U.S. Department of the Interior
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Prepared in cooperation with
IDAHO TRANSPORTATION DEPARTMENT
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U.S. ARMY CORPS OF ENGINEERS

Estimating the Magnitude of Peak Flows at Selected Recurrence Intervals for Streams in Idaho

Water-Resources Investigations Report 02–4170

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Multiply	By	To obtain
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
foot (ft)	0.3048	meter
foot per mile (ft/mi)	0.1894	meter per kilometer
inch (in.)	2.54	centimeter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer

Sea level: In this report, “sea level” refers to the North American Vertical Datum of 1988 (NAVD of 1988)—a vertical control datum established by the minimum-constraint adjustment of Canadian-Mexican-United States leveling observations and held fixed at Father Point/Rimouski, Quebec, Canada.

Water year: In U.S. Geological Survey reports dealing with surface-water supply, a water year is the 12-month period, October 1 through September 30. The water year is designated by the calendar year in which it ends; thus, the water year ending September 30, 2002, is called the “2002 water year.”

Estimating the Magnitude of Peak Flows at Selected Recurrence Intervals for Streams in Idaho

By Charles Berenbrock

Abstract

Methods for estimating magnitudes of peak flows at various recurrence intervals, needed for highway-structure and water-control design and planning, were developed for gaged and ungaged sites on streams throughout Idaho. Recurrence intervals of 2, 5, 10, 25, 50, 100, 200, and 500 years were selected for analysis of peak flows.

For gaged sites in Idaho, peak-flow estimates were calculated by fitting a log-Pearson Type III distribution to the annual peak-flow data for each site. Annual peak flows through 1997 were used in the analysis. Basin and climatic characteristics for these gaged sites were calculated from 1:24,000 digital-elevation models and various thematic data coverages using a geographic information system. Peak-flow data and basin and climatic characteristics for 333 gaged sites were combined to develop a database that was used for the analysis. To estimate the magnitude of peak flows at ungaged sites near gaged sites on the same stream, a method was developed on the basis of drainage-area ratios.

To estimate the magnitude of peak flows for ungaged sites on unregulated and undiverted streams, two regional regression methods were developed. The first regression method, termed the regional regression method, used generalized least-squares regression to develop a set of predictive equations for estimating peak flows at selected recurrence intervals for seven hydrologic regions in Idaho. These regional regression equations related basin and climatic characteristics to peak flows. The regional regression equations were all functions of drainage area plus one or two other basin characteristics. Average errors of prediction for these regression equations ranged from +143 percent to −58.8 percent. The range of errors was narrowest, from about +51.9 to about −34.2, for region 5. Error ranges were usually narrower for the middle recurrence intervals than for the lower and upper recurrence intervals. A computer program was developed to calculate the magnitude of peak flows at each recurrence interval, the average error of prediction, and the 90-percent confidence interval for each ungaged site.

The second regression method, termed the region-of-influence method, was used to develop a unique regression equation for each estimate that is based on a subset of gaged sites with values of basin and climatic characteristics similar to those for the ungaged sites. All 333 gages in the database were used to select the subset. Root-mean-squared errors for this method ranged from 55.5 percent to 72.4 percent. Differences in root-mean-squared errors between regional regression equations and the region-of-influence method were quite large. The average difference in root-mean-squared errors for the region-of-influence method was more than 10 percent greater than the average differences for the regional regression equations. For region 5, the average difference was greater than 20 percent. However, for region 8, the root-mean-squared errors were, in general, only slightly smaller for the region-of-influence method than for the regional regression equations. The region-of-influence method is not recommended for use in determining flood-frequency estimates for ungaged sites in Idaho because the results, overall, are less accurate and the calculations are more complex than those of regional regression equations. The regional regression equations were considered to be the primary method of estimating the magnitude and frequency of peak flows for ungaged sites in Idaho.

INTRODUCTION

Reliable estimates of the magnitude and frequency of floods (termed peak flows in this report) are needed by Federal, State, regional, and local designers and managers. The design of highway, road, and railroad stream crossings; delineation of flood plains and floodprone areas; management of water-control structures; and management of irrigation and water supplies are all activities that require estimates of the frequency distributions, or recurrence intervals, of peak flows. Such estimates can be calculated directly by using statistical methods for gaged sites (sites where streamflow-gaging stations, or gages, have been established) that have at least 10 years of annual peak-flow record (Riggs, 1972; Interagency Advisory Committee on Water Data, 1982). Longer records usually result in more reliable estimates. It is not feasible, however, to collect 10 years of annual peak-flow records for every location where an estimate of the flood-frequency distribution is needed, nor is it reasonable to wait 10 years for an estimate once a site has been identified.

Accurate estimates of peak-flow magnitudes at various frequencies are necessary for effective structural design and planning purposes. Underestimating peak flows can result in loss of life, disruption of service, and costly maintenance, and overestimates can result in excessive construction cost. Unfortunately, design and planning activities often require peak-flow magnitude and frequency information for locations where there are inadequate or no peak-flow data. To meet information needs for design and planning, estimates of the magnitude of annual peak flows for gaged sites have been regionalized. This process relates flood frequencies estimated for gaged sites to measurable basin and climatic or channel-geometry characteristics so that reliable flood frequencies can be estimated for ungaged sites by use of regression equations. Flood-frequency studies have been conducted within Idaho since the 1970s (see “Previous Studies” section). Often, the area of study was subdivided into regions of similar hydrology (hydrologic regions) to improve the predictive ability of the regression equations.

In 1998, the U.S. Geological Survey (USGS) conducted a study in cooperation with the Idaho Transportation Department (ITD), Idaho Bureau of Disaster Services (BDS), and U.S. Army Corps of Engineers (COE) to develop regional regression equations that would define the relation between peak flows and basin characteristics. The equations and the estimating methods used in this study will provide more accurate estimates of peak flows for Idaho than provided in previous reports because of the use of additional data and availability of more robust statistical methods.

Purpose and Scope

This report documents estimation of the magnitude of peak flows at recurrence intervals of 2, 5, 10, 25, 50, 100, 200, and 500 years. Two methods, the log-Pearson Type III distribution and the drainage-area ratio, are presented for estimating peak flows for gaged sites and for ungaged sites near gaged sites on the same stream. Two methods based on regression analysis are presented for estimating peak flows for ungaged sites on unregulated and undiverted streams in Idaho—the regional regression method and the region-of-influence method. Standard errors of estimate were calculated to show the predictive reliability of each method, and the results were compared to evaluate their applications and limitations. To compare the two methods on an equal basis, each method was applied to the same dataset, which consisted of 333 gaged sites with at least 10 years of unregulated, undiverted peak-flow record. Information in this report describing peak-flow compilation and methods for estimating peak flows for ungaged sites was derived mainly from documentation of a similar study in North Carolina by Pope and Tasker (1999).

For information on estimating peak flows in urbanized drainage basins, the reader is referred to a national study by Sauer and others (1983). Techniques for estimating peak flows for ungaged sites on regulated streams were beyond the scope of this report.

Acknowledgments

The author recognizes the hard work and dedication of the many USGS hydrologic technicians in collecting, processing, and storing the peak-flow data necessary for the completion of this report. Also, the author appreciates the assistance of the many Federal, State, and local agencies that financially supported operation of gages throughout Idaho where peak-flow data are collected. Special recognition goes to Gary Tasker, USGS, who provided a computer program for use in this study.

Previous Studies

Thomas and others (1973) were the first to develop regional regression equations for estimating flood-frequency characteristics for Idaho streams. Their regression equations only directly determined the 10-year peak flow (Q_{10}). Ratios were used to estimate the 25-

year (Q_{25}) and 50-year peak flows (Q_{50}). Standard errors for Q_{10} ranged from 41 to 62 percent (table 1). Their equations were applicable only for streams draining areas between 0.5 and 200 mi^2. In their analysis, the State was divided into nine regions and separate regression equations and ratios were developed for each. The following basin characteristics were used in one or more of their equations: basin area, percent forest area, percent water area, and latitude and longitude. Harenberg (1980) developed several sets of regression equations for Idaho on the basis of channel-geometry and basin characteristics. The characteristics used in his study were bankfull width, drainage area, and the 24-hour rainfall intensity for the 2-year recurrence interval. He used fewer than half of the gaging stations used in the previous study because channel-geometry characteristics could not be determined at every gage. He demonstrated that standard errors were smaller when channel-geometry variables were included with basin characteristics in regression equations, but standard errors in his study were 20 to 30 percent larger than in the previous study (table 1), which used a dataset twice as large.

Using peak-flow data through 1977, Kjelstrom and Moffatt (1981) developed regional regression equations using the method of moments. About 270 gages were used and the State was divided into three regions. Their equations used one or more of the following basin characteristics to calculate the logarithmic mean and logarithmic standard deviation: drainage area, mean basin elevation, percent forest cover, slope of the main channel, mean annual precipitation in the basin, mean minimum January temperature of the basin, and the 24-hour rainfall intensity for a 2-year recurrence interval. The frequency factor for the selected recurrence interval then was multiplied by the logarithmic standard deviation and added to the logarithmic mean to obtain the logarithmic magnitude of peak flow.

Table 1. Average standard errors of prediction for selected peak-flow recurrence intervals estimated by using regional regression equations from previous studies in Idaho

[Q_{10}, peak flow with a recurrence interval of 10 years; Q_{25}, peak flow with a recurrence interval of 25 years; Q_{50}, peak flow with a recurrence interval of 50 years; Q_{100}, peak flow with a recurrence interval of 100 years; min, minimum value; max, maximum value; —, no regional regression equations were available for the indicated recurrence interval]

Peak flow		Average standard errors of prediction, in percent						
		Thomas and others (1973)	Harenberg (1980)	Kjelstrom and Moffatt (1981)	Quillian and Harenberg (1982)	Hedman and Osterkamp (1982)	Thomas and others (1994)	This study
Q_{10}	min	41	71	[1] 41	49	[2] 60	66	41
	max	62	92	[1] 90	107		95	77
Q_{25}	min	—	71	[1] 41	—	[2] 62	66	40
	max	—	92	[1] 90	—		90	75
Q_{50}	min	—	71	[1] 41	46	[2] 71	72	41
	max	—	91	[1] 90	118		89	72
Q_{100}	min	—	72	[1] 41	49	[2] 83	77	41
	max	—	91	[1] 90	123		90	72

[1] The same average standard error of prediction was applicable to all peak-flow estimates.
[2] Only the average error was available.

The antilogarithm then was applied to obtain the magnitude of peak flow. Standard errors of estimate in their study ranged from 41 to 90 percent (table 1).

In a network and cost-estimate analysis of gages in Idaho, Quillian and Harenberg (1982) developed regional regression equations for nine regions in the State. They used the same regions as in the first regional regression study by Thomas and others (1973). They developed equations for the 2-, 10-, 50-, and 100-year peak flows and the mean annual flow. Their equations were based on basin characteristics, and standard errors were larger than errors from the three previous regional regression studies. Hedman and Osterkamp (1982) also developed regional regression equations for selected peak flows and for the mean annual flow for the western half of the United States. Their equations were based on channel-geometry characteristics, and drainage basins in the State were grouped into a much larger region composed of the Rocky Mountains. However, data from only three gages in Idaho were used in their analysis. These gages were located on tributaries to the Snake River. Standard errors were within the ranges of error from the previous studies (table 1).

Thomas and others (1994) developed regional regression equations for 16 regions in the southwestern United States. Only the southern part of Idaho was included in their analysis, which comprised four regions. The eastern and western Snake River Plain regions composed most of the area. Basin and climatic characteristics (basin area, mean elevation, and (or) mean annual precipitation) also were needed to determine the peak flow at the selected recurrence interval. They used peak-flow data through 1991. Standard errors for their study were similar to those from previous studies that used basin and climatic characteristics (table 1).

General Description of Study Area

The landscape of Idaho is quite diverse, with areas of flat, extensive plains, rolling hills, and rugged mountains. Land-surface elevations range from 14,000 ft above sea level at Borah Peak to about 1,800 ft at Porthill, in the northern part of the State. A prominent geographic feature of Idaho is the Snake River Plain, which bisects the southern part of the State. Volcanic rocks and alluvium underlie the plain and, in the eastern part, much of the volcanic rock is exposed. In the western part of the plain, however, the alluvium is thousands of feet thick. Land use in the plain is mostly desert shrubs and large tracts of irrigated lands. Most of the State north of the Snake River Plain is in the Rocky Mountains and is underlain principally by granitic rocks. Land use in this area is dominated by forest and woodland, except in the area between Coeur d'Alene Lake and the Clearwater River, where cropland is the major land use.

Annual precipitation varies widely in the State, primarily because of orographic effects. Annual precipitation tends to be greatest in the mountains, where it is as much as 70 in. in the northern and central mountains that border Montana (Molnau, 1995). Valley areas tend to be drier than adjacent mountains, especially in Birch Creek and Big Lost, Little Lost, Pahsimeroi, and Lemhi River Valleys. In the Snake River Plain, annual precipitation is less than 10 in.

Annual runoff generally follows the precipitation pattern, and quantities are larger in areas of higher elevation. Streamflows vary greatly on a seasonal basis, as snowmelt provides the bulk of annual runoff in May, June, and July for mountain streams and in March, April, and May for streams draining the lower foothills and valley-floor areas. Streamflows generally are smallest in late fall and winter, and many streams can become dry during this period.

The major drainage basins in Idaho are the Snake, Salmon, Clearwater, Spokane, Pend Oreille, and Kootenai River Basins, which are all within the Columbia River Basin. The Snake River drains most of the southern half of the State (fig. 1). Near King Hill, more than 5,000 ft^3/s discharges to the Snake River from ground water (Kjelstrom, 1995). The Snake River winds westward through the Snake River Plain until it reaches Oregon, then heads northward to the city of Lewiston, Idaho (fig. 1). In central Idaho, the Salmon River joins the Snake River at the Idaho-Oregon boundary about 40 mi south of Lewiston, and the Clearwater River joins the Snake River at Lewiston. In northern Idaho, the Coeur d'Alene River flows westward to Coeur d'Alene Lake. The lake's outlet drains to the Spokane River, which flows westward from Idaho to Washington and joins the Columbia River. The Clark Fork flows from Montana into Idaho and into Pend Oreille Lake. The lake's outlet drains to the Pend Oreille River, which winds westward through Idaho to Washington and joins the Columbia River. The Kootenai River flows northwestward from Montana through a small area of Idaho to Canada and joins the Columbia River.

PEAK-FLOW COMPILATION

The first step in the regionalization of flood-frequency estimates is compilation of a list of all gaged sites with annual peak-flow records. Such sites are either continuous-record sites or crest-stage sites. At continuous-record sites, the water-surface elevation, or stage, of the stream is recorded at fixed intervals, typically ranging from 5 to 60 minutes. At crest-stage sites, only the crest, or highest stages that occur between site visits (usually several months) are recorded. Regardless of the type of gage, discharge measurements are made throughout the range of recorded stages, and a relation between stage and discharge is developed for the gaged site. Using this stage-discharge relation, or rating, discharges for all recorded stages are determined. The highest peak discharge that occurs during a given year is the annual peak for the year, and the list of annual peaks is the annual peak-flow record.

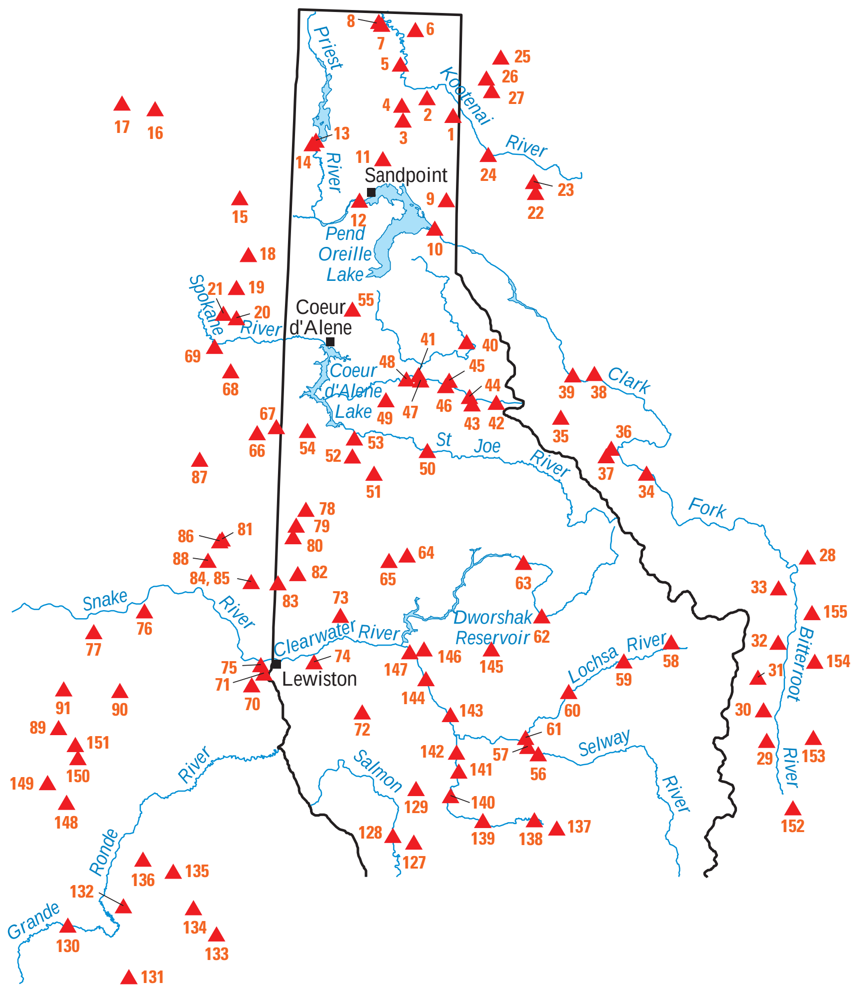
Initially, more than 500 gages, including gages from bordering States, were determined to have some annual peak-flow records. Examination of flow records for these gages revealed that many were on streams regulated by reservoirs or had irrigation diversion(s) that would significantly affect peak flows at the gage. These gages then were excluded from the database. Gages that did not have 10 or more years of peak-flow records were excluded from the database and not used in any subsequent calculations (Riggs, 1972; Interagency Advisory Committee on Water Data, 1982). Flood-frequency characteristics for the remaining 333 gages (fig. 1) were calculated and formed the database that was used for the regional regression and region-of-influence methods.

BASIN AND CLIMATIC CHARACTERISTICS

Because basin and climatic characteristics are widely used in regression equations, several basin and climatic variables have been measured previously at most USGS gages in Idaho and bordering States. These data were stored in the Basin Characteristics File of the USGS Water Data Storage and Retrieval System (WATSTORE) and were determined by measuring the characteristic on the largest scaled (most detailed) topographic map available. For example, drainage area was determined by manually planimetering the outline of the basin upstream from each gage and was usually done on 1:24,000-scale maps (USGS 7.5-minute quadrangle maps) to ensure consistency of the data. Other basin and climatic characteristics that were measured at some gages and stored in WATSTORE included basin perimeter, mean basin elevation, basin slope, basin relief, drainage density, and aspect.

Except for drainage area, basin and climatic characteristic data were not readily available for all gages used in this study. In addition, mean annual precipitation for each basin had to be reevaluated because more recent estimates throughout Idaho were available (Molnau, 1995). Because of the large number of sites involved and the need for consistent and unbiased methodology in making measurements and calculations, the Arc/Info geographic information system (GIS) was used to measure and calculate basin and climatic characteristics.

Therefore, all basin characteristics in this study, including the remeasurement of drainage area, were obtained using Arc Macro Language programs written for Arc/Info (Environmental Systems Research Institute, Inc., 1999). These programs generated the basin characteristic values from the datasets listed in table 2. More than 50 separate basin and climatic characteristics were obtained for each of the 333 gages included in the study. Several characteristics were removed from consideration after correlation plots of the data were reviewed. Generally, if two basin characteristics correlated well, the one that was the least difficult to obtain was kept and the other was removed from the database. Other characteristics were removed because of missing data or difficulty in obtaining data. By following this process, 18 basin and climatic characteristics were retained for use in the multiple-regression analysis. Of the 18 characteristics used in the analysis, 7 were included in at least one of the final equations. These 7 standard characteristics were: drainage area (DA), mean basin elevation (E), forested area (F), mean annual precipitation (P), basin slope (BS), north-facing slopes greater than 30 percent (NF30), and slopes greater than 30 percent (S30). Basin azimuth, area higher than 6,000 ft in elevation, slope of the main channel, length of the main channel, basin relief, basin perimeter, ruggedness number (basin relief divided by square root of drainage area), area of basin containing sedimentary rocks, area of basin containing granitic rocks, area of basin containing volcanic rocks, and minimum average temperatures also were included in the analysis but were not used in any of the equations. General descriptions of how the 7 basin and climatic characteristics used in the equations were measured are listed in table



EXPLANATION

▲ 39 Gaging station and identification number (name and basin characteristics shown in table 4)

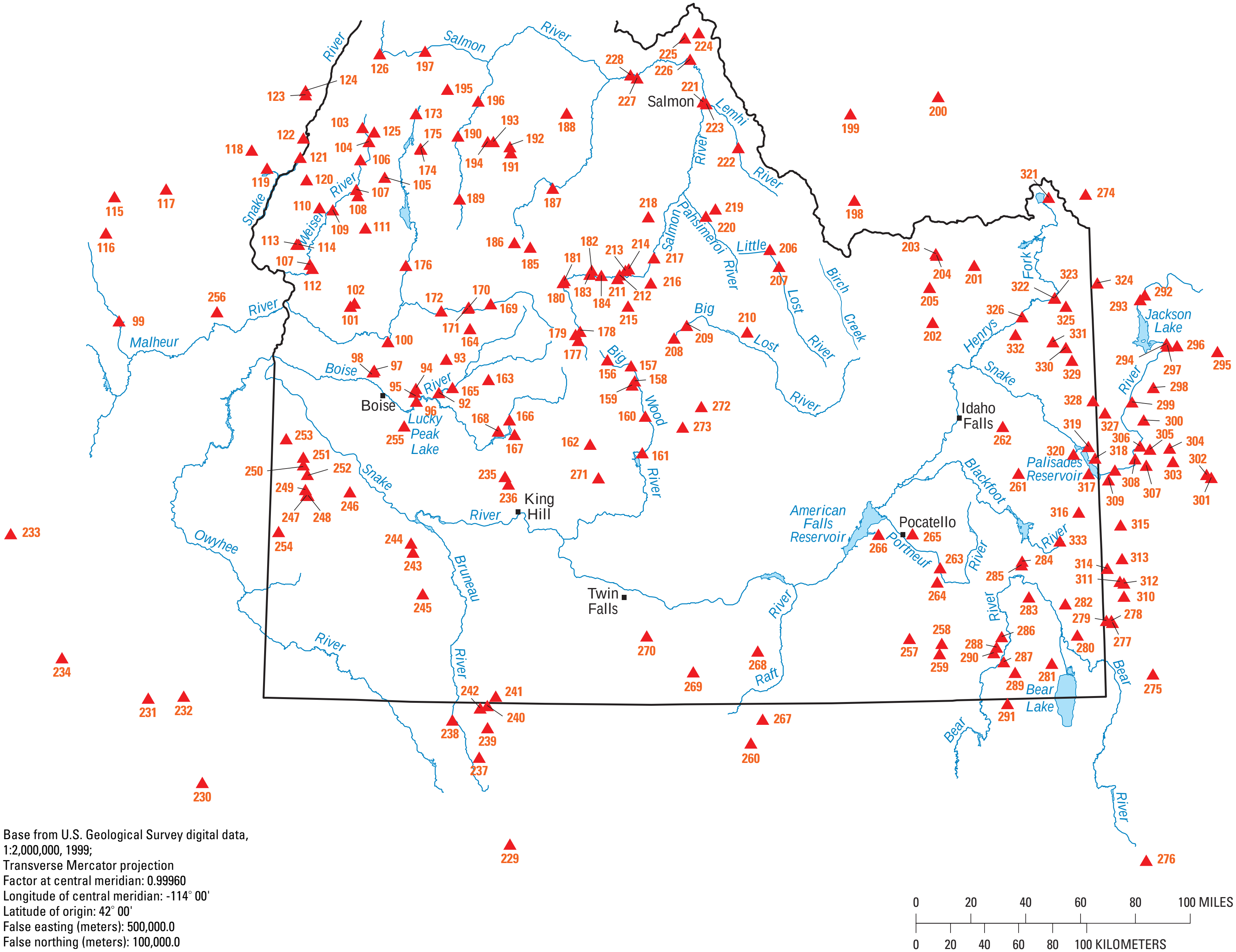


Figure 1. Locations of streamflow-gaging stations in Idaho and bordering States used in regional regression analysis.

Table 2. Selected data sources used to obtain basin and climatic characteristics for regional regression analysis

[Multiply meter by 3.281 to obtain foot; multiply kilometer (km) by 0.6214 to obtain mile]

Dataset name	Source description
National Elevation Dataset (NED)	Basin characteristics were calculated using 30-meter resolution digital elevation data **(http://gisdata.usgs.gov/ned/)**
National Elevation Dataset Hydrologic Derivatives (NED-H)	Hydrologic derivatives of NED data were developed using procedures similar to those in Stage 1 processing, using a custom projection for Idaho **(http://edcnts12.cr.usgs.gov/ned-h/about/Stage1.html)**
National Land Cover Dataset (NLCD)	Vogelmann, J.E., Sohl, T.L., Campbell, P.V., and Shaw, D.M., 1998, Regional land cover characterization using Landsat Thematic Mapper data and ancillary data sources: Environmental Monitoring and Assessment, v. 51, p. 415–428 **(http://edcwww.cr.usgs.gov/programs/lccp/)**
Idaho map of mean annual precipitation[1]	Molnau, M., 1995, Mean annual precipitation, 1961–1990, Idaho: Moscow, University of Idaho, Agricultural Engineering Department, State Climate Program, scale 1:1,000,000 **(http://snow.ag.uidaho.edu/Climate/reports.html)**
Western United States average monthly or annual precipitation[2]	Daly, C., and Taylor, G., 1998, Western United States average monthly or annual precipitation, 1961–90, Oregon: Portland, Water and Climate Center of the Natural Resources Conservation Service, grid-cell resolution 4 km **(http://www.ocs.orst.edu/prism/prism_new.html)**

[1]Used for areas in Idaho.
[2]Used for areas outside of Idaho.

3, and basin characteristic values obtained for the 333 gages (fig. 1) are presented in table 4.

All basin and climatic characteristics were calculated in a GIS using Arc/Info programs. For example, the DA program compares adjacent grid cells to develop an outline of the DA upstream from the point of interest on the stream using the 30-meter-resolution digital-elevation data (table 3). Then the program counts the number of cells within the DA and multiplies by 30 square meters to determine DA. To convert from square meters to square miles, the program multiplies DA by 3.861×10^{-7}. Because WATSTORE DA was available for most gages, the GIS-calculated DA then was compared with the WATSTORE DA, and the percent difference between GIS-calculated DA and WATSTORE DA was determined and used to help verify the delineation of basin boundaries. Sites with greater than 10-percent difference between the GIS-calculated and WATSTORE values were flagged and reexamined. Errors in the GIS boundary delineation were corrected by comparing USGS 7.5-minute topographic maps with the original manually planimetered basin boundary. After the GIS basin boundaries were adjusted, basin characteristics were recalculated and rechecked until satisfactory results were obtained. The final GIS-calculated DA is compared with the WATSTORE DA in figure 2. Several sites with DA fewer than 10 mi^2 did not meet the criteria of less than 10-percent difference between GIS-calculated DA and WATSTORE DA because the resolution of the GIS data was much finer (30 meters, or about 100 ft) than the map resolution. These sites were examined manually to determine whether the GIS delineation was consistent and correct; if not, the boundaries were adjusted accordingly and basin and climatic characteristics were recalculated. The GIS-calculated DA was determined to be appropriate and used for all sites in this study (table 4).

DETERMINATION OF REGIONS FOR REGIONAL REGRESSION ANALYSIS

In regional flood-frequency analysis, attempts are made to define regions that are hydrologically homogeneous in terms of the characteristics being studied (Haan, 1977). This helps to obtain a better fitting regression equation and reduces standard errors. In this study, eight regions were delineated on the basis of the following factors: (1) grouping of similar basin and climatic characteristics based on a statistical cluster analysis; (2) geographic features, such as large mountain ranges or breaks between mountains and plains; and (3) scientific judgment based on general knowledge of the area. Cluster analysis, which is a statistical technique that defines common areas on the basis of the similarity of variables used in the analysis, was used to delineate eight regions in Idaho. The cluster analysis was based on 17 of the 18 basin and climatic characteristics defined by the total variance explained by each characteristic and by eliminating redundant information. Drainage area was not used in this analysis because it is not a region-specific variable. Characteristics from the 333 gages included in the study were used. Characteristics were normalized to a mean of 0 so as not to influence the grouping by differences in units of measurement among the characteristics. Normalization makes the data less dependent on the kind of characteristic. Clustering also was limited to fewer than 13 groups; otherwise, groups were indistinctive or undefinable.

Cluster analysis resulted in six to eight well-defined groups. Other groupings were indistinctive or less well defined. Eight groups were considered optimal because they provided an adequate number of sites in each region for the regression analysis (fig. 3).

Initial grouping on the basis of cluster analysis delineated a large part of the Snake River Plain as one region. However, when the number of possible groups was increased to 10, 11, or 12, sites on the plain showed more diversity between one another and differences were greater between sites located on the eastern and western sides of the plain. These differences also were apparent in the regionalization study by Thomas and others (1994) and somewhat apparent in the study by Thomas and others (1973), who divided the eastern and western Snake River Plain into separate regions. In keeping with the numbering system of Hortness and Berenbrock (2001), region 7 was divided accordingly and redesignated as regions 7a and 7b, which correspond with the western Snake River Plain and eastern Snake River Plain, respectively (fig. 3).

A part of the area commonly referred to as the eastern Snake River Plain (region 0) was excluded 1
from the regionalization for several reasons: (1) Most of the streams in this region either are regulated or are significantly affected by irrigation diversions, (2) several springs with extremely large discharges add significant flow to streams in the region, and (3) the lithology of the area consists mainly of layered basalts that exhibit extremely high rates of infiltration. The effects of these features on the hydrology of the area cannot be characterized by a regional regression approach.

METHODS FOR ESTIMATING PEAK FLOWS FOR GAGED SITES

Two methods were developed to estimate peak flows at various recurrence intervals for gaged sites

Table 3. Description of selected basin and climatic characteristics used in the final predictive equations

[Multiply meter by 3.281 to obtain foot; multiply kilometer (km) by 0.6214 to obtain mile]

Characteristic	Description
Drainage area (DA)	Drainage area of the basin that contributes surface runoff, in square miles; estimated using Arc/Info Grid with 30-meter-resolution digital-elevation models (DEMs)
Mean basin elevation (E)	Mean elevation of the basin, in feet above sea level; estimated using Arc/Info Grid and averaging elevations using 30-meter-resolution DEMs
Forested area (F)	Area of the basin containing forest, in percent of total drainage area; estimated using Arc/Info Grid with a 37-meter-resolution land-cover grid
Mean annual precipitation (P)	Mean annual precipitation over the entire drainage area, in inches; estimated using Arc/Info Grid with a combination of 500-meter (within Idaho) and 4-km (outside of Idaho) resolution precipitation grids
Basin slope (BS)	Average slope of the basin, in percent; estimated using the “average maximum technique” in Arc/Info Grid with 30-meter-resolution DEMs
North-facing slopes greater than 30 percent (NF30)	Area of north-facing slopes with slopes greater than 30 percent, in percent of drainage area; estimated using the “average maximum technique” in Arc/Info Grid with 30-meter-resolution DEMs
Slopes greater than 30 percent (S30)	Area with slopes greater than 30 percent, in percent of drainage area; estimated using the “average maximum technique” in Arc/Info Grid with 30-meter-resolution DEMs

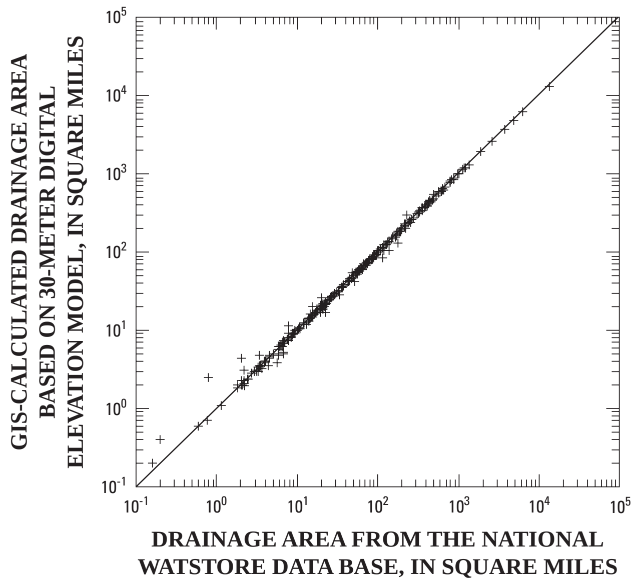


Figure 2. Comparison between GIS-calculated drainage area and national WATSTORE drainage area for streamflow-gaging stations in Idaho and bordering States. (GIS, geographic information system; WATSTORE, Water Data Storage and Retrieval System)

or for an ungaged site near a gaged site on the same stream. These methods and their limitations are explained in this section, and step-by-step procedures and examples for using the methods are given in the section entitled "Application of Methods." If the site in question does not fit in either category, then the method developed for estimating peak flows for ungaged sites on unregulated and undiverted streams, which is explained in the section entitled "Methods for Estimating Peak Flows for Ungaged Sites," can be used.

Gaged Sites

Flood-frequency estimates for a given stream site typically are presented as a set of exceedance probabilities or, alternatively, recurrence intervals, along with the associated peak flows. Exceedance probability is defined as the probability of exceeding a specified peak flow in a 1-year period and is expressed as decimal fractions less than 1.0 or as percentages less than 100. A peak flow with an exceedance probability of 0.10 has a 10-percent chance of being exceeded in any given year. Recurrence interval is defined as the number of years, on average, during which the specified peak flow is expected to be exceeded one time and is expressed as number of years. A peak flow with a 10-year recurrence interval is one that, on average, will be exceeded once every 10 years. Recurrence interval and exceedance probability are mathematical inverses of one another; thus, a discharge with an exceedance probability of 0.10 has a recurrence interval of 10 years ($\frac{1}{0.10} = 10$). Conversely, a peak flow with a recurrence interval of 10 years has an exceedance probability of one-tenth or 0.10 ($\frac{1}{10} = 0.10$). It is important to remember that recurrence intervals, regardless of length, always refer to the average number of occurrences over a long period of time; for example, a 10-year peak flow is one that might occur about 10 times in a 100-year period, rather than exactly once every 10 years.

Flood-frequency estimates for gaged sites are calculated by fitting some known statistical distribution to the series of annual peak flows. For this study, estimates of peak-flow frequency were calculated by fitting a log-Pearson Type III distribution to the logarithms (base 10) of the annual peak flows, following the guidelines and using the calculation methods described in Bulletin 17B of the Interagency Advisory Committee on Water Data (1982). The equation for fitting the log-Pearson Type III distribution to an observed series of annual peak flows is as follows:

$$\log Q_T = \overline{X} + KS, \qquad (1)$$

where

Q_T *is* T-year peak flow, in cubic feet per second;

$\overline{X}$ *is* mean of the log-transformed annual peak flow;

K *is* frequency factor dependent on the recurrence interval and the skew coefficient of the log-transformed annual peak flow; and

S *is* standard deviation of the log-transformed annual peak flow.

Values of K for a wide range of recurrence intervals and skew coefficients are published in Appendix 3 of Bulletin 17B (Interagency Advisory Committee on Water Data, 1982).

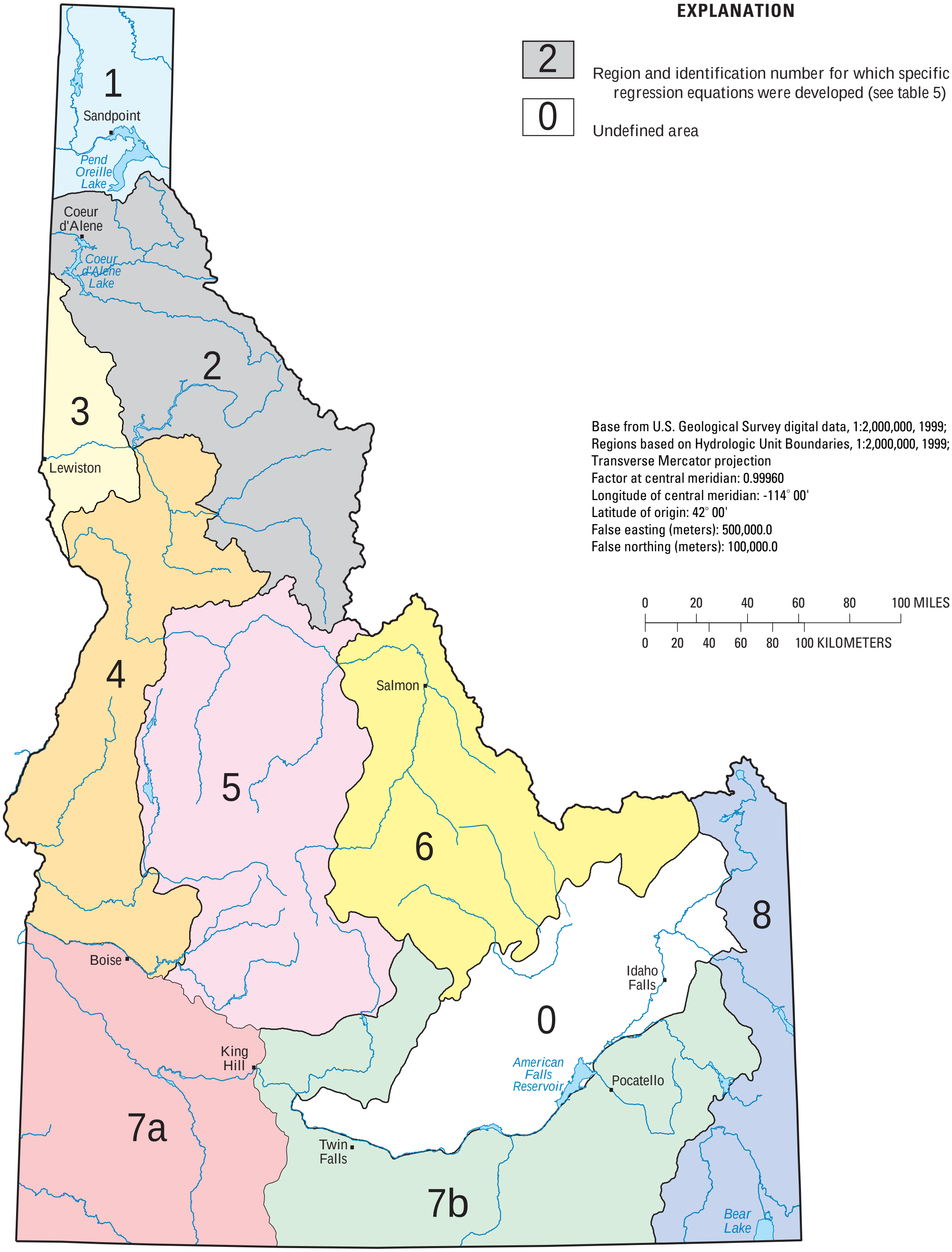


Figure 3. Locations of regions in Idaho used in regional regression analysis.

A skew coefficient measures the symmetry of the distribution of a set of peak flows about the median of the distribution. A peak-flow distribution with a mean equal to the median is said to have zero skew. A positively skewed distribution has a mean that exceeds the median. One or more extremely large peak flows within a record of significantly smaller peak flows often result in a positive skew coefficient. A negatively skewed distribution has a mean that is less than the median. Several very small peak flows within a record of generally larger peak flows often result in a negative skew.

The calculated skew coefficient for any peak-flow record is very sensitive to extreme peak flows. Therefore, the skew coefficient for a gage with a short period of record might not provide an accurate estimate of the population skew. Thus, a flood-frequency estimate made using equation (1) might not be reliable. A more accurate estimate of skew coefficient can be obtained by weighting the sample (individual gage) skew coefficient with a regional skew coefficient (Interagency Advisory Committee on Water Data, 1982).

A regional skew coefficient is based on regional trends in the skew coefficients calculated from long-term gages. A nationwide regional skew study was conducted by the Interagency Advisory Committee on Water Data (1982), and skew coefficients from long-term gages throughout the Nation were calculated and used to produce a map showing equal lines of regional skew. Kjelstrom and Moffatt (1981) produced regional skew maps of Idaho for rainfall, snowmelt, and rainfall-snowmelt events. Their regional skew map for snowmelt matched the nationwide regional skew map. Therefore, their maps were used to calculate the regional skew for gages in this study. To calculate the weighted skew, the mean square error of regional skew and sample skew are needed. The mean square errors of regional skew from the 1981 maps were 0.18 for rainfall events, 0.15 for snowmelt events, and 0.16 for rainfall-snowmelt events (L.C. Kjelstrom, U.S. Geological Survey, written commun., 1999). Flood-frequency estimates for all gages used in this study were calculated using a weighted skew.

Fitting the log-Pearson Type III distribution to a long series of annual peak flows is fairly straightforward. Often, however, a series of peak flows can include extremely small or large peak flows that depart significantly from the trend in the data (low or high outliers). The peak-flow record also can include peak flows that occurred outside of the period of regularly collected (systematic) record. Such peak flows, known as historical peaks, are often the maximum peak flows known to have occurred. The interpretation of outliers and historical peak information in the fitting process can greatly affect the final flood-frequency estimate. Bulletin 17B (Interagency Advisory Committee on Water Data, 1982) provides guidelines for detecting and interpreting these outliers and provides calculation methods for making appropriate corrections to the distribution to account for their presence.

Bulletin 17B (Interagency Advisory Committee on Water Data, 1982) guidelines were followed for determining flood-frequency estimates for the 333 gages that formed the database (table 5). The period of known peak flows and the number of years of known peak flows also are listed in table 5. For gages not listed in table 5, flood-frequency estimates can be calculated using procedures described in this section and in Bulletin 17B (Interagency Advisory Committee on Water Data, 1982).

Ungaged Sites Near Gaged Sites on the Same Stream

Flood frequencies for ungaged sites near gaged sites on the same stream can be estimated using a ratio of drainage area for the ungaged site to drainage area for the gaged site as shown in the following equation (the drainage-area ratio DA_u/DA_g should be approximately between 0.5 and 1.5):

$$Q_u = \left(\frac{DA_u}{DA_g}\right)^{a} Q_g \,, \tag{2}$$

where

Q_u *is* peak flow for the selected flood frequency for the ungaged site,

DA_u *is* drainage area for the ungaged site,

DA_g *is* drainage area for the gaged site,

a *is* exponent for drainage area for each hydrologic region (table 6), and

Q_g *is* peak flow for the selected flood frequency for the gaged site.

The exponent, *a*, was determined by regressing the logarithms of the T-year flood (T = 2, 5, 10, 25, 50, 100, 200, and 500) against the logarithm of DA for each region and averaging the regression coefficients for the eight recurrence intervals. The values of the exponent for each region are shown in table 6.

If an ungaged site is between two gaged sites, the flood-frequency data for the ungaged site can be estimated by interpolating between values for the two gages using the following equation:

$$Q_u = \left[\frac{Q_{g_1}(DA_{g_2} - DA_u) + Q_{g_2}(DA_u - DA_{g_1})}{(DA_{g_2} - DA_{g_1})}\right], \quad (3)$$

where

- Q_u *is* peak flow for the selected frequency for the ungaged site between gaged sites 1 and 2,
- Q_{g_1} *is* peak flow for the selected flood frequency for the upstream gage,
- DA_{g_2} *is* drainage area for the downstream gage,
- DA_u *is* drainage area for the ungaged site,
- Q_{g_2} *is* peak flow for the selected flood frequency for the downstream gage, and
- DA_{g_1} *is* drainage area for the upstream gage.

METHODS FOR ESTIMATING PEAK FLOWS FOR UNGAGED SITES

Two regional regression methods were used to develop equations for estimating peak flows for ungaged sites on unregulated and undiverted streams in Idaho. The first method used generalized least-squares (GLS) regression to define a set of predictive equations that related peak flow at the 2-, 5-, 10-, 25-, 50-, 100-, 200-, and 500-year recurrence intervals to selected basin characteristics for each hydrologic region in Idaho. The second method, the region-of-influence (ROI) method (Tasker and Slade, 1994), was used to develop unique regression equations for each ungaged site on the basis of an optimal set of gaged sites with values of basin and climatic characteristics that were similar to those of the ungaged site. GLS regression also was used to develop the predictive equations for the ROI method. Neither method was reliable for the eastern Snake River Plain (region 0) (see section entitled "Determination of Regions" for more explanation).

Table 6. Value of exponent, *a*, for regions in Idaho used in regional regression analysis

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

Regional Regression Method

For both regression methods, all peak-flow data and basin and climatic characteristics were transformed to base-10 logarithms. Before transformation of the data, a value of 1 was added to data that were a percentage measure (for example, forest cover). This would ensure that 0 values, which cannot be transformed, would not result. Also, mean basin elevation (E) values were divided by 1,000 before transformation to allow for more convenient coefficients in the final equations. Transformation was performed to obtain linear relations between explanatory variables (basin and climatic characteristics) and response variables (T-year peak flows) and to achieve equal variance about the regression line.

Ordinary least-squares (OLS) linear regression was used initially to determine the best combination of transformed explanatory variables to use in the GLS regression equation for each region. Initially, 18 explanatory variables were considered. The best combination of the explanatory variables was based on minimizing Mallow's Cp, the PRESS statistic, the standard error of the estimate (SEE) (Helsel and Hirsch, 1992), and passing of diagnostic checks to test for outliers, high-influence values, and multicollinearity between explanatory variables. For example, the best combination of explanatory variables for region 1 was drainage area, mean basin elevation, and percent forest cover. These three variables were highly significant (the *p*-values from the T-statistics were less than 0.0001) in the OLS regression.

OLS regression is an appropriate and efficient regression analysis to use when the peak flows for gaged sites (response variables) are independent of each other (no correlation exists between pairs of sites) and when the record lengths and variability of the peak flows for different gaged sites are approximately equal. Records of peak flow from gages on the same stream, on different streams within the same basins, or even on streams in adjacent basins can be highly correlated, however, because the peak flows might have resulted from the same rainfall-snowmelt events. Peak-flow record lengths for sites used in this study ranged from 10 to 91 years and, thus, cannot be considered equal for all sites. Peak flows for gaged sites ranged from 4 to 149,000 ft^3/s and cannot be considered equal for all sites. For these reasons, OLS regression was used only as an exploratory technique.

GLS regression, as described by Stedinger and Tasker (1985), is a regression technique that takes into account the correlation between sites, as well as the differences in record lengths and variability of peak flows for gaged sites. These factors are accounted for in GLS regression by assigning different weights to each observation of the peak flow on the basis of its contribution to the total variance of the sample flow statistics.

GLS regression was used to calculate the final coefficients and measures of accuracy for the regional regression equations for each region. The computer program GLSNET (Tasker and Stedinger, 1989) was used to develop the regional regression equations and error results. To account for the effects of cross correlation, the GLS regression used a "best-fit" mathematical relation between sample cross-correlation coefficients and distance between sites for site pairs with long periods (at least 30 years) of concurrent record. This best-fit relation then was used to populate a cross-correlation matrix for the sites contained in each region. The matrix was used to give less weight to sites whose concurrent peak flows were correlated with those for other sites. The variability of peak flows for each site was measured by the standard deviation of the population of all peak flows for that site. The standard deviation of the population of peak flows for each site was calculated from a regression of the sample standard deviations against drainage area. These regression estimates of the standard deviations were used to assign weights to peak flows. Finally, the length of record at each site was used as a direct measure of the relative reliability of the T-year flow estimates calculated from those records. Less weight was given to sites with shorter periods of record.

Region-of-Influence Method

The ROI method (Tasker and Slade, 1994) was used to estimate T-year peak flows for ungaged sites from regression relations between T-year peak flows and basin and climatic characteristics for a unique subset of gaged sites. This unique subset of gaged sites, first suggested by Acreman and Wiltshire (1987), was described by Burn (1990a, 1990b) as the region of influence for the ungaged site, hence the name of the method. The unique subset of gaged sites is defined as the number, N, of gaged sites nearest to the ungaged site (Pope and Tasker, 1999), where nearest is determined from the Euclidean distance metric:

$$d_{ij} = \left[\sum_{k=1}^{p} \frac{(x_{ik} - x_{jk})^2}{sd\,(x_k)} \right]^{\frac{1}{2}}, \qquad (4)$$

where

d_{ij} *is* distance between two sites i and j in terms of basin and climatic characteristics,

p *is* number of basin and climatic characteristics used to calculate d_{ij},

x_{ik} *is* k^{th} basin and climatic characteristics at site i,

x_{jk} *is* k^{th} basin and climatic characteristics at site j,

x_k *is* k^{th} basin and climatic characteristic, and

$sd\,(x_k)$ *is* sample standard deviation for x_k.

The distance metric measures the multidimensional distance between two sites defined in terms of the basin and climatic characteristics.

This distance metric is directly analogous to the more familiar equation for distance, $D = [(x_2 - x_1)^2 + (y_2 - y_1)^2]^{\frac{1}{2}}$ in a two-dimensional rectangular coordinate system. The only difference between this equation and equation (4) is the use of sample standard deviation to standardize the different basin and climatic characteristics (remove the effects of disproportional units) and the notational difference of using an additional subscript (k) rather than changing variable symbols (x, y).

The ROI for an ungaged site is determined using equation (4) by first computing the distances (d_{ij}) between the ungaged site and all the gaged sites. The distances are ranked and the N sites with the smallest d_{ij} compose the ROI for that ungaged site. This technique is analogous to separating an area into similar physiographic, climatic, and (or) hydrologic regions (regionalization) as was done for the previous regression method. Once the ROI is determined, GLS regression techniques are used to develop the unique predictive relations between T-year peak flows and basin characteristics for the ungaged site.

The basin and climatic characteristics used to define an ROI need not be the same explanatory variables used in the subsequent GLS regression. For example, in a flood-frequency analysis in North Carolina for which the ROI method was used, the set of characteristics used as explanatory variables was a subset of the characteristics used to define d_{ij} (Pope and Tasker, 1999).

The number of gaged sites and basin characteristics used to define the ROI and perform the GLS regression were selected by trial and error, using a calculated root-mean-squared error (RMSE) as the criterion for selection. RMSE was calculated by removing one site at a time from the database and using the remaining sites to define a new regression equation for the site and to calculate an estimate of the peak flow. RMSE was calculated as the square root of the arithmetic mean of the differences between the estimated and calculated values of peak flow for each site. Then RMSEs were compared with results from the regional regression method for each region.

RESULTS OF ESTIMATING PEAK FLOWS FOR UNGAGED SITES

Two methods were developed to estimate peak flows at various recurrence intervals for ungaged sites on unregulated and undiverted streams in Idaho. These methods are explained in a previous section entitled "Methods for Estimating Peak Flows for Ungaged Sites," and step-by-step procedures and examples of using the methods are given in the section entitled "Application of Methods."

Regional Regression Analysis

GLS regression equations for recurrence intervals of 2, 5, 10, 25, 50, 100, 200, and 500 years were developed for all regions (table 7). Drainage area (DA) was included in regression equations for all regions; mean basin elevation (E), for five of the regions; and mean annual precipitation (P), for two of the regions. At least one of the following variables—forest cover (F), north-facing slopes greater than 30 percent (NF30), basin slope (BS), and slopes greater than 30 percent (S30)—was included in regression equations for three regions. No equation included more than three explanatory variables. Region 7b was the only region that included only one explanatory variable (DA). Three of the explanatory variables—NF30, BS, and S30—have not been used previously in regional regression equations for estimation of flood frequency in Idaho.

The standard error of the regression model and the average standard error of prediction also are listed in table 7. The standard error of the regression model is a measure of how well the regression model fits the data used to construct it. This error term is also often termed the standard error of estimate. The average standard error of prediction is the sum of two components—model error plus sampling error—which results from estimating model parameters from samples of the population. The model error is a characteristic of the model and is a constant for all sites. The sampling error for a given site, however, depends on the values of the explanatory variables used to develop the peak-flow estimate at that site. The error of prediction, therefore, varies from site to site. The standard error of prediction provides a better overall measure of a model's predictive reliability than does the model error. A more rigorous mathematical description of these errors and how to convert them from logarithms (base-10 units) to percent errors are given in a report by Pope and Tasker (1999, p. 12).

Standard errors of the model were different for each region and for each recurrence interval (table 7). The largest and smallest average standard errors of the model were +131 percent and -56.6 percent, respectively. The range of model standard errors for all recurrence intervals was narrowest for region 5. The range

Table 7. Predictive regression equations and their accuracy in estimating peak flows for ungaged sites on unregulated and undiverted streams in Idaho

[Q, peak flow, in cubic feet per second; DA, drainage area, in square miles; E, mean basin elevation, in feet; F, percentage of forest cover in the basin; P, mean annual precipitation, in inches; NF30, percentage of north-facing slopes greater than 30 percent; S30, percentage of slopes greater than 30 percent; BS, average basin slope, in percent]

Peak-flow regression equations for given recurrence interval (2 to 500 years)	Standard error of model (percent)	Standard error of prediction (percent)
Region 1 (Equations based on data from 21 gaging stations)		
$Q_2 = 2.52\ DA^{0.775}\ (E/1{,}000)^{3.32}\ (F+1)^{-0.504}$	+69.0 to -40.8	+78.4 to -43.9
$Q_5 = 23.0\ DA^{0.720}\ (E/1{,}000)^{3.36}\ (F+1)^{-0.885}$	+53.3 to -34.8	+61.1 to -37.9
$Q_{10} = 81.5\ DA^{0.687}\ (E/1{,}000)^{3.40}\ (F+1)^{-1.10}$	+49.0 to -32.9	+56.8 to -36.2
$Q_{25} = 339\ DA^{0.649}\ (E/1{,}000)^{3.44}\ (F+1)^{-1.36}$	+48.5 to -32.6	+57.1 to -36.3
$Q_{50} = 876\ DA^{0.623}\ (E/1{,}000)^{3.47}\ (F+1)^{-1.53}$	+50.6 to -33.6	+60.1 to -37.6
$Q_{100} = 2{,}080\ DA^{0.597}\ (E/1{,}000)^{3.49}\ (F+1)^{-1.68}$	+54.2 to -35.2	+64.8 to -39.3
$Q_{200} = 4{,}660\ DA^{0.572}\ (E/1{,}000)^{3.52}\ (F+1)^{-1.82}$	+58.9 to -37.1	+70.8 to -41.4
$Q_{500} = 12{,}600\ DA^{0.540}\ (E/1{,}000)^{3.56}\ (F+1)^{-2.00}$	+66.5 to -39.9	+80.1 to -44.5
Region 2 (Equations based on data from 44 gaging stations)		
$Q_2 = 0.742\ DA^{0.897}\ P^{0.935}$	+60.2 to -37.6	+64.2 to -39.1
$Q_5 = 1.50\ DA^{0.888}\ (E/1{,}000)^{-0.330}\ P^{0.992}$	+60.1 to -37.5	+64.3 to -39.1
$Q_{10} = 2.17\ DA^{0.884}\ (E/1{,}000)^{-0.538}\ P^{1.04}$	+61.4 to -38.0	+65.8 to -39.7
$Q_{25} = 3.24\ DA^{0.879}\ (E/1{,}000)^{-0.788}\ P^{1.10}$	+63.9 to -39.0	+68.7 to -40.7
$Q_{50} = 4.22\ DA^{0.876}\ (E/1{,}000)^{-0.962}\ P^{1.14}$	+66.1 to -39.8	+71.4 to -41.6
$Q_{100} = 5.39\ DA^{0.874}\ (E/1{,}000)^{-1.13}\ P^{1.18}$	+68.5 to -40.6	+74.1 to -42.6
$Q_{200} = 6.75\ DA^{0.872}\ (E/1{,}000)^{-1.29}\ P^{1.21}$	+71.1 to -41.5	+77.1 to -43.5
$Q_{500} = 8.90\ DA^{0.869}\ (E/1{,}000)^{-1.49}\ P^{1.26}$	+74.7 to -42.8	+81.3 to -44.8
Region 3 (Equations based on data from 26 gaging stations)		
$Q_2 = 26.3\ DA^{0.864}\ (E/1{,}000)^{-0.502}$	+78.3 to -43.9	+86.4 to -46.4
$Q_5 = 127\ DA^{0.842}\ (E/1{,}000)^{-1.31}$	+52.1 to -34.3	+58.6 to -36.9
$Q_{10} = 265\ DA^{0.837}\ (E/1{,}000)^{-1.68}$	+45.2 to -31.1	+51.8 to -34.1
$Q_{25} = 504\ DA^{0.833}\ (E/1{,}000)^{-1.95}$	+43.0 to -30.1	+50.3 to -33.5
$Q_{50} = 719\ DA^{0.832}\ (E/1{,}000)^{-2.08}$	+43.9 to -30.5	+51.9 to -34.2
$Q_{100} = 965\ DA^{0.831}\ (E/1{,}000)^{-2.18}$	+46.3 to -31.6	+55.1 to -35.5
$Q_{200} = 1{,}240\ DA^{0.831}\ (E/1{,}000)^{-2.26}$	+49.7 to -33.2	+59.4 to -37.3
$Q_{500} = 1{,}660\ DA^{0.832}\ (E/1{,}000)^{-2.35}$	+55.4 to -35.6	+66.2 to -39.8

Table 7. Predictive regression equations and their accuracy in estimating peak flows for ungaged sites on unregulated and undiverted streams in Idaho—Continued

Peak-flow regression equations for given recurrence interval (2 to 500 years)	Standard error of model (percent)	Standard error of prediction (percent)
Region 4 (Equations based on data from 60 gaging stations)		
$Q_2 = 16.3\ DA^{0.893}\ (E/1{,}000)^{-0.121}$	+80.5 to -44.6	+83.5 to -45.5
$Q_5 = 46.3\ DA^{0.874}\ (E/1{,}000)^{-0.459}$	+66.6 to -40.0	+69.1 to -40.9
$Q_{10} = 79.2\ DA^{0.863}\ (E/1{,}000)^{-0.628}$	+61.2 to -37.9	+63.6 to -38.9
$Q_{25} = 139\ DA^{0.852}\ (E/1{,}000)^{-0.801}$	+56.9 to -36.3	+59.5 to -37.3
$Q_{50} = 198\ DA^{0.844}\ (E/1{,}000)^{-0.910}$	+55.2 to -35.6	+57.7 to -36.6
$Q_{100} = 273\ DA^{0.837}\ (E/1{,}000)^{-1.01}$	+54.2 to -35.1	+56.9 to -36.3
$Q_{200} = 365\ DA^{0.831}\ (E/1{,}000)^{-1.10}$	+53.8 to -35.0	+56.6 to -36.1
$Q_{500} = 521\ DA^{0.822}\ (E/1{,}000)^{-1.20}$	+53.9 to -35.0	+56.9 to -36.3
Region 5 (Equations based on data from 46 gaging stations)		
$Q_2 = 0.0297\ DA^{0.995}\ P^{2.20}\ (NF30+1)^{-0.664}$	+43.6 to -30.4	+46.7 to -31.8
$Q_5 = 0.0992\ DA^{0.970}\ P^{1.92}\ (NF30+1)^{-0.602}$	+41.7 to -29.4	+44.8 to -30.9
$Q_{10} = 0.178\ DA^{0.957}\ P^{1.79}\ (NF30+1)^{-0.571}$	+41.7 to -29.4	+45.0 to -31.1
$Q_{25} = 0.319\ DA^{0.943}\ P^{1.66}\ (NF30+1)^{-0.538}$	+42.3 to -29.7	+46.0 to -31.5
$Q_{50} = 0.456\ DA^{0.934}\ P^{1.58}\ (NF30+1)^{-0.517}$	+43.1 to -30.1	+47.1 to -32.0
$Q_{100} = 0.620\ DA^{0.926}\ P^{1.52}\ (NF30+1)^{-0.499}$	+44.1 to -30.6	+48.4 to -32.6
$Q_{200} = 0.813\ DA^{0.919}\ P^{1.46}\ (NF30+1)^{-0.483}$	+45.3 to -31.2	+49.8 to -33.2
$Q_{500} = 1.12\ DA^{0.911}\ P^{1.39}\ (NF30+1)^{-0.464}$	+46.9 to -31.9	+51.9 to -34.2
Region 6 (Equations based on data from 31 gaging stations)		
$Q_2 = 0.000258\ DA^{0.893}\ P^{3.15}$	+71.2 to -41.6	+76.5 to -43.4
$Q_5 = 0.00223\ DA^{0.846}\ P^{2.68}$	+63.9 to -39.0	+68.8 to -40.8
$Q_{10} = 0.00632\ DA^{0.824}\ P^{2.45}$	+62.9 to -38.6	+67.9 to -40.4
$Q_{25} = 0.0181\ DA^{0.801}\ P^{2.22}$	+63.4 to -38.8	+68.8 to -40.8
$Q_{50} = 0.0346\ DA^{0.787}\ P^{2.08}$	+64.4 to -39.2	+70.2 to -41.2
$Q_{100} = 0.0607\ DA^{0.775}\ P^{1.96}$	+65.8 to -39.7	+71.8 to -41.8
$Q_{200} = 0.100\ DA^{0.763}\ P^{1.85}$	+67.3 to -40.2	+73.8 to -42.4
$Q_{500} = 0.180\ DA^{0.750}\ P^{1.73}$	+69.6 to -41.0	+76.5 to -43.3

Table 7. Predictive regression equations and their accuracy in estimating peak flows for ungaged sites on unregulated and undiverted streams in Idaho—Continued

Peak-flow regression equations for given recurrence interval (2 to 500 years)	Standard error of model (percent)	Standard error of prediction (percent)
Region 7a (Equations based on data from 28 gaging stations)		
$Q_2 = 2.28\ DA^{0.759}\ (E/1{,}000)^{0.769}$	+74.8 to -42.8	+82.3 to -45.2
$Q_5 = 27.3\ DA^{0.762}\ (E/1{,}000)^{-0.211}$	+59.9 to -37.5	+66.6 to -40.0
$Q_{10} = 88.4\ DA^{0.766}\ (E/1{,}000)^{-0.669}$	+55.2 to -35.6	+62.2 to -38.3
$Q_{25} = 286\ DA^{0.771}\ (E/1{,}000)^{-1.12}$	+52.9 to -34.6	+60.6 to -37.7
$Q_{50} = 592\ DA^{0.774}\ (E/1{,}000)^{-1.41}$	+53.1 to -34.7	+61.4 to -38.0
$Q_{100} = 1{,}120\ DA^{0.778}\ (E/1{,}000)^{-1.65}$	+54.4 to -35.2	+63.3 to -38.8
$Q200 = 1{,}970\ DA^{0.781}\ (E/1{,}000)^{-1.87}$	+56.5 to -36.1	+66.2 to -39.8
$Q_{500} = 3{,}860\ DA^{0.784}\ (E/1{,}000)^{-2.13}$	+60.4 to -37.6	+71.1 to -41.5
Region 7b (Equations based on data from 17 gaging stations)		
$Q_2 = 10.2\ DA^{0.611}$	+131 to -56.6	+143 to -58.8
$Q_5 = 17.1\ DA^{0.624}$	+95.3 to -48.8	+104 to -50.9
$Q_{10} = 22.4\ DA^{0.633}$	+79.7 to -44.4	+86.9 to -46.5
$Q_{25} = 29.9\ DA^{0.644}$	+66.9 to -40.1	+73.5 to -42.3
$Q_{50} = 35.7\ DA^{0.653}$	+61.7 to -38.1	+68.0 to -40.5
$Q_{100} = 41.6\ DA^{0.662}$	+59.5 to -37.3	+66.1 to -39.8
$Q_{200} = 47.5\ DA^{0.672}$	+60.0 to -37.5	+66.9 to -40.1
$Q_{500} = 55.5\ DA^{0.686}$	+64.1 to -39.1	+71.8 to -41.8
Region 8 (Equations based on data from 60 gaging stations)		
$Q_2 = 1.49\ DA^{0.942}\ BS^{1.15}\ (S30+1)^{-0.563}$	+82.9 to -45.3	+86.9 to -46.5
$Q_5 = 1.93\ DA^{0.915}\ BS^{1.53}\ (S30+1)^{-0.862}$	+76.1 to -43.2	+79.8 to -44.4
$Q_{10} = 2.10\ DA^{0.903}\ BS^{1.75}\ (S30+1)^{-1.03}$	+74.7 to -42.7	+78.3 to -43.9
$Q_{25} = 2.22\ DA^{0.892}\ BS^{1.99}\ (S30+1)^{-1.21}$	+74.5 to -42.7	+78.2 to -43.9
$Q_{50} = 2.26\ DA^{0.886}\ BS^{2.15}\ (S30+1)^{-1.33}$	+75.0 to -42.9	+78.9 to -44.1
$Q_{100} = 2.27\ DA^{0.882}\ BS^{2.31}\ (S30+1)^{-1.44}$	+75.9 to -43.1	+79.9 to -44.4
$Q_{200} = 2.25\ DA^{0.878}\ BS^{2.45}\ (S30+1)^{-1.54}$	+77.0 to -43.5	+81.2 to -44.8
$Q_{500} = 2.22\ DA^{0.874}\ BS^{2.62}\ (S30+1)^{-1.67}$	+78.8 to -44.1	+83.2 to -45.4

of model standard errors for 2-, 5-, and 10-year recurrence intervals was widest for region 7b and, for 25- through 500-year recurrence intervals, was widest for region 8. The largest and smallest average standard errors of prediction ranged from +143 percent to -58.8 percent (table 7). The range of average standard errors of prediction was narrowest for region 5. Model and prediction errors generally were closer to 0 for the middle recurrence intervals (5, 10, 25, and 50 years) and farther from 0 for the lower and upper recurrence intervals (2, 100, 200, and 500 years). Basically, results of average standard errors of prediction were similar to results of model standard errors.

Average standard errors from these regression equations were compared with the average standard errors from previous regression studies in Idaho (table 1). The average standard errors of prediction in table 7 were converted to a single average standard error of prediction, in percent, by procedures described by Aitchison and Brown (1957). This single value was required for comparison with a single value from previous studies. For this study, average standard errors of prediction for Q_{100} in all regions ranged from a minimum of 41 percent for region 5 to a maximum of 72 percent for region 8. Standard errors generally were smallest for region 5 and largest for region 8. Standard errors from this study were consistently smaller and the ranges narrower than those from previous studies (table 1). No real comparison can be made with Kjelstrom and Moffatt's study (1981) because no distinction was made in errors between frequencies. Only the maximum error of 62 percent from the study of Thomas and others (1973) was smaller than the maximum error from this study (77 percent).

Region-of-Influence Analysis

Initially, basin and climatic characteristics from the final regional regression equations (table 7) were used to define an ROI and explanatory variables. The entire database, which consisted of 333 gaged sites, was used to determine the unique subset of gaged sites. Combinations of the seven variables were tested to determine the number (N) of gaged sites and the number and identity of the basin and climatic characteristics of d_{ij} and explanatory variables in the ROI. Each set of variables was tested using values of N starting at 20 and increasing by 5 until 100 sites were used. Initial testing indicated that RMSEs increased significantly when DA was used singly or in combination with other variables for d_{ij}. As a result, DA was used only as an explanatory variable in subsequent testing.

The best combination of variables to define the ROI was forest cover and slopes greater than 30 percent, and the optimal value for N was 40. The best combination of explanatory variables defined by the GLS regression part of the analysis was drainage area, mean basin elevation, mean annual precipitation, and forest cover.

The average RMSE was calculated for the ROI method (table 8) and ranged from 55.5 percent for a 5-year recurrence interval to 72.4 percent for a 500-year recurrence interval. Also, the average RMSE was calculated for the regional regression equations (table 7) for each region and recurrence interval and is shown in table 8. On the basis of RMSE comparisons (table 8) between the ROI method and the regional regression equations, the regional regression equations produced better overall results (smaller RMSEs) for regions 1 through 7a. For parts of regions 7b and 8, the ROI method produced slightly better results than did the regional regression equations only in the lower frequency intervals. For most regions, the differences between the two methods were greater than 10 percent and, for region 5, were greater than 20 percent.

In an effort to obtain smaller RMSE values than the regional regression equations produced, regions were combined to form several sets of larger regions. In other ROI studies (Pope and Tasker, 1990; Tasker and Slade, 1994; Hodge and Tasker, 1995), the ROI method was applied to several large regions (containing at least 100 gaged sites) within the respective State. In this study, regions 1, 2, and 3 were combined to form the first set; regions 4 and 5 were combined to form the second set; and regions 6, 7a, 7b, and 8 were combined to form the third set. Then the ROI method was applied to each of the three combined regions. Combining regions did not result in smaller RMSE values than when all 333 gaged sites in the database were used. Regions were subsequently recombined and retested but, again, no smaller RMSE values resulted than when all gages were used. Therefore, the ROI method is not recommended and should not be used for determining flood-frequency estimates for ungaged sites on unregulated and undiverted streams in Idaho because the results, overall, are less accurate and the calculations are more complex than those of regional regression equations.

Table 8. Average root-mean-squared errors, in percent, for region-of-influence and regional regression methods for selected recurrence intervals

Recurrence interval	Average root-mean-squared error, in percent									
	Region-of-influence method	Regional regression method								
		Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Region 7a	Region 7b	Region 8
2	60.2	63.1	52.8	68.8	66.8	39.8	61.7	65.9	109	69.2
5	55.5	50.5	52.9	48.7	56.4	38.3	56.2	54.6	81.2	64.1
10	55.9	47.4	53.9	43.6	52.4	38.5	55.5	51.3	69.2	63.0
25	58.3	47.5	56.2	42.5	49.4	39.2	56.3	50.2	59.5	62.9
50	60.9	49.8	58.0	43.7	48.1	40.0	57.2	50.7	55.6	63.4
100	64.0	53.3	60.0	46.1	47.4	41.1	58.4	52.2	54.2	64.2
200	67.4	57.6	62.2	49.3	47.2	42.1	59.7	54.3	54.8	65.1
500	72.4	64.3	65.2	54.3	47.4	43.7	61.8	57.8	58.3	66.5

LIMITATIONS OF REGIONAL REGRESSION EQUATIONS

The average standard errors of prediction given in table 7 represent the general measure of how well the regional regression equations will estimate peak flows when they are applied to ungaged sites. The accuracy of the equations will be reduced if the values of explanatory variables are outside the range of the values used to develop the equations. The magnitude of this reduction in accuracy is unknown. Standard errors of prediction vary from site to site, depending on the values of the explanatory variables for each site. The standard errors of prediction will be smaller for sites where values of the explanatory variables are near the mean of their range. If the value of an explanatory variable used in the regression equations is near its extreme (maximum or minimum, table 4), the equations might result in unreliable and erroneous estimates. For example, figure 4 shows a “cloud of common values” for the two explanatory variables used in regression equations for region 3. If the maximum value for drainage area and the minimum value for mean basin elevation were used, this combination would plot outside the cloud of common values and, thus, the equations might result in unreliable estimates.

Generating basin characteristic values using datasets or algorithms other than those described in this study also will result in estimates of unknown reliability. The standard errors for each equation are applicable only if the datasets presented in table 2 and methods described in table 3 are used to obtain the required basin characteristics; however, GIS programs other than Arc/Info can be used to measure and calculate the basin characteristics.

The regression equations are not applicable for streams that exhibit significant gains and (or) losses as a result of flow from springs or seepage through highly permeable streambeds. The equations also are not applicable for streams affected by irrigation diversions or large dams that regulate streamflow. The Boise River downstream from Lucky Peak Lake, the Clearwater River downstream from Dworshak Reservoir, and the entire Snake River in Idaho are examples of stream

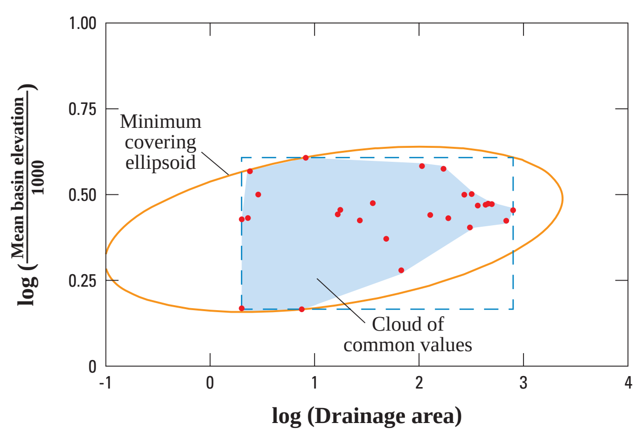


Figure 4. Joint distribution of drainage area and mean basin elevation, and minimum covering ellipsoid for gaged sites in region 3, Idaho

reaches within the study area for which the regional regression equations are not applicable.

The regional regression equations might not be reliable for sites in urbanized basins. Techniques for estimating peak flows for urban streams are presented in a report by Sauer and others (1983).

In general, the equations are more reliable (smaller standard errors of estimate) for estimating the middle peak-flow frequencies (10, 25, and 50 years) than for estimating the high peak-flow frequencies (100, 200, and 500 years) and the low peak-flow frequencies (2 and 5 years). This finding is consistent with findings in many other regional regression studies.

APPLICATION OF METHODS

For gaged sites, the magnitude of peak flows at selected recurrence intervals can be calculated using the procedures for log-Pearson Type III distribution described in the section “Methods of Estimating Peak Flows for Gaged Sites” and procedures described in Bulletin 17B (Interagency Advisory Committee on Water Data, 1982).

For ungaged sites near gaged sites on the same stream, the magnitude of peak flows can be calculated using the drainage-area ratio, also described in the section “Methods for Estimating Peak Flows for Gaged Sites,” and summarized as follows: First, the site is located on a map and the hydrologic region in which the site is located is identified. Next, the drainage boundaries of the site are delineated and the drainage area contained within those boundaries is measured using GIS software. With this information, peak flows can be calculated using equation (2), presented on p. 12. If the ungaged site lies between two gaged sites, peak flows can be calculated using equation (3), presented on p. 13.

If the ungaged site is not near a gaged site, then regional regression equations (table 7) are used to calculate peak flows. Basin and climatic characteristics used in all methods are determined using the datasets described in table 2 and methods described in table 3.

In the subsequent paragraphs, specific examples are given for calculating peak flows. The first example addresses the situation where an ungaged site is relatively near a gaged site on the same stream. The second example addresses the situation where regression equations are needed to calculate peak flows for a specific site. The third example addresses the same situation as the second example, except that the drainage area of the specified site encompasses parts of two separate regions.

Example 1

A 100-year peak-flow (Q_{100}) estimate for an ungaged site located upstream from a gaged site on the same stream in region 4 is needed. The 100-year peak flow at the gage is 7,010 ft^3/s. The drainage-area ratio method (equation 2) is used to estimate Q_{100} for the ungaged site. The drainage area (DA) is 428 mi^2 for the gaged site and 351 mi^2 for the ungaged site. DA for both sites is determined using a GIS and the datasets in table 2. The value for exponent *a* is 0.85 (table 6) for region 4. The drainage-area ratio (DA_u/DA_g) is 0.82, which is between the guideline of 0.5 and 15.

$$Q_u = \left(\frac{DA_u}{DA_g}\right)^a Q_g \,, \qquad (2)$$

$$Q_{100} = \left(\frac{351}{428}\right)^{0.85} 7{,}010$$

$$Q_{100} = 5{,}920 \text{ ft}^3/\text{s}$$

Final values are rounded to three significant figures.

Example 2

A 100-year peak-flow estimate for an ungaged site in region 5 is needed. The required basin characteristics for region 5 regional regression equations were determined to be the following: DA, 480.5 mi^2; P, 28.33 in.; and NF30, 21.5 percent. Then

$$Q_{100} = 0.620\, DA^{0.926} P^{1.52} (NF30 + 1)^{-0.499} \qquad (5)$$

$$Q_{100} = 0.620\, (480.5)^{0.926}\, 28.33^{1.52} (21.5 + 1)^{-0.499}$$

$$Q_{100} = 6{,}430 \text{ ft}^3/\text{s}$$

Final values are rounded to three significant figures.

On the basis of the range of the average standard errors of prediction given in table 7, about 67 percent of all estimates at this site will be between 4,340 and 9,540 ft^3/s (-32.6 to +48.4 percent). Put another way, there is about a 67-percent certainty that the “true” value of Q_T is between 4,340 and 9,540 ft^3/s. Instead of calculating these equations (table 7) manually, a computer program for the regional regression equations, presented in the section titled “Computer Program for Regional Regression Equations,” can be used. This computer program also calculates the error of prediction and the 90-percent confidence interval for individual estimates for each recurrence interval and for each region.

Example 3

A 100-year peak-flow estimate is needed for an ungaged stream in region 4 with a drainage basin encompassing parts of regions 4 and 5. The procedure is similar to that given in example 2, except the regional regression equations would be solved for each of the associated regions and the results would be averaged or apportioned according to the fraction of the contributing drainage area that is in each region (Sando, 1998). The required basin characteristics for region 4 and 5 equations were determined to be the following: DA, 853.0 mi^2; P, 35.4 in.; E, 5,125.6 ft; and NF30, 24.6 percent. The part of the drainage area in region 4 is 622.0 mi^2 and the part in region 5 is 231.0 mi^2.

Region 4 equations

$$Q_{100} = 273DA^{0.837}\,(E/1{,}000)^{-1.01} \quad (6)$$

$$Q_{100} = 273\,(853.0)^{0.837}\,(5{,}125.6/1{,}000)^{-1.01}$$

$$Q_{100} = 14{,}877 \text{ ft}^3\text{/s}$$

Region 5 equations

$$Q_{100} = 0.620DA^{0.926}\,P^{1.52}\,(NF30 + 1)^{-0.499} \quad (7)$$

$$Q_{100} = 0.620\,(853.0)^{0.926} + (35.4)^{1.52}\,(24.6)^{-0.499}$$

$$Q_{100} = 14{,}395 \text{ ft}^3\text{/s}$$

Area-weighted average of the 100-year peak flows

$$Q_u = Q_{g_1}\left(\frac{DA_{g_1}}{DA}\right) + Q_{g_2}\left(\frac{DA_{g_2}}{DA}\right) \quad (8)$$

$$Q_{100} = 14{,}877\,(622.0/853.0) + 14{,}395\,(231.0/853.0)$$

$$Q_{100} = 14{,}700 \text{ ft}^3\text{/s}$$

Final values are rounded to three significant figures.

The computer program “Regional Regression Program” also can be used to estimate the peak-flow values in this example. The regional regression equation computer program would be executed twice, once for region 4 and once for region 5. Then the average value would be estimated by weighting according to drainage area (area-weighted average) as shown in equation 8.

COMPUTER PROGRAM FOR REGIONAL REGRESSION EQUATIONS

As part of the study described in this report, a computer program was adapted to calculate peak flows using regional regression equations (table 7). The program also calculates the associated site-specific errors of prediction for ungaged sites.

The computer software package includes an executable program file and other supporting files. The software package and instructions for downloading, installing, and executing the program are available from the Idaho District home page on the World Wide Web at URL **http://idaho.usgs.gov/PDF/wri024170/program.html** The executable program *idregeq.exe* will calculate peak flows for the regional regression equations (table 7). This program must be executed in a disk operating system (DOS) and the user will be prompted to input data for ungaged sites.

The regional regression equations can be calculated manually, but the program allows more convenient and efficient calculation of the errors of prediction. The errors of prediction for ungaged sites are calculated by matrix algebra using the weighted matrix $(X^T \Lambda^{-1} X)^{-1}$ obtained from GLS analysis. Further explanation for computing the error of prediction is given in a report by Hodgkins (1999), and the $(X^T \Lambda^{-1} X)^{-1}$ matrices for each recurrence interval and region are shown in table 9.

To execute the regional regression program, enter the program's name (*idregeq.exe*) in a DOS window. The program will ask for the name of an output file to save program results, an identifier (name and (or) number) of the ungaged site, the region number where the ungaged site is located, and the value for each explanatory variable used in the region's regional regression equations. Results will be displayed on the screen, and all program results will be saved in a single output file no matter how many times the program repeats. A computer session for example 2 is shown in figure 5, and the bold letters and (or) numbers are entries specified by the user and needed by the program. Figure 5 also shows calculated peak flows, site-specific standard errors of prediction (SE) and the 90-percent confidence intervals for the estimates. A confidence interval gives the level of confidence about an upper and lower limit. For example 2 (fig. 5), the 100-year peak flow is 6,430 ft^3/s, and errors of prediction range from -31.7 percent to +46.5 percent. There is a 90-percent confidence level that the predicted value for the 100-year peak flow is between 3,380 ft^3/s and 12,200 ft^3/s. If input data for explanatory variables are outside the minimum and maximum values (for example, the dashed-line box in figure 4), the program will print a warning that the specific explanatory variable is beyond the observed data.

Caution should be used when extrapolating beyond the area of the original sample data (cloud of common values) (fig. 4) when estimating peak flows from a regression model. In regression, extrapolation occurs when at least one of the predictors is outside the range of sample data. In multiple regression, it is possible for the explanatory variables to be within the minimum and maximum values and still be considered an extrapolation. For example (fig. 4), a log (Drainage area) of 2.7 and log (Mean basin elevation/1,000) of 0.21 are within the minimum and maximum values of both variables, but these values are considered extrapolations because the sample data do not contain similar combinations of variables. To define the area of interpolation or extrapolation in multiple regression, a minimum covering ellipsoid (MCE) is used because it can be expressed in mathematical form, whereas the area represented by the cloud of common values in figure 4 cannot. For two explanatory variables in a regression equation, a graph similar to figure 4 can be produced and the joint distribution can be easily seen. But for three or more explanatory variables in a regression equation, the area represented by the cloud of common values would be more difficult, if not impossible, to distinguish. To determine whether the combination of explanatory variables in an interpolation or an extrapolation, MCE calculations are included in the computer program. The program prints a warning only if the combination of explanatory variables is greater than the MCE. For more information concerning the MCE, refer to the report by Weisberg (1990). For example 2, the three explanatory variables resulted in no warning statements; thus, input data were interpolated.

SUMMARY

Accurate and reliable estimates of the magnitude and frequency of floods are critical for such activities as bridge design, flood-plain delineation and management, water-supply management, and management of water-control structures, among others. Recognizing the need for accurate estimates of flood frequency for ungaged, unregulated, and undiverted streams in Idaho, the U.S. Geological Survey, in cooperation with the Idaho Department of Transportation, Idaho Bureau of Disaster Services, and the U.S. Army Corps of Engineers, conducted a study to further define the relation between peak flows at selected recurrence intervals and selected physical and climatic characteristics. This study documents the development of methods for estimating peak flows for gaged and ungaged sites. For gaged sites, peak flows can be obtained from tables in this report or calculated by using the log-Pearson Type III distribution and following the guidelines and calculation methods described in Bulletin 17B. If the ungaged site is on a gaged stream, then peak flows can be estimated by the drainage-area ratio method that relates the drainage area for the ungaged site to the drainage area for the gaged site.

Two methods also were developed for regionalizing, or extending in space, flood-frequency estimates for gaged sites. In the first method, traditional regional regression analysis, a generalized least-squares regression was used to develop a set of predictive equations for each of the eight hydrologic regions in Idaho. In the second method, the region-of-influence method, peak-flow estimates for ungaged sites were predicted interactively on the basis of data from a subset of gaged sites with basin and climatic characteristics similar to those of the ungaged sites.

Flow records from an initial set containing more than 500 gaged sites were examined. Sites that did not

Figure 5. Input session of example 2 for the regional regression program (*idregeq.exe*). Bolded letters and numbers are input by the user.

[RI, recurrence interval in years; cfs, cubic feet per second; DA, drainage area in square miles; P, mean annual precipitation in inches; NF30, north-facing slopes greater than 30 percent in percent; C:\>, DOS command prompt]

C:\>**idregeq.exe**

```
This program computes estimates of T-year peak flows for ungaged sites in Idaho on the basis of the
REGIONAL REGRESSION METHOD.


For more information, please refer to the following report:
Berenbrock, Charles, 2002, Estimating the Magnitude of Peak Flows at Selected
Recurrence Intervals for Streams in Idaho: U.S. Geological Survey Water-
Resources Investigations Report 02-4170, 59 p.

************************************************************
* No warranty, expressed or implied, is made by the        *
* U.S. Geological Survey as to the accuracy and            *
* functioning of the program and related program material. *
************************************************************

ENTER name for output file: exp2.out

ENTER site id: Example 2

ENTER region where site is located (1,2,3,4,5,6,7a,7b,8):5

REGIONAL REGRESSION METHOD
         **** REGION 5 ****
ENTER watershed characteristics for site

Drainage area (square miles) = 480.5

Mean annual precipitation (inches)= 28.33

North-facing slopes greater than 30 percent (percent) = 21.5

Peak-flow estimates for:

Example 2
Region 5:  DA=   480.5, P=  28.33, NF30=  21.5

         PEAK FLOW      STANDARD ERRORS OF      90-PERCENT CONFIDENCE
   RI       (CFS)      PREDICTION (PERCENT)        INTERVALS (CFS)
-----------------------------------------------------------------------
    2       2740.         45.3       -31.2       1460.       5140.
    5       3730.         43.4       -30.3       2040.       6840.
   10       4410.         43.5       -30.3       2400.       8090.
   25       5200.         44.3       -30.7       2800.       9640.
   50       5740.         45.3       -31.2       3060.      10800.
  100       6430.         46.5       -31.7       3380.      12200.
  200       6950.         47.8       -32.3       3600.      13400.
  500       7650.         49.7       -33.2       3880.      15100.

 Do you want to enter another site? (y or n) n

C:\>
```

have 10 or more years of record and sites affected by regulation or diversions were excluded from further analysis. The remaining 333 sites formed the database for the two regionalization methods. Peak-flow data and basin and climatic characteristics data (explanatory variables) were compiled and calculated for sites in the database by using a geographic information system. These data also were included in the database. Preliminary multiple-regression analyses, using ordinary least-squares regression, were conducted to identify the best combination of explanatory variables for inclusion in the generalized least-squares analysis.

Generalized least-squares analysis was used to develop a set of equations for each region that relate the 2-, 5-, 10-, 25-, 50-, 100-, 200-, and 500-year recurrence interval peak flows to basin and climatic characteristics. Regression equations for region 7b included only one explanatory variable; equations for regions 1, 5, and 8 included the most explanatory variables (three). All regional regression equations required drainage area as an input variable. Three of the explanatory variables—north-facing slopes greater than 30 percent, basin slope, and slopes greater than 30 percent—have not been used previously in regional regression equations for estimating peak flows in Idaho. Model standard errors and standard errors of prediction also were calculated for each equation. The average standard error of prediction ranged from +143 to -34.2 percent. The range of errors was narrowest (-34.2 to +51.9) for region 5. Usually, errors were smaller and the range of errors was narrower for the middle recurrence intervals (10, 25, and 50 years) than for the lower and upper recurrence intervals (2, 5, 200, and 500 years).

The region-of-influence method also was adapted to the peak-flow and basin and climatic characteristics data for Idaho. The drainage area, mean basin elevation, mean annual precipitation, and forest cover were required to predict the 2-, 5-, 10-, 25-, 50-, 100-, 200-, and 500-year recurrence interval peak flows for a specified ungaged site. All 333 gaged sites in the database were used to determine the region of influence. The average root-mean-squared error for the region-of-influence method ranged from 55.5 percent to 72.4 percent. The RMSEs were generally larger for the ROI method, averaging greater than 10 percent for regions 1 through 7a. In region 5, the RMSEs were generally greater than 20 percent. In region 8, the RMSEs were generally smaller for the region-of-influence method than for the regional regression equations, and for region 7b, the RMSEs were smaller only for the 2-, 5-, 10-, and 25-year recurrence interval peak flows. Therefore, the region-of-influence method is not recommended for use in determining flood-frequency estimates for ungaged sites in Idaho because the results are less accurate and the calculations are more complex than those of regional regression equations. The regional regression equations are considered to be the primary method of estimating the magnitude and frequency of peak flows for ungaged sites on undiverted and unregulated streams in Idaho.

A computer program (*idregeq.exe*) automates the calculations required for the regional regression equations, site-specific errors of prediction, and the 90-percent confidence intervals.

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Tables 4, 5, and 9

Table 4. Basin and climatic characteristics for streamflow-gaging stations in Idaho and bordering States used in regional regression analysis

[DA, drainage area; E, mean basin elevation; F, percentage of forest cover in the basin; P, mean annual precipitation; BS, average basin slope; NF30, percentage of north-facing slopes greater than 30 percent; S30, percentage of slopes greater than 30 percent; mi², square miles; ft, feet; in., inches; ft/mi, feet per mile; ID, Idaho; MT, Montana; NV, Nevada; OR, Oregon; WA, Washington; WY, Wyoming; Y.N.P., Yellowstone National Park]

Map No.	Gaging station No.	Gaging station name	DA (mi^2)	E (ft)	F (percent)	P (in.)	BS (percent)	NF30 (percent)	S30 (percent)
			REGION 1						
1	12305500	Boulder Creek near Leonia, ID	55.3	4,686.9	92.0	48.30	37.1	21.8	69.4
2	12309000	Cow Creek near Bonners Ferry, ID	17.6	3,189.5	77.1	30.05	26.7	28.8	40.8
3	12310800	Trail Creek at Naples, ID	16.0	3,498.6	92.6	31.27	24.3	13.7	27.8
4	12311000	Deep Creek at Moravia, ID	133.1	3,257.0	72.6	30.36	21.2	9.7	27.0
5	12313500	Ball Creek near Bonners Ferry, ID	26.6	5,194.4	78.7	42.20	40.6	18.3	70.2
6	12316800	Mission Creek near Copeland, ID	12.5	4,084.4	94.5	29.15	25.4	5.8	33.2
7	12320500	Long Canyon Creek near Porthill, ID	29.9	5,347.3	89.5	41.32	46.4	22.7	81.4
8	12321000	Smith Creek near Porthill, ID	71.1	5,054.2	70.4	46.14	37.0	19.8	62.3
9	12392100	Trapper Creek near Clark Fork, ID	1.1	4,844.3	96.1	57.78	50.2	9.1	91.6
10	12392155	Lightning Creek at Clark Fork, ID	115.1	4,648.5	82.4	54.32	43.2	20.3	71.8
11	12392300	Pack River near Colburn, ID	121.4	4,280.6	62.6	38.15	32.2	15.9	52.4
12	12392800	Hornby Creek near Dover, ID	3.1	2,519.6	89.4	30.00	17.9	3.7	11.9
13	12393500	Priest River at outlet of Priest Lake near Coolin, ID	596.6	3,941.3	79.0	38.79	28.9	13.7	46.3
14	12393600	Binarch Creek near Coolin, ID	10.6	3,258.6	97.6	30.58	35.0	16.6	59.3
15	12396000	Calispell Creek near Dalkena, WA	68.2	3,622.5	79.6	36.71	30.1	20.0	51.8
16	12408500	Mill Creek near Colville, WA	82.5	3,520.8	89.4	37.74	29.6	13.9	46.2
17	12409000	Colville River at Kettle Falls, WA	1,011.0	2,904.3	77.0	27.57	22.3	9.0	28.2
18	12427000	Little Spokane River at Elk, WA	84.4	2,459.0	65.2	28.22	13.2	4.1	10.4
19	12429600	Deer Creek near Chattaroy, WA	31.0	2,683.7	65.3	27.61	15.3	4.4	9.0
20	12430370	Bigelow Gulch near Spokane, WA	4.4	2,245.2	23.9	19.37	9.7	0.6	2.6
21	12431000	Little Spokane River at Dartford, WA	634.9	2,397.7	54.6	25.11	12.2	2.8	9.4
			REGION 2						
22	12302500	Granite Creek near Libby, MT	23.7	5,275.3	66.4	52.96	54.1	26.7	82.4
23	12303100	Flower Creek near Libby, MT	11.3	5,466.8	76.7	52.64	48.3	30.0	71.2
24	12303500	Lake Creek at Troy, MT	125.0	4,069.2	87.3	43.94	38.5	21.0	62.8
25	12304250	Whitetail Creek near Yaak, MT	2.4	4,299.5	81.5	31.61	27.4	0.5	37.2
26	12304300	Cyclone Creek near Yaak, MT	5.7	4,627.2	96.9	40.99	33.9	30.1	63.5
27	12304400	Fourth of July Creek near Yaak, MT	7.8	4,468.8	96.7	38.86	35.9	26.7	72.6
28	12341000	Rattlesnake Creek at Missoula, MT	79.9	5,708.4	79.3	37.04	36.9	16.7	57.6
29	12345800	Camas Creek near Hamilton, MT	5.1	7,064.0	51.8	50.32	42.5	19.5	73.4
30	12347500	Blodgett Creek near Corvallis, MT	26.1	6,649.7	50.4	60.87	57.0	32.1	82.8
31	12350200	Gash Creek near Victor, MT	3.3	6,684.3	73.4	54.70	37.9	22.0	69.2

Table 4. Basin and climatic characteristics for streamflow-gaging stations in Idaho and bordering States used in regional regression analysis--Continued

Map No.	Gaging station No.	Gaging station name	DA (mi^2)	E (ft)	F (percent)	P (in.)	BS (percent)	NF30 (percent)	S30 (percent)
		REGION 2 -- Continued							
32	12350500	Kootenai Creek near Stevensville, MT	29.0	6,557.7	60.4	55.58	58.8	28.8	89.6
33	12352000	Lolo Creek above Sleeman Creek, near Lolo, MT	249.2	5,272.8	84.7	46.82	35.3	19.1	58.9
34	12353800	Thompson Creek near Superior, MT	12.0	4,648.3	88.2	39.04	41.2	27.3	76.2
35	12353850	East Fork Timber Creek near Haugan, MT	2.6	4,669.2	96.0	48.34	32.8	1.6	54.3
36	12354000	St. Regis River near St. Regis, MT	43.6	4,843.4	88.3	44.49	47.2	30.4	84.6
37	12354100	North Fork Little Joe Creek near St. Regis, MT	14.4	4,854.3	89.8	42.42	45.6	28.5	83.1
38	12389500	Thompson River near Thompson Falls, MT	641.5	4,567.1	85.8	29.56	30.0	15.9	47.0
39	12390700	Prospect Creek at Thompson Falls, MT	181.5	4,437.3	93.1	43.68	43.5	27.8	79.6
40	12411000	North Fork Coeur d'Alene River above Shoshone Creek, near Prichard, ID	334.0	3,947.0	89.7	48.25	40.8	24.7	75.6
41	12413000	North Fork Coeur d'Alene River at Enaville, ID	893.7	3,835.9	88.9	45.38	41.9	25.4	77.6
42	12413100	Boulder Creek at Mullan, ID	3.1	5,212.4	93.2	49.41	46.7	33.1	83.0
43	12413140	Placer Creek at Wallace, ID	15.0	4,411.0	94.2	41.53	49.6	31.2	88.8
44	12413150	South Fork Coeur d'Alene River at Silverton, ID	105.6	4,615.4	89.8	42.52	45.8	27.5	82.3
45	12413200	Montgomery Creek near Kellogg, ID	4.5	3,648.3	91.8	40.23	48.0	13.6	89.3
46	12413210	South Fork Coeur d'Alene at Elizabeth Park near Kellogg, ID	181.8	4,301.2	88.5	43.34	45.8	27.2	82.5
47	12413470	South Fork Coeur d'Alene River near Pinehurst, ID	287.1	4,096.4	83.5	45.09	44.6	26.9	80.7
48	12413500	Coeur d'Alene River at Cataldo, ID	1,207.4	3,878.0	87.3	45.01	42.3	25.5	77.8
49	12413700	Latour Creek near Cataldo, ID	24.8	4,316.0	85.6	54.84	41.8	27.9	81.6
50	12414500	St. Joe River at Calder, ID	1,024.5	4,545.6	89.8	46.95	41.3	24.7	74.4
51	12414900	St. Maries River near Santa, ID	272.6	3,592.6	80.6	37.73	25.1	12.5	34.9
52	12415000	St. Maries River at Lotus, ID	434.5	3,465.5	82.2	35.63	23.8	11.4	31.7
53	12415100	Cherry Creek near St. Maries, ID	7.1	3,308.1	86.4	31.71	30.3	23.5	51.3
54	12415200	Plummer Creek Tributary at Plummer, ID	2.0	2,966.3	35.9	20.00	15.2	1.5	9.9
55	12416000	Hayden Creek below North Fork, near Hayden Lake, ID	21.5	3,564.7	95.1	38.75	41.8	25.3	81.2
56	13336500	Selway River near Lowell, ID	1,913.1	5,511.8	82.8	40.58	44.2	24.1	785.6
57	13336600	Swiftwater Creek near Lowell, ID	6.2	3,814.8	93.7	33.22	42.7	39.6	80.2
58	13336650	East Fork Papoose Creek near Powell Ranger Station, ID	4.5	4,832.2	82.4	47.61	47.2	17.1	87.9
59	13336850	Weir Creek near Powell Ranger Station, ID	12.2	4,817.1	86.5	48.18	48.7	13.9	88.5
60	13336900	Fish Creek near Lowell, ID	88.3	4,467.2	91.3	46.34	34.7	13.7	55.7
61	13337000	Lochsa River near Lowell, ID	1,179.4	5,197.2	88.2	46.62	38.5	20.4	63.5
62	13340500	North Fork Clearwater River at Bungalow Ranger Station, ID	997.5	4,888.8	82.2	52.47	39.0	22.1	68.1
63	13340600	North Fork Clearwater River near Canyon Ranger Station, ID	1,294.2	4,732.9	82.9	51.40	40.4	22.7	69.9
64	13341300	Bloom Creek near Bovill, ID	3.0	3,716.0	86.8	48.07	32.0	27.6	55.6
65	13341400	East Fork Potlatch River near Bovill, ID	42.7	3,617.2	86.0	42.67	26.3	14.0	36.4

Table 4. Basin and climatic characteristics for streamflow-gaging stations in Idaho and bordering States used in regional regression analysis--Continued

Map No.	Gaging station No.	Gaging station name	DA (mi^2)	E (ft)	F (percent)	P (in.)	BS (percent)	NF30 (percent)	S30 (percent)
		REGION 3							
66	12423550	Hangman Creek Tributary near Latah, WA	2.3	2,693.4	1.1	20.41	11.4	1.7	1.9
67	12423700	South Fork Rock Creek Tributary near Fairfield, WA	0.6	2,720.9	7.9	19.91	11.0	2.6	3.2
68	12423900	Stevens Creek Tributary near Moran, WA	2.0	2,671.8	9.9	18.97	17.2	0.9	2.0
69	12424000	Hangman Creek at Spokane, WA	674.9	2,647.1	19.4	20.83	10.5	2.3	6.7
70	13334700	Asotin Creek below Kearney Gulch near Asotin, WA	170.5	3,752.2	30.5	23.01	35.4	20.7	57.5
71	13335200	Critchfield Draw near Clarkston, WA	2.0	1,472.6	0.2	11.90	12.7	0.9	3.9
72	13341100	Cold Springs Creek near Craigmont, ID	8.2	4,040.1	10.7	20.00	8.9	0.2	1.0
73	13341500	Potlatch River at Kendrick, ID	453.7	2,969.1	59.8	29.51	18.2	5.5	17.8
74	13342450	Lapwai Creek near Lapwai, ID	268.9	3,149.2	30.7	19.31	18.9	7.7	22.2
75	13343450	Dry Creek at mouth near Clarkston, WA	7.5	1,458.4	0.2	12.08	8.6	0.1	1.4
76	13343800	Meadow Creek near Central Ferry, WA	67.2	1,898.5	0.0	16.12	14.2	2.3	6.7
77	13344500	Tucannon River near Starbuck, WA	431.8	2,943.7	23.7	23.98	26.4	11.9	36.0
78	13344700	Deep Creek Tributary near Polatch, ID	2.9	3,156.8	87.6	28.67	24.3	17.8	27.1
79	13344800	Deep Creek near Potlatch, ID	35.8	2,977.9	46.4	24.92	18.7	5.0	19.8
80	13345000	Palouse River near Potlatch, ID	316.0	3,165.1	63.4	30.07	21.2	9.0	25.8
81	13346100	Palouse River at Colfax, WA	491.7	2,963.6	41.7	26.93	17.7	6.2	17.8
82	13346300	Crumarine Creek near Moscow, ID	2.4	3,694.1	79.3	29.55	27.4	10.0	41.1
83	13346800	Paradise Creek at University of Idaho, at Moscow, ID	17.6	2,844.2	12.5	24.53	11.8	1.0	6.0
84	13348000	South Fork Palouse River at Pullman, WA	126.9	2,745.5	6.9	23.76	11.9	0.8	3.3
85	13348500	Missouri Flat Creek at Pullman, WA	27.1	2,652.2	0.6	23.23	10.0	0.0	0.0
86	13349210	Palouse River below South Fork at Colfax, WA	788.7	2,842.0	27.4	25.33	15.5	4.2	12.1
87	13349400	Pine Creek at Pine City, WA	304.6	2,527.0	1.6	19.00	9.1	0.5	1.2
88	13350500	Union Flat Creek near Colfax, WA	189.8	2,691.9	0.0	20.97	10.5	0.5	1.1
89	14016000	Dry Creek near Walla Walla, WA	48.5	2,342.9	18.4	30.10	21.4	8.9	23.7
90	14016500	East Fork Touchet River near Dayton, WA	106.2	3,820.0	59.8	42.10	38.9	21.0	65.9
91	14017000	Touchet River at Bolles, WA	363.3	2,928.8	31.7	30.50	27.3	13.4	38.5
		REGION 4							
92	13185500	Cottonwood Creek at Arrowrock Reservoir, ID	20.8	5,198.1	36.8	19.08	39.8	18.4	70.7
93	13196500	Bannock Creek near Idaho City, ID	4.8	5,313.2	60.4	22.08	32.9	26.2	57.4
94	13200000	Mores Creek above Robie Creek, near Arrowrock Dam, ID	397.0	5,070.8	66.3	24.76	31.3	16.7	51.0
95	13200500	Robie Creek near Arrowrock Dam, ID	16.0	4,680.6	65.0	23.34	39.8	23.4	70.6
96	13201000	Mores Creek near Arrowrock, ID	424.4	5,024.2	65.0	24.48	31.7	17.0	52.0
97	13207000	Spring Valley Creek near Eagle, ID	19.2	4,017.4	8.0	19.42	24.3	9.3	30.2
98	13207500	Dry Creek near Eagle, ID	59.4	3,963.4	11.7	20.39	25.3	8.8	34.3
99	13216500	North Fork Malheur River above Beulah Reservoir near Beulah, OR	342.5	5,360.8	52.7	23.79	21.6	6.0	23.2

Table 4. Basin and climatic characteristics for streamflow-gaging stations in Idaho and bordering States used in regional regression analysis--Continued

Map No.	Gaging station No.	Gaging station name	DA (mi^2)	E (ft)	F (percent)	P (in.)	BS (percent)	NF30 (percent)	S30 (percent)
		REGION 4--Continued							
100	13248900	Cottonwood Creek near Horseshoe Bend, ID	7.0	3,882.5	0.0	17.16	23.9	15.2	26.3
101	13250600	Big Willow Creek near Emmett, ID	55.2	4,099.3	4.8	15.88	23.6	7.3	28.0
102	13250650	Fourmile Creek near Emmett, ID	6.2	3,804.1	1.7	12.88	22.9	2.9	21.4
103	13251300	West Branch Weiser River near Tamarack, ID	4.0	4,947.6	81.5	39.75	27.3	3.2	41.5
104	13251500	Weiser River at Tamarack, ID	36.6	4,654.2	87.8	34.61	22.3	4.9	27.1
105	13252500	East Fork Weiser River near Council, ID	2.3	6,883.5	76.0	40.00	27.0	16.9	36.5
106	13253500	Weiser River at Starkey, ID	105.4	4,969.7	88.1	32.34	26.5	10.7	38.0
107	13256000	Weiser River near Council, ID	391.9	4,668.2	64.6	29.64	24.2	9.6	32.7
108	13257000	Middle Fork Weiser River near Mesa, ID	86.1	5,430.2	74.1	34.00	27.4	11.1	38.3
109	13258500	Weiser River near Cambridge, ID	596.4	4,636.5	58.2	29.23	23.5	8.7	30.6
110	13260000	Pine Creek near Cambridge, ID	55.3	4,751.8	42.3	22.43	26.4	10.0	37.9
111	13261000	Little Weiser River near Indian Valley, ID	79.5	5,313.9	67.1	28.23	26.9	11.2	36.5
112	13266000	Weiser River near Weiser, ID	1,448.3	4,141.3	32.7	22.23	19.3	6.4	22.1
113	13267000	Mann Creek near Weiser, ID	56.8	4,846.2	55.4	22.12	31.6	10.6	53.4
114	13267100	Deer Creek near Midvale, ID	4.3	3,233.7	1.1	10.00	15.7	0.5	6.1
115	13269300	North Fork Burnt River near Whitney, OR	110.8	4,901.1	81.6	25.11	18.7	4.5	17.7
116	13270800	South Fork Burnt River above Barney Creek near Unity, OR	38.9	5,823.5	91.6	28.59	28.2	16.9	42.0
117	13275500	Powder River near Baker, OR	205.2	5,224.6	74.5	24.67	26.5	9.6	40.8
118	13288200	Eagle Creek above Skull Creek near New Bridge, OR	155.7	5,742.6	67.6	47.53	40.5	14.5	63.7
119	13289100	Immigrant Gulch near Richlavel, OR	6.7	3,581.4	1.4	24.97	25.4	3.1	32.3
120	13289600	East Brownlee Creek at Brownlee Ranger Station, ID	7.4	5,913.0	79.2	30.00	44.9	18.5	78.9
121	13289960	Wildhorse River at Brownlee Dam, ID	177.1	5,037.5	62.2	27.53	29.4	14.3	43.3
122	13290190	Pine Creek near Oxbow, OR	298.5	4,287.7	50.2	33.71	27.4	9.8	40.0
123	13291000	Imnaha River above Gumboot Creek, OR	99.8	6,374.4	64.6	56.25	37.0	21.0	58.7
124	13291200	Mahogany Creek near Homestead, OR	4.1	5,192.1	75.4	37.19	33.5	18.5	53.2
125	13315500	Mud Creek near Tamarack, ID	15.1	4,742.2	93.0	35.36	27.4	6.7	45.0
126	13316500	Little Salmon River at Riggins, ID	576.1	5,421.1	71.8	29.61	33.4	15.5	51.5
127	13316800	North Fork Skookumchuck Creek near White Bird, ID	15.3	5,031.2	69.3	30.22	30.6	15.8	44.2
128	13317000	Salmon River at White Bird, ID	13,418.3	6,753.8	58.3	24.72	37.7	19.1	60.3
129	13317200	Johns Creek near Grangeville, ID	5.0	3,961.5	33.1	24.22	11.7	8.5	10.9
130	13319000	Grande Ronde River at La Grande, OR	687.4	4,582.0	68.4	27.57	20.3	6.5	21.8
131	13320000	Catherine Creek near Union, OR	104.1	5,263.8	85.9	39.66	28.6	10.6	40.8
132	13323600	Indian Creek near Imbler, OR	24.8	5,515.7	77.1	43.58	21.3	6.3	20.8
133	13329500	Hurricane Creek near Joseph, OR	29.6	7,461.3	47.0	64.64	57.2	22.9	87.0
134	13330000	Lostine River near Lostine, OR	71.5	6,893.5	52.1	56.69	49.2	22.1	77.2

Table 4. Basin and climatic characteristics for streamflow-gaging stations in Idaho and bordering States used in regional regression analysis--Continued

Map No.	Gaging station No.	Gaging station name	DA (mi²)	E (ft)	F (percent)	P (in.)	BS (percent)	NF30 (percent)	S30 (percent)
		REGION 4--Continued							
135	13330500	Bear Creek near Wallowa, OR	72.1	5,804.7	67.2	44.74	45.6	23.2	75.0
136	13331500	Minam River at Minam, OR	239.2	5,699.5	66.4	46.47	43.5	21.3	70.5
137	13337200	Red Horse Creek near Elk City, ID	9.1	5,052.5	93.9	36.37	27.9	11.9	42.3
138	13337500	South Fork Clearwater River near Elk City, ID	260.8	5,095.1	91.7	35.30	24.1	10.1	28.8
139	13337700	Peasley Creek near Golden, ID	14.2	4,880.8	94.3	35.81	35.0	9.5	57.9
140	13338000	South Fork Clearwater River near Grangeville, ID	843.4	5,116.5	91.8	34.88	29.7	14.0	42.4
141	13338200	Sally Ann Creek near Stites, ID	13.8	3,142.8	57.6	31.08	24.8	16.6	32.0
142	13338500	South Fork Clearwater River at Stites, ID	1,168.3	4,546.6	70.5	31.31	25.7	11.9	35.1
143	13339000	Clearwater River at Kamiah, ID	4,827.4	4,956.2	77.4	38.29	36.2	19.1	58.6
144	13339500	Lolo Creek near Greer, ID	241.4	3,528.6	84.1	31.53	22.6	8.4	25.5
145	13339700	Canal Gulch Creek at Pierce Ranger Station, ID	6.4	3,539.5	92.2	40.00	17.5	1.1	8.5
146	13339900	Deer Creek near Orofino, ID	5.2	2,955.8	82.6	29.82	18.0	7.2	17.7
147	13340000	Clearwater River at Orofino, ID	5,507.9	4,736.4	76.6	37.36	34.4	17.7	54.5
148	14010000	South Fork Walla Walla River near Milton, OR	61.9	4,273.1	68.3	46.44	46.3	21.9	74.7
149	14011000	North Fork Walla Walla River near Milton, OR	42.6	3,640.0	57.2	42.17	42.1	23.9	71.2
150	14013000	Mill Creek near Walla Walla, WA	58.8	3,933.2	68.6	47.97	50.5	28.8	85.5
151	14013500	Blue Creek near Walla Walla, WA	17.1	3,136.4	45.7	40.52	38.3	24.9	68.8
		REGION 5							
152	12343400	East Fork Bitterroot River near Conner, MT	379.3	6,361.7	78.6	28.42	33.2	18.1	55.1
153	12346500	Skalkaho Creek near Hamilton, MT	88.1	6,676.0	86.4	29.55	38.8	22.5	67.5
154	12351000	Burnt Fork Bitterroot River near Stevensville, MT	73.0	6,495.2	79.6	30.60	36.5	21.3	62.0
155	12351400	Eightmile Creek near Florence, MT	20.8	5,389.4	62.1	24.51	39.1	24.2	69.3
156	13135200	Prairie Creek near Ketchum, ID	17.3	8,558.1	59.0	34.44	45.9	24.1	72.1
157	13135500	Big Wood River near Ketchum, ID	137.5	8,204.0	55.8	31.42	40.6	20.8	67.5
158	13135800	Adams Gulch near Ketchum, ID	10.5	7,373.5	61.5	30.69	42.5	32.9	79.2
159	13136500	Warm Springs Creek at Guyer Hot Springs, near Ketchum, ID	92.6	7,696.0	59.7	35.77	42.6	23.1	77.8
160	13139500	Big Wood River at Hailey, ID	627.6	7,685.6	43.2	29.35	42.7	22.1	74.0
161	13141000	Big Wood River near Bellevue, ID	786.2	7,347.3	35.5	26.45	40.2	20.8	69.3
162	13141400	Deer Creek near Fairfield, ID	11.8	6,496.3	30.1	19.80	33.4	13.1	62.2
163	13184200	Roaring River near Rocky Bar, ID	22.1	7,274.7	61.3	41.26	32.6	15.7	46.8
164	13184800	Beaver Creek near Lowman, ID	10.0	5,796.4	52.1	32.14	24.2	7.8	29.9
165	13185000	Boise River near Twin Springs, ID	831.6	6,415.7	50.2	32.42	44.3	23.2	75.1
166	13186000	South Fork Boise River near Featherville, ID	641.6	7,025.2	50.6	34.72	42.1	21.5	74.4
167	13186500	Lime Creek near Bennett, ID	133.6	6,276.7	22.4	22.40	29.3	11.4	47.3
168	13187000	Fall Creek near Anderson Ranch Dam, ID	55.6	6,171.1	59.2	32.16	33.6	14.0	59.3
169	13234300	Fivemile Creek nr Lowman, ID	11.3	6,623.7	49.9	32.33	44.6	14.7	76.2

Table 4. Basin and climatic characteristics for streamflow-gaging stations in Idaho and bordering States used in regional regression analysis--Continued

Map No.	Gaging station No.	Gaging station name	DA (mi^2)	E (ft)	F (percent)	P (in.)	BS (percent)	NF30 (percent)	S30 (percent)
		REGION 5--Continued							
170	13235000	South Fork Payette River at Lowman, ID	449.3	6,824.5	54.3	34.51	46.7	23.2	76.6
171	13235100	Rock Creek at Lowman, ID	16.5	5,793.4	63.3	31.40	39.5	25.9	72.2
172	13237300	Danskin Creek near Crimes Pass, ID	10.0	4,779.2	68.8	26.49	46.3	16.1	83.7
173	13238300	Deep Creek near McCall, ID	3.6	7,255.3	60.3	49.73	22.5	2.5	23.4
174	13240000	Lake Fork Payette River above Jumbo Creek, near McCall, ID	48.7	6,921.9	71.6	37.22	42.1	16.5	67.9
175	13240500	Lake Fork Payette River above Reservoir near McCall, ID	51.7	6,905.7	72.6	36.82	41.0	15.7	65.6
176	13245400	Tripod Creek at Smiths Ferry, ID	8.6	5,514.1	87.7	28.13	19.8	3.6	18.3
177	13292400	Beaver Creek near Stanley, ID	14.9	8,255.9	57.7	41.59	35.4	22.1	56.9
178	13292500	Salmon River near Obsidian, ID	93.9	8,181.1	56.9	34.66	32.8	17.8	53.1
179	13293000	Alturas Lake Creek near Obsidian, ID	35.6	8,161.5	47.1	44.47	37.6	19.0	60.4
180	13295000	Valley Creek at Stanley, ID	148.9	7,318.8	63.0	23.94	26.1	12.0	37.0
181	13295500	Salmon River below Valley Creek, at Stanley, ID	510.4	7,786.2	54.9	29.61	30.4	14.6	45.2
182	13296000	Yankee Fork Salmon River near Clayton, ID	187.3	7,992.1	74.5	27.11	41.0	22.7	71.1
183	13296500	Salmon River below Yankee Fork, near Clayton, ID	811.1	7,791.6	61.9	27.95	33.6	17.1	53.7
184	13297100	Peach Creek near Clayton, ID	7.6	7,809.8	78.1	22.53	47.1	16.6	87.1
185	13308500	Middle Fork Salmon River near Cape Horn, ID	133.8	7,482.6	70.8	28.40	26.6	11.6	40.2
186	13309000	Bear Valley Creek near Cape Horn, ID	181.7	7,060.3	70.1	30.02	20.2	7.6	24.7
187	13309220	Middle Fork Salmon River near Yellow Pine, ID	1,038.7	7,189.7	68.9	29.00	38.4	20.3	64.1
188	13310000	Big Creek near Big Creek, ID	451.5	6,981.2	78.6	28.71	44.3	24.6	74.0
189	13310500	South Fork Salmon River near Knox, ID	91.7	6,631.3	88.7	37.46	31.7	18.3	52.9
190	13310700	South Fork Salmon River near Krassel Ranger Station, ID	329.3	6,381.8	83.7	33.62	38.0	19.9	63.8
191	13311000	East Fork South Fork Salmon River at Stibnite, ID	19.3	7,724.4	83.7	34.05	35.3	20.4	62.6
192	13311500	East Fork South Fork Salmon River near Stibnite, ID	42.9	7,619.9	77.3	30.88	40.8	22.8	72.5
193	13312000	East Fork South Fork Salmon River near Yellow Pine, ID	106.9	7,404.6	78.2	30.02	41.7	22.2	73.0
194	13313000	Johnson Creek at Yellow Pine, ID	216.4	7,135.2	91.7	34.31	28.2	11.3	40.7
195	13313500	Secesh River near Burgdorf, ID	100.5	6,963.9	82.7	43.91	24.8	10.7	61.8
196	13314000	South Fork Salmon River near Warren, ID	1,164.0	6,696.9	81.2	33.15	37.4	18.4	60.5
197	13315000	Salmon River near French Creek, ID	12,228.0	6,913.7	57.4	24.41	37.8	19.3	60.4
		REGION 6							
198	06013500	Big Sheep Creek below Muddy Creek near Dell, MT	277.0	7,928.2	14.5	18.82	24.1	10.1	31.8
199	06015500	Grasshopper Creek near Dillon, MT	349.0	6,940.1	28.9	19.22	18.8	5.6	19.6
200	06019500	Ruby River above reservoir near Alder, MT	525.5	7,235.2	26.0	22.93	20.1	6.2	20.5
201	13108500	Camas Creek at Eighteenmile Shearing Corral, near Kilgore, ID	228.4	6,943.3	39.4	26.84	12.8	3.2	12.8
202	13112000	Camas Creek at Camas, ID	393.9	6,428.8	22.9	21.10	8.6	1.9	7.5

Table 4. Basin and climatic characteristics for streamflow-gaging stations in Idaho and bordering States used in regional regression analysis--Continued

Map No.	Gaging station No.	Gaging station name	DA (mi^2)	E (ft)	F (percent)	P (in.)	BS (percent)	NF30 (percent)	S30 (percent)
		REGION 6--Continued							
203	13112900	Huntley Canyon at Spencer, ID	4.0	6,820.0	58.0	17.33	24.8	11.2	33.1
204	13113000	Beaver Creek at Spencer, ID	123.2	7,027.5	29.9	20.29	19.6	7.9	23.5
205	13113500	Beaver Creek at Dubois, ID	238.7	6,696.9	24.4	19.42	16.7	5.1	18.8
206	13117200	Main Fork near Goldburg, ID	16.2	8,734.8	49.7	26.30	32.6	10.9	53.0
207	13117300	Sawmill Creek near Goldburg, ID	74.2	8,380.5	54.1	23.79	32.7	14.2	53.7
208	13120000	North Fork Big Lost River at Wild Horse, near Chilly, ID	114.7	8,659.7	58.1	29.80	43.1	22.0	72.1
209	13120500	Big Lost River at Howell Ranch, near Chilly, ID	440.4	8,626.3	37.9	26.96	37.8	17.9	60.8
210	13128900	Lower Cedar Creek above Diversion 3, near Mackay, ID	8.4	9,461.0	21.0	26.61	66.2	17.1	94.2
211	13297300	Holman Creek near Clayton, ID	6.1	7,298.7	69.6	20.81	36.6	24.9	61.5
212	13297330	Thompson Creek near Clayton, ID	29.5	7,618.4	68.9	22.60	47.7	23.5	85.8
213	13297350	Bruno Creek near Clayton, ID	6.4	7,520.2	66.3	21.74	40.8	21.2	68.3
214	13297355	Squaw Creek below Bruno Creek, near Clayton, ID	71.6	7,729.2	73.0	25.17	36.3	16.3	60.2
215	13297450	Little Boulder Creek near Clayton, ID	18.3	8,951.8	39.2	31.98	41.3	23.5	64.3
216	13298000	East Fork Salmon River near Clayton, ID	540.2	8,092.5	31.7	26.00	38.2	20.6	62.7
217	13298300	Malm Gulch near Clayton, ID	9.3	7,015.7	9.4	20.99	36.3	16.8	63.5
218	13299000	Challis Creek near Challis, ID	84.6	7,780.8	62.4	25.59	37.2	18.3	62.0
219	13301700	Morse Creek above Diversion near May, ID	17.9	8,178.6	45.4	21.25	51.4	26.7	87.5
220	13301800	Morse Creek near May, ID	20.0	7,926.5	40.7	20.24	47.9	24.1	80.6
221	13302500	Salmon River at Salmon, ID	3,746.1	7,397.5	37.3	21.63	33.4	16.7	52.9
222	13305000	Lemhi River near Lemhi, ID	907.1	7,430.9	24.3	15.62	25.2	11.9	36.9
223	13305500	Lemhi River at Salmon, ID	1,258.0	7,108.2	24.9	15.26	26.4	12.4	39.1
224	13305700	Dahlonega Creek at Gibbonsville, ID	32.5	6,184.7	90.9	25.32	45.2	18.8	86.3
225	13305800	Hughes Creek near North Fork, ID	20.5	6,707.4	83.9	27.88	41.3	20.7	75.8
226	13306000	North Fork Salmon River at North Fork, ID	210.3	6,258.1	77.8	22.87	43.6	23.1	78.0
227	13306500	Panther Creek near Shoup, ID	520.7	7,028.2	80.2	24.00	38.6	20.9	62.2
228	13307000	Salmon River near Shoup, ID	6,236.7	7,154.3	41.1	20.37	33.3	16.6	52.8
		REGION 7a							
229	10315500	Marys River above Hot Springs Creek near Deeth, NV	389.8	6,589.8	2.3	15.19	17.5	5.3	21.8
230	10329500	Martin Creek near Paradise Valley, NV	176.2	6,210.4	4.1	21.88	21.0	8.3	26.4
231	10352500	McDermitt Creek near Mc Dermitt, NV	225.4	5,890.4	1.4	17.00	17.3	4.3	17.2
232	10353000	East Fork Quinn River near McDermitt, NV	137.9	6,117.4	2.1	22.24	22.2	10.0	28.0
233	10396000	Donner And Blitzen River near Frenchglen, OR	204.7	6,197.6	22.4	29.07	16.2	5.5	15.2
234	10406500	Trout Creek near Denio, NV	86.7	6,025.9	3.9	16.86	23.1	9.0	31.2
235	13155200	Burns Gulch near Glenns Ferry, ID	0.7	6,089.9	1.3	25.00	30.7	1.7	53.2
236	13155300	Little Canyon Creek at Stout Crossing near Glenns Ferry, ID	14.2	5,927.8	3.0	23.47	25.2	8.3	36.8

Table 4. Basin and climatic characteristics for streamflow-gaging stations in Idaho and bordering States used in regional regression analysis--Continued

Map No.	Gaging station No.	Gaging station name	DA (mi^2)	E (ft)	F (percent)	P (in.)	BS (percent)	NF30 (percent)	S30 (percent)
		REGION 7a--Continued							
237	13161200	Seventy Six Creek near Charleston, NV	3.6	7,067.5	1.3	24.49	27.4	6.6	38.9
238	13161300	Meadow Creek near Rowland, NV	57.6	6,597.0	3.6	19.58	25.7	11.9	35.2
239	13162200	Jarbidge River at Jarbidge, NV	22.6	8,260.7	37.8	33.79	48.8	22.7	85.8
240	13162400	Buck Creek near Jarbidge, NV	25.8	7,069.6	13.7	22.42	17.9	7.7	18.8
241	13162500	East Fork Jarbidge River near Three Creek, ID	84.9	7,603.0	24.5	24.77	35.3	16.1	55.2
242	13162600	Columbet Creek near Jarbidge, NV	3.5	7,028.8	8.4	22.15	16.8	7.1	14.1
243	13169500	Big Jacks Creek near Bruneau, ID	243.7	5,170.0	0.0	13.81	10.1	2.3	7.4
244	13170000	Little Jacks Creek near Bruneau, ID	103.4	5,067.4	0.1	14.22	13.2	3.8	11.5
245	13170100	Sugar Creek Tributary near Grasmere, ID	4.5	4,856.2	0.0	10.00	8.0	0.0	0.2
246	13172200	Fossil Creek near Oreana, ID	16.7	3,879.7	2.1	9.79	11.4	4.2	11.0
247	13172666	West Fork Reynolds Creek near Reynolds, ID	0.4	6,821.4	40.2	15.00	17.5	6.0	10.4
248	13172668	East Fork Reynolds Creek near Reynolds, ID	0.2	6,810.7	3.3	25.00	13.3	0.4	0.6
249	13172680	Reynolds Creek at Toolgate Weir near Reynolds, ID	18.7	6,133.6	38.4	21.22	23.0	11.1	24.9
250	13172720	Macks Creek near Reynolds, ID	12.5	4,883.0	11.1	13.64	21.1	7.7	21.6
251	13172735	Salmon Creek near Reynolds, ID	13.1	5,001.8	5.5	14.66	26.1	9.7	36.3
252	13172740	Reynolds Creek at Outlet Weir near Reynolds, ID	91.8	5,015.7	12.4	14.83	20.2	7.2	20.7
253	13172800	Little Squaw Creek Tributary near Marsing, ID	1.8	4,447.6	0.0	10.00	14.3	0.1	8.3
254	13178000	Jordan Creek above Lone Tree Creek, near Jordan Vallley, ID	454.2	5,781.8	38.9	26.15	19.5	5.8	21.8
255	13210300	Bryans Run near Boise, ID	9.1	3,605.5	0.0	10.23	3.2	0.0	0.0
256	13226500	Bully Creek at Warmsprings near Vale, OR	535.3	4,133.8	0.8	12.26	17.4	3.7	15.3
		REGION 7b							
257	10119000	Little Malad River above Elkhorn Reservoir, near Malad City, ID	107.1	6,070.2	8.1	13.20	17.7	6.1	17.8
258	10122500	Devil Creek above Campbell Creek, near Malad City, ID	12.5	5,986.6	9.4	15.08	17.5	4.7	17.9
259	10123000	Devil Creek above Evans Dividers, near Malad City, ID	34.0	5,883.8	11.1	16.79	20.8	6.6	24.4
260	10172940	Dove Creek near Park Valley, UT	28.7	6,681.4	0.7	17.00	17.5	3.7	13.7
261	13057600	Homer Creek near Herman, ID	26.7	6,477.2	14.9	15.65	9.0	0.6	1.4
262	13057940	Willow Creek below Tex Creek near Ririe, ID	431.4	6,422.9	19.2	16.61	13.3	2.8	8.4
263	13073700	Robbers Roost Creek near McCammon, ID	3.9	6,767.0	41.5	24.88	42.4	21.8	77.0
264	13075000	Marsh Creek near McCammon, ID	367.4	5,587.7	9.0	14.30	16.8	6.4	20.2
265	13075600	North Fork Pocatello Creek near Pocatello, ID	14.0	5,756.2	7.7	15.00	21.2	8.0	17.3
266	13076200	Bannock Creek near Pocatello, ID	407.3	5,545.4	7.3	16.28	16.4	6.9	18.7
267	13077700	George Creek near Yost, UT	7.9	8,483.9	40.7	23.66	32.3	29.7	51.8
268	13079200	Cassia Creek near Elba, ID	81.2	6,460.8	16.3	17.39	23.5	12.2	33.0
269	13083000	Trapper Creek near Oakley, ID	52.4	6,339.4	6.2	17.39	28.1	14.4	41.3
270	13092000	Rock Creek near Rock Creek, ID	81.6	6,350.2	9.4	14.46	31.6	13.8	48.7

Table 4. Basin and climatic characteristics for streamflow-gaging stations in Idaho and bordering States used in regional regression analysis--Continued

Map No.	Gaging station No.	Gaging station name	DA (mi^2)	E (ft)	F (percent)	P (in.)	BS (percent)	NF30 (percent)	S30 (percent)
		REGION 7b--Continued							
271	13145700	Schooler Screek near Gooding, ID	2.1	5,624.1	0.0	10.00	10.1	0.2	2.0
272	13147300	Muldoon Creek near Garfield Guard Station, ID	12.3	8,395.8	30.8	25.00	47.4	12.7	79.0
273	13148000	Little Wood River at Campbell Ranch near Carey, ID	263.4	7,045.9	17.9	22.03	34.9	13.5	57.5
		REGION 8							
274	06037500	Madison River near West Yellowstone, MT	434.9	7,900.0	93.9	42.30	11.3	2.4	7.9
275	09223000	Hams Fork below Pole Creek near Frontier, WY	128.6	8,466.6	72.8	31.97	20.4	5.0	19.5
276	10015700	Sulphur Creek above reservoir, below La Chapelle Creek, near Evanston, WY	58.5	7,971.5	25.4	21.62	9.6	0.3	1.2
277	10040000	Thomas Fork near Geneva, ID	45.4	7,243.6	24.8	23.80	26.5	8.1	36.9
278	10040500	Salt Creek near Geneva, ID	38.1	7,448.4	51.3	26.84	27.9	8.3	42.9
279	10041000	Thomas Fork near Wyoming-Idaho State Line, WY	113.8	7,330.7	36.5	25.13	27.4	8.7	40.7
280	10047500	Montpelier Creek at Irrigators Weir, near Montpelier, ID	50.6	7,360.5	28.5	21.49	32.0	14.1	52.6
281	10058600	Bloomington Creek at Bloomington, ID	24.3	7,684.3	37.6	35.10	27.4	15.7	40.5
282	10069000	Georgetown Creek near Georgetown, ID	21.9	7,824.2	55.4	26.14	40.6	19.6	70.8
283	10072800	Eightmile Creek near Soda Springs, ID	17.2	7,598.6	75.5	30.73	29.9	15.1	47.3
284	10076400	Soda Creek at Fivemile Meadows, near Soda Springs, ID	42.5	6,193.0	1.2	18.42	5.1	0.8	3.4
285	10077000	Soda Creek near Soda Springs, ID	50.9	6,184.9	2.3	18.19	6.1	1.7	5.5
286	10084500	Cottonwood Creek near Cleveland, ID	62.4	6,720.9	40.4	23.61	20.9	5.8	21.8
287	10089500	Mink Creek near Mink Creek, ID	68.4	6,534.7	40.0	26.57	28.6	14.9	42.4
288	10090800	Battle Creek Tributary near Treasureton, ID	4.7	5,837.2	2.2	15.10	17.4	4.8	10.3
289	10093000	Cub River near Preston, ID	30.4	7,384.3	53.7	36.05	31.3	13.9	49.4
290	10096000	Cub River above Maple Creek near Franklin, ID	23.2	5,691.9	2.5	14.22	19.8	5.1	18.0
291	10099000	High Creek near Richmond, UT	16.3	7,655.4	62.2	40.94	49.4	30.6	86.6
292	13010000	Snake River at south boundary of Y.N.P., WY	477.4	7,232.2	82.6	47.68	15.9	5.6	14.8
293	13010065	Snake River above Jackson Lake at Flagg Ranch, WY	502.5	8,199.4	82.8	47.42	15.8	5.5	14.7
294	13011500	Pacific Creek at Moran, WY	162.7	8,134.7	72.4	36.25	20.3	6.1	20.8
295	13011800	Blackrock Creek Tributary near Moran, WY	2.5	9,690.1	39.2	39.20	22.8	2.8	23.2
296	13011900	Buffalo Fork above Lava Creek near Moran, WY	330.1	8,951.0	59.7	37.05	27.0	12.1	33.9
297	13012000	Buffalo Fork near Moran, WY	370.2	8,815.8	60.2	35.58	26.3	11.5	32.8
298	13014500	Gros Ventre River at Kelly, WY	608.0	8,863.0	62.6	31.62	23.3	8.3	26.9
299	13015000	Gros Ventre River at Zenith, WY	627.2	8,792.9	61.5	31.27	22.8	8.1	26.3
300	13018300	Cache Creek near Jackson, WY	10.7	8,291.9	75.7	34.72	40.3	21.0	71.2
301	13019210	Rim Draw near Bondurant, WY	4.7	8,030.8	94.9	26.96	26.5	7.6	38.8
302	13019220	Sour Moose Creek near Bondurant, WY	2.8	7,773.4	82.4	25.46	22.8	6.7	25.2
303	13019400	Cliff Creek near Bondurant, WY	58.2	8,078.6	71.6	28.09	35.1	17.7	55.5

Table 4. Basin and climatic characteristics for streamflow-gaging stations in Idaho and bordering States used in regional regression analysis--Continued

Map No.	Gaging station No.	Gaging station name	DA (mi^2)	E (ft)	F (percent)	P (in.)	BS (percent)	NF30 (percent)	S30 (percent)
		REGION 8--Continued							
304	13019438	Little Granite Creek at mouth near Bondurant, WY	82.7	8,559.5	54.5	31.02	38.6	16.1	60.8
305	13019500	Hoback River near Jackson, WY	561.3	7,961.5	60.9	26.68	30.3	12.7	42.6
306	13020000	Fall Creek near Jackson, WY	46.9	7,459.6	65.6	28.89	32.7	18.4	50.5
307	13021000	Cabin Creek near Jackson, WY	9.0	7,274.0	72.5	23.64	35.6	26.5	64.7
308	13022550	Red Creek near Alpine, WY	3.9	7,938.7	38.8	30.63	53.6	7.7	88.7
309	13023000	Greys River above reservoir, near Alpine, WY	448.8	8,105.3	72.2	34.91	35.1	16.7	54.5
310	13023800	Fish Creek near Smoot, WY	3.2	7,568.8	68.8	27.87	18.7	3.2	11.9
311	13024000	Salt River near Smoot, WY	48.2	8,010.1	73.4	32.89	28.0	9.3	40.5
312	13024500	Cottonwood Creek near Smoot, WY	25.7	8,647.5	73.4	39.48	45.1	21.6	81.3
313	13025000	Swift Creek near Afton, WY	27.7	8,496.0	72.3	39.33	49.3	20.7	84.9
314	13025500	Crow Creek near Fairview, WY	113.8	8,441.5	34.5	29.44	24.9	9.9	33.2
315	13027000	Strawberry Creek near Bedford, WY	20.1	8,469.4	54.0	40.81	49.7	20.1	80.7
316	13027200	Bear Canyon near Freedom, WY	3.3	7,087.4	50.8	28.44	27.9	4.5	40.2
317	13029500	McCoy Creek above reservoir near Alpine, WY	108.1	7,017.8	59.3	26.69	27.5	12.4	40.4
318	13030000	Indian Creek above reservoir near Alpine, WY	36.5	7,962.0	46.8	31.08	51.5	25.2	83.1
319	13030500	Elk Creek above reservoir near Irwin, ID	58.5	7,908.8	59.5	34.15	49.8	26.6	81.4
320	13032000	Bear Creek above reservoir near Irwin, ID	78.3	7,187.5	56.1	26.74	38.8	22.6	69.7
321	13038900	Targhee Creek near Macks Inn, ID	20.9	8,273.4	57.8	30.06	34.6	11.8	49.3
322	13044500	Warm River at Warm River, ID	131.1	6,675.6	69.3	31.78	9.1	1.5	5.5
323	13045500	Robinson Creek at Warm River, ID	123.7	6,418.3	65.4	35.26	10.6	1.3	5.4
324	13046680	Boundary Creek near Bechler Ranger Station Y.N.P., ID	85.4	7,912.5	87.7	56.03	6.9	0.2	3.3
325	13047500	Falls River near Squirrel, ID	333.6	7,540.3	83.6	52.87	11.0	2.4	7.8
326	13049500	Falls River near Chester, ID	512.9	6,974.2	63.3	42.64	9.9	2.1	6.4
327	13050700	Mail Cabin Creek near Victor, ID	3.0	8,287.6	77.8	40.89	45.1	37.0	86.6
328	13050800	Moose Creek near Victor, ID	21.8	8,499.6	65.1	54.17	41.7	23.4	68.3
329	13052200	Teton River above South Leigh Creek, near Driggs, ID	341.4	7,302.9	39.7	31.73	23.6	13.3	34.5
330	13054000	Teton River near Tetonia, ID	479.2	7,200.1	38.2	30.33	21.5	11.5	30.0
331	13054400	Milk Creek near Tetonia, ID	17.5	6,551.9	15.7	16.55	9.2	0.4	1.8
332	13055000	Teton River near St. Anthony, ID	874.8	6,920.9	36.1	27.65	19.0	9.1	24.3
333	13062700	Angus Creek near Henry, ID	14.3	6,881.2	28.3	20.00	18.0	5.3	18.2

Table 5. Peak flows at selected recurrence intervals for streamflow-gaging stations in Idaho and bordering States used in regional regression analysis

Map No.	Gaging station	Peak flow, in cubic feet per second, for given recurrence intervals, in years: 2	5	10	25	50	100	200	500	Period of known peak flows	Number of years of known peak
						REGION 1					
1	12305500	1,240	1,720	2,050	2,470	2,800	3,130	3,470	3,930	1929-80	50
2	12309000	42	89	134	210	284	373	482	661	1928-31, 33, 35-38, 74	11
3	12310800	154	241	317	439	550	682	838	1,090	1961-80	19
4	12311000	929	1,340	1,640	2,030	2,340	2,660	2,990	3,460	1928-74	45
5	12313500	524	886	1,180	1,630	2,020	2,460	2,950	3,710	1928-34, 72-79	15
6	12316800	338	426	477	534	573	610	644	686	1959-81	23
7	12320500	602	797	930	1,100	1,230	1,370	1,500	1,690	1928-59	32
8	12321000	1,930	2,520	2,890	3,340	3,670	3,990	4,300	4,710	1928-71	43
9	12392100	42	99	162	285	419	601	847	1,300	1962-81	20
10	12392155	3,140	3,770	4,180	4,700	5,080	5,460	5,850	6,370	1989-99	11
11	12392300	2,580	3,490	4,160	5,060	5,790	6,550	7,370	8,540	1959-82	24
12	12392800	36	44	49	54	58	61	64	68	1961-71	11
13	12393500	4,830	6,110	6,840	7,660	8,200	8,700	9,160	9,730	1913-48	35
14	12393600	64	99	124	157	183	209	237	276	1962-71	18
15	12396000	506	814	1,070	1,450	1,780	2,150	2,580	3,230	1951-97	47
16	12408500	298	458	563	693	786	877	966	1,080	1940-86	47
17	12409000	1,150	1,850	2,320	2,890	3,300	3,700	4,080	4,570	1923-97	75
18	12427000	109	134	150	171	186	201	216	236	1949-79	31
19	12429600	137	192	234	291	338	388	443	521	1962-75	14
20	12430370	22	60	105	191	285	410	576	875	1950, 62-75	15
21	12431000	1,290	1,970	2,460	3,100	3,590	4,090	4,610	5,320	1929-32, 47-97	55
						REGION 2					
22	12302500	642	969	1,230	1,600	1,920	2,270	2,660	3,250	1933, 37-44, 48, 54, 59-69, 74	23
23	12303100	226	319	385	474	544	617	693	801	1960-92	33
24	12303500	2,170	3,070	3,720	4,620	5,340	6,100	6,920	8,080	1945-57, 74, 83-96	28
25	12304250	27	42	54	70	84	98	114	137	1960-74	15
26	12304300	128	183	225	286	337	393	455	547	1960-78	19
27	12304400	170	244	293	355	401	448	494	557	1960-74	15
28	12341000	1,270	1,670	1,900	2,170	2,360	2,540	2,700	2,910	1899, 1948, 58-59, 61-64, 66-67	10

Table 5. Peak flows at selected recurrence intervals for streamflow-gaging stations in Idaho and bordering States used in regional regression analysis--Continued

Map No.	Gaging station	Peak flow, in cubic feet per second, for given recurrence intervals, in years: 2	5	10	25	50	100	200	500	Period of known peak flows	Number of years of known peak
						REGION 2--Continued					
29	12345800	148	209	247	293	326	357	388	427	1958-73	16
30	12347500	627	741	805	875	921	964	1,000	1,050	1947-69, 72	24
31	12350200	109	159	191	229	257	284	311	344	1958-73	16
32	12350500	810	1,060	1,200	1,370	1,490	1,600	1,700	1,830	1948-53, 58-73	22
33	12352000	1,670	2,110	2,360	2,660	2,850	3,040	3,210	3,420	1951-60, 72, 74	12
34	12353800	67	117	154	202	240	278	317	370	1961-79, 82	20
35	12353850	39	60	73	90	103	115	127	142	1961-75, 79	16
36	12354000	4,410	7,360	9,690	13,100	15,900	19,100	22,500	27,700	1911-17, 34, 48, 54, 59-75	27
37	12354100	180	238	273	314	342	369	394	426	1960-74	15
38	12389500	2,310	3,630	4,590	5,880	6,890	7,950	9,060	10,600	1948, 56-97	43
39	12390700	1,590	2,370	2,960	3,770	4,440	5,160	5,940	7,070	1956-97	42
40	12411000	6,040	9,280	11,600	14,700	17,100	19,600	22,300	25,900	1951-97	47
41	12413000	15,100	24,100	31,000	40,800	49,000	57,900	67,600	81,700	1940-97	58
42	12413100	104	142	168	201	225	250	275	309	1961-71, 73-80	19
43	12413140	376	674	919	1,290	1,600	1,960	2,350	2,940	1968-97	30
44	12413150	1,660	2,370	2,870	3,530	4,050	4,590	5,100	5,930	1968-88	21
45	12413200	73	121	159	212	256	303	355	429	1962-71	10
46	12413210	1,940	3,350	4,580	6,530	8,300	10,400	12,800	16,700	1987-99	13
47	12413470	3,660	6,240	8,370	11,600	14,300	17,500	21,000	26,400	1988-97	10
48	12413500	18,800	29,400	37,800	50,000	60,300	71,800	84,500	104,000	1911-97	66
49	12413700	587	936	1,230	1,700	2,120	2,610	3,190	4,100	1967-71, 73-81	14
50	12414500	15,500	22,300	26,900	32,900	37,500	42,200	47,000	53,600	1911-12, 21 -97	79
51	12414900	3,060	5,210	6,900	9,340	11,400	13,600	16,100	19,700	1966-97	32
52	12415000	4,780	8,090	11,000	15,600	19,800	24,800	30,700	40,100	1912, 21-66	45
53	12415100	113	161	199	253	299	350	407	492	1961-71, 74	12
54	12415200	67	97	119	149	172	196	222	258	1961-81	21
55	12416000	319	566	763	1,050	1,290	1,560	1,850	2,270	1948-97	43
56	13336500	25,500	33,000	37,700	43,300	47,400	51,400	55,300	60,400	1911, 30-99	71
57	13336600	73	114	143	180	208	236	265	304	1962-71	10

Table 5. Peak flows at selected recurrence intervals for streamflow-gaging stations in Idaho and bordering States used in regional regression analysis--Continued

Map No.	Gaging station	Peak flow, in cubic feet per second, for given recurrence intervals, in years: 2	5	10	25	50	100	200	500	Period of known peak flows	Number of years of known peak
						REGION 2--Continued					
58	13336650	78	106	124	145	161	176	190	210	1962-71	10
59	13336850	267	416	522	660	767	876	988	1,140	1962-71	10
60	13336900	1,710	2,030	2,220	2,440	2,600	2,750	2,890	3,080	1958-67	10
61	13337000	18,700	24,400	28,100	32,700	36,000	39,300	42,600	46,900	1911-12, 30-99	72
62	13340500	16,300	20,400	22,900	25,900	28,100	30,100	32,200	34,800	1945-69	25
63	13340600	18,800	25,000	29,200	34,600	38,700	42,900	47,100	52,900	1967-97	33
64	13341300	58	93	120	157	187	219	253	303	1960-71, 73-79	19
65	13341400	644	917	1,110	1,350	1,550	1,740	1,940	2,220	1960-71	12
						REGION 3					
66	12423550	55	120	171	240	293	346	400	469	1961-70, 72-76	16
67	12423700	25	33	37	42	45	48	51	54	1962-76	15
68	12423900	18	44	67	103	133	166	202	253	1954-73	20
69	12424000	6,510	10,600	13,300	16,600	19,000	21,400	23,700	26,600	1948-97	50
70	13334700	405	919	1,460	2,470	3,510	4,880	6,650	9,800	1960-82, 91-96	30
71	13335200	17	116	296	757	1,340	2,210	3,410	5,670	1959-76	18
72	13341100	47	108	166	260	346	447	564	746	1961-65, 67-71, 74-81	18
73	13341500	6,210	9,050	11,000	13,700	15,700	17,800	20,000	23,000	1945-71	26
74	13342450	816	1,890	2,910	4,580	6,120	7,940	10,000	13,300	1975-97	23
75	13343450	78	240	473	996	1,650	2,650	4,000	6,750	1963-77	15
76	13343800	651	1,310	1,890	2,760	3,530	4,380	5,340	6,780	1964-78	15
77	13344500	1,490	3,170	4,670	7,030	9,130	11,500	14,300	18,400	1915-17, 29-31, 59-90, 95-97	41
78	13344700	56	83	103	132	156	182	210	251	1961-71	11
79	13344800	799	1,300	1,690	2,260	2,750	3,280	3,870	4,750	1961-71, 74-81	19
80	13345000	3,580	5,800	7,470	9,800	11,700	13,700	15,800	18,900	1915-19, 67-97	36
81	13346100	4,530	6,820	8,480	10,800	12,600	14,500	16,500	19,400	1956-79	24
82	13346300	12	18	22	27	31	36	40	46	1956-59, 61, 63-64, 66-71	13
83	13346800	331	526	669	864	1,020	1,180	1,350	1,590	1979-97	19
84	13348000	1,040	1,840	2,520	3,590	4,550	5,660	6,950	8,960	1934-42, 48, 59-81	33
85	13348500	396	644	852	1,170	1,450	1,780	2,160	2,740	1935-40, 48, 60-79	27
86	13349210	5,600	8,980	11,600	15,200	18,200	21,400	24,800	29,800	1963-95	33

Table 5. Peak flows at selected recurrence intervals for streamflow-gaging stations in Idaho and bordering States used in regional regression analysis--Continued

Map No.	Gaging station	Peak flow, in cubic feet per second, for given recurrence intervals, in years								Period of known peak flows	Number of years of known peak
		2	5	10	25	50	100	200	500		
						REGION 3--Continued					
87	13349400	1,840	3,680	5,350	8,040	10,500	13,500	16,900	22,300	1962-79	18
88	13350500	865	1,540	2,090	2,890	3,570	4,320	5,150	6,380	1954-79	26
89	14016000	522	1,080	1,560	2,310	2,970	3,720	4,560	5,820	1949-53, 55-67	18
90	14016500	858	1,500	2,050	2,910	3,670	4,560	5,590	7,200	1944-51, 56-68	21
91	14017000	2,770	4,430	5,660	7,380	8,760	10,200	11,800	14,100	1906-89	84
						REGION 4					
92	13185500	91	191	283	431	567	727	914	1,210	1914-18, 39-43, 55	11
93	13196500	13	24	34	47	59	72	87	108	1939-41, 51-71	24
94	13200000	1,650	2,880	3,790	5,020	5,980	6,970	7,980	9,380	1951-97	47
95	13200500	62	110	148	205	253	306	365	453	1951-71	21
96	13201000	1,930	3,080	3,930	5,080	5,990	6,950	7,950	9,360	1916-54	39
97	13207000	51	129	207	341	469	622	805	1,100	1955-59, 61-71	16
98	13207500	94	237	384	640	890	1,190	1,560	2,160	1955-68	14
99	13216500	882	1,620	2,240	3,170	3,960	4,850	5,830	7,310	1904-82, 84-94	90
100	13248900	78	136	185	262	332	413	508	658	1961-71, 73-80	19
101	13250600	938	1,430	1,770	2,210	2,550	2,900	3,250	3,720	1957, 62-82, 97	23
102	13250650	92	233	359	548	706	875	1,050	1,300	1962-71	10
103	13251300	39	58	73	92	107	123	139	163	1960-77	18
104	13251500	484	720	884	1,100	1,270	1,440	1,620	1,860	1937-71, 74-75, 97	38
105	13252500	55	65	71	78	82	86	90	95	1933-35, 37-43	10
106	13253500	991	1,540	1,940	2,490	2,920	3,380	3,870	4,555	1939-49, 56	12
107	13256000	2,910	4,290	5,260	6,550	7,550	8,590	9,660	11,200	1937-41, 43-53, 56	17
108	13257000	817	1,210	1,480	1,840	2,110	2,390	2,670	3,060	1911-13, 20-21, 37-49, 56, 81-82, 85-88, 97	26
109	13258500	4,770	7,090	8,590	10,400	11,700	13,000	14,300	15,900	1939-97	59
110	13260000	266	430	560	750	910	1,090	1,280	1,570	1939-62, 97	25
111	13261000	729	1,070	1,320	1,650	1,910	2,180	2,460	2,860	1923-27, 38-71, 97	40
112	13266000	9,720	15,200	19,000	23,600	27,100	30,500	33,800	38,200	1890-91, 1895-1904, 11-14, 53-97	61
113	13267000	420	655	831	1,080	1,270	1,490	1,710	2,040	1911-13, 19337-65	32
114	13267100	67	106	135	175	208	243	281	334	1962-71	10
115	13269300	686	931	1,080	1,260	1,390	1,520	1,640	1,790	1967-80	16
116	13270800	73	108	131	162	185	208	231	263	1964-81	18
117	13275500	708	1,060	1,290	1,570	1,780	1,980	2,170	2,430	1904-16, 20-25, 27-68	61
118	13288200	2,020	2,700	3,150	3,750	4,200	4,660	5,140	5,800	1958-97	40

Table 5. Peak flows at selected recurrence intervals for streamflow-gaging stations in Idaho and bordering States used in regional regression analysis--Continued

Map No.	Gaging station	Peak flow, in cubic feet per second, for given recurrence intervals, in years: 2	5	10	25	50	100	200	500	Period of known peak flows	Number of years of known peak
						REGION 4--Continued					
119	13289100	89	137	169	211	242	273	303	345	1964-65, 67-81	17
120	13289600	91	167	226	311	380	454	532	642	1962-71	10
121	13289960	903	1,530	2,030	2,740	3,340	3,990	4,700	5,750	1979-96	18
122	13290190	2,570	4,140	5,310	6,920	8,210	9,570	11,000	13,000	1967-96	30
123	13291000	1,640	1,960	2,150	2,400	2,580	2,750	2,930	3,160	1945-53	9
124	13291200	72	103	123	150	169	189	209	236	1965-75	11
125	13315500	199	280	334	402	453	505	557	626	1937-38, 46-59, 62-71	26
126	13316500	4,900	6,710	7,900	9,390	10,500	11,600	12,700	14,100	1948, 51-99	48
127	13316800	138	218	282	373	449	533	625	761	1960-71	12
128	13317000	61,600	83,000	95,600	110,000	120,000	129,000	137,000	148,000	1894, 1911-99	88
129	13317200	98	208	309	468	612	779	970	1,270	1961-72	12
130	13319000	3,260	4,860	6,020	7,580	8,810	10,100	11,400	13,300	1904-09, 11-15, 18-23, 26-89	81
131	13320000	749	1,010	1,170	1,360	1,500	1,630	1,760	1,930	1912, 15, 18-19, 26, 97	75
132	13323600	405	545	637	753	840	926	1,010	1,130	1938-50	13
133	13329500	540	735	859	1,010	1,120	1,230	1,330	1,470	1915, 24-78	56
134	13330000	1,580	1,930	2,140	2,390	2,570	2,740	2,900	3,110	1913, 26-91, 95-97	70
135	13330500	923	1,220	1,400	1,630	1,800	1,960	2,120	2,330	1915, 24-85, 95-97	66
136	13331500	3,110	4,090	4,730	5,530	6,120	6,700	7,290	8,080	1913, 66-97	33
137	13337200	90	140	176	224	261	299	338	392	1962-71	10
138	13337500	1,930	2,600	3,060	3,650	4,100	4,560	5,030	5,680	1945-74	30
139	13337700	91	134	166	208	242	277	315	367	1962-81	16
140	13338000	5,000	6,770	8,030	9,700	11,000	12,400	13,800	15,900	1911-20, 23-63	51
141	13338200	186	249	291	341	378	415	451	499	1961-71	11
142	13338500	6,560	9,620	11,700	14,300	16,300	18,300	20,300	22,900	1964-99	36
143	13339000	53,000	67,800	76,800	87,400	94,900	102,000	109,000	118,000	1911-65	55
144	13339500	2,140	3,260	4,030	5,050	5,830	6,610	7,420	8,510	1980-99	20
145	13339700	123	174	207	251	283	316	349	394	1962-81	19
146	13339900	109	228	336	507	660	837	1,040	1,350	1962-71, 74-81	18
147	13340000	54,200	69,100	78,100	88,500	95,800	103,000	109,000	118,000	1931-33, 35-38, 65-99	42
148	14010000	776	1,180	1,510	1,970	2,370	2,810	3,300	4,040	1903, 07, 09-16, 32-91	70
149	14011000	489	812	1,080	1,490	1,840	2,250	2,710	3,420	1930, 33-69	38
150	14013000	890	1,550	2,120	3,010	3,810	4,740	5,830	7,540	1914-17, 40-97	62
151	14013500	317	548	730	991	1,210	1,440	1,700	2,070	1940-42, 44-71	31

Table 5. Peak flows at selected recurrence intervals for streamflow-gaging stations in Idaho and bordering States used in regional regression analysis--Continued

Map No.	Gaging station	Peak flow, in cubic feet per second, for given recurrence intervals, in years								Period of known peak flows	Number of years of known peak
		2	5	10	25	50	100	200	500		
						REGION 5					
152	12343400	2,340	3,260	3,830	4,510	5,000	5,460	5,900	6,470	1956-73	18
153	12346500	659	855	971	1,110	1,200	1,280	1,360	1,470	1948-54, 58-79	29
154	12351000	342	507	616	749	846	940	1,030	1,150	1920, 22-24, 38-73	40
155	12351400	51	73	88	106	119	131	144	159	1958-73	16
156	13135200	170	245	293	352	393	434	473	524	1962-71	10
157	13135500	905	1,250	1,470	1,740	1,940	2,130	2,310	2,560	1948-71	24
158	13135800	40	84	122	179	228	282	342	430	1962-71	10
159	13136500	495	656	758	882	972	1,060	1,150	1,260	1941-58	18
160	13139500	2,290	3,520	4,340	5,330	6,050	6,740	7,410	8,270	1915-97	83
161	13141000	1,660	2,760	3,460	4,270	4,820	5,330	5,790	6,350	1912-96	85
162	13141400	54	87	112	144	170	196	223	262	1961-72	11
163	13184200	332	454	526	611	668	722	773	837	1958, 63-71, 73-76, 78-80	17
164	13184800	102	149	182	224	256	289	323	369	1962-71	10
165	13185000	6,610	9,400	11,300	13,700	15,600	17,500	19,400	22,000	1871-72, 1911-99	91
166	13186000	4,400	6,050	7,010	8,110	8,840	9,510	10,100	10,900	1945-97	53
167	13186500	655	963	1,200	1,440	1,640	1,840	2,050	2,320	1946-56	11
168	13187000	513	709	845	1,030	1,170	1,310	1,470	1,680	1945-56	12
169	13234300	151	236	304	406	493	590	700	866	1962-71, 73-80	18
170	13235000	4,230	5,660	6,540	7,580	8,310	9,000	9,700	10,500	1941-99	59
171	13235100	148	241	312	412	495	584	681	821	1962-71	10
172	13237300	35	55	69	87	101	116	130	151	1962-71	10
173	13238300	346	436	493	563	614	664	714	780	1962-71	10
174	13240000	1,340	1,770	2,040	2,370	2,610	2,840	3,070	3,370	1946-97	52
175	13240500	1,280	1,750	2,050	2,400	2,700	2,900	3,130	3,440	1926-45	20
176	13245400	89	135	167	207	238	269	300	342	1962-71, 73-80	18
177	13292400	143	182	205	231	249	265	281	300	1963-71	9
178	13292500	517	643	716	800	858	913	964	1,030	1941-52	12
179	13293000	482	580	634	693	732	768	801	841	1941-52	12
180	13295000	1,000	1,360	1,570	1,830	2,010	2,180	2,340	2,540	1911-13, 21-74, 93-99	63
181	13295500	3,070	4,100	4,720	5,440	5,950	6,420	6,880	7,450	1926-60, 74	36
182	13296000	1,470	2,240	2,780	3,490	4,030	4,590	5,160	5,940	1921-49, 74	29
183	13296500	4,970	6,810	7,960	9,320	10,300	11,200	12,100	13,200	1922-91	70
184	13297100	33	60	82	113	138	164	192	232	1963-72	10
185	13308500	1,660	2,200	2,520	2,900	3,170	3,420	3,660	3,960	1929-72, 74	45

Table 5. Peak flows at selected recurrence intervals for streamflow-gaging stations in Idaho and bordering States used in regional regression analysis--Continued

Map No.	Gaging station	Peak flow, in cubic feet per second, for given recurrence intervals, in years: 2	5	10	25	50	100	200	500	Period of known peak flows	Number of years of known peak
					REGION 5--Continued						
186	13309000	2,110	2,810	3,240	3,740	4,080	4,410	4,720	5,110	1922-60	39
187	13309220	8,870	12,600	15,100	18,300	20,600	23,000	25,400	28,500	1973-81	9
188	13310000	3,780	4,780	5,340	5,940	6,340	6,700	7,020	7,410	1945-58	14
189	13310500	1,030	1,330	1,510	1,710	1,850	1,980	2,110	2,270	1929, 31-60	31
190	13310700	3,330	4,620	5,450	6,460	7,200	7,920	8,620	9,550	1967-99	29
191	13311000	173	250	302	368	417	466	516	583	1929-42, 83-97	29
192	13311500	352	499	594	713	800	886	971	1,080	1929-40	12
193	13312000	953	1,270	1,470	1,720	1,910	2,090	2,270	2,510	1929-43	15
194	13313000	2,930	3,930	4,540	5,280	5,810	6,320	6,810	7,440	1929-99	71
195	13313500	1,400	1,780	2,010	2,280	2,470	2,650	2,830	3,050	1943-52	10
196	13314000	11,400	15,100	17,500	20,400	22,600	24,800	26,900	29,800	1932-48	13
197	13315000	61,500	75,100	82,600	91,000	96,500	101,000	106,000	112,000	1945-56	12
					REGION 6						
198	06013500	331	517	647	818	948	1,080	1,220	1,400	1946-53, 60-91	40
199	06015500	393	681	890	1,170	1,380	1,590	1,810	2,100	1921-32, 46-53, 55-58, 60-73, 75	39
200	06019500	968	1,350	1,630	1,990	2,270	2,570	2,880	3,310	1939-97	59
201	13108500	808	1,310	1,680	2,180	2,580	2,990	3,420	4,020	1937-53, 69-73	22
202	13112000	454	768	980	1,240	1,430	1,610	1,790	2,010	1925-97	73
203	13112900	9.8	17	23	32	39	47	55	66	1962-71	10
204	13113000	307	516	670	880	1,040	1,220	1,390	1,640	1941-52, 69-93	35
205	13113500	264	454	597	792	947	1,110	1,280	1,510	1921-73, 83-87	57
206	13117200	135	197	237	285	319	351	383	423	1962-71	10
207	13117300	379	522	611	717	793	866	937	1,030	1961-73	13
208	13120000	742	1,060	1,260	1,510	1,680	1,850	2,020	2,230	1944-97	54
209	13120500	2,150	3,000	3,490	4,050	4,430	4,780	5,100	5,490	1904-14, 20-97	89
210	13128900	183	228	254	286	308	330	350	377	1963-73, 80-84	16
211	13297300	8.9	15	20	26	32	37	43	51	1963-71, 74	10
212	13297330	123	240	332	461	565	675	790	950	1973-97	25
213	13297350	7.4	19	29	45	59	74	90	113	1971-97	27
214	13297355	252	469	630	845	1,010	1,180	1,340	1,570	1973-97	25
215	13297450	206	323	405	511	591	671	753	863	1970-86	17
216	13298000	1,590	2,330	2,810	3,400	3,820	4,230	4,630	5,140	1929-38, 73-81	19
217	13298300	85	245	422	744	1,070	1,480	1,980	2,820	1962-71	10
218	13299000	246	347	413	497	559	621	683	766	1944-63	20
219	13301700	147	206	243	288	321	353	384	424	1962-71, 73-76, 78-80	17

Table 5. Peak flows at selected recurrence intervals for streamflow-gaging stations in Idaho and bordering States used in regional regression analysis--Continued

Map No.	Gaging station	Peak flow, in cubic feet per second, for given recurrence intervals, in years: 2	5	10	25	50	100	200	500	Period of known peak flows	Number of years of known peak
						REGION 6--Continued					
220	13301800	21	54	85	133	176	224	277	355	1962-71	10
221	13302500	8,490	12,200	14,500	17,200	19,000	20,800	22,500	24,600	1912-16, 20-97	83
222	13305000	910	1,450	1,810	2,260	2,580	2,900	3,210	3,610	1956-97	42
223	13305500	988	1,630	2,070	2,630	3,050	3,450	3,860	4,380	1929-43	15
224	13305700	97	164	212	277	327	379	431	504	1962-71	10
225	13305800	139	196	233	277	310	341	372	412	1962-80	19
226	13306000	556	744	862	1,000	1,100	1,200	1,300	1,420	1930-39	10
227	13306500	1,760	2,500	2,950	3,450	3,800	4,110	4,410	4,770	1945-77	33
228	13307000	13,500	18,200	21,000	24,200	26,400	28,400	30,400	32,800	1945-81	37
229	10315500	375	726	1,050	1,570	2,060	2,640	3,330	4,440	1943-80, 82-97	54
230	10329500	393	1,070	1,830	3,330	4,930	7,070	9,890	15,000	1922-27, 29-33, 35-97	74
231	10352500	454	1,210	1,950	3,200	4,340	5,680	7,220	9,580	1949-97	49
232	10353000	407	679	870	1,120	1,300	1,490	1,670	1,920	1949-81	33
233	10396000	1,380	2,270	2,890	3,670	4,250	4,820	5,390	6,130	1911-16, 18-21, 30, 38-98	72
234	10406500	111	190	252	340	413	491	575	696	1911, 22-23, 25-91	70
235	13155200	5.7	12	18	27	36	46	58	76	1960-71	12
236	13155300	87	151	207	294	374	467	577	751	1961-71, 73-80	19
						REGION 7a					
237	13161200	23	49	70	101	126	152	180	218	1963-79	17
238	13161300	188	400	587	878	1,130	1,420	1,750	2,240	1964-78	15
239	13162200	302	475	601	772	907	1,050	1,200	1,400	1963-78	16
240	13162400	81	173	256	385	500	630	778	1,000	1929-32, 54-71	22
241	13162500	444	622	738	882	989	1,090	1,200	1,340	1963-78	16
242	13162600	12	24	34	51	66	83	103	133	1939-49, 63, 66-97	44
243	13169500	165	573	1,030	1,830	2,590	3,470	4,490	6,020	1939-49	11
244	13170000	140	421	749	1,390	2,080	2,990	4,160	6,240	1961-71, 73-80	19
245	13170100	23	50	76	120	163	216	279	383	1961-71, 74-76, 78-80	17
246	13172200	43	149	291	603	975	1,510	2,260	3,720	1965-78	14
247	13172666	5.1	8.9	12	16	19	23	27	32	1963-93	31
248	13172668	4.2	6.6	8.3	10	12	13	15	16	1966-93	28
249	13172680	169	288	368	468	540	609	677	762	1964-90	27

Table 5. Peak flows at selected recurrence intervals for streamflow-gaging stations in Idaho and bordering States used in regional regression analysis--Continued

Map No.	Gaging station	Peak flow, in cubic feet per second, for given recurrence intervals, in years: 2	5	10	25	50	100	200	500	Period of known peak flows	Number of years of known peak
						REGION 7a--Continued					
250	13172720	85	218	346	554	741	955	1,200	1,560	1964-93	30
251	13172735	63	191	331	580	823	1,120	1,470	2,030	1963-93	31
252	13172740	322	908	1,520	2,590	3,610	4,840	6,300	8,590	1961-71, 73-80	19
253	13172800	10	33	59	106	153	210	279	388	1946-52, 55-71	24
254	13178000	1,960	3,120	4,000	5,250	6,290	7,400	8,610	10,400	1961-80	19
255	13210300	59	175	299	514	720	966	1,250	1,710	1904-06, 10-17, 22-23, 38-62, 64-85	59
256	13226500	1,470	3,780	5,950	9,320	12,240	15,500	19,000	24,100	1963-79	17
						REGION 7b					
257	10119000	109	259	430	769	1,150	1,670	2,390	3,750	1912-13, 32, 41-69	32
258	10122500	65	110	145	194	235	279	327	396	1939-61	23
259	10123000	120	175	217	276	326	380	439	526	1941-43, 47-52	9
260	10172940	10	37	75	166	280	451	704	1,220	1959-73	15
261	13057600	208	318	393	488	559	629	699	792	1963-71	9
262	13057940	787	1,330	1,730	2,260	2,680	3,110	3,560	4,180	1978-79, 86-97	14
263	13073700	14	21	27	34	40	46	52	62	1961-71	11
264	13075000	298	445	566	750	911	1,100	1,310	1,640	1955-97	43
265	13075600	22	38	50	69	86	104	125	156	1961-1971	11
266	13076200	214	409	572	817	1,030	1,260	1,520	1,910	1985-94	10
267	13077700	69	109	141	188	228	274	325	402	1960-89	30
268	13079200	176	342	489	721	931	1,170	1,460	1,890	1957-67, 71	12
269	13083000	50	83	110	151	186	226	271	340	1911-16, 19-30, 32-97	84
270	13092000	200	329	415	520	596	668	738	826	1910-13, 39, 44-74	36
271	13145700	23	40	51	66	77	87	98	111	1961-76, 78-80	19
272	13147300	106	143	165	191	209	226	242	262	1963-71	9
273	13148000	880	1,410	1,800	2,330	2,750	3,190	3,660	4,300	1920-26, 41-58	25
						REGION 8					
274	06037500	1,360	1,710	1,930	2,200	2,390	2,570	2,750	2,990	1914-17, 19-73, 84-96	70
275	09223000	771	1,180	1,430	1,720	1,920	2,100	2,260	2,460	1953-98	46
276	10015700	335	706	1,060	1,660	2,230	2,930	3,770	5,160	1958-97	39
277	10040000	147	249	324	424	501	581	662	774	1940-51	12
278	10040500	165	294	386	506	595	684	772	887	1940-51	12
279	10041000	400	807	1,130	1,570	1,930	2,300	2,680	3,200	1950-92	43
280	10047500	99	140	166	199	222	246	269	299	1943-79	37

Table 5. Peak flows at selected recurrence intervals for streamflow-gaging stations in Idaho and bordering States used in regional regression analysis--Continued

Map No.	Gaging station	Peak flow, in cubic feet per second, for given recurrence intervals, in years								Period of known peak flows	Number of years of known peak
		2	5	10	25	50	100	200	500		
						REGION 8--Continued					
281	10058600	150	205	235	267	287	304	319	337	1961-86	26
282	10069000	50	69	82	101	117	133	151	177	1940-56	17
283	10072800	121	171	205	251	287	324	363	417	1961-86	26
284	10076400	73	108	129	153	169	183	196	212	1965-86	22
285	10077000	187	243	276	313	337	359	380	406	1914-17, 19-73, 84-96	70
286	10084500	372	561	691	861	990	1,120	1,260	1,440	1953-98	46
287	10089500	355	400	426	456	476	495	514	537	1958-97	39
288	10090800	45	96	138	198	248	301	357	434	1940-51	12
289	10093000	591	717	794	885	950	1,010	1,070	1,150	1940-51	12
290	10096000	558	624	660	702	730	756	780	810	1950-92	43
291	10099000	200	228	244	261	273	284	295	308	1943-79	37
292	13010000	5,360	6,100	6,460	6,800	7,010	7,180	7,330	7,500	1961-86	26
293	13010065	8,030	11,800	14,200	17,000	19,100	21,000	22,900	25,300	1940-56	17
294	13011500	2,510	3,350	3,830	4,360	4,710	5,030	5,320	5,670	1961-86	26
295	13011800	41	56	66	77	85	93	101	111	1965-86	22
296	13011900	4,080	4,970	5,510	6,180	6,650	7,110	7,560	8,150	1966-97	32
297	13012000	4,090	4,720	5,110	5,570	5,890	6,200	6,510	6,900	1918, 45-60	17
298	13014500	3,180	3,850	4,260	4,760	5,130	5,480	5,830	6,290	1958-97	39
299	13015000	2,700	3,890	4,700	5,740	6,530	7,330	8,140	9,250	1940-51	12
300	13018300	79	119	145	178	201	224	247	276	1940-51	12
301	13019210	13	17	18	20	21	22	23	24	1950-92	43
302	13019220	15	20	23	27	30	33	35	38	1943-79	37
303	13019400	612	837	982	1,160	1,290	1,420	1,550	1,720	1961-86	26
304	13019438	292	530	714	970	1,180	1,400	1,630	1,950	1940-56	17
305	13019500	3,750	4,780	5,440	6,240	6,830	7,410	7,980	8,740	1961-86	26
306	13020000	391	508	583	675	741	807	872	957	1965-86	22
307	13021000	128	164	184	206	221	234	247	262	1914-17, 19-73, 84-96	70
308	13022550	21	31	38	47	53	59	66	74	1953-98	46
309	13023000	3,290	4,410	5,100	5,900	6,450	6,980	7,480	8,120	1958-97	39
310	13023800	47	74	93	114	130	145	159	176	1940-51	12
311	13024000	250	334	386	446	489	529	568	617	1940-51	12
312	13024500	242	312	353	401	434	464	493	530	1950-92	43
313	13025000	505	623	693	776	834	890	943	1,010	1943-79	37
314	13025500	227	294	333	377	407	434	460	493	1961-86	26

Table 5. Peak flows at selected recurrence intervals for streamflow-gaging stations in Idaho and bordering States used in regional regression analysis--Continued

Map No.	Gaging station	Peak flow, in cubic feet per second, for given recurrence intervals, in years								Period of known peak flows	Number of years of known peak
		2	5	10	25	50	100	200	500		
					REGION 8--Continued						
315	13027000	263	320	353	390	416	439	462	490	1932-43	12
316	13027200	44	84	113	154	187	220	254	301	1961-71	11
317	13029500	924	1,200	1,360	1,550	1,670	1,790	1,900	2,030	1954-71, 74	19
318	13030000	200	255	288	326	353	377	401	431	1918, 54-71	19
319	13030500	464	591	666	751	810	864	916	981	1918, 1954-71	19
320	13032000	517	672	762	865	934	999	1,060	1,130	1918, 34-36, 54-71	22
321	13038900	258	327	368	416	449	480	509	547	1963-80	18
322	13044500	461	628	736	869	966	1,060	1,160	1,280	1912-14, 18-32	18
323	13045500	605	844	986	1,150	1,260	1,360	1,450	1,570	1912-14, 18-32	18
324	13046680	502	666	763	875	951	1,020	1,090	1,170	1984-97	14
325	13047500	3,550	4,480	5,060	5,760	6,270	6,770	7,260	7,900	1905-09, 18-97	85
326	13049500	3,540	4,560	5,210	6,020	6,620	7,210	7,800	8,580	1920-97	78
327	13050700	38	51	59	70	77	85	92	102	1962-71	10
328	13050800	280	338	371	408	433	456	478	504	1962-71	10
329	13052200	1,460	1,920	2,200	2,530	2,760	2,980	3,200	3,470	1962-97	36
330	13054000	1,270	1,710	1,990	2,320	2,560	2,780	3,000	3,280	1930-32, 34, 40-57	22
331	13054400	84	254	445	802	1,170	1,620	2,190	3,150	1962-80	19
332	13055000	3,380	4,610	5,420	6,450	7,210	7,970	8,750	9,780	1890-93, 1903-09, 20-97	88
333	13062700	283	516	701	968	1,190	1,430	1,680	2,060	1963-71, 74-80	16

Table 9. $(X^T \Lambda^{-1} X)^{-1}$ matrices for the T-year (T = 2, 5, 10, 25, 50, 100, 200, and 500) regional regression equations for Idaho

[Some numbers are in scientific notation; DA, drainage area; E, mean basin elevation; F, percentage of forest cover in the basin; P, mean annual precipitation; NF30, percentage of north-facing slopes greater than 30 percent; BS, average basin slope; S30, percentage of slopes greater than 30 percent]

$(X^T \Lambda^{-1} X)^{-1}$ matrix

REGION 1

CONSTANT	DA	E	F
2-year recurrence interval			
0.70947	-0.13937E-01	0.74767E-01	-0.38336
-0.13937E-01	0.50165E-02	0.20736E-02	0.22620E-02
0.74767E-01	0.20736E-02	0.26166	-0.11881
-0.38336	0.22620E-02	-0.11881	0.23590
5-year recurrence interval			
0.56929	-0.13099E-01	0.42010E-01	-0.29924
-0.13099E-01	0.36470E-02	0.19558E-02	0.29579E-02
0.42010E-01	0.19558E-02	0.18097	-0.77605E-01
-0.29924	0.29579E-02	-0.77605E-01	0.17800
10-year recurrence interval			
0.58339	-0.14658E-01	0.30779E-01	-0.30104
-0.14658E-01	0.34412E-02	0.21476E-02	0.38258E-02
0.30779E-01	0.21476E-02	0.16433	-0.66963E-01
-0.30104	0.38258E-02	-0.66963E-01	0.17462
25-year recurrence interval			
0.67266	-0.18001E-01	0.24555E-01	-0.34210
-0.18001E-01	0.36737E-02	0.25408E-02	0.51651E-02
0.24555E-01	0.25408E-02	0.16945	-0.65577E-01
-0.34210	0.51651E-02	-0.65577E-01	0.19420
50-year recurrence interval			
0.77568	-0.21203E-01	0.23830E-01	-0.39246
-0.21203E-01	0.40965E-02	0.29094E-02	0.62941E-02
0.23830E-01	0.29094E-02	0.18638	-0.70549E-01
-0.39246	0.62941E-02	-0.70549E-01	0.22091
100-year recurrence interval			
0.90234	-0.24874E-01	0.25410E-01	-0.45552
-0.24874E-01	0.46760E-02	0.33256E-02	0.75159E-02
0.25410E-01	0.33256E-02	0.21144	-0.79177E-01
-0.45552	0.75159E-02	-0.79177E-01	0.25532
200-year recurrence interval			
1.0492	-0.28955E-01	0.28796E-01	-0.52941
-0.28955E-01	0.53858E-02	0.37810E-02	0.88248E-02
0.28796E-01	0.37810E-02	0.24315	-0.90760E-01
-0.52941	0.88248E-02	-0.90760E-01	0.29625
500-year recurrence interval			
1.2708	-0.34905E-01	0.35617E-01	-0.64167
-0.34905E-01	0.64979E-02	0.44322E-02	0.10677E-01
0.35617E-01	0.44322E-02	0.29391	-0.10996
-0.64167	0.10677E-01	-0.10996	0.35911

Table 9. $(X^T \Lambda^{-1} X)^{-1}$ matrices for the T-year (T = 2, 5, 10, 25, 50, 100, 200, and 500) regional regression equations for Idaho—Continued

$(X^T \Lambda^{-1} X)^{-1}$ matrix

REGION 2

CONSTANT	DA	E	P
2-year recurrence interval			
0.39901	0.98739E-03	0.72212E-01	-0.27258
0.98739E-03	0.13325E-02	0.30477E-02	-0.32694E-02
0.72212E-01	0.30477E-02	0.25340	-0.14973
-0.27258	-0.32694E-02	-0.14973	0.23015
5-year recurrence interval			
0.40948	0.75032E-03	0.70109E-01	-0.27767
0.75032E-03	0.13652E-02	0.32756E-02	-0.32653E-02
0.70109E-01	0.32756E-02	0.26226	-0.15266
-0.27767	-0.32653E-02	-0.15266	0.23452
10-year recurrence interval			
0.43572	0.58300E-03	0.71219E-01	-0.29374
0.58300E-03	0.14491E-02	0.35727E-02	-0.33884E-02
0.71219E-01	0.35727E-02	0.28123	-0.16164
-0.29374	-0.33884E-02	-0.16164	0.24816
25-year recurrence interval			
0.48030	0.37791E-03	0.74431E-01	-0.32172
0.37791E-03	0.15910E-02	0.40229E-02	-0.36188E-02
0.74431E-01	0.40229E-02	0.31249	-0.17716
-0.32172	-0.36188E-02	-0.17716	0.27185
50-year recurrence interval			
0.51875	0.23295E-03	0.77775E-01	-0.34614
0.23295E-03	0.17127E-02	0.43888E-02	-0.38254E-02
0.77775E-01	0.43888E-02	0.33895	-0.19062
-0.34614	-0.38254E-02	-0.19062	0.29249
100-year recurrence interval			
0.56026	0.95155E-04	0.81735E-01	-0.37268
0.95155E-04	0.18437E-02	0.47711E-02	-0.40529E-02
0.81735E-01	0.47711E-02	0.36719	-0.20520
-0.37268	-0.40529E-02	-0.20520	0.31490
200-year recurrence interval			
0.60440	-0.36634E-04	0.86222E-01	-0.40104
-0.36634E-04	0.19825E-02	0.51679E-02	-0.42981E-02
0.86222E-01	0.51679E-02	0.39694	-0.22073
-0.40104	-0.42981E-02	-0.22073	0.33883
500-year recurrence interval			
0.66637	-0.20300E-03	0.92873E-01	-0.44102
-0.20300E-03	0.21769E-02	0.57136E-02	-0.46470E-02
0.92873E-01	0.57136E-02	0.43836	-0.24258
-0.44102	-0.46470E-02	-0.24258	0.37254

Table 9. $(X^T \Lambda^{-1} X)^{-1}$ matrices for the T-year (T = 2, 5, 10, 25, 50, 100, 200, and 500) regional regression equations for Idaho—Continued

$(X^T \Lambda^{-1} X)^{-1}$ matrix

REGION 3

CONSTANT	DA	E
2-year recurrence interval		
0.72994E-01	-0.40438E-02	-0.13200
-0.40438E-02	0.31745E-02	-0.38284E-02
-0.13200	-0.38284E-02	0.29798
5-year recurrence interval		
0.49599E-01	-0.26739E-02	-0.86950E-01
-0.26739E-02	0.18477E-02	-0.17835E-02
-0.86950E-01	-0.17835E-02	0.18907
10-year recurrence interval		
0.47622E-01	-0.25401E-02	-0.82140E-01
-0.25401E-02	0.16155E-02	-0.12690E-02
-0.82140E-01	-0.12690E-02	0.17493
25-year recurrence interval		
0.51762E-01	-0.27416E-02	-0.88365E-01
-0.27416E-02	0.16452E-02	-0.10704E-02
-0.88365E-01	-0.10704E-02	0.18572
50-year recurrence interval		
0.57529E-01	-0.30306E-02	-0.97974E-01
-0.30306E-02	0.17899E-02	-0.10973E-02
-0.97974E-01	-0.10973E-02	0.20523
100-year recurrence interval		
0.64774E-01	-0.33881E-02	-0.11036
-0.33881E-02	0.20002E-02	-0.12259E-02
-0.11036	-0.12259E-02	0.23114
200-year recurrence interval		
0.73334E-01	-0.38016E-02	-0.12523
-0.38016E-02	0.22687E-02	-0.14516E-02
-0.12523	-0.14516E-02	0.26285
500-year recurrence interval		
0.86049E-01	-0.44010E-02	-0.14759
-0.44010E-02	0.26877E-02	-0.18708E-02
-0.14759	-0.18708E-02	0.31114

Table 9. $(X^{T} \Lambda^{-1} X)^{-1}$ matrices for the T-year (T = 2, 5, 10, 25, 50, 100, 200, and 500) regional regression equations for Idaho—Continued

$(X^{T} \Lambda^{-1} X)^{-1}$ matrix

REGION 4

CONSTANT	DA	E
2-year recurrence interval		
0.76068E-01	-0.75066E-03	-0.10719
-0.75066E-03	0.17192E-02	-0.36670E-02
-0.10719	-0.36670E-02	0.16698
5-year recurrence interval		
0.60600E-01	-0.76276E-03	-0.84468E-01
-0.76276E-03	0.13324E-02	-0.26384E-02
-0.84468E-01	-0.26384E-02	0.13046
10-year recurrence interval		
0.56593E-01	-0.82946E-03	-0.78182E-01
-0.82946E-03	0.12090E-02	-0.22437E-02
-0.78182E-01	-0.22437E-02	0.11985
25-year recurrence interval		
0.55279E-01	-0.93740E-03	-0.75557E-01
-0.93740E-03	0.11357E-02	-0.19384E-02
-0.75557E-01	-0.19384E-02	0.11475
50-year recurrence interval		
0.55980E-01	-0.10258E-02	-0.75999E-01
-0.10258E-02	0.11190E-02	-0.18033E-02
-0.75999E-01	-0.18033E-02	0.11471
100-year recurrence interval		
0.57609E-01	-0.11181E-02	-0.77771E-01
-0.11181E-02	0.11239E-02	-0.17209E-02
-0.77771E-01	-0.17209E-02	0.11678
200-year recurrence interval		
0.59915E-01	-0.12138E-02	-0.80509E-01
-0.12138E-02	0.11445E-02	-0.16761E-02
-0.80509E-01	-0.16761E-02	0.12037
500-year recurrence interval		
0.63756E-01	-0.13453E-02	-0.85259E-01
-0.13453E-02	0.11901E-02	-0.16596E-02
-0.85259E-01	-0.16596E-02	0.12688

Table 9. $(X^T \Lambda^{-1} X)^{-1}$ matrices for the T-year (T = 2, 5, 10, 25, 50, 100, 200, and 500) regional regression equations for Idaho—Continued

$(X^T \Lambda^{-1} X)^{-1}$ matrix

REGION 5

CONSTANT	DA	P	NF30
2-year recurrence interval			
0.27767	-0.62717E-02	-0.15755	-0.21191E-01
-0.62717E-02	0.15842E-02	0.33900E-02	-0.17302E-02
-0.15755	0.33900E-02	0.98903E-01	0.12712E-02
-0.21191E-01	-0.17302E-02	0.12712E-02	0.18410E-01
5-year recurrence interval			
0.26636	-0.65343E-02	-0.15078	-0.19510E-01
-0.65343E-02	0.15652E-02	0.35123E-02	-0.16736E-02
-0.15078	0.35123E-02	0.94362E-01	0.94276E-03
-0.19510E-01	-0.16736E-02	0.94276E-03	0.17377E-01
10-year recurrence interval			
0.27539	-0.72395E-02	-0.15568	-0.19203E-01
-0.72395E-02	0.16639E-02	0.38862E-02	-0.17632E-02
-0.15568	0.38862E-02	0.97206E-01	0.60777E-03
-0.19203E-01	-0.17632E-02	0.60777E-03	0.17717E-01
25-year recurrence interval			
0.29496	-0.83118E-02	-0.16653	-0.19363E-01
-0.83118E-02	0.18324E-02	0.44586E-02	-0.19283E-02
-0.16653	0.44586E-02	0.10373	0.18438E-03
-0.19363E-01	-0.19283E-02	0.18438E-03	0.18681E-01
50-year recurrence interval			
0.31294	-0.91632E-02	-0.17655	-0.19762E-01
-0.91632E-02	0.19733E-02	0.49139E-02	-0.20698E-02
-0.17655	0.49139E-02	0.10982	-0.11140E-03
-0.19762E-01	-0.20698E-02	-0.11140E-03	0.19632E-01
100-year recurrence interval			
0.33276	-0.10035E-01	-0.18763	-0.20337E-01
-0.10035E-01	0.21217E-02	0.53802E-02	-0.22203E-02
-0.18763	0.53802E-02	0.11659	-0.38839E-03
-0.20337E-01	-0.22203E-02	-0.38839E-03	0.20716E-01
200-year recurrence interval			
0.35403	-0.10924E-01	-0.19954	-0.21051E-01
-0.10924E-01	0.22763E-02	0.58558E-02	-0.23778E-02
-0.19954	0.58558E-02	0.12389	-0.64991E-03
-0.21051E-01	-0.23778E-02	-0.64991E-03	0.21904E-01
500-year recurrence interval			
0.38398	-0.12124E-01	-0.21633	-0.22174E-01
-0.12124E-01	0.24889E-02	0.64978E-02	-0.25949E-02
-0.21633	0.64978E-02	0.13421	-0.97656E-03
-0.22174E-01	-0.25949E-02	-0.97656E-03	0.23608E-01

Table 9. $(X^T \Lambda^{-1} X)^{-1}$ matrices for the T-year (T = 2, 5, 10, 25, 50, 100, 200, and 500) regional regression equations for Idaho—Continued

$(X^T \Lambda^{-1} X)^{-1}$ matrix

REGION 6

CONSTANT	DA	P
2-year recurrence interval		
0.73182	-0.19589E-01	-0.50715
-0.19589E-01	0.32568E-02	0.93413E-02
-0.50715	0.93413E-02	0.35932
5-year recurrence interval		
0.64178	-0.17889E-01	-0.44309
-0.17889E-01	0.28998E-02	0.85868E-02
-0.44309	0.85868E-02	0.31296
10-year recurrence interval		
0.64897	-0.18653E-01	-0.44665
-0.18653E-01	0.29679E-02	0.89884E-02
-0.44665	0.89884E-02	0.31468
25-year recurrence interval		
0.68723	-0.20406E-01	-0.47131
-0.20406E-01	0.31852E-02	0.98667E-02
-0.47131	0.98667E-02	0.33111
50-year recurrence interval		
0.72572	-0.21964E-01	-0.49663
-0.21964E-01	0.33910E-02	0.10638E-01
-0.49663	0.10638E-01	0.34829
100-year recurrence interval		
0.76837	-0.23615E-01	-0.52486
-0.23615E-01	0.36143E-02	0.11450E-01
-0.52486	0.11450E-01	0.36756
200-year recurrence interval		
0.81351	-0.25317E-01	-0.55485
-0.25317E-01	0.38479E-02	0.12286E-01
-0.55485	0.12286E-01	0.38810
500-year recurrence interval		
0.87556	-0.27612E-01	-0.59621
-0.27612E-01	0.41662E-02	0.13411E-01
-0.59621	0.13411E-01	0.41650

Table 9. $(X^T \Lambda^{-1} X)^{-1}$ matrices for the T-year (T = 2, 5, 10, 25, 50, 100, 200, and 500) regional regression equations for Idaho—Continued

$(X^T \Lambda^{-1} X)^{-1}$ matrix

REGION 7a

CONSTANT	DA	E
2-year recurrence interval		
0.27535	-0.10043E-01	-0.32931
-0.10043E-01	0.29644E-02	0.69738E-02
-0.32931	0.69738E-02	0.40923
5-year recurrence interval		
0.23543	-0.88447E-02	-0.27938
-0.88447E-02	0.22933E-02	0.66030E-02
-0.27938	0.66030E-02	0.34388
10-year recurrence interval		
0.24212	-0.92360E-02	-0.28606
-0.92360E-02	0.21875E-02	0.71983E-02
-0.28606	0.71983E-02	0.35006
25-year recurrence interval		
0.26803	-0.10339E-01	-0.31562
-0.10339E-01	0.22544E-02	0.83448E-02
-0.31562	0.83448E-02	0.38440
50-year recurrence interval		
0.29504	-0.11429E-01	-0.34698
-0.11429E-01	0.23961E-02	0.93703E-02
-0.34698	0.93703E-02	0.42175
100-year recurrence interval		
0.32653	-0.12680E-01	-0.38378
-0.12680E-01	0.25920E-02	0.10499E-01
-0.38378	0.10499E-01	0.46596
200-year recurrence interval		
0.36169	-0.14066E-01	-0.42502
-0.14066E-01	0.28316E-02	0.11719E-01
-0.42502	0.11719E-01	0.51577
500-year recurrence interval		
0.41302	-0.16081E-01	-0.48542
-0.16081E-01	0.32057E-02	0.13456E-01
-0.48542	0.13456E-01	0.58902

Table 9. $(X^T \Lambda^{-1} X)^{-1}$ matrices for the T-year (T = 2, 5, 10, 25, 50, 100, 200, and 500) regional regression equations for Idaho—Continued

$(X^T \Lambda^{-1} X)^{-1}$ matrix

REGION 7b

CONSTANT	DA
2-year recurrence interval	
0.52959E-01	-0.27639E-01
-0.27639E-01	0.17103E-01
5-year recurrence interval	
0.35447E-01	-0.18388E-01
-0.18388E-01	0.11360E-01
10-year recurrence interval	
0.28742E-01	-0.14817E-01
-0.14817E-01	0.91404E-02
25-year recurrence interval	
0.24078E-01	-0.12308E-01
-0.12308E-01	0.75821E-02
50-year recurrence interval	
0.22709E-01	-0.11549E-01
-0.11549E-01	0.71136E-02
100-year recurrence interval	
0.22745E-01	-0.11530E-01
-0.11530E-01	0.71060E-02
200-year recurrence interval	
0.23947E-01	-0.12122E-01
-0.12122E-01	0.74783E-02
500-year recurrence interval	
0.27094E-01	-0.13718E-01
-0.13718E-01	0.84751E-02

Table 9. $(X^T \Lambda^{-1} X)^{-1}$ matrices for the T-year (T = 2, 5, 10, 25, 50, 100, 200, and 500) regional regression equations for Idaho—Continued

$(X^T \Lambda^{-1} X)^{-1}$ matrix

REGION 8

CONSTANT	DA	P	S30
2-year recurrence interval			
0.13509	-0.10754E-01	-0.17622	0.87079E-01
-0.10754E-01	0.29289E-02	0.75498E-02	-0.32850E-02
-0.17622	0.75498E-02	0.30082	-0.17123
0.87079E-01	-0.32850E-02	-0.17123	0.10528
5-year recurrence interval			
0.11982	-0.95381E-02	-0.15664	0.77537E-01
-0.95381E-02	0.26072E-02	0.66765E-02	-0.29116E-02
-0.15664	0.66765E-02	0.26855	-0.15317
0.77537E-01	-0.29116E-02	-0.15317	0.94356E-01
10-year recurrence interval			
0.11788	-0.94019E-02	-0.15429	0.76478E-01
-0.94019E-02	0.25782E-02	0.65545E-02	-0.28648E-02
-0.15429	0.65545E-02	0.26551	-0.15173
0.76478E-01	-0.28648E-02	-0.15173	0.93636E-01
25-year recurrence interval			
0.11957	-0.95651E-02	-0.15673	0.77832E-01
-0.95651E-02	0.26337E-02	0.66320E-02	-0.29078E-02
-0.15673	0.66320E-02	0.27107	-0.15530
0.77832E-01	-0.29078E-02	-0.15530	0.96081E-01
50-year recurrence interval			
0.12248	-0.98191E-02	-0.16072	0.79924E-01
-0.98191E-02	0.27113E-02	0.67827E-02	-0.29807E-02
-0.16072	0.67827E-02	0.27900	-0.16015
0.79924E-01	-0.29807E-02	-0.16015	0.99257E-01
100-year recurrence interval			
0.12621	-0.10138E-01	-0.16580	0.82561E-01
-0.10138E-01	0.28066E-02	0.69799E-02	-0.30741E-02
-0.16580	0.69799E-02	0.28883	-0.16609
0.82561E-01	-0.30741E-02	-0.16609	0.10311
200-year recurrence interval			
0.13049	-0.10500E-01	-0.17161	0.85568E-01
-0.10500E-01	0.29136E-02	0.72086E-02	-0.31814E-02
-0.17161	0.72086E-02	0.29995	-0.17277
0.85568E-01	-0.31814E-02	-0.17277	0.10744
500-year recurrence interval			
0.13677	-0.11027E-01	-0.18014	0.89964E-01
-0.11027E-01	0.30682E-02	0.75464E-02	-0.33391E-02
-0.18014	0.75464E-02	0.31613	-0.18247
0.89964E-01	-0.33391E-02	-0.18247	0.11368