METHODS FOR ESTIMATING PEAK DISCHARGE AND FLOOD BOUNDARIES OF STREAMS IN UTAH

By Blakemore E. Thomas and K. L. Lindskov

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GLOSSARY

Bankfull stage.--The stage or depth at which a stream first overflows its natural banks.

Control.--The term "control" (or control of flow), as used in this report, refers to the relation between discharge and depth of flow. Natural controls in an open channel are of two types, channel and section. Channel control exists when the physical characteristics of a reach of channel downstream from the site of interest determines the relation between discharge and depth at the site. Section control exists when the physical characteristics of a single cross section of a stream determines the relation between discharge and depth.

Elevation.--Height of land or water surface as related to the National Geodetic Vertical Datum of 1929 (NGVD of 1929).

Flood depth.--A term used herein to represent a vertical distance above a line connecting points of zero flow along a reach of channel.

Flood plain.--The flat area adjoining a stream channel constructed by the stream in the present climate and overflowed at times of high discharge.

Gaging station.--A specific site on a stream or other body of water where systematic observations of gage height, discharge, or water-quality parameters (or any combination of these) are obtained.

Log-Pearson Type III distribution.--A probability distribution used in flood-frequency analysis, which is described by three parameters; mean, standard deviation, and coefficient of skewness of the logarithms of the sample observations.

Mixed-population flood area.--The transition zone between a high altitude mountain area and a much flatter plain or plateau area where floods are caused by snowmelt, rainfall, or a combination of both.

Multiple-regression analysis.--A statistical technique where a relation is derived between a dependent variable and one or more independent variables. The result is usually expressed as a regression equation.

Peak discharge.--A momentary maximum rate of streamflow.

Recurrence interval.--The average interval of time, in years, within which a given flood will be equaled or exceeded once.

Residual.--The difference between the measured value of an observation and the corresponding fitted value obtained by use of the fitted regression equation.

Stage.--The height of a water surface above an established datum plane; also gage height.

Stage-discharge relation (rating curve).--A graph showing the relation between gage height and the volume of water flowing in a channel.

Stage of zero flow.--A term used herein to denote the depth above a datum plane or an elevation at a cross section on a stream at which the stream ceases to flow.

Standard error of estimate (in percent).--The range of error of a regression estimate to be expected about two-thirds of the time. It is a measure of how well the observed data agree with the regression equation and is computed from the distribution of residuals about the regression line.

T-year depth.--For this report, the T-year depth is the water-surface stage or elevation for the T-year discharge minus the channel-bottom stage or elevation at zero flow.

T-year discharge.--The peak-flow rate, in cubic feet per second, that will be equaled or exceeded, on an average, once in T-years.

Water-surface profile.--A graph of elevation of the water surface of a stream, plotted as ordinate, against distance, measured in the upstream direction, plotted as abscissa.

CONVERSION FACTORS

Most values in this report are given in inch-pound units. The conversion factors are shown to obtain metric equivalents to four significant figures.

Multiply	By	To obtain
Cubic foot per second (ft^3/s)	0.02832	Cubic meter per second (m^3/s)
Foot (ft)	0.3048	Meter (m)
Foot per mile (ft/mi)	0.1894	Meter per kilometer (m/km)
Inch (in.)	25.40	Millimeter (mm)
	2.540	Centimeter (cm)
Mile (mi)	1.609	Kilometer (km)
Square foot (ft^2)	0.0929	Square meter (m^2)
Square mile (mi^2)	2.590	Square kilometer (km^2)

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ABSTRACT

Equations for estimating 2-, 5-, 10-, 25-, 50-, and 100-year peak discharges and flood depths at ungaged sites in Utah were developed using multiple-regression techniques. Ratios of 500- to 100-year values also were determined. The peak-discharge equations are applicable to unregulated streams and the flood-depth equations are applicable to unregulated flow in natural stream channels. The flood-depth information can be used to approximate flood-prone areas. Drainage area and mean basin elevation are the two basin characteristics needed to use these equations. The standard error of estimate ranges from 38 to 74 percent for the 100-year peak discharge and from 23 to 33 percent for the 100-year flood depth.

Five different flood-mapping methods are described. Streams are classified into four categories as a basis for selecting a flood-mapping method. Procedures for transferring flood depths obtained from the regression equations to a flood-boundary map are outlined. Also, previous detailed flood mapping by government agencies and consultants is summarized to assist the user in quality control and to minimize duplication of effort.

Methods are described for transferring flood-frequency data from gaged to ungaged sites on the same stream. Peak-discharge and flood-depth frequency relations and selected basin-characteristics data, updated through 1980 water year, are tabulated for more than 300 gaging stations in Utah and adjoining states. In addition, weighted estimates of peak-discharge relations based on the station data and the regression estimates are provided for each gaging station used in the regression analysis.

INTRODUCTION

This report contains methods for estimating peak discharges and flood boundaries of streams in Utah. The peak-discharge information can be used for a wide variety of projects ranging from the design of bridges, culverts, dams, and embankments to detailed flood-plain and flood-insurance studies based on complex hydraulic characteristics of the stream and valley. The equations for estimating flood depth can be used for a simple, rapid approximation of flood-prone areas.

The equations for estimating peak discharge and flood depth were developed using multiple-regression techniques. Peak-discharge records at 282 gaging stations on unregulated streams throughout Utah and adjoining states were used to define the flood-frequency curve for each station. Regional equations were developed by relating estimates of selected frequency peak discharges and depths at the gaging stations to basin and climatic characteristics.

Five general methods of flood mapping are discussed. Step-by-step guidelines on how to use the physiographic method, a simple and rapid method of flood mapping, are presented. The other four methods are only briefly explained. The reader is referred to Burkham (1977, 1978) for a detailed description of the advantages and limitations of four of the five general methods of flood mapping.

This report was prepared by the U.S. Geological Survey in cooperation with the U.S. Bureau of Land Management (BLM). The increasing amount of development of energy resources on BLM-administered lands in Utah has created a need for a quick and inexpensive methodology to determine flood hazards. This report was prepared to provide the BLM with a simple and inexpensive method (physiographic method) for outlining flood-prone areas. The appropriateness of this simplified method should be judged by how it satisfies the objectives of the user. The physiographic method should be adequate for many locations in Utah. In some areas, however, where expensive structures or human life are involved, a more sophisticated analysis (such as the detailed method) may be required. In addition to the flood-plain mapping procedures, a summary of previous flood mapping in Utah by government agencies and consultants is included herein to guide the reader to more detailed mapping and to minimize duplication of effort.

The U.S. Geological Survey has published several reports concerning the magnitude and frequency of floods in Utah. Woolley (1946) and Butler and Marsell (1972) described the characteristics of cloudburst floods in Utah. U.S. Geological Survey (1957), Whitaker (1969), Butler and Mundorff (1970), and Roeske, Cooley, and Aldridge (1978) described large infrequent floods that have occurred in Utah. Berwick (1962), Thomas, Broom, and Cummans (1963), Butler, Reid, and Berwick (1966), Patterson and Somers (1966), Butler and Cruff (1971), Whitaker (1971), Fields (1975), and Eychaner (1976) provided methods for estimating the magnitude and frequency of floods at ungaged sites. The first four reports used the index-flood method of estimating peak discharges. The latter four reports used multiple-regression techniques to develop equations for estimating peak discharges. The methods presented in this report should provide more reliable estimates of peak discharge because more years of record and more gaging stations are included in the analysis.

CLASSIFICATION OF METHODS USED IN FLOOD MAPPING

Burkham (U.S. Geological Survey, Sacramento, California, written commun., 1981), in work on flood-hazard areas in the Great Basin, grouped flood-mapping methods into five general categories--detailed, historical, analytical, physiographic, and reconnaissance. The reader is referred to Burkham (1977, 1978) for a detailed description of the limitations, accuracy, and relative expense of four of these five methods. The reconnaissance method is described in detail by Wolman (1971). This report uses the same classification scheme and only brief descriptions of the five flood-mapping methods are given.

Four steps are usually involved in the mapping of flood-prone areas. They are:

1. Determining the T-year discharge. (See glossary.)

2. Determining the depth of water associated with the T-year discharge.

3. Determining the water-surface profile for the T-year discharge.

4. Developing a flood-boundary map. This requires the transfer of elevations from a water-surface profile to a topographic map.

The T-year discharge can be obtained by a number of different methods (Riggs, 1973), which are independent of the flood-mapping method. Methods are presented later in this report for determining T-year discharges for streams in Utah. The five different flood-mapping methods include some variation of the four flood-mapping steps to arrive at the flood-boundary map. The discussion for each method will relate to the above four steps.

Detailed Method

The detailed method, commonly called step-backwater, is applicable to a wide range of hydraulic and topographic conditions. The stream channel must have fairly stable boundaries. This means that the stream-channel boundaries must have a low probability of change that would significantly affect the hydraulic characteristics of a T-year discharge.

The detailed method is probably the most accurate of all five methods and is the most expensive to use. Detailed field surveys of channel cross sections and channel and valley elevations are needed, either by ground surveys or by aerial photography combined with ground control. All four flood-mapping steps are used in this method.

The T-year depths and water-surface profile are computed using a combination of Bernoulli's energy equation and the Manning equation (Chow, 1959, p. 249-296). A number of computer programs have been developed to make the computations required for determining water-surface profiles. Three commonly used computer programs are HEC-2, developed by the U.S. Army Corps of Engineers (USCE) (1973); E-431, developed by the U.S. Geological Survey (Shearman, 1976); and WSP-2, developed by the U.S. Soil Conservation Service (1976).

A flood-boundary map is developed by transferring the water-surface elevations from a profile to a topographic map. The elevations can be transferred directly from field surveys, or from field surveys in conjunction with aerial photographs, or solely on the basis of elevation contours on a topographic map. Field surveys or field surveys in conjunction with aerial photographs can be used with a high degree of accuracy. The accuracy of contours and the contour interval must be considered when evaluating the accuracy of a flood-boundary map determined using elevation contours on a topographic map. The standard error of ground elevations based on contours on topographic maps is assumed to be about one-fourth of the contour interval

(Burkham, 1978, p. 517-518). Flood-boundary maps prepared by the U.S. Army Corps of Engineers are examples of maps developed by the detailed method (see table 10 at back of report).

Historical Method

The historical method can be used for a wide range of hydraulic and topographic conditions. Data needed for this method are (1) the peak discharge and recurrence interval of a historical flood, (2) a water-surface profile for this flood, and (3) a T-year discharge. The boundaries of the historical flood are adjusted to the boundaries of a T-year discharge by using one of the several flow equations (Manning, Chezy, and so forth) or using a simple ratio. The historical method can be very accurate; however, very few flood profiles and boundaries of major historical floods have been determined for Utah streams.

Analytical Method

The analytical method can be used for a wide range of hydraulic and topographic conditions. The stream channel must have fairly stable boundaries. This method, developed by Burkham (1977), is similar to the detailed method. It involves the same four steps for mapping flood-prone areas, but the T-year depths and water-surface profile are determined by a different procedure.

The analytical method is based on the assumption that channel control conditions exist during a T-year discharge and the relation between depth and discharge can be adequately represented as a straight line on logarithmic graph paper. An equation representing this relation (Manning equation) is used to make estimates of the T-year depth. The necessary data are the T-year discharge and a small amount of field information. A channel shape factor, channel width at a reference depth, channel-bottom slope or water-surface slope, and Mannings roughness factor, n, must be determined at representative subreaches in the reach of interest. Step-by-step guidelines on how to use the analytical method are provided in Burkham (1977). This method is less accurate than the detailed method and less expensive.

Physiographic Method

The physiographic method is based on work by Leopold and Maddock (1953) who showed that the channel geometry of a stream is a function of the discharge of water and sediment, which, in turn is a function of the physical and climatic characteristics of the drainage basin. The direct basinwide relationship between depth and discharge is based on the assumption that discharge is of equal frequency of occurrence at all sites within the basin.

The physiographic method can be used for natural stream channels having stable boundaries. It cannot be used where local on-site conditions such as bridges, culverts, and other modified channels affect the natural depth-discharge relation. This method is useful for a simple, rapid approximation of flood-prone areas.

The physiographic method consists of three steps: Determining T-year depths, developing a T-year profile, and developing a flood-boundary map. T-year depths are estimated from regional regression equations which are developed by relating T-year depths determined at gaging stations to basin and climatic characteristics. An explanation of how the T-year depths are developed into a flood profile and then into a flood-boundary map is given later in this report.

Reconnaissance Method

The reconnaissance method is, as the name implies, a fairly rough method of delineating flood-prone areas. The hydrologist uses results of a general examination of the stream of interest as a basis for delineating on a topographic map the boundaries of a rare flood. The boundaries are delineated based on geomorphic and hydraulic principles. No cross sections are surveyed and no formal hydraulic computations are made. The user of this method needs considerable experience in several related fields of geomorphology, hydraulics, soil science, and so forth. Drawbacks to the method are (1) the relation between the boundaries of the flood and a recurrence interval is not established, and (2) values for the range of accuracy of the results cannot be given. However, this procedure may be the most logical for delineating flood boundaries on surfaces where stream-channel boundaries are very unstable (such as alluvial fans, pediments, and flat surfaces of unconsolidated material), and on streams where the channel becomes discontinuous. Most of the maps for communities participating in the National Flood Insurance Program were developed by this method (see table 11 at back of report).

CLASSIFICATION OF STREAMS FOR FLOOD-HAZARD DEFINITION

A stream is classified based on the topography of the area through which it is flowing. The topography will directly influence the type of flood hazards that may occur. Also, the accuracy and reliability of a flood-mapping method is dependent on the topography adjacent to the stream channel.

Burkham (U.S. Geological Survey, Sacramento, California, written commun., 1981) provided a detailed description of flood-hazard areas in the Great Basin. He described the different flood hazards and the merits of each flood-mapping method for streams in mountains, alluvial fans, alluvial valleys, and playas. Burkham's discussion about flood hazards in the Great Basin is applicable to Utah with a few minor differences due to the different physiography of the Colorado River Basin in Utah. About one-half of Utah is in the Great Basin and one-half is in the Colorado River Basin.

The Great Basin is in the Basin and Range physiographic province described by Fenneman (1931). The Great Basin includes a series of northward-trending fault-block mountain ranges separated by alluvium-filled valleys. Alluvial fans and pediments are widespread and are the transition zone between the mountains and valleys.

Most of the Colorado River Basin in Utah includes the Colorado Plateaus physiographic province and the Uinta Mountains, which are part of the Middle Rocky Mountain physiographic province (Fenneman, 1931). The east-west trending Uinta Mountains are a high glaciated mountain range located on the northern boundary of the Colorado Plateau. The Colorado Plateaus physiographic province is characterized by high plateaus modified by various degrees of erosion. Topography in this region is extremely varied. Major land forms in the region are plains, plateaus, pediments, and laccolith-formed mountains. Drainage systems generally are deeply incised.

The topography of the Colorado River Basin, the Great Basin, and the Uinta Mountains is incorporated into the following stream classification scheme. The stream classification can be used to determine which flood-mapping methods are most applicable.

Category 1--Streams in Mountains

Streams in mountains are usually in V-shaped valleys with gentle to steep sideslopes that extend to the low-water channel. This category also includes streams in canyonland areas in the Colorado River Basin where stream channels are deeply incised into the surrounding bedrock. The flood plain is very narrow or nonexistent. Surficial material is bedrock or colluvium. Stream channels generally are very stable.

Category 2--Streams on Pediments or Alluvial Fans

Pediments and alluvial fans occur just downstream from mountain or plateau fronts. Longitudinal slopes range from 2 to 20 percent, with slopes on alluvial fans occasionally reaching 30 percent. A pediment is an erosional surface cut on rock and usually covered with a thin layer of alluvium. Alluvial fans are made up of material deposited by streams emerging from mountains onto a lower surface of flatter gradient. The surface relief of the land perpendicular to the channel is fairly flat and the flood plain can be very wide. Surficial material is alluvium (boulders, gravel, and sand). Larger streams may be cut through the fan material down into bedrock. Stream channels usually are unstable on both alluvial fans and pediments. Because of the depositional nature of alluvial fans, channels generally are more unstable on alluvial fans than on pediments. These two landforms, however, tend to grade into each other and it is sometimes difficult to distinguish one from the other without detailed geologic mapping. Therefore, they are grouped together for this classification.

Category 3--Streams in Areas of Low-Surface Relief

The areas of low-surface relief include land forms with slopes of less than 10 percent. This includes the top surfaces of plateaus and plains. The surface relief of the land perpendicular to the channel is fairly flat, stream meanders are often well developed, and the flood plain can be very wide. Surficial material is unconsolidated weathered rock or bedrock. Channels cut into unconsolidated material usually are unstable and channels cut into bedrock are stable.

Category 4--Streams in Alluvial Valleys

Alluvial valleys exist throughout Utah. The stream channel is cut into material that has been deposited by the stream. Typically, an alluvial valley will have a flat valley bordered by hillslopes on each side. The flood plain can be tens of feet to several miles wide. Surficial material is alluvium. Channel stability can range from very unstable to stable.

In categories 2, 3, and 4, the stream channel needs to be classified as incised or discontinuous. A stream channel that becomes discontinuous needs special treatment when determining the flood boundaries. Most flood-mapping methods are not applicable to discontinuous stream channels. For categories 2 and 3, the stream needs to be classified as local runoff (a stream that begins on the pediment, alluvial fan, or plain) or as a stream originating in the mountains or high plateaus and flowing through the pediment, alluvial fan, or plain. Channel boundaries are more unstable on a local runoff stream than on a stream that originates in the mountains. This characteristic can be used in evaluating the reliability of a flood-mapping method for streams on these surfaces.

USE OF FLOOD-MAPPING METHODS

The choice of the appropriate flood-mapping method to use for a particular stream depends on the objectives of the user, the desired accuracy, the cost, the time available, the experience of the user, and the topography of the stream valley. Burkham (1978) and Wolman (1971) describe the factors involved in selecting the best mapping method for a particular situation. Only the topography factor is discussed in this report.

The four stream classifications and the flood-mapping methods that are applicable to each stream category are shown in table 1. The accuracy and reliability of each method as it applies to the stream classification is rated on a relative scale of poor-fair-good.

Only the reconnaissance method is applicable to a discontinuous stream channel regardless of the category under which the stream is listed. The accuracy and reliability of the results of the reconnaissance method for discontinuous channels depends on the knowledge and experience of the user.

Category 2 (streams on pediments or alluvial fans) and category 3 (streams in areas of low-surface relief) are grouped together in this table. These categories are similar in that stream channels usually are unstable and can range from very unstable to stable. Thus, flood-plain area estimates on these surfaces are more uncertain than in mountains or alluvial valleys. Generally, alluvial fans will have the most unstable channels followed by pediments and then plains (low-surface relief). This characteristic needs to be considered in determining which flood-mapping method to use and in evaluating its reliability.

DESCRIPTION OF METHODS FOR ESTIMATING T-YEAR DISCHARGES AND DEPTHS

This section describes the methods that can be used to estimate T-year discharges and depths for streams in Utah. The T-year discharges can be used in the detailed, historical, and analytical flood-mapping methods. The T-year depths are for use in the physiographic method and can be used as a reference depth in the analytical method. These methods are for use at a study site which is defined for this report as a short reach of a stream. The study site will fit into one of three categories: at a gaged site, a site near a gaged site on the same stream, or an ungaged site.

Table 1.--Applicable flood-mapping methods for the different categories of streams

Category	Description	Applicable methods	Accuracy and reliability
1	Streams in mountains	Detailed	Good
		Historical	Do.
		Analytical	Do.
		Physiographic	Fair to good
		Reconnaissance	Poor to good[1]
2,3	Streams on pediments or alluvial fans or in areas of low-surface relief (entrenched streams originating in mountains)	Detailed	Poor to good[2]
		Historical	Do.
		Analytical	Do.
		Physiographic	Poor to fair[2]
		Reconnaissance	Poor to good[1]
2,3	Streams on pediments or alluvial fans or in areas of low-surface relief (local runoff)	Detailed	Poor
		Historical	Do.
		Analytical	Do.
		Reconnaissance	Poor to good[1]
4	Streams in alluvial valleys	Detailed	Good
		Historical	Do.
		Analytical	Do.
		Physiographic	Fair
		Reconnaissance	Poor to good[1]

[1] Depends on the knowledge and experience of the user.

[2] Depends on how deep stream is incised and if the channel is cut into unconsolidated material or bedrock.

Gaged Sites

Peak-discharge and flood-depth data for gaged sites are listed in table 12 at the back of the report. The top line in the flood-characteristics section of the table is the station flood-frequency data. The bottom line is a weighted flood-frequency estimate based on the station flood frequency and the regional regression estimate of flood frequency at the gaged site. The regional regression equations are described on pages 11-23. The weighted estimate is considered to be the best estimate of flood frequency at a gaged site on an unregulated stream.

The last section of table 12 (p. 76-77) presents flood- and basin-characteristics data for gaging stations not used in the regression analysis. The annual peak discharges for most of these stations are materially affected by diversions or regulation. The flood-frequency relations apply to the streams for the conditions (volume of diversions, reservoir releases, and so forth) that were present during the period of record used to define the flood-frequency relation. If there are major changes in the amount of diversions or reservoir releases, then the flood-frequency relation given here may not be representative of future flows.

Weighted estimates are used for unregulated streams to reduce the time-sampling error that may occur in a station flood-frequency estimate. This time-sampling error is the error associated with the length of record for a station. A station with a short period of record may have a large time-sampling error because its record may not be representative of the actual flood history of the site which would be based on a large number of years. The observed period of record at a station has the possibility of falling within a wet or dry climatic cycle. The weighted estimate of flood frequency should be a better indicator of the true values because the regression estimate is an average of the flood histories of many gaging stations over a long period of time.

The weighting procedure used in this report is described by Sauer (1974). This procedure weights the station flood frequency and the regression estimate of flood frequency by the years of record at the station and the equivalent years of record of the regression estimate. The flood-frequency data for a station with a long period of record will be given greater weight than that for a station with a short period of record. The following equation is used:

$$Q_{T(w)} = \frac{Q_{T(s)}\ (N) + Q_{T(r)}\ (E)}{N + E}$$

where

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

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

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

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

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

The U.S. Water Resources Council (1981, p. 21) recommends using 10 years of equivalent years of record when accuracy appraisals of the regression equations are not made. Accuracy appraisals were made following a procedure described in Hardison (1971); however, the resulting values varied considerably throughout the State. Because of this variability and the many assumptions and possible errors in these accuracy appraisals, it was decided to use a value of 10 years for all the regression estimates.

Sites Near Gaged Sites on the Same Stream

Peak discharges can be computed by the following equation:

$$Q_{T(u)} = Q_{T(g)} \, (A_u/A_g)^x$$

where

$Q_{T(u)}$ = peak discharge, in cubic feet per second, at ungaged site for recurrence interval T-years;

$Q_{T(g)}$ = peak discharge, in cubic feet per second, at gaged site for recurrence interval T-years;

A_u = drainage area, in square miles, at ungaged site;

A_g = drainage area, in square miles, at gaged site; and

x = exponent for each flood region as follows:

Flood region	Exponent, x
Northern Mountains High Elevation	0.9
Northern Mountains Low Elevation	.7
Uinta Basin	.4
High Plateaus	.7
Low Plateaus	.4
Great Basin High Elevation	.7

The exponent was determined by regressing the six T-year discharges (T= 2, 5, 10, 25, 50, 100 years) on drainage area for each flood region and taking the average of the drainage area exponent ($Q_T = a \cdot Area^x$) for the six equations. The above equation is considered applicable for ungaged sites where the drainage area ratio is between 0.75 and 1.5. The same procedure may be used for T-year depths. Simply change the exponent x to 0.25 and replace Q with depth. The exponent of drainage area in the flood-depth equations varied little between the flood regions, thus for simplicity an average of 0.25 is recommended. In addition to the ratio method for sites near gaged sites, if a study site is between two gages, the peak discharge or flood depth may be estimated by interpolation between values for the two gages with allowance for major tributaries.

Ungaged Sites

This method consists of a series of regression equations relating peak discharge and flood depth to basin characteristics. A discussion of the multiple-regression analysis is given in the "Analytical development of regression equations" section of this report. The resulting equations have the following form:

$$Y_T = a(X_1)^{b_1} (X_2)^{b_2}$$

where

Y_T = flood characteristic, either peak discharge or flood depth for recurrence interval T-years;

X_1, X_2 = basin characteristics;

a = regression constant; and

b_1, b_2 = regression coefficients.

Two basin characteristics (independent variables) are needed to use the regression equations in this report. These basin characteristics should be measured from the largest scale topographic map available. The characteristics are:

1. A is drainage area, in square miles--It is determined by planimetering the contributing drainage area on a topographic map.

2. E is mean basin elevation, in thousands of feet--The mean basin elevation is determined using a transparent grid overlay on a topographic map. The elevations of a minimum of 20 equally spaced points are determined and the average of the points is taken.

Flood Regions

One regression model for Utah does not adequately explain the variation in flood characteristics throughout the State. The State was, therefore, divided into seven different flood regions (fig. 1) and separate regression equations were developed for six of these regions. This removes some of variation in the system not explained by independent variables readily available on existing maps and thus makes the subsequent equations simpler. Regression equations were not developed for stations in the Great Basin below 5,000 feet elevation for reasons described on page 16.

The flood regions were delineated based on residual patterns, mean basin elevation of the gaging stations, and on the type of floods that have occurred at the gaging stations (snowmelt, thunderstorm, frontal rainfall, or combinations thereof).

The boundaries of the flood regions are based on the mean basin elevation of the drainage basin, datum of the study site, drainage divides, or political features such as county lines or State highways. A detailed explanation of the boundaries in figure 1 is given in the next few pages under the subsection for each flood region. Detailed reference is made to streams,

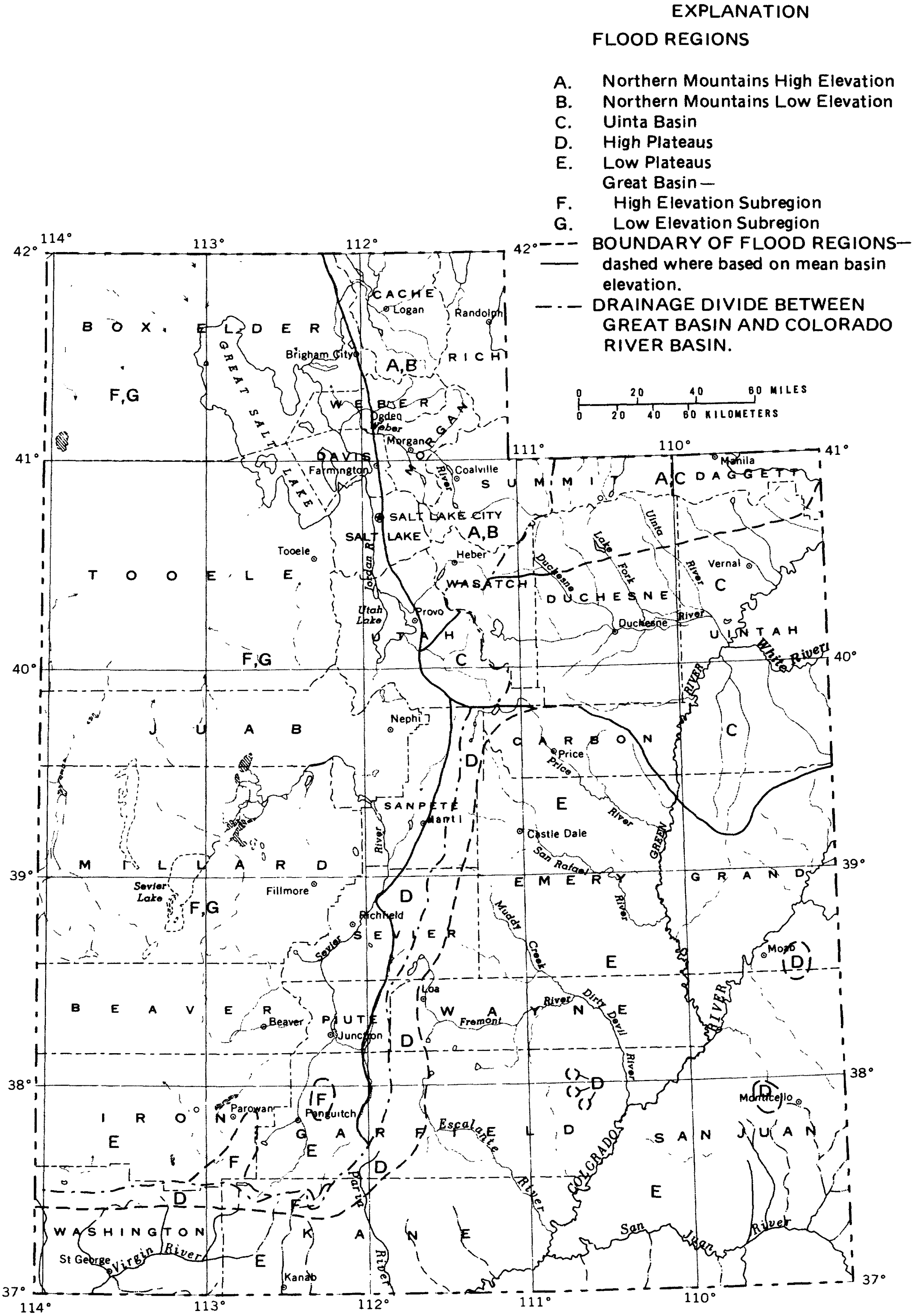


Figure 1.—Flood regions in Utah.

highways, and towns which are not shown in figure 1. All of these streams, highways, and towns, however, appear on U.S. Geological Survey maps, scale 1:500,000. To determine which flood region the study site is in, the user needs to determine the datum and mean basin elevation of the study site. The datum is the elevation (NGVD of 1929) at the site and the mean basin elevation is determined for the drainage basin which contributes streamflow to the study site.

The mean basin elevation boundaries in figure 1 roughly coincide with the upper elevation limit where thunderstorm floods are less frequent than those from snowmelt (Woolley, 1946; Farmer and Fletcher, 1971). The thunderstorms that occur in the high elevation regions are usually not of large areal extent and do not produce many of the larger floods. However, flood peaks from rare thunderstorms can exceed those from snowmelt, especially for small basins. In the lower elevation regions, thunderstorm floods usually dominate the flood history of streams.

The mean basin elevations that define boundaries in the State increase from north to south. North of 40° latitude, the boundary is at 7,500 feet. Between 38° and 40° latitude, the boundary is at 8,000 feet. South of 38° latitude, a study site in a high elevation region must have a mean basin elevation greater than 8,000 feet and a datum greater than 7,000 feet. These different boundaries were selected because at high elevations thunderstorm floods are more significant in the southern parts of the State. This is apparent in the gaging-station records. Based on many adjustments of the region boundaries, the boundaries selected (fig. 1) gave the best results in terms of lowest standard error of estimate and realistic estimates of flood magnitudes.

Northern Mountains High Elevation Region

The Northern Mountains High Elevation Region includes all sites north of 40° latitude and east of $112^{\circ}10'$longitude (fig. 1) that have a mean basin elevation greater than 7,500 feet. The southern boundary coincides with a mean basin elevation of 7,500 feet from the Colorado border to the Duchesne River at Tabiona. The absolute southern boundary (study site cannot be south of this boundary) is from east to west, along the Green River to the confluence with the Duchesne River, then along the Duchesne River to the town of Tabiona. The boundary then follows the drainage divide between the Duchesne River and Currant Creek up to the Great Basin-Colorado River Basin drainage divide. It extends south along the Great Basin-Colorado River Basin drainage divide to the drainage divide between Hobble Creek and Diamond Fork and follows that divide westward to near the town of Spanish Fork. The western boundary follows the Wasatch Front at an elevation of 4,500 feet from Spanish Fork in a north-northwest direction to the Idaho border at about $112^{\circ}10'$ longitude near the town of Portage, Utah.

The topography is mostly mountainous and most streams are in the mountains or alluvial valley stream categories. Most of the floods result from snowmelt. Thunderstorm floods generally are smaller in magnitude than the annual snowmelt peaks. However, peaks from rare thunderstorm floods over small basins can exceed those from snowmelt.

Sixty-two stations were used in the peak-discharge analyses and 42 stations were used in the flood-depth analyses. Peak-discharge estimates for streams that cross Mississippian limestone formations that crop out in this region could be much higher than actual values because water readily infiltrates into these locally permeable formations.

The regression equations relating peak discharge and flood depth to basin characteristics for the Northern Mountains High Elevation Region are listed in table 2. The flood- and basin-characteristics data for this region are listed in table 12.

Northern Mountains Low Elevation Region

The Northern Mountains Low Elevation Region includes all sites in the Great Basin north of 40° latitude and east of 112°10' longitude (fig. 1) that have a mean basin elevation less than 7,500 feet. Several stations in Idaho in the Bear River Basin are included in this region. The boundaries coincide with the Northern Mountains High Elevation Region, except all sites are in the Great Basin.

Topography in this region is mostly mountainous, however, all four stream categories can be found. This is a mixed population flood area where floods may result from snowmelt, thunderstorms, or a combination. The infrequent thunderstorm floods usually will have a higher magnitude than the snowmelt floods.

Twenty-nine stations were used in the peak-discharge analyses and 12 stations were used in the flood-depth analyses. Mississippian limestone formations crop out to a minor extent in this region and peak-discharge estimates should be viewed with discretion for streams that cross such outcrops because of the likely loss of flow to these formations.

The regression equations relating peak discharge and flood depth to basin characteristics for the Northern Mountains Low Elevation Region are listed in table 3. The flood- and basin-characteristics data for this region are listed in table 12.

Uinta Basin Region

The Uinta Basin Region is south and east of the Northern Mountains High Elevation Region and north of the Low Plateaus Region (fig. 1). There is no mean basin elevation criterion except on the northern boundary with the Northern Mountains High Elevation Region where the boundary is based on a mean basin elevation of 7,500 feet. The region includes all sites in the Colorado River Basin, north of 40° latitude, up to the Wyoming border with a mean basin elevation less than 7,500 feet. The western and southern boundary extends from the mountain front near the town of Spanish Fork up the north face of Loafer Mountain, then eastward through the town of Birdseye to the drainage divide taking in all streams flowing northward into Soldier Creek. Then it follows the county line between Utah County and Carbon County eastward to the Price River at State Highway 6. From there eastward to State Highway 53 (Wellington to Myton), the boundary coincides with the Low Plateaus Region and is based on a mean basin elevation of 8,000 feet. Sites with a mean basin elevation greater than 8,000 feet are in the Uinta Basin Region and those with a mean basin elevation less than 8,000 feet are in the Low Plateaus Region. From State Highway 53, the boundary is along the major drainage divide (Roan Cliffs) of the Uinta Basin to the Colorado State line.

The topography is mostly high plateaus cut by deeply incised streams. All four stream categories can be found in the region. This is a mixed population flood area and thunderstorms will produce the larger floods.

Twenty-five stations were used in the peak-discharge analyses and 16 stations were used in the flood-depth analyses. Estimates of peak discharges and depths need to be viewed with discretion because the region has widely varying topography, a mixed population of floods, and few gaging stations for the large area it covers. The peak-discharge equations apply to all unregulated streams except the White River. The White River was excluded from this analysis because most of its drainage area is in Colorado and many of the annual peak discharges result from snowmelt in Colorado. The station record for 09306500, White River near Watson, is representative of the entire reach of the White River in Utah.

The regression equations relating peak discharge and flood depth to basin characteristics for the Uinta Basin Region are listed in table 4. The flood- and basin-characteristics data for this region are listed in table 12.

High Plateaus Region

The High Plateaus Region is south of the Uinta Basin Region and east of the Great Basin Region (fig. 1). This region includes all sites in the Colorado River Basin south of the Uinta Basin Region that meet the following elevation criteria: (1) Between 39°50' latitude and 38° latitude, the mean basin elevation must be greater than 8,000 feet. (2) South of 38° latitude, the mean basin elevation must be greater than 8,000 feet and the study site datum must be greater than 7,000 feet. The region also includes streams in the Great Basin on the western side of the Wasatch Plateau which may be below a mean basin elevation of 8,000 feet. The northern and western boundary is as follows: from north to south, it starts at the Colorado River Basin-Great Basin drainage divide just north of Scofield Reservoir and coincides with the Uinta Basin Region boundary in this area. From the town of Birdseye, the High Plateaus boundary follows State Highway 89 southward to the town of Vermillion. Then it follows State Highway 24 to Otter Creek, then south along Otter Creek to the confluence with East Fork Sevier River, then south along East Fork Sevier River to State Highway 12, then east along State Highway 12 to the drainage divide between the Great Basin and Colorado River Basin.

The topography is mostly mountains or high plateaus. All four stream categories can be found in this region, although most streams are in the mountains or alluvial valley categories. This is a mixed population flood area and the infrequent thunderstorm floods can have greater magnitudes than snowmelt floods.

Twenty-seven stations were used in the peak-discharge analyses and 20 stations were used in the flood-depth analyses. The alluvial fans on the west side of the Wasatch Plateau and the Aquarius (mostly in Garfield County) and Awampa Plateaus (mostly in Wayne County), where some permeable volcanic material occurs, are areas where peak-discharge estimates may be slightly higher than actual values. The regression equations relating peak discharge and flood depth to basin characteristics for the High Plateaus Region are listed in table 5. The flood- and basin-characteristics data for this region are listed in table 12.

Low Plateaus Region

The Low Plateaus Region includes a large area, mostly in the Colorado River Basin south of 39°50' latitude (fig. 1). Between about 39°50' latitude and 38° latitude, all sites are in the Colorado River Basin and have a mean basin elevation less than 8,000 feet. The region includes all of Utah south of 38° latitude and all sites in this southern part must have a mean basin elevation less than 8,000 feet or a study site datum less than 7,000 feet.

The topography in this region is extremely varied and all four stream categories can be found. A major distinguishing feature is the deep and narrow canyons that are present throughout the region. Summer thunderstorms produce most of the large magnitude floods. Snowmelt floods are rare and usually small.

Eighty-one stations were used in the peak-discharge analyses and 46 stations were used in the flood-depth analyses. Peak-discharge estimates should be viewed with discretion when much of the drainage basin is made up of wind-deposited material or alluvium, or where streams cross permeable volcanic material, alluvial fans, or playas.

The regression equations relating peak discharge and flood depth to basin characteristics for the Low Plateaus Region are listed in table 6. The flood- and basin-characteristics data for this region are listed in table 12.

Great Basin Region

The Great Basin Region includes most of western Utah (fig. 1). This region consists of northward-trending mountains paralleled by alluvium-filled valleys. Large alluvial fans are widespread throughout the region and the upper elevation limit of the fans is generally between 6,000 and 6,500 feet. Floods in the mountains occur as a result of snowmelt or thunderstorms. Thunderstorms will produce most of the floods on the alluvial fans and valley floors. Gaging stations are sparse and thus it was difficult to develop regression relations for the whole region. Most of the gaging stations are in the mountains or on alluvial fans. Because many of these stations had no flow during more than 25 percent of the years of record, no flood-frequency relations could be developed for them (U.S. Water Resources Council, 1981, p. 5-1). Therefore, regression equations were developed only for those gaging stations that have flood-frequency relations, and that have a mean basin elevation greater than 6,000 feet and a datum greater than 5,000 feet. There are four stations below these elevation criteria which have flood-frequency relations, but the predicted floods at these stations did not fit in with the higher elevation group. Thus, the Great Basin Region is divided into two subregions based on elevation of the study site. These two subregions, Great Basin High Elevation and Great Basin Low Elevation, are discussed in the following sections.

Regression equations apply to the High Elevation Subregion and alternative procedures are given in a following section for predicting flood characteristics in the Low Elevation Subregion. The regression equations for the High Elevation Subregion are primarily predicting peak discharge from snowmelt. However, infrequent intense thunderstorms can occur at higher elevations and thus these regression estimates must be viewed with discretion. The alternative procedures for the Low Elevation Subregion, which will predict higher peaks, might be used for a very conservative estimate of peak discharge in the 6,000 to 8,000 feet elevation range; or an average can be taken of the two estimates.

High Elevation Subregion.--All sites in the High Elevation Subregion are in the Great Basin (fig. 1). The eastern boundary coincides with the Northern Mountains (High and Low Elevation) Regions and the High Plateaus Region. North of 38^{0} latitude, the mean basin elevation must be greater than 6,000 feet and the study site datum must be greater than 5,000 feet. South of 38^{0} latitude, the mean basin elevation must be greater than 8,000 feet and the study site datum must be greater than 7,000 feet.

The High Elevation Subregion is mostly in mountainous topography. Streams in this subregion may be in the mountains, alluvial valley, or alluvial fan/pediment category. This is a mixed population flood area with floods resulting from snowmelt or thunderstorms. The infrequent thunderstorms will produce larger floods than snowmelt.

Thirty stations were used in the peak-discharge analyses and 19 stations were used in the flood-depth analyses. Peak-discharge estimates should be viewed with discretion for streams that cross alluvial fans, because flows are likely to decrease as the water infiltrates or spreads out over the fan. This decrease in flow is usually true, however, if a thunderstorm occurs just over the alluvial fan, the resulting flood can be very large.

The regression equations relating peak discharge and flood depth to basin characteristics for the Great Basin High Elevation Subregion are listed in table 7. The flood- and basin-characteristics data for this region are listed in table 12.

Low Elevation Subregion.--The Low Elevation Subregion includes all sites in the Great Basin north of 38^{0} latitude (fig. 1) that have a mean basin elevation less than 6,000 feet or a study site datum less than 5,000 feet. The topography in this subregion is mostly alluvial fans, alluvial basins, and playas. Most of the floods in this subregion will result from thunderstorms.

No regression equations were developed for this subregion because of the extremely variable flood characteristics and the small number of gaging stations with 75 percent or more years of record with any flow. To estimate flood characteristics in this subregion, some alternatives are discussed in the following paragraphs.

Table 2.--Regression equations for peak discharges and flood depths of selected recurrence-interval floods for Northern Mountains High Elevation Region

Equation: Q, peak discharge, in cubic feet per second; D, flood depth, in feet; A, drainage area, in square miles; and E, mean basin elevation, in thousands of feet.

Recurrence interval, in years	Equation	Number of stations used in analysis	Average standard error of estimate, in percent
	Peak Discharge		
2	$Q = 0.044\ A^{0.831}\ E^{2.67}$	62	44
5	$Q = 0.064\ A^{0.822}\ E^{2.67}$	62	39
10	$Q = 0.071\ A^{0.815}\ E^{2.70}$	62	37
25	$Q = 0.077\ A^{0.807}\ E^{2.76}$	62	37
50	$Q = 0.079\ A^{0.801}\ E^{2.80}$	62	37
100	$Q = 0.078\ A^{0.795}\ E^{2.86}$	62	38
	Flood Depth		
2	$D = 1.02\ A^{0.241}$	42	25
5	$D = 1.22\ A^{0.238}$	42	23
10	$D = 1.33\ A^{0.236}$	42	23
25	$D = 1.44\ A^{0.235}$	42	23
50	$D = 1.54\ A^{0.230}$	42	23
100	$D = 1.67\ A^{0.222}$	42	23

Table 3.--Regression equations for peak discharges and flood depths of selected recurrence-interval floods for Northern Mountains Low Elevation Region

Equation: Q, peak discharge, in cubic feet per second; D, flood depth, in feet; A, drainage area, in square miles; and E, mean basin elevation, in thousands of feet.

Recurrence interval, in years	Equation	Number of stations used in analysis	Average standard error of estimate, in percent
	Peak Discharge		
2	$Q = 562\ A^{0.755}\ E^{-2.06}$	29	77
5	$Q = 6{,}660\ A^{0.757}\ E^{-3.08}$	29	70
10	$Q = 30{,}500\ A^{0.758}\ E^{-3.74}$	29	69
25	$Q = 184{,}000\ A^{0.758}\ E^{-4.54}$	29	68
50	$Q = 644{,}000\ A^{0.758}\ E^{-5.10}$	29	69
100	$Q = 2.08 \times 10^{6}\ A^{0.757}\ E^{-5.63}$	29	69
	Flood Depth		
2	$D = 0.804\ A^{0.245}$	12	32
5	$D = 0.971\ A^{0.252}$	12	27
10	$D = 0.996\ A^{0.272}$	12	26
25	$D = 1.05\ A^{0.287}$	12	26
50	$D = 1.12\ A^{0.287}$	12	26
100	$D = 1.21\ A^{0.283}$	12	26

Table 4.--Regression equations for peak discharges and flood depths of selected recurrence-interval floods for Uinta Basin Region

Equation: Q, peak discharge, in cubic feet per second; D, flood depth, in feet; A, drainage area, in square miles; and E, mean basin elevation, in thousands of feet.

Recurrence interval, in years	Equation	Number of stations used in analysis	Average standard error of estimate, in percent
	Peak Discharge		
2	$Q = 1{,}500\ A^{0.403}\ E^{-1.90}$	25	82
5	$Q = 143{,}000\ A^{0.374}\ E^{-3.66}$	25	66
10	$Q = 1.28 \times 10^{6}\ A^{0.362}\ E^{-4.50}$	25	64
25	$Q = 1.16 \times 10^{7}\ A^{0.352}\ E^{-5.32}$	25	66
50	$Q = 4.47 \times 10^{7}\ A^{0.347}\ E^{-5.85}$	25	70
100	$Q = 1.45 \times 10^{8}\ A^{0.343}\ E^{-6.29}$	25	74
	Flood Depth[1]		
2	$D = 1.03\ A^{0.159}$	16	30
5	$D = 13.3\ A^{0.148}\ E^{-1.03}$	16	28
10	$D = 68.6\ A^{0.131}\ E^{-1.69}$	16	26
25	$D = 556\ A^{0.128}\ E^{-2.59}$	16	24
50	$D = 1{,}330\ A^{0.123}\ E^{-2.95}$	15	24
100	$D = 1{,}210\ A^{0.130}\ E^{-2.86}$	14	23

[1] The number of stations used in the flood-depth analysis varies because station rating curves were extended only as far as available information would permit.

Table 5.--Regression equations for peak discharges and flood depths of selected recurrence-interval floods for High Plateaus Region

Equation: Q, peak discharge, in cubic feet per second; D, flood depth, in feet; A, drainage area, in square miles; and E, mean basin elevation, in thousands of feet.

Recurrence interval, in years	Equation	Number of stations used in analysis	Average standard error of estimate, in percent
	Peak Discharge		
2	$Q = 10.8\ A^{0.800}$	27	66
5	$Q = 25.1\ A^{0.740}$	27	53
10	$Q = 680\ A^{0.706}\ E^{-1.30}$	27	53
25	$Q = 10,300\ A^{0.672}\ E^{-2.33}$	27	57
50	$Q = 64,200\ A^{0.651}\ E^{-3.03}$	27	62
100	$Q = 347,000\ A^{0.631}\ E^{-3.68}$	27	68
	Flood Depth[1]		
2	$D = 11.2\ A^{0.284}\ E^{-1.22}$	20	34
5	$D = 26.7\ A^{0.278}\ E^{-1.47}$	20	28
10	$D = 40.1\ A^{0.272}\ E^{-1.57}$	20	26
25	$D = 53.7\ A^{0.269}\ E^{-1.62}$	20	26
50	$D = 113\ A^{0.252}\ E^{-1.89}$	19	28
100	$D = 150\ A^{0.250}\ E^{-1.97}$	19	30

[1] The number of stations used in the flood-depth analysis varies because station rating curves were extended only as far as available information would permit.

Table 6.--Regression equations for peak discharges and flood depths of selected recurrence-interval floods for Low Plateaus Region

Equation: Q, peak discharge, in cubic feet per second; D, flood depth, in feet; A, drainage area, in square miles; and E, mean basin elevation, in thousands of feet.

Recurrence interval, in years	Equation	Number of stations used in analysis	Average standard error of estimate, in percent
	Peak Discharge		
2	$Q = 3,980\ A^{0.535}\ E^{-2.21}$	81	87
5	$Q = 13,300\ A^{0.467}\ E^{-2.23}$	81	72
10	$Q = 23,700\ A^{0.433}\ E^{-2.23}$	81	67
25	$Q = 42,500\ A^{0.398}\ E^{-2.21}$	81	65
50	$Q = 61,000\ A^{0.375}\ E^{-2.19}$	81	65
100	$Q = 83,100\ A^{0.356}\ E^{-2.17}$	81	66
	Flood Depth[1]		
2	$D = 11.3\ A^{0.230}\ E^{-1.23}$	46	35
5	$D = 22.7\ A^{0.180}\ E^{-1.25}$	46	35
10	$D = 29.3\ A^{0.157}\ E^{-1.21}$	46	37
25	$D = 32.0\ A^{0.141}\ E^{-1.10}$	46	38
50	$D = 35.8\ A^{0.128}\ E^{-1.06}$	45	37
100	$D = 17.9\ A^{0.143}\ E^{-0.680}$	43	33

[1] The number of stations used in the flood-depth analysis varies because station rating curves were extended only as far as available information would permit.

Table 7.—Regression equations for peak discharges and flood depths of selected recurrence-interval floods for Great Basin High Elevation Subregion

Equation: Q, peak discharge, in cubic feet per second; D, flood depth, in feet; A, drainage area, in square miles; and E, mean basin elevation, in thousands of feet.

Recurrence interval, in years	Equation	Number of stations used in analysis	Average standard error of estimate, in percent
	Peak Discharge		
2	$Q = 0.004\ A^{0.786}\ E^{3.51}$	30	83
5	$Q = 15.5\ A^{0.681}$	30	69
10	$Q = 24.2\ A^{0.665}$	30	61
25	$Q = 38.7\ A^{0.648}$	30	58
50	$Q = 52.1\ A^{0.638}$	30	60
100	$Q = 68.1\ A^{0.630}$	30	65
	Flood Depth		
2	$D = 0.568\ A^{0.260}$	19	36
5	$D = 0.784\ A^{0.276}$	19	28
10	$D = 0.957\ A^{0.275}$	19	24
25	$D = 1.16\ A^{0.281}$	19	24
50	$D = 1.36\ A^{0.276}$	19	27
100	$D = 1.53\ A0.279$	19	30

(page 25 follows)

Two envelope curves for maximum peak discharge versus drainage area for two sets of data for Great Basin streams are shown in figure 2. The higher curve, obtained from a national study by Crippen and Bue (1977), envelopes the maximum peak discharges observed through September 1974, in the Great Basin area (Crippen and Bue, 1977, fig. 18), including parts of Utah, California, Arizona, and Nevada. The lower curve envelopes the peak discharge of record for 28 gaging stations in the Great Basin of western Utah and eastern Nevada. These 28 stations do not fit in the Great Basin High Elevation Subregion. Values for these 28 stations are listed in table 12 under the Great Basin Low Elevation Subregion.

It is difficult to assign a frequency or probability to either of the two envelope curves in figure 2. Crippen and Bue (1977) did not attempt to assign a frequency to their curve, which is intended for estimating maximum potential floods. Record length averaged 15 years for the 28 stations used to develop the lower envelope curve. Using design probability theory (Riggs, 1968, p. 13), an approximate 100-year peak discharge relation was sketched on figure 2. Design probability indicates that for a number of independent 15-year records, about 86 percent should not experience a 100-year peak discharge. This theory, however, assumes that the peak discharges at individual stations are independent of those for other stations and represent a random sample of the total population. All 28 stations were operated during 1960-80 and the records for these 28 stations could have a time-sampling bias. Thus, this 100-year peak-discharge relation is only a reference and no accuracy judgments are intended.

An alternative for estimating flood characteristics for the Great Basin Low Elevation Subregion is to use the equations developed for the Low Plateaus Region (table 6). A plot of the 100-year peak discharge values from the equation for the Low Plateaus Region with a mean basin elevation of 5,000 feet is between the upper envelope curve and the approximate 100-year peak-discharge relation obtained by design probability and using data for the 28 gaging stations (fig. 2). This comparison indicates the equations in table 6 probably overestimate peak discharges for streams in the Great Basin Low Elevation Subregion. Such estimates provide a factor of safety and may provide reasonable estimates of T-year discharges. The user should recognize the assumptions and limitations of this method. The appropriate T-year discharge can be used with the detailed or analytical methods for determining T-year depth and flood boundaries.

Reports by Fields (1975) and Hedman and Osterkamp (1982) also provide methods to compute selected T-year discharges for ungaged streams in the Great Basin. However, the methods require that the user measure selected channel widths in the field.

Although the channel depth-discharge relations for streams in the Great Basin are similar to those for streams with low mean basin elevation in the Low Plateaus Region, use of the depth-frequency relations developed for the Low Plateaus Region with the physiographic method should be used with judgment. Many of the streams in the Great Basin in Utah have unstable boundaries and areas mapped as inundated by T-year discharge may change with time.

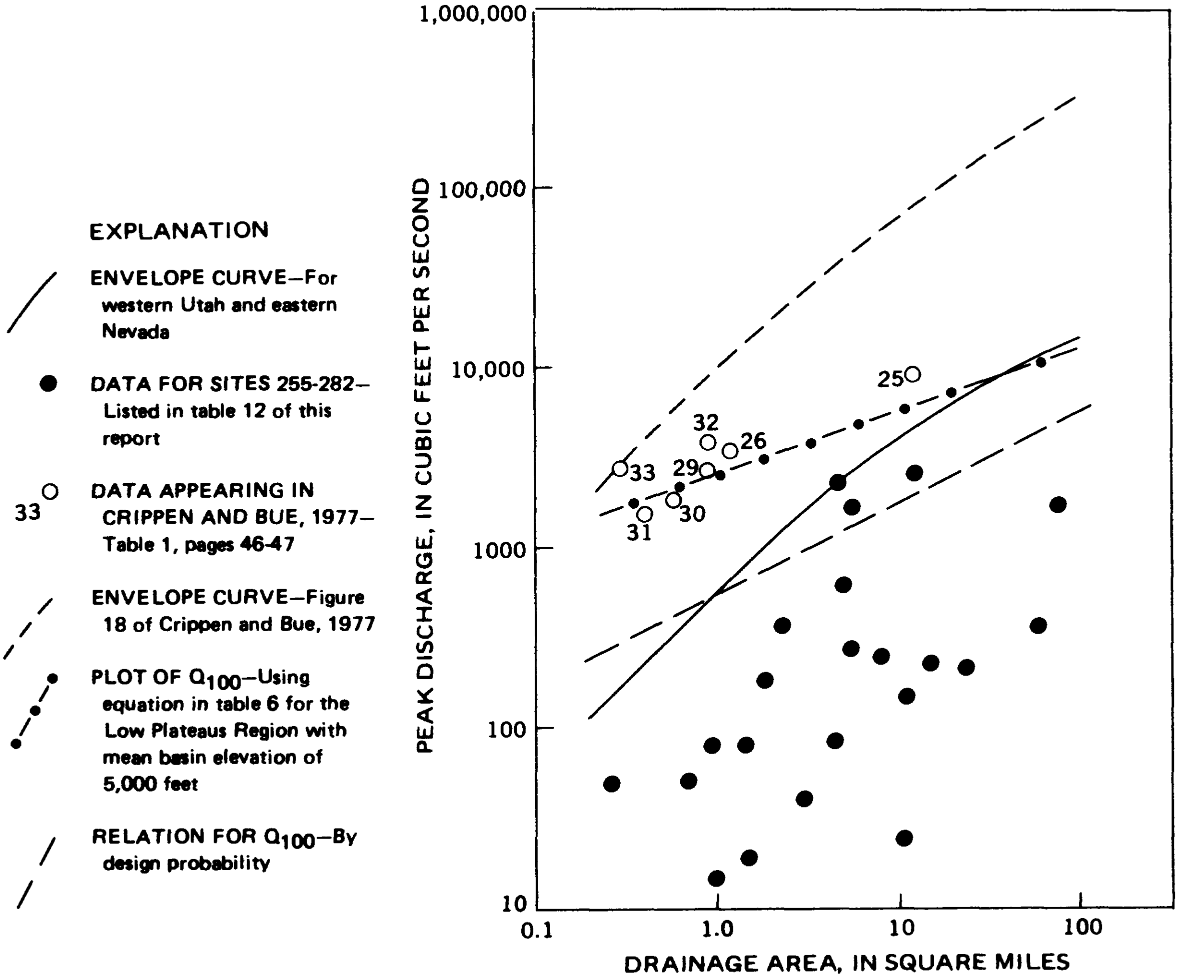


Figure 2.—Peak discharge versus drainage area for desert streams in western Utah and eastern Nevada.

Estimating 500-Year Peak Discharges and Flood Depths

Regression equations were not developed for determining the 500-year peak discharges and flood depths. The flood-frequency analysis of station data is fairly accurate in defining flood-frequency relations where the extension of the flood-frequency relation does not exceed twice the number of years of record. Thus, the extension of a flood-frequency relation defined with a short record to the 500-year recurrence interval is very uncertain. Time-sampling errors of short records can be large because the short records may not be representative of the long-term flood history. In Utah, there are 63 stations on unregulated streams with 25 or more years of record and only 16 stations on unregulated streams with 50 or more years of record. This is too small a sample to adequately define regression equations for the 500-year flood.

It is recognized that the 500-year peak-discharge and flood-depth information is needed for some planning documents. Therefore, ratios of the 500-year peak discharges and flood depths to the 100-year values were developed for each flood region (table 8). No accuracy judgments are given or implied for these ratios. The ratio is the average of every station in the region. The standard deviation about this average value also is given to make the user aware of the variability within each region. The 500-year station values of peak discharge and flood depth were obtained from extending the log-Pearson Type III flood-frequency relation and the rating curve for each station. The 500-year peak discharges and flood depths are not given in table 12 because of the aforementioned uncertainties in the long extensions. The ratios can be used for a gaged site, site near a gaged site, or an ungaged site.

Limitations of Regression Equations

The following are general limitations for using the regression equations for Utah streams. Specific limitations for each flood region were given earlier in the description of each flood region.

1. Equations for estimating peak discharge may not apply to streams:

   a. Where a significant part of the watershed is urbanized.

   b. Where manmade works such as large storage reservoirs, flood-detention structures, or major diversions have a significant effect on peak discharge.

   c. Where basin and climatic characteristics are outside of the range of those used to develop the regression equation. The ranges of the variables used in each equation are given in table 9.

2. Equations for estimating flood depth are not applicable to regulated streams, where stream channel boundaries are very unstable (such as on alluvial fans and on very wide sandy desert wash-type channels), and where local on-site conditions such as bridges, culverts, and modified channels affect the natural depth-discharge relation.

Table 8.—Ratios for predicting 500-year peak discharge and flood depth
[An analysis of variance showed only two groups of the six flood regions are appropriate]

Flood region	Peak discharge: Average ratio Q_{500}/Q_{100}	Peak discharge: Standard deviation	Peak discharge: Number of stations used	Flood depth: Average ratio D_{500}/D_{100}	Flood depth: Standard deviation	Flood depth: Number of stations used
Northern Mountains High Elevation; Northern Mountains Low Elevation	1.3	0.11	82	1.1	0.03	53
Uinta Basin; High Plateaus; Low Plateaus; Great Basin High Elevation Subregion	1.7	.43	155	1.3	.15	85

Table 9.—Range of basin characteristics used in regression equations

Flood region	Drainage area (A) (square miles): T-year discharge equations	Drainage area (A) (square miles): T-year depth equations	Mean basin elevation (E) (feet): T-year discharge equations	Mean basin elevation (E) (feet): T-year depth equations
Northern Mountains High Elevation	2.49–356	7.5–356	7,540–10,960	7,540–10,960
Northern Mountains Low Elevation	2.08–268	2.35–268	5,810–7,470	6,730–7,450
Uinta Basin	2.89–950	2.89–897	5,360–9,060	6,110–9,060
High Plateaus	.43–415	1.47–415	7,470–10,500	8,160–10,000
Low Plateaus	.96–4,160	.96–1,540	4,300–8,890	4,810–8,890
Great Basin High Elevation Subregion	4.19–164	5.58–164	6,070–9,370	7,100–9,370

3. For streams where peak discharges are significantly affected by man, stream-system studies or flood routing may be used to estimate the peak discharges (U.S. Army Corps of Engineers, 1976). Butler, Reid, and Berwick (1966) and Patterson and Somers (1966) provide methods for estimating peak discharges on some of the regulated streams in Utah. Flood-prone area estimates on streams where the depth-discharge relation is affected by man will require open-channel hydraulic studies such as the detailed flood-mapping method.

APPLICATION OF METHODS

1. From figure 1 and the explanation of boundaries in the section on flood regions (p. 11-17) determine which flood region the study site is in. Some streams will cross the boundary of two regions when the boundary is based on mean basin elevation, or in a few cases, an absolute boundary crosses some streams. For sites that are near the boundary of two flood regions, it is recommended that flood characteristics be computed for both flood regions and then the average of the two estimates should be used. This transition zone procedure is described in the following section on application of ungaged sites method.

2. From table 12 determine if the study site is on a gaged stream.

3. If the study site is located at a gaged site listed in table 12, use the weighted flood-frequency values and the flood depths in table 12.

4. If the study site is located near a gaged site on the same stream, use the method described in the section "Sites Near Gaged Sites on the Same Stream."

5. If the study site is located on an ungaged stream, use the method described in the section "Ungaged Sites."

Sites Near Gaged Sites on the Same Stream

Peak-discharge and flood-depth information for sites near gaged sites on the same stream can be computed using the method described on page 10. The first step is to determine the drainage area ratio of ungaged site to gaged site. If the ratio is between 0.75 and 1.50, the equation on page 10 should be used to compute the required peak discharges or flood depths. If the drainage area ratio is outside that range, the method for "Ungaged Sites" should be used. Peak-discharge and flood-depth values for sites between gaged sites on the same stream can be computed by interpolating between values for gaged sites appearing in table 12.

Example 1.--Flood Frequency Near a Gaged Site

Determine the Q_{10}-, Q_{50}-, Q_{100}-year recurrence interval peak discharges for the Duchesne River at an ungaged site where the drainage area (A_u) is 310 square miles. From table 12, note that station 09277500, Duchesne River near Tabiona, Utah (drainage area A_g = 356 mi^2) is in the Northern Mountains High Elevation Region and is located downstream of the study site.

Check that the drainage area ratio A_u/A_g is between 0.75 and 1.5:

$$A_u/A_g = 310 \text{ mi}^2/356 \text{ mi}^2 = 0.87$$

This meets the ratio requirement, and the following relation is used:

$$Q_{T(u)} = Q_{T(g)} \; (A_u/A_g)^x$$

where

x = 0.9 for the Northern Mountains High Elevation Region, and

$Q_{T(g)}$ = the weighted discharge from table 12.

Obtain the weighted discharges at the gage from table 12:

$$Q_{10} = 2{,}280 \text{ ft}^3/\text{s}$$

$$Q_{50} = 2{,}790 \text{ ft}^3/\text{s}$$

$$Q_{100} = 2{,}980 \text{ ft}^3/\text{s}$$

Compute discharges at ungaged site:

$$Q_{10(u)} = 2{,}280 \; (310/356)^{0.9} = 2{,}010 \text{ ft}^3/\text{s}$$

$$Q_{50(u)} = 2{,}790 \; (0.87)^{0.9} = 2{,}460 \text{ ft}^3/\text{s}$$

$$Q_{100(u)} = 2{,}980 \; (0.87)^{0.9} = 2{,}630 \text{ ft}^3/\text{s}$$

Ungaged Sites

Peak discharges and flood depths at ungaged sites can be computed by one of the following procedures, depending on the location of the site and its relation to the flood-region boundaries. Procedure 1 is for sites where regression equations for one region are used. Procedure 2 is for sites that are near region boundaries. Where streams cross region boundaries, the predicted flood characteristics for a site that is near a region boundary may be quite different depending on which regression equation is used. Therefore, it is recommended that an averaging procedure be used for sites that fall near region boundaries. This should smooth out the transition zone between two flood regions. The following criteria should be used to determine if the averaging procedure 2 should be used:

1. Flood-region boundary is based on mean basin elevation or study site datum. If a study site has a mean basin elevation or study site datum within 500 feet of either side of the boundary, then flood characteristics should be computed using the regression equations for both regions and the average of the two estimates used. The average can either be an arithmetic mean or prorated according to the amount of drainage area in each region.

2. A few boundaries follow county lines or State highways. If a study site is on a stream that crosses an absolute boundary and is within 2 miles of either side of the boundary, then the above averaging procedure should be used.

3. If a study site does not fall within the above criteria for averaging, then the regression equations for one region should be used.

Procedure 1--Computation of Flood Characteristics for Sites Where Regression Equations for One Region Are Used

The flood region is identified in figure 1 and appropriate equations are selected from tables 2-7.

Example 2--Use of the regression equations

Determine the peak discharges and flood depths for recurrence intervals of 10, 50, and 100 years for an ungaged site in the Low Plateaus Region. The equations for peak discharges and flood depths for the Low Plateaus Region are listed in table 6. The required basin characteristics are: drainage area (A), in square miles, and mean basin elevation (E), in thousands of feet. Using the procedures outlined on page 11, the drainage area is computed as 45 square miles and the mean basin elevation is 6,400 feet.

These basin characteristics are inserted into the appropriate equations which are solved as follows:

$$Q_{10} = 23{,}700\ A^{0.433}\ E^{-2.23} = 23{,}700\ (45)^{0.433}\ (6.40)^{-2.23} = 1{,}960\ ft^3/s$$

$$Q_{50} = 61{,}000\ A^{0.375}\ E^{-2.19} = 4{,}360\ ft^3/s$$

$$Q_{100} = 83{,}100\ A^{0.356}\ E^{-2.17} = 5{,}740\ ft^3/s$$

$$D_{10} = 29.3\ A^{0.157}\ E^{-1.21} = 29.3\ (45)^{0.157}\ (6.40)^{-1.21} = 5.6\ feet$$

$$D_{50} = 35.8\ A^{0.128}\ E^{-1.06} = 8.1\ feet$$

$$D_{100} = 17.9\ A^{0.143}\ E^{-0.680} = 8.7\ feet$$

Procedure 2--Averaging Procedure for Sites That Are Near Flood-Region Boundaries

The flood regions are identified in figure 1 and using the criteria on pages 30-31 it is determined that the averaging procedure should be used. The appropriate equations for the two flood regions are then selected from tables 2-7.

Example 3--Use of regression equations for two regions and averaging

Determine the peak discharges and flood depths for recurrence intervals of 10, 50, and 100 years for an ungaged site that is near the Northern Mountains High Elevation Region and the Uinta Basin Region boundary based on a mean basin elevation of 7,500 feet. The equations for peak discharges and flood depths for the Northern Mountains High Elevation Region and the Uinta Basin Region are listed in tables 2 and 4. The required basin characteristics are: drainage area (A), in square miles, and mean basin elevation (E), in thousands of feet. Using the procedures outlined on page 11, the drainage area is computed as 96 square miles and the mean basin elevation is 7,200 feet. These basin characteristics are inserted into the appropriate equations and then the average of the two estimates for each region is taken.

Northern Mountains High Elevation Region

$$Q_{10} = 0.071\ A^{0.815}\ E^{2.70} = 0.071\ (96)^{0.815}\ (7.20)^{2.70} = 605\ ft^3/s$$

$$Q_{50} = 0.079\ A^{0.801}\ E^{2.80} = 769\ ft^3/s$$

$$Q_{100} = 0.078\ A^{0.795}\ E^{2.86} = 832\ ft^3/s$$

$$D_{10} = 1.33\ A^{0.236} = 1.33\ (96)^{0.236} = 3.9\ feet$$

$$D_{50} = 1.54\ A^{0.230} = 4.4\ feet$$

$$D_{100} = 1.67\ A^{0.222} = 4.6\ feet$$

Uinta Basin Region

$$Q_{10} = 1.28(10)^6\ A^{0.362}\ E^{-4.50} = 1.28(10)^6\ (96)^{0.362}\ (7.20)^{-4.50} = 926\ ft^3/s$$

$$Q_{50} = 4.47(10)^7\ A^{0.347}\ E^{-5.85} = 2{,}100\ ft^3/s$$

$$Q_{100} = 1.45(10)^8\ A^{0.343}\ E^{-6.29} = 2{,}810\ ft^3/s$$

$$D_{10} = 68.6\ A^{0.131}\ E^{-1.69} = 68.6(96)^{0.131}\ (7.20)^{-1.69} = 4.4\ feet$$

$$D_{50} = 1{,}330\ A^{0.123}\ E^{-2.95} = 6.9\ feet$$

$$D_{100} = 1{,}210\ A^{0.130}\ E^{-2.86} = 7.7\ feet$$

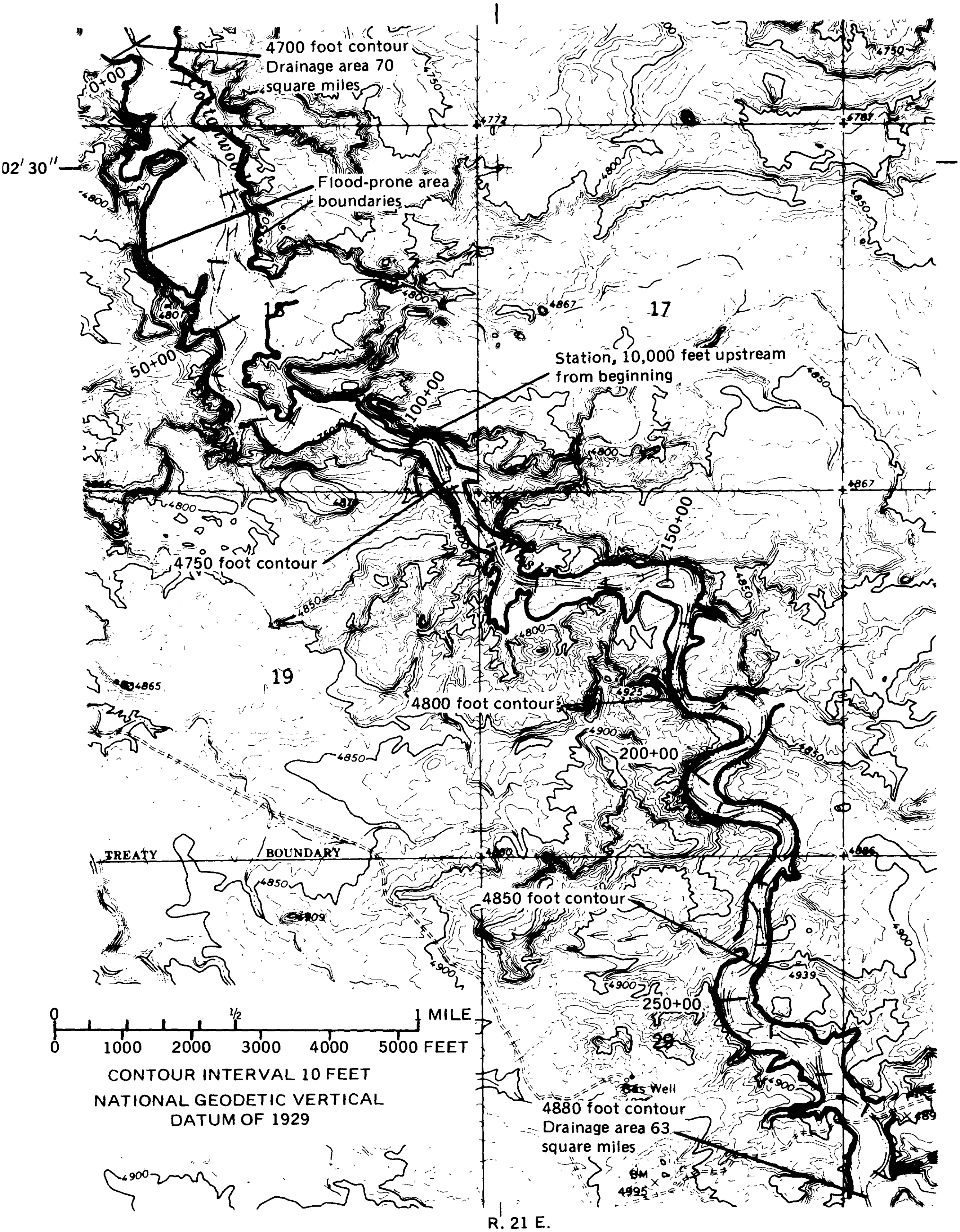
Transition zone - average flood characteristics estimate

Flood characteristic	Northern Mountains High Elevation Region	Uinta Basin Region	Average estimate
	Peak discharge, in cubic feet per second		
Q_{10}	605	926	766
Q_{50}	769	2,100	1,430
Q_{100}	832	2,810	1,820
	Flood depth, in feet		
D_{10}	3.9	4.4	4.2
D_{50}	4.4	6.9	5.6
D_{100}	4.6	7.7	6.2

DELINEATION OF FLOOD-PRONE AREAS USING THE PHYSIOGRAPHIC METHOD

The procedure for estimating flood depths and water-surface elevations, and for delineating areas inundated by the 100-year flood on topographic maps is described in the following example for Cottonwood Wash. The wash is a tributary to the White River in the Uinta Basin, and is located about 30 miles southwest of Vernal (fig. 1).

The first step is to construct a zero-flow stage profile of a reach of Cottonwood Wash by locating points where contour lines cross the wash. It is necessary to assume that the contour lines on the topographic map are exact and intersect streams at about the stage of zero flow (Edelen, 1976, p. 6). Then a zero-flow stage profile is constructed using these points of intersection. Five of the 19 points of intersection are indicated by leaders on the topographic map (fig. 3) where the 4,700 to 4,880, 10-foot contour lines intersect Cottonwood Wash. The profile of zero-flow stage appearing in figure 4 was plotted using these 19 points.



Base from U. S. Geological Survey 1:24,000 series, Ouray SE, Utah, 1964

Figure 3.—Elevation of stream at zero flow, drainage areas, and boundaries of area inundated by the 100-year flood for a part of Cottonwood Wash.

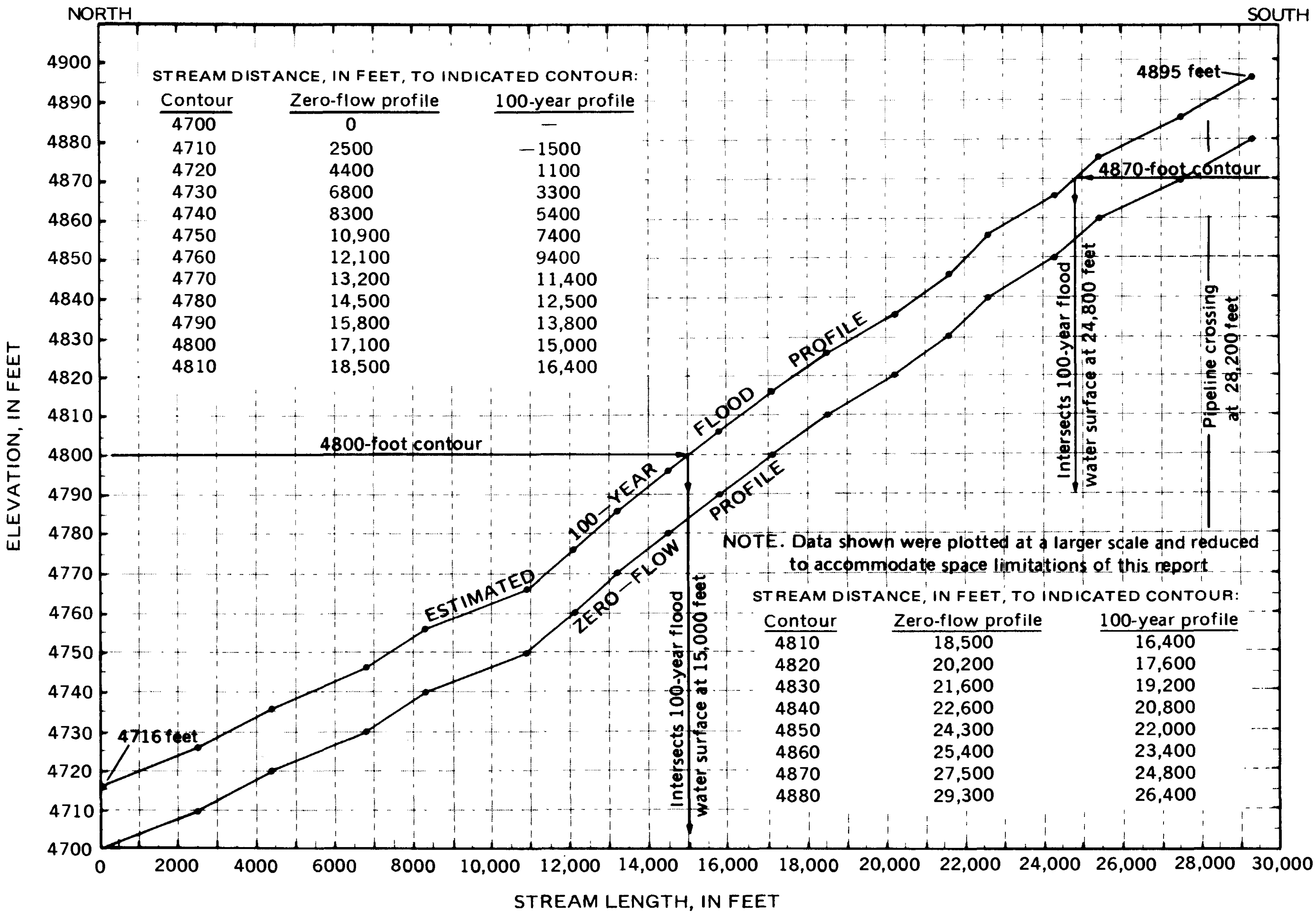


Figure 4.—Zero-flow and 100-year flood profiles for a part of Cottonwood Wash.

The second step is to determine the drainage areas and mean basin elevations for drainages to the most upstream and downstream locations by outlining the drainage boundaries above these points on appropriate topographic maps. The drainage area can then be planimetered and the mean basin elevation determined by averaging 20 or more equally spaced grid points. (See page 11.) Where the 4,700-foot contour line crosses, the drainage area is 70 square miles and the mean basin elevation is 5,500 feet. At the upstream end where the 4,880-foot contour crosses, the values are 63 square miles and 5,560 feet. Applying these values of drainage area and mean basin elevation to the flood-depth equation for the Uinta Basin Region (table 4), $D_{100} = 1{,}210\ A^{0.130}\ E^{-2.86}$, one obtains a downstream 100-year flood depth of 16.0 feet and an upstream value of 15.3 feet. These flood-depth values are then added to the zero-flow profile, and an estimated 100-year profile for the reach is constructed more or less parallel to the zero-flow profile. (See fig. 4.) If there is a large difference between depths obtained for the upstream and downstream locations, depths should be computed at one or more intermediate locations.

The next step is to use the estimated 100-year flood profile and determine the approximate area that is inundated by the 100-year flood. An example is shown for a part of Cottonwood Wash in figure 3. As shown in figure 4, the estimated 100-year flood elevations vary from 4,716 feet where the 4,700-foot contour crosses the stream to 4,895 feet where the 4,880-foot contour crosses. The appropriate locations (stationing or stream length) where the water surface of the 100-year flood intersects the contour lines at the left and right ends of the cross sections are determined from figure 4 and are used to mark the edges in figure 3. Also the left and right bank edges of the 100-year flood are located about 1.6 contour intervals out from where the topographic contours cross the stream at the zero-flow profile on the map.

The same procedure is also applicable to reaches between gaging stations. In some cases, one only needs to obtain the appropriate depths from table 12, thus, eliminating using an equation to compute the depths. Also, many times, low-water profiles and cross sections are available from other government agencies and can be used to more accurately delineate the flood-prone areas.

ANALYTICAL DEVELOPMENT OF REGRESSION EQUATIONS

Using multiple-regression techniques, equations for estimating T-year discharges and depths were developed by relating flood-frequency data at 254 gaging stations in Utah and adjoining states to basin and climatic characteristics measured from maps (fig. 5). These flood and basin characteristics are given in table 12. All the gaging stations had 10 or more years of record and the annual flood peaks were not significantly affected by diversions or regulation. Some of the gaging stations were on streams that had dams or major diversions built during the period of record for the station. For these stations, the earlier unregulated part of the record was used in the flood-frequency analysis and only that unregulated part of the record is shown in table 12.

The methods used to determine the two dependent variables (T-year discharge and T-year depth) are described first. Then the regression analysis is briefly explained.

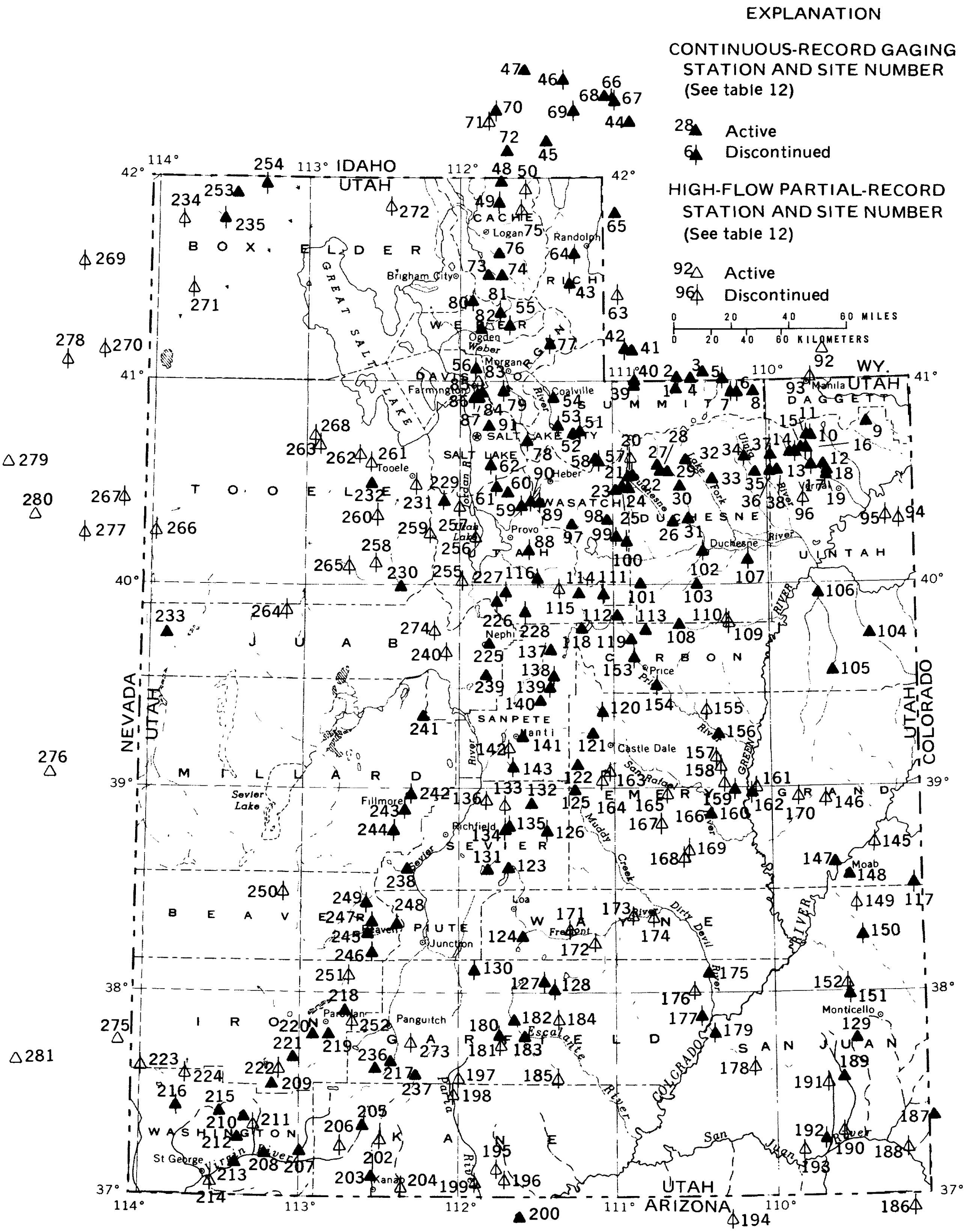


Figure 5.—Location of gaging stations.

Station Flood-Frequency Relations

The relation of annual peak discharge to exceedance probability, or to recurrence interval, is referred to as a flood-frequency relation or curve. Exceedance probability is the chance that a flood will equal or exceed a given magnitude in any year. Recurrence interval is the reciprocal of the exceedance probability and is the average number of years between exceedances.

Flood-frequency relations were defined for each gaging site for records through September 30, 1980, using the log-Pearson Type III probability distribution. Techniques recommended by the U.S. Water Resources Council (1981) were used to fit the Pearson Type III distribution to the logarithms of annual maximum discharges at each site. Adjustments were made for historic peaks and outliers where necessary. The skew coefficient used was a weighted average of the station skew and a skew taken from the generalized skew map appearing in the report by the U.S. Water Resources Council (1981). Estimates of the 2-, 5-, 10-, 25-, 50-, and 100-year floods taken from these frequency curves are given for each station in table 12.

Computation of Flood Depth

Depths for floods of recurrence intervals of 2, 5, 10, 25, 50, and 100 years were computed for 155 gaging stations. Some of the stations used in the discharge analysis were not used in the depth analysis because of artificial controls (such as culverts and bridges), or very unstable channel boundaries at the gaged site, or there was not enough information to accurately extend rating curves to cover large flood discharges.

The most recent rating curve for each station was used as the base stage-discharge relation. Because of time and budget limitations, the ratings were extended to the 100-year or 500-year flood without obtaining additional field data. Generally a straight-line extension on log-log paper was made except where channel shape indicated that a straight-line extension was not appropriate. Many of the rating curves required long extensions. Flood depth is the stage of the T-year flood minus the stage of zero flow.

Regression Analysis

Standard multiple-regression techniques were used to develop the equations for estimating T-year discharges and T-year depths. The SAS software package was used in the analysis (SAS Institute Inc., 1979).

Many basin characteristics were investigated in the multiple-regression analysis in an attempt to find the best relations for estimating T-year discharge and depth. The RSQUARE procedure, which evaluates all possible combinations of the independent variables, was used to determine the best equations for each dependent variable. A stepwise regression, with maximum R^2 improvement option, was also used to further refine the equations. Equations were investigated with log-transformed variables, untransformed variables, and a combination of log-transformed and untransformed variables. The multiplicative model (all variables are log transformed) provided the best results, high R^2 value and low standard error of estimate, and it is used in all the equations in this report.

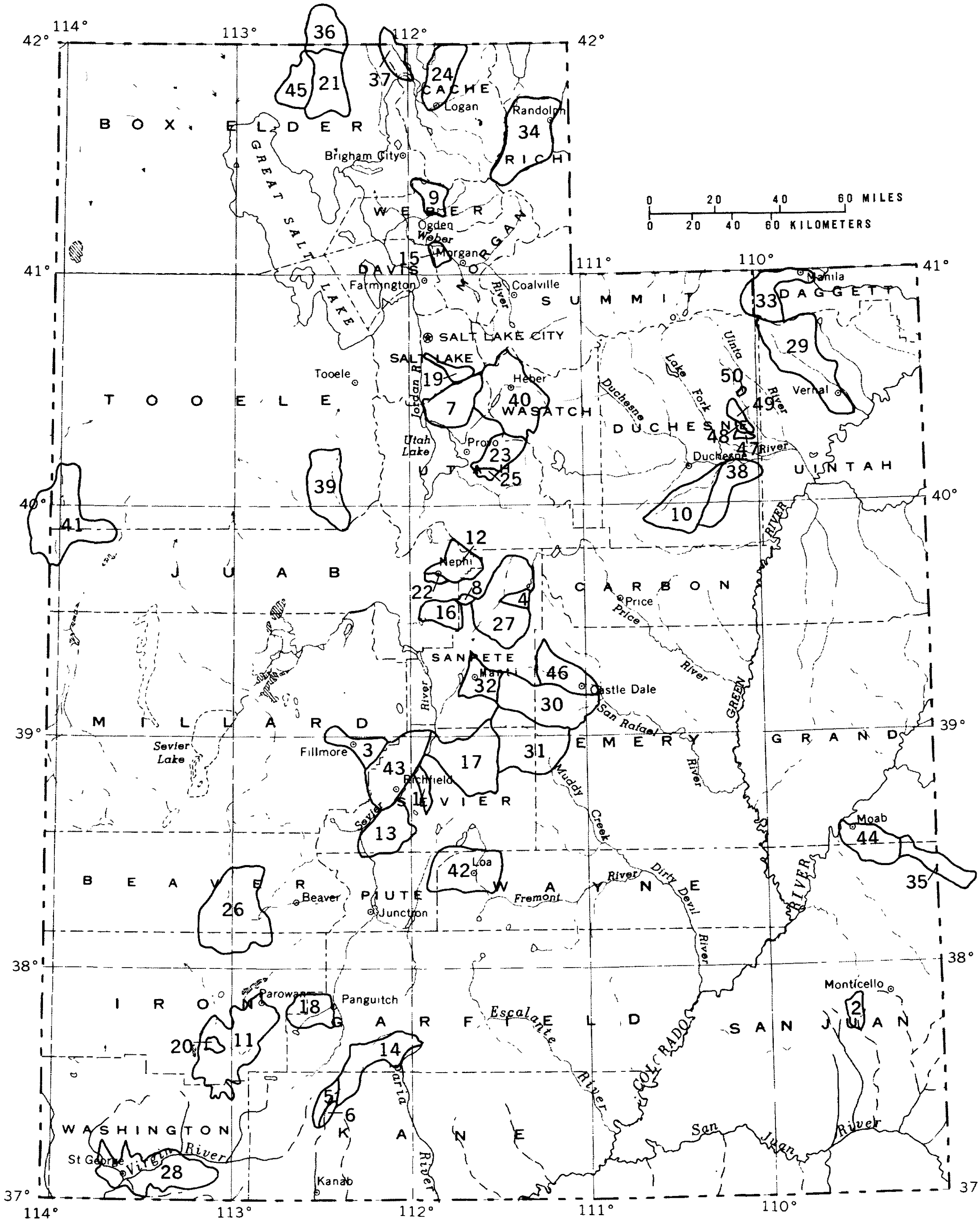
The following independent variables were investigated as possible predictors of T-year discharges and depths:

1. Drainage area, in square miles;
2. Main channel slope, in feet per mile;
3. Main channel length, in miles;
4. Mean basin elevation, in thousands of feet;
5. Percentage of basin above elevation of 6,000 feet;
6. Area of lakes and ponds, in percent;
7. Forested area, in percent;
8. Azimuth of main channel (ranked variable; N=8, NE=7, NW=6, E=5, W=4, SE=3, SW=2, S=1);
9. Mean annual precipitation, in inches (U.S. Weather Bureau, 1963);
10. 100-year, 24-hour rainfall, in inches (Miller and others, 1973);
11. Elevation of gage datum, in feet;
12. Streambed slope, in feet per mile (local slope of the stream channel at the gaged site); and
13. Geology factor (based on relative infiltration rates of surface geologic formations outlined on a geologic map of Utah, (Utah Geological and Mineral Survey, 1980).

Only drainage area and mean basin elevation appear in the final equations.

PREVIOUS FLOOD MAPPING

The first step before one would delineate areas inundated by T-year discharges or depths using any of the methods described previously is to consider the flood boundaries determined in work by others. For example, the areas inundated by a 100-year flood have been delineated for many stream reaches by other government agencies and consultants. Flood-plain information studies by the U.S. Army Corps of Engineers, flood-insurance studies for the Federal Insurance Administration (prepared by consultants and other government agencies), watershed studies by the U.S. Soil Conservation Service, and flood-prone area maps by the U.S. Geological Survey provide miscellaneous and detailed information. A general tabulation of these studies and where the information may be obtained are listed in tables 10 and 11 and figures 6 and 7. Many times the flood-plain information appearing in these reports can be transferred directly to the appropriate scale map. If a published flood-inundation map differs substantially from one prepared by the methods described here, the final results should be coordinated with the appropriate agency to add credibility and where possible minimize duplication of effort.



Base by U. S. Soil Conservation Service, taken from U. S. Geological Survey 1:1,000,000 National Atlas

Figure 6.—Location of U. S. Soil Conservation Service watershed projects. (From Utah District of the U. S. Soil Conservation Service work plan, 1978.)

EXPLANATION

3	WATERSHED PROJECT LISTED BELOW

1. Glenwood
2. Blanding
3. Chalk Creek
4. Birch Creek, included in 27
5. Upper Kanab
6. Sink Valley
7. American Fork—Dry Creek
8. Tidds Canyon
9. North Fork—Ogden River
10. Sowers—Antelope
11. Coal Creek
12. Salt Creek
13. Monroe—Annabella
14. Tropic
15. Peterson—Milton
16. Levan
17. Salina Creek
18. Panguitch—Threemile
19. Little Cottonwood
20. Greens Lake
21. Blue Creek—Howell
22. Miller—Biglows
23. Hobble Creek
24. North Cache
25. Maple Canyon
26. Minersville
27. North Sanpete
28. Warner Draw
29. Dry Fork
30. Ferron
31. Muddy Creek
32. Manti—Sixmile
33. Sheep Creek—Carter Creek
34. Woodruff Creek
35. West Paradox (Colorado)
36. Pocatello Valley (Idaho)
37. Clarkston Creek (Idaho)
38. Pleasant Valley
39. Vernon
40. Wasatch Soil Conservation District
41. Deep Creek—Callao (Nevada)
42. Upper Fremont
43. Richfield—West Sevier
44. Moab
45. Hansel Valley
46. Cottonwood Creek
47. Martin Lateral
48. Hancock Cove
49. Class K-2
50. T. N. Dodd Irrigation Co.

Figure 6.—Continued

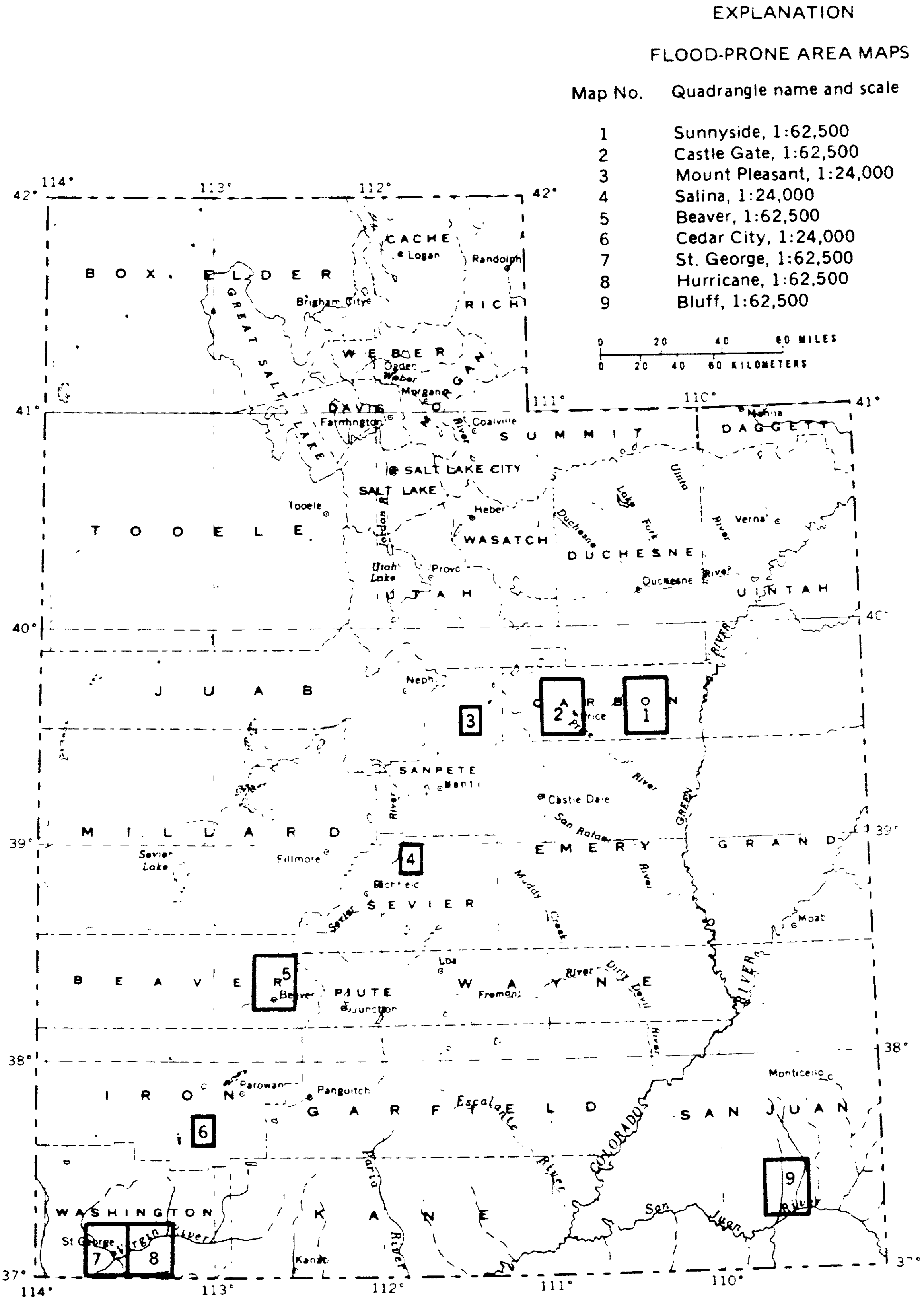


Figure 7.—Flood-prone area maps available from the U. S. Geological Survey, Water Resources Division

SUMMARY

A brief description of five different methods of flood mapping--detailed, historical, analytical, physiographic, and reconnaissance--is given to make the user aware of these methods and their principal advantages and limitations. The physiographic method, a simple and rapid method of flood mapping, is the primary emphasis on flood mapping for this report.

Streams are classified into four categories based on the topography adjacent to the stream channel and the type of flood hazards that may occur. The user can use this stream classification to determine which flood-mapping methods are most applicable to a particular stream.

Multiple-regression equations relating T-year discharges and depths to basin characteristics for recurrence intervals of 2, 5, 10, 25, 50, and 100 years were developed for six regions in Utah. Ratios of 500- to 100-year values also were determined for these six regions. Drainage area and mean basin elevation are the only independent variables used. The standard error of estimate ranges from 38 to 74 percent for the 100-year peak discharge and from 23 to 33 percent for the 100-year flood depth.

Examples are given on how to use the regression equations for any ungaged site and the drainage-area ratio method of transferring gaged data to ungaged sites on the same stream. Procedures for transferring flood depths obtained from the regression equations to a flood-boundary map are outlined. Also previous detailed flood mapping by government agencies and consultants is summarized to assist the user in quality control and to minimize duplication of effort.

The peak-discharge and flood-depth frequency relations and basin-characteristics data for gaging stations are tabulated. In addition, weighted estimates of peak-discharge relations based on station data and the regression estimates are provided for each of the gaged sites on unregulated streams. The use of weighted values at the gaged sites may provide more reliable flood-magnitude estimates than the use of station data only.

(page 45 follows)

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Table 10.—Summary of previous detailed flood mapping by the U.S. Army Corps of Engineers, Sacramento District, Sacramento, Calif.

[All maps printed in the U.S. Corps of Engineers report series are titled "Flood Plain Information", except Weber River, Ogden study which is in a "Flood Hazard Information" report.]

Description of area mapped	Completion date
Jordan River complex, Salt Lake City.—Jordan River between 5700 South and Cudahy Lane on the north and east side tributaries from their canyon mouth.	October 1969
American Fork and Dry Creek, American Fork and Lehi.—American Fork downstream from rodeo grounds to Interstate Highway 15, and Dry Creek from Interstate 15 downstream to State Highway 68.	November 1969
Barton, Mill, and Stone Creeks, Bountiful, West Bountiful, and Woods Cross.—Barton and Stone Creeks from approximately the eastern city limits of Bountiful to the Denver and Rio Grande Western Railroad in West Bountiful, and Mill Creek from Orchard Drive in Bountiful to 1100 West Street in West Bountiful.	December 1969
Burch Creek, Ogden.—Canyon mouth in southeast Ogden downstream to confluence with Weber River	November 1970
Ogden River, Ogden.—Canyon mouth downstream to confluence with Weber River.	June 1971
Provo River and Rock Canyon Creek, Provo, Orem.—Provo River from canyon mouth downstream to Provo-Orem Diagonal, and Rock Canyon Creek from canyon mouth downstream to Provo River.	June 1971
Provo River and Slate Canyon Creek, Provo.—Provo River from Provo-Orem Diagonal downstream to Utah Lake, and outwash fan of Slate Canyon.	May 1972

Table 10.—Summary of previous detailed flood mapping by the U.S. Army Corps of Engineers, Sacramento District, Sacramento, Calif.—Continued

Description of area mapped	Completion date
Virgin River and Fort Pierce Wash, St. George.—Virgin River from Mill Creek to Man of War Road, and Fort Pierce Wash from State Highway 64 to mouth.	April 1973
Hobble Creek, Springville.—Mapleton Drive near canyon mouth downstream to Interstate Highway 15.	June 1973
Logan River, Logan.—State Dam at mouth of Logan Canyon downstream to Mendon Road Bridge.	June 1973
Jordan River Complex II Midvale-Draper.—Jordan River from Bullion Street upstream to County boundary, and Dry, Willow, and Corner Canyon Creeks from Jordan River upstream to foothills of Wasatch Mountains.	March 1974
Farmington Bay tributaries, Farmington-Centerville.—Farmington, Steed, Ricks, Parrish, and Deuel Creeks from canyon mouths downstream to Denver and Rio Grande Western Railroad.	June 1974
Box Elder Creek, Brigham City.—Black Slough upstream to the settling basin of diversion to Box Elder, Perry, and Ogden-Brigham Canals.	June 1975
Weber River, Ogden.—Highway 84 upstream to Interstate Highway 80 N.	April 1976
Blacksmith Fork and Spring Creek, Millville.—Blacksmith Fork from U.S. Highway 89-91 upstream to State Highway 242, Spring Creek from U.S. Highway 89-91 upstream to Center Street in Providence, and Millville Canyon Creek from canyon mouth downstream to confluence with Blacksmith Fork.	May 1976

Table 11.—List of communities participating with the Federal Insurance Administration in the National Flood Insurance Program as of March 31, 1982, and those not in program but which have special flood-hazard areas

[Information obtained from National Flood Insurance Program Community States Book, Federal Emergency Management Agency, Federal Insurance Administration, Washington, D. C. 20472.]

Community: Asterisk (*), unincorporated area only.

Date of current effective map (or map index): NSFHA, no special flood-hazard area; R, entry date into regular program; S, suspended community; F, effective map is a flood insurance map.

Community	Date of entry, emergency or regular (R) program	Date of current effective map (or map index)
Alpine, City of	Feb. 11, 1976 (R)	(NSFHA)
Alton, Town of	Feb. 5, 1979	—
Amalga, Town of	July 22, 1980 (R)	July 22, 1980
American Fork, City of	Nov. 25, 1980 (R)	Nov. 25, 1980
Annabella, Town of	Oct. 30, 1979 (R)	Oct. 30, 1979
Aurora, Town of	Dec. 4, 1979 (R)	Jan. 12, 1982
Beaver County*	May 23, 1975	—
Bicknell, Town of	July 10, 1975	Jan. 24, 1975
Bountiful, City of	Sept. 29, 1978 (R)	Mar. 2, 1982
Box Elder County*	Dec. 17, 1974	Jan. 30, 1979
Brigham City, City of	Aug. 17, 1981 (R)	Aug. 17, 1981
Cache County*	Feb. 12, 1980	Sept. 29, 1981
Carbon County*	Nov. 15, 1979 (R)	Nov. 15, 1979
Castle Dale, City of	May 1, 1980 (R)	May 1, 1980
Cedar City, City of	Mar. 19, 1975	Mar. 5, 1976
Cedar Fort, Town of	Oct. 6, 1976	Feb. 7, 1975
Centerville, City of	Mar. 1, 1982 (R)	Mar. 1, 1982
Charleston, Town of	Aug. 5, 1980 (R)	Aug. 5, 1980
Circleville, Town of	Sept. 14, 1977	June 11, 1976
Clarkston, Town of	Aug. 18, 1980 (R)	Aug. 19, 1980
Clearfield, City of	Feb. 20, 1979 (R)	Feb. 20, 1979
Clinton, City of	July 21, 1978 (R)	(NSFHA)
Coalville, City of	July 24, 1975	Oct. 3, 1975
Corinne, City of	July 15, 1980 (R)	July 15, 1980
Davis County*	Mar. 1, 1982 (R)	Mar. 1, 1982
Delta, City of	May 20, 1975	July 25, 1975
Draper, City of	Apr. 30, 1980	—
Duchesne, City of	Nov. 25, 1974	Oct. 24, 1975
East Carbon, City of	Mar. 7, 1975	Oct. 29, 1976
East Layton, City of	Oct. 17, 1974	Apr. 1, 1977
Elsinore, Town of	Aug. 14, 1979 (R)	Aug. 14, 1979
Emery County*	July 25, 1975	Jan. 17, 1978
Emery, Town of	Sept. 11, 1978 (R)	(NSFHA)

Table 11.—List of communities participating with the Federal Insurance Administration in the National Flood Insurance Program as of March 31, 1982, and those not in program but which have special flood-hazard areas—Continued

Community	Date of entry, emergency or regular (R) program	Date of current effective map (or map index)
Ephraim, City of	Jan. 31, 1975	Jan. 16, 1976
Escalante, Town of	Aug. 28, 1979 (R)	Aug. 28, 1979
Eureka, City of	July 2, 1975	Nov. 7, 1975
Fairview, City of	June 12, 1975	Jan. 9, 1976
Farmington, City of	Aug. 17, 1981 (R)	Aug. 17, 1981
Ferron, Town of	Jan. 20, 1975	Dec. 26, 1975
Fillmore, City of	May 1, 1975	May 14, 1976
Fruit Heights, City of	Aug. 17, 1981 (R)	Aug. 17, 1981
Garfield County*	July 3, 1975	Jan. 10, 1978
Glendale, Town of	May 19, 1977	Apr. 2, 1976
Glenwood, Town of	July 1, 1977	Oct. 22, 1976
Grantsville, City of	July 9, 1975	—
Green River, City of	Apr. 7, 1975	Dec. 5, 1975
Gunnison, City of	Aug. 27, 1975	Aug. 13, 1976
Harrisville, City of	Sept. 29, 1975	Aug. 8, 1975
Hatch, Town of	July 24, 1979 (R)	July 24, 1979
Heber City, City of	Mar. 25, 1975	—
Helper, City of	Mar. 1, 1979 (R)	Mar. 1, 1979
Henefer, Town of	May 20, 1980 (R)	May 20, 1980
Henrieville, Town of	Sept. 25, 1979 (R)	Sept. 25, 1979
Holden, Town of	Sept. 28, 1977	June 3, 1977
Honeyville, Town of	July 29, 1980 (R)	July 29, 1980
Huntington, City of	July 9, 1975	May 24, 1974
Hurricane, City of	Aug. 5, 1975	July 12, 1977
Hyde Park, Town of	July 29, 1980 (R)	July 29, 1980
Hyrum, City of	Apr. 8, 1980 (R)	Apr. 8, 1980
Iron County*	May 8, 1975	Apr. 11, 1978
Ivins, Town of	Oct. 21, 1974	Sept. 12, 1975
Joseph, Town of	Aug. 24, 1979 (R)	Aug. 28, 1979
Junction, Town of	Jan. 7, 1975	Aug. 8, 1975
Kamas, City of	July 2, 1975	July 30, 1976
Kanarraville, Town of	June 6, 1977	Dec. 17, 1976
Kane County*	July 1, 1975	Jan. 10, 1978
Kanosh, Town of	Nov. 25, 1977	Apr. 2, 1976
Kaysville, City of	Mar. 1, 1982 (R)	Mar. 1, 1982
Koosharem, Town of	July 16, 1979	Dec. 24, 1976
Laketown, Town of	Mar. 12, 1980	Nov. 12, 1976
LaVerkin, Town of	Sept. 3, 1975	July 2, 1976
Layton, City of	Dec. 13, 1974	May 14, 1976

Table 11.—List of communities participating with the Federal Insurance Administration in the National Flood Insurance Program as of March 31, 1982, and those not in program but which have special flood-hazard areas—Continued

Community	Date of entry, emergency or regular (R) program	Date of current effective map (or map index)
Leeds, Town of	Aug. 11, 1978	Apr. 2, 1976
Lehi, City of	Sept. 14, 1979 (R)	Sept. 14, 1979
Levan, Town of	Aug. 1, 1978	Dec. 9, 1980
Lewiston, City of	July 29, 1980 (R)	July 29, 1980
Logan, City of	Nov. 26, 1974	Apr. 8, 1977
Manti, City of	July 10, 1975	Dec. 19, 1975
Mantua, Town of	July 8, 1980 (R)	July 8, 1980
Mapleton, City of	Dec. 16, 1980 (R)	Dec. 16, 1980
Marysvale, Town of	Mar. 8, 1977	Feb. 11, 1977
Mendon, City of	July 22, 1980 (R)	July 22, 1980
Midvale, City of	Dec. 9, 1976	Sept. 26, 1975
Midway, City of	Aug. 19, 1980 (R)	Aug. 19, 1980
Milford, City of	Feb. 24, 1975	Dec. 19, 1975
Moab, City of	June 4, 1980 (R)	June 4, 1980
Monroe, City of	July 24, 1979 (R)	July 24, 1979
Morgan, City of	Nov. 26, 1974	Apr. 16, 1976
Morgan County*	June 25, 1975	Feb. 14, 1978
Moroni, City of	Aug. 5, 1980 (R)	Aug. 5, 1980
Mount Pleasant, City of	Feb. 25, 1976	July 11, 1975
Murray, City of	Dec. 19, 1974	Dec. 19, 1975
Myton, City of	July 29, 1981	Apr. 2, 1976
Nephi, City of	May 29, 1975	—
Newton, Town of	July 22, 1980 (R)	July 22, 1980
Nibley, Town of	Mar. 24, 1975	July 18, 1975
North Logan, City of	Sept. 26, 1974	Nov. 21, 1975
North Ogden, City of	Oct. 2, 1975	May 6, 1977
North Salt Lake City, City of	Aug. 29, 1978 (R)	Dec. 22, 1981
Oak City, Town of	Sept. 22, 1975	Feb. 7, 1975
Oakley, Town of	June 11, 1975	Dec. 24, 1976
Ogden, City of	Dec. 27, 1974	Aug. 16, 1977
Orangeville, City of	Mar. 1, 1979 (R)	Mar. 1, 1979
Orderville, Town of	Mar. 15, 1978	Mar. 4, 1980
Orem, City of	Mar. 10, 1975	Oct. 29, 1976
Panguitch, City of	Aug. 28, 1979 (R)	Aug. 28, 1979
Paragonah, Town of	Mar. 12, 1975	Feb. 14, 1975
Park City, City of	May 8, 1975	Sept. 3, 1976
Parowan, City of	June 9, 1975	Dec. 19, 1975
Perry, City of	May 20, 1980 (R)	May 20, 1980
Piute County*	Mar. 14, 1978	Nov. 8, 1977

Table 11.—List of communities participating with the Federal Insurance Administration in the National Flood Insurance Program as of March 31, 1982, and those not in program but which have special flood-hazard areas—Continued

Community	Date of entry, emergency or regular (R) program	Date of current effective map (or map index)
Plain City, City of	May 19, 1981 (R)	May 19, 1981
Pleasant Grove, City of	Aug. 5, 1975	–
Pleasant View, City of	Mar. 30, 1981 (R)	(NSFHA)
Price, City of	Mar. 1, 1979 (R)	Dec. 29, 1981
Providence, City of	May 2, 1975	Aug. 13, 1976
Provo, City of	Feb. 1, 1979 (R)	Dec. 2, 1980
Redmond, Town of	July 2, 1975	–
Richfield, City of	Sept. 26, 1974	Dec. 5, 1975
Richmond, City of	Aug. 12, 1980 (R)	Aug. 12, 1980
Riverdale, City of	Feb. 3, 1982 (R)	Feb. 3, 1982
Riverton, City of	Oct. 23, 1975	July 23, 1976
Roy, City of	Oct. 24, 1978 (R)	Oct. 24, 1978
Salem, City of	July 16, 1979 (R)	July 16, 1979
Salina, City of	Apr. 30, 1974	Sept. 26, 1975
Salt Lake City, City of	May 28, 1974	Dec. 27, 1974
Salt Lake County*	Sept. 26, 1974	Aug. 30, 1977
San Juan County*	June 30, 1975	Jan. 31, 1978
Sandy, City of	Feb. 3, 1975	Jan. 16, 1976
Sanpete County*	Mar. 2, 1976	Nov. 14, 1978
Santa Clara, Town of	Aug. 7, 1975	June 4, 1976
Santaguin, City of	May 16, 1975	–
Scipio, Town of	Aug. 3, 1978	July 12, 1977
Sevier County*	Nov. 14, 1975	Feb. 7, 1978
Sigurd, Town of	Sept. 26, 1975	Sept. 19, 1975
Smithfield, City of	Dec. 18, 1974	Dec. 26, 1975
South Jordan, City of	June 10, 1975	Jan. 30, 1976
South Ogden, City of	Mar. 1, 1982 (R)	Mar. 1, 1982
South Salt Lake, City of	May 23, 1975	Sept. 19, 1975
South Weber, City of	Sept. 12, 1978 (R)	May 19, 1981
Spring City, City of	Aug. 5, 1980 (R)	Aug. 5, 1980
Stockton, Town of	Aug. 5, 1980 (R)	Aug. 5, 1980
St. George, City of	Aug. 28, 1974	Nov. 4, 1980
Summit County*	June 10, 1975	Jan. 3, 1978
Sunnyside, City of	Sept. 29, 1978 (R)	Sept. 29, 1978
Sunset, City of	Nov. 21, 1978 (R)	Nov. 21, 1978
Syracuse, City of	June 1, 1978 (R)	(NSFHA)
Tooele County*	June 7, 1976	–
Tooele, City of	Mar. 10, 1975	Apr. 9, 1976
Torrey, Town of	Mar. 22, 1979	Nov. 12, 1976

Table 11.—List of communities participating with the Federal Insurance Administration in the National Flood Insurance Program as of March 31, 1982, and those not in program but which have special flood-hazard areas—Continued

Community	Date of entry, emergency or regular (R) program	Date of current effective map (or map index)
Tropic, Town of	Dec. 4, 1979 (R)	Dec. 4, 1979
Uintah County*	Nov. 30, 1977	Aug. 15, 1978
Uintah, Town of	May 19, 1981 (R)	May 19, 1981
Utah County*	Nov. 12, 1971	Jan. 10, 1975
Vernal, City of	Apr. 16, 1975	July 30, 1976
Virgin, Town of	June 25, 1975	June 25, 1976
Wasatch County*	Apr. 4, 1975	Dec. 13, 1977
Washington County*	Oct. 15, 1975	Feb. 7, 1978
Washington, City of	July 7, 1975	June 4, 1976
Weber County*	Mar. 25, 1975	May 2, 1978
Wellington, City of	Feb. 9, 1977	Apr. 9, 1976
Wellsville, City of	July 29, 1980 (R)	July 29, 1980
Wendover, Town of	Aug. 19, 1980 (R)	Aug. 19, 1980
West Bountiful, City of	Aug. 3, 1981 (R)	Aug. 3, 1981
West Jordan, City of	July 16, 1975	Mar. 5, 1976
Willard, City of	Jan. 16, 1976	Jan. 9, 1976
Woodruff, Town of	July 22, 1980 (R)	July 22, 1980
Woods Cross, City of	Aug. 29, 1978 (R)	Aug. 29, 1978

Table 11.—List of communities participating with the Federal Insurance Administration in the National Flood Insurance Program as of March 31, 1982, and those not in program but which have special flood-hazard areas—Continued

Community	Hazard area identified	Date on which sanctions apply
Antimony, Town of	Apr. 2, 1976	Apr. 2, 1977
Bear River City, City of	Sept. 5, 1975	Sept. 5, 1976
Beaver, City of	June 11, 1974	June 11, 1975
Cleveland, Town of	July 12, 1977	July 12, 1978
Cornish, Town of	Apr. 2, 1976	Apr. 2, 1977
Deweyville, Town of	Apr. 29, 1977	Apr. 29, 1978
Elwood, Town of	Jan. 24, 1975	Jan. 24, 1976
Enterprise, City of	Aug. 16, 1974	Aug. 16, 1975
Fountain Green, City of	Apr. 2, 1976	Apr. 2, 1977
Francis, Town of	July 25, 1975	July 25, 1976
Genola, Town of	Feb. 7, 1975	Feb. 7, 1976
Goshen, Town of	Feb. 7, 1975	Feb. 7, 1976
Grand County*	Oct. 6, 1981	Oct. 6, 1982
Hilldale, Town of	June 4, 1976	June 4, 1977
Huntsville, Town of	June 21, 1974	June 21, 1975
Kanab, City of	Oct. 29, 1976	Oct. 29, 1977
Kingston, Town of	Feb. 4, 1977	Feb. 4, 1978
Lindon, City of	June 21, 1977	June 21, 1978
Loa, Town of	Dec. 20, 1974	Dec. 20, 1975
Mayfield, Town of	May 28, 1976	May 28, 1977
Meadow, Town of	July 2, 1976	July 2, 1977
Millville, Town of	Oct. 22, 1976	Oct. 22, 1977
Monticello, City of	Dec. 24, 1976	Dec. 24, 1977
Paradise, Town of	Nov. 5, 1976	Nov. 5, 1977
Payson, City of	June 28, 1974 (F)	Nov. 15, 1978 (S)
Randolph, Town of	Aug. 16, 1974	Aug. 16, 1975
Rush Valley, Town of	Oct. 25, 1977	Oct. 25, 1978
Springdale, Town of	May 10, 1977	May 10, 1978
Springville, City of	Feb. 1, 1974 (F)	Sept. 29, 1978 (S)
Toquerville, Town of	June 25, 1976	June 25, 1977
Tremonton, City of	Apr. 23, 1976	Apr. 23, 1977
Trenton, Town of	June 27, 1975	June 27, 1976
Vernon, Town of	June 4, 1976	June 4, 1977
Wallsburg, Town of	July 2, 1976	July 2, 1977

SITE NO.: SEE FIGURE 5.
FLOOD CHARACTERISTICS: PEAK DISCHARGES ARE: (FIRST LINE) STATION FLOOD-FREQUENCY VALUES USED IN MULTIPLE-REGRESSION ANALYSIS (SECOND LINE) WEIGHTED FLOOD-FREQUENCY VALUES.

SITE NO.	STATION NO.	STATION NAME	PERIOD OF RECORD USED (WATER YEARS)	BASIN CHARACTERISTICS: DRAINAGE AREA (SQUARE MILES)	BASIN CHARACTERISTICS: MEAN BASIN ELEVATION (FEET)
				NORTHERN MOUNTAINS	
1	09217900	Blacks Fork near Robertson, Wyo.	1938-39; 1967-80	130	10,640
2	09218500	Blacks Fork near Millburne, Wyo.	1940-70	152	10,270
3	09220000	East Fork of Smiths Fork near Robertson, Wyo.	1940-79	53.0	10,250
4	09220500	West Fork of Smiths Fork near Robertson, Wyo.	1940-80	37.2	9,790
5	09226000	Henrys Fork near Lonetree, Wyo.	1943-72	56	10,270
6	09226500	Middle Fork Beaver Creek near Lonetree, Wyo.	1949-70	28	10,480
7	09227500	West Fork Beaver Creek near Lonetree, Wyo.	1949-62	23	10,490
8	09228500	Burnt Fork near Burntfork, Wyo.	1944-65; 1967-75	52.8	10,300
9	09235600	Pot Creek above diversions, near Vernal, Ut.	1958-61; 1963-80	24.6	8,170
10	09264000	Ashley Creek below Trout Creek, near Vernal, Ut.	1944-54	27	9,930
11	09264500	South Fork Ashley Creek near Vernal, Ut.	1944-55	20	10,480
12	09266500	Ashley Creek near Vernal, Ut.	1914-80	101	9,440
13	09268000	Dry Fork above sinks, near Dry Fork, Ut.	1940-75	44.4	10,240
14	09268500	North Fork of Dry Fork near Dry Fork, Ut.	1946-80	8.62	10,120
15	09268900	Brownie Canyon above sinks, near Dry Fork, Ut.	1961-67; 1969-80	8.24	10,110
16	09269000	East Fork of Dry Fork near Dry Fork, Ut.	1946-63	12	9,360
17	09270000	Dry Fork below springs, near Dry Fork, Ut.	1941-45; 1954-69	97.4	9,360
18	09270500	Dry Fork at mouth, near Dry Fork, Ut.	1955-80	115	9,190
19	09271000	Ashley Creek at Sign of the Maine, near Vernal, Ut.	1900-04;1940-42; 1944-65	241	9,100
20	09273000	Duchesne River at Provo River Trail, near Hanna, Ut.	1930-33; 1936-40; 1942-43; 1945-53	39	9,730
21	09273500	Hades Creek near Hanna, Ut.	1950-68	7.5	9,730
22	09274000	Duchesne River (North Fork) near Hanna, Ut.	1922-23; 1946-53	78	9,810
23	09275000	West Fork Duchesne River below Dry Hollow, near Hanna, Ut.	1950-68; 1975-80	43.8	9,100
24	09275500	West Fork Duchesne River near Hanna, Ut.	1946-49; 1951-80	61.6	8,840
25	09276000	Wolf Creek above Rhoades Canyon, near Hanna, Ut.	1946-54; 1956-80	10.6	9,040
26	09277500	Duchesne River near Tabiona, Ut.	1919-53	356	8,770
27	09277800	Rock Creek above South Fork, near Hanna, Ut.	1966-80	98.9	10,360
28	09278000	South Fork Rock Creek near Hanna, Ut.	1954-78; 1980	15.7	10,000
29	09278500	Rock Creek near Hanna, Ut.	1950-69; 1975-80	122	10,200

FLOOD CHARACTERISTICS												
PEAK DISCHARGE (CUBIC FEET PER SECOND), FOR INDICATED RECURRENCE INTERVAL (YEARS)						FLOOD DEPTH (FEET), FOR INDICATED RECURRENCE INTERVAL (YEARS)						MAXIMUM PEAK DISCHARGE OF RECORD (CUBIC FEET PER SECOND)
2	5	10	25	50	100	2	5	10	25	50	100	
HIGH ELEVATION REGION												
1,550	1,990	2,240	2,510	2,690	2,860	3.2	3.6	3.9	4.2	4.4	4.5	2,160
1,490	1,970	2,230	2,570	2,780	3,000							
1,470	1,840	2,070	2,350	2,560	2,760	–	–	–	–	–	–	2,530
1,460	1,880	2,130	2,450	2,670	2,890							
501	738	916	1,160	1,370	1,590	–	–	–	–	–	–	1,450
520	757	926	1,160	1,350	1,560							
442	708	912	1,200	1,430	1,690	–	–	–	–	–	–	2,100
432	678	859	1,120	1,320	1,540							
583	900	1,150	1,500	1,790	2,110	–	–	–	–	–	–	2,010
594	895	1,120	1,430	1,680	1,960							
316	490	610	764	880	996	–	–	–	–	–	–	775
333	501	610	757	861	970							
168	254	315	396	460	525	–	–	–	–	–	–	417
230	335	401	496	561	633							
287	506	687	960	1,200	1,470	–	–	–	–	–	–	3,200
392	619	784	1,030	1,230	1,460							
66	129	182	263	333	411	2.4	3.0	3.3	3.7	4.2	4.4	286
100	165	214	287	345	410							
436	563	635	715	768	817	–	–	–	–	–	–	630
377	505	577	670	728	790							
315	415	472	537	581	621	2.1	2.5	2.7	2.9	3.2	3.4	460
300	407	468	550	602	657							
1,050	1,540	1,850	2,230	2,500	2,760	3.0	3.5	3.9	4.3	4.5	4.8	3,500
1,020	1,490	1,780	2,140	2,400	2,650							
532	754	895	1,070	1,190	1,310	2.8	3.3	3.6	3.9	4.0	4.1	1,010
528	747	882	1,060	1,170	1,290							
78	114	137	165	184	203	1.5	1.7	1.9	2.0	2.2	2.4	169
89	129	154	186	207	230							
182	267	323	392	442	491	1.8	2.5	2.8	3.1	3.3	3.5	395
161	235	282	343	385	429							
131	191	226	266	291	314	2.0	2.5	2.8	3.1	3.3	3.5	240
133	192	226	269	295	322							
539	780	932	1,110	1,240	1,370	3.6	4.0	4.5	5.0	5.5	5.8	974
615	877	1,030	1,230	1,360	1,500							
531	887	1,110	1,370	1,540	1,690	3.0	4.1	4.6	5.2	5.6	6.0	1,210
619	969	1,180	1,440	1,600	1,760							
1,420	2,060	2,480	3,000	3,380	3,760	4.2	4.7	5.1	5.5	5.7	5.9	4,110
1,450	2,070	2,460	2,960	3,310	3,660							
710	896	1,000	1,130	1,210	1,290	3.2	3.6	3.8	4.0	4.1	4.2	1,180
607	786	885	1,120	1,100	1,180							
75	108	129	153	170	187	1.5	1.8	1.9	2.1	2.2	2.4	156
84	121	143	172	191	212							
1,220	1,430	1,540	1,660	1,730	1,800	4.4	4.7	4.9	5.1	5.3	5.4	1,500
975	1,230	1,360	1,540	1,640	1,750							
476	694	821	963	1,060	1,140	2.8	3.5	3.8	4.2	4.4	4.7	740
446	644	758	894	983	1,060							
454	613	700	793	852	903	2.2	2.6	2.8	3.0	3.1	3.3	758
454	618	708	812	876	937							
48	61	69	78	84	89	–	–	–	–	–	–	82
63	84	95	111	121	132							
1,410	1,830	2,070	2,330	2,500	2,650	3.5	3.9	4.2	4.5	4.6	4.8	2,500
1,520	2,010	2,280	2,600	2,790	2,980							
1,680	2,180	2,460	2,770	2,970	3,150	4.2	4.8	5.0	5.4	5.5	5.7	2,760
1,420	1,880	2,140	2,460	2,660	2,850							
96	138	165	198	221	243	1.2	1.4	1.5	1.6	1.7	1.8	189
126	180	212	257	285	316							
1,750	2,170	2,380	2,600	2,730	2,850	5.9	6.6	6.9	7.2	7.4	7.6	2,540
1,590	2,020	2,240	2,510	2,660	2,820							

TABLE 12.—FLOOD CHARACTERISTICS AND SELECTED BASIN

SITE NO.	STATION NO.	STATION NAME	PERIOD OF RECORD USED (WATER YEARS)	BASIN CHARACTERISTICS	
				DRAINAGE AREA (SQUARE MILES)	MEAN BASIN ELEVATION (FEET)
				NORTHERN MOUNTAINS HIGH	
30	09279000	Rock Creek near Mountain Home, Ut.	1938-80	147	10,000
31	09279100	Rock Creek near Talmage, Ut.	1964-80	238	9,400
32	09289500	Lake Fork River above Moon Lake, near Mountain Home, Ut.	1943-55; 1964-80	77.9	10,800
33	09292500	Yellowstone River near Altonah, Ut.	1945-80	132	10,440
34	09296000	Uinta River above Clover Creek, near Neola, Ut.	1946-55	132	10,960
35	09297000	Uinta River near Neola, Ut.	1925-27; 1930-80	163	10,710
36	09298000	Farm Creek near Whiterocks, Ut.	1950-59; 1961-80	14.9	9,180
37	09298500	Whiterocks River above Paradise Creek, near Whiterocks, Ut.	1946-55	90	10,700
38	09299500	Whiterocks River near Whiterocks, Ut.	1902-03; 1918-20; 1922-25; 1930-80	113	10,370
39	10011500	Bear River near Utah-Wyoming State line	1943-80	172	9,770
40	10012000	Mill Creek at Utah-Wyoming State line	1943-48; 1950-62	59	9,320
41	10015700	Sulphur Creek above reservoir, near Evanston, Wyo.	1958-80	64.2	8,050
42	10016000	Sulphur Creek near Evanston, Wyo.	1943-48; 1950-59	80.5	7,930
43	10021000	Woodruff Creek near Woodruff, Ut.	1940; 1942-43; 1950-70	56.8	7,900
44	10032000	Smiths Fork near Border, Wyo.	1942-80	165	8,270
45	10058600	Bloomington Creek at Bloomington, Ida.	1961-80	24.0	7,860
46	10069000	Georgetown Creek near Georgetown, Ida.	1940-56	22.2	7,830
47	10072800	Eightmile Creek near Soda Springs, Ida.	1961-80	22.6	7,710
48	10099000	High Creek near Richmond, Ut.	1944-52; 1971-72; 1979	16.2	7,700
49	10102300	Summit Creek above diversions, near Smithfield, Ut.	1962-79	11.6	7,590
50	10107700	Logan River near Garden City, Ut.	1962-73	34	8,230
51	10128200	South Fork Weber River near Oakley, Ut.	1965-74	16	8,780
52	10128500	Weber River near Oakley, Ut.	1905-80	162	9,090
53	10129350	Crandall Creek near Peoa, Ut.	1964-73	12	7,700
54	10131000	Chalk Creek at Coalville, Ut.	1927-80	250	7,540
55	10137500	South Fork Ogden River near Huntsville, Ut.	1921-65	148	7,960
56	10141500	Holmes Creek near Kaysville, Ut.	1950-66	2.49	7,560
57	10153800	North Fork Provo River near Kamas, Ut.	1964-80	24.4	9,550
58	10154000	Shingle Creek near Kamas, Ut.	1964-73	8.4	9,280
59	10160800	North Fork Provo River at Wildwood, Ut.	1965-74	12.3	8,100

FLOOD CHARACTERISTICS												
PEAK DISCHARGE (CUBIC FEET PER SECOND), FOR INDICATED RECURRENCE INTERVAL (YEARS)						FLOOD DEPTH (FEET), FOR INDICATED RECURRENCE INTERVAL (YEARS)						MAXIMUM PEAK DISCHARGE OF RECORD (CUBIC FEET PER SECOND)
2	5	10	25	50	100	2	5	10	25	50	100	
ELEVATION REGION—Continued												
1,600	2,030	2,270	2,540	2,720	2,880	4.0	4.3	4.6	4.8	4.9	5.0	2,920
1,540	1,990	2,230	2,530	2,720	2,900							
1,580	1,960	2,170	2,390	2,530	2,650	3.3	3.7	4.0	4.1	4.3	4.4	2,320
1,610	2,080	2,330	2,650	2,840	3,030							
1,330	1,740	2,000	2,330	2,560	2,790	3.2	3.7	3.9	4.2	4.4	4.7	2,700
1,230	1,640	1,880	2,210	2,430	2,650							
1,000	1,300	1,490	1,720	1,880	2,040	2.5	2.9	3.1	3.2	3.4	3.5	1,880
1,070	1,420	1,630	1,900	2,080	2,270							
1,300	1,840	2,180	2,610	2,920	3,220	3.4	4.2	4.7	5.2	5.6	6.0	2,300
1,410	1,980	2,310	2,770	3,070	3,390							
1,380	2,070	2,570	3,240	3,770	4,330	2.3	2.9	3.2	3.6	3.9	4.2	5,000
1,430	2,120	2,590	3,240	3,740	4,270							
90	179	244	331	396	460	1.2	1.6	1.9	2.2	2.4	2.6	350
106	189	247	326	382	440							
1,100	1,580	1,870	2,210	2,450	2,670	–	–	–	–	–	–	1,780
1,070	1,510	1,770	2,110	2,330	2,560							
1,110	1,640	1,980	2,390	2,690	2,980	3.0	3.8	4.1	4.8	5.0	5.2	2,750
1,120	1,640	1,960	2,370	2,650	2,940							
1,830	2,310	2,590	2,900	3,120	3,310	3.8	4.2	4.4	4.7	4.8	5.0	2,980
1,740	2,230	2,510	2,850	3,070	3,280							
391	544	642	760	845	927	–	–	–	–	–	–	690
430	601	702	836	923	1,020							
365	545	681	871	1,030	1,190	3.5	4.1	4.3	4.6	4.8	5.0	1,220
365	535	653	819	949	1,080							
520	795	977	1,200	1,370	1,530	–	–	–	–	–	–	1,220
483	718	863	1,050	1,180	1,310							
263	368	427	493	535	573	–	–	–	–	–	–	528
278	390	450	525	570	615							
963	1,220	1,350	1,500	1,590	1,680	3.7	4.3	4.5	4.8	4.9	5.1	1,610
943	1,220	1,350	1,520	1,620	1,730							
146	202	232	265	285	302	–	–	–	–	–	–	248
148	206	237	275	298	320							
50	67	79	94	106	118	–	–	–	–	–	–	110
84	116	135	161	178	197							
110	144	164	187	203	218	–	–	–	–	–	–	209
119	161	184	214	233	252							
206	250	278	311	336	360	1.8	2.0	2.1	2.2	2.3	2.4	355
159	203	229	262	285	308							
147	212	253	300	334	365	–	–	–	–	–	–	302
121	175	207	246	273	299							
315	346	360	375	383	390	–	–	–	–	–	–	365
276	336	366	407	430	456							
198	226	241	258	268	278	1.9	2.0	2.0	2.1	2.1	2.2	259
172	216	240	274	294	315							
1,820	2,390	2,740	3,160	3,460	3,750	3.9	4.5	4.7	5.0	5.3	5.6	4,170
1,740	2,290	2,630	3,030	3,320	3,600							
91	124	143	166	181	195	2.0	2.3	2.5	2.7	2.8	2.9	134
86	119	138	163	178	194							
535	809	962	1,130	1,230	1,320	2.9	3.7	4.0	4.5	4.7	5.0	1,540
603	892	1,050	1,230	1,340	1,440							
782	1,270	1,560	1,900	2,210	2,310	3.7	4.8	5.3	5.9	6.2	6.6	1,890
770	1,220	1,480	1,800	2,000	2,180							
18	28	36	44	50	56	–	–	–	–	–	–	36
19	29	35	44	49	55							
403	512	576	651	702	750	2.4	2.7	2.9	3.1	3.2	3.4	705
352	461	523	604	656	709							
179	204	218	233	243	253	2.5	2.6	2.7	2.8	2.9	3.0	238
139	173	191	217	233	250							
106	148	177	215	244	274	1.5	1.8	1.9	2.1	2.2	2.5	225
100	141	166	201	225	251							

TABLE 12.—FLOOD CHARACTERISTICS AND SELECTED BASIN

SITE NO.	STATION NO.	STATION NAME	PERIOD OF RECORD USED (WATER YEARS)	BASIN CHARACTERISTICS: DRAINAGE AREA (SQUARE MILES)	BASIN CHARACTERISTICS: MEAN BASIN ELEVATION (FEET)
				NORTHERN MOUNTAINS HIGH	
60	10164500	American Fork above Upper Powerplant, near American Fork, Ut.	1927-52; 1954-80	51.1	8,460
61	10165500	Dry Creek near Alpine, Ut.	1948-55; 1959-74	9.82	8,770
62	10167500	Little Cottonwood Creek near Salt Lake City, Ut.	1948-63	27.4	8,680
				NORTHERN MOUNTAINS	
63	10019700	Whitney Canyon Creek near Evanston, Wyo.	1965-80	8.93	7,300
64	10023000	Big Creek near Randolph, Ut.	1941-44; 1950-70	52.2	7,370
65	10027000	Twin Creek at Sage, Wyo.	1944-60; 1962; 1976-80	246	7,270
66	10040000	Thomas Fork near Geneva, Ida.	1940-51	45.3	7,170
67	10040500	Salt Creek near Geneva, Ida.	1940-51	37.6	7,390
68	10041000	Thomas Fork near Wyoming-Idaho State line	1950; 1952-80	113	7,290
69	10047500	Montpelier Creek at irrigators weir, near Montpelier, Ida.	1943-70; 1977-78	49.5	7,370
70	10084500	Cottonwood Creek near Cleveland, Ida.	1939-80	61.7	6,650
71	10090800	Battle Creek tributary near Treasureton, Ida.	1961-71; 1973-79	4.5	5,810
72	10093000	Cub River near Preston, Ida.	1940-52; 1956-80	31.6	6,890
73	10104700	Little Bear River below Davenport Creek, near Avon, Ut.	1969-80	61.6	6,730
74	10104900	East Fork Little 8ear River above reservoir, near Avon, Ut.	1964-80	56.7	7,350
75	10107800	Temple Fork near Logan, Ut.	1962-73	15.4	7,290
76	10113500	8lacksmith Fork above Utah Power & Light Co.'s dam, near Hyrum, Ut.	1914-17; 1919-22; 1925-80	268	7,150
77	10132500	Lost Creek near Croydon, Ut.	1921-23; 1941-66	123	7,320
78	10133700	Three Mile Creek near Park City, Ut.	1964-74	2.68	7,340
79	10135000	Hardscrabble Creek near Porterville, Ut.	1942-70	28.1	7,220
80	10137680	North Fork Ogden River near Eden, Ut.	1964-74	6.03	7,170
81	10137780	Middle Fork Ogden River above diversions, near Huntsville, Ut.	1964-74	31.3	7,250
82	10139300	Wheeler Creek near Huntsville, Ut.	1959-80	11.1	6,620
83	10142000	Farmington Creek above diversions near Farmington, Ut.	1950-80	10.0	7,470
84	10142500	Ricks Creek above diversions, near Centerville, Ut.	1950-66	2.35	7,360
85	10143000	Parrish Creek above diversions, near Centerville, Ut.	1950-68	2.08	7,090
86	10143500	Centerville Creek above diversions, near Centerville, Ut.	1952-75; 1978-80	3.15	6,940
87	10144000	Stone Creek above diversions, near Bountiful, Ut.	1950-64; 1966	4.48	7,050
88	10152500	Hobble Creek near Springville, Ut.	1904-16; 1945-73	105	7,110
89	10158500	Round Valley Creek near Wallsburg, Ut.	1939-50	71.9	6,960
90	10160000	Deer Creek near Wildwood, Ut.	1939-50	26	7,450
91	10172200	Red Butte Creek at Fort Douglas, near Salt Lake City, Ut.	1964-80	7.25	6,800

FLOOD CHARACTERISTICS												
PEAK DISCHARGE (CUBIC FEET PER SECOND), FOR INDICATED RECURRENCE INTERVAL (YEARS)						FLOOD DEPTH (FEET), FOR INDICATED RECURRENCE INTERVAL (YEARS)						MAXIMUM PEAK DISCHARGE OF RECORD (CUBIC FEET PER SECOND)
2	5	10	25	50	100	2	5	10	25	50	100	
ELEVATION REGION—Continued												
343	461	528	600	647	689	1.6	1.9	2.1	2.2	2.3	2.4	645
343	465	533	611	660	706							
200	279	333	405	461	518	2.7	3.1	3.4	3.7	3.9	4.2	597
169	236	281	341	386	433							
471	560	613	677	722	765	–	–	–	–	–	–	736
375	465	516	583	627	672							
LOW ELEVATION REGION												
47	88	121	169	209	253	–	–	–	–	–	–	160
48	84	111	149	178	214							
78	126	162	215	258	306	–	–	–	–	–	–	337
108	171	215	275	318	374							
243	521	739	1,030	1,260	1,490	–	–	–	–	–	–	853
352	652	875	1,160	1,370	1,610							
147	250	326	428	506	587	–	–	–	–	–	–	418
159	262	335	430	496	579							
165	294	386	506	595	684	–	–	–	–	–	–	382
154	260	333	425	488	563							
441	790	1,020	1,300	1,500	1,680	2.6	3.4	3.8	4.4	4.6	5.0	1,040
414	724	928	1,180	1,350	1,520							
97	144	174	209	235	259	–	–	–	–	–	–	224
117	176	214	259	288	325							
354	519	625	756	850	941	–	–	–	–	–	–	788
335	504	616	759	859	971							
37	82	128	208	287	384	–	–	–	–	–	–	98
41	86	130	203	271	361							
583	682	733	787	821	851	2.6	2.9	3.0	3.2	3.3	3.4	803
491	590	644	705	744	787							
462	723	909	1,160	1,350	1,540	2.6	3.2	3.7	4.2	4.5	4.9	1,200
391	624	791	1,020	1,180	1,370							
462	589	667	761	828	893	–	–	–	–	–	–	760
363	483	559	649	708	780							
61	96	120	150	173	195	1.4	1.7	1.8	2.0	2.2	2.3	124
67	105	131	162	183	210							
485	816	1,040	1,320	1,530	1,730	2.4	3.2	3.7	4.2	4.6	4.9	1,620
509	851	1,080	1,370	1,580	1,800							
233	413	553	750	910	1,080	–	–	–	–	–	–	770
264	450	588	774	914	1,080							
9	12	13	15	16	17	–	–	–	–	–	–	15
14	20	25	29	32	37							
249	364	431	505	553	596	2.3	2.7	2.9	3.1	3.3	3.4	464
216	319	381	450	494	541							
91	120	137	159	174	188	–	–	–	–	2.5	2.6	156
66	91	108	128	141	157							
457	562	626	702	756	808	2.6	2.8	3.0	3.2	3.3	3.4	744
300	391	448	516	560	616							
106	208	294	421	529	649	–	–	–	–	–	–	440
95	180	251	354	439	539							
151	238	298	376	434	493	–	–	–	–	–	–	366
127	199	248	312	359	408							
19	34	44	56	66	74	.7	1.0	1.1	1.2	1.3	1.5	51
18	31	40	51	58	66							
13	22	28	35	40	44	–	–	–	–	–	–	30
15	24	30	38	43	49							
14	23	29	36	41	46	–	–	–	–	–	–	35
17	28	35	45	51	58							
24	49	71	102	129	158	–	–	–	–	–	–	82
27	50	68	94	114	139							
256	468	630	851	1,030	1,210	2.2	3.2	3.8	4.5	5.0	5.6	1,250
271	481	639	851	1,020	1,190							
117	155	180	210	232	253	2.5	3.0	3.3	3.7	4.0	4.2	201
182	280	348	434	489	572							
62	88	103	121	133	143	1.0	1.2	1.3	1.4	1.5	1.6	99
82	123	148	177	194	218							
16	28	36	48	58	69	–	–	–	–	–	–	60
28	48	62	81	95	114							

TABLE 12.—FLOOD CHARACTERISTICS AND SELECTED BASIN

SITE NO.	STATION NO.	STATION NAME	PERIOD OF RECORD USED (WATER YEARS)	BASIN CHARACTERISTICS	
				DRAINAGE AREA (SQUARE MILES)	MEAN BASIN ELEVATION (FEET)
					UINTA BASIN
92	09225200	Squaw Hollow near Burntfork, Wyo.	1965-B0	6.57	6,610
93	09229450	Henrys Fork tributary near Manilla, Ut.	1965-74	3.15	6,600
94	09263700	Cliff Creek near Jensen, Ut.	1960-74	64	6,570
95	09263800	Cow Wash near Jensen, Ut.	1960-71; 1973-74	9.40	5,360
96	09271B00	Halfway Hollow tributary near LaPoint, Ut.	1960-74	4.20	6,550
97	092B0400	Hobble Creek at Daniels Summit, near Wallsburg, Ut.	1964-80	2.B9	9,060
9B	09287000	Currant Creek below Red Ledge Hollow near Fruitland, Ut.	1946-68; 1975-80	50.1	B,880
99	092B7500	Water Hollow near Fruitland, Ut.	1946-71	13.8	8,380
100	09288000	Currant Creek near Fruitland, Ut.	1935-74	140	8,360
101	0928B150	West Fork Avintaquin Creek near Fruitland, Ut.	1965-80	56.1	8,310
102	092BB500	Strawberry River at Duchesne, Ut.	1909-10; 1914-6B	950	7,660
103	0928B900	Sowers Creek near Duchesne, Ut.	1965-80	40.6	B,120
104	09306B00	Bitter Creek near Bonanza, Ut.	1971-80	324	7,300
105	09307500	Willow Creek above diversions, near Ouray, Ut.	1951-55; 195B-70; 1975-80	297	7,710
106	09308000	Willow Creek near Ouray, Ut.	1947-55; 1960-68; 1975-79	B97	7,140
107	09308200	Pleasant Valley Wash tributary near Myton, Ut.	1960-70	15	6,110
10B	09308500	Minnie Maud Creek near Myton, Ut.	1952-55; 195B-75; 1977-B0	32.0	8,460
109	09309000	Minnie Maud Creek at Nutter Ranch near Myton, Ut.	1947-55; 1960-73	231	7,BB0
110	09309100	Gate Canyon near Myton, Ut.	1960-63; 1965-72	5.4	6,860
111	09312500	White River near Soldier Summit, Ut.	1940-67	53	8,360
112	09312700	Beaver Creek near Soldier Summit, Ut.	1961-68; 1971-76; 1979-80	26.1	8,750
113	09312800	Willow Creek near Castle Gate, Ut.	1963-80	62.8	B,120
114	10148200	Tie Fork near Soldier Summit, Ut.	1964-80	19.4	7,500
115	10148300	Dairy Fork near Thistle, Ut.	1959-72	11	6,950
116	1014B500	Spanish Fork at Thistle, Ut.	1908-25; 1933-36; 1938-74	490	7,130

FLOOD CHARACTERISTICS												
PEAK DISCHARGE (CUBIC FEET PER SECOND), FOR INDICATED RECURRENCE INTERVAL (YEARS)						FLOOD DEPTH (FEET), FOR INDICATED RECURRENCE INTERVAL (YEARS)						MAXIMUM PEAK DISCHARGE OF RECORD (CUBIC FEET PER SECOND)
2	5	10	25	50	100	2	5	10	25	50	100	
REGION												
103	227	339	516	673	852	–	–	–	–	–	–	620
97	250	407	678	940	1,260							
24	101	205	427	677	1,020	–	–	–	–	–	–	588
45	160	301	579	873	1,260							
165	753	1,540	3,100	4,740	6,800	2.1	4.2	5.7	7.4	–	–	1,360
189	728	1,410	2,720	4,090	5,820							
298	800	1,320	2,240	3,120	4,200	–	–	–	–	–	–	2,950
237	762	1,400	2,660	4,020	5,830							
91	301	532	937	1,320	1,780	1.4	2.5	3.3	4.5	5.4	6.5	702
85	281	502	900	1,290	1,770							
72	100	118	141	157	174	1.8	2.1	2.3	2.4	2.6	2.7	145
58	88	109	137	159	183							
260	443	569	726	840	950	2.3	2.9	3.4	3.8	4.1	4.4	946
223	383	496	642	751	861							
29	60	89	136	178	227	1.3	1.4	1.7	2.1	2.5	2.7	133
42	88	129	194	251	318							
324	508	643	829	979	1,140	1.8	2.2	2.5	2.9	3.1	3.5	1,260
298	483	623	820	983	1,160							
239	538	828	1,320	1,790	2,360	1.7	2.4	3.0	3.7	4.4	5.1	1,830
199	438	663	1,040	1,390	1,820							
1,090	1,690	2,100	2,620	3,010	3,400	–	–	–	–	–	–	3,490
1,000	1,600	2,030	2,600	3,040	3,520							
50	142	240	416	587	797	–	–	–	–	–	–	350
79	191	300	485	659	869							
67	342	801	1,970	3,530	5,950	–	–	–	–	–	–	1,660
210	601	1,080	2,070	3,240	4,930							
226	448	655	1,000	1,330	1,720	3.1	4.2	5.0	6.1	6.9	7.9	2,240
251	523	775	1,190	1,580	2,050							
612	1,920	3,420	6,220	9,090	12,700	2.4	4.0	4.9	6.9	8.5	10.0	11,000
597	1,770	3,060	5,450	7,860	10,800							
157	802	1,750	3,840	6,190	9,330	1.4	2.9	4.6	8.8	11.5	–	2,590
151	669	1,390	2,920	4,620	6,880							
93	312	567	1,040	1,520	2,110	1.7	2.7	3.4	4.5	5.2	6.1	1,370
96	284	493	873	1,250	1,720							
483	845	1,100	1,440	1,700	1,960	3.9	5.7	6.7	7.7	8.3	9.1	1,380
417	763	1,020	1,390	1,700	2,020							
179	727	1,390	2,600	3,770	5,170	.8	1.9	2.9	4.2	5.1	6.1	1,000
132	503	943	1,740	2,520	3,460							
175	306	409	554	673	801	1.8	2.6	3.1	3.7	4.0	4.2	1,120
164	295	402	555	684	826							
50	86	112	147	175	203	–	–	–	–	–	–	135
65	119	161	222	272	328							
217	399	551	783	985	1,210	–	–	–	–	–	–	836
193	369	519	751	954	1,180							
29	90	168	332	521	787	1.2	1.9	2.6	3.6	4.5	5.6	422
58	157	266	468	680	961							
159	403	665	1,140	1,630	2,260	2.4	3.5	4.6	5.7	6.5	7.2	980
134	356	594	1,020	1,460	2,010							
511	769	955	1,210	1,400	1,610	–	–	–	–	–	–	1,800
500	816	1,070	1,450	1,760	2,130							

SITE NO.	STATION NO.	STATION NAME	PERIOD OF RECORD USED (WATER YEARS)	BASIN CHARACTERISTICS	
				DRAINAGE AREA (SQUARE MILES)	MEAN BASIN ELEVATION (FEET)
					HIGH PLATEAUS
117	09177500	Taylor Creek near Gateway, Colo.	1945-67	12	9,000
118	09310500	Fish Creek above reservoir, near Scofield, Ut.	1939-61;1963-76; 1978-80	60.1	8,710
119	09313000	Price River near Heiner, Ut.	1935-69; 1980	415	8,160
120	09318000	Huntington Creek near Huntington, Ut.	1909-79	190	9,000
121	09324500	Cottonwood Creek near Orangeville, Ut.	1910-27; 1932-65	208	8,940
122	09326500	Ferron Creek (Upper Station) near Ferron, Ut.	1912-23; 1948-80	138	8,800
123	09329050	Seven Mile Creek near Fish Lake, Ut.	1965-80	24.0	10,000
124	09329900	Pine Creek near Bicknell, Ut.	1965-80	104	9,300
125	09330500	Muddy Creek near Emery, Ut.	1911-14; 1949-80	105	8,850
126	09331500	Ivie Creek above diversions near Emery, Ut.	1951-74	50	8,870
127	09338000	East Fork Boulder Creek near Boulder, Ut.	1951-55; 1958-72	21.4	10,500
128	09338500	East Fork Deer Creek near Boulder, Ut.	1951-55; 1959-73	1.9	9,290
129	09378630	Recapture Creek near Blanding, Ut.	1966-80	3.77	8,880
130	10185000	Antimony Creek near Antimony, Ut.	1947-48; 1958-76	84.0	9,560
131	10187300	Otter Creek near Koosharem, Ut.	1965-80	23.5	9,580
132	10205030	Salina Creek near Emery, Ut.	1964-80	51.8	8,720
133	10205070	Cottonwood Creek near Salina, Ut.	1959-68	7.8	7,470
134	10205200	West Fork Sheep Creek near Salina, Ut.	1958-69	.43	8,690
135	10205300	Sheep Creek at mouth, near Salina, Ut.	1958-69	1.47	8,780
136	10205700	Salina Creek above diversions, near Salina, Ut.	1959-74	280	7,950
137	10208500	Oak Creek near Fairview, Ut.	1965-80	11.8	8,560
138	10210000	Pleasant Creek near Mount Pleasant, Ut.	1946; 1955-75	16.4	8,830
139	10211000	Twin Creek near Mount Pleasant, Ut.	1955-66	5.9	8,900
140	10215700	Oak Creek near Spring City, Ut.	1965-74; 1980	8.35	9,140
141	10215900	Manti Creek below Dugway Creek, near Manti, Ut.	1965-74; 1979-80	26.4	9,080
142	10216300	Sixmile Creek near Sterling, Ut.	1959-74	29	8,700
143	10216400	Twelvemile Creek near Mayfield, Ut.	1960-78	59.4	8,570

FLOOD CHARACTERISTICS												
PEAK DISCHARGE (CUBIC FEET PER SECOND), FOR INDICATED RECURRENCE INTERVAL (YEARS)						FLOOD DEPTH (FEET), FOR INDICATED RECURRENCE INTERVAL (YEARS)						MAXIMUM PEAK DISCHARGE OF RECORD (CUBIC FEET PER SECOND)
2	5	10	25	50	100	2	5	10	25	50	100	
REGION												
114	265	401	610	791	992	–	–	–	–	–	–	555
103	233	348	524	677	847							
561	796	938	1,100	1,220	1,320	2.9	3.5	3.8	4.1	4.4	4.6	1,160
506	741	897	1,090	1,240	1,380							
1,180	2,230	3,170	4,700	6,110	7,780	3.5	4.5	5.2	6.1	6.7	7.3	9,340
1,220	2,220	3,160	4,640	6,000	7,580							
816	1,300	1,630	2,050	2,360	2,660	3.4	4.1	4.6	5.1	5.4	5.7	2,500
804	1,290	1,620	2,060	2,380	2,690							
1,300	2,080	2,670	3,460	4,090	4,760	5.1	6.5	7.3	8.4	–	–	7,220
1,220	1,960	2,520	3,270	3,870	4,500							
919	1,540	2,010	2,700	3,260	3,880	4.6	5.8	6.6	7.6	8.2	8.8	4,180
853	1,440	1,880	2,530	3,060	3,650							
152	219	259	306	338	367	1.8	2.2	2.4	2.7	2.8	2.9	225
146	236	283	344	389	431							
75	233	419	784	1,170	1,680	1.4	2.3	3.2	4.5	5.6	6.9	707
217	444	640	980	1,310	1,720							
581	1,180	1,690	2,460	3,130	3,870	3.5	5.4	6.8	8.7	10.4	11.8	3,340
552	1,090	1,560	2,240	2,840	3,490							
188	403	593	888	1,150	1,440	3.4	4.8	5.6	6.5	7.3	7.9	1,240
205	418	604	886	1,140	1,410							
200	303	374	464	532	599	–	–	–	–	–	–	483
175	283	342	422	481	539							
20	65	122	245	389	594	1.2	1.6	1.9	2.3	2.7	3.1	350
20	57	101	193	297	444							
17	43	70	121	171	235	.6	1.0	1.4	1.9	2.4	2.9	142
23	52	83	135	184	245							
229	417	551	726	856	985	2.4	3.2	3.7	4.3	4.6	5.0	669
276	497	639	831	976	1,120							
55	79	94	113	127	140	–	–	–	–	–	–	117
86	148	187	240	283	326							
177	350	485	673	821	974	2.7	3.8	4.5	5.4	5.9	6.5	519
206	393	550	772	956	1,150							
26	103	213	460	758	1,190	–	–	–	–	–	–	457
41	109	213	419	655	983							
3	8	13	20	26	32	–	–	–	–	–	–	12
4	11	17	28	38	50							
12	23	33	46	57	68	1.0	1.3	1.5	1.7	1.8	1.9	32
13	28	42	64	83	105							
561	934	1,240	1,700	2,110	2,560	–	–	–	–	–	–	2,300
722	1,200	1,710	2,440	3,110	3,850							
138	200	237	282	312	340	2.5	3.0	3.3	3.5	3.7	3.9	262
115	183	237	313	376	444							
164	352	544	890	1,240	1,690	1.4	2.2	2.8	3.8	4.3	4.8	2,060
148	314	480	773	1,060	1,440							
69	133	192	289	379	487	–	–	–	–	–	–	488
58	115	168	252	330	421							
119	193	247	319	375	433	1.2	1.5	1.7	1.9	2.1	2.2	300
90	159	211	285	346	410							
349	441	502	580	638	698	2.2	2.4	2.5	2.7	2.8	2.9	682
258	369	451	564	655	752							
223	430	613	901	1,160	1,460	1.6	2.2	2.6	3.4	4.0	4.6	1,050
199	381	546	801	1,030	1,290							
271	492	681	975	1,240	1,540	2.4	3.6	4.3	5.3	6.2	7.1	1,350
275	500	703	1,010	1,280	1,590							

TABLE 12.–FLOOD CHARACTERISTICS AND SELECTED BASIN

SITE NO.	STATION NO.	STATION NAME	PERIOD OF RECORD USED (WATER YEARS)	BASIN CHARACTERISTICS DRAINAGE AREA (SQUARE MILES)	MEAN BASIN ELEVATION (FEET)
					LOW PLATEAUS
144[1]	09168100	Disappointment Creek near Dove Creek, Colo.	1958-80	145	8,000
145	09181000	Onion Creek near Moab, Ut.	1951-55; 1961-68	18.8	5,700
146	09182600	Salt Wash near Thompson, Ut.	1959-71; 1973-74	3.9	5,510
147	09183000	Courthouse Wash near Moab, Ut.	1950-55; 1966-80	162	4,810
148	09184000	Mill Creek near Moab, Ut.	1915-17; 1949-71; 1973-80	74.9	7,170
149	09185200	Kane Springs Canyon near Moab, Ut.	1959; 1961-74	17.8	6,620
150	09185500	Hatch Wash near La Sal, Ut.	1950-71	378	6,550
151	09186500	Indian Creek above Cottonwood Creek, near Monticello, Ut.	1950-71	31.2	8,590
152	09187000	Cottonwood Creek near Monticello, Ut.	1950-57; 1960-67	115	7,210
153	09313500	Price River near Helper, Ut.	1904-06; 1908-16; 1918-20; 1922-34	530	7,920
154	09314200	Miller Creek near Price, Ut.	1960-71; 1973	62	7,040
155	09314400	Coleman Wash tributary near Woodside, Ut.	1959-68	3.6	5,540
156	09314500	Price River at Woodside, Ut.	1909-10; 1946-73; 1975-80	1,540	6,490
157	09315150	Saleratus Wash tributary near Woodside, Ut.	1959-71; 1973-74	10	5,070
158	09315200	Saleratus Wash tributary No. 2 near Woodside, Ut.	1959-71; 1973-74	4.4	5,030
159	09315400	Saleratus Wash above Cottonwood Wash, near Green River, Ut.	1959-68	120	5,430
160	09315500	Saleratus Wash at Green River, Ut.	1949-70	180	5,050
161	09315900	Browns Wash tributary near Green River, Ut.	1959-73	3.89	4,300
162	09316000	Browns Wash near Green River, Ut.	1949-59; 1961-68	75	5,220
163	09327600	Ferron Creek tributary near Ferron, Ut.	1959; 1961-71	.96	6,300
164	09328050	Dry Wash near Moore, Ut.	1959-73	14	6,320
165	09328300	Sids Draw near Castle Dale, Ut.	1959-73	17.6	6,380
166	09328500	San Rafael River near Green River, Ut.	1909-18; 1946-80	1,628	6,910
167	09328600	Georges Draw near Hanksville, Ut.	1959-67; 1969-73	6.63	7,010
168	09328700	Temple Wash near Hanksville, Ut.	1959-68	38.2	5,630
169	09328720	Old Woman Wash near Hanksville, Ut.	1959-68	17.6	5,450
170	09328900	Crescent Wash at Crescent Junction, Ut.	1959-68	23.3	6,180
171	09330120	Sulphur Creek near Fruita, Ut.	1959-74	56.7	7,400
172	09330200	Pleasant Creek at Notom, Ut.	1959-73	80.6	7,980
173	09330300	Neilson Wash near Caineville, Ut.	1959-73	22.3	4,830
174	09330400	Fremont River near Hanksville, Ut.	1959-73	1,900	7,450

[1] Not located in figure 5.

FLOOD CHARACTERISTICS: PEAK DISCHARGE (CUBIC FEET PER SECOND), FOR INDICATED RECURRENCE INTERVAL (YEARS)						FLOOD DEPTH (FEET), FOR INDICATED RECURRENCE INTERVAL (YEARS)						MAXIMUM PEAK DISCHARGE OF RECORD (CUBIC FEET PER SECOND)
2	5	10	25	50	100	2	5	10	25	50	100	
REGION												
1,110	2,320	3,320	4,770	5,980	7,270	–	–	–	–	–	–	7,270
919	1,960	2,840	4,180	5,330	6,590							
754	1,400	1,860	2,470	2,930	3,380	2.0	2.9	3.6	4.4	5.0	5.5	2,100
604	1,260	1,810	2,660	3,420	4,260							
281	727	1,170	1,900	2,580	3,370	–	–	–	–	–	–	1,380
245	660	1,080	1,810	2,520	3,350							
1,920	3,830	5,570	8,430	11,100	14,300	3.5	4.9	5.9	7.4	8.7	10.1	12,300
1,910	3,980	5,840	8,910	11,700	15,100							
787	2,140	3,600	6,260	8,930	12,300	–	–	–	–	–	–	5,110
725	1,930	3,210	5,530	7,840	10,700							
535	844	1,060	1,340	1,550	1,770	2.6	3.5	4.0	4.7	5.2	5.4	1,290
435	808	1,120	1,620	2,070	2,600							
501	1,220	1,950	3,240	4,500	6,060	2.0	2.9	3.7	4.9	5.9	7.0	4,650
812	1,840	2,800	4,440	5,970	7,800							
136	383	679	1,280	1,950	2,880	2.0	3.2	4.3	5.9	7.5	9.3	2,330
161	435	738	1,330	1,960	2,810							
353	1,140	2,080	3,920	5,880	8,450	1.5	3.3	5.2	8.1	10.5	13.2	2,200
463	1,270	2,150	3,780	5,460	7,580							
1,890	4,000	5,920	8,960	11,700	14,900	4.5	5.8	6.8	8.0	8.9	9.8	12,000
1,700	3,600	5,300	8,000	10,400	13,300							
1,460	3,420	5,130	7,670	9,800	12,100	4.4	8.7	11.6	15.8	–	–	5,000
1,040	2,440	3,690	5,610	7,280	9,110							
262	611	927	1,420	1,850	2,330	–	–	–	–	–	–	1,040
221	571	917	1,510	2,090	2,760							
4,210	6,930	8,710	10,900	12,400	13,800	7.9	9.4	10.1	10.7	11.0	11.3	9,720
4,000	6,800	8,730	11,300	13,200	15,100							
824	2,260	3,760	6,390	8,940	12,000	–	–	–	–	–	–	5,340
645	1,770	2,940	5,010	7,020	9,430							
1,010	2,550	3,920	5,960	7,660	9,470	–	–	–	–	–	–	3,720
705	1,820	2,840	4,440	5,830	7,370							
3,050	5,960	8,620	13,000	17,000	21,800	–	–	–	–	–	–	19,500
2,140	4,410	6,480	9,900	13,000	16,700							
2,470	4,770	6,650	9,410	11,700	14,200	4.2	5.9	7.0	8.4	9.4	10.4	14,200
2,260	4,550	6,470	9,400	11,900	14,700							
210	616	1,070	1,910	2,770	3,860	–	–	–	–	–	–	1,470
257	758	1,300	2,310	3,330	4,590							
1,820	3,760	5,400	7,830	9,870	12,100	6.4	9.1	10.6	12.2	13.3	14.3	5,620
1,550	3,330	4,870	7,250	9,310	11,600							
114	343	596	1,050	1,500	2,060	1.4	2.6	3.5	4.8	5.8	6.8	600
92	285	500	900	1,300	1,810							
328	646	931	1,390	1,800	2,290	3.8	5.0	5.8	6.7	7.4	8.3	1,630
308	687	1,050	1,660	2,240	2,930							
447	1,200	1,940	3,170	4,290	5,580	2.6	3.6	4.2	4.8	5.3	5.7	2,150
391	1,050	1,690	2,790	3,810	5,000							
2,150	4,110	5,820	8,540	11,000	13,800	–	–	–	–	–	–	12,000
2,290	4,390	6,190	9,040	11,600	14,500							
214	596	1,020	1,790	2,580	3,570	–	–	–	–	–	–	1,650
187	522	886	1,550	2,230	3,070							
127	403	740	1,420	2,170	3,180	–	–	–	–	–	–	1,880
370	974	1,590	2,700	3,800	5,160							
264	936	1,720	3,180	4,620	6,390	–	–	–	–	–	–	2,650
350	1,050	1,800	3,160	4,490	6,110							
439	1,140	1,890	3,260	4,670	6,460	–	–	–	–	–	–	4,160
411	1,070	1,740	2,960	4,170	5,680							
528	1,220	1,870	2,910	3,840	4,920	–	–	–	–	–	–	2,600
484	1,140	1,750	2,770	3,690	4,780							
259	817	1,450	2,610	3,780	5,230	2.3	3.6	4.8	6.4	7.6	9.0	2,040
327	896	1,490	2,550	3,600	4,870							
969	2,390	3,710	5,780	7,600	9,630	4.3	8.3	11.7	15.9	19.2	–	5,450
839	2,110	3,310	5,270	7,040	9,070							
4,330	7,340	9,600	12,700	15,200	17,700	–	–	–	–	–	–	15,300
3,670	6,460	8,590	11,700	14,200	16,900							

TABLE 12.—FLOOD CHARACTERISTICS AND SELECTED BASIN

SITE NO.	STATION NO.	STATION NAME	PERIOD OF RECORD USED (WATER YEARS)	BASIN CHARACTERISTICS DRAINAGE AREA (SQUARE MILES)	MEAN BASIN ELEVATION (FEET)
					LOW PLATEAUS
175	09333500	Dirty Devil River above Poison Spring Wash, near Hanksville, Ut.	1948-73; 1976-80	4,159	6,600
176	09333900	Butler Canyon near Hite, Ut.	1959-74	14.7	5,150
177	09334000	North Wash near Hanksville, Ut.	1950-70	136	5,400
178	09334400	Fry Canyon near Hite, Ut.	1959-73	20.9	6,250
179	09334500	White Canyon near Hanksville, Ut.	1951-70	276	6,090
180	09336000	Birch Creek near Escalante, Ut.	1959-74	36	8,080
181	09336400	Upper Valley Creek near Escalante, Ut.	1959-74	53	7,620
182	09337000	Pine Creek near Escalante, Ut.	1951-55; 1958-75; 1977-80	68.1	8,890
183	09337500	Escalante River near Escalante, Ut.	1910-12; 1943-55; 1972-80	320	8,030
184	09338900	Deer Creek near Boulder, Ut.	1959-74	63	7,680
185	09339200	Twentymile Wash near Escalante, Ut.	1959-68	140	6,170
186	09371100	Teec Nos Pos Wash near Teec Nos Pos, Ariz.	1967-76	16.0	7,600
187	09372000	McElmo Creek near Colorado-Utah State line	1951-80	346	6,300
188	09372200	McElmo Creek near Bluff, Ut.	1959-70	720	6,200
189	09378700	Cottonwood Wash near Blanding, Ut.	1959-80	205	6,820
190	09378720	Cottonwood Wash at Bluff, Ut.	1959-68	340	6,250
191	09378950	Comb Wash near Blanding, Ut.	1959-68	10.3	5,760
192	09379000	Comb Wash near Bluff, Ut.	1959-68	280	6,060
193	09379300	Lime Creek near Mexican Hat, Ut.	1959-73	67.2	5,360
194	09379560	El Capitan Wash near Kayenta, Ariz.	1963-76	5.88	5,690
195	09379800	Coyote Creek near Kanab, Ut.	1959-72	89	5,110
196	09379820	Buck Tank Draw near Kanab, Ut.	1961-70	5.25	5,030
197	09381100	Henrieville Creek at Henrieville, Ut.	1959-74	34	7,120
198	09381500	Paria River near Cannonville, Ut.	1951-55; 1959-74	220	6,890
199	09381800	Paria River near Kanab, Ut.	1959-73	668	6,390
200	09382000	Paria River at Lees Ferry, Ariz.	1924-80	1,410	6,150
201[1]	09403000	Bright Angel Creek near Grand Canyon, Ariz.	1924-73	101	7,390
202	09403500	Kanab Creek near Glendale, Ut.	1959-74	72	7,250
203	09403600	Kanab Creek near Kanab, Ut.	1959-80	198	6,670
204	09403700	Johnson Wash near Kanab, Ut.	1959-74	237	6,300
205	09404450	East Fork Virgin River near Glendale, Ut.	1967-80	69.2	7,300

[1] Not located in figure 5.

FLOOD CHARACTERISTICS: PEAK DISCHARGE (CUBIC FEET PER SECOND), FOR INDICATED RECURRENCE INTERVAL (YEARS)						FLOOD CHARACTERISTICS: FLOOD DEPTH (FEET), FOR INDICATED RECURRENCE INTERVAL (YEARS)						MAXIMUM PEAK DISCHARGE OF RECORD (CUBIC FEET PER SECOND)
2	5	10	25	50	100	2	5	10	25	50	100	
REGION—Continued												
5,640	11,500	16,800	25,300	32,900	41,800	–	–	–	–	–	–	35,000
5,560	11,100	15,900	23,500	30,300	38,200							
411	749	1,030	1,430	1,780	2,160	2.8	4.4	5.3	6.3	7.0	7.5	1,950
425	925	1,390	2,150	2,870	3,700							
1,190	3,070	4,990	8,300	11,500	15,300	3.6	5.7	7.1	8.7	10.0	11.2	8,900
1,230	3,070	4,870	7,950	10,900	14,300							
447	1,930	3,790	7,300	10,800	14,900	2.1	4.8	6.9	9.7	11.7	13.9	3,500
409	1,530	2,870	5,370	7,860	10,800							
2,200	4,260	5,970	8,530	10,700	13,100	3.5	5.2	6.4	7.9	9.1	10.3	7,390
1,960	3,930	5,580	8,130	10,300	12,800							
434	1,090	1,740	2,850	3,890	5,140	1.7	2.8	3.6	4.6	5.4	6.2	3,400
370	929	1,480	2,430	3,320	4,390							
721	1,580	2,440	3,920	5,390	7,210	–	–	–	–	–	–	5,560
588	1,320	2,050	3,300	4,530	6,040							
173	422	655	1,030	1,360	1,740	3.0	4.5	5.5	6.7	7.6	8.5	1,010
209	505	783	1,240	1,660	2,150							
771	1,760	2,670	4,110	5,420	6,910	3.6	5.1	5.9	7.0	7.8	8.6	3,450
800	1,800	2,700	4,140	5,450	6,950							
327	1,250	2,430	4,790	7,300	10,600	2.0	3.3	4.6	6.3	7.5	8.9	3,820
356	1,140	2,080	3,890	5,770	8,200							
1,660	3,020	4,080	5,570	6,790	8,080	–	–	–	–	–	–	4,620
1,330	2,660	3,780	5,510	7,010	8,690							
557	841	1,050	1,320	1,530	1,760	–	–	–	–	–	–	1,350
378	684	952	1,380	1,780	2,250							
930	1,510	1,950	2,570	3,090	3,640	–	–	–	–	–	–	3,040
1,090	1,970	2,690	3,790	4,740	5,800							
595	1,670	2,990	5,740	8,890	13,400	–	–	–	–	–	–	13,100
1,450	3,210	4,900	7,930	11,000	14,900							
1,190	3,670	6,440	11,500	16,600	22,900	–	–	–	–	–	–	20,500
1,130	3,210	5,450	9,490	13,500	18,400							
956	2,770	5,090	10,200	16,300	25,200	–	–	–	–	–	–	42,100
1,150	2,970	5,050	9,370	14,300	21,200							
749	1,460	2,110	3,170	4,150	5,330	–	–	–	–	–	–	3,430
519	1,130	1,710	2,710	3,660	4,800							
1,830	3,170	4,320	6,110	7,710	9,570	–	–	–	–	–	–	8,390
1,670	3,250	4,610	6,790	8,730	11,000							
1,690	4,190	6,600	10,500	14,200	18,400	3.7	5.9	7.4	9.0	10.5	11.9	6,600
1,380	3,410	5,350	8,520	11,500	14,900							
482	959	1,370	2,000	2,560	3,180	–	–	–	–	–	–	2,340
373	822	1,240	1,940	2,590	3,350							
1,400	2,760	3,880	5,540	6,940	8,470	4.1	5.9	6.9	8.2	9.1	10.0	4,590
1,310	2,800	4,080	6,110	7,890	9,910							
10	72	215	712	1,570	3,240	–	–	–	–	–	–	680
141	429	770	1,510	2,440	3,870							
866	2,070	3,330	5,640	8,000	11,000	–	–	–	–	–	–	7,360
665	1,610	2,580	4,340	6,120	8,350							
2,780	4,860	6,590	9,210	11,500	14,100	5.1	8.0	10.0	13.0	15.0	16.5	11,600
2,210	4,010	5,530	7,890	9,960	12,300							
2,480	5,290	7,960	12,400	16,600	21,700	9.2	10.8	13.5	16.0	17.7	19.8	15,400
2,340	4,950	7,310	11,200	14,800	19,000							
4,140	7,630	10,300	13,900	16,800	19,800	–	–	–	–	–	–	16,100
4,040	7,510	10,200	13,900	16,900	20,000							
424	997	1,580	2,620	3,640	4,930	–	–	–	–	–	–	4,400
448	1,050	1,650	2,720	3,750	5,040							
621	1,440	2,150	3,200	4,090	5,040	3.2	5.1	6.4	7.8	9.0	10.0	2,100
571	1,340	2,020	3,090	4,040	5,090							
1,030	1,800	2,390	3,210	3,870	4,570	–	–	–	–	–	–	3,030
1,020	2,030	2,870	4,190	5,330	6,630							
996	2,060	2,890	4,040	4,930	5,840	6.3	8.6	9.9	11.7	12.5	13.5	2,750
1,100	2,350	3,380	4,950	6,270	7,720							
152	368	585	964	1,330	1,780	1.5	2.6	3.3	4.2	5.2	6.0	640
286	691	1,080	1,740	2,380	3,130							

TABLE 12.—FLOOD CHARACTERISTICS AND SELECTED BASIN

SITE NO.	STATION NO.	STATION NAME	PERIOD OF RECORD USED (WATER YEARS)	BASIN CHARACTERISTICS DRAINAGE AREA (SQUARE MILES)	MEAN BASIN ELEVATION (FEET)
					LOW PLATEAU
206	09404500	Mineral Gulch near Mount Carmel, Ut.	1959-69; 1971-72; 1974	7.6	6,110
207	09405500	North Fork Virgin River near Springdale, Ut.	1913-14; 1926-80	344	7,350
208	09406000	Virgin River at Virgin, Ut.	1910-71; 1979-80	934	6,400
209	09406300	Kanarra Creek at Kanarraville, Ut.	1960-80	9.85	7,950
210	09406700	South Ash Creek below Mill Creek, near Pintura, Ut.	1967-80	11.0	7,210
211	09406800	South Ash Creek near Pintura, Ut.	1959-70; 1973-74	14.0	6,720
212	09408000	Leeds Creek near Leeds, Ut.	1964-80	15.5	6,360
213	09408150	Virgin River near Hurricane, Ut.	1967-80	1,499	6,350
214	09408200	Fort Pierce Wash near St. George, Ut.	1959-69	1,650	4,870
215	09408400	Santa Clara River near Pine Valley, Ut.	1960-80	18.7	8,720
216	09409500	Moody Wash near Veyo, Ut.	1955-69	33	6,070
217	10174500	Sevier River at Hatch, Ut.	1915-23; 1925-26; 1939-80	340	8,480
218	10241400	Little Creek near Paragonah, Ut.	1960-80	15.8	7,470
219	10241470	Center Creek above Parowan Creek near Parowan, Ut.	1965-80	11.6	8,450
220	10241600	Summit Creek near Summit, Ut.	1965-80	24.0	8,230
221	10242000	Coal Creek near Cedar City, Ut.	1916-19; 1935-80	80.9	8,640
222	10242100	Shirts Creek near Cedar City, Ut.	1959-74	12.8	8,032
223	10242420	Shoal Creek near Enterprise, Ut.	1960-70; 1972; 1974	19	6,160
224	10242440	Cottonwood Creek near Enterprise, Ut.	1961-65; 1969-74	6.0	6,110

FLOOD CHARACTERISTICS: PEAK DISCHARGE (CUBIC FEET PER SECOND), FOR INDICATED RECURRENCE INTERVAL (YEARS)						FLOOD DEPTH (FEET), FOR INDICATED RECURRENCE INTERVAL (YEARS)						MAXIMUM PEAK DISCHARGE OF RECORD (CUBIC FEET PER SECOND)
2	5	10	25	50	100	2	5	10	25	50	100	
REGION—Continued												
239	1,050	2,160	4,490	7,070	10,500	2.4	5.7	11.8	13.0	15.9	–	3,210
229	865	1,680	3,350	5,160	7,530							
1,820	3,330	4,560	6,380	7,920	9,630	5.2	7.3	9.0	11.2	12.7	13.9	9,150
1,710	3,190	4,400	6,220	7,770	9,500							
3,810	7,270	10,300	14,900	19,100	23,800	5.3	7.7	9.3	11.6	13.6	15.4	22,800
3,640	6,990	9,890	14,300	18,400	22,900							
148	373	614	1,060	1,510	2,090	1.6	2.4	3.0	4.0	4.8	5.7	1,000
145	375	618	1,070	1,520	2,090							
238	641	1,050	1,750	2,420	3,200	2.3	3.6	4.0	4.8	5.4	6.0	1,910
215	581	953	1,610	2,240	2,980							
194	469	739	1,200	1,630	2,140	1.7	3.0	3.9	5.2	6.3	7.3	938
214	545	873	1,450	2,010	2,670							
283	1,100	2,170	4,380	6,800	10,000	2.1	3.5	4.4	5.8	6.9	8.0	2,980
285	991	1,860	3,630	5,520	7,990							
6,470	12,600	17,600	24,800	30,600	36,900	7.4	11.5	14.3	17.9	20.4	22.2	20,100
5,170	10,100	14,100	19,900	24,700	30,000							
2,240	4,650	6,730	9,910	12,700	15,800	–	–	–	–	–	–	8,760
4,190	8,340	11,700	16,900	21,200	26,100							
79	176	275	450	625	847	1.9	2.8	3.5	4.6	5.5	6.6	776
105	254	403	670	940	1,270							
208	801	1,610	3,360	5,390	8,230	3.3	6.1	7.5	12.2	14.3	16.7	1,810
317	969	1,740	3,290	4,980	7,240							
608	897	1,090	1,340	1,520	1,710	2.1	2.8	3.2	3.7	4.0	4.3	1,490
638	1,030	1,320	1,740	2,080	2,450							
36	126	245	509	823	1,280	1.1	2.1	2.9	4.2	5.3	6.7	351
91	261	451	830	1,230	1,780							
63	158	261	453	652	910	1.5	2.7	3.6	5.1	6.2	7.3	353
90	235	386	670	950	1,310							
73	252	498	1,050	1,730	2,730	1.1	1.6	2.2	3.0	3.8	4.9	858
124	360	635	1,200	1,830	2,700							
773	1,730	2,580	3,920	5,090	6,420	–	–	–	–	–	–	4,620
703	1,580	2,370	3,610	4,710	5,960							
269	495	684	969	1,220	1,490	–	–	–	–	–	–	1,070
225	466	685	1,050	1,390	1,780							
40	108	185	335	496	710	1.2	2	2.4	3.0	3.4	3.9	390
173	458	745	1,260	1,770	2,400							
145	398	684	1,240	1,820	2,590	–	–	–	–	–	–	1,470
166	467	791	1,410	2,030	2,830							

TABLE 12.—FLOOD CHARACTERISTICS AND SELECTED BASIN

SITE NO.	STATION NO.	STATION NAME	PERIOD OF RECORD USED (WATER YEARS)	BASIN CHARACTERISTICS: DRAINAGE AREA (SQUARE MILES)	BASIN CHARACTERISTICS: MEAN BASIN ELEVATION (FEET)
					GREAT BASIN HIGH
225	10146000	Salt Creek at Nephi, Ut.	1926-37; 1951-80	95.6	7,490
226	10147000	Summit Creek near Santaquin, Ut.	1910-16; 1955-66	14.6	8,400
227	10147500	Payson Creek above diversions, near Payson, Ut.	1948-62	18.8	7,610
228	10148400	Nebo Creek near Thistle, Ut.	1964-73	36.7	7,540
229	10166430	West Canyon near Cedar Fort, Ut.	1965-75	26.8	7,630
230	10172700	Vernon Creek near Vernon, Ut.	1959; 1962; 1964-80	25.0	7,100
231	10172790	Settlement Canyon near Tooele, Ut.	1960-70	5.77	7,900
232	10172800	South Willow Creek near Grantsville, Ut.	1961-80	4.19	8,370
233	10172870	Trout Creek near Callao, Ut.	1959-80	8.19	9,100
234	10172920	Cotton Creek near Grouse Creek, Ut.	1961-70	19.1	6,560
235	10172940	Dove Creek near Park Valley, Ut.	1959-73	33.2	6,620
236	10173450	Mammoth Creek above West Hatch Ditch near Hatch, Ut.	1965-80	105	9,000
237	10183900	East Fork Sevier River near Rubys Inn, Ut.	1962-80	71.6	8,640
238	10194200	Clear Creek above diversions near Sevier, Ut.	1958-80	164	7,880
239	10219200	Chicken Creek near Levan, Ut.	1963-77; 1979-80	27.9	7,480
240	10220300	Tintic Wash tributary near Nephi, Ut.	1960-70; 1972-74	18	6,070
241	10224100	Oak Creek above Little Creek, near Oak City, Ut.	1965-80	5.58	7,710
242	10232500	Chalk Creek near Fillmore, Ut.	1944-71	58.7	8,020
243	10233000	Meadow Creek near Meadow, Ut.	1914;1966-75	11.6	8,380
244	10233500	Corn Creek near Kanosh, Ut.	1959-75	87.0	7,400
245	10234500	8eaver River near 8eaver, Ut.	1914-80	91.0	9,280
246	10235000	South Creek near 8eaver, Ut.	1965-76	14.7	8,730
247	10236000	North Fork North Creek near 8eaver, Ut.	1959-76	14.1	8,340
248	10236500	South Fork North Creek near Beaver, Ut.	1966-76	23.0	9,370
249	10237500	Indian Creek near Beaver, Ut.	1948-49; 1966-75	18.5	8,370
250	10240600	Big Wash near Milford, Ut.	1959-68	51	6,120
251	10241300	Fremont Wash near Paragonah, Ut.	1959-74	120	7,240
252	10241430	Red Creek near Paragonah, Ut.	1965-75	6.3	9,050
253	13077700	George Creek near Yost, Ut.	1960-80	7.84	8,570
254	13079000	Clear Creek near Naf, Id.	1945-70	20.2	7,870

FLOOD CHARACTERISTICS: PEAK DISCHARGE (CUBIC FEET PER SECOND), FOR INDICATED RECURRENCE INTERVAL (YEARS)						FLOOD CHARACTERISTICS: FLOOD DEPTH (FEET), FOR INDICATED RECURRENCE INTERVAL (YEARS)						MAXIMUM PEAK DISCHARGE OF RECORD (CUBIC FEET PER SECOND)
2	5	10	25	50	100	2	5	10	25	50	100	
ELEVATION SUBREGION												
214	372	497	675	824	985	2.0	3.0	3.5	4.3	4.9	5.5	832
205	367	498	688	849	1,030							
73	123	157	203	237	271	.8	1.0	1.1	1.3	1.4	1.5	215
68	114	152	209	255	305							
139	258	352	483	590	703	1.9	2.7	3.1	3.7	4.2	4.7	465
103	201	279	393	489	595							
111	209	291	414	519	637	1.2	1.9	2.4	3.1	3.7	4.2	478
96	195	278	407	519	648							
56	175	326	649	1,030	1,560	1.1	2.0	2.8	4.0	5.1	6.2	1,660
61	161	273	495	742	1,080							
24	93	189	408	674	1,060	.7	1.3	2.0	3.1	4.2	5.6	825
33	109	195	375	582	873							
22	64	108	180	247	324	.9	1.3	1.6	1.9	2.2	2.4	155
22	58	94	152	205	268							
33	55	71	92	107	122	–	–	–	–	–	–	92
29	50	68	94	115	138							
44	79	105	142	171	202	1.6	2.1	2.3	2.6	2.9	3.1	129
46	75	104	147	183	223							
4	17	40	99	180	312	.6	1.0	1.4	2.2	2.9	3.8	91
17	66	106	180	261	374							
10	36	76	169	287	469	–	–	–	–	–	–	275
25	89	145	251	367	529							
404	575	681	805	892	974	3.3	4.0	4.3	4.7	4.9	5.2	652
382	496	625	799	939	1,090							
119	205	275	379	468	568	–	–	–	–	–	–	448
155	232	323	461	581	718							
262	435	556	713	831	949	2.4	3.4	4.0	4.9	5.3	5.9	769
276	455	605	816	988	1,170							
50	118	183	289	388	503	–	–	–	–	–	–	268
55	130	197	306	406	522							
64	161	259	430	597	801	–	–	–	–	–	–	545
47	140	220	356	485	643							
20	45	69	108	143	185	.9	1.3	1.6	1.9	2.1	2.4	120
20	47	72	112	148	192							
232	414	571	815	1,030	1,280	–	–	–	–	–	–	1,850
210	370	516	743	943	1,180							
54	105	146	203	249	298	1.4	1.8	2.1	2.4	2.6	2.8	198
51	94	135	197	249	308							
136	361	595	1,000	1,400	1,890	1.5	2.5	3.3	4.3	5.1	6.0	1,350
142	347	548	884	1,210	1,600							
365	615	787	1,000	1,160	1,310	2.1	2.7	3.0	3.3	3.6	3.9	1,080
362	579	748	964	1,130	1,290							
30	76	126	219	315	440	–	–	–	–	–	–	200
48	87	136	221	305	409							
39	76	108	158	202	251	1.4	2.1	2.6	3.4	3.9	4.4	198
45	82	120	178	231	290							
165	461	798	1,450	2,140	3,060	1.1	1.7	2.2	2.8	3.4	4.0	1,550
144	304	511	900	1,300	1,840							
34	74	114	187	260	355	–	–	–	–	–	–	311
50	92	139	219	294	388							
159	336	488	716	911	1,130	–	–	–	–	–	–	520
105	281	409	605	776	970							
105	200	276	383	471	564	1.8	2.7	3.3	4.1	4.6	5.2	282
134	278	394	567	715	882							
14	25	33	44	54	64	–	–	–	–	–	–	48
26	39	56	84	109	137							
69	98	118	142	159	176	1.2	1.4	1.5	1.6	1.7	1.8	146
59	87	111	144	170	200							
121	184	226	278	317	355	–	–	–	–	–	–	386
104	166	213	276	327	382							

SITE NO.	STATION NO.	STATION NAME	PERIOD OF RECORD USED (WATER YEARS)	BASIN CHARACTERISTICS	
				DRAINAGE AREA (SQUARE MILES)	MEAN BASIN ELEVATION (FEET)
					GREAT BASIN LO
255	10146900	Utah Lake tributary near Elberta, Ut.	1961-74	4.71	5,530
256	10153200	Big Cove Wash near Lehi, Ut.	1961-74	.44	5,190
257	10166400	Tickville Gulch near Cedar Valley, Ut.	1961-74	15.6	5,740
258	10172720	East Government Creek tributary near Vernon, Ut.	1961-74	.98	6,340
259	10172740	Rush Valley tributary near Fairfield, Ut.	1961-74	.26	5,850
260	10172760	Clover Creek near Clover, Ut.	1960-74	4.45	7,190
261	10172810	Mack Canyon near Grantsville, Ut.	1961-74	2.84	7,200
262	10172830	North Fork Muskrat Canyon near Timpie, Ut.	1961-74	1.78	7,080
263	10172835	Skull Valley tributary near Delle, Ut.	1960-74	1.5	5,780
264	10172885	Great Salt Lake Desert tributary No. 2 near Dugway, Ut.	1961-74	5.48	5,570
265	10172890	Government Creek near Dugway, Ut.	1961-74	59	6,080
266	10172900	Bar Creek near Ibapah, Ut.	1959-74	12	5,460
267	10172902	Dead Cedar Wash near Wendover, Ut.	1961-78	5.0	6,910
268	10172905	Great Salt Lake Desert tributary near Delle, Ut.	1961-74	.97	6,010
269	10172909	Burnt Creek near Shores, Nev.	1968-78	10.5	7,320
270	10172913	Loray Wash tributary near Cobre, Nev.	1961-78	24	6,590
271	10172925	Great Salt Lake Desert tributary No. 3 near Park Valley, Ut.	1961-73	10.1	6,120
272	10172990	Blue Spring Creek near Snowville, Ut.	1960-73	78	5,300
273	10174800	Red Canyon tributary near Bryce Canyon, Ut.	1959-74	2.2	7,860
274	10223800	Hop Creek near Jericho, Ut.	1961-74	1.81	6,470
275	10242460	Escalante Valley tributary near Panaca, Nev.	1964-80	7.9	6,790
276	10243660	Conners Pass Creek near Shoshone, Nev.	1962-80	.45	7,920
277	10243950	Millick Canyon tributary near Currie, Nev.	1965-78	1.4	6,470
278	10244220	Maverick Canyon near Oasis, Nev.	1968-78	3.02	7,150
279	10244240	Clover Valley tributary near Arthur, Nev.	1968-80	3.0	6,370
280	10245080	Nelson Creek tributary near Currie, Nev.	1961-78	.7	6,000
281	10245270	Drylake Valley tributary near Caliente, Nev.	1967-80	11	5,910
282[1]	10245450	Illipah Creek tributary near Hamilton, Nev.	1962-80	5.47	7,100

[1] Not located in figure 5.

FLOOD CHARACTERISTICS												
PEAK DISCHARGE (CUBIC FEET PER SECOND), FOR INDICATED RECURRENCE INTERVAL (YEARS)						FLOOD DEPTH (FEET), FOR INDICATED RECURRENCE INTERVAL (YEARS)						MAXIMUM PEAK DISCHARGE OF RECORD (CUBIC FEET PER SECOND)
2	5	10	25	50	100	2	5	10	25	50	100	
ELEVATION SUBREGION												
179	724	1,430	–	–	–	–	–	–	–	–	–	2,210
–	–	–	–	–	–	–	–	–	–	–	–	8.0
28	78	130	–	–	–	–	–	–	–	–	–	236
–	–	–	–	–	–	–	–	–	–	–	–	5.6
–	–	–	–	–	–	–	–	–	–	–	–	49
–	–	–	–	–	–	–	–	–	–	–	–	87
–	–	–	–	–	–	–	–	–	–	–	–	2.1
–	–	–	–	–	–	–	–	–	–	–	–	.6
–	–	–	–	–	–	–	–	–	–	–	–	20
–	–	–	–	–	–	–	–	–	–	–	–	1,720
–	–	–	–	–	–	–	–	–	–	–	–	370
66	383	914	2,240	–	–	1.9	3.3	4.6	6.7	8.7	10.0	2,690
–	–	–	–	–	–	–	–	–	–	–	–	752
–	–	–	–	–	–	–	–	–	–	–	–	80
–	–	–	–	–	–	–	–	–	–	–	–	25
–	–	–	–	–	–	–	–	–	–	–	–	220
–	–	–	–	–	–	–	–	–	–	–	–	420
102	380	726	–	–	–	–	–	–	–	–	–	1,820
–	–	–	–	–	–	–	–	–	–	–	–	365
–	–	–	–	–	–	–	–	–	–	–	–	182
–	–	–	–	–	–	–	–	–	–	–	–	250
–	–	–	–	–	–	–	–	–	–	–	–	3
–	–	–	–	–	–	–	–	–	–	–	–	83
–	–	–	–	–	–	–	–	–	–	–	–	0
–	–	–	–	–	–	–	–	–	–	–	–	43
–	–	–	–	–	–	–	–	–	–	–	–	52
–	–	–	–	–	–	–	–	–	–	–	–	156
–	–	–	–	–	–	–	–	–	–	–	–	287

TABLE 12.–FLOOD CHARACTERISTICS AND SELECTED BASIN

SITE NO.	STATION NO.	STATION NAME	PERIOD OF RECORD USED (WATER YEARS)	BASIN CHARACTERISTICS	
				DRAINAGE AREA (SQUARE MILES)	MEAN BASIN ELEVATION (FEET)
			MISCELLANEOUS AND PARTIALLY REGULATED GAGING [These sites are not		
283	09180000	Dolores River near Cisco, Ut.	1951-80	4,580	–
284	09235800	Pot Creek near Vernal, Ut.	1958-80	107	–
285	09262000	Big Brush Creek near Vernal, Ut.	1939-46; 1948-79	79.6	–
286	09271500	Ashley Creek near Jensen, Ut.	1947-80	383	–
287	09291000	Lake Fork River below Moon Lake, near Mountain Home, Ut.	1922-27; 1930-32; 1942-80	112	–
288	09295000	Duchesne River at Myton, Ut.	1901-10; 1912-62; 1964-80	2,643	–
289	09302000	Duchesne River near Randlett, Ut.	1943-62; 1964-80	4,247	–
290	09306500	White River near Watson, Ut.	1904-05; 1923-53; 1955-79	4,020	–
291	09310000	Gooseberry Creek near Scofield, Ut.	1931-32; 1941-80	16.8	–
292	09328000	San Rafael River near Castle Dale, Ut.	1948-64; 1973-80	930	–
293	09330230	Fremont River near Caineville, Ut.	1967-80	1,208	–
294	09332100	Muddy Creek below Interstate Highway I-70, near Emery, Ut.	1951-55; 1957-68; 1974-80	418	–
295	09410000	Santa Clara River above Winsor Dam near Santa Clara, Ut.	1943-71	338	–
296	10017000	Yellow Creek near Evanston, Wyo.	1943-45; 1950-78	79.2	–
297	10026500	Bear River near Randolph, Ut.	1944-60; 1962-80	1,616	–
298	10106000	Little Bear River near Paradise, Ut.	1937-80	198	–
299	10109000	Logan River above State Dam, near Logan, Ut.	1896-1980	214	–
300	10118000	Bear River near Collinston, Ut.	1890-1980	6,267	–
301	10126000	Bear River near Corinne, Ut.	1950-57; 1964-80	7,029	–
302	10129300	Weber River near Peoa, Ut.	1957-77	296	–
303	10130700	East Fork Chalk Creek near Coalville, Ut.	1965-74	35	–
304	10134500	East Canyon Creek near Morgan, Ut.	1932-80	144	–
305	10154200	Provo River near Woodland, Ut.	1964-80	162	–
306	10155000	Provo River near Hailstone, Ut.	1950-80	233	–
307	10159500	Provo River below Deer Creek Dam, Ut.	1953-80	547	–
308	10163000	Provo River at Provo, Ut.	1903-05; 1937-80	673	–
309	10171000	Jordan River at Salt Lake City, Ut.	1943-80	3,438	–
310	10176300	Panquitch Creek near Panquitch, Ut.	1961-80	97.0	–
311	10180000	Sevier River near Circleville, Ut.	1915-18; 1920-22; 1924-26; 1950-80	986	–
312	10183500	Sevier River near Kingston, Ut.	1916-26; 1930-31; 1933-80	1,131	–
313	10189000	East Fork Sevier River near Kingston, Ut.	1913-80	1,207	–
314	10191500	Sevier River below Piute Dam, near Marysvale, Ut.	1912-75; 1977-80	2,441	–
315	10194000	Sevier River above Clear Creek near Sevier, Ut.	1914-16; 1939-55; 1961-80	2,707	–
316	10205000	Sevier River near Sigurd, Ut.	1915-80	3,375	–
317	10206000	Salina Creek at Salina, Ut.	1914-15; 1943-55; 1960-80	292	–
318	10237000	Beaver River at Adamsville, Ut.	1914-80	303	–
319	10239000	Beaver River at Rocky Ford Dam, near Minersville, Ut.	1914-75; 1977-80	535	–

FLOOD CHARACTERISTICS: PEAK DISCHARGE (CUBIC FEET PER SECOND), FOR INDICATED RECURRENCE INTERVAL (YEARS)						FLOOD DEPTH (FEET), FOR INDICATED RECURRENCE INTERVAL (YEARS)						MAXIMUM PEAK DISCHARGE OF RECORD (CUBIC FEET PER SECOND)
2	5	10	25	50	100	2	5	10	25	50	100	
STATIONS NOT USED IN REGRESSION ANALYSIS shown in figure 5]												
5,580	9,510	12,600	17,100	20,800	24,800	6.6	8.4	9.6	11.0	12.1	13.2	17,400
43	111	176	284	382	–	–	–	–	–	–	–	286
259	356	418	495	551	606	–	–	–	–	–	–	543
786	1,530	2,070	2,780	3,310	3,830	–	–	–	–	–	–	2,790
897	1,410	1,770	2,240	2,600	2,980	2.8	3.5	4.0	4.5	4.8	5.2	2,180
3,860	6,100	7,480	9,080	10,100	11,100	5.3	6.6	7.2	7.8	8.2	8.5	12,800
3,990	6,480	8,070	9,960	11,300	12,500	5.2	6.7	7.5	8.3	8.8	9.4	10,300
4,070	5,450	6,350	7,460	8,280	9,090	5.2	7.5	9.4	11.0	11.8	13.0	8,160
222	304	352	404	438	468	2.5	3.0	3.4	3.6	3.8	3.9	414
1,410	2,410	3,190	4,310	5,220	6,210	4.1	5.2	5.8	6.8	7.4	8.1	4,510
1,130	1,920	2,490	–	–	–	3.3	4.3	4.9	–	–	–	2,310
1,010	1,680	2,140	2,740	3,190	–	5.3	6.6	7.2	7.7	8.1	–	2,890
902	2,310	3,770	6,350	8,890	12,000	3.7	5.4	6.6	8.2	9.5	–	6,190
123	217	288	387	467	551	–	–	–	–	–	–	477
1,320	2,110	2,590	3,130	3,490	3,810	–	–	–	–	–	–	2,660
669	984	1,220	1,540	1,800	2,070	–	–	–	–	–	–	2,000
1,100	1,480	1,690	1,930	2,080	2,220	–	–	–	–	–	–	2,480
4,940	6,770	7,940	9,360	10,400	11,400	–	–	–	–	–	–	11,600
4,610	5,940	6,770	7,780	8,510	9,230	10.4	12.2	13.3	14.4	15.4	16.2	7,880
1,390	1,960	2,300	2,670	2,930	–	–	–	–	–	–	–	2,160
288	368	420	–	–	–	–	–	–	–	–	–	541
208	295	360	451	525	604	–	–	–	–	–	–	872
1,940	2,310	2,530	2,780	–	–	4.7	4.9	5.3	5.6	–	–	2,950
2,400	2,990	3,300	3,630	3,840	4,030	4.2	4.6	4.9	5.1	5.3	5.5	3,880
1,210	1,800	2,160	2,590	2,890	3,170	–	–	–	–	–	–	2,190
834	1,280	1,560	1,890	2,130	2,350	–	–	–	–	–	–	2,520
244	293	322	357	382	405	–	–	–	–	–	–	384
143	258	361	528	682	–	–	–	–	–	–	–	670
594	1,020	1,360	1,870	2,290	2,760	3.0	3.8	4.6	5.4	5.9	6.5	2,730
586	1,000	1,320	1,760	2,110	2,490	–	–	–	–	–	–	3,000
383	663	918	1,340	1,730	2,210	2.3	3.1	3.8	4.7	5.4	6.2	2,030
701	975	1,190	1,490	1,750	2,040	–	–	–	–	–	–	2,600
735	1,030	1,250	1,570	1,830	2,110	2.9	3.3	3.7	4.0	4.3	4.7	2,270
364	606	808	1,120	1,390	1,700	3.1	4.0	4.6	5.3	6.0	6.7	2,400
453	823	1,110	1,530	1,860	2,220	–	–	–	–	–	–	1,800
278	538	743	1,030	1,260	1,500	–	–	–	–	–	–	1,090
145	265	375	558	732	943	–	–	–	–	–	–	762

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