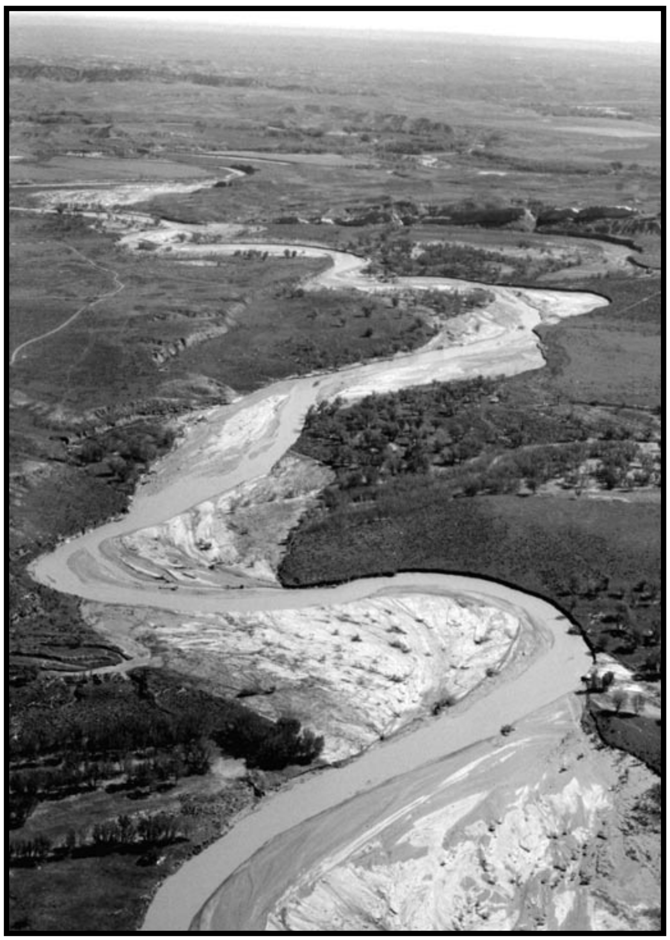
PEAK-FLOW CHARACTERISTICS OF WYOMING STREAMS

Water-Resources Investigations Report 03-4107



U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared in cooperation with the

WYOMING DEPARTMENT OF TRANSPORTATION

Front cover photographs:

A. Flooding of Lance Creek near Bright, Wyoming, May 19, 1978. The force of debris and water would have destroyed the bridge had the water not breached the road (Parrett and others, 1984; photograph by Fred Boner).

B. Flooding of Little Snake River in Baggs, Wyoming, during May 12-17, 1984. Peak flow was about 13,000 cubic feet per second (Druse, 1991; photograph from U.S. Geological Survey files).

C. Following flooding of South Fork Powder River at Interstate Highway 25, near Kaycee, Wyoming, May 25, 1978. Peak flow occurred 7 days earlier (Photograph by Bruce Ringen).

Back cover photographs:

A. Flooding of Greybull River near Basin, Wyoming, June 1963. Residents observed standing waves over 8 feet in height (Gillette Standard and Tribune, June 20, 1963). Peak flow was 19,400 cubic feet per second at U.S. Geological Survey streamflow-gaging station 06277500 (upper left corner of photograph; photograph from U.S. Geological Survey files).

B. Flooding of Belle Fourche River at Interstate Highway 90, near Moorcroft, Wyoming, May 19, 1978 (Photograph by Fred Boner).

U.S. Department of the Interior
U.S. Geological Survey

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By **Kirk A. Miller**

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WYOMING DEPARTMENT OF TRANSPORTATION

Cheyenne, Wyoming
2003

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CONTENTS

	Page
Abstract	1
Introduction	1
Purpose and scope	2
Acknowledgements	2
Previous investigations	2
Description of study area	3
Methods	5
Streamflow-gaging stations	5
Basin characteristics	6
Data compilation	6
Determination of basin characteristics	6
Frequency analyses	8
Historical data	8
Base discharge	8
Trend testing	10
Skew evaluation	10
Map of skew isolines	11
Skew prediction equation	12
Mean of gaging station skew values	12
Previous investigations	12
Regional relations	13
Delineation of regions	13
Regression analyses	17
Results	18
Regional equations	18
Rocky Mountains	19
Central Basins and Northern Plains	19
Eastern Basins and Eastern Plains	21
Eastern Mountains	21
Overthrust Belt	24
High Desert	26
Limitations	26
Applications	30
Ungaged site on an ungaged stream in one region	31
Ungaged site on an ungaged stream in two regions	31
Gaged site	32
Ungaged site near a gaging station on the same stream in one region	33
Ungaged site between two gaging stations on the same stream	35
Summary	35
Selected references	37
Supplemental information	41

PLATES

1. Map showing locations of streamflow-gaging stations and hydrologic regions used in study .... In pocket
2. Map showing soils hydrologic index data .... In pocket

CONTENTS—Continued

Page

FIGURES

1. Location map of study area 4
2-3. Graph showing:
   2. Comparison of mean basin elevation determined using a geographic information system with mean basin elevation in the U.S. Geological Survey National Water Information System 7
   3. Comparison of mean-annual basin precipitation determined using a geographic information system with mean-annual basin precipitation in the U.S. Geological Survey National Water Information System 7
4. Example annual peak-flow frequency curve 9
5. Generalized skew map for Wyoming and surrounding states 11
6-7. Map showing:
   6. Physiographic provinces and sections for Wyoming and surrounding states 14
   7. Hydrologic regions for determining peak-flow characteristics of Wyoming streams 16
8. Graph showing example of relation between cross-correlation coefficients of annual peaks and distance between sites 18
9-10. Map showing:
   9. Mean March precipitation, Eastern Mountains Regions 25
   10. Mean January precipitation, Overthrust Belt Region 27
11. Graph showing joint distribution of mean basin elevation and basin drainage area for gaged sites in the Rocky Mountains Regions 30

TABLES

1. Equations for estimating peak-flow characteristics, Rocky Mountains Regions, Wyoming (Region 1) 20
2. Equations for estimating peak-flow characteristics, Central Basins and Northern Plains Region, Wyoming (Region 2) 21
3. Equations for estimating peak-flow characteristics, Eastern Basins and Eastern Plains Region, Wyoming (Region 3) 22
4. Equations for estimating peak-flow characteristics, Eastern Mountains Regions, Wyoming (Region 4) 24
5. Equations for estimating peak-flow characteristics, Overthrust Belt Region, Wyoming (Region 5) 26
6. Equations for estimating peak-flow characteristics, High Desert Region, Wyoming (Region 6) 28
7. Applicable ranges of basin characteristics for use in regional regression equations 29
8. Exponents for drainage-area ratio in equation for estimating peak-flow characteristics at an ungaged site near a gaging station on the same stream in one region 34
9. Streamflow-gaging stations used in study, Wyoming and surrounding states 43
10. Basin characteristics, selected streamflow-gaging stations, Wyoming and surrounding states 52
11. Peak-flow characteristics, selected streamflow-gaging stations, Wyoming and surrounding states 67

CONVERSION FACTORS

Multiply	By	To obtain
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer
cubic foot per second (ft^3/s)	0.02832	cubic meter per second

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88), unless otherwise noted; horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Peak-Flow Characteristics of Wyoming Streams

By Kirk A. Miller

ABSTRACT

Peak-flow characteristics for unregulated streams in Wyoming are described in this report. Frequency relations for annual peak flows through water year 2000 at 364 streamflow-gaging stations in and near Wyoming were evaluated and revised or updated as needed. Analyses of historical floods, temporal trends, and generalized skew were included in the evaluation. Physical and climatic basin characteristics were determined for each gaging station using a geographic information system. Gaging stations with similar peak-flow and basin characteristics were grouped into six hydrologic regions. Regional statistical relations between peak-flow and basin characteristics were explored using multiple-regression techniques. Generalized least squares regression equations for estimating magnitudes of annual peak flows with selected recurrence intervals from 1.5 to 500 years were developed for each region. Average standard errors of estimate range from 34 to 131 percent. Average standard errors of prediction range from 35 to 135 percent. Several statistics for evaluating and comparing the errors in these estimates are described. Limitations of the equations are described. Methods for applying the regional equations for various circumstances are listed and examples are given.

INTRODUCTION

Peak-flow characteristics of streams are essential for addressing various water-resources issues in Wyoming. Engineers require peak-flow information for the cost-effective design of bridges, culverts, and other structures that convey or control streamflows, and for the appropriate sizing of impoundments. County and city planners use peak-flow information in land-use zoning and emergency preparedness. Government and private entities incorporate these characteristics into reservoir management schemes. Scientists use these estimates in the studies of the hydrology, water-quality, and ecology of watersheds.

Characteristics of peak flows often are expressed as magnitudes of discharge with discrete probabilities—or frequencies—of occurrence. The magnitudes and frequencies of occurrence typically are determined by a statistical analysis of the annual instantaneous maximum flows as measured at a streamflow-gaging station. However, peak-flow characteristics often are needed at sites where streamflow-gaging station data are absent (or insufficient) and typical frequency analyses are not possible. As in other States, Wyoming water resources officials use various methods to estimate peak-flow characteristics at these sites. One such method commonly used is the regional regression approach.

Regression equations relating peak-flow magnitudes and frequencies to selected basin characteristics can be developed for groups of streamflow-gaging stations. Gaging stations are grouped based on similarities in basin characteristics that influence hydrologic processes in a given region. Basin characteristics are described by variables that quantify physical properties (for example basin elevation) and climatic properties (for example annual precipitation). Regression equations are constructed for each region using a few independent variables that are significant in their relation to a specific peak-flow frequency. Estimates of peak-flow frequencies are determined by substituting the basin characteristics of the site of interest in the appropriate regional regression equation.

Regional relations for estimating peak-flow characteristics for Wyoming streams require periodic evaluation and update. Basin characteristics, such as mean annual precipitation, become better defined as additional years of data are collected. Likewise, streamflow statistics, such as the “100-year flood” can be more accurately and precisely determined with longer periods of record. In addition to better accounting of these temporal variabilities in basin and streamflow characteristics, quantification of these data also is enhanced by new analytical techniques and additional data points. Ultimately, errors in regression equations for estimating peak-flow characteristics can be reduced.

Purpose and Scope

This report describes: (1) updated peak-flow frequency analyses for selected streamflow-gaging stations in Wyoming, and (2) revised methods for estimating peak-flow characteristics for unregulated, non-urban streams in Wyoming. Analyses described in this report are based on 364 selected continuous- and partial-record streamflow-gaging stations in Wyoming or within about 50 miles of the State. Instantaneous peak-flow data through water year 2000 were included in the frequency analyses. The study described in this report included up to 15 years of additional peak-flow data and 60 additional gaging stations not used in previous regional peak-flow analyses[1]. Streamflows at gaging stations that were selected generally were minimally affected by anthropogenic activities. Selected gaging stations also had a record of at least 10 annual peak flows. Equations for estimating peak-flow characteristics described in this report were developed using generalized least squares (GLS) regression.

Updated equations relating peak-flow characteristics to channel width (Lowham, 1976, 1988) were beyond the scope of this study. The scope of this study did not allow for verification of channel-width data or collection of additional channel-width data to supplement the additional streamflow data compiled and additional gaging stations included. This study also did not evaluate or update relations between annual mean streamflow and basin characteristics.

[1] Lowham (1988) used 333 gaging stations to develop regional regression equations for estimating peak-flow characteristics. Of those gaging stations, 29 were not included in this study because they did not meet the study criteria.

Acknowledgments

William Bailey, Wyoming Department of Transportation (WDOT), and the WDOT Research Advisory Committee are acknowledged for their support throughout this study. The U.S. Geological Survey (USGS) hydrologic technicians and hydrologists that collect streamflow data are acknowledged; without their dedication, this study would not have been possible. Gary Tasker, USGS-retired, is gratefully acknowledged for his assistance in the regression analyses. Ken Wahl is acknowledged for his assistance in hydrological and statistical analyses. The author also acknowledges the assistance of Merry Gamper and Andy Massey in delineating gaging-station basin boundaries. Emily Sabado and Sue Roberts are acknowledged for their skillful preparation of the report text and figures. Reviews by Thomas Quinn, Ryan Thompson, Robert Tortorelli, Janet Carter, and Jim Wilson improved the report. Finally, all the local, State, and Federal agencies that contribute to the operation of streamflow gages in Wyoming and the surrounding States are acknowledged.

Previous Investigations

Early investigations by USGS personnel developed a general approach for regionalizing peak-flow characteristics that was used in subsequent studies. Dalrymple (1960) noted that combining gaging-station peak-flow records within a region would reduce sampling error and produce relations applicable throughout that region. The approach used by Dalrymple (1960) was based on developing a dimensionless frequency curve defining the ratio of any frequency to the mean annual peak flow—or "index flood"—for each region. Benson (1962) summarized the history of methods for evaluating peak flows, including a listing of basin characteristics used in USGS statewide investigations. A subsequent investigation by Benson (1964) detailed a comprehensive analysis of several topographic, meteorologic, and runoff characteristics with potential for influencing peak flows in most of Texas and New Mexico. Equations for estimating peak flows in rainfall-dominated areas had standard errors ranging from 107 (1.2-year recurrence interval) to 43 percent (100-year recurrence interval). Thomas and Benson (1970) published a summary of methods for generalizing streamflow characteristics using basin characteristics; to date, this is one of the more commonly cited references on the subject.

Previous investigations by the USGS have resulted in methods for estimating peak-flow characteristics specific to streams in Wyoming. Carter and Green (1963) summarized some of the earliest regional flood-frequency investigations in Wyoming—both unpublished and published studies (for example Berwick, 1962; Thomas and others, 1963). Carter and Green (1963) presented nine regional composite frequency curves for estimating floods with recurrence intervals between 1.1 and 50 years for the State. Each regional curve was based on relations between a regional index flood and selected basin characteristics. The regional index flood was defined as the mean annual flood, assumed to be that peak flow with a frequency of occurrence equal to 2.33 years ($Q_{2.33}$). Relations for a large part of south-central Wyoming were not possible because of a paucity of peak-flow data.

Wahl (1970) described relations between peak flows and basin characteristics for the mountainous areas of Wyoming. Those relations resulted in the first regression equations for estimating peak flows with 2- through 50-year recurrence intervals for two mountainous regions. Streamflow records of sufficient length were not available to develop equations for non-mountainous areas. A subsequent investigation indicated unique regression equations for five regions—including non-mountainous areas—were possible (S.A. Druse and K.L. Wahl, U.S. Geological Survey, written commun., June 1972).

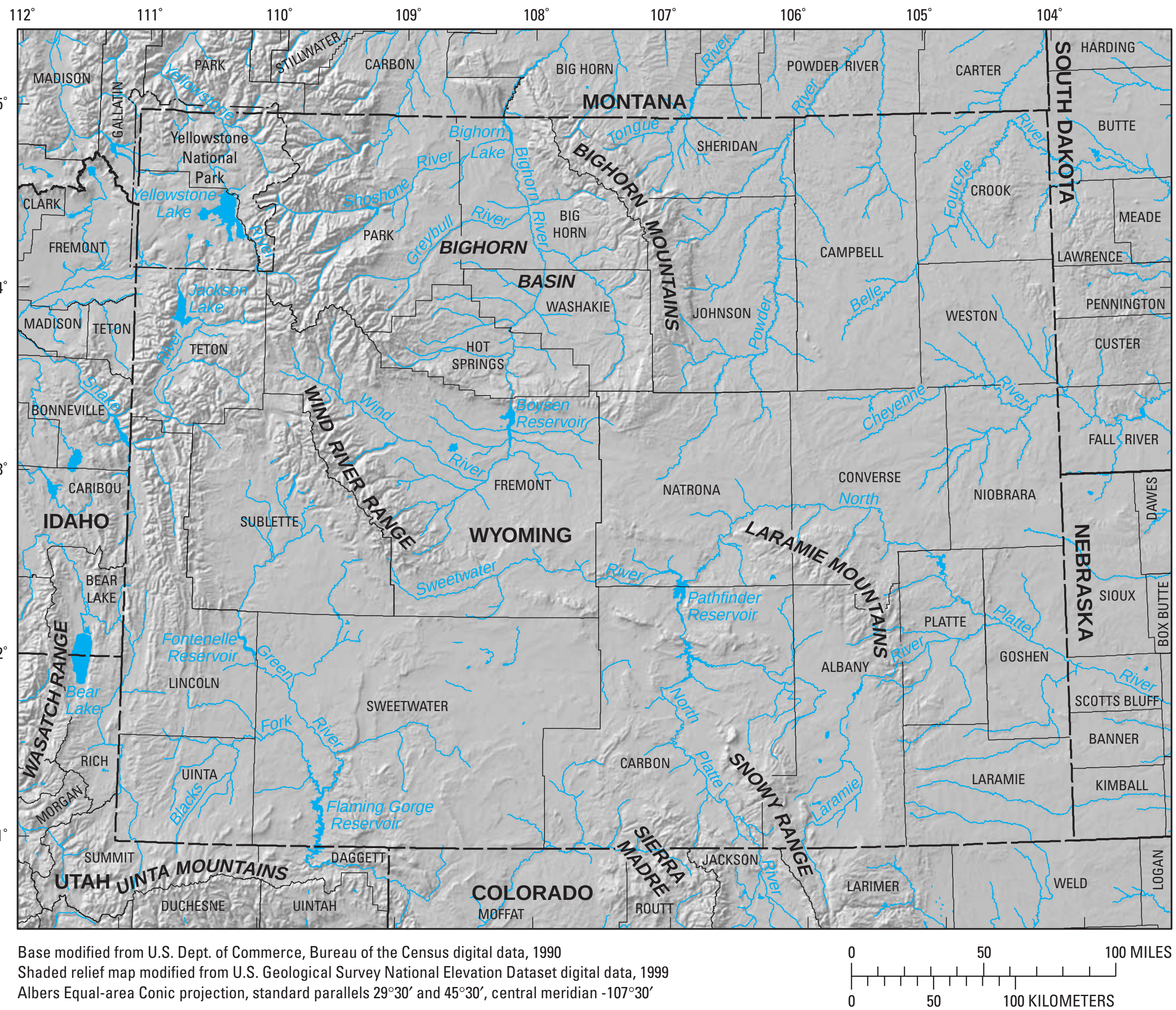
Lowham (1976) distinguished four unique hydrologic regions and developed regional equations for estimating peak streamflows with 2- through 100-year recurrence intervals. Peak-flow relations for small basins (less than 11 sq. mi.) were developed with information from a concurrent study (Craig and Rankl, 1978). In a subsequent investigation, Lowham (1988) incorporated additional streamflow data and other techniques to consolidate the State into three hydrologic regions. Also incorporated were findings later published by Cooley (1990) where paleoflood evidence was used to make historical adjustments to the frequency relations for 21 streamflow-gaging stations. Additional equations for estimating peak flows with 200- and 500-year recurrence intervals were derived.

Recently completed USGS investigations of peak-flow characteristics in surrounding States and the region are important to this report. Because of specific similarities in peak-flow and basin characteristics, these investigations were evaluated and compared with elements of this study including overall study design, regional skew analyses, specific basin characteristics, and hydrologic-region delineation. One of the earliest uses of GLS regression for estimating peak flows was by Omang (1992), who used the technique to develop regional equations for Montana. Thomas and others (1997) studied peak-flow characteristics of the southwestern United States and included an extensive analysis of regional skew. Regional skew relations were evaluated and regression equations were determined for seven regions in South Dakota by Sando (1998) and for seven regions in Nebraska by Soenksen and others (1999). Vaill (2000) updated equations for five existing regions in Colorado and included as much as 12 additional years of peak-flow data and 64 additional gaging stations. A recent analysis of regional skew also was completed by USGS investigators in Montana (Charles Parrett, U.S. Geological Survey, oral commun., 2000).

Description of Study Area

Wyoming is located in the western United States on the edges of the Great Plains and the Rocky Mountains. Topographic relief of the State is large; altitudes range from less than 3,100 feet (National Geodetic Vertical Datum of 1929) where the Belle Fourche River flows into South Dakota, to over 13,000 feet in the Wind River Range (fig. 1). The Continental Divide forms the crest of several of Wyoming's mountain ranges, traversing the State from southeast to northwest. Because of the State's topography and location, streams in Wyoming are the headwaters for several major rivers that flow to both the Atlantic and Pacific Oceans.

Diverse physiographic characteristics combine with regional climatic patterns to create environmental conditions that influence the peak-flow characteristics of Wyoming streams. The most influential of these combinations are the mountain ranges of the State and two different continental-scale precipitation sources.



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

Figure 1. Location map of study area.

Mountain ranges dominate most of the western two-thirds of Wyoming, generally striking north to south. The mountain ranges, due to their orientation, serve as barriers to prevailing westerly winds and southeasterly upslope winds. Air masses from lower elevations are forced up the mountain ranges by the winds. The higher mountain elevations cause cooling of these air masses and condensation of moisture in them, resulting in precipitation. The mountain ranges and the high average elevation and northerly location of the State cause most of the precipitation to occur as snow (Wahl, 1970; Martner, 1986; Druse, 1991; Perry and others, 2001).

Sources of precipitation in Wyoming are the result of two different regional climate patterns. Weather systems transporting moisture from the Pacific Ocean are the primary source of precipitation in the western part of the State. Upslope systems bring moisture from the Gulf of Mexico and are the main source of precipitation in eastern Wyoming. As previously noted, the mountain ranges are the controlling factors in determining the parts of the State most affected by each of these climate patterns (Martner, 1986; Druse, 1991).

Peak flows in Wyoming streams are the result of runoff from snowmelt and rainfall. Because of the effects of the mountain ranges previously described, at least 70 percent of the State's waters originate as snow in the mountainous areas. Mountain streamflows are dominated by a single snowmelt peak of moderate duration during late spring through early summer. Variability in these peaks is small because variability in the aerial and annual accumulations of snow is small (Wahl, 1970; Martner, 1986; Druse, 1991, Miller, 1999).

Most streams originating in the basins or plains areas of Wyoming are ephemeral, flowing only as a result of local snowmelt or intense rainstorms (Wahl, 1970). Intense localized convective rainstorms can produce most of the total flow for any given year in these watersheds. The distribution and occurrence of these events vary annually (Lowham, 1988, p. 18). Because of the localized extent and annual variability of these storms, the resulting flows in any given watershed also vary annually. Flows of streams originating in the basin or plains areas often consist of multiple peak flows in any given year: a lowland snowmelt peak of moderate duration occurring late winter through early spring and several rainstorm peaks of short duration occurring late spring through late summer (Miller, 1999).

METHODS

Streamflow-gaging stations were evaluated for use in the study and annual peak-flow data were compiled. Basin characteristics data were compiled, reduced, and evaluated as predictors of peak-flow characteristics. Frequency analyses were completed for each gaging station in accordance with recommended methods. Regional regression equations relating peak-flow magnitudes to significant basin characteristics were developed.

Streamflow-Gaging Stations

Active and discontinued continuous- and partial-record USGS streamflow-gaging stations were evaluated to determine their suitability for inclusion in the study. Gaging stations located in Wyoming and within about 50 miles of the State were considered. Gaging station descriptions and other data sources were reviewed to determine the extent of any regulation, diversions, interbasin transfers, and (or) urban development within the watersheds. In general, gaging stations with these types of anthropogenic influences were not included in further analyses. However, some gaging stations with small reservoirs and (or) relatively few irrigated acres were included in the analyses if those influences were believed to have minimal effects on annual peak flows. Gaging stations immediately downstream of large lakes also were not included in further analyses. Streamflow-gaging stations used in the study are shown on plate 1 and listed in table 9 in the Supplemental Information section near the end of this report.

The annual peak-flow data used in this report were collected, compiled, and reviewed by the USGS and cooperating agencies. These data are published annually in the USGS Water-Data Report series for each State (for example, Swanson and others, 2001). Streamflow data also are available in digital files that can be retrieved via the World Wide Web (internet) at ***http://waterdata.usgs.gov/nwis/***. Data also can be requested by contacting the USGS Wyoming District Chief at the address on the back of the title page of this report.

Basin Characteristics

Digital datasets describing hydrologically-relevant physical and climatic basin characteristics were compiled for evaluation as predictors of annual peak flows. Values for these basin characteristics were determined for each gaging station using a geographic information system (GIS). These values were compared to previously published data to evaluate the accuracy of the approach.

Data Compilation

Data describing the physical and climatic basin characteristics of the study area were compiled for evaluation as explanatory variables in relations for estimating peak-flow characteristics. Basin characteristics were considered for compilation based on the findings of previous investigations, the availability of data defining the basin characteristic, and the potential relevance of a basin characteristic not previously considered in estimating peak flows. These basin characteristics included drainage area, elevation, basin and channel slope, precipitation characteristics, and soil properties. Previous investigations of peak-flow characteristics in Wyoming and surrounding states have considered several other physical and climatic basin characteristics including forest cover, snow accumulation, and basin storage. Those basin characteristics were not considered during this study because (1) previous studies had repeatedly demonstrated their relative insignificance, (2) their determination would involve considerable effort, or (3) existing data sources were dated or of an inappropriate scale.

The National Elevation Dataset (NED) (U.S. Geological Survey, 1999) was acquired for the study. These data are a digital grid of the land surface consisting of equal-size cells, each with the elevation in meters above NAVD 88 as an attribute. In addition to providing elevation information, the NED can be processed to yield other basin characteristics such as drainage area and basin slope.

Precipitation data were obtained from the Oregon Climate Service (OCS). These digital data consist of several datasets describing mean-annual and monthly precipitation for the period 1961-90 (Oregon Climate Service, 1998a; 1998b). These data were developed using spatial regression methods that incorporated precipitation data from high-elevation meteorological sites and traditional weather stations (Daly and others, 1994).

Soil properties were available from a digital dataset developed for a national model of water quality (Schwarz and Alexander, 1995). These data consist of hydrologically-relevant, average soil properties including clay content, permeability, and an index developed from soil hydrologic groupings. Several of these characteristics have not been investigated in previous studies.

Determination of Basin Characteristics

Basin characteristics for each peak-flow gaging station used in the study were determined using a combination of compiled spatial data and available computer tools. Previously published data were used for some basin characteristics. Where available, previously published data also were used to validate the characteristics determined by computer methods. Basin characteristics are listed for all gaging stations used in this study in table 10 in the Supplemental Information section near the end of this report. Basin characteristics that might be useful for other investigations but were not used in this study are also listed in table 10.

A GIS and a suite of tools developed for the GIS (Viger and others, 1998) were used to compute basin characteristics. Tools using a combination of routines in the GIS software and task-specific programs were used to semi-automatically delineate the drainage-basin boundary for each gaging station in the study. Digital boundaries of the drainage-basins were required for determining basin characteristics from other digital spatial data. Prior to basin delineation, a hydrologic derivative was generated from the NED using the tools. This step generates flow direction and accumulation for each cell in the grid. Next, the cell in the NED that most closely represented the location of the gaging station was selected as the outflow of the basin for the proper delineation of the drainage area. In many instances, the location of the gaging station was not coincident with the cell that represented the outflow of the gaging-station basin. The reasons for these discrepancies include the precision of the gaging-station location, the precision of the NED relative to that of the gaging station location, and differences in the hydrologic derivative of the NED relative to the actual stream network. In the final step, the tools automatically delineated the drainage area boundary using the outflow cell and the flow accumulation grid.

The accuracies of the digital basin boundaries were evaluated for their suitability in determining other basin characteristics. The areas of the digital boundaries were compared with drainage area values previously published. Gaging stations with differences in the drainage areas that were larger than 5 percent were evaluated further. The GIS was used to visually inspect the digital boundaries for errors by displaying the boundaries relative to other spatial data, including stream line- and attribute-data, and small-scale hydrologic unit boundaries. If further evaluation was required, the location of the gaging station was checked by reviewing gaging station records and detailed maps. In cases where the differences still could not be resolved, the digital boundaries were compared with topographic information using the GIS and digital raster graphics. This final measure generally resulted in acceptance of the GIS-delineated drainage-basin boundary and revision of the published drainage-basin area.

Physical and climatic basin characteristics for the gaging stations were determined using the digital basin boundaries, the GIS, and the various spatial datasets previously described. Area-weighted averages for each characteristic were calculated by the GIS for the area within the digital boundary for each respective gaging station (table 10). The area-weighted maximum, minimum, and standard deviation of the characteristics also were calculated and reviewed to ensure the determinations were reasonable. The basin characteristics values determined using the GIS approach were evaluated for accuracy by comparison with previously published data where available.

Some basin characteristics determined using the GIS approach compared favorably with previously published values for the same gaging stations. Mean basin elevations computed using the GIS approach closely replicated published values (fig. 2). Mean annual precipitation values for gaging stations coincident with Lowham's (1988) Plains and High Desert Regions also were similar to published values (fig. 3).

Other basin characteristics determined using the GIS approach did not compare well with previously published values for the same gaging stations. Mean annual precipitation values computed using the GIS approach for gaging stations coincident with Lowham's (1988) Mountainous Regions were notably larger than published values for the same gaging stations (fig. 3). The differences probably are a result of the approach used to develop the OCS precipitation dataset. The OCS approach incorporated data from high-elevation meteorological sites not included in previous analyses. In addition, the use of elevation in the OCS approach as an explanatory variable in determining precipitation probably contributes to the observed differences. Some differences might be a result of differences in the time periods the datasets are based on.

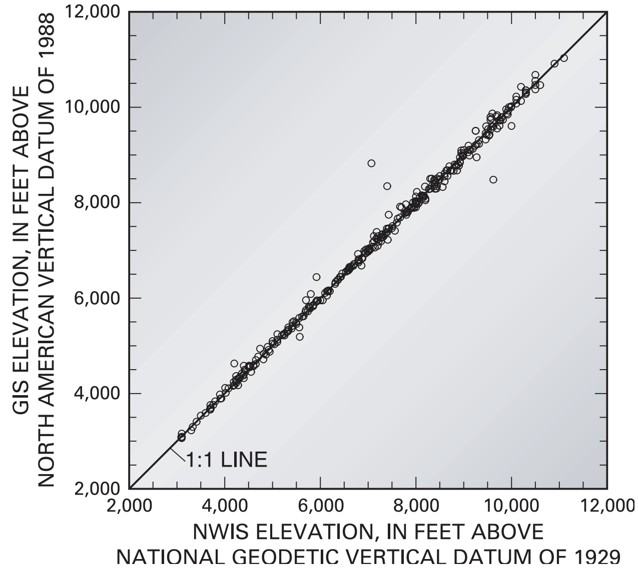


Figure 2. Comparison of mean basin elevation determined using a geographic information system (GIS) with mean basin elevation in the U.S. Geological Survey National Water Information System (NWIS).

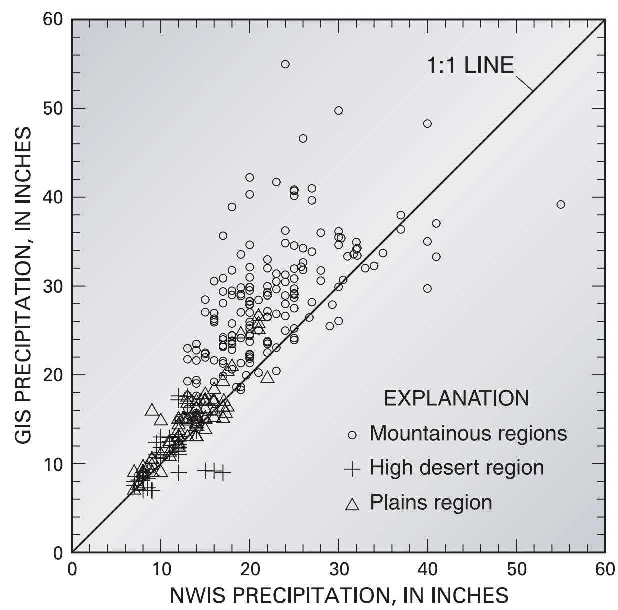


Figure 3. Comparison of mean-annual basin precipitation determined using a geographic information system (GIS) with mean-annual basin precipitation in the U.S. Geological Survey National Water Information System (NWIS).

Frequency Analyses

A peak-flow frequency analysis is the relation between the magnitude and frequency of occurrence of annual peak flows. The relation is described by a probability distribution, where the frequency of occurrence is expressed as the probability of those flows being equaled or exceeded, on average, in any given year. Expressed in percentages, a peak flow with an annual exceedance probability of 0.01 has a 1-percent probability of being equaled or exceeded, on average, in any given year. Exceedance probability also is expressed as the time between occurrences, or recurrence interval. Recurrence interval is the reciprocal in percent of the annual exceedance probability. Thus, a peak-flow with an annual exceedance probability of 0.01 has a recurrence interval of 100 years; or, a peak-flow with an annual exceedance probability of 0.01 will be equaled or exceeded on average once in 100 years (Chow and others, 1988; William Thomas, Michael-Baker Corp., written commun., 1997; Robert Tortorelli, U.S. Geological Survey, written commun., 2002).

Frequency analyses were completed in accordance with recommended methods described in Bulletin 17-B (Interagency Advisory Committee on Water Data, 1982). The Pearson Type III probability distribution of the logarithms (LPIII) of annual peak flows is the recommended distribution for defining gaging-station peak-flow frequencies of occurrence (Interagency Advisory Committee on Water Data, 1982, p. 3). The LPIII distribution is fit to the annual peak flows using three parameters: the mean, the standard deviation, and the skew of the logarithms. These parameters are analogous to the mid-point, the average slope, and the shape of the distribution in the form of a frequency curve. An example frequency curve developed from a fit of the LPIII distribution to annual peak flows at a gaging station is shown in figure 4.

The USGS computer program PEAKFQ (Thomas and others, 1998) was used to determine the peak-flow frequency relations for the gaging stations used in this study. The program incorporates the recommended procedures for peak-flow frequency analyses described by the Interagency Advisory Committee on Water Data (IACWD) (1982). The computer program and supporting documentation can be downloaded from the World Wide Web (internet) at ***http://water.usgs.gov/software***.

The recommended procedures for annual peak-flow frequency analyses include certain elements that warrant additional discussion of how they were incorporated in the study. Discussion of the use of historical peak-flow data and peak flows below a gage-base are presented in the following sections. Also presented in the following sections are methods used in testing for trends and an evaluation of skew relations.

Historical Data

Historical peak flows were used to adjust the LPIII frequency analyses at 38 gaging stations for which those data were available. Historical peak flows are defined as large peak flows that occurred at some time other than during the systematic record of annual peak flows. Historical peak flows were incorporated in the frequency analyses as described by the Interagency Advisory Committee on Water Data (1982). Data for historical peak flows often are available only as anecdotal information from long-term residents, their descendents, newspaper accounts, and other unpublished sources. Historical peak-flow data also are available as indirect measurements of peak flows at gaging stations occurring before or after the period of systematic record. Other historic peak flows are based on an estimate of the peak flow and an approximate historic period based on an analysis of the site geomorphology and vegetation (Cooley, 1990).

Base Discharge

LPIII frequency analyses were adjusted for annual peak-flow records that included peak flows below a base discharge. A specific type of gage used to record annual peak flows is the crest-stage gage (Buchanan and Somers, 1968, p. 27-28). Because of their design, crest-stage gages are limited in the range of stage measured. The gages were installed such that the anticipated range of annual peak flows would be recorded; however, the lower peak flows sometimes were not recorded. The discharge corresponding to the lower end of the range in stage was the base discharge. Values for annual peak flows below this base discharge frequently were quantified only as less than the base discharge. For many gaging stations where several annual peak flows occurred below the base discharge after installation, the crest-stage gage was lowered or a second gage installed to record future occurrences of these lower peak flows.

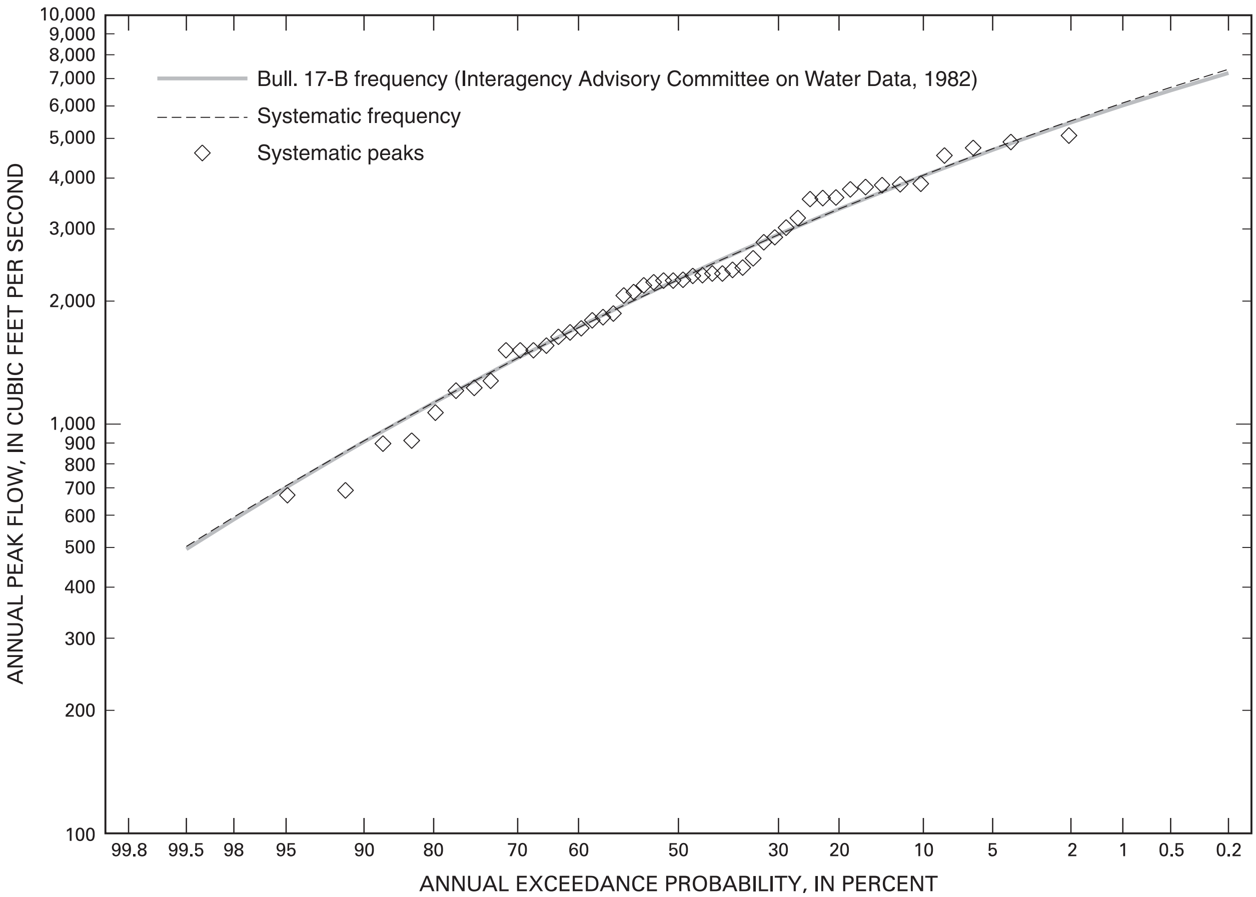


Figure 4. Example annual peak-flow frequency curve.

The IACWD procedure for incorporating peak flows below a base discharge in a peak-flow frequency analysis incorporates a conditional probability approach. The approach consists of (1) fitting a conditional LPIII distribution to only the annual peaks above the base discharge, (2) estimating the probability of any given annual peak flow exceeding the base discharge, (3) then adjusting the conditional LPIII distribution using the estimated probability. A synthetic skew is then estimated for use in calculating the weighted skew coefficient. The procedure is appropriate for most gaging-station peak-flow records where less than 25 percent of the values in the series are below the base discharge (Interagency Advisory Committee on Water Data, 1982). The procedure also is used for peak-flow records that include years with no streamflow.

The IACWD conditional probability approach uses only those annual peak flows larger than the highest base discharge to determine the conditional LPIII distribution for the gaging-station frequency analysis. For a few gaging stations, a few years of peak flows were compiled consisting of values above and below the initial base discharge. This initial record often was followed by several more years of record after the gage was lowered. The second part of those records frequently consisted of several peak flows below the initial base discharge. Because the conditional probability approach uses only those peaks above the initial base discharge, a substantial part of the annual peak flow record is not used in the procedure, resulting in important information about the distribution of annual peak flows being dismissed.

In a few situations, the peak-flow record did not meet the criteria for conditional probability adjustment because more than 25 percent of the peak flows that occurred after the gage was lowered were less than the initial base discharge. Frequency analyses of annual peak-flow records were estimated for these gaging stations. For each gaging station, the censored values recorded prior to lowering of the base discharge were ignored. The remaining values recorded prior to lowering of the base discharge were classified as historical peak flows. The frequency analysis was completed using methods described by the Interagency Advisory Committee on Water Data (1982) for historical records. The frequency curves developed using this modified historical approach were compared with frequency curves for other gaging stations with similar peak-flow characteristics and frequency curves of the same gaging stations developed by previous investigators (Druse and others, 1988).

Trend Testing

The frequency analyses of annual peak flows used in this study were predicated on the assumption that the processes controlling these peak flows were stationary with respect to time. To verify this assumption, the annual peak-flow series for all gaging stations used in the study were evaluated for temporal trends using Kendall’s tau. Kendall’s tau is a nonparametric test commonly used in hydrologic studies to measure the strength of an increasing or decreasing monotonic relation between two variables. Specifically, for a series of annual peak flows, tau is used to identify a monotonic change in the central value over time (Hirsch and others, 1982; Helsel and Hirsch, 1992; Wahl, 1998). The presence of monotonic trends in the annual peak-flow series for 28 of the 364 gaging stations was indicated by significant values of Kendall’s tau ($\alpha = 0.05$). Values of tau were less than –0.3 or greater than +0.3 for 19 of the 28 series. For comparison, a “strong” value (absolute) of tau would be about 0.7 or larger (Helsel and Hirsch, 1992, p. 212).

Kendall’s tau and other nonparametric tests are useful in hydrologic investigations because of their insensitivity to individual outliers. Peak-flow series, however, can include successive years of extremely small annual peak flows (or large peak flows) that have a significant influence on such tests when those successive peak flows occur near the beginning or end of the series. The effect of successive extreme values also is a function of the number of successive extremes relative to the length of the peak-flow series (Wahl, 1998).

The peak-flow series for the 28 gaging stations with indicated trends were plotted for further evaluation. The indicated trends for most of the 28 gaging stations apparently were influenced by one or more successive small or large annual peak flows. The absolute values of tau were inversely proportional to the length of the annual peak-flow series. Given these observations, the indicated trends probably were not a function of changes to the processes controlling annual peak flows at these gaging stations.

Skew Evaluation

A skew coefficient is one of three parameters required for fitting the LPIII frequency distribution to a record of annual peak flows. The skew is calculated from the logarithm of the peak flows and is a function of the shape of the distribution. Because skew coefficients are sensitive to extreme values, those calculated from smaller samples are more likely to be less accurate. Thus, skews calculated for shorter length peak-flow records are less accurate than skews calculated for longer records (Tasker, 1978; Interagency Advisory Committee on Water Data, 1982).

The accuracy of the skew coefficient can be improved by considering a generalized skew estimated from the skews of several gaging stations in the same region. The resulting skew coefficient is a weighted estimate of the gaging station skew and the generalized skew, with the weights calculated as the inverse of their respective mean square errors. Generalized skew relations for the Nation were developed by the IACWD and described as a map of isolines of equal skew (Interagency Advisory Committee on Water Data, 1982, plate 1). For Wyoming, the IACWD generalized skew relations are shown in figure 5.

The generalized skew relations as defined by the Interagency Advisory Committee on Water Data (1982, plate 1) were used for the annual peak-flow frequency analyses in this study. The IACWD generalized skew relations were evaluated, and regional relations for the study area were explored. Specifically, a regional relation was sought that better defined skew in the northeastern part of the State than the existing generalized skew relations.

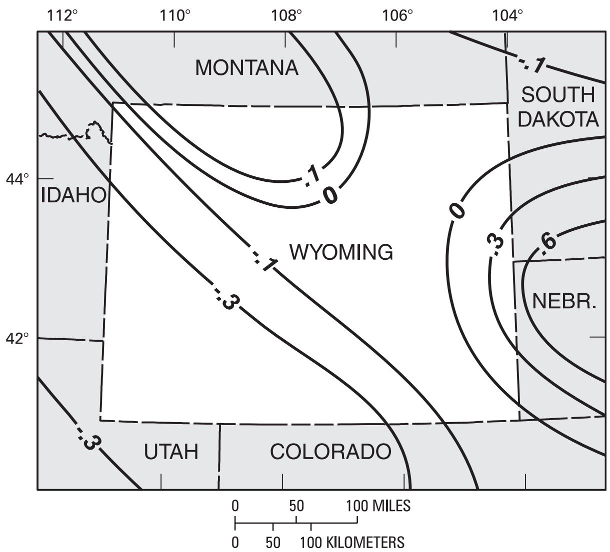


Figure 5. Generalized skew map for Wyoming and surrounding states (modified from Interagency Advisory Committee on Water Data, 1982).

Peak-flow frequency analyses for gaging stations in the study area were used to determine if the IACWD generalized skew relations could be improved upon. The IACWD recommends analyzing skew relations for a region of interest using three methods: (1) a map of skew isolines for the study area; (2) a skew prediction equation; and (3) the mean of the gaging station skew values. Regional skew relations developed using one or more of these methods are the preferred alternative to the IAWCD generalized skew relations. The guidelines for the three methods recommend the use of at least 40 gaging stations or all the gaging stations within 100 miles of the area of interest for determining regional skew relations. Periods of peak-flow record for each of the gaging stations should be at least 25 years in length, and annual peak flows should not be affected by anthropogenic activities (Interagency Advisory Committee on Water Data, 1982, p. 11).

Skew coefficients for all gaging stations used in the peak-flow frequency analyses with at least 25 years of annual peak flows were compiled for further evaluation. This initial compilation resulted in values for 146 gaging stations for the study area. The gaging station skews were adjusted for bias as described by Tasker and Stedinger (1986). Anomalous values in the initial compilation were evaluated by plotting the cumulative distribution of the adjusted gaging station skews. Distinct differences in the distribution were apparent for 38 gaging stations with adjusted gaging station skews less than about –1.0 or greater than about +0.5. Additional analyses of those 38 gaging stations indicated the anomalous values were the result of one or more small or large annual peak flows. The spatial distributions of the anomalous values also were evaluated. A cluster of a few large positive adjusted gaging stations skews was apparent in an area where the gaging station skews generally were positive; a similar effect was apparent for one cluster of large negative adjusted gaging station skews. Otherwise, there was no apparent spatial trend in the anomalous values. These values were removed from the initial compilation because the apparent localized variability of the anomalous values would be counter to the generalized intent of regional skew relations. The final compilation consisted of adjusted gaging station skews for 108 gaging stations in the study area.

Regional skew relations were analyzed using the three methods as described in the following sections. In addition, previous investigations of regional skew analyses are discussed. After considering the regional skew analyses and previous investigations, revisions to the existing IACWD skew relations for Wyoming were not made because (1) regional skew relations that improved upon the IACWD generalized skew relations were not apparent; (2) previous investigations in the region have not demonstrated conclusively the IACWD generalized skew relations are inadequate; and (3) there is a Nationally recognized need for better definition and use of generalized skew relations beyond the current guidelines.

Map of Skew Isolines

A regional map of skew isolines was developed for the study area from the final adjusted gaging station skews and evaluated as an alternative to the IACWD generalized skew relations (Interagency Advisory Committee on Water Data, 1982, plate 1). Initial “surfaces” were created from spatial interpolation of the skew values using kriging algorithms in a GIS. The IACWD recommendations of using 40 gaging stations or all gaging stations within 100 miles for the area of interest were used as guidelines to set parameters in the kriging algorithms. Isolines were developed using contouring routines in the GIS. The skew surfaces and accompanying variance surfaces along with the relevant isolines and gaging-station locations were plotted and compared with the existing IACWD generalized skew relations.

The regional skew map developed for the study area did not appear to improve upon the existing generalized IACWD skew map (fig. 5). The regional map replicated the trend of the IACWD generalized skew map, which depicts a moderately negative to strongly negative to neutral skew as observed from the southwest corner of the study area to the middle of Wyoming. In contrast to this general agreement, the regional map indicated skew relations in the northeastern corner of the study area were strongly negative. Additional evaluation of those data indicated that the regional skew isolines in that area were based on values from only 18 gaging stations. Adjusted skew values for four of those gaging stations were strongly negative (less than –0.9); the average adjusted skew of the other 14 stations was moderately negative (about –0.2). The regional skew relations also were not well defined in northeastern Wyoming because most of the gaging stations used in analyses for that area were located outside of the State toward the edge of the study area and not inside the State where the definition was needed. Interpretations of those relations were complicated further by significant differences in basin and peak-flow characteristics for those gaging stations.

Skew Prediction Equation

An equation for the study area relating adjusted gaging station skews to physical and climatic basin characteristics was not a feasible alternative to the IAWCD generalized skew relations (Interagency Advisory Committee on Water Data, 1982, plate 1). A stepwise-multiple regression approach was used to determine if a single equation describing regional skew for the study area could be developed. No individual or combination of basin characteristics significantly ($\alpha = 0.05$) related to the adjusted gaging stations skews for the study area was determined. It was expected that a single equation could not be developed due to the large range in values across the study area for many of the basin characteristics. Separate equations for subareas with similar basin characteristics were not developed because several of those subareas lacked sufficient data, notably the plains of northeastern Wyoming.

Mean of Gaging Station Skew Values

The mean of the adjusted skew values for all the gaging stations in the study area was not a feasible alternative to the IACWD generalized skew relations (Interagency Advisory Committee on Water Data, 1982, plate 1). The mean of the adjusted gaging-stations skews was –0.22; the variance of the skews was 0.17. However, the use of the mean of the skew for all gaging stations in the study area was not defensible due to the large range in values for peak-flow and basin characteristics across the State. The procedure used recommends a minimum of 20 gaging stations (Interagency Advisory Committee on Water Data, 1982, p. 11). Separate means for subareas with similar basin characteristics were not calculated because several of those subareas had fewer than 20 gaging stations—again—notably the plains of northeastern Wyoming.

Previous Investigations

Previous investigations of skew characteristics in the region have resulted in varying conclusions. Several studies concluded that existing generalized skew relations described by the Interagency Advisory Committee on Water Data (1982) could not be improved upon significantly. In South Dakota, the IACWD generalized skew relations were compared to skew coefficients determined by regression equations relating gaging-station skew to basin characteristics and to average gaging-station skews determined by hydrologic regions (Sando, 1998). The comparison indicated the differences between regional skew coefficients determined by the three methods were small, resulting in the use of the IACWD generalized relations. For Montana, regional skew relations recently were evaluated and it was concluded the IACWD generalized relations were adequate for that State (Charles Parrett, U.S. Geological Survey, oral commun., 2000). Other studies concluded existing generalized skew relations were not adequate. An investigation of peak-flow characteristics in the southwestern United States included an extensive analysis of regional skew relations (Thomas and others, 1997). That analysis examined several methods for defining regional skew relations and concluded that none of them could improve upon a uniform value of zero skew, the mean of the gaging-station skew for the study area. Soenksen and others (1999) evaluated regional skew characteristics in Nebraska resulting in a complex combination of (a) regression equations relating gaging-station skew to basin characteristics for four hydrologic regions in the State and (b) a generalized skew map for application to one particular basin and all low-permeability basins regardless of hydrologic region. Several gaging stations with as few as 18 years of peak-flow record were used in the analyses (Soenksen and others, 1999, p. 9).

The varying conclusions resulting from analyses of regional skew characteristics in recent investigations support the need for additional study of the development and application of generalized skew relations. In 1987, the Hydrology Subcommittee of the IACWD concluded that more guidance was needed with respect to generalized skew relations. In 1989, a new work group was formed and several topics were selected for study, one of which was the definition and use of generalized skew relations. As of 1997, no supplemental guidance to Interagency Advisory Committee on Water Data (1982) had been published (William Thomas, Michael-Baker Corp., written commun., 1997).

Regional Relations

Peak-flow characteristics were related to selected basin characteristics for gaging stations grouped by region. Regions were delineated based on similarities in hydrologic and basin characteristics that influence peak flows in a given area. Individual regional relations between peak flow and basin characteristics were explored using all-possible- and step-wise ordinary least squares (OLS) and weighted-least squares (WLS) regression. Using the best WLS relations, final equations for selected recurrence intervals were developed for each region using GLS regression as recommended (U.S. Geological Survey Office of Surface Water Technical Memorandum Number 87.08, 1987).

Delineation of Regions

Wyoming was divided into six hydrologic regions for this study based on similarities in peak-flow characteristics and the environmental factors that influence them. The purpose of dividing the State for regional analyses was to ensure that the final equations were sound from a hydrologic perspective and to reduce the errors in the estimates obtained from the regression equations. Annual peak flows in the mountainous areas of Wyoming typically are in response to snowmelt runoff. Annual peak flows in the basins and plains areas generally are the result of rainfall runoff. Estimates of peak-flow characteristics obtained from regression equations developed from a mixed-population dataset of both types of runoff would have questionable hydrologic meaning. In addition, the estimates likely would have large errors because of differences in the distribution of each type of runoff. For example, preliminary statewide (i.e., no regions) OLS regression analyses resulted in equations with average standard errors of estimate larger than 100 percent. In addition to differences in the type of runoff, other environmental factors influence peak flows and are unique to specific areas of the State. For example, Lowham (1988) noted that peak flows from rainfall-runoff were larger in the northern and eastern parts of the State than in the south-central and southwestern parts of the State. Lowham (1988) attributed this characteristic to differences in rainstorm events and delineated those areas as separate regions to reduce the errors in the regression estimates.

The six hydrologic regions in this study were delineated using a two-tiered approach similar to those used in previous investigations. The objective of the first tier was to divide those areas of the State where annual peak flows are dominated by snowmelt runoff from those areas where annual peak flows generally are the result of rainfall runoff. In this study, as in previous investigations, the geographic separation of snowmelt-runoff and rainfall-runoff areas was made by distinguishing between mountainous and non-mountainous areas of Wyoming; annual peak flows are dominated by snowmelt runoff in the mountainous areas and by rainfall runoff in the non-mountainous areas. Mountainous and non-mountainous areas initially were delineated using physiographic provinces and province sections as defined by Fenneman and Johnson (1946) as a guide (fig. 6). The mountainous areas of Wyoming were delineated by the Southern, Middle, and Northern Rocky Mountain provinces and the Black Hills Section of the Great Plains Province. The Bighorn Basin (fig. 1) part of the Middle Rocky Mountain Province was not included with the mountainous areas. The easternmost parts of the Columbia Plateau and the Basin and Range provinces were incorporated in the mountainous areas to include selected peak-flow gaging stations that are not in Wyoming. The non-mountainous areas of the State were delineated by the Wyoming Basin Province, the Great Plains Province (excluding the Black Hills Section), and the Bighorn Basin part of the Middle Rocky Mountains Province.

The objective of the second tier was to explore differences in peak-flow characteristics within those areas and to determine if further division was warranted. Residuals from initial regression analyses were examined for spatial patterns not accounted for by the explanatory variables used. Specifically, the residuals from initial WLS regression equations for estimating annual

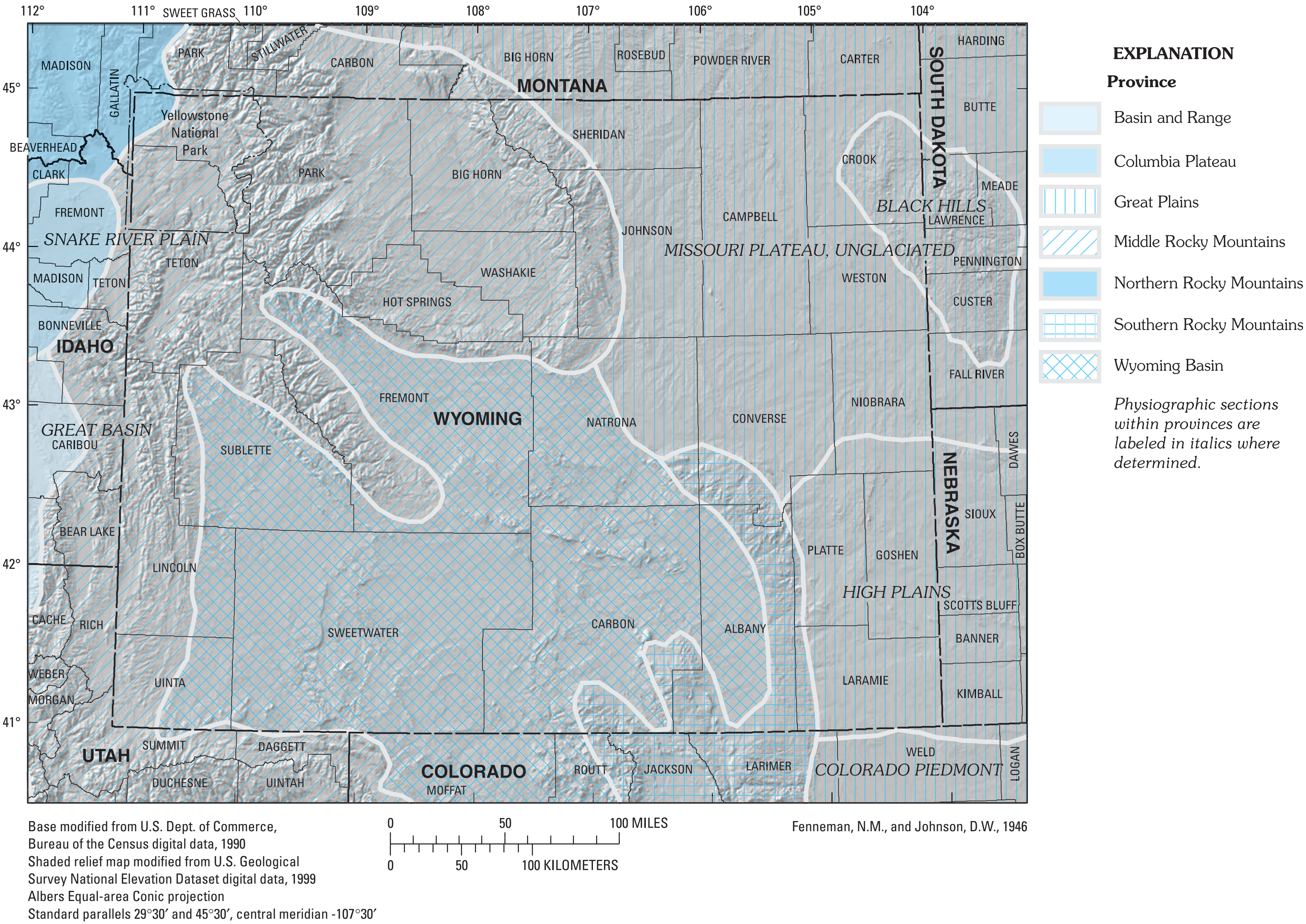


Figure 6. Physiographic provinces and sections for Wyoming and surrounding states.

peak flows with recurrence intervals of 25-, 50-, and 100-years were used. The weighting factor in the regression analyses was a function of the gaging station period of record that approximated the general relation described by Wahl (1970, p. 8). Using spatial interpolation and visualization tools in a GIS, smoothed “surfaces” of the residuals were created and compared with physiographic characteristics of the study area. Groups of large positive and large negative residuals—represented as highs and lows in the “surfaces”—were noted for parts of the study area, resulting in further division of the first-tier delineations and the delineation of the six hydrologic regions. Major river basin boundaries and delineations from previous investigations in and around Wyoming were given consideration, and adjustments were made to some of the previously delineated boundaries for the final regions (fig. 7 and plate 1).

The Rocky Mountains Regions incorporate most of the mountainous areas of Wyoming, including all of the ranges in northwestern Wyoming, the Wind River Range, the Bighorn Mountains, the northern Laramie Mountains, the Sierra Madre, the Snowy Range, and the Uinta Mountains (fig. 1; Region 1, fig. 7 and plate 1). These medium- to high-elevation ranges mostly are forested with some alpine areas and some open woodlands. Most of the precipitation in these ranges occurs as snow from Pacific storm fronts during the winter months. Annual peak flows generally are caused by late spring and early summer melting of winter snow accumulations. Because of the low spatial and annual variability in snow accumulations, variability also is low in the resulting annual peak flows.

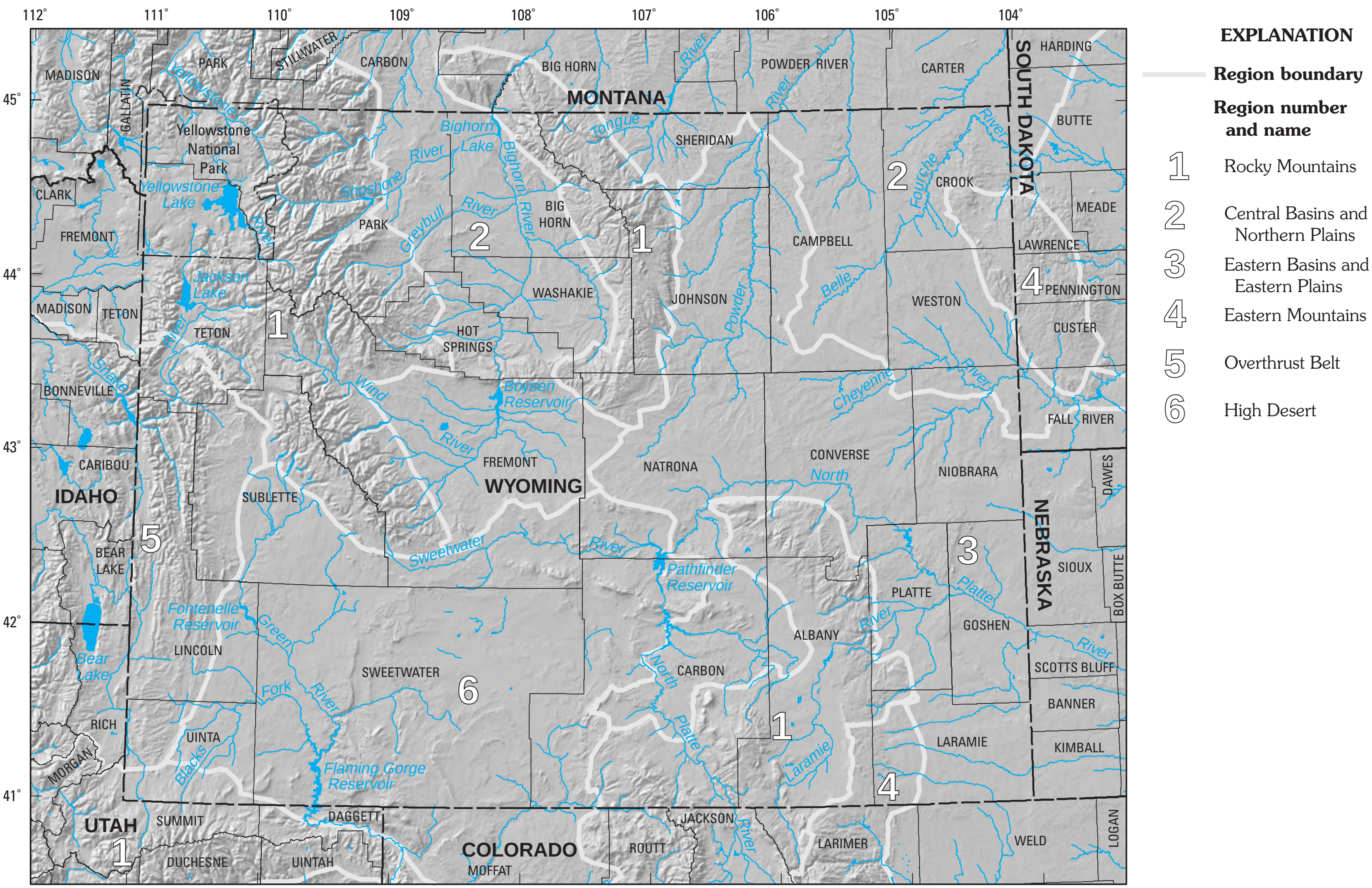
The Central Basins and Northern Plains Region includes the Bighorn Basin and the plains of northeastern Wyoming (fig. 1; Region 2, fig. 7 and plate 1). These areas are semiarid to arid and are characterized by grasslands, shrublands, and some open woodlands. Annual peak flows generally are caused by moderate to very intense localized convective rainstorms. As a result, measured annual peak flows are characterized by large year-to-year variability.

The Eastern Basins and Eastern Plains Region includes most of the lower elevation areas of the Powder River drainage in Wyoming, parts of the upper Cheyenne River drainage, the middle and lower North Platte River drainage, and the High Plains (fig. 1; fig. 6; Region 3, fig. 7 and plate 1). These semiarid grasslands were separated from the Central Basins and Northern Plains Region because annual peak flows generally were larger than annual peak flows measured in that region. Precipitation characteristics and the resulting variability in annual peak flows in the Eastern Basins and Eastern Plains Region are similar to those in the Central Basins and Northern Plains Region.

The Eastern Mountains Regions includes the Black Hills and the southern Laramie Mountains (fig. 1; fig. 6; Region 4, fig. 7 and plate 1). These low- to medium-elevation mountains mostly are forested with some open woodlands. These areas were delineated separately from the Rocky Mountains Regions because annual peak flows generally were more variable than annual peak flows measured in those regions. In contrast with the other mountainous regions in the State, proportionally more of the winter precipitation occurs later in the season (March and into April) in the Eastern Mountains Regions because of regional climate patterns. In addition, many annual peak flows are the result of mixed snowmelt runoff and rainfall runoff or rainfall runoff alone.

The Overthrust Belt Region includes the ranges of western Wyoming that are mostly located within Lincoln County and western Sublette County (Region 5, fig. 7 and plate 1). These mostly forested, medium-elevation ranges were separated from the Rocky Mountains Regions because annual peak flows generally were smaller than annual peak flows measured in those regions. Most of the precipitation in these ranges occurs as snow during the winter months from Pacific storm fronts, with the largest totals occurring during January. Annual peak flows generally result from snowmelt runoff.

The High Desert Region includes the plains and desert areas of south-central and southwestern Wyoming, is mostly desert shrubland, and is much higher in elevation than the other non-mountainous areas of the State (Region 6, fig. 7 and plate 1). Soils in the High Desert Region generally are characterized by lower clay content and larger permeability rates than the Central Basins and Northern Plains Region and the Eastern Basins and Eastern Plains Region (Schwarz and Alexander, 1995). Soils properties might contribute to lower peak flows, which are more common in the High Desert Region than in the other non-mountainous areas. Annual peak flows generally are the result of low-to moderate-intensity, regional-scale precipitation (Lowham, 1988). These storm characteristics probably contribute to measured annual peak flows that are less variable—as well as lower magnitude—when compared to those in other non-mountainous areas of the State.



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

0 50 100 MILES
0 50 100 KILOMETERS

Figure 7. Hydrologic regions for determining peak-flow characteristics of Wyoming streams.

Regression Analyses

Equations relating annual peak flows for selected recurrence intervals to significant basin characteristics were developed using OLS, WLS, and GLS multiple-regression techniques. Initial equations were developed using OLS and WLS regression techniques to provide additional information useful in delineating hydrologic regions (previously described in the *Delineation of regions* section). The OLS and WLS regression techniques also were used to explore the significance of individual explanatory variables—and combinations thereof—in determining regional peak-flow characteristics.

Relations between the magnitudes of annual peak flows for selected recurrence intervals and basin characteristics were explored for each hydrologic region using OLS and WLS multiple-regression techniques. All peak-flow and basin characteristics were transformed to base-10 logarithms ($\log_{10}$) to make the relations between the dependent and independent variables linear, to make the distribution of the model variance more constant, and to make the regression residuals more normal. The resulting relations were of the form:

$$\log Q_T = \log K + a\log A + b\log B + ... + n\log N \qquad (1)$$

which, after determining the antilogarithms are of the form:

$$Q_T = K(A)^a(B)^b...(N)^n \qquad (2)$$

where

Q_T	=	estimated peak flow, in cubic feet per second, for a recurrence interval of *T* years (i.e., the dependent or response variable);
K	=	regression constant;
$a, b, \ldots, n$	=	regression coefficients; and
$A, B, \ldots, N$	=	values of basin characteristics (i.e., the independent or explanatory variables).

The explanatory variables were evaluated to determine the basin characteristic or combination of characteristics (previously described in the *Basin Characteristics* section) that provided the best model for estimating peak flows in a region for a given recurrence interval. The models were developed and evaluated using stepwise and all-possible OLS and WLS regression tools in the computer program Statit (Statware, 1990). The significance of the explanatory variables was determined by their T- and p-values (in general, $|T| >\sim 2.0$ or $p < 0.05$). The sign and magnitude of the regression coefficients for the variables were reviewed from a hydrologic perspective. Values of the regression diagnostics Mallow’s Cp, adjusted R-squared, and mean square error were used to determine the best WLS model (Helsel and Hirsch, 1992). The basin characteristics for the best models were used to develop the final GLS regression equations.

Sensitivity testing of the initial equations sometimes resulted in discontinuous peak-flow frequency relations. These discontinuities occurred when the explanatory variables (or combinations thereof) were different between equations for consecutive recurrence intervals. The discontinuities especially were apparent for values of the explanatory variables near the extremes or outside of their range. To resolve potential discontinuities in estimated peak flows over the range of recurrence intervals for any given region, variables that were significant for some of the equations either were included in all or were not included in any of the final equations. Inclusion of marginally significant variables ($p > 0.1$) in the final equations sometimes resulted in slight increases (1 to 2 percent) in the standard errors when compared to equivalent equations developed from the most significant variables only.

Final regional equations relating annual peak-flow magnitudes for selected recurrence intervals to significant basin characteristics were developed using GLS regression. In comparison with OLS regression, GLS regression generally results in smaller errors in regression parameters, relatively unbiased estimates of parameter variance, and a better estimate of model error (Stedinger and Tasker, 1985). The GLS procedure effectively incorporates short records of annual peak flows that can be detrimental to an OLS procedure (Stedinger and Tasker, 1985, p. 1428). The GLS regression approach also results in better overall predictability of the model in split-sample comparisons with the OLS approach (Tasker and others, 1987).

The GLS regression procedure accounts for two assumptions commonly violated by application of the OLS regression approach to regional regression analyses of annual peak flows at gaging stations. For regional regression analyses using an OLS approach, annual peak flows are assumed to be independent from site to site, which is not necessarily true. Peak flows at different sites resulting from the same regional runoff event are significantly cross-correlated. In regional analyses of annual peak flows using OLS regression, the variance of the peak flows is assumed to be constant from site to site. Because the variance is partly dependent on the period of record (the length and the timing of the record), the assumption of constant variance also is not necessarily true when peak-flow records of different lengths or occurring during different periods are used in the regression analyses (Stedinger and Tasker, 1985).

To account for between-site cross correlations and unequal variances in annual peak flows, regional regression models developed using the GLS approach incorporate a covariance weighting matrix. Each weighting matrix requires estimates of cross correlation between all pairs of sites in each region. Because estimates of between-site cross correlation are imprecise for gaging stations with shorter record lengths, regional cross-correlation estimates are determined using nonlinear-regression models relating cross-correlation coefficients to distances between gaging stations (fig. 8). Unequal variances resulting from varying record lengths also are accounted for in the weighting matrix (Stedinger and Tasker, 1989).

Additional information describing the GLS regression approach is presented in Stedinger and Tasker (1985), Tasker and others (1987), and Tasker and Stedinger (1989). The USGS computer program GLSNET (Tasker and others, 1995) was used to determine the covariance weighting matrix and to develop the final equations. This computer program and supporting documentation can be retrieved from the World Wide Web (internet) at ***http://water.usgs.gov/software***.

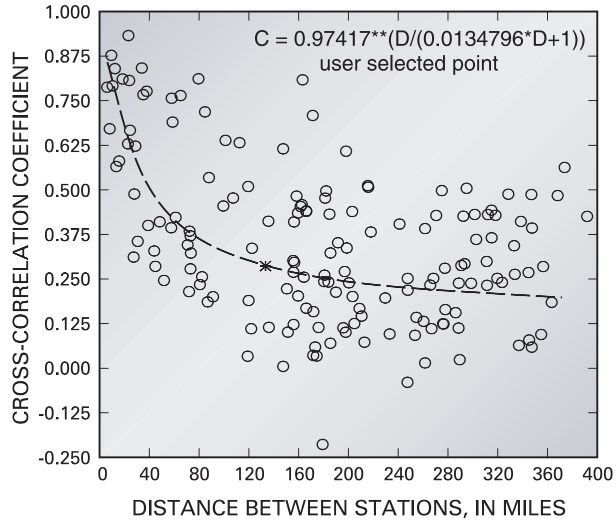


Figure 8. Example of relation between cross-correlation coefficients of annual peaks and distance between sites.

RESULTS

Regional equations for estimating peak-flow magnitudes for selected recurrence intervals from 1.5 to 500 years are described in this section. In addition to the average model and prediction errors, additional statistics are included for use in assessing the error of any one peak-flow estimate or prediction. Limitations of the regional equations are discussed in the context of the hydrologic conditions and basin characteristics of the gaging stations used to define them. Limitations and applications of the equations and other methods for estimating peak-flow characteristics under various circumstances also are described in this section.

Regional Equations

Equations for estimating peak flows for selected recurrence intervals from 1.5 to 500 years are tabulated by hydrologic region. The explanatory variables are listed in the equations in order of decreasing p-values. Included with the equations are several statistics for use in assessing the average uncertainty in the results. The average standard error of the estimate (SE_E) quantifies the average model error and is a measure of the variability in the dependent variable that is not accounted for by the independent variables. Values of SE_E are listed herein for comparison with results from previous investigations. However, because the SE_E does not reflect prediction errors made when the relations are used to estimate peak flows, a better means of assessing the quality of a regression relation is the average standard error of prediction (SE_P), which includes the average sampling error and the average model error (Gary Tasker, U.S. Geological Survey, written commun., 1995). In general, values of SE_P are slightly larger than corresponding values of SE_E because of the incorporation of the sampling error. The average equivalent years of record are a measure of the predictive accuracy of the regression equation (Hardison, 1971). The measure represents an estimate of the number of years of record required, on average, at a gaging station that would result in a frequency analysis of equal accuracy as the regional equation.

In addition to measures of average errors, additional statistics are included for use in assessing the error of any one peak-flow estimate or prediction. A good measure of error in a specific prediction is the confidence interval of the prediction, i.e., the prediction interval (Gary Tasker, U.S. Geological Survey, written commun., 1995). The prediction interval is a function of the SE_P and the critical value of the t-distribution[2] ($\alpha/2$, $n\text{-}p$) (Hodge and Tasker, 1995). Factors for estimating the lower and upper 95-percent prediction interval limits are listed for each equation. To estimate the prediction interval, the peak flow estimated from the regression equation is multiplied by the factors to obtain lower and upper limits.

Rocky Mountains

Equations for estimating peak-flow characteristics for the Rocky Mountains Regions (Region 1, fig. 7) are listed in table 1. Independent variables determined to be most significant in this region were drainage area and mean basin elevation. For estimating peak flows with recurrence intervals of 10 years or more, the site longitude was found to be significant. To resolve potential discontinuities in estimated peak flows over the range of recurrence intervals, longitude was included as an explanatory variable in all the equations. Values of SE_E ranged from 34 to 55 percent; SE_P ranged from 35 to 56 percent.

In addition to drainage area and elevation, Lowham (1988) determined that mean annual precipitation was a significant explanatory variable in the Mountainous Regions of that study. As a result, two sets of equations were developed for that study because of the significant correlation between mean basin elevation and mean annual precipitation. This study indicated mean annual precipitation was less significant (SE_E as much as 7 percent larger) or not significant ($\alpha = 0.05$) when compared with mean basin elevation as an explanatory variable for estimating peak flows in the Rocky Mountains Regions. Thus, the final equations in this study are based only on mean basin elevation.

[2] Given a prediction interval of $100(1-\alpha)$, the critical value is determined from the t-distribution for $\alpha/2$ and $n\text{-}p$ degrees of freedom, where n is the number of gaging stations used to develop the regression equation, and p is the number of explanatory variables in the regression equation plus one.

The uncertainties in the equations for the Rocky Mountains Regions compare favorably with results from previous investigations in and around Wyoming. Values of SE_E for equations developed by this study ranged from 12 to 31 percent less than those values for similar equations developed by Lowham (1988, p. 27). The largest improvements were in equations for estimating peak flows with longer recurrence intervals. The uncertainties in the equations also compare favorably with those values for recent equations developed for the mountainous regions of Colorado (Vaill, 2000, p. 9) and Montana (Omang, 1992, p. 63).

Central Basins and Northern Plains

Equations for estimating peak-flow characteristics for the Central Basins and Northern Plains Region (Region 2, fig. 7) are listed in table 2. The independent variable determined to be most significant in this region was drainage area. Values of SE_E ranged from 54 to 131 percent; SE_P ranged from 56 to 135 percent.

The large uncertainties in estimates of peak flows for shorter recurrence intervals are a function of the large year-to-year variability in annual peak flows measured at gaging stations in the Central Basins and Northern Plains Region. Also, the large values for SE_E are consistent with results from previous investigations of areas with similar basin and climate characteristics (Lowham, 1988, p. 30, Plains Region; Omang, 1992, p. 64, Southeast Plains Region). Overall, the uncertainties in the equations for the Central Basins and Northern Plains Region compare favorably with results from previous investigations in Wyoming. Values of SE_E for equations developed by this study ranged from 13 percent greater to 41 percent less than those values for similar equations developed by Lowham (1988, p. 30). The improvements were in equations for estimating peak flows with recurrence intervals equal to or greater than 25 years.

A previous investigation by Lowham (1988) incorporated a geographic factor in regression equations for some non-mountainous areas of Wyoming. The geographic factor was developed to account for differences within a region between peak-flow characteristics for gaging stations and those estimated by the regional equation. A geographic factor was not required for the Central Basins and Eastern Plains Region equations developed during this study.

Table 1. *Equations for estimating peak-flow characteristics, Rocky Mountains Regions, Wyoming (Region 1)*

[SE_E, average standard error of estimate; SE_P, average standard of error of prediction; Q_T, estimated peak flow, in cubic feet per second for recurrence interval of *T* years; *AREA*, total drainage area, in square miles; *ELEV*, mean basin elevation, in feet; *LNG*, longitude of basin outlet location, in decimal degrees]

Equation	SE_E (percent)	SE_P (percent)	Average equivalent years of record	95-percent prediction interval factor	
				Lower limit	Upper limit
$Q_{1.5} = 0.126(AREA^{0.885})\left(\left(\frac{ELEV-3,000}{1,000}\right)^{2.56}\right)((LNG-100)^{0.032})$	55	56	1.0	0.354	2.82
$Q_{2} = 0.313(AREA^{0.866})\left(\left(\frac{ELEV-3,000}{1,000}\right)^{2.32}\right)((LNG-100)^{-0.069})$	49	50	1.2	.396	2.53
$Q_{2.33} = 0.458(AREA^{0.858})\left(\left(\frac{ELEV-3,000}{1,000}\right)^{2.22}\right)((LNG-100)^{-0.110})$	46	47	1.3	.414	2.42
$Q_{5} = 1.89(AREA^{0.829})\left(\left(\frac{ELEV-3,000}{1,000}\right)^{1.85}\right)((LNG-100)^{-0.262})$	38	39	2.4	.476	2.10
$Q_{10} = 4.71(AREA^{0.810})\left(\left(\frac{ELEV-3,000}{1,000}\right)^{1.60}\right)((LNG-100)^{-0.357})$	35	36	3.8	.503	1.99
$Q_{25} = 12.1(AREA^{0.790})\left(\left(\frac{ELEV-3,000}{1,000}\right)^{1.34}\right)((LNG-100)^{-0.451})$	34	35	5.4	.509	1.96
$Q_{50} = 22.3(AREA^{0.776})\left(\left(\frac{ELEV-3,000}{1,000}\right)^{1.16}\right)((LNG-100)^{-0.510})$	35	36	6.3	.500	2.00
$Q_{100} = 38.6(AREA^{0.764})\left(\left(\frac{ELEV-3,000}{1,000}\right)^{1.00}\right)((LNG-100)^{-0.562})$	37	38	6.9	.486	2.06
$Q_{200} = 64.3(AREA^{0.752})\left(\left(\frac{ELEV-3,000}{1,000}\right)^{0.857}\right)((LNG-100)^{-0.611})$	39	40	7.2	.467	2.14
$Q_{500} = 120(AREA^{0.738})\left(\left(\frac{ELEV-3,000}{1,000}\right)^{0.674}\right)((LNG-100)^{-0.670})$	42	43	7.3	.440	2.28

Table 2. *Equations for estimating peak-flow characteristics, Central Basins and Northern Plains Region, Wyoming (Region 2)*

[SE_E, average standard error of estimate; SE_P, average standard error of prediction; Q_T, estimated peak flow, in cubic feet per second for recurrence interval of *T* years; *AREA*, total drainage area, in square miles]

Equation	SE_E (percent)	SE_P (percent)	Average equivalent years of record	95-percent prediction interval factor	
				Lower limit	Upper limit
$Q_{1.5} = 17.8(AREA^{0.486})$	131	135	1.4	0.131	7.61
$Q_{2} = 29.9(AREA^{0.475})$	110	113	1.6	.164	6.08
$Q_{2.33} = 37.1(AREA^{0.470})$	102	105	1.7	.180	5.57
$Q_{5} = 80.9(AREA^{0.455})$	79	81	3.4	.244	4.11
$Q_{10} = 134(AREA^{0.447})$	67	69	5.9	.290	3.45
$Q_{25} = 225(AREA^{0.439})$	58	60	10.4	.333	3.01
$Q_{50} = 311(AREA^{0.434})$	54	57	13.9	.350	2.86
$Q_{100} = 415(AREA^{0.430})$	54	56	16.9	.354	2.83
$Q_{200} = 536(AREA^{0.427})$	55	57	19.0	.346	2.89
$Q_{500} = 728(AREA^{0.425})$	58	61	20.1	.326	3.07

Eastern Basins and Eastern Plains

Equations for estimating peak-flow characteristics for the Eastern Basins and Eastern Plains Region (Region 3, fig. 7) are listed in table 3. The independent variables determined to be most significant in this region were drainage area and soils hydrologic index (plate 2). Values of SE_E ranged from 43 to 122 percent; SE_P ranged from 46 to 127 percent.

The large values of SE_E for estimating peak flows at shorter recurrence intervals are expected for the same reasons previously described (see *Central Basins and Northern Plains Region* section). Overall, the uncertainties in the equations for the Eastern Basins and Eastern Plains Region compare favorably with results from previous investigations in Wyoming. Values of SE_E for equations developed by this study ranged from 3 to 38 percent less than those values for similar equations developed by Lowham (1988, p. 30). The largest improvements were in equations for estimating peak flows with moderate to longer recurrence intervals. The geographic factor developed by Lowham (1988) was not required.

Eastern Mountains

Characterization of peak flows in the Black Hills and the Laramie Mountains historically has been problematic. The paucity of gaging stations, the variability in streamflows, and geologic influences on hydrology all contribute to the difficulty of regionalizing peak-flow characteristics in the mountainous areas of eastern Wyoming. Previous equations for estimating peak flows in these areas tend to produce values smaller than expected (William Bailey, Wyoming Department of Transportation, written commun., 1996; Sando, 1998). In previous investigations, the mountainous areas of eastern Wyoming have been both included and separated from hydrologic regions incorporating the other mountainous areas of the State. Wahl (1970) included

Table 3. *Equations for estimating peak-flow characteristics, Eastern Basins and Eastern Plains Region, Wyoming (Region 3)*

[SE_E, average standard error of estimate; SE_P, average standard error of prediction; Q_T, estimated peak flow, in cubic feet per second for recurrence interval of *T* years; *AREA*, total drainage area, in square miles; *SOIL*, mean basin soils hydrologic index (plate 2), unitless]

Equation	SE_E (percent)	SE_P (percent)	Average equivalent years of record	95-percent prediction interval factor	
				Lower limit	Upper limit
$Q_{1.5} = 1.12(AREA^{0.401})(SOIL^{3.01})$	122	127	2.0	0.140	7.12
$Q_{2} = 2.28(AREA^{0.402})(SOIL^{2.90})$	94	98	2.6	.193	5.18
$Q_{2.33} = 3.10(AREA^{0.403})(SOIL^{2.84})$	85	89	3.1	.218	4.58
$Q_{5} = 10.1(AREA^{0.407})(SOIL^{2.60})$	58	61	7.7	.324	3.08
$Q_{10} = 21.9(AREA^{0.410})(SOIL^{2.44})$	48	51	14.4	.384	2.61
$Q_{25} = 48.8(AREA^{0.416})(SOIL^{2.27})$	43	46	23.6	.413	2.42
$Q_{50} = 80.9(AREA^{0.423})(SOIL^{2.16})$	44	48	28.0	.405	2.47
$Q_{100} = 127(AREA^{0.432})(SOIL^{2.05})$	47	51	29.5	.382	2.62
$Q_{200} = 193(AREA^{0.441})(SOIL^{1.94})$	52	56	28.9	.350	2.86
$Q_{500} = 323(AREA^{0.454})(SOIL^{1.80})$	60	66	26.6	.302	3.31

the Black Hills with the mountains of north-central Wyoming in hydrologic area “A;” the Laramie Mountains were incorporated into hydrologic area “B,” which encompassed the rest of the mountainous areas of the State. Lowham (1976, p. 4) characterized the Black Hills and the Laramie Mountains as “subdued mountain areas where peak flows occur from both snowmelt and rainfall runoff,” and separated the areas from the other mountainous areas of the State. Then in a subsequent investigation, “advanced analytical methods and more complete streamflow data” resulted in these areas being combined with the other mountainous areas of the State (Lowham, 1988, p. 18). Most recently, Miselis and others (1999) demonstrated that regional relations for estimating a range of streamflow characteristics could be improved by developing regression equations specific to the various mountain ranges.

This study determined that delineation of a separate region for the Eastern Mountains (Region 4, fig. 7) was appropriate. When compared to other mountainous areas of the State, the available data indicate peak flows in the eastern mountainous areas generally are more variable. The eastern mountainous areas also are unique because of the late winter and early spring moisture from the south and east. More annual peak flows result from rainfall runoff than snowmelt runoff in the eastern mountains, compared to other mountainous areas of the State. Finally, additional gaging stations in northeastern Wyoming and western South Dakota not used in previous investigations, as well as recently completed analyses by Sando (1998), support the delineation of a separate region for the area.

As previously noted, annual peak flows in the eastern mountainous areas of the State are caused by snowmelt runoff, rainfall runoff, and a combination of snowmelt runoff and rainfall runoff. A cursory analysis by Sando (1998, p. 5) indicated that runoff from rainfall only accounts for as much as 90 percent of the annual peak flows in most of the Black Hills area. The physiographic area referenced as the Black Hills by

Sando (1998, fig. 1), however, extended to the east, beyond the mountains and onto the surrounding, lower elevation plains and did not include the mountainous areas in Wyoming to the west and northwest. Annual peak flows in the Laramie Mountains also occur because of rainfall runoff. Additionally, peak flows resulting from a combination of snowmelt runoff and rainfall runoff can occur. Significant flooding occurred in the northern Black Hills in 1965, when up to 34 inches of snow accumulated May 8-9 and was followed by nearly 7 inches of rain during May 14-15 (Benson and others, 1991).

Data that explicitly define the runoff source of annual peak flows are not readily available (Sando, 1998; Kenneth Wahl, U.S. Geological Survey, oral commun., 2001). To estimate the number of rainfall-only annual peak flows for streams in the eastern mountains of Wyoming, certain assumptions were made. A qualitative comparison of latitude and elevation of the areas was made with other mountainous areas of the State using guidelines defined by Thomas and others (1997, p. 70). Using these observations, along with information on the timing of annual peak flows resulting from snowmelt runoff in other mountainous areas of the State, it was estimated that less than one-half of the annual peak flows at gaging stations used in this study for the eastern mountains regions of Wyoming resulted from rainfall-only events.

Annual peak flows resulting from rainfall runoff in streams along the eastern front of the Rocky Mountains typically are larger than those generated by snowmelt runoff (William Thomas, Jr., Michael-Baker Corp., written commun., 1997). The most devastating flood in the region—the June 9-10, 1972 Black Hills-Rapid City flood—occurred as a result of runoff from as much as 15 inches of rain in less than 6 hours (Larimer, 1973; Schwarz and others, 1975). Frequency analyses of annual peak flows that do not distinguish between snowmelt- and rainfall-runoff sources generally overestimate shorter recurrence interval flows and underestimate those for longer recurrence intervals. Composite relations—determined by combining separate rainfall- and snowmelt-runoff frequency curves—can be developed to mitigate these effects (Crippen, 1978; William Kirby, U.S. Geological Survey, described in William Thomas, Jr., Michael-Baker Corp., written commun., 1997).

Composite frequency analyses of annual peak-flow data for gaging stations in the Eastern Mountains Regions were not determined for this study. The hypothesis that most annual peak flows from rainfall-only runoff are larger than annual peak flows from snowmelt runoff could not be validated using the information available for the gaging stations selected for the eastern mountainous areas of this study. There also were no apparent differences in the distributions of annual peak flow from the two types of runoff. However, the lack of information explicitly defining the source of each annual peak flow required certain assumptions (see previous paragraphs in this section). These assumptions might have contributed to the inability to differentiate between snowmelt runoff and rainfall runoff. The variability in peak-flow data, the paucity of gaging stations, and short periods of records also contributed to the inability to differentiate the two types of annual peak flows.

Detailed analyses of mixed-population peak flows for regions characteristically similar to the eastern mountainous areas of Wyoming are described by Thomas and others (1997). Frequency relations for 51 gaging stations with annual peak flows resulting from both rainfall runoff and snowmelt runoff were evaluated. Differences between frequency analyses that did not differentiate the two types of peak flow and those that did were determined to be insignificant. Frequency relations based on the mixed-population data were deemed adequate for recurrence intervals of 100 years or less.

Equations for estimating peak-flow characteristics for the Eastern Mountains Regions are listed in table 4. The independent variables determined to be most significant in this region were drainage area and mean March precipitation (fig. 9). For estimating peak flows with recurrence intervals of 2.33 years or less and 50 years or more, the site latitude was found to be significant. To resolve potential discontinuities in estimated peak flows over the range of recurrence intervals, latitude was included as an explanatory variable in all the equations. Values of SE_E ranged from 41 to 46 percent; SE_P ranged from 53 to 56 percent.

Mean precipitation for other winter months, as well as annual precipitation, were significant variables in equations for various recurrence intervals; however, March precipitation was the most significant. The uncertainties in the equations for the Eastern Mountains Regions compare favorably with results from previous investigations in and around Wyoming. Values of SE_E for equations developed by this study ranged

Table 4. *Equations for estimating peak-flow characteristics, Eastern Mountains Regions, Wyoming (Region 4)*

[SE_E, average standard error of estimate; SE_P, average standard error of prediction; Q_T, estimated peak flow, in cubic feet per second for recurrence interval of *T* years; *AREA*, total drainage area, in square miles; *MAR*, mean March precipitation, in inches; *LAT*, latitude of basin outlet location, in decimal degrees]

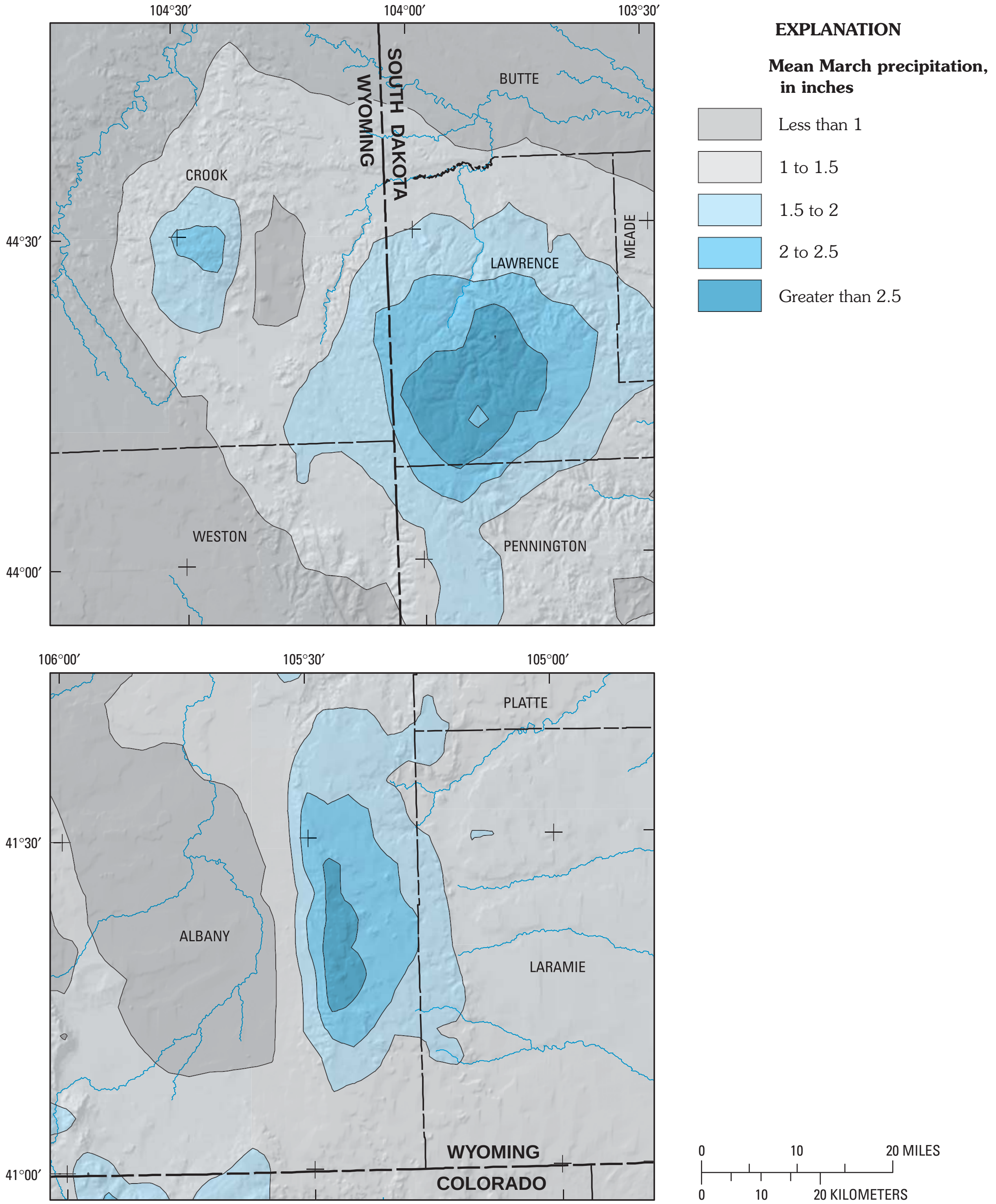
Equation	SE_E (percent)	SE_P (percent)	Average equivalent years of record	95-percent prediction interval factor	
				Lower limit	Upper limit
$Q_{1.5} = 4.27(AREA^{0.518})(MAR^{1.42})((LAT-40)^{-0.435})$	46	53	3.4	0.349	2.87
$Q_{2} = 6.26(AREA^{0.506})(MAR^{1.33})((LAT-40)^{-0.315})$	46	53	3.2	.348	2.87
$Q_{2.33} = 7.27(AREA^{0.503})(MAR^{1.30})((LAT-40)^{-0.262})$	46	53	3.3	.348	2.87
$Q_{5} = 12.2(AREA^{0.506})(MAR^{1.19})((LAT-40)^{-0.048})$	45	53	4.6	.346	2.89
$Q_{10} = 16.9(AREA^{0.518})(MAR^{1.12})((LAT-40)^{0.107})$	45	54	6.3	.345	2.90
$Q_{25} = 23.5(AREA^{0.536})(MAR^{1.05})((LAT-40)^{0.283})$	43	54	8.9	.345	2.90
$Q_{50} = 29.1(AREA^{0.549})(MAR^{1.01})((LAT-40)^{0.403})$	42	54	11.0	.344	2.91
$Q_{100} = 35.3(AREA^{0.562})(MAR^{0.963})((LAT-40)^{0.517})$	42	54	13.1	.342	2.92
$Q_{200} = 42.2(AREA^{0.573})((LAT-40)^{0.626})(MAR^{0.922})$	41	55	15.1	.339	2.95
$Q_{500} = 52.5(AREA^{0.585})((LAT-40)^{0.766})(MAR^{0.873})$	41	56	17.5	.332	3.01

from 13 to 35 percent less that those values for similar equations for the mountainous regions as a whole developed by Lowham (1988, p. 28). The values of SE_E were 44 to 58 percent less than those values for equations previously developed for the eastern mountains only by Lowham (1976, p. 22, Region 4). The uncertainties in the equations also compare favorably with those values for recent equations developed for the Black Hills of South Dakota (Sando, 1998, p. 17, “Subregion G”).

Overthrust Belt

Equations for estimating peak-flow characteristics for the Overthrust Belt Region (Region 5, fig. 7) are listed in table 5. The independent variable determined to be most significant in this region was drainage area. Mean January precipitation (fig. 10) was found to be significant for estimating peak flows with recurrence intervals of 25 years or less. To resolve potential discontinuities in estimated peak flows over the range of recurrence intervals, mean January precipitation was included as an explanatory variable in all the equations. Because mean January precipitation is marginally significant as an explanatory variable for estimating peak flows with recurrence intervals greater than 25 years, values of SE_P increased slightly (1 to 2 percent) when compared to equivalent equations with drainage area as the only explanatory variable. Values of SE_E ranged from 58 to 67 percent; SE_P ranged from 61 to 72 percent.

For equations for estimating peak flows for shorter recurrence intervals, mean precipitation data for other winter months were significant; however, mean January precipitation was the most significant. Mean annual precipitation was not significant for any equa-



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

Oregon Climate Service, 1998b

Figure 9. Mean March precipitation, Eastern Mountains Regions.

Table 5. *Equations for estimating peak-flow characteristics, Overthrust Belt Region, Wyoming (Region 5)*

[SE_E, average standard error of estimate; SE_P, average standard error of prediction; Q_T, estimated peak flow, in cubic feet per second for recurrence interval of *T* years; *AREA*, total drainage area, in square miles; *JAN*, mean January precipitation, in inches]

Equation	SE_E (percent)	SE_P (percent)	Average equivalent years of record	95-percent prediction interval factor	
				Lower limit	Upper limit
$Q_{1.5} = 2.08(AREA^{0.871})(JAN^{1.02})$	60	63	0.8	0.310	3.23
$Q_2 = 3.07(AREA^{0.869})(JAN^{0.884})$	58	61	.7	.317	3.15
$Q_{2.33} = 3.58(AREA^{0.868})(JAN^{0.831})$	58	61	.6	.319	3.13
$Q_5 = 6.19(AREA^{0.864})(JAN^{0.643})$	58	61	.8	.319	3.14
$Q_{10} = 8.71(AREA^{0.861})(JAN^{0.529})$	59	62	1.0	.313	3.19
$Q_{25} = 12.3(AREA^{0.857})(JAN^{0.415})$	61	64	1.2	.304	3.29
$Q_{50} = 15.2(AREA^{0.853})(JAN^{0.346})$	62	66	1.4	.296	3.38
$Q_{100} = 18.3(AREA^{0.850})(JAN^{0.287})$	64	68	1.6	.288	3.48
$Q_{200} = 21.6(AREA^{0.847})(JAN^{0.235})$	65	69	1.7	.280	3.57
$Q_{500} = 26.2(AREA^{0.842})(JAN^{0.176})$	67	72	1.9	.270	3.71

tions, with p-values much larger than the significance level ($\alpha = 0.05$). The uncertainties in the equations for the Overthrust Belt Region generally are larger than the uncertainties for equations previously developed. Values of SE_E for equations developed by this study ranged from 24 percent more to 18 percent less than those values for similar equations for the mountainous regions as a whole developed by Lowham (1988, p. 28). However, previous equations for estimating peak flows in these areas tend to yield values larger than expected.

High Desert

Equations for estimating peak-flow characteristics for the High Desert Region (Region 6, fig. 7) are listed in table 6. The independent variables determined to be most significant in this region were drainage area and site latitude. Values of SE_E ranged from 52 to 66 percent; SE_P ranged from 57 to 73 percent.

The uncertainties in the equations for the High Desert Region compare favorably with results from previous investigations in Wyoming. Values of SE_E for equations developed by this study ranged from 4 percent more to 10 percent less than those values for similar equations developed by Lowham (1988, p. 32). The largest improvements were in equations for estimating peak flows with shorter recurrence intervals. The geographic factor developed by Lowham (1988) was not required.

Limitations

Applications of the regional equations are limited by the hydrologic conditions and basin characteristics of the gaging stations used to define them. Anthropogenic developments—such as diversions for irrigation, regulation by reservoirs, and urbanization—alter natural hydrologic conditions and change the characteristics of annual peak flows. The equations were developed using annual peak flows from gaging stations on streams with little or no anthropogenic effects. For the

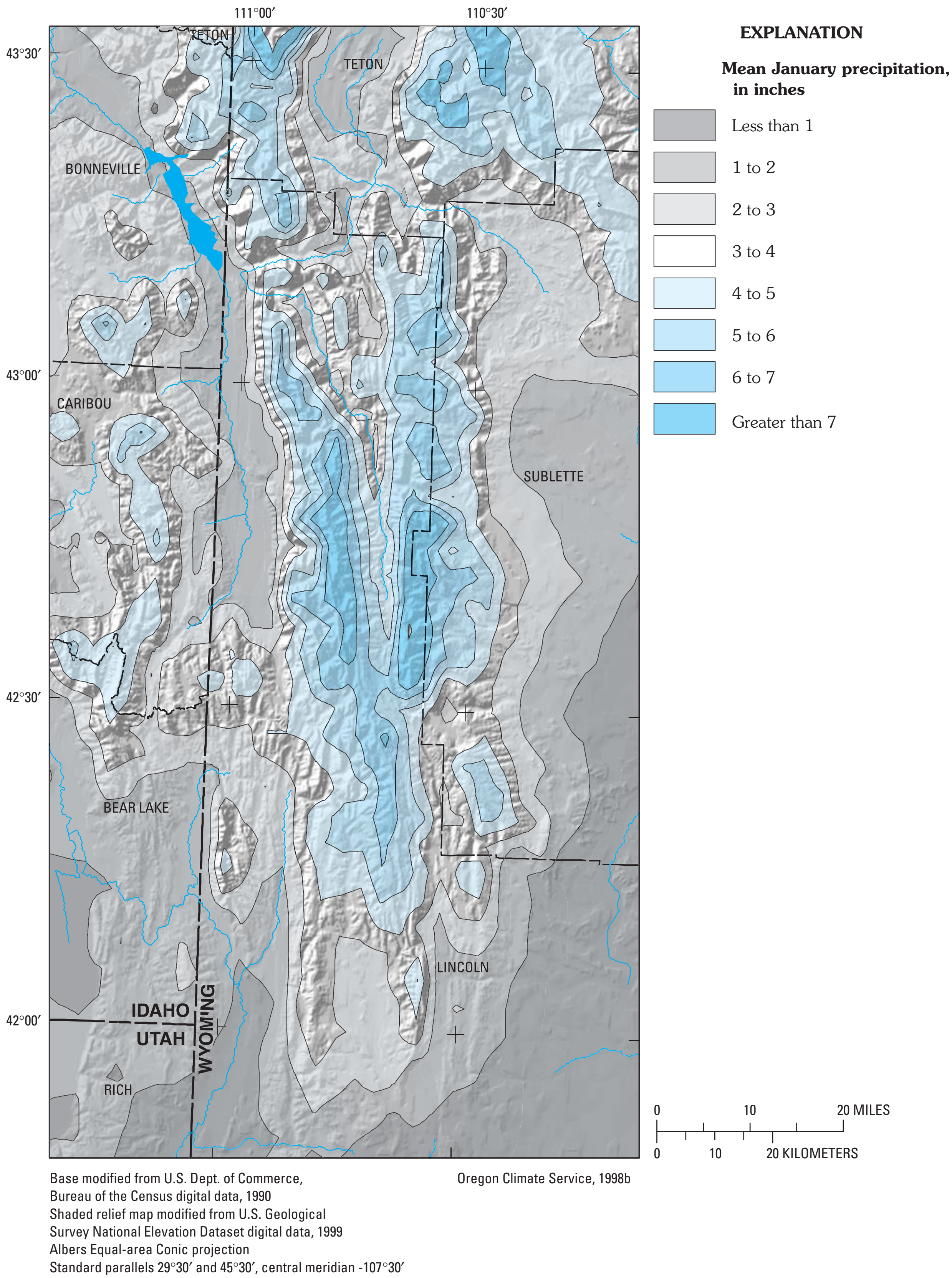


Figure 10. Mean January precipitation, Overthrust Belt Region.

Table 6. *Equations for estimating peak-flow characteristics, High Desert Region, Wyoming (Region 6)*

[SE_E, average standard error of estimate; SE_P, average standard error of prediction; Q_T, estimated peak flow, in cubic feet per second for recurrence interval of *T* years; *AREA*, total drainage area, in square miles; *LAT*, latitude of basin outlet location, in decimal degrees]

Equation	SE_E (percent)	SE_P (percent)	Average equivalent years of record	95-percent prediction interval factor	
				Lower limit	Upper limit
$Q_{1.5} = 12.7(AREA^{0.626})((LAT-40)^{-1.18})$	66	72	3.2	0.266	3.76
$Q_2 = 22.2(AREA^{0.608})((LAT-40)^{-1.24})$	60	66	3.2	.292	3.43
$Q_{2.33} = 28.1(AREA^{0.600})((LAT-40)^{-1.26})$	59	64	3.3	.301	3.32
$Q_5 = 66.4(AREA^{0.567})((LAT-40)^{-1.35})$	53	59	4.7	.328	3.05
$Q_{10} = 116(AREA^{0.544})((LAT-40)^{-1.40})$	52	57	6.4	.336	2.98
$Q_{25} = 204(AREA^{0.520})((LAT-40)^{-1.44})$	52	58	8.5	.331	3.02
$Q_{50} = 290(AREA^{0.504})((LAT-40)^{-1.46})$	53	60	9.7	.320	3.13
$Q_{100} = 394(AREA^{0.489})((LAT-40)^{-1.47})$	56	63	10.4	.304	3.29
$Q_{200} = 519(AREA^{0.476})((LAT-40)^{-1.48})$	59	67	10.9	.286	3.49
$Q_{500} = 719(AREA^{0.459})((LAT-40)^{-1.49})$	64	73	11.1	.261	3.83

few gaging stations on streams with some development, the effect on annual peak flows was negligible. Examples of negligible developments are small stock ponds or few irrigated acres, the areas of which total less than 5 percent of the gaging station drainage area. Thus, applications of the equations are limited to drainages with little or no development. Methods for estimating peak-flow characteristics for urban streams are described by Sauer and others (1983).

The delineation of hydrologic regions is not meant to imply absolute differences in the magnitudes of peak flows or abrupt changes in the environmental characteristics that affect peak flows. Rather, boundaries delineating regions represent the middle of transition zones between areas with similar hydrologic characteristics. Further, region boundaries in parts of the State are less well defined because of a lack of peak-flow data in those areas (for example, the headwaters of the Belle Fourche and Cheyenne River basins). Applications of the equations near region boundaries should be critically evaluated.

The regional equations were developed using regression techniques relating peak-flow characteristics to basin characteristics. Because the basin characteristics are relatively small samples of larger populations, it is likely that they do not define the entire range in values of those populations. Thus, the regional relations are defined for the ranges of values sampled. Application of the equations to ungaged sites with basin characteristics approaching the limits of the ranges in values might be subject to errors of unknown magnitudes[3] due to extrapolation beyond the limits of the combined data used to define the relations. The applicable ranges of basin characteristics by hydrologic region are listed in table 7.

[3] Values of SE_P for the equations increase for values of basin characteristics that are increasingly larger or smaller than the means of those basin characteristics used to define the equations. Thomas and others (1997, p.17) speculated these errors could be large.

Table 7. *Applicable ranges of basin characteristics for use in regional regression equations*

[--, not applicable]

Basin characteristics[1]	Hydrologic region: Rocky Mountains	Central Basins and Northern Plains	Eastern Basins and Eastern Plains	Eastern Mountains	Overthrust Belt	High Desert
Drainage area (square miles)	0.52 – 2,620	0.06 – 2,070	0.20 – 1,230	0.20 – 471	2.77 – 564	1.26 – 1,180
Mean basin elevation (feet)	5,950 – 10,700	--	--	--	--	--
Longitude (decimal degrees)	105.21 – 111.34	--	--	--	--	--
Mean basin soil hydrologic index (unitless)	--	--	2.1 – 4.0	--	--	--
Mean March precipitation[2] (inches)	--	--	--	.71 – 4.63	--	--
Latitude (decimal degrees)	--	--	--	40.54 – 44.57	--	41.02 – 42.59
Mean January precipitation[2] (inches)	--	--	--	--	.94 – 8.77	--

[1]Drainage area is total area upstream of site. Elevation, soils hydrologic index, and all precipitation characteristics are area-weighted averages. Longitude and latitude are basin outlet location.

[2]Mean precipitation characteristics based on 1961-90 averages (Oregon Climate Service, 1998a; 1998b).

The use of more than one explanatory variable in the regression equations complicates the definition of the range of values. For one explanatory variable, the range is easily defined by the minimum and maximum value used in the relation. For two variables, the range is defined by a two-dimensional “cloud” of values. Values of basin characteristics for an ungaged site could be within the range of values for the individual characteristics but not within the two-dimensional range of values. For example, a hypothetical watershed in the Rocky Mountains Regions might have a basin drainage area of 1 square mile and a mean basin elevation of 6,000 feet. These values are within the individual ranges of the independent variables used to define the regional equations; however, the values are not within the two-dimensional range of values (fig. 11). Relations developed from more than two independent variables would have similar multi-dimensional ranges for applicable values.

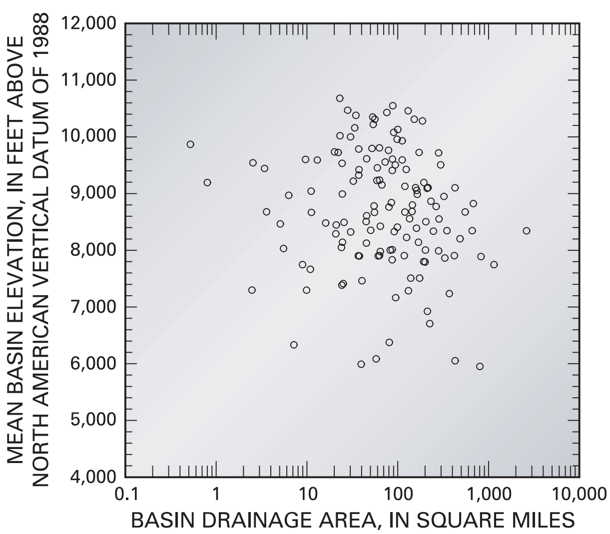


Figure 11. Joint distribution of mean basin elevation and basin drainage area for gaged sites in the Rocky Mountains Regions.

Regression equations developed for the mountainous areas of the State are not applicable for estimating the magnitude and recurrence of annual peak flows resulting from rainfall-only runoff. For most of the mountain ranges in Wyoming, large annual peak flows resulting only from rainfall are not frequent. Moderate to large rainfall-only events in the Eastern Mountains Regions—especially the Black Hills—have occurred. The magnitude of rainfall-only events in these regions might be underestimated by the regression equations. Previous studies have indicated similar regional regression equations for recurrence intervals greater than 100 years could underestimate peak flows by about 10 percent (Thomas and others, 1997, p. 74-75).

Annual peak-flow frequency relations for gaging stations in neighboring states used in this study might differ from relations determined for the same gaging stations used in other investigations. These differences are the result of the use of different regional skew relations, varying interpretations of historical data, and differences in the treatment of outliers. In some cases, a different period of record available for use at the time of the investigation might have resulted in different frequency relations.

APPLICATIONS

The regional regression equations can be used to estimate peak-flow characteristics for ungaged sites on ungaged streams with a drainage area located in one region, in two regions, or in Wyoming and an adjacent state. More accurate peak-flow characteristics for gaged sites can be estimated using the regional equations in combination with station frequency analyses. Gaging-station data can be used to more accurately estimate peak-flow characteristics at an ungaged site on the same stream.

Basin characteristics for an ungaged site required in the regional regression equations can be computed using a GIS and tools like those developed by Viger and others (1998). Digital spatial data for computing the required basin characteristics are publicly accessible (see previous *Basin Characteristics* section and following section for sources). Drainage area is the total area within the basin. Basin elevation, soils hydrologic index, and precipitation characteristics should be computed as area-weighted averages. Latitude and longitude are the location of the ungaged site. In the absence of GIS computer resources, other methods (for example, Lowham, 1988; Thomas and others, 1997) can be used as follows.

1. Drainage area (AREA) can be determined by planimetering or digitizing the total basin area in square miles on the largest-scale topographic map available.

2. Mean basin elevation (ELEV) can be determined by placing a transparent equal-cell grid over the drainage area on the largest-scale topographic map available. The elevation value in feet of a minimum of 25 equally-spaced grid intersections are summed and divided by the number of points to determine ELEV.
3. Soils hydrologic index (SOIL) can be determined by placing a transparent equal-cell grid over the drainage area in plate 2. The soils hydrologic index value of several equally-spaced grid intersections are summed and divided by the number of points to determine SOIL. The number of intersections used is limited in practice by the size of the drainage area and the scale of plate 2.
4. Mean March precipitation (MAR, fig. 9) or mean January precipitation (JAN, fig. 10) can be determined by placing a transparent equal-cell grid over the drainage area in the figure. The precipitation value in inches of several equally-spaced grid intersections are summed and divided by the number of points to determine the precipitation characteristic of interest. The number of intersections used is limited in practice by the size of the drainage area and the scale of figures 9 and 10.
5. Latitude (LAT) and longitude (LNG) can be determined by scaling or digitizing the location of the ungaged site in decimal degrees on the largest-scale topographic map available.

Ungaged Site on an Ungaged Stream in One Region

The regression equations listed in tables 1 through 6 can be used directly to estimate peak-flow characteristics for an ungaged site on an ungaged stream with a drainage area located entirely within a single region. The appropriate equations are determined by locating the drainage area of the ungaged site on plate 1 and noting the region. Values for the required basin characteristics are substituted in the regional equation and the magnitude of the annual peak-flow frequency of interest can be calculated.

Example: Estimate the 100-year peak flow for Murphy Creek at Interstate 25 near Kaycee, Wyoming. The drainage area for the site is located entirely within the Eastern Basins and Eastern Plains Region (Region 3) (fig. 7 and plate 1). The equations for Region 3 require the basin characteristics drainage area and soils hydrologic index. The drainage area for the site is 49 square miles. The area-weighted average soils hydrologic index is 3.5. The values for drainage area and soils hydrologic index are within the two-dimensional range of variables used to define the equations for Region 3. From the equation for Q_{100} in table 3, the estimated 100-year peak flow is

$$Q_{100} = 127(49^{0.432})(3.5^{2.05}) = 8{,}900 \text{ ft}^3/\text{sec}.$$

From table 3, the 95-percent prediction interval for the estimated 100-year peak flow is from

8,900 x 0.382 = 3,400 ft^3/sec to

8,900 x 2.62 = 23,000 ft^3/sec.

Ungaged Site on an Ungaged Stream in Two Regions

For an ungaged site on an ungaged stream with a drainage area located in two regions, peak-flow characteristics are estimated by using regression equations from both regions. The required basin characteristics are computed for those parts of the total drainage within each region. Values for the required basin characteristics are substituted in the appropriate regional equations and the magnitude of the annual peak flow for the frequency of interest is calculated for each region using the total drainage area. The results from the two regions are averaged using an area-weighted approach as described in the following equation (for example, Sando, 1998):

$$Q_{TU} = Q_{TR_i}\left(\frac{A_i}{A}\right) + Q_{TR_{ii}}\left(\frac{A_{ii}}{A}\right) \qquad (3)$$

where

Q_{TU} = peak flow, in cubic feet per second, for a recurrence interval of *T* years, for the ungaged site;

Q_{TR_i} = peak flow, in cubic feet per second, for a recurrence interval of *T* years, from regression equation for region *i*;

A_i = drainage area, in square miles, for that part of the ungaged site total drainage area within region *i*;

A = total drainage area, in square miles, for the ungaged site;

$Q_{TR_{ii}}$ = peak flow, in cubic feet per second, for a recurrence interval of *T* years, from regression equation for region *ii*; and

A_{ii} = drainage area, in square miles, for that part of the ungaged site total drainage area within region *ii*.

Example: Estimate the 25-year peak flow for North Fork Crazy Woman Creek near the confluence with Middle Fork Crazy Woman Creek near Buffalo, Wyoming. The drainage area for the site is located in both the Rocky Mountains Regions (Region 1) and the Eastern Basins and Eastern Plains Region (Region 3) (fig. 7 and plate 1). The equations for Region 1 require the basin characteristics drainage area, mean basin elevation, and longitude. The equations for Region 3 require drainage area and soils hydrologic index. The total drainage area for the site is about 170 square miles, with about 120 square miles in Region 1 and about 50 square miles in Region 3. The area-weighted average basin elevation for the drainage area in Region 1 is about 7,300 feet above NAVD 88. The longitude for a site on the region boundary is about 106.8 degrees. The area-weighted soils hydrologic index for the area in Region 3 is about 2.9. From the equation for Q_{25} in table 1, the estimated 25-year peak flow for Region 1 is

$$Q_{25} = 12.1(170^{0.790})\left(\left(\frac{7{,}300\text{-}3{,}000}{1{,}000}\right)^{1.34}\right)$$
$$((106.8-100)^{-0.451}) = 2{,}080 \text{ ft}^3/\text{sec.}$$

From the equation for Q_{25} in table 3, the estimated 25-year peak flow for Region 3 is

$$Q_{25} = 48.8(170^{0.416})(2.9^{2.27}) = 4{,}630 \text{ ft}^3/\text{sec.}$$

The final area-weighted estimate for the 25-year peak flow using equation 3 is

$$Q_{25} = 2{,}080\left(\frac{120}{170}\right) + 4{,}630\left(\frac{50}{170}\right) = 2{,}800 \text{ ft}^3/\text{sec.}$$

Equation 3 also can be used to estimate peak-flow characteristics for an ungaged site on an ungaged stream where part of the drainage area is in Wyoming (region *i*) and the remainder in an adjacent state (region *ii*). Methods for estimating peak-flow characteristics in adjacent states are described for Montana (Omang, 1992), South Dakota (Sando, 1998), Nebraska (Soenksen and others,1999), Colorado (Vaill, 2000), and Utah and Idaho (Thomas and others, 1997).

Gaged Site

Regional regression equations can be used to improve peak-flow frequency analyses at gaging stations. For any given frequency, a weighted average of the magnitudes determined from the regional equation plus the gaging station frequency analysis generally results in a better estimate of the peak-flow magnitude at a gaged site with a short period of record. For sites located in the mountainous areas of Wyoming, periods of record less than about 15 years are considered short; for the plains and basins of the State, records less than about 25 years are considered short (Wahl, 1970; S.A. Druse and K.L. Wahl, U.S. Geological Survey, written commun., 1974; Lowham, 1988).

Weighted average peak-flow characteristics can be computed with the following equation (Sando, 1998):

$$Q_{TW} = \frac{nQ_{TS} + enQ_{TR}}{n + en} \tag{4}$$

where

Q_{TW} = weighted peak flow, in cubic feet per second, for recurrence interval of *T* years;

n = number of annual peaks used to compute Q_{TS};

Q_{TS} = gaging station peak flow, in cubic feet per second, for recurrence interval of *T* years, determined from the gaging station peak-flow frequency analysis;

en = average equivalent years of record for Q_{TR} (tables 1-6); and

Q_{TR} = peak flow, in cubic feet per second, for recurrence interval of *T* years from regional regression equation.

The average equivalent years of record are a measure of the predictive accuracy of the regression equation (Hardison, 1971). The measure represents the average number of years of record required at a gaging station that would result in a frequency analysis of equal accuracy to that of the regional equation. The number of annual peak flows for each gaging station is listed in table 11 (in the Supplemental Information section at the back of report). The average equivalent years of record for each equation are listed in tables 1-6.

Example: Compute a weighted estimate of the 50-year peak flow for USGS gaging station 06301480 Coney Creek above Twin Lakes near Big Horn, Wyoming (map number 105). The drainage area for the site is located entirely within the Rocky Mountains Regions (Region 1) (fig. 7 and plate 1). The equations for Region 1 require the basin characteristics drainage area, mean basin elevation, and longitude. From table 10, the drainage area for the site is 3.41 square miles, the area-weighted average basin elevation is 9,440 feet above NAVD 88, and the longitude is about 107.32 degrees (NAD 83). From the equation for Q_{50} in table 1, the estimated 50-year peak flow for Region 1 is

$$Q_{50} = 22.3(3.41^{0.776})\left(\left(\frac{9{,}440 - 3{,}000}{1{,}000}\right)^{1.16}\right)$$
$$((107.32 - 100)^{-0.510}) = 182 \text{ ft}^3/\text{sec}.$$

From table 11, the estimated 50-year peak flow from the station frequency analysis is 147 cubic feet per second and the number of annual peak flows is 10. From table 1, the average equivalent years of record for the equation for estimating the 50-year peak flow is 6.3. The regional-weighted estimate for the 50-year peak flow using equation 4 is

$$Q_{50} = \frac{10(147) + 6.3(182)}{10 + 6.3} = 160 \text{ ft}^3/\text{sec}.$$

Ungaged Site near a Gaging Station on the Same Stream in One Region

Gaging-station peak-flow characteristics can be used to more accurately estimate peak-flow characteristics for an ungaged site on the same stream in one region. If the drainage area of the gaging station is within about 75 to 150 percent of the drainage area for the ungaged site, the magnitude of the peak flow for the frequency of interest can be calculated using a ratio of the drainage areas (Sando, 1998). Otherwise, peak-flow characteristics can be estimated as previously described for an ungaged site on an ungaged stream. A weighted peak-flow estimate for the gaged site and the drainage area of the ungaged site is required. These values are substituted in the following equation:

$$Q_{TU} = Q_{TW}\left(\frac{A_u}{A_g}\right)^{x_T} \qquad (5)$$

where

- Q_{TU} = peak flow, in cubic feet per second, for a recurrence interval of *T* years, for the ungaged site;
- Q_{TW} = weighted peak flow, in cubic feet per second, for recurrence interval of *T* years, for the gaging station determined from equation 4 (see previous discussion in *Gaged Site* section);
- A_u = drainage area, in square miles, for the ungaged site;
- A_g = drainage area, in square miles, for the gaging station; and
- x_T = exponent for region, for a recurrence interval of *T* years (table 8).

Example: Estimate the 100-year peak flow for Poison Creek near Moneta, Wyoming. U.S. Geological Survey streamflow-gaging station 06255500 Poison Creek near Shoshoni, Wyoming (map number 50) is located downstream from the ungaged site. The drainage area for USGS 06255500 is 500 square miles (table 10). The drainage area for the ungaged site, about 380 square miles, is within 75 percent of the drainage area for the gaged site. The drainage area for Poison Creek is located entirely within the Central Basins and Northern Plains Region (Region 2) (fig. 7 and plate 1). Drainage area is the only required basin characteristic in equations for Region 2. From the equation for Q_{100} in table 2, the estimated 100-year peak flow for USGS 06255500 is

$$Q_{100} = 415(500^{0.430}) = 6{,}000 \text{ ft}^3/\text{sec}$$

Table 8. *Exponents for drainage-area ratio in equation for estimating peak-flow characteristics at an ungaged site near a gaging station on the same stream in one region*

Hydrologic region	Exponent for recurrence interval of *T* years									
	1.5	2	2.33	5	10	25	50	100	200	500
Rocky Mountains	0.885	0.866	0.858	0.829	0.810	0.790	0.776	0.764	0.752	0.738
Central Basins and Northern Plains	.486	.475	.470	.455	.447	.439	.434	.430	.427	.425
Eastern Basins and Eastern Plains	.401	.402	.403	.407	.410	.416	.423	.432	.441	.454
Eastern Mountains	.518	.506	.503	.506	.518	.536	.549	.562	.573	.585
Overthrust Belt	.871	.869	.868	.864	.861	.857	.853	.850	.847	.842
High Desert	.626	.608	.600	.567	.544	.520	.504	.489	.476	.459

From table 11, the estimated 100-year peak flow from the gaging station frequency analysis is 18,200 cubic feet per second and the number of annual peak flows is 15. From table 2, the average equivalent years of record for the equation for estimating the 100-year peak flow is 16.9. The regional-weighted estimate for the 100-year peak flow for USGS 06255500 using equation 4 is

$$Q_{100} = \frac{15(18{,}200) + 16.9(6{,}000)}{15 + 16.9}$$
$$= 11{,}700 \text{ ft}^3/\text{sec.}$$

From table 8, the exponent for the drainage-area ratio is 0.430. The estimated 100-year peak flow for the ungaged site using equation 5 is

$$Q_{100} = 11{,}700\left(\frac{380}{500}\right)^{0.430} = 10{,}000 \text{ ft}^3/\text{sec.}$$

Ungaged Site between Two Gaging Stations on the Same Stream

Peak-flow characteristics for an ungaged site between two gaging stations on the same stream can be estimated using an extension of the approach in the previous section. Initial estimates of the peak-flow magnitude for the frequency of interest are calculated twice—once for each gaging station—using the drainage-area ratio equation (see equation 5, previously described in the *Ungaged Site near a Gaging Station on the Same Stream in One Region* section). The drainage area for both gaging stations should be within about 75 to 150 percent of the drainage area for the ungaged site. If one or both of the gaging-station drainage areas do not meet this requirement, peak-flow characteristics can be estimated as previously described for either an ungaged site near a gaging station on the same stream or for an ungaged site on an ungaged stream as appropriate. The logarithms of the initial estimates are computed and averaged to calculate the final estimate of peak flow using the following equation (Sando, 1998):

$$\log Q_{TU} = \frac{[\log(Q_{TUi}) + \log(Q_{TUii})]}{2} \qquad (6)$$

where

Q_{TU} = average peak flow, in cubic feet per second, for a recurrence interval of *T* years, for the ungaged site;

Q_{TUi} = peak flow, in cubic feet per second, for a recurrence interval of *T* years, for the ungaged site, determined from equation 5 for gaging station *i*; and

Q_{TUii} = peak flow, in cubic feet per second, for a recurrence interval of *T* years, for the ungaged site, determined from equation 5 for gaging station *ii*.

The final estimate is determined by calculating the antilogarithm of $\log Q_{TU}$. An example is not provided because most of the calculations duplicate those described in previous examples.

SUMMARY

Peak-flow characteristics are essential for addressing various water resources issues in Wyoming. Characteristics of peak flows often are expressed as discharges with discrete probabilities—or frequencies—of occurrence. Regression equations relating peak-flow frequencies to selected basin characteristics can be developed for groups of streamflow-gaging stations. Regional relations for estimating peak-flow characteristics for Wyoming streams require periodic evaluation and update. The purpose of this report is to describe (1) updated peak-flow frequency analyses for selected streamflow-gaging stations in Wyoming, and (2) revised methods for estimating peak-flow characteristics for unregulated, non-urban streams in Wyoming. Analyses described in this report are based on 364 continuous- and partial-record streamflow-gaging stations selected in Wyoming or within about 50 miles of the State. Instantaneous peak-flow data through water year 2000 were included in the frequency analyses. These data represent up to 15 years of additional peak-flow data and 65 additional gaging stations not used in previous regional peak-flow analyses.

Wyoming is located in the western United States on the edges of the Great Plains and the Rocky Mountains. Diverse physiographic characteristics and regional climatic patterns combine to create environmental conditions that influence the peak-flow characteristics of Wyoming streams. The most influential of these combinations are the mountain ranges of the State and two different continental-scale precipitation sources.

Peak flows in Wyoming streams are the result of runoff from snowmelt and rainfall. Mountain streamflows are dominated by a single snowmelt peak of moderate duration during late spring or early summer. Variability in these peaks is small because variability in the aerial and annual accumulations of snow is small. Flows of streams originating in the basin or plains areas often consist of multiple peaks in any given year: a lowland snowmelt peak of moderate duration occurring late winter or early spring and several rainstorm peaks of short duration occurring late spring through late summer. Because of the localized extent and annual variability of these storms, the resulting flows in any given watershed are variable between years.

Digital data describing hydrologically relevant physical and climatic properties were compiled from various sources. Basin characteristics for each peak-flow gaging station used in the study were determined from those digital data using a geographic information system (GIS) and a suite of tools developed for the GIS. Those values were compared to previously published data where available. Differences in the data were resolved.

Frequency analyses were completed in accordance with recommended methods described in Bulletin 17-B of the Hydrology Subcommittee of the Office of Water Data Coordination, Interagency Advisory Committee on Water Data (IACWD). Frequency relations for each gaging station were determined by fitting the logarithms of the annual peak-flow series to the Pearson Type III (LPIII) probability distribution using three parameters: the mean, the standard deviation, and the skew of the logarithms. Historical peak flows were used to adjust the LPIII frequency analyses at 38 gaging stations where those data were available. LPIII frequency analyses were adjusted for annual peak-flow records that included peak flows below a base discharge. The annual peak-flow series were evaluated for temporal trends. The generalized skew relations as defined by the IACWD were used for the annual peak-flow frequency analyses in this study.

Wyoming was divided into six hydrologic regions for this study based on similarities in peak-flow characteristics and the environmental factors that influence them. The six hydrologic regions in this study were delineated using a two-tiered approach similar to those used in previous investigations. The Rocky Mountains Regions incorporate most of the mountainous areas of Wyoming, including all of the ranges in northwestern Wyoming, the Wind River Range, the Bighorn Mountains, the northern Laramie Mountains, the Sierra Madre, the Snowy Range, and the Wasatch Range. The Central Basins and Northern Plains Region include the Bighorn Basin and the plains of northeastern Wyoming. The Eastern Basins and Eastern Plains Region includes most of the lower elevation parts of the Powder River basin, parts of the upper Cheyenne River basin, the middle and lower North Platte River basin, and the High Plains. The Eastern Mountains Regions include the Black Hills and the southern Laramie Mountains. The Overthrust Belt Region includes the ranges of western Wyoming mostly located within Lincoln County and western Sublette County. The High Desert Region includes the plains and desert areas of south-central and southwestern Wyoming.

Relations between the magnitudes of annual peak flows for selected recurrence intervals and basin characteristics were explored for each hydrologic region using ordinary least squares (OLS) and weighted least squares (WLS) multiple-regression techniques. The explanatory variables were evaluated to determine the basin characteristic or combination of characteristics that provided the best model for estimating peak flows in a region for a given recurrence interval. Final regional equations relating annual peak-flow magnitudes for selected recurrence intervals to significant basin characteristics as determined by the best WLS model were developed using generalized least squares (GLS) regression. The GLS regression procedure accounts for two assumptions commonly violated by application of the OLS regression approach to regional regression analyses of annual peak flows at gaging stations. To account for between-site cross correlations and unequal variances in annual peak flows, regional regression models developed using the GLS approach incorporate a covariance weighting matrix.

Equations for estimating peak-flow characteristics for the Rocky Mountains Regions were developed using drainage area, mean elevation, and site longitude. Values of the average standard error of estimate (SE_E) ranged from 34 to 55 percent. Equations for estimating peak flows for the Central Basins and Northern Plains Region were developed using drainage area. Values of SE_E ranged from 54 to 131 percent. Equations for estimating peak flows for the Eastern Basins and Eastern

Plains Region were developed using drainage area and soils hydrologic index. Values of SE_E ranged from 43 to 122 percent. Equations for estimating peak flows for the Eastern Mountains Regions were developed using drainage area, mean March precipitation, and site latitude. Values of SE_E ranged from 41 to 46 percent. Equations for estimating peak flows for the Overthrust Belt Region were developed using drainage area and mean January precipitation. Values of SE_E ranged from 58 to 67 percent. Equations for estimating peak flows for the High Desert Region were developed using drainage area and site latitude. Values of SE_E ranged from 52 to 66 percent.

Applications of the regional equations are limited by the hydrologic conditions and basin characteristics of the gaging stations used to define them. Applications of the equations are limited to drainages with little or no development. Application of the equations to ungaged sites with basin characteristics approaching the limits of the ranges in values might be subject to errors of unknown magnitudes due to extrapolation beyond the limits of the combined data used to define the relations. Regression equations developed for the mountainous areas of the State are not applicable for estimating the magnitude and recurrence of annual peak flows resulting from rainfall-only runoff.

The regional regression equations can be used to estimate peak-flow characteristics for ungaged sites on ungaged streams with drainage areas located in one region, in two regions, or in Wyoming and an adjacent State. More accurate peak-flow characteristics for gaged sites can be estimated using the regional equations in combination with gaging station frequency analyses. Gaging-station data can be used to more accurately estimate peak-flow characteristics at an ungaged site on the same stream.

SELECTED REFERENCES

Benson, M.A., 1962, Evolution of methods for evaluating the occurrence of floods: U.S. Geological Survey Water-Supply Paper 1580-A, p. A1-A30.

_____1964, Factors affecting the occurrence of floods in the Southwest: U.S. Geological Survey Water-Supply Paper 1580-D, p. D1-D72, 1 plate.

Benson, R.D., Lytle, W.F., Smith, R.D., and Dvorak, D.E., 1991, South Dakota floods and droughts, *in* Paulson, R.W., Chase, E.B., Roberts, R.S., and Moody, D.W., comp., National water summary 1988-89, Hydrologic events and floods and droughts: U.S. Geological Survey Water-Supply Paper 2375, p. 497-504.

Berwick, V.K., 1962, Floods in Utah—Magnitude and frequency: U.S. Geological Survey Circular 457, 24 p.

Buchanan, T.J., and Somers, W.P., 1968, Stage measurement at gaging stations: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. A7, 28 p.

Burr, M.J., and Korkow, K.L., 1996, Peak-flow frequency estimates through 1994 for gaged streams in South Dakota: U.S. Geological Survey Open-File Report 96-202, 407 p.

Carter, J.R., and Green, A.R., 1963, Floods in Wyoming—Magnitude and frequency: U.S. Geological Survey Circular 478, 27 p.

Chow, V.T., Maidment, D.R., and Mays, L.W., 1988, Applied hydrology: New York, McGraw-Hill, Inc., 572 p.

Cooley, M.E., 1990, Use of paleoflood investigations to improve flood-frequency analyses of plains streams in Wyoming: U.S. Geological Survey Water-Resources Investigations Report 88-4209, 75 p.

Craig, G.S., Jr., and Rankl, J.G., 1978, Analysis of runoff from small drainage basins in Wyoming: U.S. Geological Survey Water-Supply Paper 2056, 70 p.

Crippen, J.R., 1978, Composite log-type III frequency-magnitude curve of annual floods: U.S. Geological Survey Open-File Report 78-352, 4 p.

Dalrymple, Tate, 1960, Flood-frequency analyses, *in* Manual of Hydrology—Part 3. Flood-flow techniques: U.S. Geological Survey Water-Supply Paper 1543-A, p. 1-80.

Daly, C., Neilson, R.P., and Phillips, D.L., 1994, A statistical-topographic model for mapping climatological precipitation over mountainous terrain: Journal of Applied Meteorology, v. 33, p. 140-158.

Druse, S.A., 1991, Wyoming floods and droughts, *in* Paulson, R.W., Chase, E.B., Roberts, R.S., and Moody, D.W., comp., National water summary 1988-89, Hydrologic events and floods and droughts: U.S. Geological Survey Water-Supply Paper 2375, p. 575-582.

Druse, S.A., Lowham, H.W., Cooley, M.E., and Wacker, A.M., 1988, Floodflow characteristics of Wyoming streams—A compilation of previous investigations: Cheyenne, Wyoming, Wyoming Highway Department, variable pagination.

Fenneman, N.M., and Johnson, D.W., 1946, Physical divisions of the United States: U.S. Geological Survey map, scale 1:7,000,000.

Hardison, C.H., 1969, Accuracy of streamflow characteristics, *in* Geological Survey research 1969: U.S. Geological Survey Professional Paper 650-D, p. D210-D214.

_____1971, Prediction error of regression estimates of streamflow characteristics at ungaged sites, *in* Geological Survey research 1971: U.S. Geological Survey Professional Paper 750-C, p. C228-C236.

Helsel, D.R., and Hirsch, R.M., 1992, Statistical methods in water resources: New York, Elsevier Science Publishers, 522 p.

Hirsch, R.M., Slack, J.R., and Smith, R.A., 1982, Techniques of trend analysis for monthly water quality data: Water Resources Research, v. 18, no. 1, p. 107-121.

Hodge, S.A., and Tasker, G.D., 1995, Magnitude and frequency of floods in Arkansas: U.S. Geological Survey Water-Resources Investigations Report 95-4224, 52 p., 4 appendices.

Interagency Advisory Committee on Water Data, 1982, Guidelines for determining flood flow frequency—Bulletin 17-B of the Hydrology Subcommittee: Reston, Virginia, U.S. Geological Survey, Office of Water Data Coordination, 183 p.

Larimer, O.J., 1973, Flood of June 9-10, 1972, at Rapid City, South Dakota: U.S. Geological Survey Hydrologic Investigations Atlas HA-511, scale 1:18,000.

Lowham, H.W., 1976, Techniques for estimating flow characteristics of Wyoming streams: U.S. Geological Survey Water-Resources Investigations Report 76-112, 83 p.

_____1988, Streamflows in Wyoming: U.S. Geological Survey Water-Resources Investigations Report 88-4045, 78 p.

Martner, B.E., 1986, Wyoming climate atlas: Lincoln, Nebraska, University of Nebraska Press, 432 p.

Miller, K.A., 1999, Surface water, *in* Zelt, R.B., and others, Environmental setting of the Yellowstone River Basin, Montana, North Dakota, and Wyoming: U.S. Geological Survey Water-Resources Investigations Report 98-4269, 112 p.

Miselis, D.V., Wesche, T.A., and Lowham, H.W., 1999, Development of hydrologic models for estimating streamflow characteristics of Wyoming's mountainous basins: Laramie, Wyoming, Project Completion Report submitted to the University of Wyoming Research Office, variable pagination.

Omang, R.J., 1992, Analysis of the magnitude and frequency of floods and the peak-flow gaging network in Montana: U.S. Geological Survey Water-Resources Investigations Report 92-4048, 70 p.

Oregon Climate Service, 1998a, Western U.S. average annual precipitation, 1961-90: Corvallis, Oregon State University, Oregon Climate Service, digital data, online version accessed September 25, 2000, at url ***http://www.ocs.orst.edu/prism/state_products/west_maps.html***

Oregon Climate Service, 1998b, Western U.S. average monthly precipitation, 1961-90: Corvallis, Oregon State University, Oregon Climate Service, digital data, online version accessed November 25, 2001, at url ***http://www.ocs.orst.edu/prism/state_products/west_maps.html***

Patterson, J.L., and Somers, W.P., 1966, Magnitude and frequency of floods in the United States, Part 9, Colorado River Basin: U.S. Geological Survey Water-Supply Paper 1683, 475 p.

Perry, C.A., Aldridge, B.N., and Ross, H.C., 2001, Summary of significant floods in the United States, Puerto Rico, and the Virgin Islands, 1970 through 1989: U.S. Geological Survey Water-Supply Paper 2502, 598 p.

Riggs, H.C., 1968, Some statistical tools in hydrology: U.S. Geological Survey Techniques of Water-Resources Investigations, book 4, chap. A1, 39 p.

Sando, S.K., 1998, Techniques for estimating peak-flow magnitude and frequency relations for South Dakota streams: U.S. Geological Survey Water-Resources Investigations Report 98-4055, 48 p.

Sauer, V.B., 1974, Flood characteristics of Oklahoma streams: U.S. Geological Survey Water-Resources Investigations Report 52-73, 301 p.

Sauer, V.B., Thomas, W.O., Stricker, V.A., and Wilson, K.V., 1983, Flood characteristics of urban watersheds in the United States: U.S. Geological Survey Water-Supply Paper 2207, 63 p.

Schwarz, F.K., Hughes, L.A., Hansen, E.M., and others, 1975, The Black Hills-Rapid City flood of June 9-10, 1972—A description of the storm and flood: U.S. Geological Survey Professional Paper 877, 45 p.

Schwarz, G.E. and Alexander, R.B, 1995, State Soil Geographic (STATSGO) Data Base for the Conterminous United States: U.S. Geological Survey Open-File Report 95-449, digital map, scale 1:250,000, online version accessed November 15, 2001, url ***http://water.usgs.gov/lookup/getspatial?ussoils***

Soenksen, P.J., Miller, L.D., Sharpe, J.B., and Watton, J.R., 1999, Peak-flow frequency relations and evaluation of the peak-flow gaging network in Nebraska: U.S. Geological Survey Water-Resources Investigations Report 99-4032, 47 p., 3 appendices.

Statware, Inc., 1990, Statit user's guide, release 2.3x (software version 3.0o, revision 9.0.0, July 11, 1996): Corvallis, Oregon, Statware, Inc., variable pagination.

Stedinger, J.R., and Tasker, G.D., 1985, Regional hydrologic analysis 1—Ordinary, weighted, and generalized least squares compared: Water Resources Research, v. 21, no. 9, p. 1421-1432.

Swanson, R.B., Smalley, M.L., Woodruff, R.E., and Clark, M.L., 2001, Water resources data, Wyoming, water year 2000, Volume 1—Surface-water data: U.S. Geological Survey Water Data Report WY-00-1, 525 p.

Tasker, G.D., 1978, Flood frequency analysis with a generalized skew coefficient: Water Resources Research, v. 14, no. 2, p. 373-376.

Tasker, G.D., Eychaner, J.H., and Stedinger, J.R., 1987, Application of generalized least squares in regional hydrologic regression analysis, *in* Subitzky, Seymour, editor, Selected papers in the hydrologic sciences, 1986: U.S. Geological Survey Water-Supply Paper 2310, p. 107-115.

Tasker, G.D., Flynn, K.M., Lumb, A.M., and Thomas, W.O., Jr., 1995, Hydrologic regression and network analysis using program GLSNET: U.S. Geological Survey computer program, online version accessed July, 2000 at url ***http://water.usgs.gov/software/glsnet.html***

Tasker, G.D., Hodge, S.A., and Barks, C.S., 1996, Region of influence regression for estimating the 50-year flood at ungaged sites: Water Resources Bulletin, vol. 32., no.1, p. 163-170.

Tasker, G.D., and Stedinger, J.R., 1986, Regional skew with weighted LS regression: Journal of Water Resources Planning, vol. 112, no. 2, p. 225-237.

_____1989, An operational GLS model for hydrologic regression: Journal of Hydrology, v. 111, p. 361-375.

Thomas, B.E., Hjalmarson, H.W., and Waltemeyer, S.D., 1997, Methods for estimating magnitude and frequency of floods in the southwestern United States: U.S. Geological Survey Water-Supply Paper 2433, 195 p.

Thomas, C.A., Broom, H.C., and Cummans, J.E., 1963, Magnitude and frequency of floods in the United States—Part 13, Snake River Basin: U.S. Geological Survey Water-Supply Paper 1688, 25 p., 5 plates.

Thomas, D.M., and Benson, M.A., 1970, Generalization of streamflow characteristics from drainage basin characteristics: U.S. Geological Survey Water-Supply Paper 1975, 55 p.

Thomas, W.O., Jr., Lumb, A.M., Flynn, K.M., and Kirby, W.H., 1998, Users manual for program PEAKFQ, annual flood frequency analysis using Bulletin 17B guidelines: U.S. Geological Survey, accessed June 6, 2001, at url ***http://water.usgs.gov/software/peakfq.html***

U.S. Geological Survey, 1987, New procedures for hydrologic regression and network analysis using generalized least squares: Office of Surface Water Technical Memorandum No. 87.08, accessed May 15, 2003, ***http://water.usgs.gov/admin/memo/SW/sw87.08.html***

_____1999, National Elevation Database (NED): Sioux Falls, South Dakota, U.S. Geological Survey digital data.

Vaill, J.E., 2000, Analysis of the magnitude and frequency of floods in Colorado: U.S. Geological Survey Water-Resources Investigations Report 99-4190, 35 p.

Viger, R.J., Markstrom, S.L., and Leavesley, G.H., 1998, The GIS Weasel—An interface for the treatment of spatial information used in watershed modeling and water resource management, *in* Proceedings of the First Federal Interagency Hydrologic Modeling Conference, April 19-23, 1998, Las Vegas, Nevada, v. II, chap. 7, p. 73-80.

Wahl, K.L, 1970, A proposed streamflow data program for Wyoming: U.S. Geological Survey open-file report, 44 p.

_____1977, Accuracy of channel measurements and the implications in estimating streamflow characteristics: U.S. Geological Survey Journal of Research, v. 5, no. 6, p. 811-814.

_____1984, Evolution of the use of channel cross-section properties for estimating streamflow characteristics, *in* Meyer, E.L., ed., Selected papers in the hydrologic sciences, 1984: U.S. Geological Survey Water-Supply Paper 2262, p. 53-66.

_____1998, Sensitivity of non-parametric trend analyses to multi-year extremes: Proceedings of the Annual Meeting of the Western Snow Conference, Snowbird, Utah, 1998, p. 157-160.

SUPPLEMENTAL INFORMATION

Table 9. *Streamflow-gaging stations used in study, Wyoming and surrounding states*

[CO, Colorado; ID, Idaho; MT, Montana; NE, Nebraska; SD, South Dakota; UT, Utah; WY, Wyoming; YNP, Yellowstone National Park]

Map number	Station number	Station name
1	06036905	Firehole River near West Yellowstone, MT
2	06037000	Gibbon River near West Yellowstone, MT
3	06037500	Madison River near West Yellowstone, MT
4	06038550	Cabin Creek near West Yellowstone, MT
5	06043200	Squaw Creek near Gallatin Gateway, MT
6	06043300	Logger Creek near Gallatin Gateway, MT
7	06043500	Gallatin River near Gallatin Gateway, MT
8	06187500	Tower Creek at Tower Falls, YNP
9	06187950	Soda Butte Creek near Lamar Ranger Station, YNP
10	06188000	Lamar River near Tower Falls Ranger Station, YNP
11	06191000	Gardner River near Mammoth, YNP
12	06191500	Yellowstone River at Corwin Springs, MT
13	06204050	West Rosebud Creek near Roscoe, MT
14	06206500	Sunlight Creek near Painter, WY
15	06207500	Clarks Fork Yellowstone River near Belfry, MT
16	06207600	Jack Creek tributary near Belfry, MT
17	06207800	Bluewater Creek near Bridger, MT
18	06209500	Rock Creek near Red Lodge, MT
19	06210000	West Fork Rock Creek below Basin Creek near Red Lodge, MT
20	06210500	West Fork Rock Creek near Red Lodge, MT
21	06215000	Pryor Creek above Pryor, MT
22	06216000	Pryor Creek at Pryor, MT
23	06218500	Wind River near Dubois, WY
24	06218700	Wagon Gulch near Dubois, WY
25	06220500	East Fork Wind River near Dubois, WY
26	06221400	Dinwoody Creek above Lakes near Burris, WY
27	06221500	Dinwoody Creek near Burris, WY
28	06222500	Dry Creek near Burris, WY
29	06222700	Crow Creek near Tipperary, WY
30	06223500	Willow Creek near Crowheart, WY
31	06224000	Bull Lake Creek above Bull Lake, WY
32	06226200	Little Dry Creek near Crowheart, WY
33	06226300	Dry Creek near Crowheart, WY
34	06228350	South Fork Little Wind River above Reservoir near Ft Washakie, WY
35	06228800	North Fork Little Wind River near Ft Washakie, WY
36	06229000	North Fork Little Wind River at Ft Washakie, WY
37	06229700	Norkok Meadow Creek near Ft Washakie, WY
38	06229900	Trout Creek near Ft Washakie, WY
39	06232000	North Popo Agie River near Milford, WY
40	06233000	Little Popo Agie River near Lander, WY
41	06233360	Monument Draw at Lower Station near Hudson, WY
42	06234700	South Fork Hall Creek near Lander, WY

Table 9. *Station names, selected gaging stations, Wyoming and surrounding states--Continued*

Map number	Station number	Station name
43	06234800	Bobcat Draw near Sand Draw, WY
44	06235700	Haymaker Creek near Riverton, WY
45	06236000	Kirby Draw near Riverton, WY
46	06238760	West Fork Dry Cheyenne Creek at upper station near Riverton, WY
47	06239000	Muskrat Creek near Shoshoni, WY
48	06255200	Dead Man Gulch near Moneta, WY
49	06255300	Poison Creek tributary near Shoshoni, WY
50	06255500	Poison Creek near Shoshoni, WY
51	06256000	Badwater Creek at Lybyer Ranch near Lost Cabin, WY
52	06256600	Red Creek near Arminto, WY
53	06256700	South Bridger Creek near Lysite, WY
54	06256900	Dry Creek near Bonneville, WY
55	06257000	Badwater Creek at Bonneville, WY
56	06257500	Muddy Creek near Pavillion, WY
57	06258400	Birdseye Creek near Shoshoni, WY
58	06260000	South Fork Owl Creek near Anchor, WY
59	06260500	South Fork Owl Creek above Curtis Ranch near Thermopolis, WY
60	06262000	North Fork Owl Creek near Anchor, WY
61	06265200	Sand Draw near Thermopolis, WY
62	06265600	Tie Down Gulch near Worland, WY
63	06265800	Gooseberry Creek at Dickie, WY
64	06266460	Murphy Draw near Grass Creek, WY
65	06267260	North Prong East Fork Nowater Creek near Worland, WY
66	06267400	East Fork Nowater Creek near Colter, WY
67	06268500	Fifteenmile Creek near Worland, WY
68	06269700	Spring Creek near Ten Sleep, WY
69	06270000	Nowood River near Ten Sleep, WY
70	06270200	Leigh Creek near Ten Sleep, WY
71	06270300	Canyon Creek tributary near Ten Sleep, WY
72	06271000	Tensleep Creek near Ten Sleep, WY
73	06272500	Paintrock Creek near Hyattville, WY
74	06273000	Medicine Lodge Creek near Hyattville, WY
75	06274100	East Fork Sand Creek near Worland, WY
76	06274190	Nowood River tributary No 2 near Basin, WY
77	06274200	Nowood River tributary No 2 near Manderson, WY
78	06274250	Elk Creek near Basin, WY
79	06274500	Greybull River near Pitchfork, WY
80	06275000	Wood River at Sunshine, WY
81	06276500	Greybull River at Meeteetse, WY
82	06277700	Twentyfour Mile Creek near Emblem, WY
83	06277750	Dry Creek tributary near Emblem, WY
84	06278300	Shell Creek above Reservoir, WY
85	06278400	Granite Creek near Shell Ranger Station near Shell, WY

Table 9. *Station names, selected gaging stations, Wyoming and surrounding states--Continued*

Map number	Station number	Station name
86	06278500	Shell Creek near Shell, WY
87	06279020	Red Gulch near Shell, WY
88	06280300	South Fork Shoshone River near Valley, WY
89	06287500	Soap Creek near St Xavier, MT
90	06288200	Beauvais Creek near St Xavier, MT
91	06289000	Little Bighorn River at State Line near Wyola, MT
92	06290000	Pass Creek near Wyola, MT
93	06290500	Little Bighorn River below Pass Creek near Wyola, MT
94	06291000	Owl Creek near Lodge Grass, MT
95	06291500	Lodge Grass Creek above Willow Creek Diversion near Wyola, MT
96	06293300	Long Otter Creek near Lodge Grass, MT
97	06295100	Rosebud Creek near Kirby, MT
98	06296500	North Fork Tongue River near Dayton, WY
99	06297000	South Fork Tongue River near Dayton, WY
100	06298000	Tongue River near Dayton, WY
101	06298500	Little Tongue River near Dayton, WY
102	06299500	Wolf Creek at Wolf, WY
103	06299900	Slater Creek near Monarch, WY
104	06300500	East Fork Big Goose Creek near Big Horn, WY
105	06301480	Coney Creek above Twin Lakes near Big Horn, WY
106	06301500	West Fork Big Goose Creek near Big Horn, WY
107	06306100	Squirrel Creek near Decker, MT
108	06306900	Spring Creek near Decker, MT
109	06306950	South Fork Leaf Rock Creek near Kirby, MT
110	06307520	Canyon Creek near Birney, MT
111	06307600	Hanging Woman Creek near Birney, MT
112	06309200	Middle Fork Powder River near Barnum, WY
113	06309450	Beaver Creek below Bayer Creek near Barnum, WY
114	06309460	Beaver Creek above White Panther Ditch near Barnum, WY
115	06311000	North Fork Powder River near Hazelton, WY
116	06312700	South Fork Powder River near Powder River, WY
117	06312795	Sanchez Creek above Reservoir near Arminto, WY
118	06312910	Dead Horse Creek tributary near Midwest, WY
119	06312920	Dead Horse Creek tributary No 2 near Midwest, WY
120	06313000	South Fork Powder River near Kaycee, WY
121	06313020	Bobcat Creek near Edgerton, WY
122	06313050	East Teapot Creek near Edgerton, WY
123	06313100	Coal Draw near Midwest, WY
124	06313180	Dugout Creek tributary near Midwest, WY
125	06313200	Hay Draw near Midwest, WY
126	06313600	Burger Draw near Buffalo, WY
127	06313630	Van Houghton Draw near Buffalo, WY
128	06313700	Dead Horse Creek near Buffalo, WY

Table 9. *Station names, selected gaging stations, Wyoming and surrounding states--Continued*

Map number	Station number	Station name
129	06313900	Caribou Creek near Buffalo, WY
130	06314000	North Fork Crazy Woman Creek near Buffalo, WY
131	06315500	Middle Fork Crazy Woman Creek near Greub, WY
132	06316700	Coal Draw near Buffalo, WY
133	06317050	Rucker Draw near Spotted Horse, WY
134	06318500	Clear Creek near Buffalo, WY
135	06319100	Bull Creek near Buffalo, WY
136	06320500	South Piney Creek at Willow Park, WY
137	06321500	North Piney Creek near Story, WY
138	06324700	Sand Creek near Broadus, MT
139	06324800	Little Powder River tributary near Gillette, WY
140	06324900	Cedar Draw near Gillette, WY
141	06324910	Cow Creek tributary near Weston, WY
142	06324970	Little Powder River above Dry Creek near Weston, WY
143	06324995	Badger Creek at Biddle, MT
144	06325400	East Fork Little Powder River tributary near Hammond, MT
145	06333850	North Creek near Alzada, MT
146	06334000	Little Missouri River near Alzada, MT
147	06334100	Wolf Creek near Hammond, MT
148	06334200	Willow Creek near Alzada, MT
149	06334330	Little Missouri River tributary near Albion, MT
150	06334500	Little Missouri River at Camp Crook, SD
151	06334610	Hawksnest Creek tributary near Albion, MT
152	06358550	Battle Creek tributary near Castle Rock, SD
153	06358600	South Fork Moreau River tributary near Redig, SD
154	06358620	Sand Creek tributary near Redig, SD
155	06379600	Box Creek near Bill, WY
156	06382200	Pritchard Draw near Lance Creek, WY
157	06386000	Lance Creek near Riverview, WY
158	06387500	Turner Creek near Osage, WY
159	06388800	Blacktail Creek tributary near Newcastle, WY
160	06392900	Beaver Creek at Mallo Camp near Four Corners, WY
161	06394000	Beaver Creek near Newcastle, WY
162	06396200	Fiddle Creek near Edgemont, SD
163	06396300	Cottonwood Creek tributary near Edgemont, SD
164	06396350	Red Canyon Creek tributary near Pringle, SD
165	06399300	Hat Creek tributary near Ardmore, SD
166	06399700	Piney Creek near Ardmore, SD
167	06400000	Hat Creek near Edgemont, SD
168	06400900	Horsehead Creek tributary near Smithwick, SD
169	06402430	Beaver Creek near Pringle, SD
170	06404000	Battle Creek near Keystone, SD
171	06404800	Grace Coolidge Creek near Hayward, SD

Table 9. *Station names, selected gaging stations, Wyoming and surrounding states--Continued*

Map number	Station number	Station name
172	06404998	Grace Coolidge Creek near Game Lodge near Custer, SD
173	06406000	Battle Creek at Hermosa, SD
174	06406800	Newton Fork near Hill City, SD
175	06409000	Castle Creek above Deerfield Reservoir near Hill City, SD
176	06422500	Boxelder Creek near Nemo, SD
177	06426195	Donkey Creek tributary above Reservoir near Gillette, WY
178	06426500	Belle Fourche River below Moorcroft, WY
179	06427700	Inyan Kara Creek near Upton, WY
180	06429300	Ogden Creek near Sundance, WY
181	06429905	Sand Creek near Ranch A near Beulah, WY
182	06430500	Redwater Creek at WY-SD State Line
183	06430800	Annie Creek near Lead, SD
184	06430898	Squaw Creek near Spearfish, SD
185	06432200	Polo Creek near Whitewood, SD
186	06432230	Miller Creek near Whitewood, SD
187	06433500	Hay Creek at Belle Fourche, SD
188	06434800	Owl Creek tributary near Belle Fourche, SD
189	06436156	Whitetail Creek at Lead, SD
190	06436700	Indian Creek near Arpan, SD
191	06437020	Bear Butte Creek near Deadwood, SD
192	06437100	Boulder Creek near Deadwood, SD
193	06437500	Bear Butte Creek near Sturgis, SD
194	06443200	White River tributary near Glen, NE
195	06443300	Deep Creek near Glen, NE
196	06443700	Soldiers Creek near Crawford, NE
197	06444000	White River at Crawford, NE
198	06456200	Pebble Creek near Esther, NE
199	06616000	North Fork Michigan River near Gould, CO
200	06620400	Douglas Creek above Keystone, WY
201	06621000	Douglas Creek near Foxpark, WY
202	06622500	French Creek near French, WY
203	06622700	North Brush Creek near Saratoga, WY
204	06623800	Encampment River above Hog Park Creek near Encampment, WY
205	06624500	Encampment River above Encampment, WY
206	06625000	Encampment River at mouth near Encampment, WY
207	06628900	Pass Creek near Elk Mountain, WY
208	06629150	Coal Bank Draw tributary near Walcott, WY
209	06629200	Coal Bank Draw tributary No 2 near Walcott, WY
210	06629700	St Mary Creek tributary near Sinclair, WY
211	06629800	Coal Creek near Rawlins, WY
212	06630200	Big Ditch tributary near Hanna, WY
213	06630800	Bear Creek near Elk Mountain, WY
214	06631100	Wagonhound Creek near Elk Mountain, WY

Table 9. *Station names, selected gaging stations, Wyoming and surrounding states--Continued*

Map number	Station number	Station name
215	06631150	Third Sand Creek near Medicine Bow, WY
216	06632400	Rock Creek above King Canyon Canal near Arlington, WY
217	06632600	Threemile Creek near Arlington, WY
218	06632700	Onemile Creek near Arlington, WY
219	06634200	Sheep Creek near Marshall, WY
220	06634300	Sheep Creek near Medicine Bow, WY
221	06634600	Little Medicine Bow River near Medicine Bow, WY
222	06634910	Medicine Bow River tributary near Hanna, WY
223	06636500	Sage Creek above Pathfinder Reservoir, WY
224	06637550	Sweetwater River near South Pass City, WY
225	06637750	Rock Creek above Rock Creek Reservoir, WY
226	06638300	West Fork Crooks Creek near Jeffrey City, WY
227	06638350	Coal Creek near Muddy Gap, WY
228	06641400	Bear Springs Creek near Alcova, WY
229	06642700	Lawn Creek near Alcova, WY
230	06642730	Stinking Creek tributary near Alcova, WY
231	06642760	Stinking Creek near Alcova, WY
232	06643300	Coal Creek near Goose Egg, WY
233	06644200	Clarks Gulch near Natrona, WY
234	06644840	McKenzie Draw tributary near Casper, WY
235	06645150	Smith Creek above Otter Creek near Casper, WY
236	06646000	Deer Creek in Canyon near Glenrock, WY
237	06646500	Deer Creek at Glenrock, WY
238	06646700	East Fork Dry Creek tributary near Glenrock, WY
239	06647500	Box Elder Creek at Boxelder, WY
240	06647890	Little Box Elder Creek near Careyhurst, WY
241	06648780	Sage Creek tributary near Orpha, WY
242	06649900	North Platte River tributary near Douglas, WY
243	06651800	Sand Creek near Orin, WY
244	06652400	Watkins Draw near Lost Springs, WY
245	06661000	Little Laramie River near Filmore, WY
246	06661580	Sevenmile Creek near Centennial, WY
247	06664500	Sybille Creek above Bluegrass Creek near Wheatland, WY
248	06667500	North Laramie River near Wheatland, WY
249	06668040	Rabbit Creek near Wheatland, WY
250	06670985	Dry Rawhide Creek near Lingle, WY
251	06671000	Rawhide Creek near Lingle, WY
252	06675300	Horse Creek tributary near Little Bear, WY
253	06679000	Dry Spottedtail Creek at Mitchell, NE
254	06746095	Joe Wright Creek above Joe Wright Reservoir, CO
255	06748200	Fall Creek near Rustic, CO
256	06748510	Little Beaver Creek near Idylwilde, CO
257	06748530	Little Beaver Creek near Rustic, CO

Table 9. *Station names, selected gaging stations, Wyoming and surrounding states--Continued*

Map number	Station number	Station name
258	06748600	South Fork Cache La Poudre River near Rustic, CO
259	06754500	Middle Crow Creek near Hecla, WY
260	06755000	South Crow Creek near Hecla, WY
261	06761900	Lodgepole Creek tributary near Pine Bluffs, WY
262	06762500	Lodgepole Creek at Bushnell, NE
263	06762600	Lodgepole Creek tributary No 2 near Albin, WY
264	09188500	Green River at Warren Bridge near Daniel, WY
265	09189500	Horse Creek at Sherman Ranger Station, WY
266	09196500	Pine Creek above Fremont Lake, WY
267	09198500	Pole Creek below Little Half Moon Lake near Pinedale, WY
268	09199500	Fall Creek near Pinedale, WY
269	09201000	New Fork River near Boulder, WY
270	09203000	East Fork River near Big Sandy, WY
271	09204000	Silver Creek near Big Sandy, WY
272	09204500	East Fork at Newfork, WY
273	09204700	Sand Creek Draw tributary near Boulder, WY
274	09205500	North Piney Creek near Mason, WY
275	09207650	Dry Basin Creek near Big Piney, WY
276	09208000	La Barge Creek near La Barge Meadows Ranger Station, WY
277	09210500	Fontenelle Creek Herschler Ranch near Fontenelle, WY
278	09212500	Big Sandy River at Leckie Ranch near Big Sandy, WY
279	09215000	Pacific Creek near Farson, WY
280	09216290	East Otterson Wash near Green River, WY
281	09216350	Skunk Canyon Creek near Green River, WY
282	09216400	Greasewood Canyon near Green River, WY
283	09216537	Delaney Draw near Red Desert, WY
284	09216550	Deadman Wash near Point of Rocks, WY
285	09216560	Bitter Creek near Point of Rocks, WY
286	09216600	Cutthroat Draw near Rock Springs, WY
287	09216695	No Name Creek near Rock Springs, WY
288	09216700	Salt Wells Creek near Rock Springs, WY
289	09216900	Bitter Creek tributary near Green River, WY
290	09217900	Blacks Fork near Robertson, WY
291	09218500	Blacks Fork near Millburne, WY
292	09220000	East Fork of Smiths Fork near Robertson, WY
293	09220500	West Fork of Smiths Fork near Robertson, WY
294	09221680	Mud Spring Hollow near Church Butte near Lyman, WY
295	09221700	Mud Spring Hollow near Lyman, WY
296	09223000	Hams Fork below Pole Creek near Frontier, WY
297	09224000	Hams Fork at Diamondville, WY
298	09224800	Meadow Springs Wash tributary near Green River, WY
299	09224810	Blacks Fork tributary No 2 near Green River, WY
300	09224820	Blacks Fork tributary No 3 near Green River, WY

Table 9. *Station names, selected gaging stations, Wyoming and surrounding states--Continued*

Map number	Station number	Station name
301	09224840	Blacks Fork tributary No 4 near Green River, WY
302	09224980	Summers Dry Creek near Green River, WY
303	09225200	Squaw Hollow near Burntfork, WY
304	09225300	Green River tributary No 2 near Burntfork, WY
305	09226000	Henrys Fork near Lonetree, WY
306	09226500	Middle Fork Beaver Creek near Lonetree, WY
307	09227500	West Fork Beaver Creek near Lonetree, WY
308	09229450	Henrys Fork tributary near Manila, UT
309	09235600	Pot Creek above diversions near Vernal, UT
310	09241000	Elk River at Clark, CO
311	09244500	Elkhead Creek near Clark, CO
312	09245000	Elkhead Creek near Elkhead, CO
313	09245500	North Fork Elkhead Creek near Elkhead, CO
314	09251800	North Fork Little Snake River near Encampment, WY
315	09253000	Little Snake River near Slater, CO
316	09253400	Battle Creek near Encampment, WY
317	09254500	Slater Fork at Baxter Ranch near Slater, CO
318	09255000	Slater Fork near Slater, CO
319	09255500	Savery Creek at upper station near Savery, WY
320	09256000	Savery Creek near Savery, WY
321	09258000	Willow Creek near Dixon, WY
322	09258200	Dry Cow Creek near Baggs, WY
323	09258900	Muddy Creek above Baggs, WY
324	10010400	East Fork Bear River near Evanston, WY
325	10011500	Bear River near UT-WY State Line
326	10012000	Mill Creek at UT-WY State Line
327	10015700	Sulphur Creek above Reservoir near Evanston, WY
328	10019700	Whitney Canyon Creek near Evanston, WY
329	10021000	Woodruff Creek near Woodruff, UT
330	10027000	Twin Creek at Sage, WY
331	10032000	Smiths Fork near Border, WY
332	10040000	Thomas Fork near Geneva, ID
333	10040500	Salt Creek near Geneva, ID
334	10041000	Thomas Fork near WY-ID State Line
335	10047500	Montpelier Creek at weir near Montpelier, ID
336	10058600	Bloomington Creek at Bloomington, ID
337	10069000	Georgetown Creek near Georgetown, ID
338	10128500	Weber River near Oakley, UT
339	13010065	Snake River above Jackson Lake at Flagg Ranch, WY
340	13011500	Pacific Creek at Moran, WY
341	13011800	Blackrock Creek tributary near Moran, WY
342	13011900	Buffalo Fork above Lava Creek near Moran, WY
343	13018300	Cache Creek near Jackson, WY

Table 9. *Station names, selected gaging stations, Wyoming and surrounding states--Continued*

Map number	Station number	Station name
344	13019210	Rim Draw near Bondurant, WY
345	13019220	Sour Moose Creek near Bondurant, WY
346	13019400	Cliff Creek near Bondurant, WY
347	13019438	Little Granite Creek at mouth near Bondurant, WY
348	13019500	Hoback River near Jackson, WY
349	13020000	Fall Creek near Jackson, WY
350	13021000	Cabin Creek near Jackson, WY
351	13022550	Red Creek near Alpine, WY
352	13023000	Greys River above Reservoir near Alpine, WY
353	13023800	Fish Creek near Smoot, WY
354	13025500	Crow Creek near Fairview, WY
355	13027000	Strawberry Creek near Bedford, WY
356	13027200	Bear Canyon near Freedom, WY
357	13029500	McCoy Creek above Reservoir near Alpine, WY
358	13030000	Indian Creek above Reservoir near Alpine, WY
359	13030500	Elk Creek above Reservoir near Irwin, ID
360	13032000	Bear Creek above Reservoir near Irwin, ID
361	13038900	Targhee Creek near Macks Inn, ID
362	13046680	Boundary Creek near Bechler Ranger Station, YNP
363	13050700	Mail Cabin Creek near Victor, ID
364	13050800	Moose Creek near Victor, ID

Table 10. *Basin characteristics, selected streamflow-gaging stations, Wyoming and surrounding states*

[Region 1, Rocky Mountains; Region 2, Central Basins and Northern Plains; Region 3, Eastern Basins and Eastern Plains; Region 4, Eastern Mountains; Region 5, Overthrust Belt; Region 6, High Desert; means are area-weighted averages]

Map number	Station number	Latitude (degrees)	Longitude (degrees)	Region	Drainage area (square miles)	Mean elevation (feet above NAVD 88)	Mean basin slope (feet per mile)	Mean annual precipitation (inches)	2-year, 24-hour precipitation (inches)	Mean January precipitation (inches)	Mean March precipitation (inches)	Mean soils permeability (inches per hour)	Mean soils hydrologic index (unitless)
1	06036905	44.6203	110.8622	1	282	7,990	510	46.1	1.40	6.07	4.59	3.86	2.69
2	06037000	44.6494	110.7839	1	118	7,910	696	33.8	1.39	3.83	3.17	3.43	2.49
3	06037500	44.6569	111.0675	1	420	7,900	606	42.2	1.38	5.37	4.16	3.78	2.60
4	06038550	44.8719	111.3414	1	30.3	8,320	1,410	38.3	1.60	4.03	4.03	1.68	2.64
5	06043200	45.4333	111.2167	1	40.4	7,460	2,190	33.7	1.70	2.49	3.40	1.50	2.63
6	06043300	45.4500	111.2333	1	2.48	7,300	2,320	29.9	1.80	2.05	2.79	2.35	2.56
7	06043500	45.4975	111.2697	1	825	7,890	1,680	36.4	1.60	3.34	3.64	2.22	2.62
8	06187500	44.9000	110.3833	1	50.4	8,350	1,380	30.0	1.41	2.99	2.58	1.90	2.64
9	06187950	44.8683	110.1647	1	99.0	8,410	2,100	32.1	1.12	3.57	2.80	4.95	2.62
10	06188000	44.9278	110.3931	1	660	8,340	1,620	32.3	1.18	3.32	2.86	3.79	2.64
11	06191000	44.9925	110.6906	1	202	8,000	1,070	34.6	1.38	3.61	3.39	3.18	2.47
12	06191500	45.1119	110.7936	1	2,620	8,340	1,310	33.0	1.35	3.50	2.86	3.78	2.58
13	06204050	45.2431	109.7306	1	52.1	9,800	2,740	39.2	2.20	4.07	3.85	5.55	2.77
14	06206500	44.7500	109.5056	1	135	8,560	2,380	34.5	1.71	3.37	2.92	2.77	2.87
15	06207500	45.0103	109.0647	1	1,150	7,750	1,640	26.2	1.62	2.43	2.31	3.21	2.77
16	06207600	45.1622	108.8233	2	0.85	4,410	743	15.0	1.40	0.72	1.09	1.02	3.70
17	06207800	45.3317	108.8011	2	28.1	4,810	685	17.1	1.50	0.84	1.28	0.96	3.52
18	06209500	45.1208	109.2958	1	124	9,430	2,140	29.7	2.40	2.17	3.10	4.71	2.77
19	06210000	45.1500	109.3250	1	63.1	9,240	2,250	30.9	1.60	2.06	3.37	4.17	2.57
20	06210500	45.1500	109.3167	1	66.9	9,150	2,230	30.6	1.60	2.04	3.32	4.14	2.57
21	06215000	45.3406	108.5686	1	39.6	5,990	1,660	18.4	2.40	1.28	1.79	1.18	3.30
22	06216000	45.4350	108.5336	2	117	5,300	1,130	18.9	2.30	1.06	1.54	1.07	3.23
23	06218500	43.5786	109.7592	1	232	8,860	1,150	29.9	1.39	3.72	2.66	2.40	2.90
24	06218700	43.5783	109.7369	2	4.89	7,650	911	15.4	1.01	1.34	1.10	1.03	2.89

Table 10. *Basin characteristics, selected streamflow-gaging stations, Wyoming and surrounding states--Continued*

Map number	Station number	Latitude (degrees)	Longitude (degrees)	Region	Drainage area (square miles)	Mean elevation (feet above NAVD 88)	Mean basin slope (feet per mile)	Mean annual precipitation (inches)	2-year, 24-hour precipitation (inches)	Mean January precipitation (inches)	Mean March precipitation (inches)	Mean soils permeability (inches per hour)	Mean soils hydrologic index (unitless)
25	06220500	43.4544	109.4658	1	427	9,100	1,760	24.6	1.41	2.23	2.08	2.02	3.15
26	06221400	43.3456	109.4094	1	88.2	10,550	2,190	29.2	2.53	2.52	2.84	2.72	3.00
27	06221500	43.4320	109.3503	1	100	10,130	2,070	27.2	2.44	2.27	2.62	2.77	2.94
28	06222500	43.3364	109.2986	1	53.7	10,220	1,510	26.5	2.54	1.80	2.58	2.62	2.98
29	06222700	43.5770	109.2617	1	30.2	10,000	1,840	24.4	1.56	1.74	2.14	0.96	3.20
30	06223500	43.2833	109.1856	1	55.4	8,670	1,180	19.9	2.41	1.23	1.83	2.44	2.84
31	06224000	43.1769	109.2022	1	187	10,280	1,920	28.7	2.42	2.65	2.86	2.63	2.99
32	06226200	43.5361	109.0889	2	10.5	8,150	1,080	16.2	1.41	0.87	1.23	1.40	2.91
33	06226300	43.3944	109.0403	2	97.9	7,690	986	14.1	1.30	0.64	1.06	1.45	2.87
34	06228350	42.9683	109.0369	1	90.3	10,080	1,760	28.4	2.43	2.58	2.83	2.68	3.00
35	06228800	43.0272	109.0006	1	112	9,930	1,520	28.1	2.32	2.39	2.85	2.64	2.99
36	06229000	43.0111	108.8861	1	128	9,590	1,430	26.7	2.26	2.21	2.68	2.56	2.95
37	06229700	43.0822	108.9033	2	15.4	6,440	549	11.3	1.61	0.25	0.76	1.54	2.62
38	06229900	42.9511	108.9483	1	16.1	8,480	1,440	21.6	2.53	1.52	2.08	1.99	2.87
39	06232000	42.8639	108.9069	1	98.4	9,960	1,810	28.9	2.59	2.51	2.99	2.54	2.98
40	06233000	42.7167	108.6428	1	125	8,230	1,200	23.8	2.12	1.72	2.45	1.88	2.90
41	06233360	42.8208	108.5831	2	8.38	5,580	452	12.5	1.36	0.26	1.03	1.54	2.72
42	06234700	42.6456	108.3897	2	3.88	6,380	851	12.8	1.35	0.25	0.87	1.34	2.77
43	06234800	42.8261	108.2217	2	2.89	5,780	568	9.0	1.36	0.25	0.71	1.29	3.12
44	06235700	43.0817	108.3794	2	9.52	5,300	401	8.8	1.22	0.26	0.28	2.58	3.09
45	06236000	43.0914	108.2683	2	129	5,380	328	8.5	1.14	0.25	0.30	1.83	2.86
46	06238760	42.9533	108.1044	2	0.69	5,490	159	9.0	1.12	0.26	0.26	2.05	2.80
47	06239000	43.1481	108.1575	2	733	5,840	303	8.9	1.13	0.25	0.57	2.16	2.76
48	06255200	43.1769	107.7839	2	4.46	5,610	568	9.0	0.95	0.25	0.73	2.55	3.04
49	06255300	43.2239	107.9997	2	0.39	5,280	301	7.0	0.98	0.22	0.22	2.61	3.08

Table 10. *Basin characteristics, selected streamflow-gaging stations, Wyoming and surrounding states--Continued*

Map number	Station number	Latitude (degrees)	Longitude (degrees)	Region	Drainage area (square miles)	Mean elevation (feet above NAVD 88)	Mean basin slope (feet per mile)	Mean annual precipitation (inches)	2-year, 24-hour precipitation (inches)	Mean January precipitation (inches)	Mean March precipitation (inches)	Mean soils permeability (inches per hour)	Mean soils hydrologic index (unitless)
50	06255500	43.2375	108.1389	2	500	5,950	245	9.1	1.05	0.26	0.66	4.18	2.38
51	06256000	43.3506	107.5561	1	131	7,290	961	19.4	1.39	1.21	1.74	2.42	2.83
52	06256600	43.2456	107.3272	2	7.15	6,680	867	14.8	1.23	0.78	1.26	1.38	3.51
53	06256700	43.4444	107.7561	2	10.0	6,570	990	13.0	1.36	0.66	1.13	1.85	3.12
54	06256900	43.2811	107.9125	2	52.6	6,140	917	11.3	1.26	0.37	0.82	2.61	3.06
55	06257000	43.2692	108.0794	2	808	6,150	593	12.3	1.14	0.54	0.99	2.33	3.01
56	06257500	43.3628	108.6022	2	267	6,680	818	9.0	1.30	0.29	0.58	1.75	2.86
57	06258400	43.3742	108.1272	2	13.2	5,950	1,190	12.1	1.35	0.28	0.71	2.52	3.07
58	06260000	43.6647	108.8672	1	87.0	9,410	1,840	20.2	1.99	1.19	1.65	1.50	3.20
59	06260500	43.6833	108.7333	1	144	8,680	1,550	18.3	1.87	1.00	1.44	1.35	3.24
60	06262000	43.7000	108.9167	1	54.8	8,780	1,760	18.2	2.00	1.01	1.47	1.59	3.07
61	06265200	43.8083	108.4667	2	6.33	5,240	555	11.0	1.18	0.26	0.78	1.32	2.49
62	06265600	43.8875	108.1292	2	1.78	4,380	712	9.0	0.99	0.25	0.75	2.14	2.90
63	06265800	44.0000	108.7569	1	95.0	7,160	1,400	16.0	1.61	0.48	1.12	1.36	3.11
64	06266460	44.0144	108.5022	2	2.32	5,340	352	9.7	1.34	0.26	0.26	0.73	3.30
65	06267260	43.9458	107.8103	2	3.77	4,500	447	9.0	0.80	0.25	0.75	0.73	3.30
66	06267400	43.9153	107.9294	2	149	4,580	571	10.5	0.86	0.35	0.69	0.85	3.25
67	06268500	44.0206	108.0117	2	518	4,880	507	9.4	1.25	0.26	0.41	1.08	3.17
68	06269700	43.9583	107.3889	1	57.9	6,080	907	16.2	1.31	0.88	1.36	1.15	3.25
69	06270000	44.0133	107.4275	1	803	5,950	831	15.7	1.18	0.92	1.31	1.25	3.04
70	06270200	44.1636	107.1539	1	2.54	9,540	729	25.8	1.79	2.26	2.26	4.08	2.90
71	06270300	44.1611	107.1083	1	0.52	9,870	972	27.0	1.93	2.30	2.30	4.38	2.98
72	06271000	44.0578	107.3872	1	247	8,340	1,170	23.3	1.61	1.67	2.07	2.61	3.12
73	06272500	44.2833	107.5000	1	164	8,990	1,430	27.0	1.65	2.07	2.49	2.90	3.14
74	06273000	44.2936	107.5397	1	86.8	8,010	1,300	24.2	1.54	1.76	2.10	1.95	3.23

Table 10. *Basin characteristics, selected streamflow-gaging stations, Wyoming and surrounding states--Continued*

Map number	Station number	Latitude (degrees)	Longitude (degrees)	Region	Drainage area (square miles)	Mean elevation (feet above NAVD 88)	Mean basin slope (feet per mile)	Mean annual precipitation (inches)	2-year, 24-hour precipitation (inches)	Mean January precipitation (inches)	Mean March precipitation (inches)	Mean soils permeability (inches per hour)	Mean soils hydrologic index (unitless)
75	06274100	44.0194	107.7806	2	19.1	4,590	607	10.4	0.77	0.25	0.75	0.73	3.30
76	06274190	44.2783	107.9092	2	1.51	4,160	308	7.0	0.75	0.23	0.23	2.76	3.20
77	06274200	44.2758	107.9083	2	1.59	4,160	309	7.0	0.75	0.23	0.23	2.75	3.20
78	06274250	44.3083	108.0306	2	96.9	4,310	504	7.6	1.09	0.25	0.25	1.01	3.19
79	06274500	44.1086	109.1600	1	282	9,720	1,990	23.7	2.23	1.22	1.98	3.21	2.88
80	06275000	44.0375	108.9733	1	194	9,200	2,230	22.4	2.05	1.13	1.86	2.45	2.94
81	06276500	44.1556	108.8764	1	681	8,820	1,750	21.3	2.07	1.00	1.73	2.63	2.86
82	06277700	44.4589	108.6083	2	12.8	5,220	234	9.7	1.20	0.26	0.26	2.32	2.81
83	06277750	44.4617	108.5700	2	0.65	4,910	386	9.0	1.12	0.26	0.26	7.46	2.20
84	06278300	44.5081	107.4031	1	23.1	10,020	1,170	31.8	2.02	2.79	3.02	4.28	3.14
85	06278400	44.5755	107.5478	1	11.1	9,040	1,020	29.8	2.24	2.33	2.90	1.62	3.16
86	06278500	44.5650	107.7122	1	145	8,800	1,350	28.5	2.04	2.31	2.69	2.26	3.23
87	06279020	44.5344	107.8350	2	47.8	5,460	929	15.9	1.22	0.90	0.94	1.03	3.19
88	06280300	44.2083	109.5542	1	297	9,510	2,710	29.7	1.89	2.68	2.63	5.27	2.67
89	06287500	45.3272	107.7694	2	98.3	4,290	886	20.9	1.80	1.09	1.42	0.58	3.46
90	06288200	45.4778	108.0092	2	100	4,230	672	19.2	1.80	0.95	1.30	0.55	3.67
91	06289000	45.0069	107.6144	1	193	7,800	1,620	25.5	2.35	1.78	2.49	0.94	3.38
92	06290000	45.0564	107.3553	2	111	5,190	969	19.6	2.10	0.94	1.40	0.95	3.05
93	06290500	45.1772	107.3933	1	428	6,050	1,170	21.8	2.20	1.28	1.84	0.94	3.19
94	06291000	45.2681	107.3008	2	163	4,170	841	17.8	1.60	0.77	1.15	0.92	3.02
95	06291500	45.1275	107.6003	1	80.7	6,380	1,270	23.5	2.20	1.47	1.92	0.87	3.42
96	06293300	45.4375	107.3950	2	11.7	3,500	605	15.8	1.40	0.72	0.72	0.87	3.06
97	06295100	45.2458	106.9672	2	35.5	4,620	629	18.3	1.50	0.76	1.26	1.37	2.86
98	06296500	44.7569	107.6222	1	32.4	9,220	1,130	30.9	2.45	2.44	3.15	0.88	3.29
99	06297000	44.7839	107.4694	1	85.0	8,840	848	28.3	2.45	2.06	2.70	3.55	2.98

Table 10. *Basin characteristics, selected streamflow-gaging stations, Wyoming and surrounding states--Continued*

Map number	Station number	Latitude (degrees)	Longitude (degrees)	Region	Drainage area (square miles)	Mean elevation (feet above NAVD 88)	Mean basin slope (feet per mile)	Mean annual precipitation (inches)	2-year, 24-hour precipitation (inches)	Mean January precipitation (inches)	Mean March precipitation (inches)	Mean soils permeability (inches per hour)	Mean soils hydrologic index (unitless)
100	06298000	44.8494	107.3039	1	204	8,500	1,040	27.0	2.42	1.32	1.86	2.08	3.15
101	06298500	44.8105	107.2839	1	25.1	7,410	1,520	23.7	2.39	1.47	2.03	1.94	3.40
102	06299500	44.7725	107.2336	1	37.8	7,900	1,520	25.2	2.41	1.66	2.26	3.28	3.11
103	06299900	44.9089	107.0469	2	18.0	4,240	764	16.3	1.59	0.74	1.08	0.54	3.35
104	06300500	44.5383	107.2258	1	20.1	9,740	1,540	30.5	2.43	2.34	2.97	3.83	3.28
105	06301480	44.6014	107.3169	1	3.41	9,440	1,210	29.6	2.43	2.19	2.90	3.96	3.26
106	06301500	44.6131	107.2969	1	24.4	9,530	1,140	29.5	2.45	2.15	2.91	4.29	3.02
107	06306100	45.0514	106.9267	2	33.6	4,410	785	17.6	1.50	0.77	1.16	0.53	3.27
108	06306900	45.0858	106.8367	2	34.7	4,120	574	16.1	1.50	0.73	0.98	0.95	3.13
109	06306950	45.1833	106.9167	2	4.53	4,260	524	17.0	1.50	0.75	1.19	1.52	2.93
110	06307520	45.2411	106.6756	2	50.2	3,990	763	15.9	1.40	0.75	0.76	2.31	2.56
111	06307600	45.2992	106.5078	2	470	3,860	609	16.5	1.40	0.74	1.01	1.65	2.97
112	06309200	43.5778	107.1378	1	45.2	8,130	660	26.1	1.64	1.76	2.59	1.50	3.20
113	06309450	43.6650	107.0625	1	10.9	7,660	1,070	23.3	1.62	1.51	2.25	0.99	3.50
114	06309460	43.6978	106.9478	1	24.2	7,390	1,200	21.3	1.62	1.32	1.95	1.00	3.51
115	06311000	44.0278	107.0803	1	24.5	8,990	692	24.4	1.95	1.87	2.27	4.15	2.87
116	06312700	43.0333	107.0167	3	262	6,300	444	10.8	1.17	0.28	0.85	2.77	2.42
117	06312795	43.3397	107.1800	1	5.53	8,030	1,000	23.0	1.52	1.43	2.17	2.39	2.74
118	06312910	43.3364	106.5344	3	1.53	5,410	396	13.0	1.11	0.70	0.70	0.37	3.80
119	06312920	43.3386	106.5264	3	1.34	5,400	585	13.0	1.10	0.69	0.69	0.37	3.80
120	06313000	43.6194	106.5767	3	1,150	5,820	474	12.5	1.13	0.51	0.79	1.85	3.08
121	06313020	43.1986	106.0903	3	8.29	5,810	417	14.3	1.37	0.73	0.73	1.13	3.62
122	06313050	43.1806	106.2111	3	5.44	5,750	532	15.0	1.24	0.76	0.76	1.14	3.62
123	06313100	43.4500	106.2333	3	11.4	5,250	606	15.0	1.33	0.78	0.88	1.19	3.63
124	06313180	43.4367	106.4197	3	0.80	5,030	357	13.0	1.14	0.70	0.70	0.37	3.80

Table 10. *Basin characteristics, selected streamflow-gaging stations, Wyoming and surrounding states--Continued*

Map number	Station number	Latitude (degrees)	Longitude (degrees)	Region	Drainage area (square miles)	Mean elevation (feet above NAVD 88)	Mean basin slope (feet per mile)	Mean annual precipitation (inches)	2-year, 24-hour precipitation (inches)	Mean January precipitation (inches)	Mean March precipitation (inches)	Mean soils permeability (inches per hour)	Mean soils hydrologic index (unitless)
125	06313200	43.4472	106.3722	3	1.60	5,080	488	13.0	1.16	0.70	0.70	0.37	3.80
126	06313600	44.1333	106.0972	3	4.57	4,420	481	13.0	1.34	0.27	0.80	2.03	3.40
127	06313630	44.1778	106.1236	3	10.8	4,320	549	13.0	1.27	0.27	0.81	2.04	3.40
128	06313700	44.2150	106.1114	3	151	4,570	511	13.0	1.48	0.26	0.65	1.54	2.93
129	06313900	44.1778	106.9194	1	5.08	8,470	796	21.8	2.33	1.26	1.88	4.09	2.90
130	06314000	44.1878	106.8300	1	44.9	8,510	1,040	22.5	2.24	1.38	1.95	4.15	2.92
131	06315500	44.0581	106.8019	1	82.7	8,000	952	21.6	1.95	1.27	1.83	3.71	2.93
132	06316700	44.5000	106.1333	3	1.64	4,110	749	13.7	1.32	0.71	0.73	1.69	2.90
133	06317050	44.7194	105.8861	3	3.98	4,180	608	15.0	1.47	0.26	0.78	2.27	2.50
134	06318500	44.3328	106.7767	1	120	8,670	1,280	24.0	2.33	1.49	2.17	3.96	2.99
135	06319100	44.2772	106.7450	3	10.8	5,950	1,110	17.5	1.57	0.75	0.80	1.43	2.90
136	06320500	44.4664	107.0342	1	33.6	10,160	1,270	31.3	2.57	2.08	3.09	3.99	3.13
137	06321500	44.5806	106.9319	1	36.8	7,900	1,230	23.1	2.55	1.33	1.99	3.91	2.97
138	06324700	45.4333	105.4333	2	10.2	3,300	405	13.0	1.50	0.69	0.69	1.47	3.26
139	06324800	44.4472	105.4611	2	0.81	4,350	687	15.0	1.60	0.26	0.77	1.64	2.80
140	06324900	44.5167	105.4444	2	3.45	4,310	672	14.2	1.64	0.25	0.74	1.64	2.80
141	06324910	44.5431	105.3611	2	0.72	4,010	380	13.0	1.75	0.25	0.74	1.64	2.80
142	06324970	44.9292	105.3517	2	1,240	4,100	444	14.0	1.69	0.25	0.75	2.22	2.95
143	06324995	45.0786	105.3617	2	6.06	3,540	453	13.0	1.60	0.26	0.79	1.16	3.30
144	06325400	45.3003	105.0989	2	3.45	3,390	334	13.0	1.60	0.25	0.76	2.60	2.50
145	06333850	45.0667	104.5167	2	1.25	3,560	327	15.0	1.70	0.24	0.73	0.19	3.80
146	06334000	45.0833	104.4000	2	904	3,890	312	15.2	1.80	0.29	0.74	0.87	3.46
147	06334100	45.1667	104.7500	2	10.1	3,700	167	15.0	1.80	0.26	0.77	0.10	3.80
148	06334200	45.1000	104.5833	2	122	3,670	193	15.0	1.80	0.25	0.75	0.21	3.78
149	06334330	45.2106	104.2614	2	1.49	3,360	155	15.0	1.60	0.24	0.73	0.19	3.80

Table 10. *Basin characteristics, selected streamflow-gaging stations, Wyoming and surrounding states--Continued*

Map number	Station number	Latitude (degrees)	Longitude (degrees)	Region	Drainage area (square miles)	Mean elevation (feet above NAVD 88)	Mean basin slope (feet per mile)	Mean annual precipitation (inches)	2-year, 24-hour precipitation (inches)	Mean January precipitation (inches)	Mean March precipitation (inches)	Mean soils permeability (inches per hour)	Mean soils hydrologic index (unitless)
150	06334500	45.5469	103.9731	2	1,970	3,660	258	15.1	1.80	0.28	0.76	0.81	3.47
151	06334610	45.3869	104.4772	2	0.92	3,520	224	15.0	1.50	0.28	0.83	0.19	3.80
152	06358550	45.0492	103.5489	3	1.57	3,080	242	15.0	1.80	0.25	0.75	0.04	4.00
153	06358600	45.1958	103.5692	2	1.62	3,060	161	15.0	1.80	0.26	0.78	1.68	3.08
154	06358620	45.2225	103.5489	2	0.06	3,160	476	15.0	1.80	0.26	0.78	1.90	3.08
155	06379600	43.1056	105.2597	3	112	5,130	268	13.0	1.78	0.25	0.75	1.75	2.98
156	06382200	43.2000	104.6833	3	5.10	4,320	384	15.0	1.39	0.27	0.80	1.68	3.20
157	06386000	43.3667	104.2667	2	2,070	4,630	340	14.3	1.67	0.28	0.78	1.41	3.26
158	06387500	44.0194	104.5028	2	47.8	4,410	273	15.1	1.61	0.26	0.74	0.48	3.78
159	06388800	43.7980	104.1811	2	0.25	4,220	324	13.0	1.59	0.24	0.72	0.46	3.80
160	06392900	44.0845	104.0614	4	10.3	6,720	715	33.2	1.85	1.25	1.72	0.83	3.00
161	06394000	43.5353	104.1172	2	1,320	4,700	465	16.8	1.63	0.40	0.90	1.23	3.24
162	06396200	43.3044	103.9961	2	0.64	3,840	110	15.0	1.90	0.25	0.75	0.96	3.60
163	06396300	43.2967	103.8672	2	0.09	3,760	408	15.0	1.90	0.25	0.75	0.96	3.60
164	06396350	43.5394	103.6556	4	0.20	4,830	359	17.0	2.00	0.24	0.71	1.73	2.70
165	06399300	43.0950	103.6736	3	3.74	3,590	267	15.0	1.90	0.24	0.73	0.83	3.66
166	06399700	43.1872	103.6400	3	7.36	3,530	257	15.0	2.00	0.26	0.78	0.96	3.60
167	06400000	43.2400	103.5878	3	962	3,980	332	15.3	2.00	0.26	0.81	1.05	3.41
168	06400900	43.2878	103.3189	2	1.52	3,410	234	17.0	2.00	0.28	0.85	6.59	2.10
169	06402430	43.5814	103.4761	4	45.8	5,130	895	19.0	2.00	0.24	0.73	1.39	2.42
170	06404000	43.8725	103.3361	3	66.0	4,940	1,280	20.6	2.00	0.25	1.01	1.16	2.52
171	06404800	43.8019	103.4342	3	7.48	5,240	963	21.0	2.00	0.24	1.04	1.36	2.40
172	06404998	43.7611	103.3636	3	25.2	5,040	1,220	19.9	2.00	0.25	0.83	1.36	2.40
173	06406000	43.8281	103.1956	3	178	4,560	1,050	19.2	2.00	0.25	0.88	1.39	2.53
174	06406800	43.9675	103.6400	4	8.17	6,110	1,190	23.8	2.00	0.25	1.23	0.78	2.70

Table 10. *Basin characteristics, selected streamflow-gaging stations, Wyoming and surrounding states--Continued*

Map number	Station number	Latitude (degrees)	Longitude (degrees)	Region	Drainage area (square miles)	Mean elevation (feet above NAVD 88)	Mean basin slope (feet per mile)	Mean annual precipitation (inches)	2-year, 24-hour precipitation (inches)	Mean January precipitation (inches)	Mean March precipitation (inches)	Mean soils permeability (inches per hour)	Mean soils hydrologic index (unitless)
175	06409000	44.0136	103.8300	4	79.2	6,670	821	28.4	2.00	0.85	1.66	0.82	2.95
176	06422500	44.1439	103.4544	3	96.0	5,360	759	24.6	2.00	0.73	1.60	1.09	2.70
177	06426195	44.2825	105.4272	3	0.20	4,550	173	17.0	1.68	0.27	0.80	3.82	2.10
178	06426500	44.3219	104.9400	2	1,690	4,720	315	14.8	1.73	0.26	0.76	1.95	2.74
179	06427700	44.2292	104.4458	2	96.5	5,510	494	23.1	1.85	1.04	1.47	1.53	2.82
180	06429300	44.4583	104.3528	4	8.42	5,700	1,340	23.5	2.00	1.21	1.86	1.73	2.70
181	06429905	44.5203	104.0833	4	267	5,500	800	24.0	1.91	1.08	1.59	1.35	2.83
182	06430500	44.5739	104.0483	4	471	5,100	756	22.3	1.89	0.98	1.46	1.44	2.74
183	06430800	44.3270	103.8939	4	3.55	6,110	1,390	30.8	1.85	1.45	2.72	1.73	2.70
184	06430898	44.4011	103.8931	4	6.95	5,670	1,770	29.3	1.85	1.27	2.48	1.73	2.70
185	06432200	44.4636	103.7281	3	10.6	4,580	968	25.1	1.80	0.92	1.88	1.65	2.77
186	06432230	44.4745	103.7375	3	6.72	4,630	1,270	25.7	1.90	1.01	1.94	1.69	2.69
187	06433500	44.6669	103.8461	3	121	3,760	681	18.6	1.80	0.49	1.19	1.37	2.89
188	06434800	44.8256	103.8517	2	3.06	3,090	167	17.0	1.80	0.27	0.80	0.43	3.56
189	06436156	44.3433	103.7658	4	6.15	5,970	1,260	30.9	1.80	1.46	2.70	1.51	2.70
190	06436700	44.8142	103.6894	3	315	3,230	197	15.0	1.80	0.25	0.74	0.13	3.92
191	06437020	44.3356	103.6350	3	16.6	5,550	1,010	28.7	1.80	1.23	2.28	1.30	2.70
192	06437100	44.3911	103.6606	3	1.32	4,980	1,090	26.6	1.80	1.10	2.02	1.73	2.70
193	06437500	44.4814	103.2753	3	192	3,800	664	21.2	1.40	0.53	1.47	1.22	2.86
194	06443200	42.6197	103.6525	3	7.97	4,580	696	15.0	1.95	0.26	0.93	3.69	2.55
195	06443300	42.6103	103.5561	3	10.9	4,480	891	15.0	1.95	0.25	0.76	3.64	2.76
196	06443700	42.6883	103.5358	3	52.6	4,570	689	16.4	1.95	0.27	1.15	3.72	2.57
197	06444000	42.6925	103.4175	3	258	4,450	642	15.7	1.93	0.26	0.93	3.55	2.53
198	06456200	42.5939	103.0653	3	3.07	4,420	209	17.0	2.05	0.25	1.25	1.12	2.30
199	06616000	40.5494	106.0206	4	20.5	9,790	1,280	34.6	1.40	3.57	3.47	5.62	2.49

Table 10. *Basin characteristics, selected streamflow-gaging stations, Wyoming and surrounding states--Continued*

Map number	Station number	Latitude (degrees)	Longitude (degrees)	Region	Drainage area (square miles)	Mean elevation (feet above NAVD 88)	Mean basin slope (feet per mile)	Mean annual precipitation (inches)	2-year, 24-hour precipitation (inches)	Mean January precipitation (inches)	Mean March precipitation (inches)	Mean soils permeability (inches per hour)	Mean soils hydrologic index (unitless)
200	06620400	41.1833	106.2694	1	22.1	9,720	476	33.0	1.44	3.09	3.44	4.46	2.64
201	06621000	41.0811	106.3069	1	120	9,130	641	24.5	1.28	1.90	2.56	4.72	2.69
202	06622500	41.2083	106.5167	1	59.6	9,450	1,130	35.5	1.47	3.00	3.99	4.12	2.68
203	06622700	41.3703	106.5200	1	37.4	9,420	921	36.0	1.41	2.78	3.99	4.42	2.64
204	06623800	41.0236	106.8242	1	72.7	9,560	1,200	44.9	1.60	7.15	5.57	4.61	2.69
205	06624500	41.2139	106.7778	1	211	9,090	1,210	20.0	1.46	2.71	2.37	4.12	2.69
206	06625000	41.3033	106.7147	1	265	8,770	1,050	35.7	1.34	4.61	4.15	3.85	2.66
207	06628900	41.5861	106.6103	1	91.5	8,330	741	24.4	1.27	1.38	2.48	3.47	2.65
208	06629150	41.7347	106.7217	3	3.65	7,080	670	11.8	0.93	0.73	0.91	1.79	3.02
209	06629200	41.7386	106.7267	3	2.41	7,060	693	11.0	0.91	0.72	0.72	2.03	2.86
210	06629700	41.7425	106.8658	3	0.46	6,900	449	11.0	0.86	0.27	0.81	5.46	2.08
211	06629800	41.7622	107.2686	6	7.32	7,380	820	12.3	1.02	0.76	0.84	1.26	3.37
212	06630200	41.8625	106.5264	3	7.42	7,040	336	11.0	0.89	0.72	0.72	2.48	2.50
213	06630800	41.6531	106.3447	1	8.93	7,750	392	15.5	1.25	0.81	1.36	2.60	2.51
214	06631100	41.6400	106.3047	1	25.6	8,490	614	19.3	1.37	1.38	1.78	3.83	2.68
215	06631150	41.7500	106.3167	3	10.8	7,230	421	12.0	1.04	0.78	0.97	1.42	3.26
216	06632400	41.5853	106.2222	1	62.9	9,810	1,010	32.0	1.56	3.19	3.45	3.84	2.61
217	06632600	41.5550	106.1719	1	6.31	8,970	1,290	22.4	1.38	2.04	2.20	3.94	2.76
218	06632700	41.5856	106.1906	1	3.59	8,680	1,030	19.0	1.32	1.53	1.75	3.45	2.71
219	06634200	42.2800	105.8850	1	61.0	7,900	705	23.5	1.45	1.87	2.62	3.33	3.25
220	06634300	42.1300	106.0053	1	174	7,510	495	20.0	1.27	1.37	2.13	3.31	2.91
221	06634600	41.9533	106.1606	3	963	7,220	351	17.6	1.18	1.04	1.81	2.64	2.76
222	06634910	42.0089	106.4922	3	3.01	6,810	417	11.3	0.91	0.70	0.70	1.08	3.50
223	06636500	42.2472	106.8833	6	190	7,180	526	12.0	1.30	0.63	1.17	2.07	2.86
224	06637550	42.3750	108.8822	1	177	8,560	814	22.8	1.58	2.53	2.02	2.35	2.97

Table 10. *Basin characteristics, selected streamflow-gaging stations, Wyoming and surrounding states--Continued*

Map number	Station number	Latitude (degrees)	Longitude (degrees)	Region	Drainage area (square miles)	Mean elevation (feet above NAVD 88)	Mean basin slope (feet per mile)	Mean annual precipitation (inches)	2-year, 24-hour precipitation (inches)	Mean January precipitation (inches)	Mean March precipitation (inches)	Mean soils permeability (inches per hour)	Mean soils hydrologic index (unitless)
225	06637750	42.5497	108.7739	1	9.20	9,030	814	29.4	1.82	2.66	3.15	2.72	3.00
226	06638300	42.3489	107.8625	6	11.6	6,990	308	11.2	1.12	0.28	0.75	3.27	2.48
227	06638350	42.3397	107.4672	6	6.08	6,790	630	11.1	1.38	0.32	0.81	3.12	2.80
228	06641400	42.5325	106.6989	3	9.33	6,450	593	11.4	1.02	0.39	0.85	2.59	2.74
229	06642700	42.4892	106.4578	3	11.5	6,840	783	17.6	1.16	0.87	1.84	2.58	2.61
230	06642730	42.5297	106.4606	3	1.34	6,160	546	12.1	1.01	0.55	0.98	1.59	3.23
231	06642760	42.5419	106.4589	3	117	6,780	616	16.8	1.18	0.83	1.70	1.35	3.28
232	06643300	42.7130	106.5369	3	5.39	5,920	712	13.7	1.20	0.55	1.14	2.13	3.10
233	06644200	42.9536	106.8078	3	2.64	6,140	761	11.8	0.89	0.25	0.76	2.48	2.79
234	06644840	43.1056	106.1514	3	2.01	5,830	551	13.0	1.33	0.72	0.72	1.13	3.62
235	06645150	42.6497	106.1794	1	9.91	7,300	1,310	27.1	1.55	1.25	2.94	1.38	3.59
236	06646000	42.7117	106.0286	1	139	7,510	896	26.4	1.55	1.47	3.48	2.75	3.30
237	06646500	42.8617	105.8672	1	212	6,920	832	22.3	1.49	1.13	2.63	2.51	3.27
238	06646700	42.7936	105.8278	3	2.60	5,720	1,070	14.3	1.33	0.51	0.92	2.30	2.95
239	06647500	42.6122	105.8581	1	63.0	7,910	1,260	26.3	1.61	1.75	3.27	3.58	3.73
240	06647890	42.7511	105.7403	1	7.18	6,330	749	15.0	1.31	0.71	1.19	2.06	2.85
241	06648780	43.0097	105.6667	3	1.38	5,420	257	13.0	1.53	0.26	0.78	3.26	2.60
242	06649900	42.6894	105.3917	3	8.53	5,240	803	13.0	1.30	0.27	0.77	2.89	2.71
243	06651800	42.6692	105.2122	3	27.8	5,050	340	13.0	1.38	0.26	0.78	3.13	2.48
244	06652400	42.7556	104.9583	3	6.95	5,220	423	15.0	1.65	0.26	0.78	1.67	2.70
245	06661000	41.2950	106.0342	1	157	9,100	798	21.3	1.38	1.89	2.06	5.49	2.73
246	06661580	41.4581	106.0100	1	11.2	8,670	648	17.7	1.37	1.36	1.73	2.44	2.79
247	06664500	41.8681	105.2117	1	225	6,710	765	16.9	1.52	0.83	1.37	3.84	3.34
248	06667500	42.1661	105.2064	1	370	7,240	787	17.6	1.42	0.95	1.55	3.98	3.02
249	06668040	42.2158	105.2286	3	1.30	5,620	606	15.0	1.32	0.27	0.80	3.40	3.07

Table 10. *Basin characteristics, selected streamflow-gaging stations, Wyoming and surrounding states--Continued*

Map number	Station number	Latitude (degrees)	Longitude (degrees)	Region	Drainage area (square miles)	Mean elevation (feet above NAVD 88)	Mean basin slope (feet per mile)	Mean annual precipitation (inches)	2-year, 24-hour precipitation (inches)	Mean January precipitation (inches)	Mean March precipitation (inches)	Mean soils permeability (inches per hour)	Mean soils hydrologic index (unitless)
250	06670985	42.3039	104.3050	3	20.0	4,620	382	13.0	1.70	0.24	0.72	3.85	2.22
251	06671000	42.1256	104.3267	3	522	4,770	324	14.5	1.68	0.31	0.85	5.39	2.12
252	06675300	41.4558	104.8833	4	8.16	6,240	318	17.0	1.52	0.59	1.27	7.20	1.80
253	06679000	41.9458	103.8264	3	77.2	4,370	249	15.0	1.75	0.27	0.80	2.89	2.16
254	06746095	40.5400	105.8822	4	3.01	10,780	1,540	44.1	1.60	4.75	4.63	7.15	2.50
255	06748200	40.5517	105.6264	4	3.59	11,030	2,120	31.7	1.90	3.60	3.12	7.78	2.47
256	06748510	40.6386	105.6611	4	0.88	10,910	1,120	25.2	1.60	2.14	2.63	5.16	2.60
257	06748530	40.6230	105.5644	4	12.3	9,830	1,320	20.4	1.70	1.31	2.05	5.16	2.60
258	06748600	40.6470	105.4931	4	92.4	9,870	1,430	22.5	1.70	1.79	2.22	5.79	2.57
259	06754500	41.1750	105.2514	4	25.8	8,140	719	19.2	1.87	1.31	1.73	3.23	3.65
260	06755000	41.1264	105.1939	4	13.9	7,800	436	17.1	1.84	0.78	1.25	3.24	3.70
261	06761900	41.2564	104.0806	3	0.44	5,300	73	17.0	1.81	0.26	1.29	5.91	2.20
262	06762500	41.2306	103.8911	3	1,230	5,850	182	15.9	1.68	0.38	1.23	5.65	2.08
263	06762600	41.3197	104.0803	3	7.82	5,340	95	17.0	1.84	0.75	1.25	4.74	2.20
264	09188500	43.0189	110.1175	5	468	9,310	1,370	29.3	1.51	4.03	2.50	4.90	2.78
265	09189500	42.9444	110.3889	5	43.0	8,800	1,170	31.0	1.57	4.77	2.95	2.96	2.50
266	09196500	43.0306	109.7694	1	75.8	10,430	2,020	29.5	1.65	4.18	2.57	2.87	2.83
267	09198500	42.8833	109.7167	1	87.5	9,610	1,350	26.5	1.58	3.67	2.21	3.73	2.43
268	09199500	42.8558	109.7200	1	37.2	9,320	1,140	26.0	1.57	3.57	2.14	4.06	2.25
269	09201000	42.7503	109.7281	1	552	8,680	1,050	22.0	1.36	2.82	1.73	4.35	2.64
270	09203000	42.6667	109.4167	1	79.2	9,760	1,180	29.0	1.74	4.03	2.36	3.33	2.37
271	09204000	42.7500	109.5167	1	45.4	9,610	915	28.3	1.56	3.93	2.26	3.50	2.24
272	09204500	42.7000	109.7167	1	348	8,340	702	20.6	1.34	2.46	1.54	4.45	2.56
273	09204700	42.5853	109.6231	6	2.26	7,330	188	13.0	1.02	0.78	0.78	3.20	2.50
274	09205500	42.6583	110.3417	5	64.9	8,950	1,430	39.3	1.63	5.86	3.37	2.70	2.53

Table 10. *Basin characteristics, selected streamflow-gaging stations, Wyoming and surrounding states--Continued*

Map number	Station number	Latitude (degrees)	Longitude (degrees)	Region	Drainage area (square miles)	Mean elevation (feet above NAVD 88)	Mean basin slope (feet per mile)	Mean annual precipitation (inches)	2-year, 24-hour precipitation (inches)	Mean January precipitation (inches)	Mean March precipitation (inches)	Mean soils permeability (inches per hour)	Mean soils hydrologic index (unitless)
275	09207650	42.4245	110.1097	6	47.2	7,270	454	11.8	1.14	1.01	0.81	1.65	3.21
276	09208000	42.5083	110.6694	5	6.30	9,000	1,540	40.8	1.67	6.25	4.02	2.36	2.70
277	09210500	42.0961	110.4158	5	152	8,110	1,170	23.8	1.41	3.20	2.03	3.28	2.72
278	09212500	42.5714	109.2828	1	94.0	9,510	1,140	27.9	1.66	3.80	2.28	3.30	2.34
279	09215000	42.1297	109.3231	6	378	7,270	385	11.0	1.02	0.64	0.85	2.11	3.32
280	09216290	41.7844	109.7342	6	16.6	6,440	274	7.5	0.84	0.25	0.75	3.57	3.03
281	09216350	41.7319	109.5108	6	15.7	6,960	364	9.0	0.97	0.30	0.89	2.66	3.41
282	09216400	41.5594	109.5106	6	45.1	7,050	769	8.4	1.02	0.27	0.82	2.04	3.45
283	09216537	41.6394	108.1286	6	32.8	7,010	317	7.0	0.99	0.24	0.41	2.60	3.50
284	09216550	41.6750	108.7361	6	152	6,970	380	8.5	1.00	0.30	0.70	2.85	3.32
285	09216560	41.6778	108.7861	6	765	7,020	349	8.2	1.00	0.28	0.57	2.64	3.32
286	09216600	41.4569	108.9417	6	7.88	6,990	737	9.0	1.02	0.33	0.69	2.28	3.55
287	09216695	41.4817	108.9714	6	18.2	7,270	793	10.2	1.05	0.58	0.71	2.47	2.98
288	09216700	41.4833	108.9667	6	515	7,320	602	10.7	1.04	0.51	0.78	2.37	3.30
289	09216900	41.5328	109.3803	6	1.65	6,800	1,510	7.1	1.02	0.24	0.71	1.87	3.76
290	09217900	40.9592	110.5794	1	130	10,460	1,510	34.6	1.30	3.95	3.40	3.36	2.83
291	09218500	41.0317	110.5786	1	152	10,310	1,390	33.5	1.50	3.71	3.34	3.19	2.84
292	09220000	41.0542	110.3978	1	53.0	10,350	1,040	32.1	1.46	2.92	2.96	2.91	2.85
293	09220500	41.0222	110.4786	1	37.2	9,790	533	27.9	1.40	1.96	2.74	1.97	2.83
294	09221680	41.3847	110.1867	6	8.83	6,750	340	7.0	0.91	0.23	0.69	2.85	3.40
295	09221700	41.3833	110.1833	6	10.2	6,750	341	7.0	0.91	0.23	0.69	2.85	3.40
296	09223000	42.1105	110.7089	5	128	8,480	1,090	32.0	1.47	4.58	2.99	3.09	2.80
297	09224000	41.7833	110.5333	5	386	7,910	829	23.6	1.31	3.05	2.05	2.32	3.03
298	09224800	41.5436	109.7600	6	5.22	6,310	193	7.0	0.86	0.23	0.70	2.85	3.40
299	09224810	41.4597	109.6222	6	12.0	6,660	468	7.3	0.93	0.24	0.73	2.77	3.40

Table 10. *Basin characteristics, selected streamflow-gaging stations, Wyoming and surrounding states--Continued*

Map number	Station number	Latitude (degrees)	Longitude (degrees)	Region	Drainage area (square miles)	Mean elevation (feet above NAVD 88)	Mean basin slope (feet per mile)	Mean annual precipitation (inches)	2-year, 24-hour precipitation (inches)	Mean January precipitation (inches)	Mean March precipitation (inches)	Mean soils permeability (inches per hour)	Mean soils hydrologic index (unitless)
300	09224820	41.4250	109.6153	6	3.59	6,580	512	7.0	0.91	0.23	0.70	2.86	3.39
301	09224840	41.4111	109.6014	6	1.26	6,580	674	7.0	0.90	0.23	0.70	2.85	3.40
302	09224980	41.3736	109.6444	6	423	6,830	326	9.4	0.97	0.39	0.87	2.87	3.18
303	09225200	41.1706	109.6094	6	6.57	6,650	656	9.2	1.00	0.26	0.77	2.34	3.64
304	09225300	41.0611	109.6181	6	13.0	6,560	478	16.0	1.04	0.44	1.33	2.84	3.40
305	09226000	41.0064	110.2703	1	56.0	10,310	980	31.4	1.40	2.98	2.99	2.70	2.82
306	09226500	40.9444	110.1786	1	28.1	10,470	1,120	30.7	1.53	2.64	2.99	2.97	2.75
307	09227500	40.9472	110.2167	1	23.0	10,680	1,270	34.9	1.44	3.20	3.15	2.73	2.78
308	09229450	41.0206	109.6794	6	3.15	6,590	671	9.0	1.10	0.25	0.75	2.85	3.40
309	09235600	40.7681	109.3183	1	24.6	8,140	1,010	20.0	1.15	1.29	1.84	3.71	1.97
310	09241000	40.7175	106.9153	1	216	9,100	1,320	38.0	1.70	5.20	4.48	4.83	2.30
311	09244500	40.7322	107.1689	1	45.4	8,610	1,010	27.0	1.40	3.39	3.11	2.06	2.29
312	09245000	40.6697	107.2844	1	64.2	8,420	1,000	26.0	1.30	3.25	2.94	1.79	2.46
313	09245500	40.6806	107.2867	1	21.0	8,450	1,120	33.3	1.60	4.17	3.73	1.69	2.62
314	09251800	41.0500	106.9583	1	9.64	9,600	1,350	49.8	1.65	7.13	6.13	3.97	2.56
315	09253000	40.9994	107.1428	1	285	8,550	1,110	33.3	1.50	4.58	3.80	3.64	2.42
316	09253400	41.1333	107.0639	1	13.0	9,590	1,210	48.3	1.64	5.28	5.58	3.87	2.54
317	09254500	40.8894	107.3300	1	80.0	8,760	932	36.2	1.40	4.66	4.09	2.30	2.30
318	09255000	40.9825	107.3822	1	161	8,390	948	33.0	1.30	4.21	3.63	1.96	2.47
319	09255500	41.2181	107.3717	1	200	7,790	593	28.4	1.36	3.32	2.86	2.98	2.69
320	09256000	41.0961	107.3789	1	330	7,860	738	29.1	1.36	3.47	2.94	3.11	2.72
321	09258000	40.9156	107.5211	1	24.0	8,050	894	29.8	1.20	3.69	3.17	1.14	2.87
322	09258200	41.3400	107.6706	6	49.7	6,940	366	12.5	1.09	0.97	0.95	3.65	2.47
323	09258900	41.1319	107.6458	6	1,180	6,990	404	13.1	1.07	1.04	1.07	2.47	2.91
324	10010400	40.8736	110.7833	1	34.6	10,380	2,060	40.2	1.60	5.37	4.38	4.43	2.85

Table 10. *Basin characteristics, selected streamflow-gaging stations, Wyoming and surrounding states--Continued*

Map number	Station number	Latitude (degrees)	Longitude (degrees)	Region	Drainage area (square miles)	Mean elevation (feet above NAVD 88)	Mean basin slope (feet per mile)	Mean annual precipitation (inches)	2-year, 24-hour precipitation (inches)	Mean January precipitation (inches)	Mean March precipitation (inches)	Mean soils permeability (inches per hour)	Mean soils hydrologic index (unitless)
325	10011500	40.9653	110.8528	1	172	9,720	1,320	33.6	1.61	3.60	3.70	4.33	2.67
326	10012000	40.9917	110.8417	1	59.0	9,230	837	29.0	1.48	2.78	3.12	2.38	2.71
327	10015700	41.1292	110.8058	1	64.2	7,980	530	21.7	1.21	1.65	2.37	1.51	3.05
328	10019700	41.4283	110.9725	5	8.93	7,330	854	14.9	1.00	0.94	1.42	0.80	3.30
329	10021000	41.4820	111.2661	5	56.8	7,890	1,220	32.2	1.40	3.33	3.65	1.88	2.63
330	10027000	41.8100	110.9700	5	246	7,190	831	14.7	1.11	1.29	1.19	1.04	3.21
331	10032000	42.2933	110.8717	5	165	8,280	1,680	34.3	1.48	4.86	3.15	4.77	2.76
332	10040000	42.3917	110.9833	5	45.3	7,250	1,410	24.2	1.21	2.76	2.05	6.95	2.80
333	10040500	42.4000	110.9917	5	37.6	7,460	1,480	26.9	1.22	3.46	2.28	3.99	2.73
334	10041000	42.4028	111.0250	5	113	7,340	1,460	25.5	1.21	3.02	2.17	4.97	2.76
335	10047500	42.3297	111.2367	5	49.5	7,360	1,710	26.5	1.20	2.43	2.32	1.95	2.61
336	10058600	42.1847	111.4250	5	24.0	7,690	1,450	41.1	1.20	4.04	3.68	0.66	2.74
337	10069000	42.4958	111.3139	5	22.2	7,830	2,150	35.4	1.30	4.13	3.28	1.79	2.67
338	10128500	40.7372	111.2472	1	162	9,060	1,830	33.4	1.65	3.46	3.73	3.98	2.60
339	13010065	44.0892	110.6939	1	486	8,200	845	47.4	1.45	6.74	4.29	3.81	2.89
340	13011500	43.8511	110.5164	1	169	8,140	1,080	36.2	1.42	5.14	2.93	3.75	2.85
341	13011800	43.7861	110.1417	1	0.80	9,190	762	39.6	1.73	5.59	3.70	3.42	2.94
342	13011900	43.8372	110.4392	1	323	8,950	1,430	37.0	1.58	5.04	3.25	4.71	2.76
343	13018300	43.4522	110.7033	5	10.6	8,300	2,130	34.8	1.30	5.06	3.04	5.68	2.87
344	13019210	43.1333	110.2278	5	3.41	8,170	1,550	28.2	1.45	3.99	2.32	7.10	2.80
345	13019220	43.1500	110.2556	5	2.77	7,780	1,200	25.9	1.40	3.62	2.07	7.10	2.80
346	13019400	43.2278	110.5047	5	58.6	8,080	1,870	27.5	1.44	3.97	2.36	6.68	2.77
347	13019438	43.2989	110.5258	5	21.1	7,960	1,910	27.7	1.25	3.92	2.32	6.32	2.84
348	13019500	43.2986	110.6694	5	564	7,970	1,610	26.6	1.38	3.75	2.25	6.15	2.82
349	13020000	43.3164	110.7383	5	46.8	7,460	1,740	29.0	1.34	3.74	2.54	2.36	2.70

Table 10. *Basin characteristics, selected streamflow-gaging stations, Wyoming and surrounding states--Continued*

Map number	Station number	Latitude (degrees)	Longitude (degrees)	Region	Drainage area (square miles)	Mean elevation (feet above NAVD 88)	Mean basin slope (feet per mile)	Mean annual precipitation (inches)	2-year, 24-hour precipitation (inches)	Mean January precipitation (inches)	Mean March precipitation (inches)	Mean soils permeability (inches per hour)	Mean soils hydrologic index (unitless)
350	13021000	43.2494	110.7778	5	8.71	7,280	1,890	23.9	1.33	2.92	1.99	2.36	2.70
351	13022550	43.1942	110.9269	5	3.88	7,940	2,840	29.0	1.46	3.90	2.70	2.36	2.70
352	13023000	43.1430	110.9761	5	448	8,110	1,870	35.0	1.50	5.01	3.15	3.11	2.76
353	13023800	42.5194	110.8958	5	3.60	7,580	998	28.0	1.32	3.80	2.28	2.37	2.70
354	13025500	42.6750	111.0069	5	115	7,450	1,320	29.0	1.20	3.28	2.60	2.00	2.97
355	13027000	42.9028	110.9000	5	21.3	8,470	2,630	40.7	1.54	6.03	3.68	2.36	2.70
356	13027200	42.9772	111.1956	5	3.30	7,090	1,470	28.2	1.62	3.32	2.79	0.00	3.20
357	13029500	43.1806	111.1153	5	108	7,020	1,470	25.0	1.30	3.00	2.20	0.54	3.22
358	13030000	43.2597	111.0667	5	36.8	7,960	2,730	30.8	1.53	4.17	2.87	2.70	2.70
359	13030500	43.3236	111.1111	5	59.2	7,920	2,640	34.1	1.48	4.61	3.12	2.87	2.84
360	13032000	43.2833	111.2214	5	77.1	7,190	2,070	24.1	1.30	2.61	2.06	0.49	3.20
361	13038900	44.6472	111.3417	1	20.8	8,290	1,850	41.0	1.40	4.77	4.18	7.33	2.23
362	13046680	44.1858	111.0053	1	86.9	7,830	384	55.7	1.33	7.67	5.50	3.35	3.02
363	13050700	43.4972	110.9833	5	3.27	8,290	2,370	41.7	1.55	5.93	3.85	2.30	2.74
364	13050800	43.5633	111.0667	5	21.4	8,500	2,200	55.0	1.54	8.77	5.55	3.64	2.66

Table 11. *Peak-flow characteristics, selected streamflow-gaging stations, Wyoming and surrounding states*

		Period of record			Statistics of annual peak flow, in base-10 logarithms of cubic feet per second			Peak flow, in cubic feet per second, for selected recurrence intervals, in years									
Map number	Station number	Begin year	End year	Number of annual peaks flows	Mean	Standard deviation	Skew	1.5	2	2.33	5	10	25	50	100	200	500
1	06036905	1984	1996	13	2.96	0.162	0.245	772	904	966	1,250	1,500	1,820	2,080	2,350	2,630	3,020
2	06037000	1984	1996	13	2.83	0.265	-0.237	534	697	778	1,140	1,460	1,880	2,210	2,530	2,870	3,320
3	06037500	1914	2000	74	3.14	0.123	0.107	1,220	1,380	1,450	1,750	2,000	2,300	2,520	2,740	2,960	3,250
4	06038550	1974	2000	27	2.63	0.182	0.420	355	423	455	613	758	962	1,130	1,320	1,520	1,810
5	06043200	1959	1975	17	2.42	0.205	0.280	214	261	283	394	495	639	756	884	1,020	1,230
6	06043300	1959	2000	42	1.18	0.275	0.206	11.4	14.9	16.7	25.8	34.7	48.2	59.9	73.1	87.9	110
7	06043500	1890	2000	72	3.70	0.138	-0.064	4,450	5,110	5,410	6,660	7,630	8,820	9,670	10,500	11,300	12,400
8	06187500	1923	1943	21	2.49	0.209	-0.266	257	318	346	469	569	692	782	870	956	1,070
9	06187950	1989	2000	12	3.17	0.135	0.040	1,310	1,500	1,590	1,950	2,240	2,600	2,870	3,130	3,390	3,740
10	06188000	1923	2000	61	3.94	0.127	0.089	7,710	8,740	9,210	11,200	12,800	14,800	16,200	17,700	19,100	21,000
11	06191000	1939	2000	51	3.08	0.134	-0.087	1,080	1,230	1,300	1,590	1,820	2,090	2,280	2,470	2,650	2,890
12	06191500	1890	2000	94	4.23	0.129	-0.341	15,400	17,500	18,500	22,300	25,000	28,000	30,100	32,000	33,800	36,000
13	06204050	1966	2000	35	2.81	0.234	-0.307	533	675	743	1,040	1,280	1,590	1,810	2,030	2,250	2,540
14	06206500	1918	1971	30	3.07	0.116	0.801	1,030	1,140	1,190	1,460	1,690	2,020	2,280	2,570	2,880	3,330
15	06207500	1922	2000	79	3.88	0.105	0.073	6,830	7,580	7,910	9,310	10,400	11,700	12,600	13,500	14,400	15,600
16	06207600	1975	1991	17	1.17	0.489	-0.154	9.33	15.2	18.6	38.5	61.5	100	136	179	229	307
17	06207800	1960	1978	12	2.05	0.528	0.535	62.2	102	126	303	570	1,180	1,930	3,070	4,780	8,340
18	06209500	1932	2000	53	3.08	0.169	-0.029	1,020	1,210	1,300	1,680	1,990	2,380	2,670	2,970	3,260	3,660
19	06210000	1938	1956	19	2.70	0.141	0.115	442	507	537	670	777	913	1,010	1,120	1,220	1,360
20	06210500	1932	1944	12	2.78	0.217	0.275	487	601	657	930	1,180	1,550	1,850	2,180	2,540	3,080
21	06215000	1921	1974	12	2.13	0.367	0.237	92.9	133	154	276	413	644	866	1,140	1,460	2,000
22	06216000	1922	2000	37	2.17	0.405	0.591	94.0	137	161	317	520	918	1,360	1,960	2,780	4,330
23	06218500	1946	1992	47	3.07	0.129	-0.279	1,050	1,190	1,260	1,520	1,710	1,930	2,080	2,220	2,350	2,520
24	06218700	1961	1984	21	1.72	0.497	-0.048	32.4	53.1	65.1	138	227	383	537	725	955	1,330
25	06220500	1950	1996	29	3.52	0.148	-0.023	2,880	3,340	3,550	4,450	5,160	6,050	6,700	7,340	7,980	8,830
26	06221400	1918	2000	35	2.95	0.126	-0.148	805	914	962	1,160	1,310	1,480	1,610	1,730	1,840	1,980
27	06221500	1909	1958	23	3.00	0.102	0.044	903	999	1,040	1,220	1,350	1,510	1,630	1,740	1,850	1,990

Table 11. *Peak-flow characteristics, selected streamflow-gaging stations, Wyoming and surrounding states--Continued*

		Period of record			Statistics of annual peak flow, in base-10 logarithms of cubic feet per second			Peak flow, in cubic feet per second, for selected recurrence intervals, in years									
Map number	Station number	Begin year	End year	Number of annual peaks flows	Mean	Standard deviation	Skew	1.5	2	2.33	5	10	25	50	100	200	500
28	06222500	1921	2000	31	2.63	0.274	-0.044	330	434	485	735	966	1,290	1,550	1,830	2,130	2,560
29	06222700	1963	1993	31	2.46	0.202	-0.174	240	294	320	431	523	638	723	808	893	1,010
30	06223500	1909	2000	31	2.33	0.320	0.192	156	213	243	403	570	832	1,070	1,350	1,670	2,170
31	06224000	1941	2000	47	3.33	0.137	-0.268	1,910	2,200	2,330	2,840	3,220	3,660	3,970	4,250	4,530	4,870
32	06226200	1961	1981	20	1.92	0.646	-0.280	46.8	89.8	117	298	536	975	1,410	1,960	2,610	3,660
33	06226300	1959	1981	22	2.36	0.342	-0.211	170	240	276	456	628	873	1,070	1,290	1,520	1,840
34	06228350	1979	2000	22	3.08	0.172	-0.207	1,040	1,230	1,320	1,700	2,000	2,370	2,630	2,890	3,130	3,460
35	06228800	1989	2000	12	3.04	0.218	-0.270	920	1,150	1,260	1,720	2,100	2,580	2,930	3,270	3,610	4,060
36	06229000	1921	1940	20	3.02	0.240	-0.247	855	1,090	1,200	1,710	2,130	2,680	3,090	3,500	3,910	4,460
37	06229700	1965	1981	16	1.21	0.726	-0.255	8.48	17.6	23.8	68.2	133	263	403	585	816	1,210
38	06229900	1961	2000	34	1.93	0.426	-0.041	56.2	85.8	102	195	298	468	626	811	1,030	1,370
39	06232000	1946	1963	18	3.08	0.223	0.213	957	1,190	1,300	1,850	2,360	3,090	3,690	4,340	5,040	6,080
40	06233000	1946	2000	53	2.80	0.245	-0.319	511	655	725	1,030	1,280	1,600	1,840	2,070	2,300	2,600
41	06233360	1965	1984	20	1.47	0.872	-0.394	14.0	33.9	48.5	165	353	750	1,190	1,760	2,490	3,730
42	06234700	1960	1972	13	1.55	0.571	-0.579	23.0	41.2	52.0	112	177	274	354	439	528	649
43	06234800	1969	1981	12	1.73	0.702	-0.138	28.0	56.5	75.5	215	422	855	1,340	1,990	2,850	4,370
44	06235700	1961	1973	12	2.49	0.501	-0.085	195	321	395	839	1,370	2,310	3,210	4,320	5,640	7,790
45	06236000	1951	1984	27	2.44	0.529	0.167	160	268	333	767	1,350	2,520	3,790	5,510	7,800	11,900
46	06238760	1965	1984	20	1.46	0.595	0.214	15.7	28.0	35.6	91.6	175	357	573	884	1,320	2,170
47	06239000	1923	1973	22	2.91	0.515	0.165	486	804	992	2,230	3,880	7,080	10,500	15,200	21,200	32,100
48	06255200	1958	1969	12	2.49	0.413	-0.130	213	321	381	706	1,050	1,600	2,080	2,630	3,260	4,200
49	06255300	1959	1981	23	1.24	0.608	-0.240	10.0	18.7	24.0	58.2	102	182	261	358	480	700
50	06255500	1949	1968	15	2.61	0.805	-0.388	207	467	651	2,020	4,080	8,220	12,600	18,200	25,100	36,400
51	06256000	1949	1968	20	2.21	0.422	0.100	106	161	191	369	574	928	1,270	1,690	2,190	3,030
52	06256600	1963	1981	19	2.03	0.412	-0.071	72.1	109	129	240	361	555	730	934	1,170	1,530
53	06256700	1960	1981	22	1.67	0.578	-0.141	27.3	48.7	61.8	146	255	456	658	912	1,220	1,740
54	06256900	1966	1981	16	2.28	0.497	-0.031	118	193	237	505	832	1,410	1,980	2,690	3,560	4,980
55	06257000	1923	1973	27	3.19	0.457	-0.031	1,000	1,580	1,910	3,820	6,040	9,820	13,400	17,800	22,900	31,300

Table 11. *Peak-flow characteristics, selected streamflow-gaging stations, Wyoming and surrounding states--Continued*

		Period of record			Statistics of annual peak flow, in base-10 logarithms of cubic feet per second			Peak flow, in cubic feet per second, for selected recurrence intervals, in years									
Map number	Station number	Begin year	End year	Number of annual peaks flows	Mean	Standard deviation	Skew	1.5	2	2.33	5	10	25	50	100	200	500
56	06257500	1949	1973	23	2.57	0.487	-0.216	242	395	483	985	1,550	2,480	3,330	4,310	5,430	7,150
57	06258400	1959	1972	14	2.33	0.295	-0.296	170	225	255	389	508	667	789	914	1,040	1,210
58	06260000	1932	1995	36	2.69	0.257	0.249	376	482	535	807	1,070	1,460	1,800	2,180	2,610	3,250
59	06260500	1945	1959	15	2.77	0.244	0.002	465	592	654	950	1,220	1,580	1,880	2,190	2,520	2,990
60	06262000	1941	1962	20	2.54	0.448	0.222	218	336	404	823	1,340	2,300	3,290	4,570	6,200	9,040
61	06265200	1960	1981	21	2.19	0.699	-0.331	83.8	170	227	616	1,150	2,160	3,180	4,440	5,980	8,450
62	06265600	1961	1984	24	1.99	0.370	-0.161	69.5	101	117	203	289	418	527	648	780	972
63	06265800	1958	1978	21	2.40	0.284	0.203	188	248	278	436	594	833	1,040	1,280	1,550	1,960
64	06266460	1965	1981	17	1.49	0.729	-0.106	15.4	31.9	43.0	128	261	550	885	1,350	1,980	3,140
65	06267260	1964	1984	21	1.90	0.530	-0.040	47.9	81.2	101	226	383	671	963	1,330	1,790	2,550
66	06267400	1972	1991	19	2.80	0.287	0.148	472	626	704	1,110	1,500	2,100	2,620	3,200	3,850	4,830
67	06268500	1951	1986	35	3.02	0.282	0.021	798	1,060	1,180	1,830	2,440	3,320	4,050	4,850	5,720	6,990
68	06269700	1961	1974	14	1.98	0.385	-0.360	69.1	102	120	206	290	407	502	601	704	847
69	06270000	1938	1992	32	3.01	0.289	0.056	771	1,030	1,150	1,800	2,430	3,350	4,130	5,000	5,940	7,350
70	06270200	1962	1974	13	1.75	0.348	-0.019	40.2	56.8	65.6	111	158	229	292	362	440	559
71	06270300	1961	1974	14	1.23	0.161	-0.388	15.0	17.6	18.9	23.7	27.2	31.3	34.1	36.7	39.2	42.2
72	06271000	1911	1972	41	3.21	0.147	-0.053	1,410	1,630	1,740	2,170	2,510	2,940	3,240	3,550	3,840	4,240
73	06272500	1921	1953	19	3.38	0.195	0.491	1,940	2,340	2,530	3,490	4,390	5,720	6,840	8,090	9,480	11,600
74	06273000	1943	1973	30	2.67	0.159	0.251	399	466	497	640	763	926	1,050	1,190	1,320	1,520
75	06274100	1960	1971	12	2.83	0.428	0.380	427	642	763	1,530	2,510	4,350	6,320	8,920	12,400	18,500
76	06274190	1965	1984	20	1.43	0.737	-0.291	14.0	29.4	39.9	115	225	445	678	979	1,360	1,990
77	06274200	1961	1971	11	1.85	0.397	-0.091	49.1	73.0	86.0	156	231	347	451	570	704	907
78	06274250	1959	1981	23	3.06	0.350	-0.147	840	1,190	1,380	2,320	3,250	4,610	5,760	7,010	8,380	10,400
79	06274500	1946	1971	25	3.33	0.228	0.343	1,670	2,080	2,280	3,300	4,280	5,720	6,960	8,330	9,870	12,200
80	06275000	1946	1972	47	3.07	0.265	-0.076	918	1,200	1,330	1,990	2,590	3,410	4,070	4,760	5,490	6,530
81	06276500	1921	1940	79	3.58	0.261	-0.172	3,030	3,940	4,390	6,460	8,290	10,700	12,600	14,600	16,600	19,400
82	06277700	1960	1981	21	1.92	0.642	0.170	42.9	80.3	104	287	571	1,210	1,990	3,140	4,780	8,020
83	06277750	1960	1981	20	1.61	0.550	-0.410	25.9	45.3	56.8	123	197	316	421	538	667	855

Table 11. *Peak-flow characteristics, selected streamflow-gaging stations, Wyoming and surrounding states--Continued*

		Period of record			Statistics of annual peak flow, in base-10 logarithms of cubic feet per second			Peak flow, in cubic feet per second, for selected recurrence intervals, in years									
Map number	Station number	Begin year	End year	Number of annual peaks flows	Mean	Standard deviation	Skew	1.5	2	2.33	5	10	25	50	100	200	500
84	06278300	1957	2000	44	2.86	0.128	0.282	636	720	759	932	1,070	1,260	1,400	1,540	1,690	1,890
85	06278400	1961	1974	13	2.40	0.106	0.294	228	253	264	313	353	403	440	478	516	567
86	06278500	1941	2000	60	3.13	0.144	-0.049	1,190	1,370	1,450	1,810	2,090	2,430	2,680	2,930	3,170	3,490
87	06279020	1967	1981	13	2.39	0.568	0.330	134	232	292	730	1,390	2,840	4,590	7,170	10,900	18,300
88	06280300	1957	2000	43	3.59	0.136	0.171	3,410	3,900	4,130	5,120	5,930	6,960	7,740	8,530	9,330	10,400
89	06287500	1939	1978	22	2.64	0.405	0.571	277	404	474	932	1,520	2,680	3,940	5,670	8,020	12,400
90	06288200	1968	1978	11	2.85	0.474	0.345	425	669	810	1,750	2,990	5,460	8,190	11,900	16,900	26,200
91	06289000	1939	2000	62	3.01	0.184	-0.112	873	1,050	1,130	1,490	1,790	2,160	2,430	2,710	2,980	3,340
92	06290000	1935	2000	40	2.51	0.327	0.547	224	305	347	598	887	1,390	1,900	2,530	3,340	4,730
93	06290500	1939	2000	60	3.10	0.234	0.603	962	1,190	1,310	1,940	2,580	3,590	4,500	5,570	6,830	8,840
94	06291000	1939	1992	19	2.34	0.335	0.087	156	217	248	418	593	865	1,110	1,390	1,700	2,190
95	06291500	1939	2000	55	2.59	0.198	-0.099	328	400	434	585	710	870	991	1,110	1,240	1,400
96	06293300	1973	2000	28	1.40	0.608	-0.486	15.5	28.7	36.9	85.1	141	232	312	401	499	641
97	06295100	1960	2000	34	1.81	0.428	-0.256	44.1	68.0	81.1	151	224	335	431	537	653	823
98	06296500	1946	1957	12	2.41	0.191	0.289	213	256	276	376	466	591	693	802	919	1,090
99	06297000	1946	1972	27	2.94	0.153	-0.023	758	882	939	1,190	1,380	1,630	1,810	1,990	2,170	2,400
100	06298000	1919	2000	71	3.19	0.170	-0.361	1,360	1,620	1,740	2,210	2,560	2,980	3,270	3,540	3,790	4,110
101	06298500	1951	1974	23	2.10	0.325	0.121	90.4	124	142	236	333	484	618	772	948	1,220
102	06299500	1944	2000	57	2.46	0.246	-0.072	228	292	323	468	597	772	910	1,050	1,200	1,410
103	06299900	1967	1981	15	2.42	0.479	0.153	163	261	317	674	1,120	1,960	2,830	3,960	5,400	7,910
104	06300500	1954	2000	46	2.70	0.162	0.362	423	495	528	688	828	1,020	1,170	1,340	1,510	1,760
105	06301480	1991	2000	10	1.96	0.104	-0.161	83.2	92.3	96.4	112	124	138	147	156	164	175
106	06301500	1954	2000	45	2.64	0.119	0.076	396	445	467	562	636	727	794	859	924	1,010
107	06306100	1976	1985	10	1.71	0.465	0.392	31.1	48.5	58.5	125	213	389	584	853	1,220	1,900
108	06306900	1958	1986	29	1.86	0.664	0.141	36.8	70.5	92.5	262	530	1,140	1,900	3,010	4,600	7,770
109	06306950	1958	1996	38	1.12	0.874	-0.393	6.23	15.1	21.7	74.0	158	337	534	794	1,120	1,680
110	06307520	1972	1991	20	1.51	0.911	-0.052	13.6	33.6	48.8	194	480	1,250	2,320	4,020	6,630	12,100
111	06307600	1974	1995	21	2.25	0.764	-0.374	93.6	203	278	818	1,600	3,120	4,700	6,680	9,110	13,100

Table 11. *Peak-flow characteristics, selected streamflow-gaging stations, Wyoming and surrounding states--Continued*

		Period of record			Statistics of annual peak flow, in base-10 logarithms of cubic feet per second			Peak flow, in cubic feet per second, for selected recurrence intervals, in years									
Map number	Station number	Begin year	End year	Number of annual peaks flows	Mean	Standard deviation	Skew	1.5	2	2.33	5	10	25	50	100	200	500
112	06309200	1962	2000	39	2.79	0.278	0.519	451	586	654	1,040	1,440	2,110	2,730	3,490	4,390	5,860
113	06309450	1979	1989	11	1.77	0.267	0.263	44.9	58.2	64.9	99.5	134	186	231	282	341	430
114	06309460	1979	1989	11	1.86	0.268	0.147	55.6	72.2	80.6	123	163	223	273	329	391	484
115	06311000	1947	2000	54	2.45	0.173	0.217	239	283	303	399	483	594	682	774	871	1,010
116	06312700	1918	1984	26	2.82	0.294	0.920	468	606	679	1,130	1,660	2,650	3,670	5,030	6,810	10,100
117	06312795	1970	1981	12	1.02	0.614	0.305	5.43	9.80	12.6	33.7	67.1	144	241	386	602	1,040
118	06312910	1965	1972	8	2.55	0.406	0.577	227	331	388	766	1,250	2,210	3,260	4,690	6,650	10,300
119	06312920	1965	1972	8	2.31	0.345	0.190	145	203	234	403	585	881	1,150	1,480	1,860	2,470
120	06313000	1950	1968	25	3.47	0.559	0.147	1,690	2,920	3,670	8,830	16,000	30,700	47,100	69,500	99,700	155,000
121	06313020	1965	1981	17	1.57	1.037	-0.249	14.7	41.7	64.0	289	751	2,000	3,690	6,290	10,100	17,800
122	06313050	1965	1979	14	2.32	0.686	0.056	106	208	275	794	1,610	3,460	5,680	8,900	13,400	22,200
123	06313100	1961	1984	24	2.82	0.464	0.012	418	662	801	1,630	2,620	4,340	6,020	8,090	10,600	14,700
124	06313180	1965	1983	19	2.22	0.502	-0.379	109	181	222	451	700	1,090	1,420	1,790	2,190	2,770
125	06313200	1958	1970	13	2.46	0.400	-0.104	197	294	347	631	933	1,400	1,820	2,300	2,840	3,650
126	06313600	1961	1971	11	2.39	0.341	0.252	171	239	274	472	688	1,040	1,380	1,770	2,250	3,020
127	06313630	1971	1981	11	2.59	0.625	0.045	209	387	500	1,310	2,500	4,980	7,810	11,700	17,000	26,800
128	06313700	1959	1990	33	2.90	0.420	-0.481	562	861	1,020	1,820	2,590	3,660	4,490	5,350	6,230	7,410
129	06313900	1961	1974	13	1.85	0.299	-0.006	53.9	72.5	81.9	129	175	242	298	359	426	524
130	06314000	1944	1984	17	2.49	0.234	0.015	247	312	343	491	624	806	950	1,100	1,260	1,490
131	06315500	1942	1972	31	2.50	0.374	0.528	209	297	345	641	1,000	1,670	2,370	3,300	4,500	6,660
132	06316700	1965	1984	20	2.14	0.664	-0.266	76.2	149	196	512	941	1,750	2,580	3,610	4,880	6,950
133	06317050	1961	1981	21	1.86	0.756	0.010	34.6	73.2	99.7	317	685	1,560	2,650	4,270	6,620	11,300
134	06318500	1894	1987	71	2.84	0.213	0.171	555	683	746	1,040	1,310	1,680	1,990	2,310	2,660	3,160
135	06319100	1969	1984	16	1.72	1.023	-0.058	19.5	53.9	82.1	386	1,060	3,110	6,200	11,500	20,100	39,400
136	06320500	1946	1958	49	2.63	0.157	0.001	365	427	455	579	680	806	900	994	1,090	1,220
137	06321500	1952	1982	31	2.68	0.231	0.402	375	468	513	748	977	1,320	1,620	1,950	2,330	2,910
138	06324700	1955	1984	30	1.22	0.773	-0.178	8.12	17.6	24.2	75.8	158	337	544	831	1,220	1,910
139	06324800	1960	1981	16	0.99	0.452	0.370	6.05	9.33	11.2	23.3	39.1	69.9	103	149	209	320

Table 11. *Peak-flow characteristics, selected streamflow-gaging stations, Wyoming and surrounding states--Continued*

		Period of record			Statistics of annual peak flow, in base-10 logarithms of cubic feet per second			Peak flow, in cubic feet per second, for selected recurrence intervals, in years									
Map number	Station number	Begin year	End year	Number of annual peaks flows	Mean	Standard deviation	Skew	1.5	2	2.33	5	10	25	50	100	200	500
140	06324900	1959	1981	23	2.19	0.346	0.235	108	151	174	301	440	669	884	1,140	1,450	1,940
141	06324910	1971	1984	14	1.76	0.583	-0.120	33.1	59.3	75.3	180	317	572	833	1,160	1,570	2,260
142	06324970	1973	2000	28	2.70	0.416	0.287	325	485	575	1,120	1,780	2,990	4,210	5,790	7,790	11,300
143	06324995	1972	2000	29	1.29	0.835	0.146	8.22	18.6	26.2	96.9	236	622	1,180	2,100	3,600	6,970
144	06325400	1974	1984	11	1.48	0.570	-0.386	18.5	32.9	41.6	92.8	153	250	339	440	552	720
145	06333850	1951	1977	24	2.37	0.442	-0.295	161	251	301	570	850	1,280	1,640	2,050	2,490	3,130
146	06334000	1912	1969	53	3.25	0.303	-0.365	1,380	1,870	2,120	3,260	4,260	5,570	6,560	7,560	8,570	9,900
147	06334100	1955	2000	46	2.14	0.540	-0.492	89.6	155	194	407	638	989	1,290	1,610	1,950	2,430
148	06334200	1958	1973	16	2.79	0.322	-0.124	455	628	717	1,160	1,580	2,200	2,700	3,250	3,830	4,680
149	06334330	1972	2000	29	0.47	0.738	0.110	1.39	2.86	3.87	12.2	26.6	61.9	107	177	282	496
150	06334500	1952	2000	46	3.33	0.408	-0.656	1,580	2,400	2,840	4,860	6,650	8,940	10,600	12,200	13,800	15,700
151	06334610	1973	2000	28	1.55	0.361	-0.459	26.7	38.6	44.8	74.0	100	136	162	189	217	253
152	06358550	1969	1979	11	2.13	0.417	0.152	88.4	133	158	304	474	771	1,060	1,420	1,860	2,590
153	06358600	1956	1980	24	1.74	0.396	0.131	37.2	54.9	64.6	120	183	289	390	513	660	900
154	06358620	1956	1972	16	1.35	0.220	0.107	17.9	22.2	24.3	34.2	43.2	55.5	65.4	76.0	87.2	103
155	06379600	1957	1981	23	2.01	0.922	-0.292	40.0	114	170	628	1,450	3,380	5,730	9,050	13,600	21,900
156	06382200	1964	1981	18	2.76	0.461	-0.252	383	610	737	1,440	2,210	3,410	4,470	5,670	7,000	9,000
157	06386000	1948	1983	34	3.24	0.339	-0.056	1,260	1,770	2,040	3,400	4,760	6,800	8,540	10,500	12,600	15,800
158	06387500	1959	1984	26	3.11	0.291	-0.028	986	1,320	1,480	2,310	3,090	4,220	5,150	6,150	7,250	8,830
159	06388800	1961	1981	21	1.59	0.339	-0.387	29.3	41.4	47.6	76.7	103	138	166	193	222	259
160	06392900	1975	2000	18	1.23	0.440	0.214	10.9	16.8	20.0	40.3	65.1	110	156	215	290	419
161	06394000	1943	1998	55	2.99	0.325	0.509	678	921	1,050	1,800	2,650	4,130	5,580	7,400	9,680	13,600
162	06396200	1956	1980	25	1.17	0.595	-0.064	8.35	15.1	19.3	47.4	85.4	159	237	338	468	691
163	06396300	1956	1980	25	1.33	0.331	0.031	15.7	21.8	25.0	41.5	58.2	83.8	106	131	159	202
164	06396350	1970	1979	10	0.51	0.619	0.037	1.77	3.26	4.20	10.9	20.6	40.6	63.2	94.2	136	212
165	06399300	1956	1979	23	1.58	0.917	-0.044	15.6	38.9	56.6	228	568	1,500	2,790	4,880	8,110	15,000
166	06399700	1956	1975	20	2.72	0.480	-0.206	339	550	670	1,360	2,130	3,390	4,530	5,860	7,380	9,700
167	06400000	1905	2000	51	2.79	0.660	-0.097	332	642	842	2,270	4,320	8,510	13,100	19,300	27,300	41,600

Table 11. *Peak-flow characteristics, selected streamflow-gaging stations, Wyoming and surrounding states--Continued*

Map number	Station number	Period of record: Begin year	Period of record: End year	Period of record: Number of annual peaks flows	Statistics of annual peak flow, in base-10 logarithms of cubic feet per second: Mean	Standard deviation	Skew	Peak flow, in cubic feet per second, for selected recurrence intervals, in years: 1.5	2	2.33	5	10	25	50	100	200	500
168	06400900	1969	1979	11	0.87	0.633	0.403	3.69	6.74	8.69	24.4	50.7	116	202	338	551	1,010
169	06402430	1991	2000	10	1.20	0.414	0.170	10.4	15.5	18.4	35.3	55.0	89.4	123	165	217	302
170	06404000	1946	2000	41	2.42	0.663	0.200	133	255	333	953	1,960	4,310	7,260	11,700	18,300	31,600
171	06404800	1989	2000	12	1.81	0.475	0.092	40.0	63.7	77.4	162	266	455	647	889	1,190	1,710
172	06404998	1972	2000	25	1.99	0.574	0.062	54.8	96.4	122	296	537	1,020	1,540	2,250	3,190	4,860
173	06406000	1950	2000	51	2.42	0.719	-0.117	135	277	373	1,090	2,190	4,550	7,250	11,000	15,900	24,900
174	06406800	1969	1979	11	1.30	0.370	0.095	13.7	19.8	23.0	40.9	60.2	91.6	120	155	194	257
175	06409000	1949	2000	52	1.82	0.385	0.704	41.9	59.6	69.3	133	215	378	559	810	1,160	1,810
176	06422500	1911	2000	38	2.30	0.634	0.607	96.5	174	223	646	1,400	3,420	6,330	11,300	19,700	39,600
177	06426195	1970	1984	15	1.39	0.473	-0.350	16.5	26.7	32.5	63.6	96.7	147	191	238	290	365
178	06426500	1924	2000	46	2.92	0.360	0.420	570	803	928	1,670	2,540	4,070	5,600	7,530	9,970	14,200
179	06427700	1959	1984	25	2.20	0.485	0.559	92.9	146	177	398	715	1,400	2,220	3,430	5,170	8,700
180	06429300	1964	1981	17	1.34	0.624	-0.068	12.0	22.3	28.8	74.0	137	263	400	580	815	1,230
181	06429905	1977	2000	17	1.82	0.493	0.505	38.5	61.3	74.6	169	304	593	936	1,440	2,150	3,590
182	06430500	1929	2000	51	2.36	0.525	0.203	133	222	275	632	1,120	2,090	3,170	4,630	6,590	10,200
183	06430800	1989	2000	12	1.38	0.474	0.472	14.3	22.3	27.0	59.0	103	195	300	449	657	1,060
184	06430898	1989	2000	12	1.78	0.468	0.466	36.0	56.1	67.6	146	253	474	725	1,080	1,570	2,510
185	06432200	1956	1972	17	2.26	0.539	-0.047	110	185	230	523	896	1,580	2,280	3,170	4,270	6,110
186	06432230	1956	1967	12	1.11	0.922	0.004	5.00	13.0	19.0	79.0	201	541	1,020	1,810	3,050	5,740
187	06433500	1954	1996	43	1.81	0.595	0.128	35.6	63.9	81.5	207	388	771	1,210	1,820	2,660	4,230
188	06434800	1970	1979	10	1.65	0.406	0.118	29.6	44.1	52.0	98.2	151	240	326	430	556	761
189	06436156	1989	2000	12	1.73	0.478	0.355	32.1	50.7	61.5	133	230	422	636	930	1,330	2,070
190	06436700	1962	1981	20	2.84	0.690	-0.204	372	745	989	2,720	5,200	10,200	15,500	22,400	31,200	46,200
191	06437020	1989	2000	12	2.16	0.588	0.126	80.1	143	181	455	847	1,670	2,600	3,890	5650	8,930
192	06437100	1956	1980	25	1.57	0.550	-0.113	22.0	38.1	47.8	109	186	326	466	640	853	1,200
193	06437500	1946	2000	37	2.70	0.676	-0.139	267	526	695	1,900	3,640	7,180	11,000	16,200	22,800	34,500
194	06443200	1953	1970	18	1.46	0.932	0.061	11.5	28.8	42.1	178	467	1,320	2,600	4,790	8,400	16,700
195	06443300	1953	1978	26	1.28	1.000	0.220	6.73	17.8	26.7	131	389	1,290	2,870	5,950	11,800	27,200

Table 11. *Peak-flow characteristics, selected streamflow-gaging stations, Wyoming and surrounding states--Continued*

		Period of record			Statistics of annual peak flow, in base-10 logarithms of cubic feet per second			Peak flow, in cubic feet per second, for selected recurrence intervals, in years									
Map number	Station number	Begin year	End year	Number of annual peaks flows	Mean	Standard deviation	Skew	1.5	2	2.33	5	10	25	50	100	200	500
196	06443700	1955	1978	24	2.03	0.874	0.279	42.2	98.1	140	568	1,500	4,420	9,070	17,600	32,800	70,600
197	06444000	1920	1993	61	2.50	0.489	0.359	188	300	365	807	1,410	2,630	4,000	5,910	8,520	13,400
198	06456200	1953	1978	26	0.89	1.021	0.385	3.00	6.69	10.0	53.2	172	640	1,560	3,560	7,730	20,400
199	06616000	1951	1982	32	2.23	0.157	-0.489	153	179	191	237	270	307	331	353	374	398
200	06620400	1956	1965	10	2.74	0.121	0.027	493	555	583	703	796	909	990	1,070	1,150	1,250
201	06621000	1947	1964	26	2.98	0.142	-0.377	860	993	1,050	1,290	1,460	1,650	1,780	1,900	2,010	2,150
202	06622500	1911	1924	14	2.98	0.175	-0.416	827	989	1,060	1,360	1,580	1,830	2,010	2,170	2,320	2,510
203	06622700	1960	2000	41	2.79	0.147	0.036	536	620	658	827	962	1,130	1,260	1,380	1,510	1,680
204	06623800	1965	2000	36	3.00	0.132	-0.492	909	1,040	1,100	1,320	1,470	1,640	1,750	1,850	1,940	2,050
205	06624500	1900	1932	19	3.44	0.143	-0.118	2,430	2,800	2,970	3,680	4,230	4,890	5,360	5,820	6,270	6,860
206	06625000	1940	1963	61	3.33	0.158	0.044	1,840	2,150	2,290	2,930	3,450	4,110	4,610	5,110	5,610	6,300
207	06628900	1957	2000	44	2.73	0.271	0.443	398	515	574	897	1,230	1,760	2,250	2,830	3,500	4,580
208	06629150	1962	1981	20	1.92	0.461	0.322	51.4	80.1	96.5	203	342	610	899	1,290	1,800	2,740
209	06629200	1962	1981	20	1.77	0.629	-0.156	32.8	61.6	79.8	203	370	693	1,030	1,460	2,010	2,930
210	06629700	1959	1971	13	0.92	0.661	0.254	4.00	7.90	10.0	29.7	61.6	138	236	386	612	1,080
211	06629800	1959	1981	23	1.49	0.404	0.195	20.5	30.4	35.9	67.9	105	170	233	312	408	569
212	06630200	1959	1981	23	2.03	0.432	-0.408	75.1	117	139	255	371	538	674	818	969	1,180
213	06630800	1962	1974	13	1.72	0.261	-0.395	42.5	55.4	61.7	89.1	112	140	161	181	201	226
214	06631100	1962	1974	13	2.36	0.129	-0.337	207	236	249	299	336	377	405	430	454	484
215	06631150	1965	1981	17	2.43	0.388	0.177	181	264	310	572	869	1,370	1,860	2,450	3,160	4,330
216	06632400	1966	2000	35	3.11	0.165	-0.236	1,110	1,320	1,410	1,790	2,090	2,440	2,690	2,940	3,170	3,470
217	06632600	1962	1974	13	2.01	0.320	0.315	73.1	99.5	113	190	272	406	530	680	858	1,140
218	06632700	1962	1974	13	1.74	0.324	-0.156	41.1	56.8	64.9	105	143	197	242	290	341	414
219	06634200	1961	1981	21	2.78	0.237	-0.144	489	620	684	973	1,220	1,550	1,800	2,060	2,320	2,680
220	06634300	1961	1981	21	2.70	0.320	0.086	369	505	576	948	1,320	1,900	2,410	2,980	3,630	4,620
221	06634600	1974	2000	27	2.99	0.437	0.203	624	956	1,140	2,280	3,670	6,180	8,720	12,000	16,000	23,100
222	06634910	1965	1984	20	1.91	0.707	-0.247	42.9	87.4	117	327	629	1,230	1,860	2,690	3,720	5,480
223	06636500	1915	1925	11	2.37	0.436	0.025	153	235	282	550	859	1,390	1,890	2,500	3,220	4,400

Table 11. *Peak-flow characteristics, selected streamflow-gaging stations, Wyoming and surrounding states--Continued*

		Period of record			Statistics of annual peak flow, in base-10 logarithms of cubic feet per second			Peak flow, in cubic feet per second, for selected recurrence intervals, in years									
Map number	Station number	Begin year	End year	Number of annual peaks flows	Mean	Standard deviation	Skew	1.5	2	2.33	5	10	25	50	100	200	500
224	06637550	1959	1981	23	2.79	0.220	-0.336	519	648	710	972	1,180	1,440	1,630	1,810	1,980	2,210
225	06637750	1962	1995	34	1.99	0.218	-0.411	82.2	103	112	152	184	221	248	273	298	328
226	06638300	1961	1981	14	1.33	0.638	-0.291	12.3	23.5	30.5	76.5	136	246	353	485	643	896
227	06638350	1961	1981	21	1.57	0.562	-0.234	22.3	39.2	49.5	112	189	324	452	607	790	1,080
228	06641400	1960	1984	24	2.09	0.412	-0.060	83.4	126	149	278	418	644	849	1,090	1,360	1,790
229	06642700	1900	1984	25	2.10	0.617	0.024	70.0	128	170	425	798	1,570	2420	3,600	5,160	8,010
230	06642730	1961	1981	12	2.02	0.579	-0.508	66.2	119	152	335	540	861	1,140	1,440	1,760	2,220
231	06642760	1961	1981	21	2.86	0.502	-0.060	453	746	917	1,960	3,220	5,450	7,640	10,300	13,600	18,900
232	06643300	1961	1984	22	1.91	0.411	-0.184	56.1	84.8	100	184	271	406	523	654	800	1,020
233	06644200	1961	1972	12	2.13	0.568	0.174	74.9	131	165	403	743	1,450	2,250	3,370	4,900	7,770
234	06644840	1965	1981	17	1.39	0.851	0.147	10.3	23.7	33.5	127	316	849	1,630	2,940	5,100	9,990
235	06645150	1979	1996	10	1.13	0.674	0.038	6.88	13.4	17.7	49.9	99.7	209	339	524	782	1,270
236	06646000	1946	2000	22	2.87	0.299	0.058	551	740	837	1,330	1,810	2,520	3,130	3,810	4,570	5,690
237	06646500	1924	1960	33	2.90	0.268	0.098	609	793	885	1,340	1,780	2,410	2,940	3,520	4,160	5,100
238	06646700	1961	1981	21	1.76	0.460	0.180	36.0	56.4	68.0	141	231	397	569	789	1,070	1,560
239	06647500	1946	2000	41	2.71	0.343	-0.009	370	520	599	1,010	1,430	2,070	2,630	3,260	3,960	5,020
240	06647890	1975	1988	14	1.46	0.402	0.216	19.1	28.3	33.3	63.0	97.7	158	218	292	383	536
241	06648780	1965	1984	19	1.06	0.753	-0.259	6.00	12.4	17.0	50.4	101	204	317	466	658	986
242	06649900	1961	1981	21	2.11	0.569	0.094	72.3	127	160	387	702	1,340	2,040	2,990	4,250	6,540
243	06651800	1955	1984	25	2.84	0.450	0.269	434	671	806	1,660	2,730	4,740	6,850	9,610	13,200	19,500
244	06652400	1960	1984	25	1.78	0.569	0.530	31.7	54.0	67.7	174	344	750	1,280	2,110	3,380	6,150
245	06661000	1911	2000	83	3.02	0.184	-0.266	892	1,070	1,160	1,510	1,790	2,120	2,360	2,600	2,820	3,110
246	06661580	1962	1984	23	1.97	0.342	0.182	66.2	92.4	106	182	264	395	516	658	826	1,090
247	06664500	1941	1968	28	2.58	0.530	-0.090	232	393	489	1,080	1,820	3,150	4,470	6,100	8,080	11,300
248	06667500	1915	1974	40	2.81	0.513	0.043	391	649	801	1,760	2,990	5,270	7,620	10,600	14,400	20,900
249	06668040	1965	1984	20	1.49	0.423	0.160	20.1	30.4	36.1	70.3	111	181	251	338	445	624
250	06670985	1969	1981	13	1.59	1.179	-0.454	14.5	48.0	77.9	399	1,080	2,890	5,230	8,660	13,400	22,200
251	06671000	1929	1992	64	2.33	0.437	0.667	129	193	229	479	824	1,550	2,390	3,620	5,360	8,850

Table 11. *Peak-flow characteristics, selected streamflow-gaging stations, Wyoming and surrounding states--Continued*

		Period of record			Statistics of annual peak flow, in base-10 logarithms of cubic feet per second			Peak flow, in cubic feet per second, for selected recurrence intervals, in years									
Map number	Station number	Begin year	End year	Number of annual peaks flows	Mean	Standard deviation	Skew	1.5	2	2.33	5	10	25	50	100	200	500
252	06675300	1961	1981	17	1.31	0.492	0.142	14.0	20.0	24.0	52.8	89.1	157	229	322	442	652
253	06679000	1949	1979	31	2.54	0.344	0.445	240	333	382	672	1,000	1,580	2,160	2,880	3,780	5,310
254	06746095	1979	1999	21	2.07	0.160	-0.131	103	121	129	164	191	225	250	273	297	328
255	06748200	1961	1973	13	1.75	0.154	0.119	48.7	56.6	60.3	76.7	90.3	108	121	135	148	167
256	06748510	1961	1973	13	1.14	0.192	-0.378	11.9	14.5	15.7	20.6	24.4	28.9	32.0	35.0	37.9	41.4
257	06748530	1961	1973	13	1.89	0.214	-0.183	63.7	79.0	86.3	118	145	179	204	230	255	289
258	06748600	1957	1979	23	2.68	0.196	-0.012	401	487	528	713	869	1,070	1,230	1,390	1,550	1,780
259	06754500	1902	1963	39	1.73	0.391	0.133	36.6	53.6	62.9	116	176	275	370	485	622	845
260	06755000	1933	1969	35	1.25	0.390	0.211	11.8	17.2	20.2	37.5	57.3	91.4	125	165	215	298
261	06761900	1960	1981	22	1.49	0.348	0.083	21.8	30.7	35.4	60.8	87.5	129	167	211	261	339
262	06762500	1932	1992	61	2.33	0.771	0.259	94.1	198	271	930	2,180	5,590	10,500	18,600	32,000	62,300
263	06762600	1960	1984	25	1.87	0.644	-0.476	44.1	84.9	111	269	461	782	1,070	1,410	1,780	2,320
264	09188500	1932	2000	68	3.44	0.130	-0.316	2,470	2,820	2,970	3,580	4,030	4,530	4,880	5,200	5,500	5,870
265	09189500	1955	1974	20	3.04	0.118	0.159	981	1,100	1,160	1,390	1,580	1,820	1,990	2,160	2,340	2,570
266	09196500	1955	1997	43	3.21	0.098	-0.174	1,510	1,670	1,740	2,010	2,200	2,430	2,580	2,720	2,860	3,020
267	09198500	1939	1971	33	2.96	0.103	-0.456	847	941	982	1,130	1,240	1,350	1,420	1,490	1,540	1,610
268	09199500	1939	1971	33	2.61	0.142	-0.514	370	428	454	551	619	694	742	786	826	873
269	09201000	1915	1969	55	3.42	0.199	-0.072	2,200	2,680	2,910	3,930	4,780	5,880	6,710	7,550	8,410	9,570
270	09203000	1939	1992	54	3.08	0.116	-0.590	1,120	1,260	1,320	1,550	1,700	1,860	1,950	2,040	2,120	2,210
271	09204000	1939	1971	31	2.85	0.111	-0.438	647	725	759	887	975	1,070	1,130	1,190	1,240	1,300
272	09204500	1905	1932	13	3.32	0.144	-0.660	1,910	2,210	2,340	2,830	3,160	3,510	3,730	3,920	4,090	4,280
273	09204700	1961	1981	18	0.98	0.534	-0.231	5.91	10.1	12.6	27.5	45.1	75.1	103	137	175	236
274	09205500	1915	1972	43	2.58	0.158	-0.455	339	398	425	529	605	691	748	800	848	908
275	09207650	1971	1981	11	2.12	0.356	-0.401	97.7	140	162	268	365	496	598	702	808	951
276	09208000	1941	1981	33	2.10	0.125	-0.305	115	130	137	164	184	206	221	235	248	265
277	09210500	1952	2000	49	2.60	0.247	-0.628	335	432	478	664	805	967	1,080	1,180	1,270	1,380
278	09212500	1911	1987	49	2.96	0.141	-0.116	806	929	985	1,220	1,400	1,610	1,770	1,920	2,060	2,260
279	09215000	1955	1973	19	2.39	0.415	-0.475	174	265	314	557	789	1,110	1,360	1,620	1,880	2,240

Table 11. *Peak-flow characteristics, selected streamflow-gaging stations, Wyoming and surrounding states--Continued*

		Period of record			Statistics of annual peak flow, in base-10 logarithms of cubic feet per second			Peak flow, in cubic feet per second, for selected recurrence intervals, in years									
Map number	Station number	Begin year	End year	Number of annual peaks flows	Mean	Standard deviation	Skew	1.5	2	2.33	5	10	25	50	100	200	500
280	09216290	1950	1984	18	2.21	0.390	0.156	110	162	190	350	532	838	1,130	1,490	1,920	2,620
281	09216350	1960	1981	13	1.22	0.501	0.559	9.52	15.2	18.6	42.8	78.3	157	252	395	604	1,030
282	09216400	1959	1974	13	1.82	0.404	-0.559	48.6	73.4	86.7	150	207	284	342	400	457	531
283	09216537	1930	1984	25	1.95	0.517	0.107	52.8	87.7	108	242	418	753	1,110	1,570	2,170	3,220
284	09216550	1961	1981	21	2.59	0.315	-0.197	294	403	460	731	984	1,340	1,620	1,920	2,240	2,690
285	09216560	1961	1975	15	2.66	0.367	-0.211	330	478	556	952	1,340	1,910	2,390	2,900	3,460	4,260
286	09216600	1959	1981	22	1.98	0.349	0.106	67.8	95.5	110	190	274	409	530	672	836	1,090
287	09216695	1950	1981	10	1.86	0.532	0.023	42.7	72.3	89.9	203	351	627	915	1,280	1,760	2,560
288	09216700	1959	1976	18	3.01	0.338	-0.512	782	1,100	1,270	2,010	2,660	3,490	4,110	4,710	5,300	6,060
289	09216900	1959	1982	24	1.08	0.353	-0.711	9.31	13.4	15.4	24.4	31.7	40.6	46.7	52.4	57.6	64.0
290	09217900	1938	1999	30	3.20	0.138	-0.523	1,440	1,650	1,750	2,120	2,370	2,650	2,830	2,990	3,140	3,310
291	09218500	1940	1970	59	3.16	0.114	0.077	1310	1,470	1,540	1,840	2,070	2,350	2,560	2,760	2,960	3,220
292	09220000	1940	1978	60	2.71	0.194	0.258	424	512	553	755	935	1,190	1,390	1,610	1,840	2,180
293	09220500	1940	1981	42	2.65	0.236	0.115	352	443	488	706	905	1,190	1,420	1,660	1,930	2,310
294	09221680	1965	1984	20	1.75	0.622	-0.279	32.6	61.0	78.8	193	341	607	869	1,190	1,570	2,170
295	09221700	1959	1971	13	1.96	0.341	-0.104	67.1	94.4	109	181	253	359	449	547	655	812
296	09223000	1953	2000	48	2.86	0.243	-0.703	606	777	858	1,180	1,410	1,680	1,850	2,000	2,140	2,300
297	09224000	1919	1949	18	3.14	0.234	-0.470	1,150	1,460	1,610	2,220	2,710	3,280	3,690	4,070	4,440	4,890
298	09224800	1962	1981	17	1.38	0.634	-0.559	14.7	28.0	36.3	85.5	143	233	312	399	491	622
299	09224810	1900	1981	18	1.33	0.598	-0.082	12.0	22.2	29.0	69.9	126	234	347	494	681	1,000
300	09224820	1930	1984	21	1.29	0.693	-0.235	10.5	21.1	28.0	77.0	147	284	429	616	851	1,250
301	09224840	1930	1981	18	1.23	0.315	0.512	11.0	16.0	19.0	30.7	44.7	68.6	92.0	121	157	218
302	09224980	1965	1981	17	2.77	0.512	-0.226	374	627	775	1,640	2,640	4,310	5,860	7,670	9,770	13,000
303	09225200	1965	1984	20	2.02	0.405	-0.225	72.4	109	129	232	339	499	636	787	953	1,190
304	09225300	1959	1981	22	2.42	0.620	-0.339	154	288	372	900	1,560	2,720	3,830	5,150	6,690	9,080
305	09226000	1943	1972	30	2.77	0.216	0.286	473	583	637	900	1,150	1,500	1,790	2,110	2,460	2,980
306	09226500	1949	1970	22	2.49	0.233	-0.214	250	316	348	490	610	764	880	996	1,110	1,270
307	09227500	1949	1962	14	2.22	0.213	-0.013	136	168	184	254	315	397	460	525	593	686

Table 11. *Peak-flow characteristics, selected streamflow-gaging stations, Wyoming and surrounding states--Continued*

		Period of record			Statistics of annual peak flow, in base-10 logarithms of cubic feet per second			Peak flow, in cubic feet per second, for selected recurrence intervals, in years									
Map number	Station number	Begin year	End year	Number of annual peaks flows	Mean	Standard deviation	Skew	1.5	2	2.33	5	10	25	50	100	200	500
308	09229450	1965	1974	10	1.36	0.737	-0.186	11.7	24.6	33.2	98.5	198	407	641	957	1,370	2,110
309	09235600	1958	1993	35	1.79	0.360	0.005	43.9	62.7	72.7	126	182	269	346	434	535	688
310	09241000	1912	1963	67	3.41	0.116	-0.312	2,340	2,630	2,760	3,260	3,620	4,020	4,290	4,540	4,780	5,070
311	09244500	1944	1973	16	2.80	0.177	-0.501	547	655	705	899	1,040	1,200	1,310	1,410	1,500	1,610
312	09245000	1953	1996	44	2.96	0.206	-0.288	772	951	1,040	1,400	1,680	2,040	2,290	2,540	2,790	3,100
313	09245500	1959	1973	15	2.60	0.250	-0.179	317	408	452	654	829	1,060	1,240	1,420	1,610	1,860
314	09251800	1956	1965	10	2.56	0.122	-0.101	328	371	390	468	527	598	647	695	741	801
315	09253000	1943	1999	54	3.33	0.173	-0.365	1,840	2,200	2,360	3,020	3,520	4,100	4,500	4,880	5,240	5,690
316	09253400	1956	1988	12	2.51	0.153	0.121	280	326	347	441	519	619	695	772	851	959
317	09254500	1912	1922	10	2.78	0.132	0.040	536	611	645	791	907	1,050	1,160	1,260	1,360	1,500
318	09255000	1911	2000	70	2.93	0.172	-0.016	721	856	919	1,200	1,420	1,710	1,930	2,150	2,370	2,660
319	09255500	1941	1972	23	2.66	0.310	-0.134	341	465	529	840	1,130	1,550	1,890	2,250	2,640	3,200
320	09256000	1942	1992	38	3.01	0.228	-0.599	864	1,090	1,200	1,630	1,950	2,320	2,560	2,790	2,990	3,240
321	09258000	1954	1993	39	2.19	0.236	-0.331	126	161	177	248	306	378	431	483	534	600
322	09258200	1970	1981	12	2.28	0.578	-0.531	119	214	272	596	956	1,510	1,980	2,490	3,040	3,800
323	09258900	1958	1971	14	2.80	0.382	-0.321	450	662	775	1,340	1,890	2,660	3,300	3,970	4,670	5,660
324	10010400	1974	1986	13	2.74	0.109	-0.254	503	562	588	689	761	844	900	952	1,000	1,060
325	10011500	1943	1965	58	3.24	0.123	-0.148	1,570	1,770	1,860	2,240	2,520	2,850	3,080	3,310	3,520	3,790
326	10012000	1943	1962	19	2.58	0.177	-0.235	327	391	420	544	642	760	845	927	1,010	1,110
327	10015700	1958	1997	40	2.51	0.261	-0.048	254	329	366	544	706	929	1,110	1,300	1,500	1,790
328	10019700	1965	1981	17	1.64	0.331	-0.061	31.8	44.3	50.8	83.8	116	165	206	251	301	375
329	10021000	1938	1969	32	2.35	0.229	-0.563	190	240	264	359	432	516	574	626	675	735
330	10027000	1944	1981	25	2.31	0.454	-0.506	141	224	270	503	732	1,060	1,310	1,580	1,850	2,220
331	10032000	1942	2000	59	2.95	0.183	-0.393	777	936	1,010	1,310	1,530	1800	1,980	2,150	2,320	2,520
332	10040000	1940	1951	12	2.15	0.283	-0.241	110	147	165	249	324	424	501	581	662	774
333	10040500	1940	1951	12	2.19	0.320	-0.440	119	165	188	294	386	506	595	684	772	887
334	10041000	1950	1992	43	2.57	0.385	-0.395	271	400	469	807	1,130	1,570	1,930	2,300	2,680	3,200
335	10047500	1943	1969	37	1.98	0.219	-0.416	79.2	98.9	108	147	178	214	240	265	288	318
336	10058600	1961	1986	26	2.15	0.186	-0.740	124	150	161	205	235	267	287	304	319	337

Table 11. *Peak-flow characteristics, selected streamflow-gaging stations, Wyoming and surrounding states--Continued*

		Period of record			Statistics of annual peak flow, in base-10 logarithms of cubic feet per second			Peak flow, in cubic feet per second, for selected recurrence intervals, in years									
Map number	Station number	Begin year	End year	Number of annual peaks flows	Mean	Standard deviation	Skew	1.5	2	2.33	5	10	25	50	100	200	500
337	10069000	1912	1956	19	1.70	0.144	0.245	43.7	50.2	53.3	67.1	78.7	93.9	106	118	130	147
338	10128500	1905	2000	96	3.25	0.158	-0.469	1,570	1,840	1,960	2,450	2,790	3,190	3,450	3,690	3,910	4,170
339	13010065	1984	2000	17	3.89	0.192	-0.394	6,580	8,000	8,660	11,400	13,400	15,800	17,500	19,100	20,700	22,600
340	13011500	1918	2000	55	3.40	0.146	-0.102	2,190	2,540	2,700	3,360	3,870	4,490	4,940	5,380	5,810	6,370
341	13011800	1964	1974	11	1.63	0.198	0.168	34.9	42.4	46.0	62.9	77.9	98.3	115	132	150	176
342	13011900	1966	2000	35	3.61	0.097	-0.074	3,760	4,140	4,310	4,990	5,490	6,080	6,490	6,870	7,250	7,720
343	13018300	1945	2000	56	1.85	0.234	-0.448	59.4	75.4	83.0	115	140	171	192	212	232	257
344	13019210	1964	1974	11	1.12	0.113	-0.614	12.1	13.6	14.2	16.5	18.1	19.7	20.7	21.5	22.3	23.2
345	13019220	1964	1981	18	1.16	0.160	-0.196	12.7	14.9	15.9	20.2	23.4	27.4	30.3	33.0	35.7	39.1
346	13019400	1964	1974	11	2.78	0.163	0.027	516	607	649	835	987	1,180	1,330	1,470	1,620	1,820
347	13019438	1982	1992	11	2.45	0.316	-0.122	211	290	330	529	718	990	1,210	1,450	1,710	2,080
348	13019500	1918	1958	15	3.57	0.124	-0.166	3,350	3,790	3,990	4,800	5,400	6,110	6,600	7,070	7,520	8,090
349	13020000	1918	1974	12	2.59	0.136	0.187	339	387	409	507	587	689	766	844	924	1,030
350	13021000	1918	1974	12	2.09	0.136	-0.532	112	128	136	164	183	204	217	229	240	253
351	13022550	1964	1973	10	1.30	0.237	-0.255	16.2	20.5	22.6	31.9	39.7	49.6	57.0	64.4	71.8	81.6
352	13023000	1918	2000	50	3.50	0.155	-0.274	2,790	3,260	3,480	4,350	5,020	5,800	6,340	6,860	7,350	7,980
353	13023800	1964	1974	11	1.64	0.262	-0.653	36.3	47.4	52.8	74.5	91.1	110	123	135	146	159
354	13025500	1946	1967	10	2.34	0.140	-0.392	198	228	241	294	332	375	404	431	455	486
355	13027000	1932	1943	12	2.41	0.105	-0.181	236	262	274	320	353	392	418	443	466	496
356	13027200	1961	1971	11	1.66	0.268	0.104	35.5	46.2	51.6	78.3	104	141	172	206	244	300
357	13029500	1917	1974	22	2.86	0.232	-0.649	619	785	864	1,170	1,400	1,660	1,840	1,990	2,130	2,300
358	13030000	1918	1971	19	2.29	0.130	-0.212	175	200	211	255	288	327	354	380	404	435
359	13030500	1918	1971	19	2.65	0.128	-0.346	404	461	486	583	654	733	787	836	882	939
360	13032000	1918	1971	22	2.70	0.143	-0.402	448	518	550	672	761	861	929	991	1,050	1,120
361	13038900	1963	1980	18	2.40	0.126	-0.114	226	257	271	327	369	420	456	490	523	566
362	13046680	1984	2000	17	2.68	0.145	-0.356	429	497	528	649	738	839	908	973	1,030	1,110
363	13050700	1962	1971	10	1.58	0.150	0.137	32.7	37.9	40.3	51.0	59.8	71.2	79.8	88.6	97.5	110
364	13050800	1962	1971	10	2.44	0.100	-0.228	253	280	292	338	372	409	435	458	481	508

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