\mathrm{PREC}^{2.45}$	+67.9 to -40.4
25	$Q = 0.0181\ \mathrm{AREA}^{0.801}\mathrm{PREC}^{2.22}$	+68.8 to -40.8
50	$Q = 0.0346\ \mathrm{AREA}^{0.787}\mathrm{PREC}^{2.08}$	+70.2 to -41.2
100	$Q = 0.0607\ \mathrm{AREA}^{0.775}\mathrm{PREC}^{1.96}$	+71.8 to -41.8
200	$Q = 0.100\ \mathrm{AREA}^{0.763}\mathrm{PREC}^{1.85}$	+73.8 to -42.4
500	$Q = 0.180\ \mathrm{AREA}^{0.750}\mathrm{PREC}^{1.73}$	+76.5 to -43.3

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; ELEV, mean basin elevation, in feet; PREC, mean annual precipitation, in inches; NS_{30}, percentage of north-facing slopes greater than 30 percent.

SEP: Standard error of prediction; n: number of stations used in the regression analysis.

Table C.44. Flood-peak flow regression equations and associated statistics for ungaged sites on unregulated and undiverted streams in Idaho (Berenbrock, 2002)—Continued

Recurrence interval, in years	Equation	SEP, in percent
	Region 7a (n = 28)	
2	$Q = 2.28\ \mathrm{AREA}^{0.759}(\mathrm{ELEV}/1{,}000)^{0.769}$	+82.3 to -45.2
5	$Q = 27.3\ \mathrm{AREA}^{0.762}(\mathrm{ELEV}/1{,}000)^{-0.211}$	+66.6 to -40.0
10	$Q = 88.4\ \mathrm{AREA}^{0.766}(\mathrm{ELEV}/1{,}000)^{-0.669}$	+62.2 to -38.3
25	$Q = 286\ \mathrm{AREA}^{0.771}(\mathrm{ELEV}/1{,}000)^{-1.12}$	+60.6 to -37.7
50	$Q = 592\ \mathrm{AREA}^{0.774}(\mathrm{ELEV}/1{,}000)^{-1.41}$	+61.4 to -38.0
100	$Q = 1{,}120\ \mathrm{AREA}^{0.778}(\mathrm{ELEV}/1{,}000)^{-1.65}$	+63.3 to -38.8
200	$Q = 1{,}970\ \mathrm{AREA}^{0.781}(\mathrm{ELEV}/1{,}000)^{-1.87}$	+66.2 to -39.8
500	$Q = 3{,}860\ \mathrm{AREA}^{0.784}(\mathrm{ELEV}/1{,}000)^{-2.13}$	+71.1 to -41.5
	Region 7b (n = 17)	
2	$Q = 10.2\ \mathrm{AREA}^{0.611}$	+143 to -58.8
5	$Q = 17.1\ \mathrm{AREA}^{0.624}$	+104 to -50.9
10	$Q = 22.4\ \mathrm{AREA}^{0.633}$	+86.9 to -46.5
25	$Q = 29.9\ \mathrm{AREA}^{0.644}$	+73.5 to -42.3
50	$Q = 35.7\ \mathrm{AREA}^{0.653}$	+68.0 to -40.5
100	$Q = 41.6\ \mathrm{AREA}^{0.662}$	+66.1 to -39.8
200	$Q = 47.5\ \mathrm{AREA}^{0.672}$	+66.9 to -40.1
500	$Q = 55.5\ \mathrm{AREA}^{0.686}$	+71.8 to -41.8
	Region 8 (n = 60)	
2	$Q = 1.49\ \mathrm{AREA}^{0.942}\mathrm{BS}_{\%}^{1.15}(\mathrm{S}_{30}+1)^{-0.563}$	+86.9 to -46.5
5	$Q = 1.93\ \mathrm{AREA}^{0.915}\mathrm{BS}_{\%}^{1.53}(\mathrm{S}_{30}+1)^{-0.862}$	+79.8 to -44.4
10	$Q = 2.10\ \mathrm{AREA}^{0.903}\mathrm{BS}_{\%}^{1.75}(\mathrm{S}_{30}+1)^{-1.03}$	+78.3 to -43.9
25	$Q = 2.22\ \mathrm{AREA}^{0.892}\mathrm{BS}_{\%}^{1.99}(\mathrm{S}_{30}+1)^{-1.21}$	+78.2 to -43.9
50	$Q = 2.26\ \mathrm{AREA}^{0.886}\mathrm{BS}_{\%}^{2.15}(\mathrm{S}_{30}+1)^{-1.33}$	+78.9 to -44.1
100	$Q = 2.27\ \mathrm{AREA}^{0.882}\mathrm{BS}_{\%}^{2.31}(\mathrm{S}_{30}+1)^{-1.44}$	+79.9 to -44.4
200	$Q = 2.25\ \mathrm{AREA}^{0.878}\mathrm{BS}_{\%}^{2.45}(\mathrm{S}_{30}+1)^{-1.54}$	+81.2 to -44.8
500	$Q = 2.22\ \mathrm{AREA}^{0.874}\mathrm{BS}_{\%}^{2.62}(\mathrm{S}_{30}+1)^{-1.67}$	+83.2 to -45.4

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; ELEV, mean basin elevation, in feet; $\mathrm{BS}_{\%}$, average basin slope, in percent; S_{30}, percentage of slopes greater than 30 percent.

SEP: Standard error of prediction; n: number of stations used in the regression analysis.

Table C.45. Exponent coefficients for estimation of peak flow of ungaged sites near gaged sites on the same stream in Utah (Kenney and others, 2007)

Hydrologic region	**Exponent, *x***
1	0.49
2	0.51
3	0.21
4	0.84
5	0.53
6	0.31
7	0.45

Applicable when the drainage area ratio (A_u/A_g) is between 0.5 and 1.5.

Table C.46. Predictive regression equations and their associated uncertainty in estimating peak flows for natural streams in Utah (Kenney and others, 2007)

Recurrence interval, in years	Equation	Average SEP, in percent	Equivalent years of record
	Region 1 (n = 46)		
2	$Q = 1.52\ \mathrm{AREA}^{0.677} 1.39^{(\mathrm{ELEV}/1{,}000)}$	62	0.97
5	$Q = 5.49\ \mathrm{AREA}^{0.614} 1.30^{(\mathrm{ELEV}/1{,}000)}$	54	1.49
10	$Q = 10.3\ \mathrm{AREA}^{0.581} 1.25^{(\mathrm{ELEV}/1{,}000)}$	53	2.00
25	$Q = 19.7\ \mathrm{AREA}^{0.547} 1.21^{(\mathrm{ELEV}/1{,}000)}$	55	2.59
50	$Q = 29.4\ \mathrm{AREA}^{0.524} 1.19^{(\mathrm{ELEV}/1{,}000)}$	57	2.92
100	$Q = 40.4\ \mathrm{AREA}^{0.512} 1.17^{(\mathrm{ELEV}/1{,}000)}$	58	3.34
200	$Q = 58.3\ \mathrm{AREA}^{0.483} 1.15^{(\mathrm{ELEV}/1{,}000)}$	63	3.35
500	$Q = 85.4\ \mathrm{AREA}^{0.457} 1.13^{(\mathrm{ELEV}/1{,}000)}$	68	3.50
	Region 2 (n = 32)		
2	$Q = 0.585\ \mathrm{AREA}^{0.847} 1.07^{\mathrm{PREC}}$	71	0.91
5	$Q = 1.56\ \mathrm{AREA}^{0.747} 1.07^{\mathrm{PREC}}$	58	1.62
10	$Q = 2.51\ \mathrm{AREA}^{0.703} 1.06^{\mathrm{PREC}}$	53	2.46
25	$Q = 4.00\ \mathrm{AREA}^{0.661} 1.06^{\mathrm{PREC}}$	51	3.70
50	$Q = 5.36\ \mathrm{AREA}^{0.635} 1.06^{\mathrm{PREC}}$	50	4.59
100	$Q = 6.92\ \mathrm{AREA}^{0.613} 1.06^{\mathrm{PREC}}$	50	5.38
200	$Q = 8.79\ \mathrm{AREA}^{0.592} 1.05^{\mathrm{PREC}}$	51	6.06
500	$Q = 12.0\ \mathrm{AREA}^{0.555} 1.05^{\mathrm{PREC}}$	52	6.84
	Region 3 (n = 14)		
2	$Q = 14.5\ \mathrm{AREA}^{0.328}$	357	0.60
5	$Q = 47.6\ \mathrm{AREA}^{0.287}$	194	1.40
10	$Q = 83.7\ \mathrm{AREA}^{0.289}$	152	2.49
25	$Q = 148\ \mathrm{AREA}^{0.298}$	130	4.21
50	$Q = 215\ \mathrm{AREA}^{0.302}$	128	5.28
100	$Q = 300\ \mathrm{AREA}^{0.303}$	136	5.89
200	$Q = 411\ \mathrm{AREA}^{0.301}$	150	6.13
500	$Q = 599\ \mathrm{AREA}^{0.299}$	177	6.10

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; ELEV, mean basin elevation, in feet; PREC, mean annual precipitation, in inches.

SEP: Standard error of prediction; n: number of stations used in the regression analysis.

Table C.47. Predictive regression equations and their associated uncertainty in estimating peak flows for natural streams in Utah (Kenney and others, 2007)—Continued

Recurrence interval, in years	Equation	Average SEP, in percent	Equivalent years of record
	Region 4 (n = 42)		
2	$Q = 0.083\ \mathrm{AREA}^{0.822} 2.72^{0.656\ (\mathrm{ELEV}/1{,}000) - 0.039\ \mathrm{BS\%}}$	49	1.35
5	$Q = 0.359\ \mathrm{AREA}^{0.816} 2.72^{0.537\ (\mathrm{ELEV}/1{,}000) - 0.035\ \mathrm{BS\%}}$	37	2.60
10	$Q = 0.753\ \mathrm{AREA}^{0.811} 2.72^{0.500\ (\mathrm{ELEV}/1{,}000) - 0.032\ \mathrm{BS\%}}$	35	3.84
25	$Q = 1.64\ \mathrm{AREA}^{0.804} 2.72^{0.414\ (\mathrm{ELEV}/1{,}000) - 0.030\ \mathrm{BS\%}}$	35	5.07
50	$Q = 2.68\ \mathrm{AREA}^{0.798} 2.72^{0.373\ (\mathrm{ELEV}/1{,}000) - 0.028\ \mathrm{BS\%}}$	37	5.56
100	$Q = 4.18\ \mathrm{AREA}^{0.792} 2.72^{0.334\ (\mathrm{ELEV}/1{,}000) - 0.023\ \mathrm{BS\%}}$	39	5.72
200	$Q = 6.29\ \mathrm{AREA}^{0.786} 2.72^{0.299\ (\mathrm{ELEV}/1{,}000) - 0.021\ \mathrm{BS\%}}$	43	5.69
500	$Q = 10.5\ \mathrm{AREA}^{0.778} 2.72^{0.256\ (\mathrm{ELEV}/1{,}000) - 0.018\ \mathrm{BS\%}}$	47	5.47
	Region 5 (n = 35)		
2	$Q = 4.32\ \mathrm{AREA}^{0.623} (\mathrm{HERB}+1)^{0.503}$	99	1.08
5	$Q = 11.7\ \mathrm{AREA}^{0.575} (\mathrm{HERB}+1)^{0.425}$	60	3.27
10	$Q = 18.4\ \mathrm{AREA}^{0.555} (\mathrm{HERB}+1)^{0.388}$	50	6.11
25	$Q = 28.8\ \mathrm{AREA}^{0.538} (\mathrm{HERB}+1)^{0.352}$	49	8.91
50	$Q = 38.4\ \mathrm{AREA}^{0.536} (\mathrm{HERB}+1)^{0.331}$	53	9.35
100	$Q = 50.2\ \mathrm{AREA}^{0.515} (\mathrm{HERB}+1)^{0.316}$	61	8.79
200	$Q = 64.7\ \mathrm{AREA}^{0.504} (\mathrm{HERB}+1)^{0.300}$	71	7.99
500	$Q = 88.3\ \mathrm{AREA}^{0.489} (\mathrm{HERB}+1)^{0.285}$	86	7.05
	Region 6 (n = 99)		
2	$Q = 4{,}150\ \mathrm{AREA}^{0.553} (\mathrm{ELEV}/1{,}000)^{-2.45}$	108	1.44
5	$Q = 13{,}100\ \mathrm{AREA}^{0.479} (\mathrm{ELEV}/1{,}000)^{-2.44}$	80	3.01
10	$Q = 24{,}700\ \mathrm{AREA}^{0.444} (\mathrm{ELEV}/1{,}000)^{-2.47}$	70	5.06
25	$Q = 49{,}500\ \mathrm{AREA}^{0.411} (\mathrm{ELEV}/1{,}000)^{-2.51}$	62	8.43
50	$Q = 77{,}400\ \mathrm{AREA}^{0.391} (\mathrm{ELEV}/1{,}000)^{-2.54}$	60	10.95
100	$Q = 115{,}000\ \mathrm{AREA}^{0.391} (\mathrm{ELEV}/1{,}000)^{-2.58}$	61	12.97
200	$Q = 166{,}000\ \mathrm{AREA}^{0.361} (\mathrm{ELEV}/1{,}000)^{-2.61}$	62	14.42
500	$Q = 258{,}000\ \mathrm{AREA}^{0.344} (\mathrm{ELEV}/1{,}000)^{-2.65}$	66	15.40

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; ELEV, mean basin elevation, in feet; $BS_{\%}$, average basin slope, in percent; HERB, area covered by herbaceous upland, in percent.

SEP: Standard error of prediction; n: number of stations used in the regression analysis.

Table C.48. Predictive regression equations and their associated uncertainty in estimating peak flows for natural streams in Utah (Kenney and others, 2007)—Continued

Recurrence interval, in years	Equation	Average SEP, in percent	Equivalent years of record
	Region 7 (n = 25)		
2	$Q = 18.4\ \mathrm{AREA}^{0.630}$	76	2.71
5	$Q = 67.4\ \mathrm{AREA}^{0.539}$	95	2.46
10	$Q = 134\ \mathrm{AREA}^{0.487}$	110	2.62
25	$Q = 278\ \mathrm{AREA}^{0.429}$	132	2.85
50	$Q = 446\ \mathrm{AREA}^{0.390}$	149	2.99
100	$Q = 683\ \mathrm{AREA}^{0.355}$	166	3.13
200	$Q = 1{,}010\ \mathrm{AREA}^{0.321}$	185	3.23
500	$Q = 1{,}620\ \mathrm{AREA}^{0.280}$	211	3.35

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles.
SEP: Standard error of prediction; n: number of stations used in the regression analysis.

Table C.49. Regression equations for estimating magnitude and frequency of floods for ungaged sites in California (Waananen and Crippen, 1977; Jennings and others, 1994; Mann and others, 2004)

Recurrence interval, in years	Equation	Average SEP, in percent
	North Coast Region (n = 125 ~ 141)	
2	$Q = 3.52\ \mathrm{AREA}^{0.90}\mathrm{PREC}^{0.89}\mathrm{H}^{-0.47}$	26
5	$Q = 5.04\ \mathrm{AREA}^{0.89}\mathrm{PREC}^{0.91}\mathrm{H}^{-0.35}$	24
10	$Q = 6.21\ \mathrm{AREA}^{0.88}\mathrm{PREC}^{0.93}\mathrm{H}^{-0.27}$	24
25	$Q = 7.64\ \mathrm{AREA}^{0.87}\mathrm{PREC}^{0.94}\mathrm{H}^{-0.17}$	24
50	$Q = 8.57\ \mathrm{AREA}^{0.87}\mathrm{PREC}^{0.96}\mathrm{H}^{-0.08}$	25
100	$Q = 9.23\ \mathrm{AREA}^{0.87}\mathrm{PREC}^{0.97}$	26
	Northeast Region (n = 20 ~ 31)	
2	$Q = 22\ \mathrm{AREA}^{0.40}$	46
5	$Q = 46\ \mathrm{AREA}^{0.45}$	38
10	$Q = 61\ \mathrm{AREA}^{0.49}$	38
25	$Q = 84\ \mathrm{AREA}^{0.54}$	40
50	$Q = 103\ \mathrm{AREA}^{0.57}$	42
100	$Q = 125\ \mathrm{AREA}^{0.59}$	45
	Sierra Region (n = 212 ~ 249)	
2	$Q = 0.24\ \mathrm{AREA}^{0.88}\mathrm{PREC}^{1.58}\mathrm{H}^{-0.80}$	34
5	$Q = 1.20\ \mathrm{AREA}^{0.82}\mathrm{PREC}^{1.37}\mathrm{H}^{-0.64}$	32
10	$Q = 2.63\ \mathrm{AREA}^{0.80}\mathrm{PREC}^{1.25}\mathrm{H}^{-0.58}$	27
25	$Q = 6.55\ \mathrm{AREA}^{0.79}\mathrm{PREC}^{1.12}\mathrm{H}^{-0.52}$	30
50	$Q = 10.4\ \mathrm{AREA}^{0.78}\mathrm{PREC}^{1.06}\mathrm{H}^{-0.48}$	34
100	$Q = 15.7\ \mathrm{AREA}^{0.77}\mathrm{PREC}^{1.02}\mathrm{H}^{-0.43}$	37
	Central Coast Region (n = 91 ~ 98)	
2	$Q = 0.0061\ \mathrm{AREA}^{0.92}\mathrm{PREC}^{2.54}\mathrm{H}^{-1.10}$	47
5	$Q = 0.118\ \mathrm{AREA}^{0.91}\mathrm{PREC}^{1.95}\mathrm{H}^{-0.79}$	39
10	$Q = 0.583\ \mathrm{AREA}^{0.90}\mathrm{PREC}^{1.61}\mathrm{H}^{-0.64}$	35
25	$Q = 2.91\ \mathrm{AREA}^{0.89}\mathrm{PREC}^{1.26}\mathrm{H}^{-0.50}$	35
50	$Q = 8.20\ \mathrm{AREA}^{0.89}\mathrm{PREC}^{1.03}\mathrm{H}^{-0.41}$	38
100	$Q = 19.7\ \mathrm{AREA}^{0.88}\mathrm{PREC}^{0.84}\mathrm{H}^{-0.33}$	41

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; PREC, mean annual precipitation, in inches; H, altitude index, average of altitude taken at points 10 percent and 85 percent distance between point of interest and basin divide, in thousand feet (10^3 ft); in the North Coast Region, use a minimum value of 1.0 for H.

SEP: Standard error of prediction; n: number of stations used in the regression analysis.

Equations are defined only for basins of 25 square miles or less in the Northeast Region.

Table C.50. Regression equations for estimating magnitude and frequency of floods for ungaged sites in California (Waananen and Crippen, 1977; Jennings and others, 1994)—Continued

Recurrence interval, in years	Equation	Average SEP, in percent
	South Coast Region (n = 137 ~ 143)	
2	$Q = 0.14\ \mathrm{AREA}^{0.72}\mathrm{PREC}^{1.62}$	47
5	$Q = 0.40\ \mathrm{AREA}^{0.77}\mathrm{PREC}^{1.69}$	37
10	$Q = 0.63\ \mathrm{AREA}^{0.79}\mathrm{PREC}^{1.75}$	33
25	$Q = 1.10\ \mathrm{AREA}^{0.81}\mathrm{PREC}^{1.81}$	32
50	$Q = 1.50\ \mathrm{AREA}^{0.82}\mathrm{PREC}^{1.85}$	35
100	$Q = 1.95\ \mathrm{AREA}^{0.83}\mathrm{PREC}^{1.87}$	39
	South Lahontan–Colorado Desert Region (n = 35 ~ 43)	
2	$Q = 7.3\ \mathrm{AREA}^{0.30}$	60
5	$Q = 53\ \mathrm{AREA}^{0.44}$	35
10	$Q = 150\ \mathrm{AREA}^{0.53}$	31
25	$Q = 410\ \mathrm{AREA}^{0.63}$	32
50	$Q = 700\ \mathrm{AREA}^{0.68}$	33
100	$Q = 1{,}080\ \mathrm{AREA}^{0.71}$	36

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; PREC, mean annual precipitation, in inches; H, altitude index, average of altitude taken at points 10 percent and 85 percent distance between point of interest and basin divide, in thousand feet (10^3 ft).

SEP: Standard error of prediction; n: number of stations used in the regression analysis.

Equations are defined only for basins of 25 square miles or less in the South Lahontan–Colorado Desert Region.

Table C.51. Regression equations for estimating magnitude and frequency of floods for ungaged sites in western Oregon (Harris and others, 1979; Jennings and others, 1994)

Recurrence interval, in years	Equation	Average SEP, in percent
	Coast Region (n = 40)	
2	$Q = 4.59\ \mathrm{AREA}^{0.96}(\mathrm{ST}+1)^{-0.45}\mathrm{I}_2^{1.91}$	33
5	$Q = 6.27\ \mathrm{AREA}^{0.95}(\mathrm{ST}+1)^{-0.45}\mathrm{I}_2^{1.95}$	32
10	$Q = 7.32\ \mathrm{AREA}^{0.94}(\mathrm{ST}+1)^{-0.45}\mathrm{I}_2^{1.97}$	33
25	$Q = 8.71\ \mathrm{AREA}^{0.93}(\mathrm{ST}+1)^{-0.45}\mathrm{I}_2^{1.99}$	34
50	$Q = 9.73\ \mathrm{AREA}^{0.93}(\mathrm{ST}+1)^{-0.44}\mathrm{I}_2^{2.01}$	35
100	$Q = 10.7\ \mathrm{AREA}^{0.92}(\mathrm{ST}+1)^{-0.44}\mathrm{I}_2^{2.02}$	37
	Willamette Region (n = 111)	
2	$Q = 8.70\ \mathrm{AREA}^{0.87}\mathrm{I}_2^{1.71}$	33
5	$Q = 15.6\ \mathrm{AREA}^{0.88}\mathrm{I}_2^{1.55}$	33
10	$Q = 21.5\ \mathrm{AREA}^{0.88}\mathrm{I}_2^{1.46}$	33
25	$Q = 30.3\ \mathrm{AREA}^{0.88}\mathrm{I}_2^{1.37}$	34
50	$Q = 38.0\ \mathrm{AREA}^{0.88}\mathrm{I}_2^{1.31}$	36
100	$Q = 46.9\ \mathrm{AREA}^{0.88}\mathrm{I}_2^{1.25}$	37
	Rogue–Umpqua Region (n = 60)	
2	$Q = 24.2\ \mathrm{AREA}^{0.86}(\mathrm{ST}+1)^{-1.16}\mathrm{I}_2^{1.15}$	44
5	$Q = 36.0\ \mathrm{AREA}^{0.88}(\mathrm{ST}+1)^{-1.25}\mathrm{I}_2^{1.15}$	43
10	$Q = 44.8\ \mathrm{AREA}^{0.88}(\mathrm{ST}+1)^{-1.28}\mathrm{I}_2^{1.14}$	44
25	$Q = 56.9\ \mathrm{AREA}^{0.89}(\mathrm{ST}+1)^{-1.31}\mathrm{I}_2^{1.12}$	46
50	$Q = 66.7\ \mathrm{AREA}^{0.90}(\mathrm{ST}+1)^{-1.33}\mathrm{I}_2^{1.10}$	49
100	$Q = 77.3\ \mathrm{AREA}^{0.90}(\mathrm{ST}+1)^{-1.34}\mathrm{I}_2^{1.08}$	51
	High Cascades Region (n = 28)	
2	$Q = 4.75\ \mathrm{AREA}^{0.90}(\mathrm{ST}+1)^{-0.62}(101-\mathrm{F})^{0.11}\mathrm{I}_2^{1.17}$	55
5	$Q = 8.36\ \mathrm{AREA}^{0.86}(\mathrm{ST}+1)^{-0.81}(101-\mathrm{F})^{0.08}\mathrm{I}_2^{1.30}$	50
10	$Q = 11.3\ \mathrm{AREA}^{0.85}(\mathrm{ST}+1)^{-0.92}(101-\mathrm{F})^{0.07}\mathrm{I}_2^{1.37}$	53
25	$Q = 15.4\ \mathrm{AREA}^{0.83}(\mathrm{ST}+1)^{-1.03}(101-\mathrm{F})^{0.05}\mathrm{I}_2^{1.46}$	59
50	$Q = 18.8\ \mathrm{AREA}^{0.82}(\mathrm{ST}+1)^{-1.10}(101-\mathrm{F})^{0.04}\mathrm{I}_2^{1.52}$	66
100	$Q = 22.6\ \mathrm{AREA}^{0.81}(\mathrm{ST}+1)^{-1.17}(101-\mathrm{F})^{0.03}\mathrm{I}_2^{1.57}$	72

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; ST, storage, area of lakes and ponds, in percent; I_2, maximum precipitation intensity, 24-hour precipitation intensity, in inches, with a recurrence interval of 2 years (figure C.23); F, percentage of basin covered by forest.

SEP: Standard error of prediction; n: number of stations used in the regression analysis. .

Table C.52. Regression equations for estimating magnitude and frequency of floods for ungaged sites in eastern Oregon (Harris and Hubbard, 1983; Jennings and others, 1994)

Recurrence interval, in years	Equation	Average SEP, in percent
	North Central Region	
2	$Q = 0.00013\ \mathrm{AREA}^{0.80}\mathrm{PREC}^{1.24}\mathrm{MnJT}^{2.53}$	
5	$Q = 0.00068\ \mathrm{AREA}^{0.76}\mathrm{PREC}^{0.90}\mathrm{MnJT}^{2.64}$	
10	$Q = 0.00134\ \mathrm{AREA}^{0.74}\mathrm{PREC}^{0.73}\mathrm{MnJT}^{2.73}$	41 to 51
25	$Q = 0.00325\ \mathrm{AREA}^{0.72}\mathrm{PREC}^{0.55}\mathrm{MnJT}^{2.78}$	
50	$Q = 0.00533\ \mathrm{AREA}^{0.70}\mathrm{PREC}^{0.44}\mathrm{MnJT}^{2.83}$	
100	$Q = 0.00863\ \mathrm{AREA}^{0.69}\mathrm{PREC}^{0.35}\mathrm{MnJT}^{2.86}$	
	East Cascade Region	
2	$Q = 0.017\ \mathrm{CL}^{1.72}\mathrm{PREC}^{1.32}$	
5	$Q = 0.118\ \mathrm{CL}^{1.59}\mathrm{PREC}^{1.01}$	
10	$Q = 0.319\ \mathrm{CL}^{1.53}\mathrm{PREC}^{0.85}$	41 to 51
25	$Q = 0.881\ \mathrm{CL}^{1.46}\mathrm{PREC}^{0.68}$	
50	$Q = 1.67\ \mathrm{CL}^{1.42}\mathrm{PREC}^{0.58}$	
100	$Q = 2.92\ \mathrm{CL}^{1.39}\mathrm{PREC}^{0.49}$	
	Southeast Region	
2	$Q = 0.105\ \mathrm{AREA}^{0.79}\mathrm{MnJT}^{1.67}$	
5	$Q = 0.328\ \mathrm{AREA}^{0.77}\mathrm{MnJT}^{1.52}$	
10	$Q = 0.509\ \mathrm{AREA}^{0.77}\mathrm{MnJT}^{1.50}$	41 to 51
25	$Q = 0.723\ \mathrm{AREA}^{0.75}\mathrm{MnJT}^{1.52}$	
50	$Q = 0.872\ \mathrm{AREA}^{0.76}\mathrm{MnJT}^{1.52}$	
100	$Q = 0.960\ \mathrm{AREA}^{0.75}\mathrm{MnJT}^{1.57}$	
	Northeast Region	
2	$Q = 0.508\ \mathrm{AREA}^{0.82}\mathrm{PREC}^{1.36}(1+\mathrm{F})^{-0.27}$	
5	$Q = 2.44\ \mathrm{AREA}^{0.79}\mathrm{PREC}^{1.09}(1+\mathrm{F})^{-0.30}$	
10	$Q = 5.28\ \mathrm{AREA}^{0.78}\mathrm{PREC}^{0.96}(1+\mathrm{F})^{-0.32}$	41 to 51
25	$Q = 11.8\ \mathrm{AREA}^{0.77}\mathrm{PREC}^{0.83}(1+\mathrm{F})^{-0.35}$	
50	$Q = 19.8\ \mathrm{AREA}^{0.76}\mathrm{PREC}^{0.75}(1+\mathrm{F})^{-0.36}$	
100	$Q = 30.7\ \mathrm{AREA}^{0.76}\mathrm{PREC}^{0.68}(1+\mathrm{F})^{-0.38}$	

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; PREC, mean annual precipitation, in inches; MnJT, mean minimum January air temperature, in degrees Fahrenheit; CL, main channel length, in miles; F, percentage of basin covered by forest.
SEP: Standard error of prediction; n: number of stations used in the regression analysis.

Table C.53. Prediction equations for estimating peak flow for ungaged watershed in western Oregon (Cooper, 2005)

Recurrence interval, in years	Equation	Average prediction error, in percent	Equivalent years of record
	Region 1: Coastal watersheds		
2	$Q = 0.05056\ AREA^{0.9489} I_2^{1.360} MxJT^{1.280} SC^{-0.4421} SP^{-0.1576}$	26.8	2.4
5	$Q = 0.01316\ AREA^{0.9385} I_2^{1.272} MxJT^{1.738} SC^{-0.5026} SP^{-0.2234}$	25.3	3.7
10	$Q = 0.008041\ AREA^{0.9324} I_2^{1.226} MxJT^{1.926} SC^{-0.5267} SP^{-0.2552}$	25.6	5.0
25	$Q = 0.005122\ AREA^{0.9258} I_2^{1.179} MxJT^{2.109} SC^{-0.5484} SP^{-0.2888}$	26.6	6.4
50	$Q = 0.003888\ AREA^{0.9215} I_2^{1.151} MxJT^{2.223} SC^{-0.5605} SP^{-0.3111}$	27.8	7.2
100	$Q = 0.003048\ AREA^{0.9176} I_2^{1.126} MxJT^{2.325} SC^{-0.5701} SP^{-0.3319}$	29.1	7.9
500	$Q = 0.001890\ AREA^{0.9099} I_2^{1.078} MxJT^{2.527} SC^{-0.5855} SP^{-0.3770}$	32.6	8.9
	Region 2A: Western interior watersheds with mean elevations greater than 3,000 feet		
2	$Q = 0.003119\ AREA^{1.021} BS_o^{0.8124} I_2^{2.050} MnJT^{3.541} MxJT^{-1.867}$	38.7	2.2
5	$Q = 0.007824\ AREA^{1.020} BS_o^{0.9022} I_2^{1.649} MnJT^{3.611} MxJT^{-2.017}$	33.8	4.2
10	$Q = 0.01546\ AREA^{1.021} BS_o^{0.9506} I_2^{1.471} MnJT^{3.620} MxJT^{-2.137}$	32.5	6.1
25	$Q = 0.03353\ AREA^{1.021} BS_o^{0.9930} I_2^{1.321} MnJT^{3.624} MxJT^{-2.278}$	32.5	8.6
50	$Q = 0.05501\ AREA^{1.022} BS_o^{1.014} I_2^{1.243} MnJT^{3.624} MxJT^{-2.366}$	33.2	10.3
100	$Q = 0.08492\ AREA^{1.022} BS_o^{1.030} I_2^{1.182} MnJT^{3.621} MxJT^{-2.440}$	34.4	11.6
500	$Q = 0.1974\ AREA^{1.023} BS_o^{1.053} I_2^{1.079} MnJT^{3.601} MxJT^{-2.566}$	37.9	13.6
	Region 2B: Western interior watersheds with mean elevations less than 3,000 feet		
2	$Q = 9.136\ AREA^{0.9004} BS_o^{0.4695} I_2^{0.8481}$	32.6	2.0
5	$Q = 14.54\ AREA^{0.9042} BS_o^{0.4735} I_2^{0.7355}$	32.4	2.8
10	$Q = 18.49\ AREA^{0.9064} BS_o^{0.4688} I_2^{0.6937}$	33.0	3.6
25	$Q = 23.72\ AREA^{0.9086} BS_o^{0.4615} I_2^{0.6578}$	34.1	4.8
50	$Q = 27.75\ AREA^{0.9101} BS_o^{0.4559} I_2^{0.6390}$	35.1	5.5
100	$Q = 31.85\ AREA^{0.9114} BS_o^{0.4501} I_2^{0.6252}$	36.2	6.2
500	$Q = 41.72\ AREA^{0.9141} BS_o^{0.4365} I_2^{0.6059}$	39.1	7.5

Equation: Q, peak flow, in cubic feet per second; AREA, drainage area, in square miles; I_2, maximum precipitation intensity, 24-hour precipitation intensity, in inches, with a recurrence interval of 2 years (figure C.23); MxJT, mean maximum January temperature, in degrees Fahrenheit (figure C.25); SC, soil storage capacity, in inches (figure C.26); SP, soil permeability, in inches per hour (figure C.27); BS_o, average basin slope, in degrees (figure C.22); MnJT, mean minimum January temperature, in degrees Fahrenheit (figure C.24).

n: number of stations used in the regression analysis.

Table C.54. Exponent coefficients for estimation of peak flow of ungaged sites near gaged sites on the same stream in Washington (Sumioka and others, 1998; Knowles and Sumioka, 2001)

Recurrence interval, in years	**Hydrologic regions of Washington**								
	Region 1	**Region 2**	**Region 3**	**Region 4**	**Region 5**	**Region 6**	**Region 7**	**Region 8**	**Region 9**
2	0.923	0.877	0.877	0.880	0.815	0.719	0.629	0.761	0.672
10	0.921	0.868	0.875	0.856	0.787	0.716	0.587	0.706	0.597
25	0.921	0.864	0.874	0.850	0.779	0.714	0.574	0.687	0.570
50	0.921	0.862	0.872	0.845	0.774	0.713	0.566	0.676	0.553
100	0.922	0.861	0.871	0.842	0.769	0.713	0.558	0.666	0.538

Applicable when the drainage area ratio (A_u/A_g) is between 0.5 and 1.5.

Table C.55. Flood-peak flow regression equations and associated statistics for hydrologic regions in Washington (Sumioka and others, 1998; Knowles and Sumioka, 2001)

Recurrence interval, in years	Equation	SEP, in percent	Equivalent years of record
	Region 1 (n = 61)		
2	$Q = 0.350\ \mathrm{AREA}^{0.923}\mathrm{PREC}^{1.24}$	32	1
10	$Q = 0.502\ \mathrm{AREA}^{0.921}\mathrm{PREC}^{1.26}$	33	2
25	$Q = 0.590\ \mathrm{AREA}^{0.921}\mathrm{PREC}^{1.26}$	34	3
50	$Q = 0.666\ \mathrm{AREA}^{0.921}\mathrm{PREC}^{1.26}$	36	3
100	$Q = 0.745\ \mathrm{AREA}^{0.922}\mathrm{PREC}^{1.26}$	37	4
	Region 2 (n = 202)		
2	$Q = 0.090\ \mathrm{AREA}^{0.877}\mathrm{PREC}^{1.51}$	56	1
10	$Q = 0.129\ \mathrm{AREA}^{0.868}\mathrm{PREC}^{1.57}$	53	1
25	$Q = 0.148\ \mathrm{AREA}^{0.864}\mathrm{PREC}^{1.59}$	53	2
50	$Q = 0.161\ \mathrm{AREA}^{0.862}\mathrm{PREC}^{1.61}$	53	2
100	$Q = 0.174\ \mathrm{AREA}^{0.861}\mathrm{PREC}^{1.62}$	54	3
	Region 3 (n = 63)		
2	$Q = 0.817\ \mathrm{AREA}^{0.877}\mathrm{PREC}^{1.02}$	57	1
10	$Q = 0.845\ \mathrm{AREA}^{0.875}\mathrm{PREC}^{1.14}$	55	1
25	$Q = 0.912\ \mathrm{AREA}^{0.874}\mathrm{PREC}^{1.17}$	54	2
50	$Q = 0.808\ \mathrm{AREA}^{0.872}\mathrm{PREC}^{1.23}$	54	2
100	$Q = 0.801\ \mathrm{AREA}^{0.871}\mathrm{PREC}^{1.26}$	55	3
	Region 4 (n = 60)		
2	$Q = 0.025\ \mathrm{AREA}^{0.880}\mathrm{PREC}^{1.70}$	82	1
10	$Q = 0.179\ \mathrm{AREA}^{0.856}\mathrm{PREC}^{1.37}$	84	1
25	$Q = 0.341\ \mathrm{AREA}^{0.850}\mathrm{PREC}^{1.26}$	87	1
50	$Q = 0.505\ \mathrm{AREA}^{0.845}\mathrm{PREC}^{1.20}$	90	2
100	$Q = 0.703\ \mathrm{AREA}^{0.842}\mathrm{PREC}^{1.15}$	92	2

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; PREC, mean annual precipitation, in inches.

SEP: Standard error of prediction; n: number of stations used in the regression analysis.

Table C.56. Flood-peak flow regression equations and associated statistics for hydrologic regions in Washington (Sumioka and others, 1998; Knowles and Sumioka, 2001)—Continued

Recurrence interval, in years	Equation	SEP, in percent	Equivalent years of record
	Region 5 (n = 19)		
2	$Q = 14.7\ \mathrm{AREA}^{0.815}$	96	1
10	$Q = 35.2\ \mathrm{AREA}^{0.787}$	63	2
25	$Q = 48.2\ \mathrm{AREA}^{0.779}$	56	3
50	$Q = 59.1\ \mathrm{AREA}^{0.774}$	53	5
100	$Q = 71.2\ \mathrm{AREA}^{0.769}$	52	6
	Region 6 (n = 23)		
2	$Q = 2.24\ \mathrm{AREA}^{0.719}\mathrm{PREC}^{0.833}$	63	1
10	$Q = 17.8\ \mathrm{AREA}^{0.716}\mathrm{PREC}^{0.487}$	69	2
25	$Q = 38.6\ \mathrm{AREA}^{0.714}\mathrm{PREC}^{0.359}$	72	2
50	$Q = 63.6\ \mathrm{AREA}^{0.713}\mathrm{PREC}^{0.276}$	74	3
100	$Q = 100\ \mathrm{AREA}^{0.713}\mathrm{PREC}^{0.201}$	77	3
	Region 7 (n = 17)		
2	$Q = 8.77\ \mathrm{AREA}^{0.629}$	128	2
10	$Q = 50.9\ \mathrm{AREA}^{0.587}$	63	7
25	$Q = 91.6\ \mathrm{AREA}^{0.574}$	54	12
50	$Q = 131\ \mathrm{AREA}^{0.566}$	53	15
100	$Q = 179\ \mathrm{AREA}^{0.558}$	56	16
	Region 8 (n = 23)		
2	$Q = 12.0\ \mathrm{AREA}^{0.761}$	133	<1
10	$Q = 32.6\ \mathrm{AREA}^{0.706}$	111	1
25	$Q = 46.2\ \mathrm{AREA}^{0.687}$	114	1
50	$Q = 57.3\ \mathrm{AREA}^{0.676}$	119	1
100	$Q = 69.4\ \mathrm{AREA}^{0.666}$	126	1

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; PREC, mean annual precipitation, in inches.

SEP: Standard error of prediction; n: number of stations used in the regression analysis.

Table C.57. Flood-peak flow regression equations and associated statistics for hydrologic regions in Washington (Sumioka and others, 1998; Knowles and Sumioka, 2001)—Continued

Recurrence interval, in years	Equation	SEP, in percent	Equivalent years of record
	Region 9 (n = 36)		
2	$Q = 0.803\ \mathrm{AREA}^{0.672}\mathrm{PREC}^{1.16}$	80	2
10	$Q = 15.4\ \mathrm{AREA}^{0.597}\mathrm{PREC}^{0.662}$	57	6
25	$Q = 41.1\ \mathrm{AREA}^{0.570}\mathrm{PREC}^{0.508}$	55	8
50	$Q = 74.7\ \mathrm{AREA}^{0.553}\mathrm{PREC}^{0.420}$	55	10
100	$Q = 126\ \mathrm{AREA}^{0.538}\mathrm{PREC}^{0.344}$	56	12

Equation: *Q*, peak flow, in cubic feet per second; AREA, drainage area, in square miles; PREC, mean annual precipitation, in inches.

SEP: Standard error of prediction; n: number of stations used in the regression analysis.

Figure C.1. Flood regions in the Southwestern United States (Thomas and others, 1997)

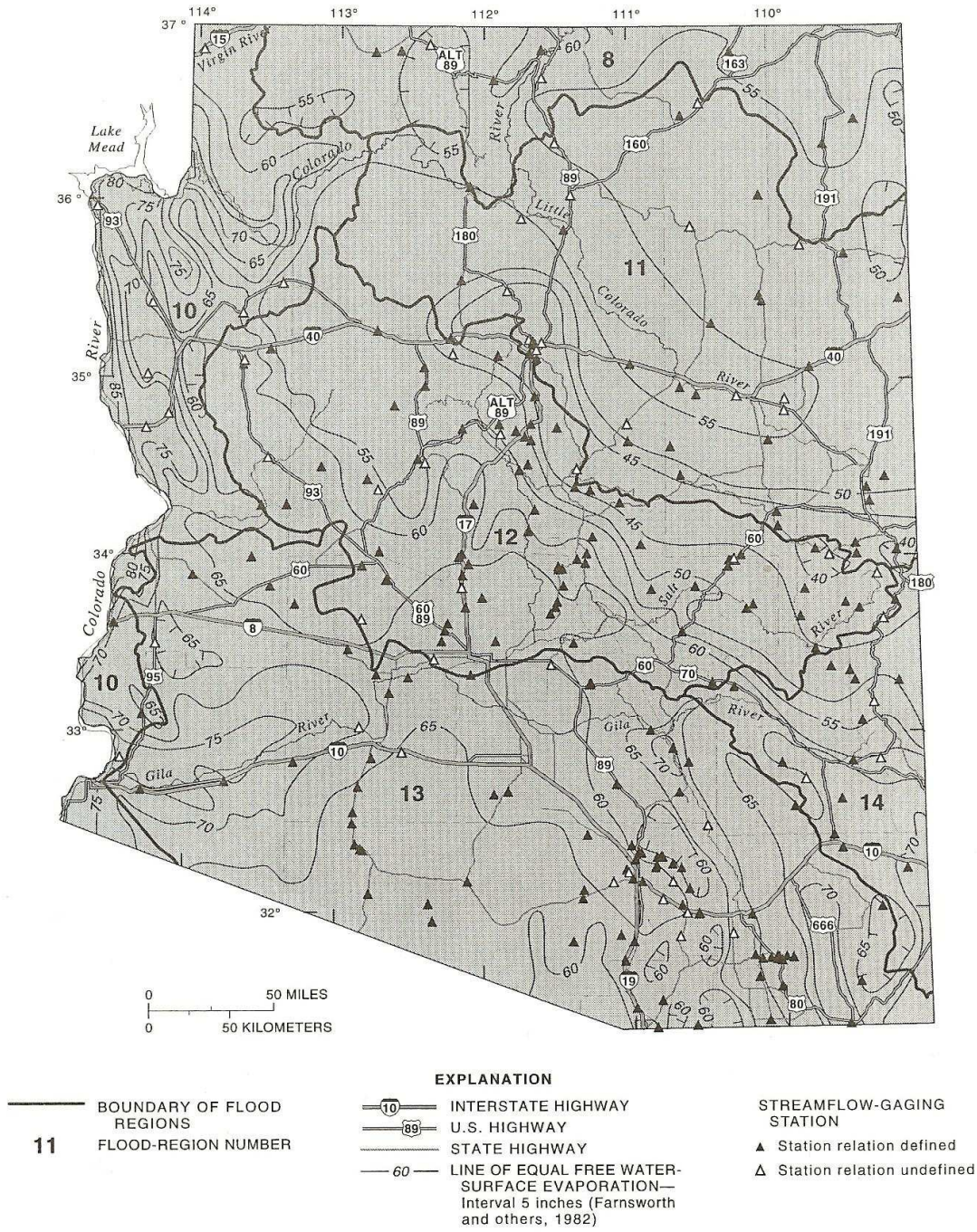


Figure C.2. Free water-surface evaporation for Arizona (Farnsworth and others, 1982; Thomas and others, 1997)

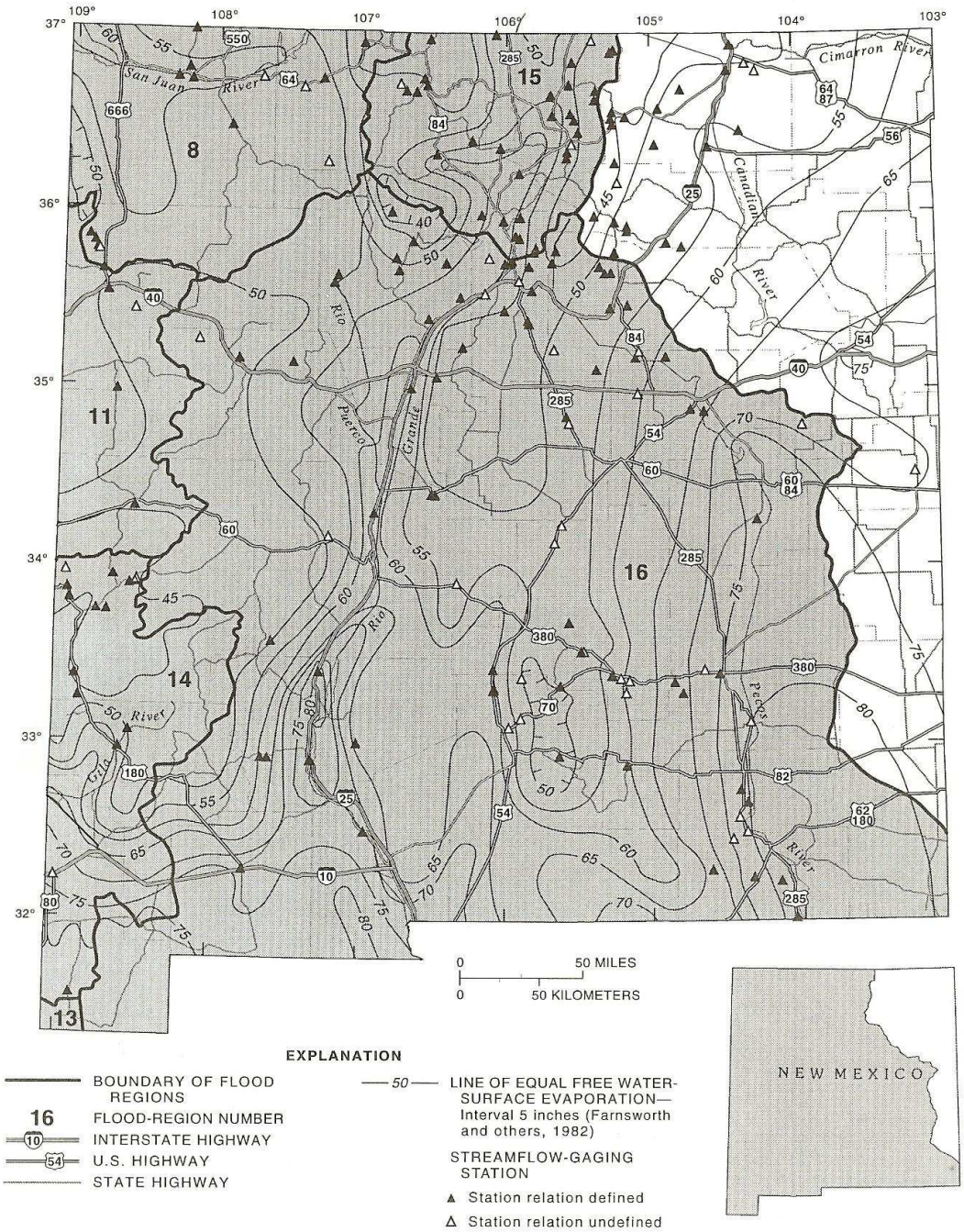


Figure C.3. Free water-surface evaporation for New Mexico (Farnsworth and others, 1982; Thomas and others, 1997)

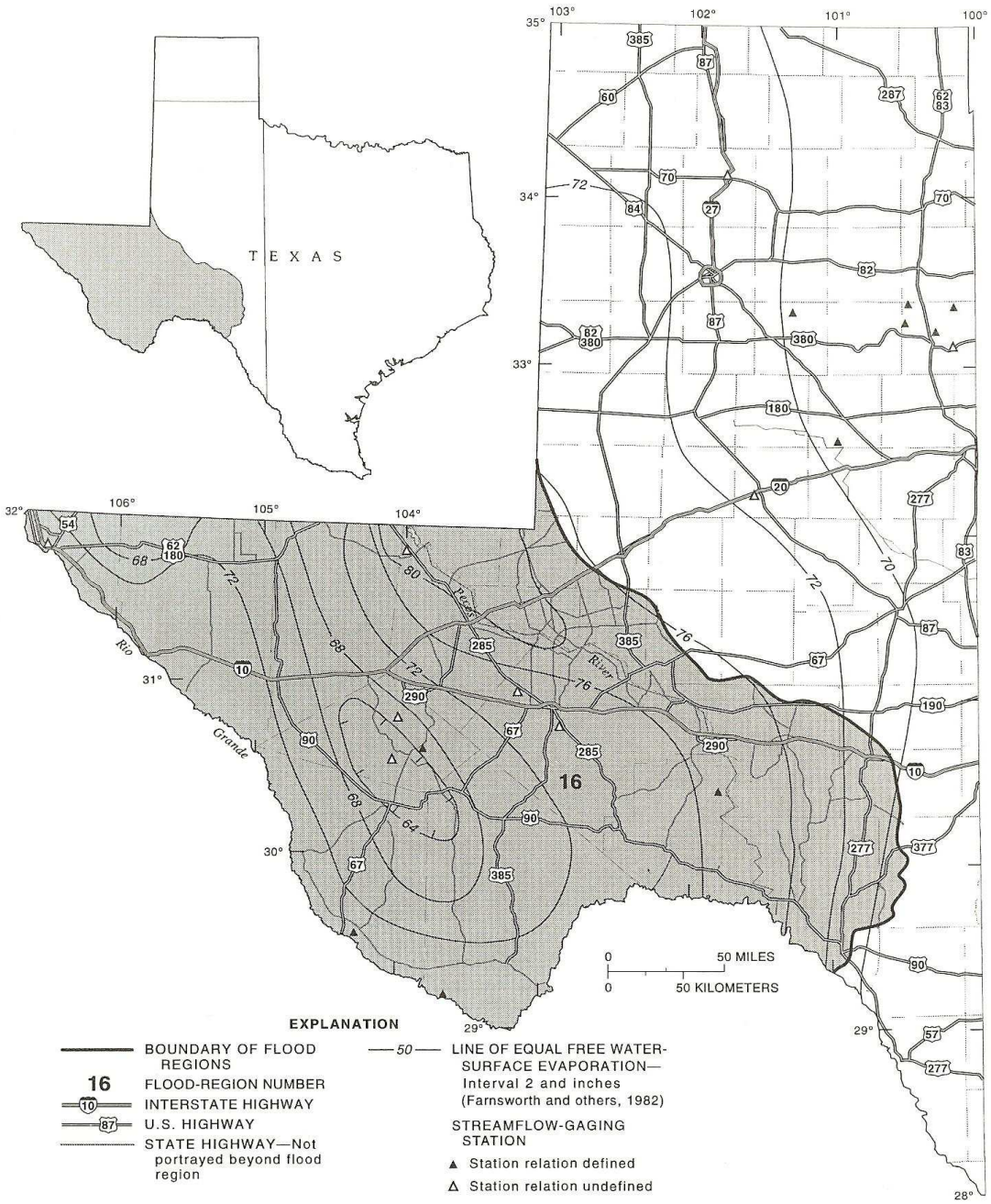


Figure C.4. Free water-surface evaporation for Texas (Farnsworth and others, 1982; Thomas and others, 1997)

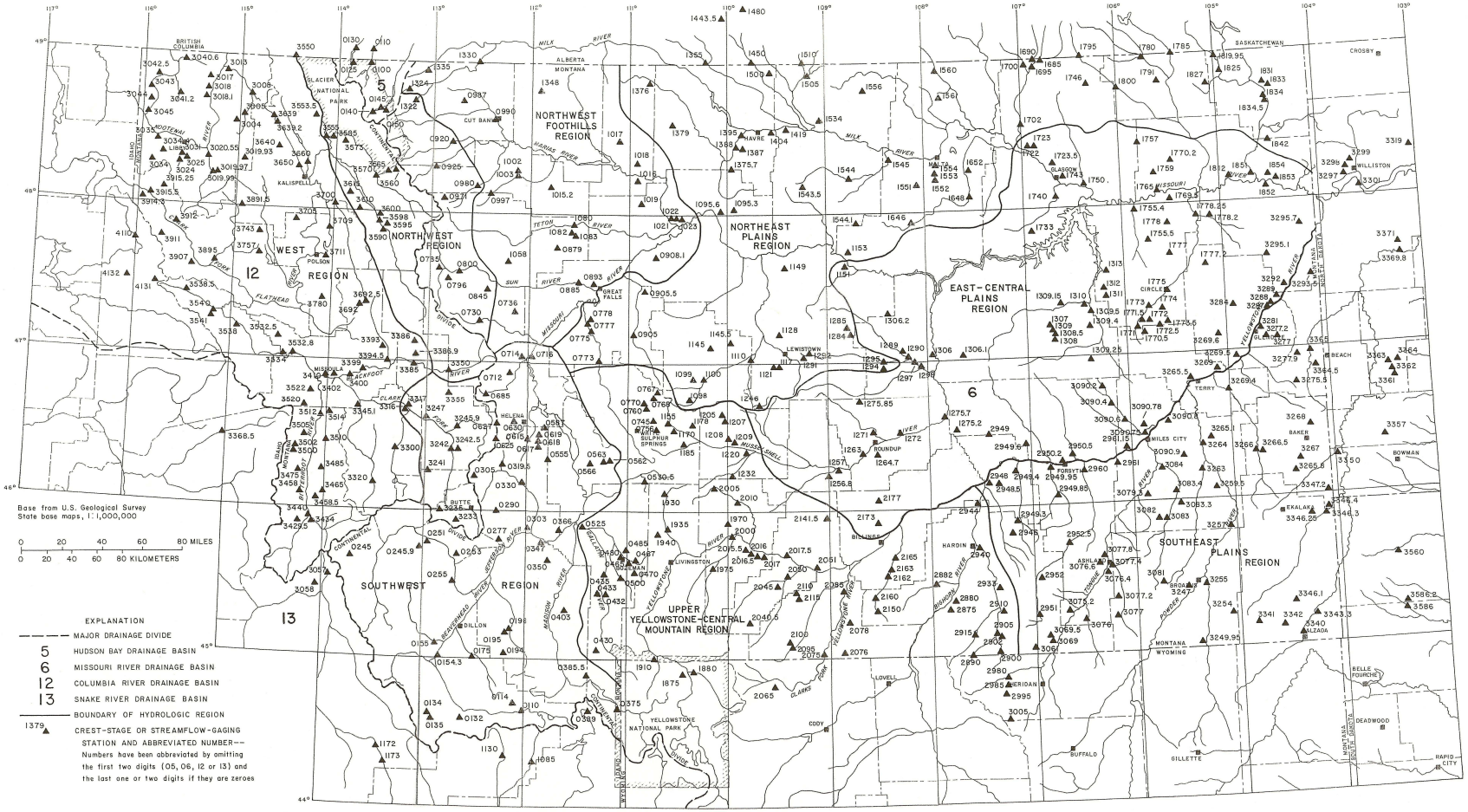


Figure C.5. Map showing boundaries of hydrologic regions and location of crest-stage and streamflow-gaging stations in Montana and adjacent areas (Omang, 1992)

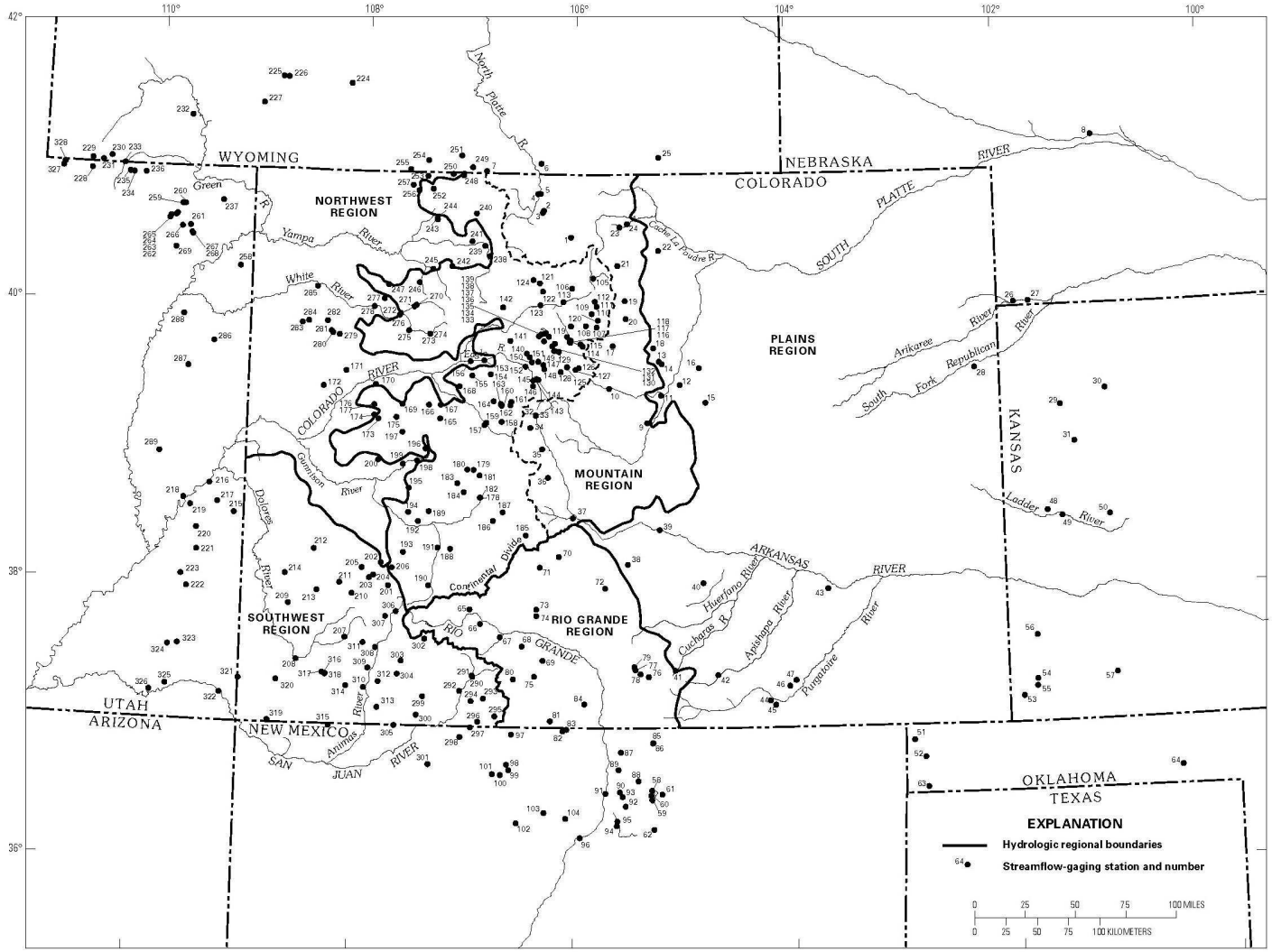


Figure C.6. Hydrologic regions and location of streamflow-gaging stations in Colorado and adjacent States (Vaill, 2000).

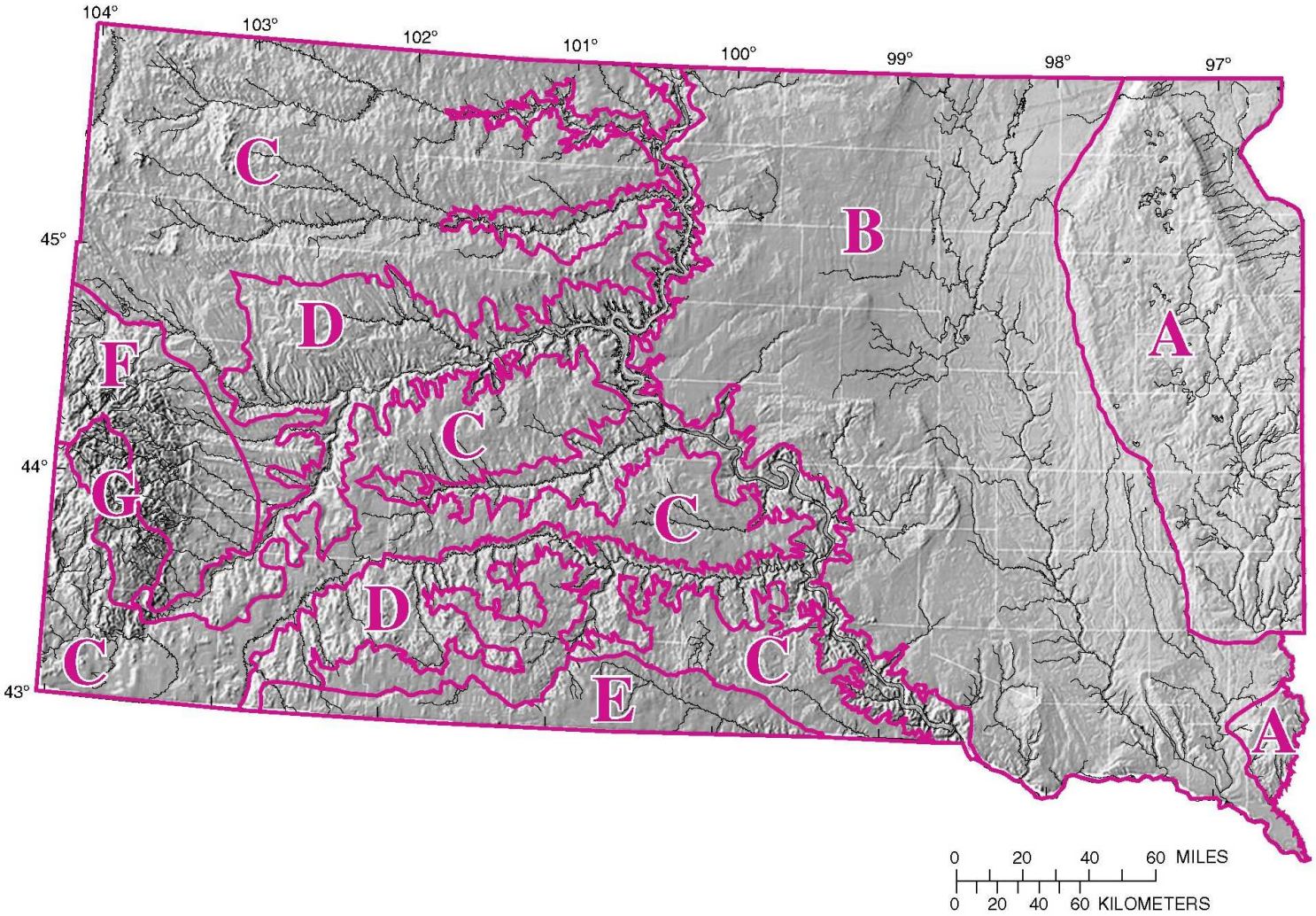


Figure C.7. Hydrologic sub-regions determined for the regional peak-flow frequency analysis for South Dakota (Sando, 1998).

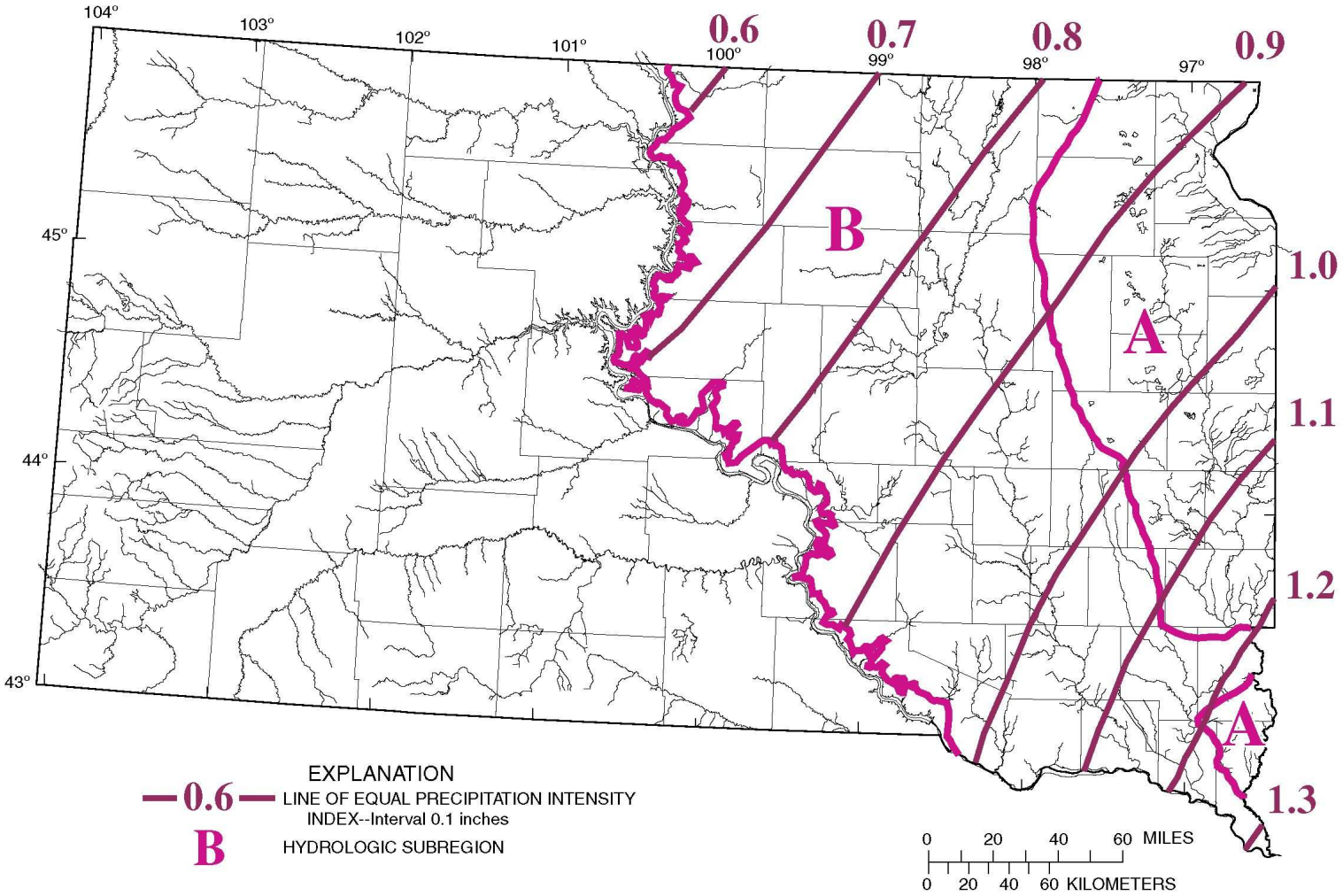


Figure C.8. Isolines of Precipitation Intensity Index (PII) for South Dakota (Sando, 1998; determined by subtracting 1.5 inches from 2-year, 24-hour precipitation isoclines, in inches, as given in U.S. Weather Bureau, 1961, and interpolating between those isolines)

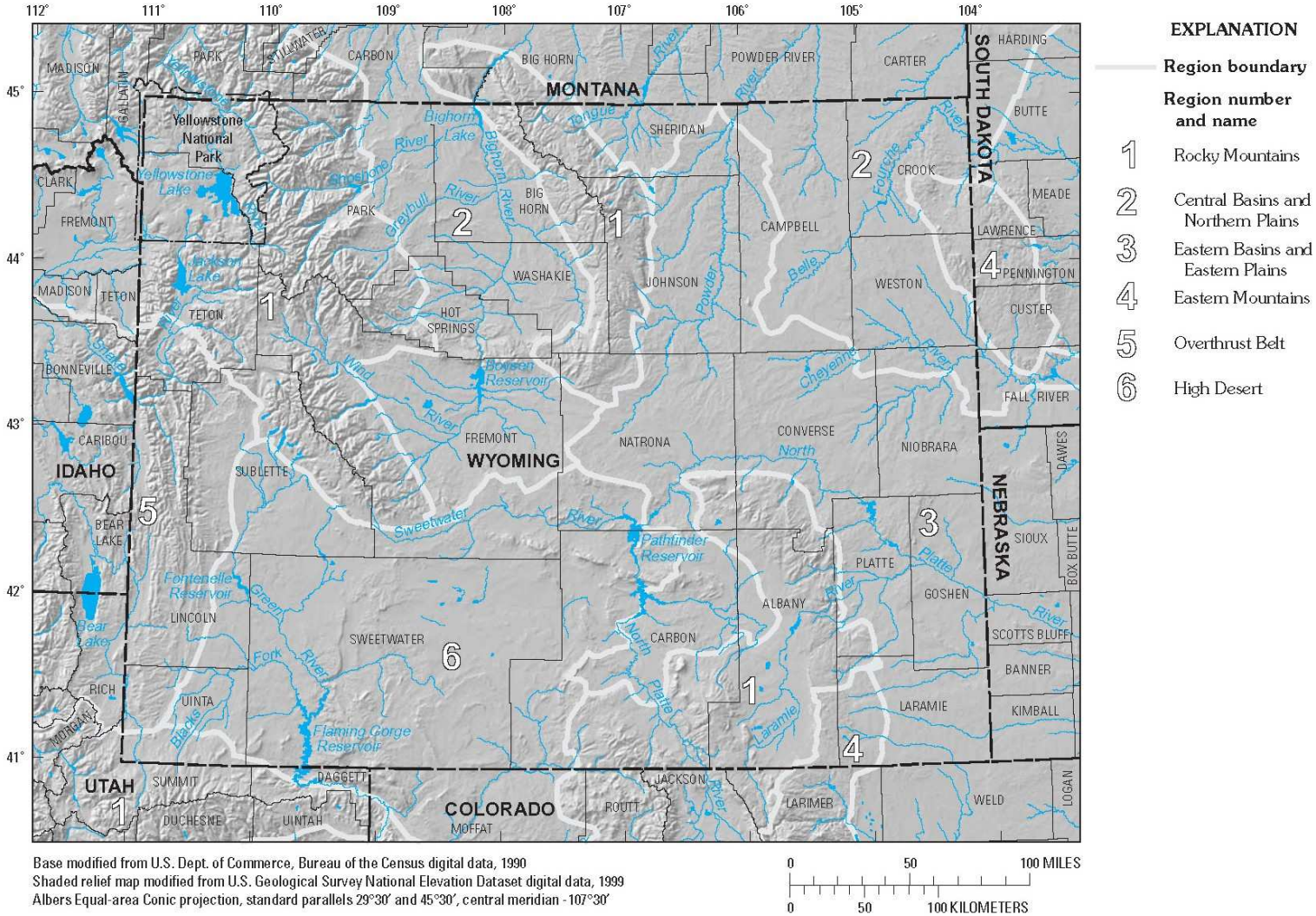


Figure C.9. Hydrologic regions for determining peak-flow characteristics of Wyoming streams (Miller, 2003).

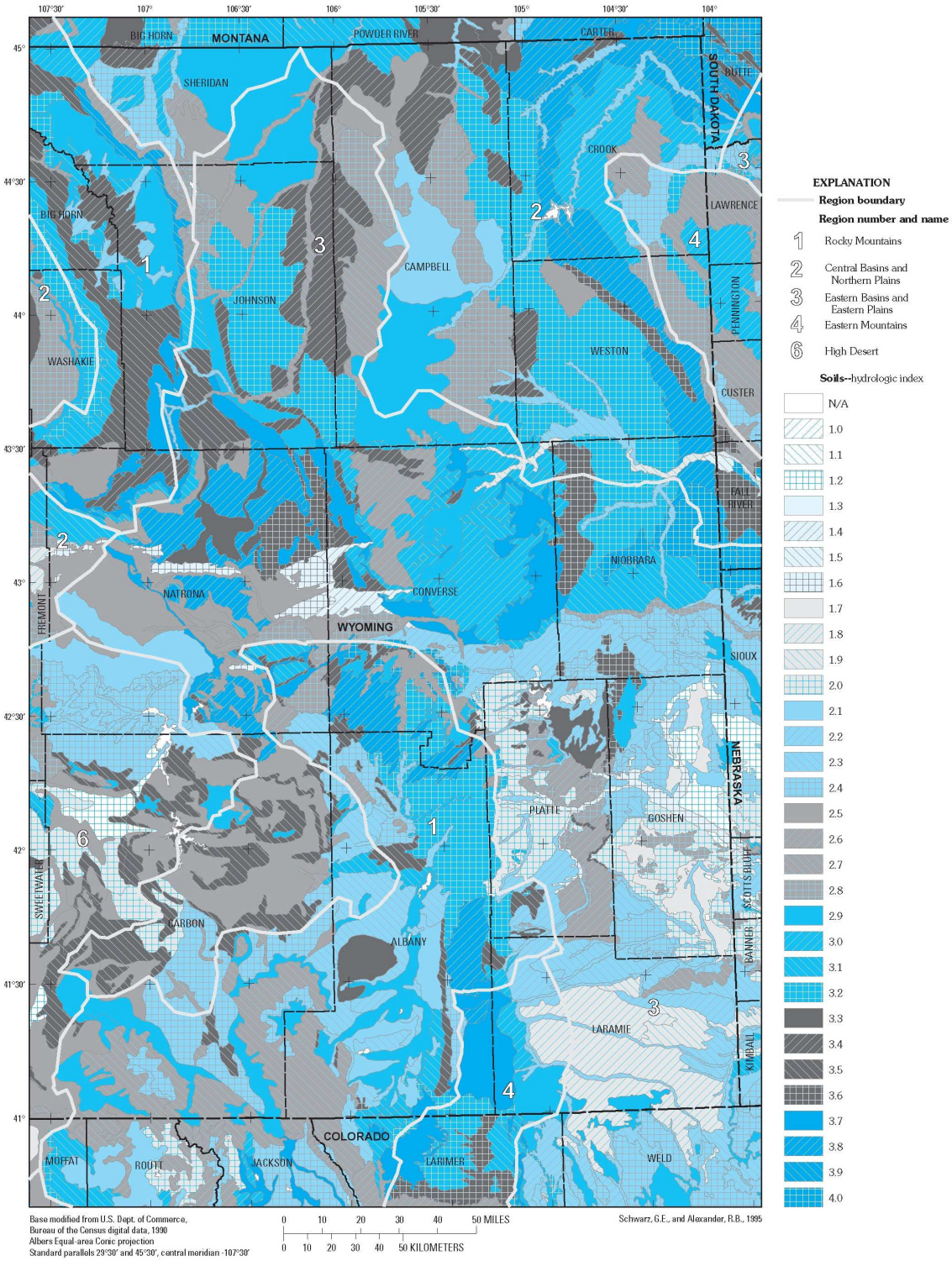
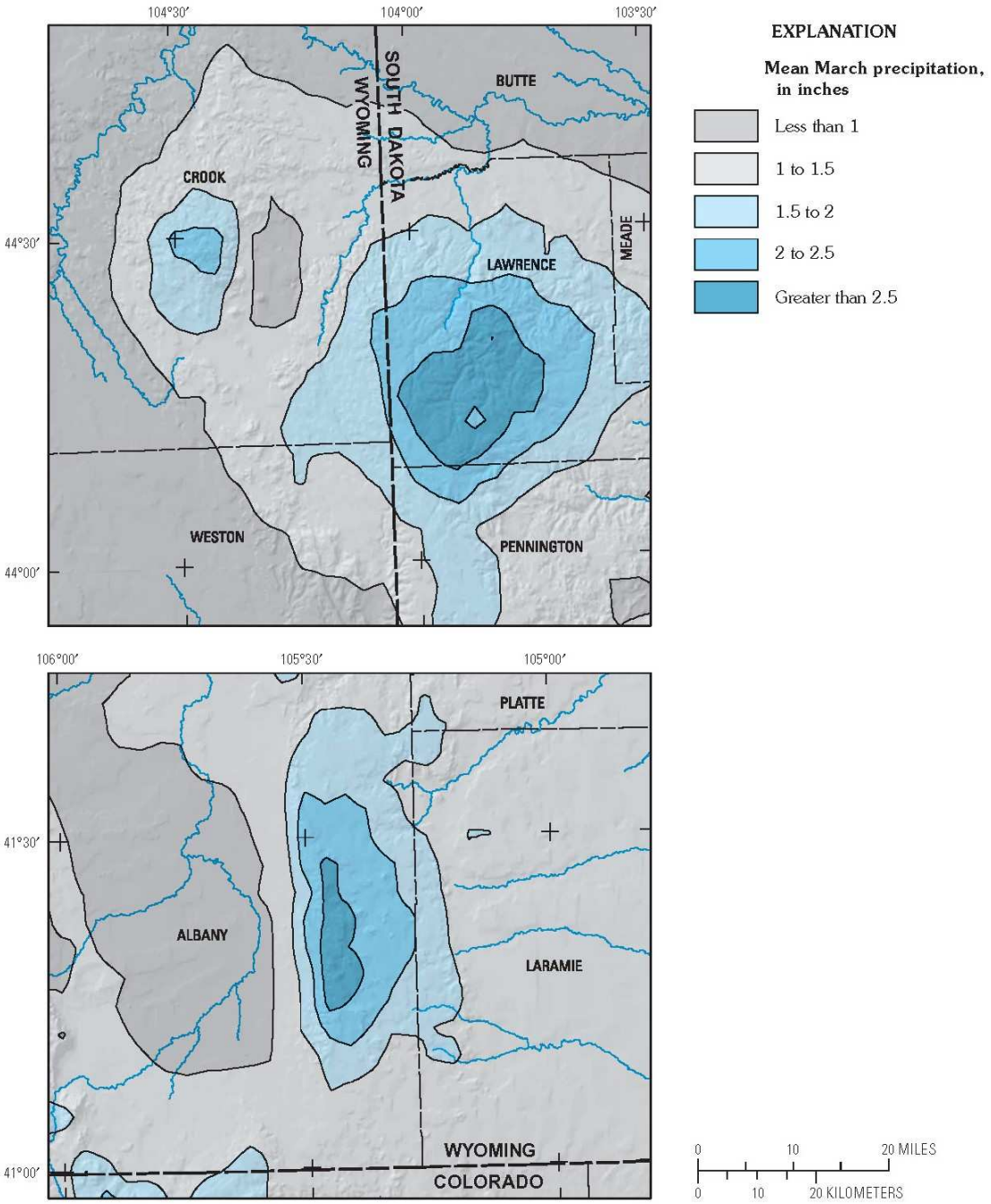


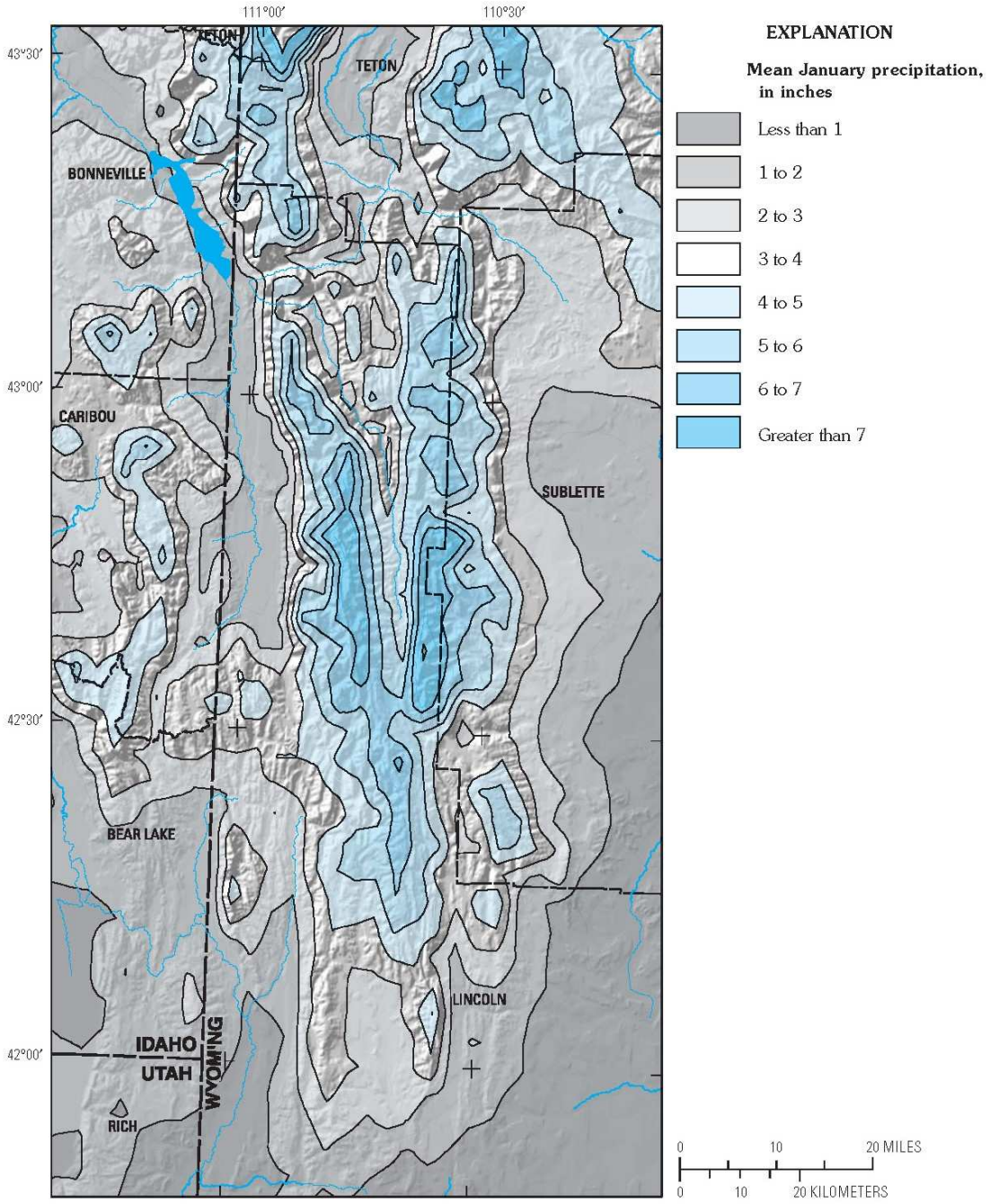
Figure C.10. Soil hydrologic index for Wyoming (Miller, 2003)



Base modified from U.S. Dept. of Commerce, Bureau of the Census digital data, 1990
Shaded relief map modified from U.S. Geological Survey National Elevation Dataset digital data, 1999
Albers Equal-area Conic projection
Standard parallels 29°30′ and 45°30′, central meridian -107°30′

Oregon Climate Service, 1998b

Figure C.11. Mean March precipitation, Eastern Mountains Region, Wyoming (Miller, 2003).



Base modified from U.S. Dept. of Commerce, Bureau of the Census digital data, 1990
Shaded relief map modified from U.S. Geological Survey National Elevation Dataset digital data, 1999
Albers Equal-area Conic projection
Standard parallels 29°30′ and 45°30′, central meridian -107°30′

Oregon Climate Service, 1998b

Figure C.12. Mean January precipitation, Overthrust Belt Region, Wyoming (Miller, 2003).

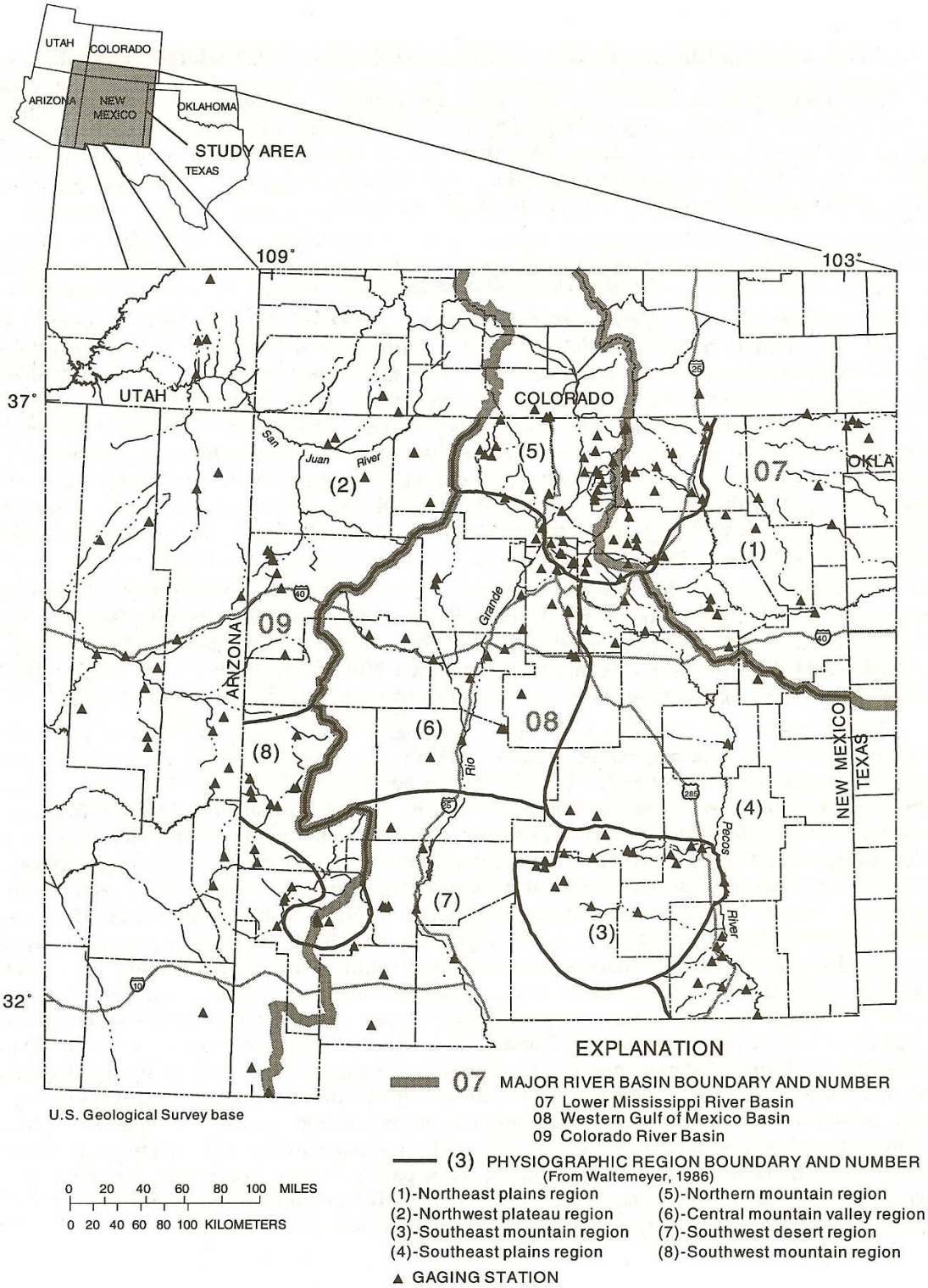


Figure C.13. Hydrologic regions of New Mexico (Waltemeyer, 1996).

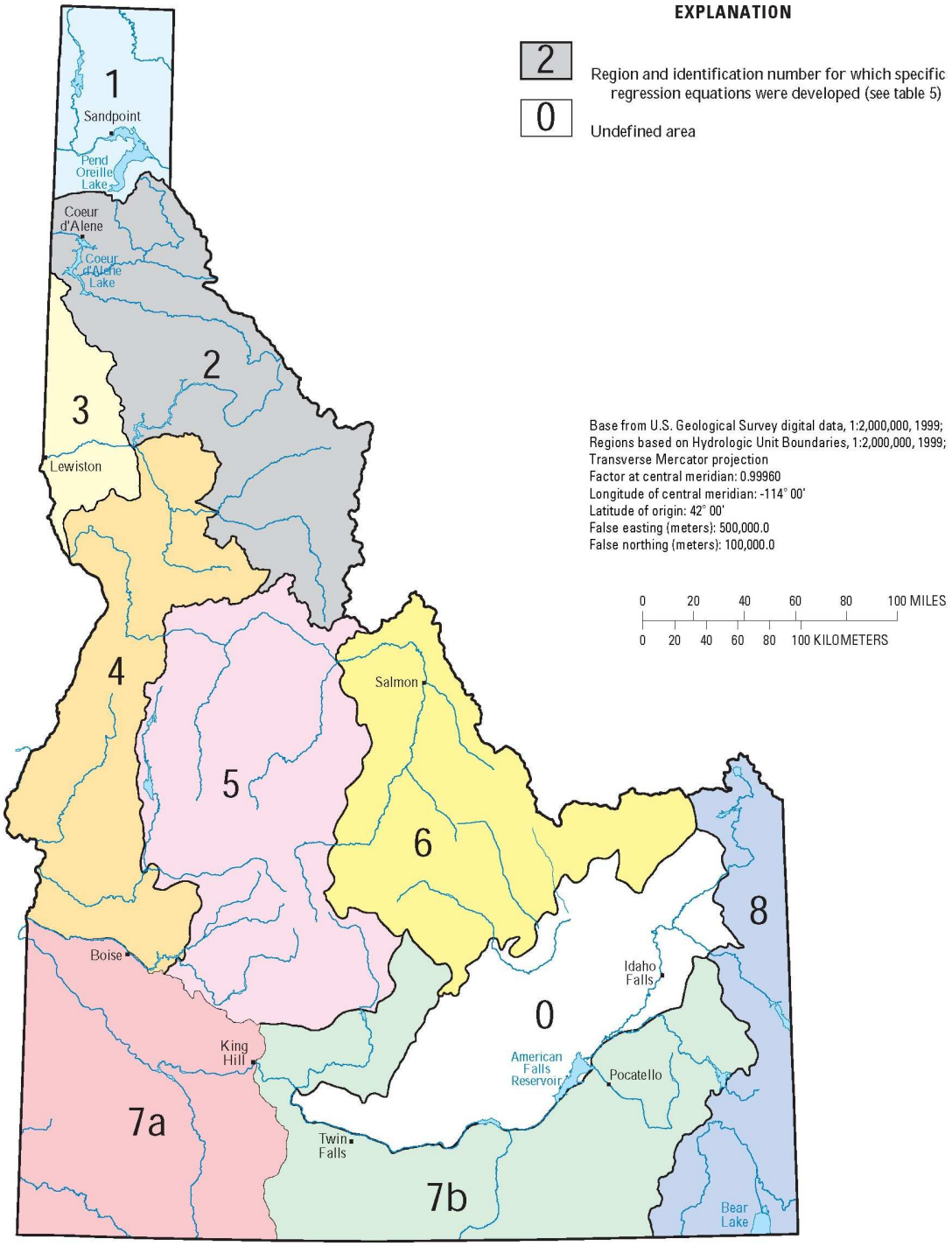


Figure C.14. Hydrologic regions of Idaho (Berenbrock, 2002).

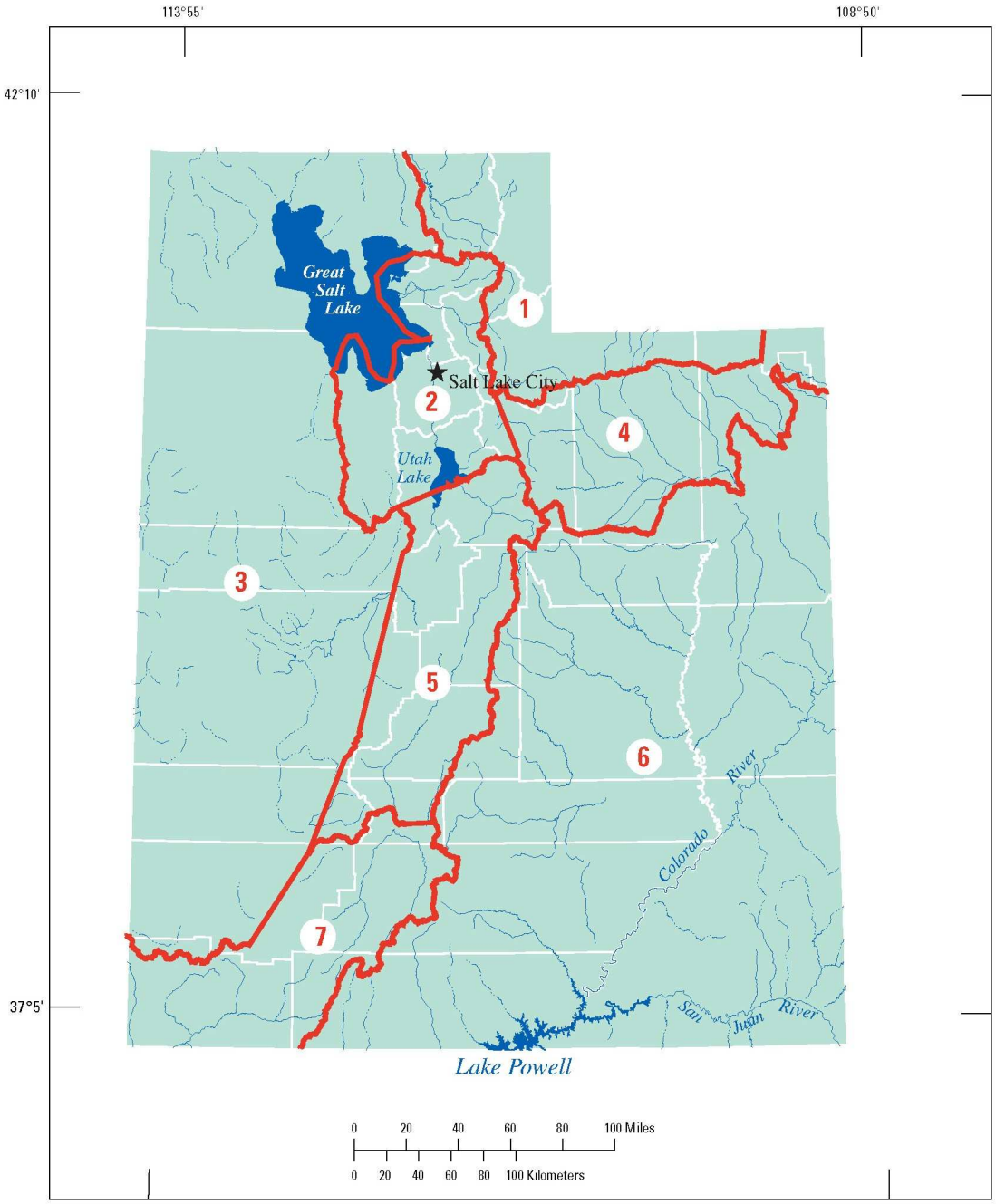


Figure C.15. Geohydrologic regions of Utah (Kenney and others, 2007).

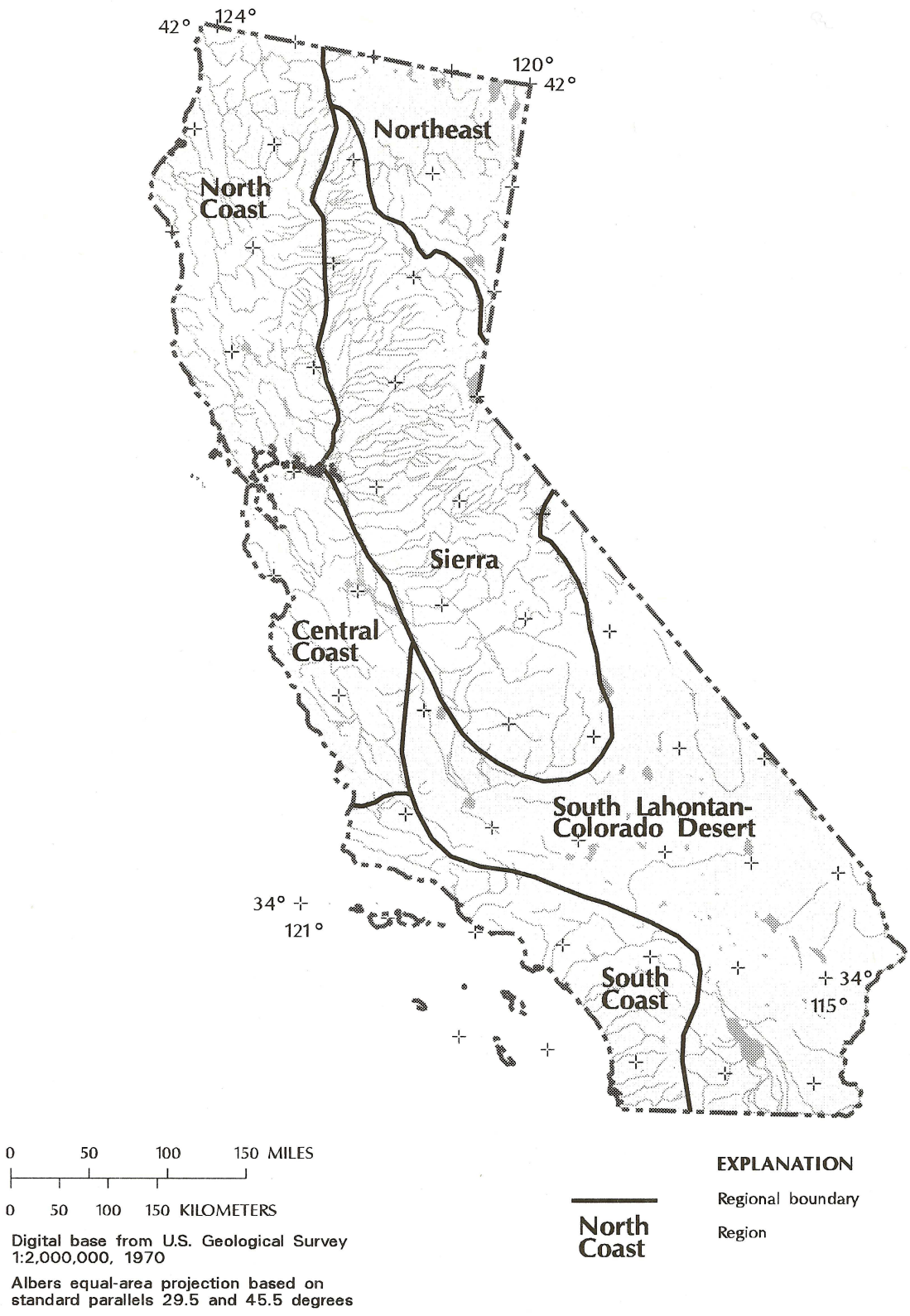


Figure C.16. Hydrologic regions of California (Waananen and Crippen, 1977; Jennings and others, 1994).

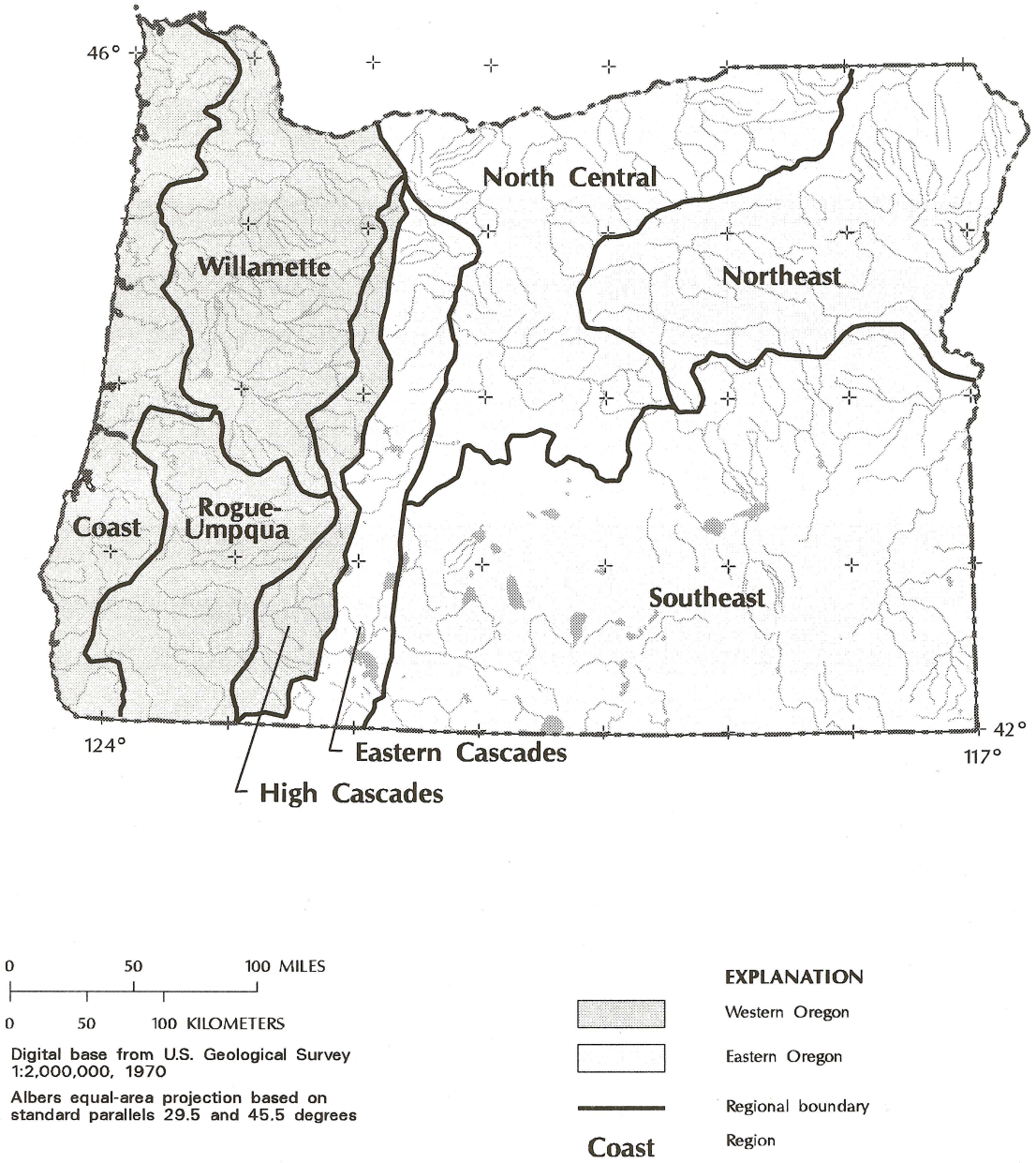


Figure C.17. Hydrologic regions of Oregon (Jennings and others, 1994).

Figure C.18. The 2-year 24-hour rainfall intensities in western Oregon (Jennings and others, 1994).

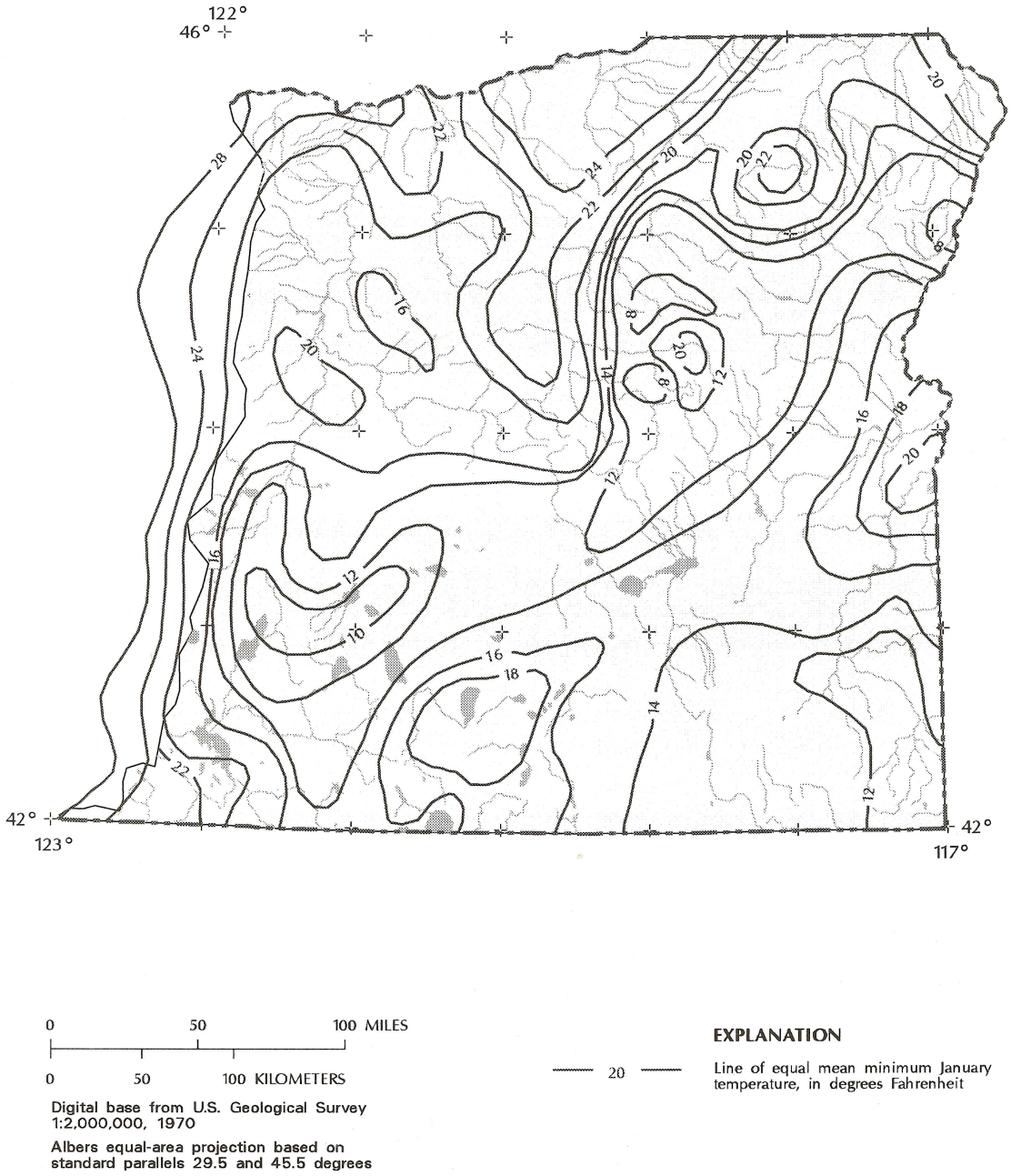


Figure C.19. Mean daily minimum January temperature in eastern Oregon (Jennings and others, 1994).

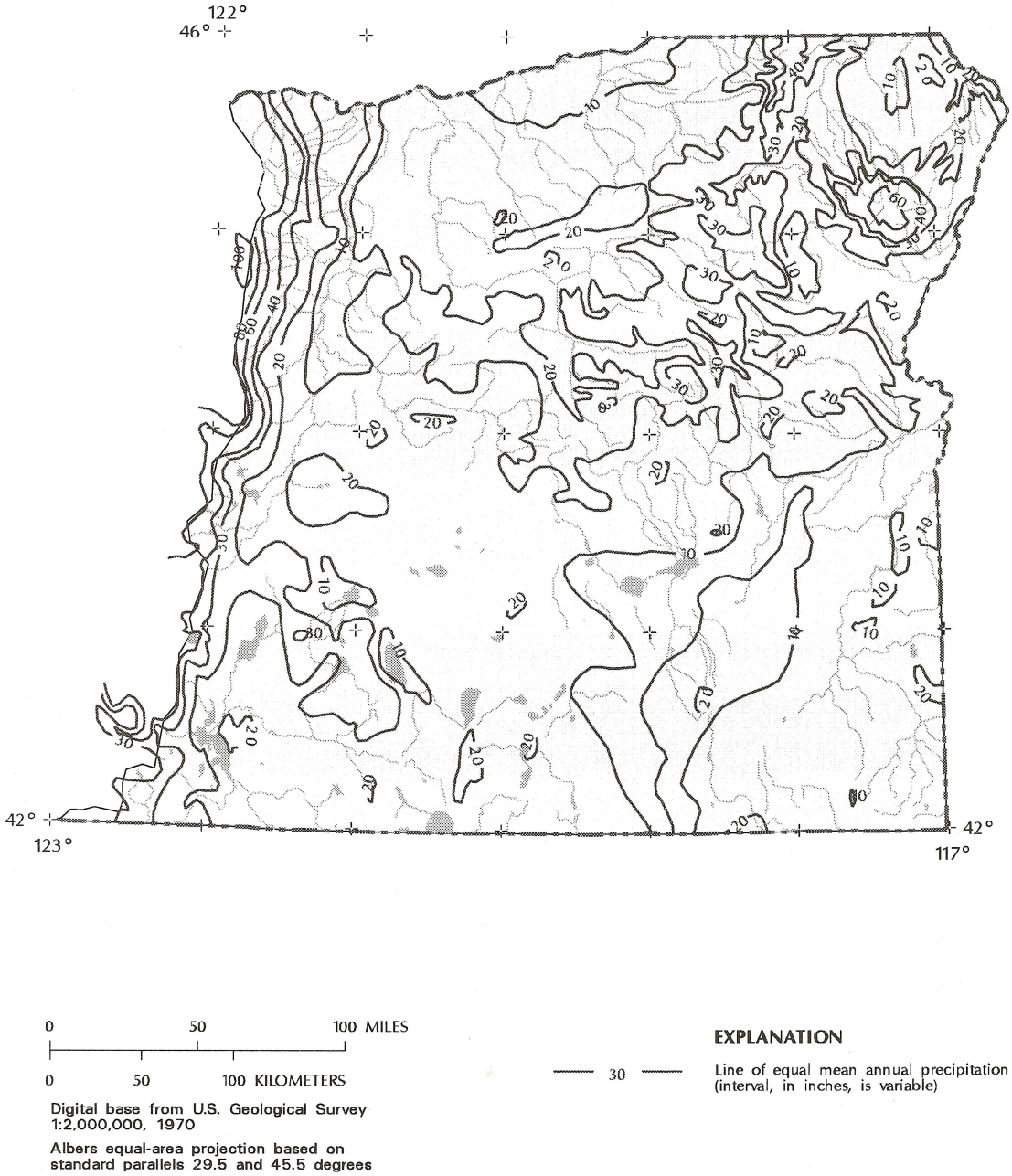


Figure C.20. Mean annual precipitation in eastern Oregon (Jennings and others, 1994).

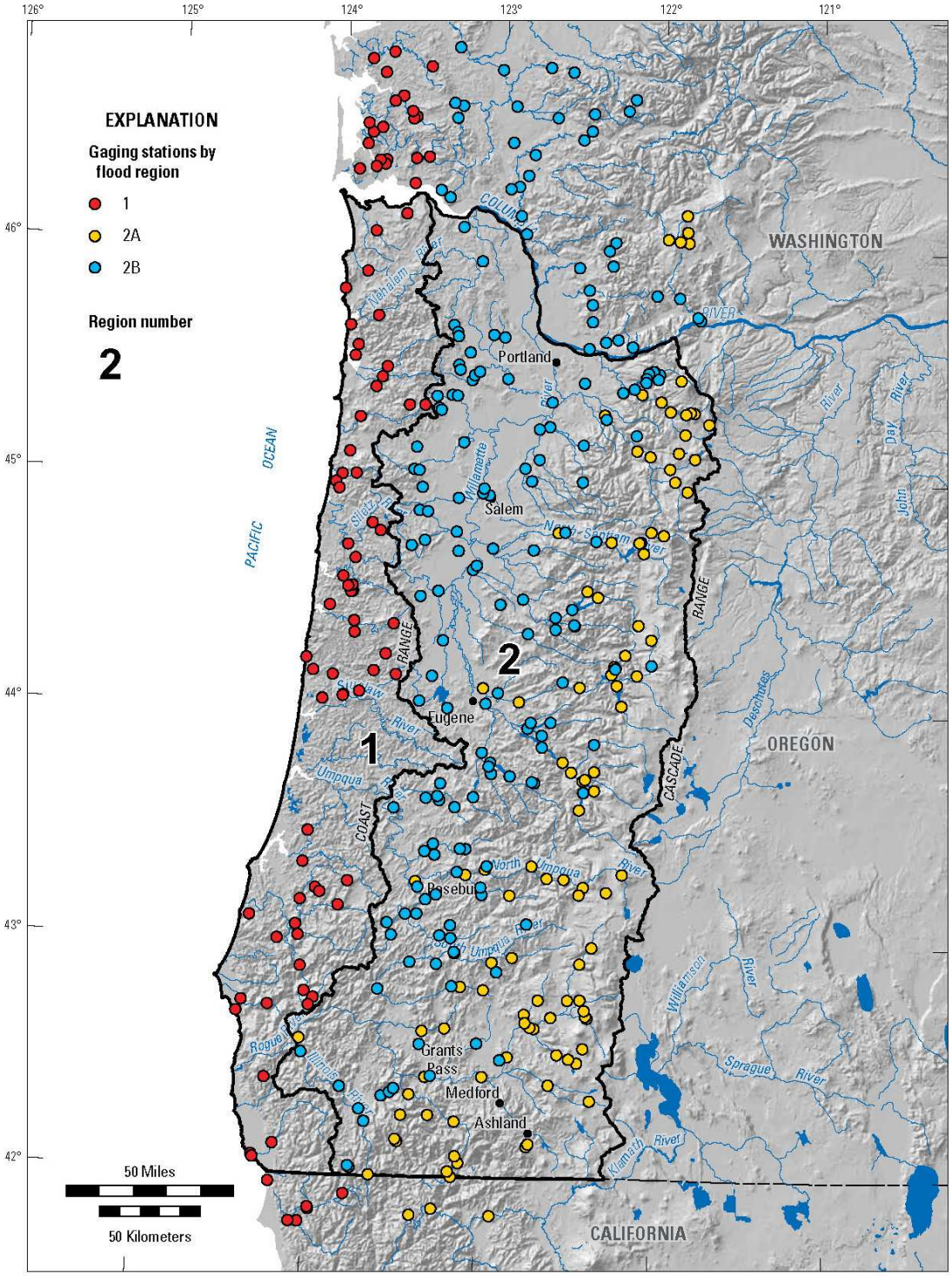


Figure C.21. Hydrologic regions of western Oregon (Cooper, 2005). Region 2A and 2B cannot be separated into discrete areas and shown together as Region 2; however, the gaging stations associated with Regions 2A and 2B give a rough approximation of the areal extent of each region.

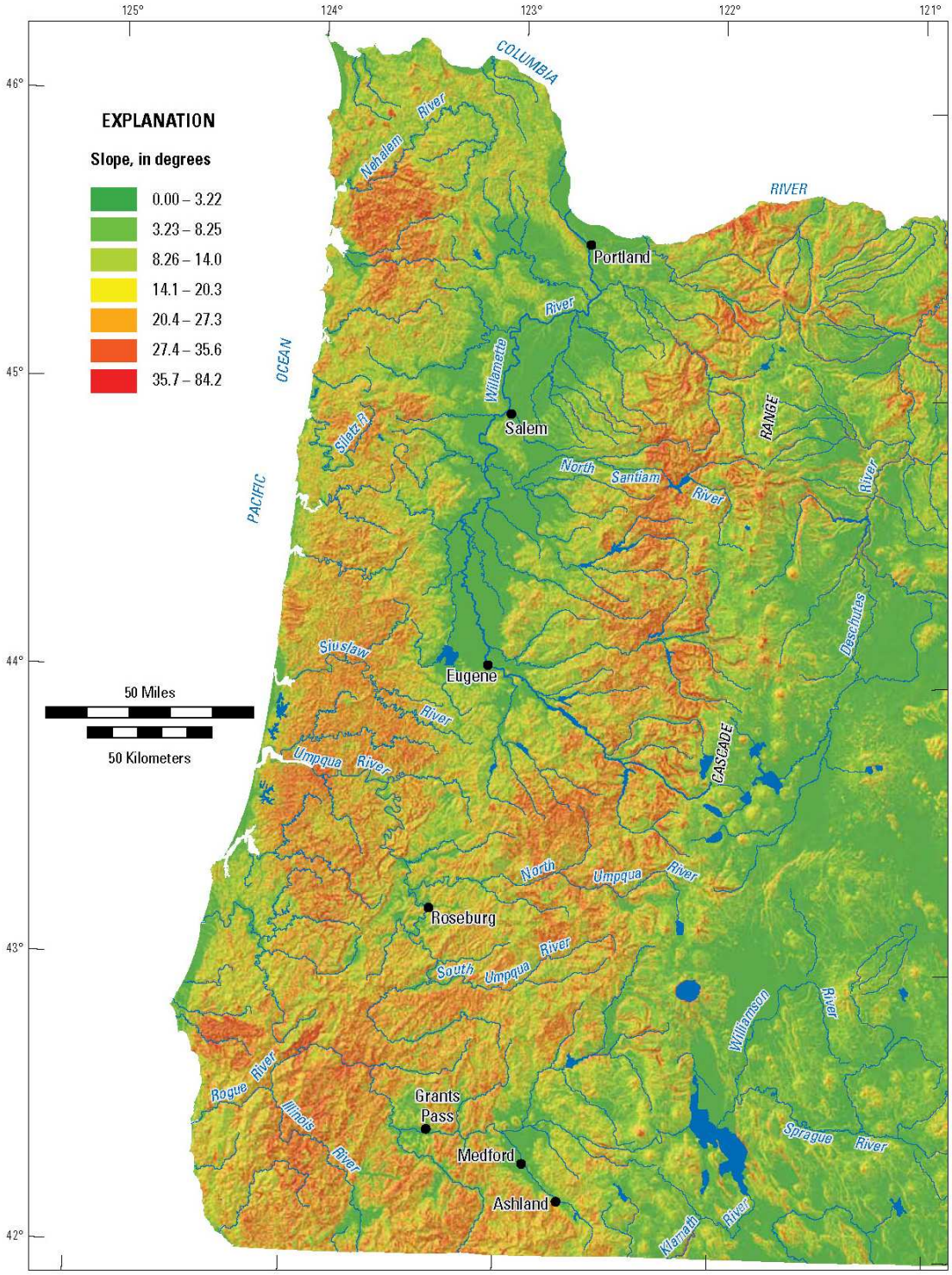


Figure C.22. Areal distribution of basin slope in western Oregon (Cooper, 2005)

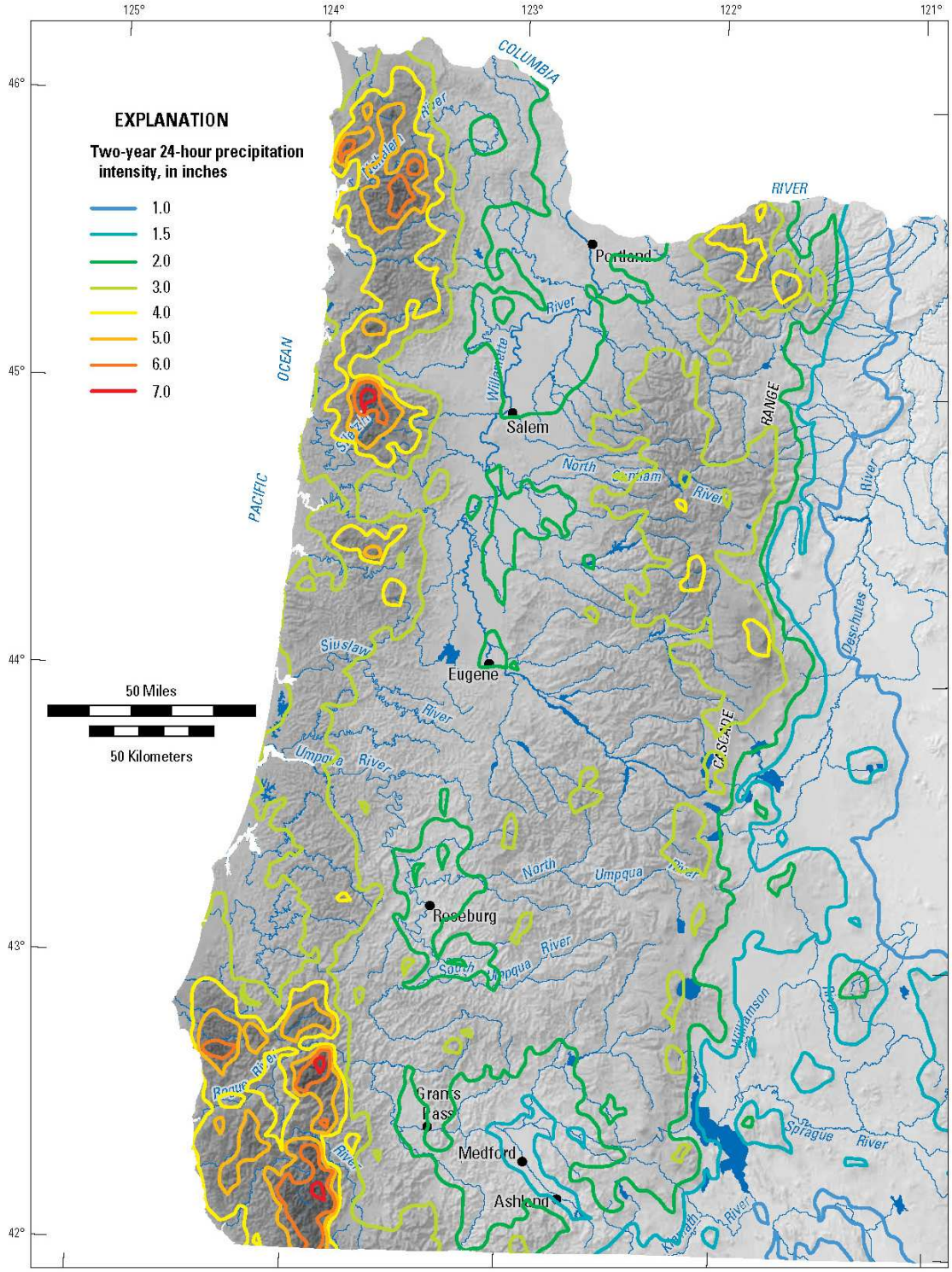


Figure C.23. The 2-year 24-hour rainfall intensity of western Oregon (1961–1990; Cooper, 2005). The isolines are superimposed on both a shaded relief map of elevation and the Geographic Information System grid of the 2-year 24-hour precipitation intensities on which the isolines are based. Darker areas represent higher precipitation intensities.

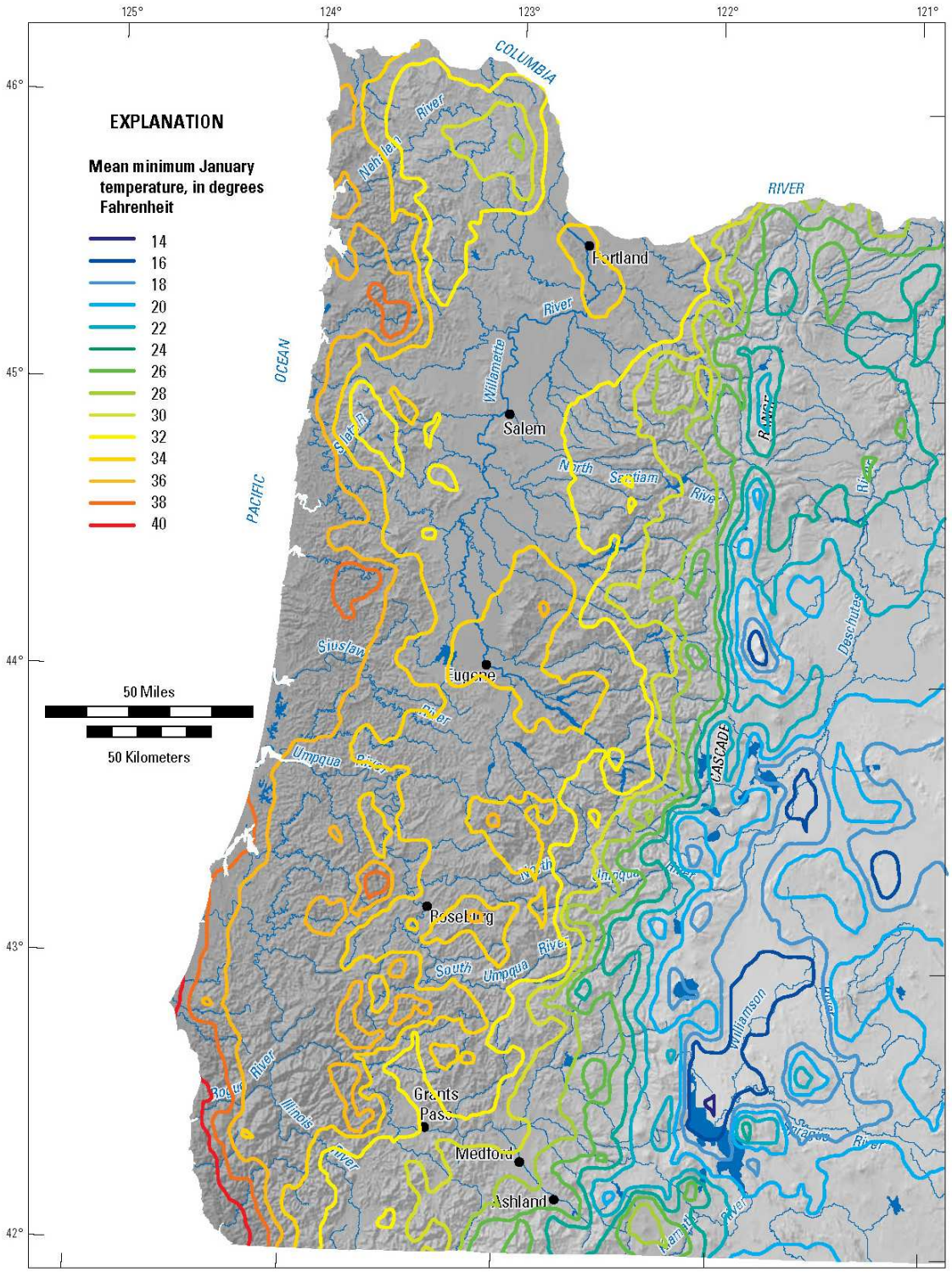


Figure C.24. Mean minimum January temperature of western Oregon (1961–1990; Cooper, 2005). The isolines are superimposed on both a shaded relief map of elevation and the Geographic Information System grid of the mean minimum January temperatures on which the isolines are based. Darker areas represent higher temperatures.

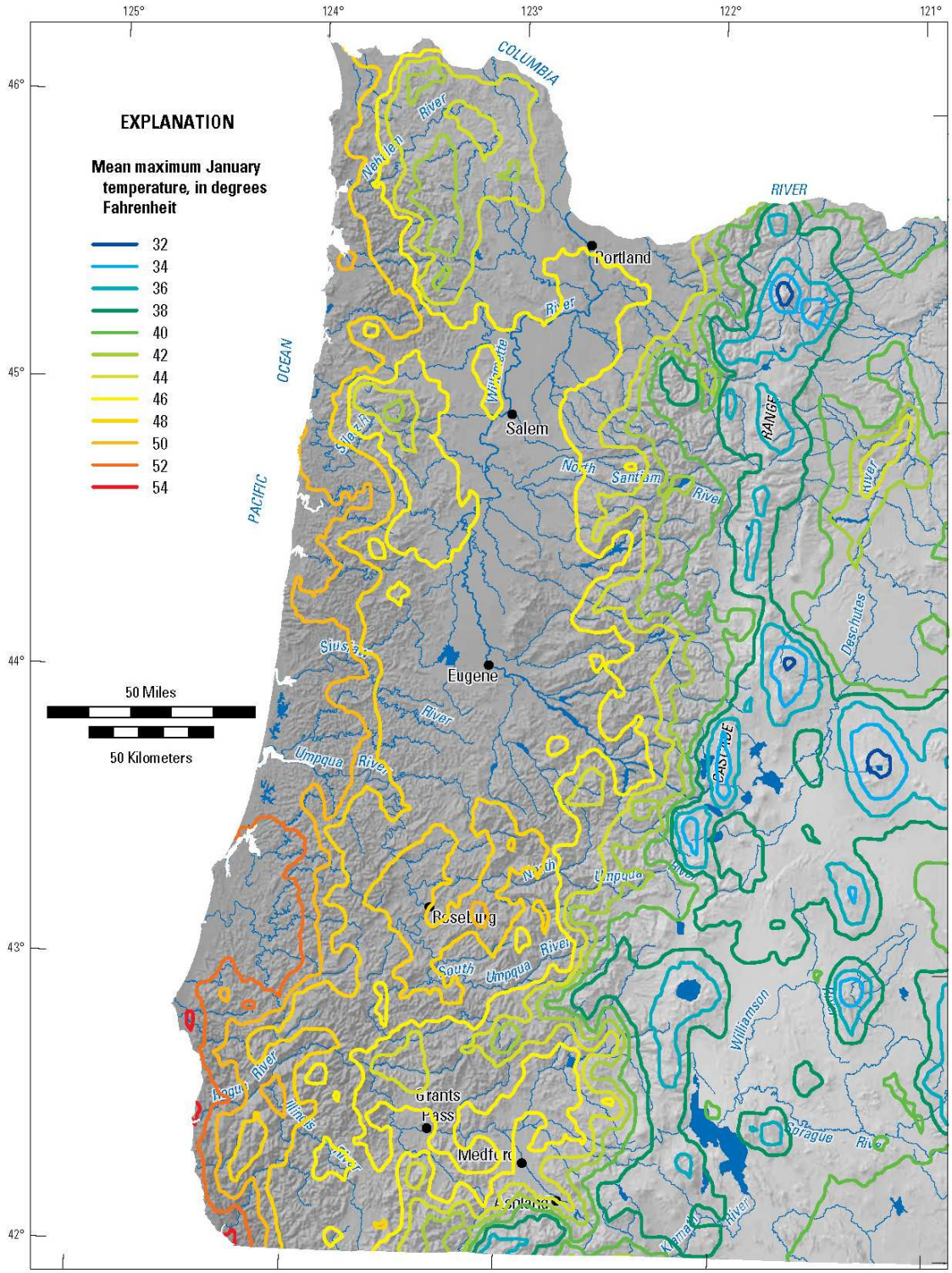


Figure C.25. Mean maximum January temperature of western Oregon (1961–1990; Cooper, 2005). The isolines are superimposed on both a shaded relief map of elevation and the Geographic Information System grid of the mean maximum January temperatures on which the isolines are based. Darker areas represent higher temperatures.

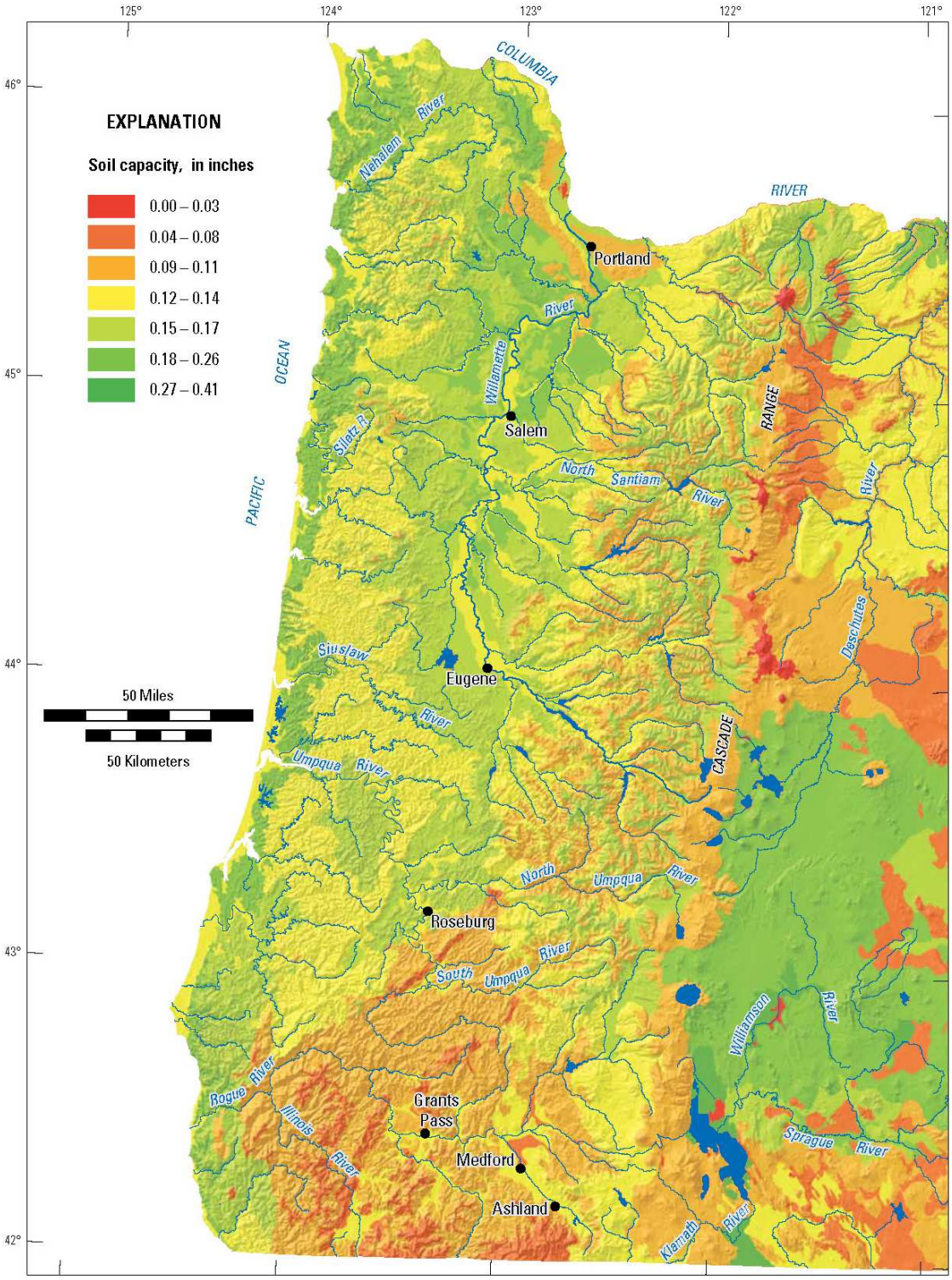


Figure C.26. Areal distribution of soil storage capacity in western Oregon (Cooper, 2005).

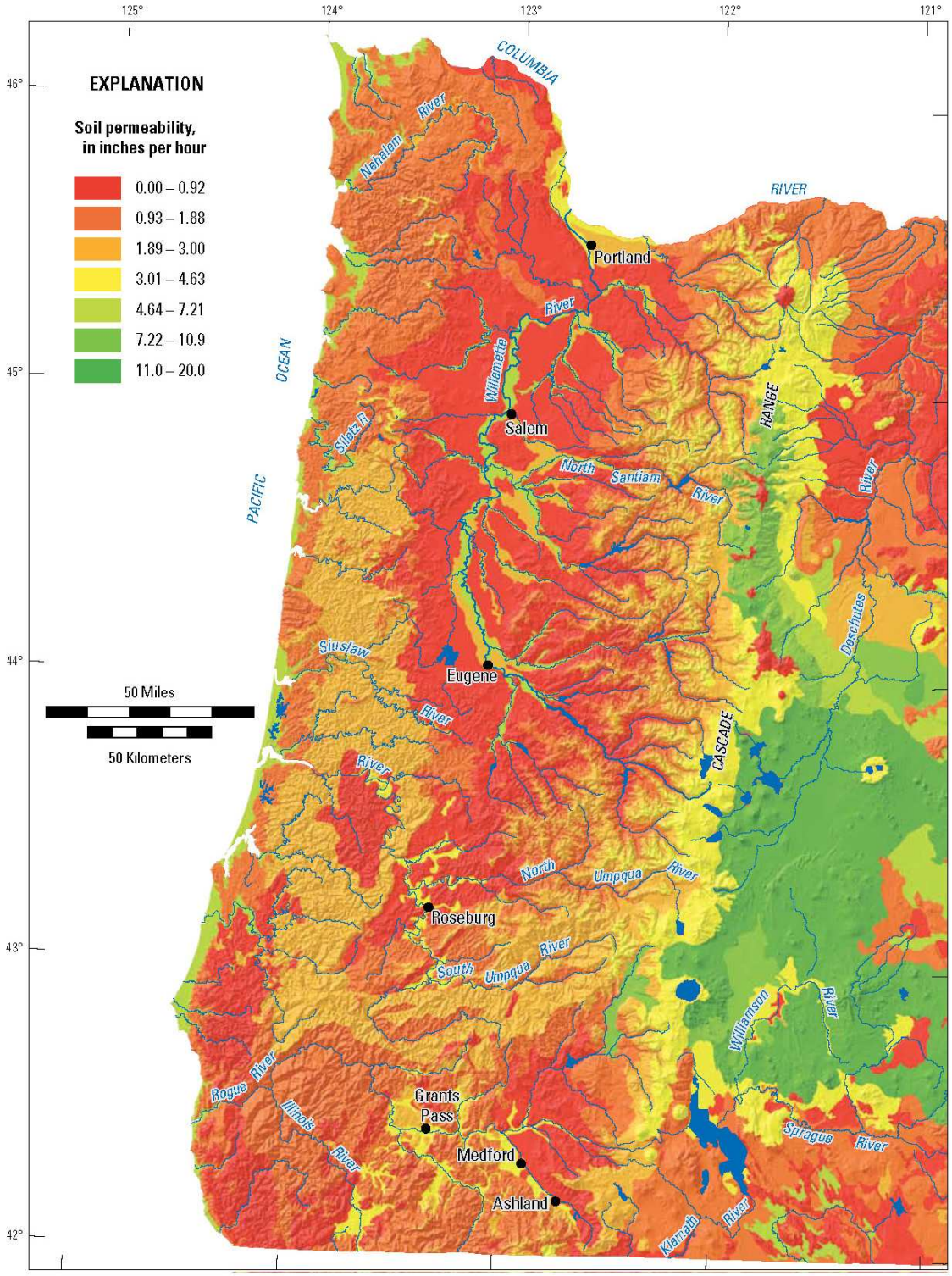


Figure C.27. Areal distribution of soil permeability in western Oregon (Cooper, 2005).

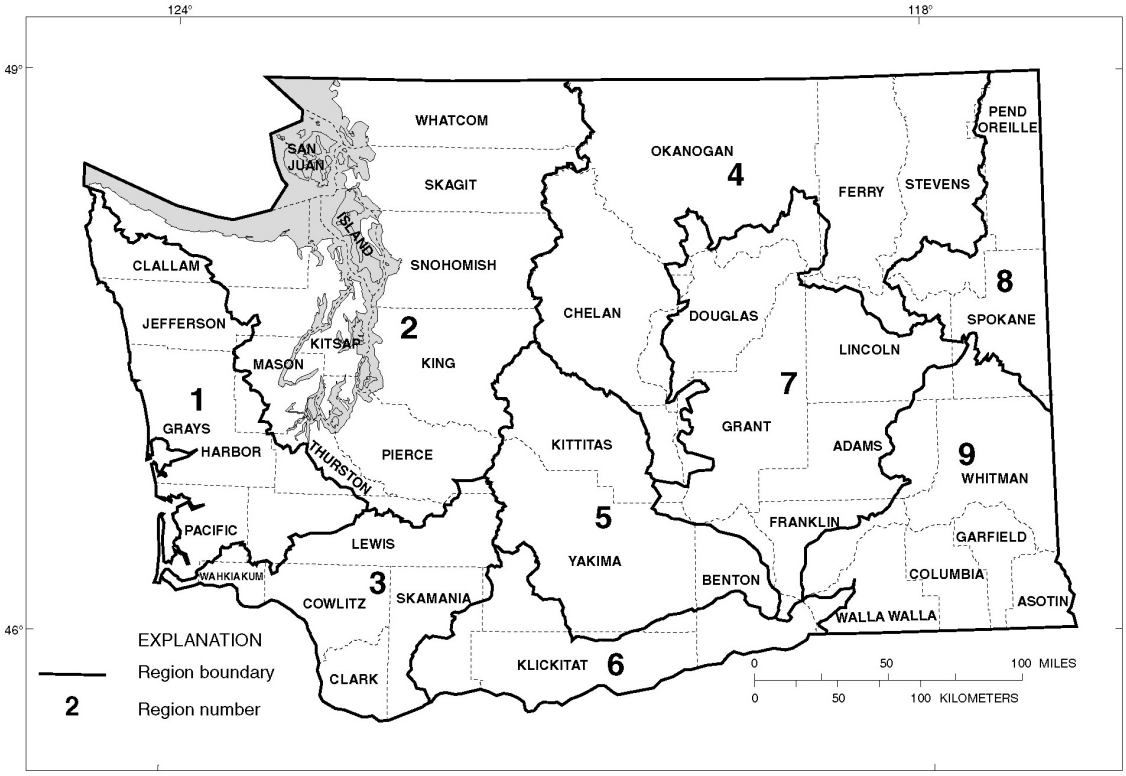


Figure C.28. Hydrologic regions of Washington (Seaber and others, 1987; Sumioka and others, 1998; Knowles and Sumioka, 2001).