USING CHANNEL GEOMETRY TO ESTIMATE FLOOD FLOWS AT UNGAGED SITES IN IDAHO

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations 80-32

Prepared in cooperation with the
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Generally, discharge estimates obtained from equations using channel characteristics have smaller standard errors than those using basin characteristics, and equations using both basin and channel characteristics have even lower standard errors.

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November 6, 1980

TO: Users of Surface-Water Data

Water-Resources Investigations 80-32

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W. A. Harenberg

ERRATA

Isopluvial values on plate 1 are in tenths of an inch.

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CONVERSION FACTORS

For the convenience of those who prefer to use SI (International System of Units) rather than the inch-pound system of units, conversion factors for terms used in this report are listed below.

Multiply Inch-Pound Unit	By	To Obtain SI Unit
	Length	
inch (in.)	25.40	millimeter
foot (ft)	0.3048	meter
	Area	
square mile (mi^2)	2.590	square kilometer
	Flow	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
	Velocity	
foot per second (ft/s)	0.3048	meter per second

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ABSTRACT

Measurements at bankfull stage were made at 136 sites to determine whether predictions of flood discharges using channel-geometry characteristics are as good as or better than predictions using basin characteristics. These measurements are used to determine the variables of bankfull width, area, depth, and velocity. These variables are combined with basin characteristics for the sites, and multiple-regression techniques are used to select the best combination of variables to estimate the selected floods.

Generally, discharge estimates obtained from equations using channel characteristics have smaller standard errors than those using basin characteristics, and equations using both basin and channel characteristics have even lower standard errors.

INTRODUCTION

To make better use of flood plains, engineers and planners need information about flood flows. With reliable estimates of the magnitude of a 10-, 50-, or 100-year flood, engineers can design effective culverts or bridges for road crossings, and planners can determine whether areas adjacent to streams are subject to frequent or infrequent flooding. Because most streams are ungaged, such specific information is generally not available where needed.

The U.S. Geological Survey is engaged in a continuing effort to use the latest techniques to transfer streamflow data to ungaged sites. As part of a nationwide effort during the early 1960's, Geological Survey studies using the mean annual flood as an index flood gave a method of deriving flood-frequency data for basins in Idaho. These studies, by Thomas, Broom, and Cummans (1963); Bodhaine and Thomas (1964); and Butler, Reid, and Berwick (1966), described the regional magnitude and frequency of floods in the Snake River basin, Upper Columbia River basin, and Great Basin, parts of which are in Idaho. The method of analysis used in these studies was described by Dalrymple (1960).

In 1970, as part of a nationwide study to evaluate the U.S. Geological Survey streamflow-data collection program, flood-frequency data for Idaho were analyzed by multiple-regression techniques (Thomas and Harenberg, 1970). This study, which considered an additional 10 years of data, produced a method for estimating flood magnitudes at selected frequencies for ungaged streams. The method uses various basin characteristics, which include drainage area, percentage forest cover, percentage lakes and ponds, latitude of basin centroid, and longitude of basin centroid.

The same analytical techniques were used by Thomas, Harenberg, and Anderson (1973) in a study to determine magnitude and frequency of floods for basins in Idaho having drainage areas between 0.5 and 200 mi^2. This study used 10 years of record from crest-stage gages in addition to data from continuous-record stream gages.

In recent years, a number of investigators have used channel-geometry measurements to estimate flood magnitudes and frequencies at a stream site. Hedman (1970); Hedman and Kastner (1972); Hedman, Moore, and Livingston (1972); Moore (1974); and Fields (1975) used measurements based on depositional features (longitudinal and point bars) within the channel to derive equations for estimating mean annual flows and flood magnitudes. Hedman, Kastner, and Hejl (1974); Scott and Kunkler (1976); and Hedman and Kastner (1977) used measurements at the active-channel level. Emmett (1972 and 1975); Riggs (1974); Lowham (1976); and Riggs and Harenberg (1976) used measurements of channel geometry at bankfull stage.

This report is based on a study of measurements at bankfull stage. Collection of data used in this study began in 1974 and continued through 1977. Analysis of the data began in 1978. The study was made by the U.S. Geological Survey, in cooperation with the Idaho Transportation Department.

Purpose and Scope

The purposes of this study are to: (1) Determine whether channel-geometry measurements can be used to estimate flood-flow characteristics at ungaged sites in Idaho, and (2) determine if channel-geometry techniques will provide estimates of flood characteristics with smaller standard errors of estimate than will estimates provided by equations using basin characteristics.

The scope of study is broad, in that, if channel-geometry methods are applicable, they could be used on all streams in Idaho.

Gaging-Station Numbering System

Each gaging station and partial-record station in Idaho has been assigned a number in accordance with the permanent numbering system used by the U.S. Geological Survey. Numbers are assigned in downstream order along the main stream, and stations on tributaries between main-stream stations are numbered in the order they enter the main stream. A similar order is followed on other ranks of tributaries. The complete 8-digit number, such as 13245000, which is used for the station "North Fork Payette River at Cascade," includes the part number "13," indicating that the Payette River is in the Snake River basin, plus a 6-digit station number. Part numbers 10 and 12 indicate Great Basin and Upper Columbia River basin, respectively.

THEORY OF USE OF CHANNEL-GEOMETRY MEASUREMENTS

Use of channel-geometry measurements to estimate streamflow characteristics involves determination of certain channel-geometry parameters and correlation of these parameters with hydraulic characteristics. Leopold and Maddock (1953) derived functions, for a cross section and among cross sections along a stream, that relate surface width, mean depth, and mean velocity to discharge. The functions have the form:

$$w = aQ^b,$$

$$d = cQ^f,$$

$$v = kQ^m,$$

where w, d, v, and Q are surface width, mean depth, mean velocity, and discharge, respectively; and a, b, c, f, k, and m are numerical constants. The relations are described by the term "hydraulic geometry."

Leopold and Maddock (1953) used discharge measurements at gaging stations to obtain data for their at-a-station and downstream analyses of hydraulic geometry. Downstream analyses require that the data be for events that have the same frequency of occurrence at each station. Leopold and Maddock used mean annual discharge.

Leopold, Wolman, and Miller (1964) considered bankfull discharge to be a more appropriate discharge to use. They defined bankfull discharge as the discharge at which water begins to overflow onto the active flood plain. The active flood plain was defined as a flat area adjacent to the channel that is presently being reworked by the river and is overflowed about 2 out of every 3 years (Wolman and Leopold, 1957; and Emmett, 1972 and 1975).

Some publications (Brown, 1971; Emmett, 1972 and 1975; Leopold and Skibitzke, 1967; and Woodyer, 1968) indicated that bankfull discharge tends to have a common frequency of occurrence from river to river. Others (Kilpatrick and Barnes, 1964; and Williams, 1978) indicated that bankfull stage does not have a common frequency of occurrence from river to river but that frequency of occurrence tends to decrease with an increase in slope of the river.

DETERMINATION OF BANKFULL CHANNEL-GEOMETRY PARAMETERS

The relations between channel-geometry measurements and discharge are based on gaging-station data and are determined in two steps. First, the site of interest is visited and bankfull stage is determined in the field. Second, the discharge at bankfull stage and the hydraulic-geometry relations are determined in the office.

Site Selection and Field-Data Collection

Channel geometry was measured at gaging stations having sufficient length of record (usually 10 years or more) to allow determination of a reasonably accurate flood-frequency curve. Although most sites selected are on unregulated streams, some are on regulated streams where channel geometry has adjusted to regulated conditions. No sites were used where discharge measurements are made from bridges, because such cross sections are not representative.

In Idaho, streams exhibit a wide range of flood-plain development. Some streams, especially in the southeastern part of the State, have well-developed flood plains (fig. 1). Streams in the mountainous northern and central parts of the State are in narrow valleys and do not have clearly defined flood plains; for such streams, bankfull stage must be identified by using the elevation of streamside vegetation (fig. 2).

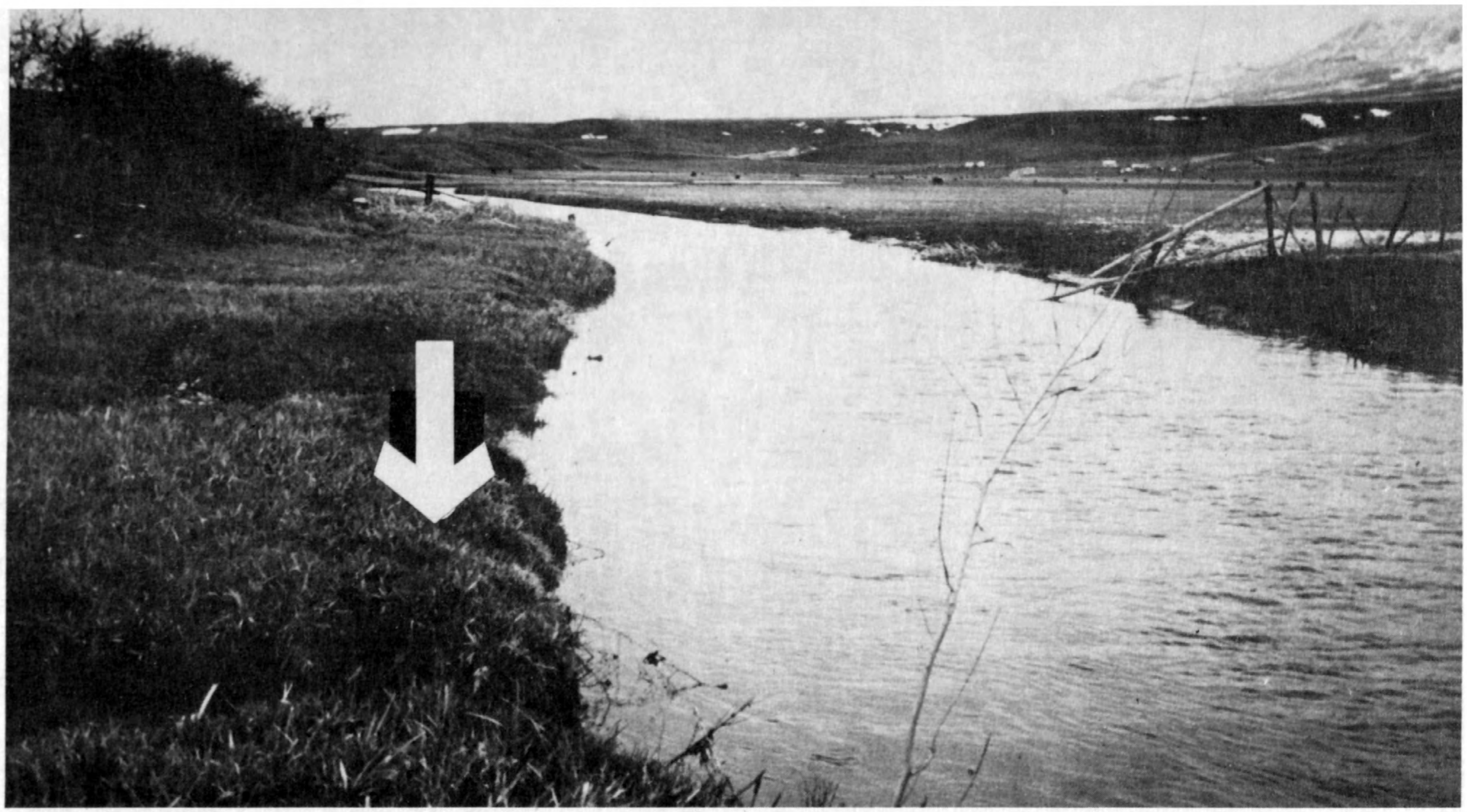


Figure 1A.--Stream having well-developed flood-plain features, Marsh Creek near McCammon, Idaho. (Arrow shows beginning of flood plain)

Figure 1B.--Stream having well-developed flood-plain features, Snake River near Blackfoot, Idaho.
(Arrow shows beginning of flood plain)

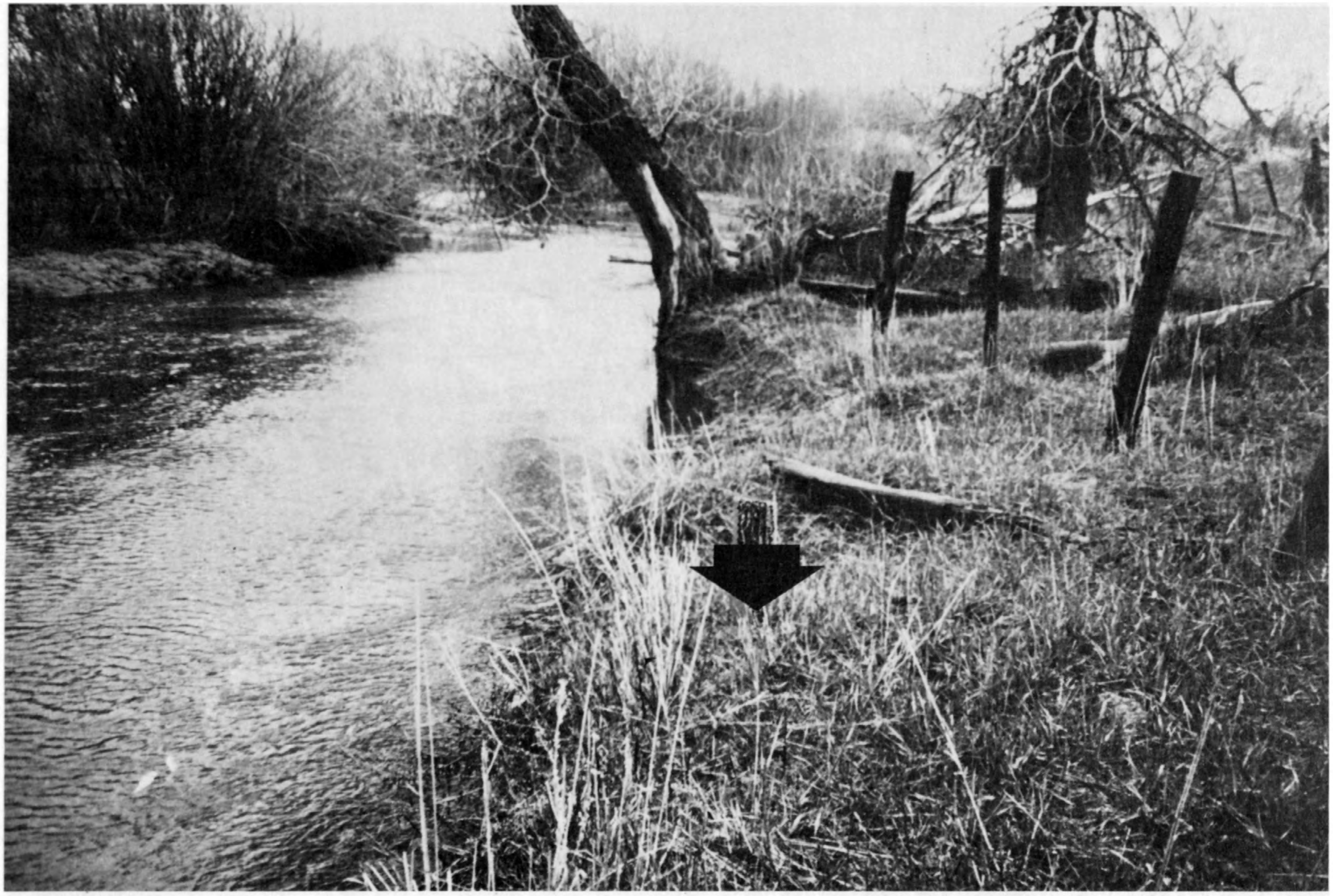


Figure 1C.--Stream having well-developed flood-plain features, Camas Creek at Camas, Idaho. (Arrow shows beginning of flood plain)

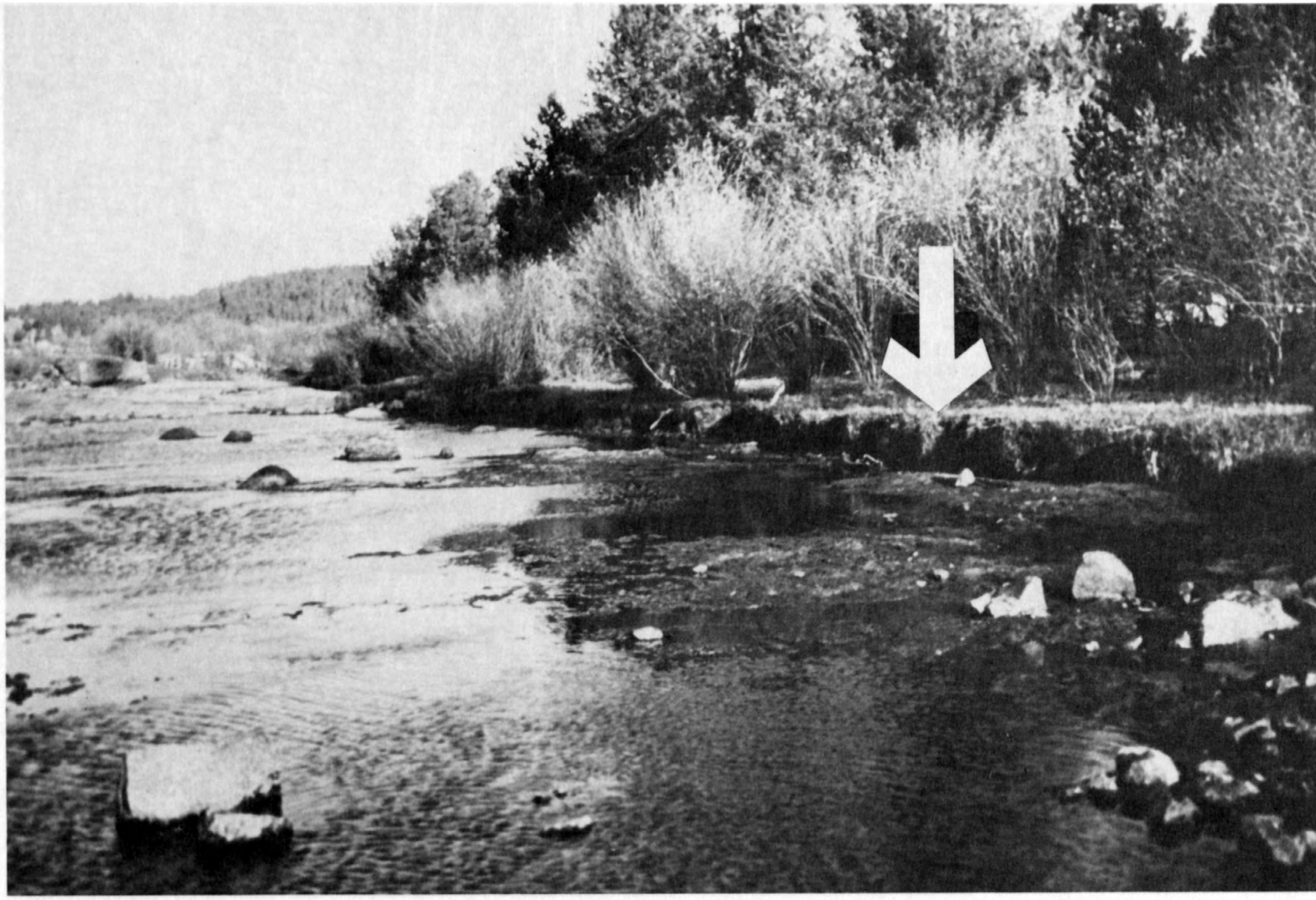


Figure 1D.--Stream having well-developed flood-plain features, North Fork Payette River at Cascade, Idaho. (Arrow shows beginning of flood plain)

Figure 2A.--Stream where vegetation was used to identify bankfull stage, Payette River near Horseshoe Bend, Idaho. (Arrow shows beginning of flood plain)

Figure 2B.--Stream where vegetation was used to identify bankfull stage, Boise River near Twin Springs, Idaho. (Arrow shows beginning of flood plain)

Figure 2C.--Stream where vegetation was used to identify bankfull stage, Little Wood River Above High Five Creek near Carey, Idaho.
(Arrow shows beginning of flood plain)

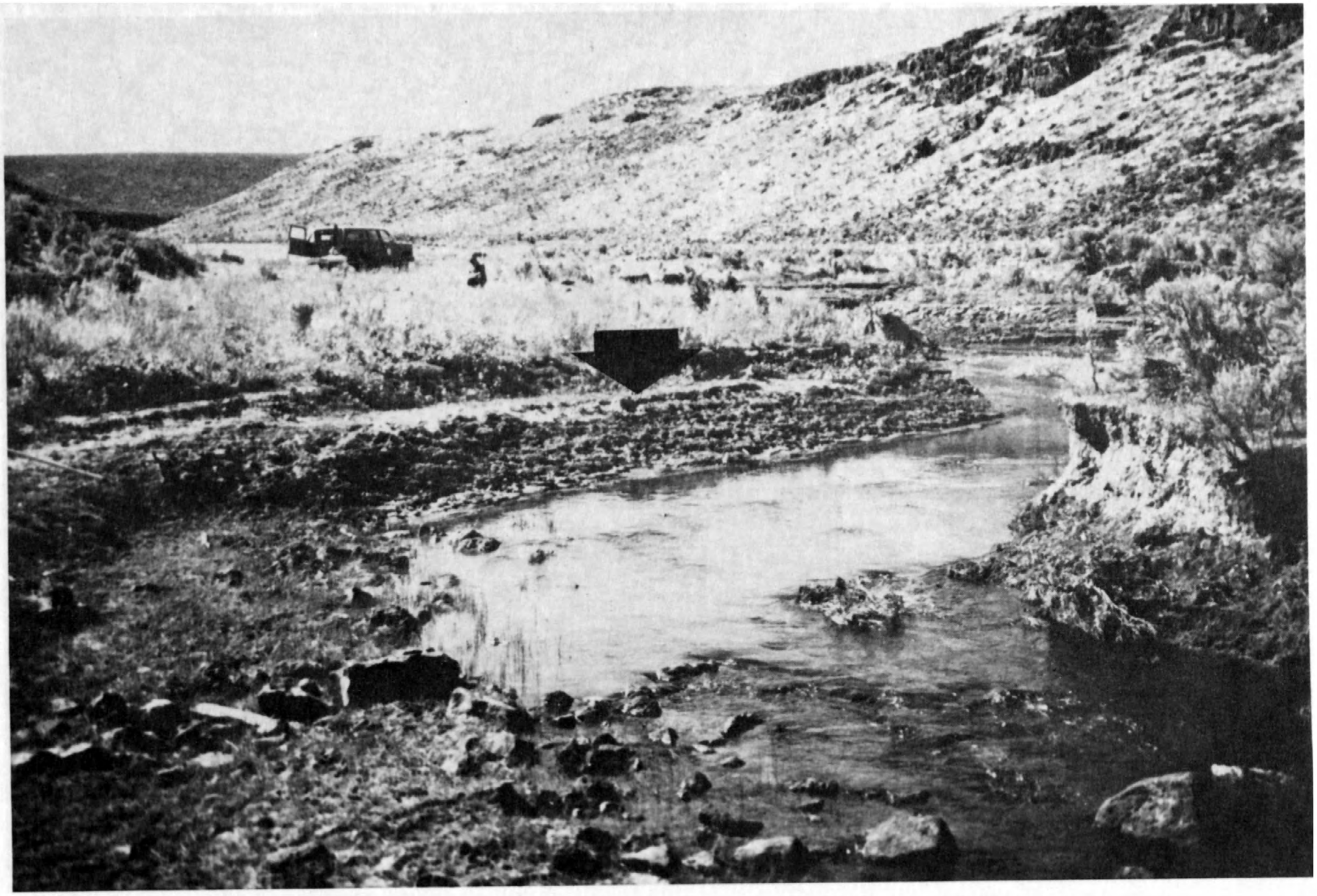


Figure 2D.--Stream where vegetation was used to identify bankfull stage, East Fork Bruneau River Near Hot Springs, Idaho.
(Arrow shows beginning of flood plain)

To establish bankfull stage at a site, the vertical difference in elevation between the water surface at the time of visit and the features that identified bankfull stage were measured at 5 to 10 points along the stream in the vicinity of the gage. The mean difference was then determined and added to the gage height to obtain bankfull stage. The 136 gage sites where bankfull stage was established are listed in table 1. Bankfull stage was not identified at five of the stations listed in table 1. Data from these stations were used in regressions involving basin characteristics only.

Office Procedures

For each site, bankfull stage (SB), measured in the field, was used to determine bankfull discharge (QB) from the latest stage-discharge relation for the gaging station (see example in fig. 3). Then an estimate of the recurrence interval for bankfull discharge was obtained from the flood-frequency relation for the gaging station (fig. 4). Bankfull stage, bankfull discharge, and recurrence interval for bankfull discharge are summarized in table 2.

Discharge-measurement data (fig. 5) for the last 5 years of record at each site were examined, and high-discharge measurements were randomly selected for plotting the width, area, depth, and velocity versus discharge. Measurements affected by anomalous conditions caused by ice, debris, or extreme moss buildup in the channel were purposefully excluded from the data. Enough measurements were chosen to cover at least one log cycle (a discharge range of a multiple of 10) on the discharge axis of graph paper. Least-squares fits using discharge as the independent variable and width, area, depth, and velocity as the dependent variables, were made and the curves plotted, as shown in figure 6. Bankfull discharge was used to determine values of bankfull width, area, depth, and velocity from the curves.

The curves for North Fork Payette River at Cascade, Idaho, in figure 6, have a break in slope at about the bankfull discharge level, as do some of the curves for other sites. For this site and for the others, least-squares determinations were made separately on the lower and upper legs of the curves. The break in slope indicates that a flood plain is present at the discharge-measurement site.

The stage-discharge relation for North Fork Payette River at Cascade (fig. 3) does not show evidence of a flood plain because the section of the river that controls the stage-discharge relation for the gaging station is at a

Table 1. Stations used in computer runs

STATION	
10039500	BEAR RIVER AT BORDER, WY
10040000	THOMAS FK NR GENEVA, ID
10040500	SALT CR NR GENEVA, ID
10041000	THOMAS FORK NEAR WYOMING-IDAHO STATE LINE
10047500	MONTPELIER CR AT WEIR, NR MONTPELIER, ID
10058600	BLOOMINGTON C AT BLOOMINGTON, ID
10072800	EIGHTMILE CREEK NEAR SODA SPRINGS, ID
10076400	SODA CR AT FIVEMEADOWS NR SODA SPRINGS, ID
12305500	BOULDER CREEK NEAR LEONIA, ID
12306500	MOYIE RIVER AT EASTPORT, ID
12307500	NOYIE RIVER AT EILEEN, ID
12310800	TRAIL CREEK AT NAPLES, ID
12311000	DEEP CREEK AT MORAVIA, ID
12316800	MISSION CREEK NEAR COPELAND, ID
12321500	BOUNDARY CREEK NEAR PORTHILL, ID
12392000	CLARK FORK AT WHITEHORSE RPD NR CABINET, ID
12392300	PACK RIVER NEAR COLBURN, ID
12393600	BINARCH CREEK NEAR COOLIN, ID
12394000	PRIEST RIVER NEAR COOLIN, ID
12395000	PRIEST RIVER NEAR PRIEST RIVER, ID
12411000	COEUR D'ALENE R AB SHN CR, NR PRICHARD, ID
* 12413100	BOULDER CREEK AT MULLAN, ID
12413140	PLACER CREEK AT WALLACE, ID
12413200	MONTGOMERY CREEK NEAR KELLOGG, ID
12414500	ST. JOE RIVER AT CALDER, ID
12414900	ST. MARIES RIVER NEAR SANTA, ID
12415000	ST. MARIES RIVER AT LOTUS, ID
12415200	PLUMMER CREEK TRIBUTARY AT PLUMMER, ID
12416000	HAYDEN CR BELOW N FORK, NR HAYDEN LAKE, ID
12419000	SPOKANE RIVER NEAR POST FALLS, ID
13011000	SNAKE RIVER AT MORAN, WY
13011500	PACIFIC CREEK AT MORAN, WY
13011900	BUFFALO FORK ABOVE LAVA CR, NR MORAN, WY
13022500	SNAKE R AB RESERVOIR NEAR ALPINE, WY
13023000	GREYS RIVER ABOVE RESERVOIR, NR ALPINE, ID
13027500	SALT R ABOVE RESERVOIR, NEAR ETNA, WY
13029500	MCCOY CREEK AB RESERVOIR, NEAR ALPINE, ID
13030000	INDIAN CREEK AB RESERVOIR, NEAR ALPINE, ID
13030500	ELK CREEK ABOVE RESERVOIR, NEAR IRWIN, ID
13032000	BEAR CREEK ABOVE RESERVOIR, NEAR IRWIN, ID
13032500	SNAKE RIVER NEAR IRWIN, ID
13037500	SNAKE R NR HEISE, ID
13038900	TARGHEE CREEK NEAR MACKS INN, ID
13039500	HENRYS FORK NEAR LAKE, ID
13042500	HENRYS FORK NR ISLAND PARK, ID
13046000	HENRYS FORK NEAR ASHTON, ID
13047500	FALLS RIVER NEAR SQUIRREL, ID
13049500	FALLS RIVER NEAR CHESTER, ID
13050500	HENRYS FORK AT ST ANTHONY, ID
13052200	TETON RIVER AB S LEIGH CR, NR DRIGGS, ID
13055000	TETON RIVER NEAR ST ANTHONY, ID
13056500	HENRYS FORK NEAR REXBURG, ID
13058000	WILLOW CREEK NEAR RIRIE, ID

Table 1. Stations used in computer runs (Continued)

STATION	
13060000	SNAKE RIVER NEAR SHELLEY, ID
13062700	ANGUS CREEK NEAR HENRY, ID
13063000	BLACKFOOT R ABOVE RESERVOIR, NR HENRY, ID
13068500	BLACKFOOT RIVER NEAR BLACKFOOT, ID
13069500	SNAKE RIVER NEAR BLACKFOOT, ID
13072000	PORTNEUF RIVER NEAR PEBBLE, ID
13073000	PORTNEUF RIVER AT TOPAZ, ID
13075000	MARSH CREEK NEAR MCCAMMON, ID
13075300	EAST FORK MINK CREEK NEAR POCATELLO, ID
13075500	PORTNEUF RIVER AT POCATELLO, ID
13079000	CLEAR CREEK NEAR NAF, ID
13079100	CASSIA CREEK AB STINSON CREEK NR ELBA, ID
13082300	MARSH CREEK NEAR ALBION, ID
13082500	GOOSE CR ABOVE TRAPPER CR, NR OAKLEY, ID
13083000	TRAPPER CREEK NEAR OAKLEY, ID
13092000	ROCK CREEK NEAR ROCK CREEK, ID
13105000	SALMON FALLS CREEK NR SAN JACINTO, NV
13112000	CAMAS CREEK AT CAMAS, ID
13113000	BEAVER CREEK AT SPENCER, ID
13114000	BEAVER CREEK AT CAMAS, ID
13117300	SAWMILL CREEK NEAR GOLDBURG, ID
13118700	LITTLE LOST RIVER BE WET CREEK NR HOWE, ID
13120000	BIG LOST R AT WILD HORSE, NEAR CHILLY, ID
13120500	BIG LOST R AT HOWELL RANCH, NR CHILLY, ID
13130900	AMTELOPE C AB WILLOW C NR DARLINGTON, ID
* 13135500	BIG WOOD RIVER NEAR KETCHUM, ID
13141000	BIG WOOD RIVER NEAR BELLEVUE, ID
* 13141500	CAMAS CREEK NEAR BLAINE, ID
13147900	LITTLE WOOD R AB HIGH 5 CR, NR CAREY, ID
13151000	LITTLE WOOD RIVER NEAR RICHFIELD, ID
13154000	CLOVER CREEK NEAR BLISS, ID
13154500	SNAKE RIVER AT KING HILL, ID
13155300	L CANYON CR AT STOUT, NR GLENNS FERRY, ID
13161500	BRUNEAU RIVER AT ROWLAND, NV
13162500	EAST FORK JARBIDGE R NR THREE CREEK, ID
13167500	E FORK BRUNEAU RIVER NR HOT SPRING, ID
* 13168500	BRUNEAU RIVER NEAR HOT SPRING, ID
13178000	JORDAN C AB LN TREE C NR JORDAN VALLEY, OR
13185000	BOISE RIVER NEAR TWIN SPRINGS, ID
* 13186000	SOUTH FORK BOISE RIVER NR FEATHERVILLE, ID
13235000	SOUTH FORK PAYETTE RIVER AT LOWMAN, ID
13239000	NORTH FORK PAYETTE RIVER AT MCCALL, ID
13240000	LAKE F PAYETTE R AB JUMBO C, NR MCCALL, ID
13243500	GOLD FORK RIVER NEAR ROSEBERRY, ID
13245000	NORTH FORK PAYETTE R AT CASCADE, ID
13246000	NORTH FORK PAYETTE RIVER NR BANKS, ID
13247500	PAYETTE RIVER NEAR HORSESHOE BEND, ID
13250600	BIG WILLOW CREEK NEAR EMMETT, ID
13251300	WEST BRANCH WEISER RIVER NR TAMARACK, ID
13251500	WEISER RIVER AT TAMARACK, ID
13258500	WEISER RIVER NEAR CAMBRIDGE, ID
13261000	LITTLE WEISER RIVER NEAR INDIAN VALLEY, ID
13265500	CRANE CREEK AT MOUTH NEAR WEISER, ID
13266000	WEISER RIVER NEAR WEISER, ID
13269000	SNAKE RIVER AT WEISER, ID

Table 1. Stations used in computer runs (Continued)

STATION	
13292400	BEAVER CREEK NEAR STANLEY,ID
13295000	VALLEY CREEK AT STANLEY, ID
13295500	SALMON R BELOW VALLEY CR, AT STANLEY, ID
13296000	YANKEE FORK SALMON RIVER NEAR CLAYTON, ID
13296500	SALMON R BELOW YANKEE FORK, NR CLAYTON, ID
13297100	PEACH CREEK NEAR CLAYTON,ID
13297300	HOLMAN CREEK NEAR CLAYTON, ID
13298000	EAST FORK SALMON RIVER NEAR CLAYTON, ID
13298500	SALMON RIVER NEAR CHALLIS, ID
13302500	SALMON RIVER AT SALMON, ID
13307000	SALMON RIVER NEAR SHOUP, ID
13308500	MIDDLE FORK SALMON RIVER NEAR CAPEHORN, ID
13310700	S FK SALMON R NR KASSEL R S,ID
13313000	JOHNSON CREEK AT YELLOW PINE, ID
13316500	LITTLE SALMON RIVER AT RIGGINS, ID
13317000	SALMON RIVER AT WHITE BIRD, ID
13336100	MEADOW CREEK NEAR LOWELL,ID
13336500	SELWAY RIVER NEAR LOWELL, ID
13336600	SWIFTWATER CREEK NEAR LOWELL, ID
13336850	WEIR CREEK NEAR POWELL RANGER STATION, ID
13337000	LOCHSA RIVER NEAR LOWELL, ID
13337500	SOUTH FORK CLEARWATER R NEAR ELK CITY, ID
13337700	PEASLEY CREEK NEAR GOLDEN, ID
13338200	SALLY ANN CREEK NEAR STITES, ID
13338500	SOUTH FORK CLEARWATER RIVER AT STITES, ID
13339700	CANAL GULCH CR AT PIERCE RANGER STA, ID
13340500	N F CLEARWATER RIVER AT BUNGALOW R S, ID
13340600	NORTH FORK CLEARWATER R AT CANYON R S,ID
13341300	BLOOM CREEK NEAR BOVILL, ID
13341400	EAST FORK POTLATCH RIVER NEAR BOVILL, ID
13341500	POTLATCH RIVER NEAR KENDRICK, ID
13344800	DEEP CREEK NEAR POTLATCH, ID
13345000	PALOUSE RIVER NEAR POTLATCH, ID

*Stations at which bankfull stage was not identified

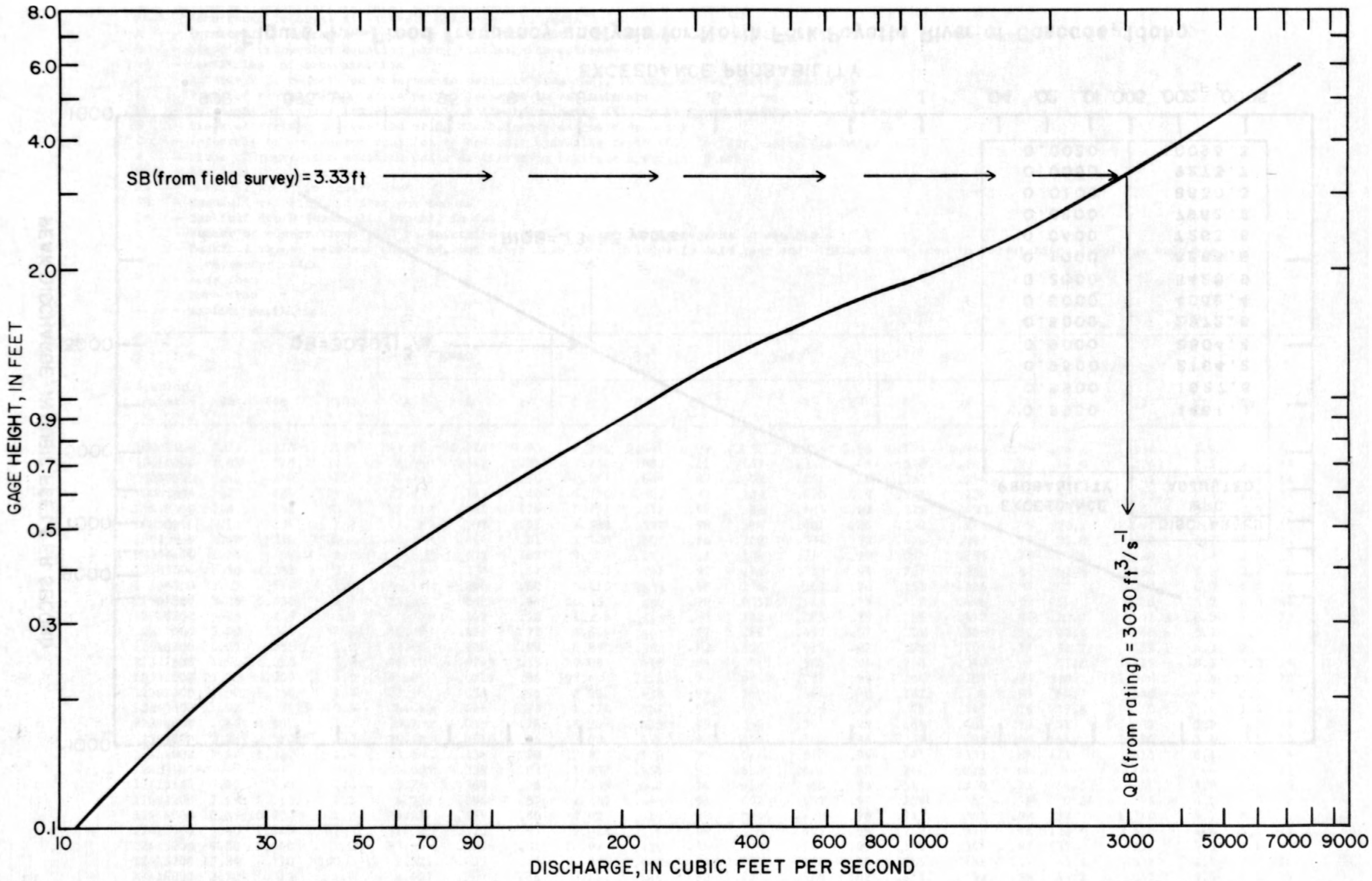
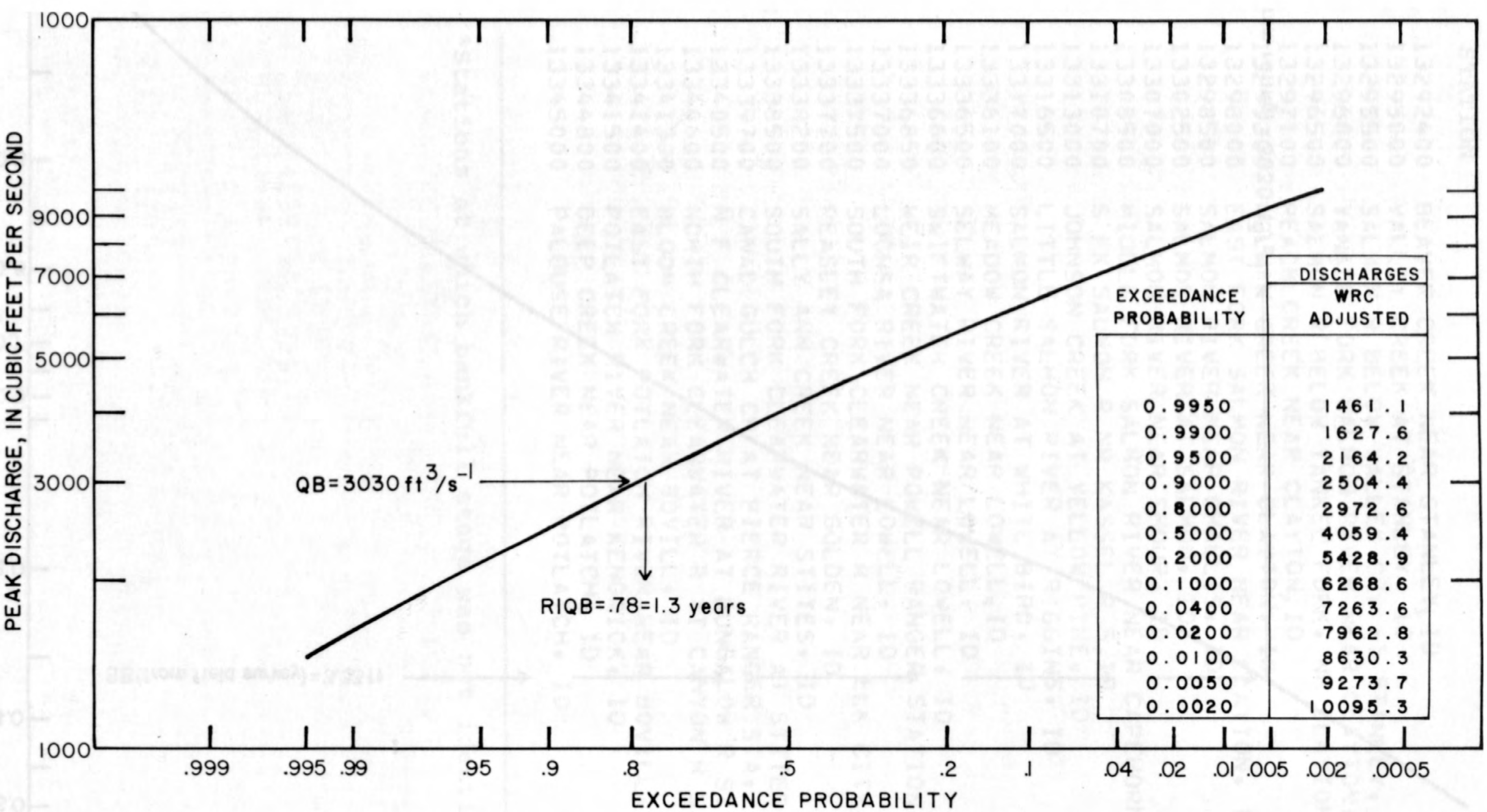


Figure 3.--Stage-discharge rating curve for North Fork Payette River at Cascade, Idaho.



EXCEEDANCE PROBABILITY	DISCHARGES WRC ADJUSTED
0.9950	1461.1
0.9900	1627.6
0.9500	2164.2
0.9000	2504.4
0.8000	2972.6
0.5000	4059.4
0.2000	5428.9
0.1000	6268.6
0.0400	7263.6
0.0200	7962.8
0.0100	8630.3
0.0050	9273.7
0.0020	10095.3

Figure 4.--Flood frequency analysis for North Fork Payette River at Cascade, Idaho.

Table 2. Station summary of channel-geometry data

Station number - Gaging-station number
SB - Bankfull stage, in feet above gage datum
QB - Bankfull discharge, in cubic feet per second
RIQB - Recurrence interval of bankfull discharge, in years
A - Intercept of regression equation to estimate width (W), in feet, using discharge (Q), in cubic feet per second
B - Slope of regression equation using discharge to estimate width
r^2 - Coefficient of determination
G - Intercept of regression equation to estimate area (AR), in square feet, using discharge
H - Slope of regression equation using discharge to estimate area
K - Intercept of regression equation to estimate velocity (V), in feet per second, using discharge
M - Slope of regression equation using discharge to estimate velocity
C - Intercept of regression equation to estimate hydraulic depth (D), in feet, using discharge
F - Slope of regression equation using discharge to estimate hydraulic depth
WB - Bankfull width, in feet
AB - Bankfull area, in square feet
VB - Bankfull velocity, in feet per second
DB - Bankfull depth (hydraulic depth), in feet
n - Number of observations used to determine values of constants in regression equations
* - Bankfull values were not computed, but other data were included in data base and stations were used in computations involving only basin characteristics
< - Less than
> - More than
-- - No data available

				$W=AQ^B$			$AR=GQ^H$			$V=KQ^M$			$D=CQ^F$							
Station number	SB	QB	RIQB	A	B	r^2	G	H	r^2	K	M	r^2	C	F	r^2	WB	AB	VB	DB	n
10039500	6.23	1,810	1.8	44.26	0.174	0.90	7.264	0.641	0.99	0.132	0.358	0.96	0.174	0.464	0.99	164	934	1.9	5.7	16
10040000	2.85	518	30	6.260	.312	.71	1.766	.683	.81	.567	.317	.48	.310	.343	.83	44.0	126	4.1	2.6	13
10040500	3.45	160	2	4.743	.353	.76	1.661	.646	.87	.602	.354	.66	.350	.294	.71	28.5	44.2	3.6	1.6	14
10041000	2.7	450	25	17.43	.123	.40	9.090	.381	.97	.109	.620	.99	.521	.258	.76	36.9	93.2	4.8	2.5	14
10047500	2.6	140	<5	12.22	.081	.79	3.271	.512	.98	.306	.486	.97	.271	.430	.97	18.3	41.7	3.4	2.3	14
10058600	3.12	104	1.3	7.382	.303	.91	2.588	.592	.96	.384	.401	.86	.352	.288	.78	30.1	40.4	2.5	1.3	11
10072800	2.88	290	>500	3.335	.404	.81	1.430	.665	.86	.700	.334	.60	.426	.262	.77	33.0	62.1	4.7	1.9	14
10076400	1.76	48	1.2	8.653	.132	.62	9.327	.289	.96	.106	.714	.99	1.081	.156	.77	14.4	28.6	1.7	2.0	13
12305500	4.90	1,385	2.5	21.31	.138	.67	5.055	.481	.93	.198	.519	.94	.237	.343	.82	57.8	164	8.5	2.8	14
12306500	8.07	4,870	1.6	24.11	.251	.60	3.615	.638	.88	.276	.363	.70	.151	.386	.94	203	813	6.0	4.0	12
12307500	5.26	5,880	1.7	83.04	.0815	.94	10.48	.487	.99	.0952	.512	.99	.128	.404	.99	168	718	8.2	4.3	16
12310800	9.76	248	3.1	8.279	.202	.28	1.390	.615	.89	.719	.385	.75	.169	.412	.82	25.2	41.3	6.0	1.6	17
12311000	5.00	216	<1.01	20.99	.135	.72	4.646	.501	.97	.216	.499	.97	.221	.366	.92	43.4	68.6	3.2	1.6	24
12316800	4.19	255	1.2	12.06	.186	.89	6.893	.388	.82	.146	.612	.92	.575	.201	.57	33.7	59.1	4.3	1.7	23
12321500	4.56	1,860	1.8	40.70	.0749	.35	10.08	.415	.89	.0989	.586	.94	.248	.340	.92	71.5	229	8.1	3.2	14
12392000	23.20	90,000	1.9	163.6	.0729	.96	505.4	.274	.96	.00196	.727	.99	3.106	.201	.95	376	11,540	7.8	31.0	13
12392300	9.90	2,210	1.4	20.96	.138	.95	3.801	.638	.99	.260	.364	.98	.182	.500	.99	60.7	518	4.3	8.5	12
12393600	11.92	71.5	1.9	4.419	.326	.73	1.214	.667	.91	.823	.335	.72	.275	.341	.70	17.8	20.9	3.4	1.2	21
12394000	6.64	4,890	1.2	90.70	.060	.76	18.38	.449	.99	.0544	.551	.99	.184	.401	.98	151	832	5.9	5.5	13
12395000	7.26	7,510	3.3	98.18	.0610	.96	23.00	.459	.98	.0431	.542	.98	.235	.398	.98	169	1,380	5.4	3.3	13
12411000	5.98	5,460	1.6	53.64	.134	.90	12.87	.488	.93	.0778	.512	.94	.241	.353	.89	171	855	6.4	5.0	14
12413100*	--	--	--	6.004	.238	.62	1.457	.555	.92	.685	.445	.88	.242	.318	.64	--	--	--	--	17
12413140	3.20	330	1.6	5.240	.369	.76	1.638	.640	.94	.610	.360	.83	.314	.270	.72	44.5	66.9	4.9	1.5	9
12413200	2.99	53.4	1.5	6.356	.0946	.57	1.449	.446	.96	.692	.552	.97	.229	.352	.96	9.26	8.54	6.2	.9	8
12414500	10.59	10,000	1.2	59.21	.159	.86	14.42	.520	.98	.0696	.479	.98	.243	.361	.97	257	1,740	5.7	6.8	12
12414900	7.60	2,440	1.6	31.72	.170	.97	7.918	.539	.99	.126	.461	.99	.249	.370	.98	120	532	4.6	4.4	12
12415000	4.50	2,660	1.2	63.38	.0926	.81	10.91	.486	.98	.0982	.514	.99	.161	.394	.97	132	471	5.6	3.6	11
12415200	13.84	770	>500	2.521	.435	.64	.839	.898	.84	1.205	.116	.10	.336	.461	.47	45.4	328	2.6	7.2	10
12416000	3.72	313	1.8	8.697	.287	.81	3.581	.484	.80	.281	.514	.82	.412	.197	.39	45.2	57.7	5.4	1.3	14

Table 2. Station summary of channel-geometry data (Continued)

Station number	SB	QB	RIQB	W=AQ^B A	B	r²	AR=GQ^H G	H	r²	V=KQ^M K	M	r²	D=CQ^F C	F	r²	WB	AB	VB	DB	n
12419000	13.55	10,500	1.02	59.59	0.175	0.99	3.148	0.689	0.98	0.318	0.310	0.93	0.0529	0.515	0.98	300	1,860	5.6	6.2	14
13011000	8.75	7,600	1.9	120	.0708	.76	.0634	.532	.99	.131	.397	.97	2.66	.60	.99	226	567	4.6	7.4	13
13011500	5.35	1,890	1.2	27.31	.162	.67	3.739	.594	.95	.267	.406	.89	.151	.419	.91	92.5	331	5.7	3.6	22
13011900	6.70	4,120	1.7	87.28	.0827	.57	1.650	.772	.96	.292	.323	.93	.0628	.532	.93	174	1,020	4.3	5.3	12
13022500	9.25	17,410	1.8	157.0	.0475	.98	13.25	.518	.99	.0823	.472	.99	.0847	.470	.99	250	2,070	8.3	8.3	13
13023000	4.60	3,370	1.9	21.54	.201	.80	4.801	.558	.99	.206	.444	.98	.222	.357	.92	110	445	7.6	4.0	19
13027500	4.00	2,160	2.0	117.0	.0465	.46	8.089	.547	.97	.125	.452	.95	.0837	.472	.96	167	539	4.0	3.2	20
13029500	4.30	570	1.3	7.390	.269	.96	3.270	.556	.99	.473	.377	.97	.438	.288	.93	40.8	111	5.2	2.7	7
13030000	4.3	320	1.3	8.728	.0934	.59	1.194	.591	.95	.861	.403	.91	.137	.497	.98	15.0	36.1	8.8	2.4	12
13030500	3.80	450	1.8	10.84	.126	.56	.666	.754	.97	1.531	.242	.77	.0613	.629	.97	23.3	66.9	6.7	3.1	14
13032000	4.85	500	1.7	23.08	.903	.70	5.255	.445	.96	.191	.554	.97	.258	.329	.91	40.5	83.5	6.0	2.0	15
13032500	10.00	15,800	1.2	164.2	.0757	.98	4.994	.632	.99	.220	.358	.99	.304	.556	.99	341	2,250	7.0	6.5	17
13037500	6.00	15,500	1.1	211.7	.0636	.97	9.156	.579	.99	.109	.421	.99	.0431	.516	.99	391	2,450	6.3	6.2	21
13038900	5.60	56	<1.01	4.724	.392	.72	1.691	.637	.80	.592	.363	.56	.356	.246	.32	22.9	22.0	2.6	1.0	18
13039500	2.30	340	1.9	.998	.736	.84	2.033	.705	.96	.450	.304	.54	.0757	.579	.94	72.7	124	2.6	2.2	16
13042500	5.00	2,300	7.7	89.68	.0333	.87	4.995	.596	.99	.197	.406	.99	.109	.466	.96	117	506	4.6	4.0	21
13046000	7.40	5,000	8.9	149.1	.0384	.69	24.01	.410	.98	.0408	.592	.99	.165	.368	.97	207	788	6.3	3.8	14
13047500	3.60	3,050	1.5	111.3	.0390	.62	8.883	.502	.96	.117	.492	.99	.0799	.462	.96	152	497	6.1	3.3	17
13049500	4.50	2,700	1.3	7.558	.0717	.77	15.59	.439	.99	.0641	.560	.99	.232	.349	.99	133	500	5.4	3.7	17
13050500	5.40	4,550	1.5	189.9	.0297	.80	15.53	.494	.98	.0638	.507	.98	.0830	.462	.99	244	993	4.6	4.1	19
13052200	3.20	1,340	1.8	68.58	.163	.42	3.420	.704	.94	.291	.297	.78	.0495	.542	.83	222	542	2.5	2.4	23
13055000	5.80	3,200	1.9	12.04	.286	.62	1.935	.708	.98	.616	.271	.83	.161	.421	.68	122	585	5.5	4.8	7
13056500	8.80	7,250	3.3	12.75	.384	.40	21.61	.536	.92	.0467	.463	.90	1.704	.151	.15	386	2,520	2.9	6.5	11
13058000	13.00	1,720	2.0	12.11	.214	.93	7.842	.519	.99	.130	.478	.99	.647	.305	.99	60.1	379	4.6	6.3	7
13060000	11.50	22,800	3.2	246.41	.0669	.91	4.512	.670	.99	.243	.320	.96	.0181	.604	.99	482	3,750	6.0	7.7	10
13062700	8.81	66.6	1.01	4.578	.412	.72	1.353	.780	.94	.742	.218	.57	.295	.368	.91	25.8	35.8	1.9	1.4	14
13063000	4.35	398	1.01	6.612	.406	.94	1.930	.769	.99	.519	.231	.93	.292	.363	.95	75.0	192	2.1	2.6	11
13068500	5.04	580	1.7	12.24	.208	.75	1.380	.759	.83	.721	.242	.33	.112	.552	.66	46.1	1,530	3.4	3.8	13
13069500	9.97	19,600	2.1	148.84	.0722	.21	26.94	.476	.93	.0360	.527	.94	.180	.405	.95	304	2,990	6.6	9.8	10
13072000	4.1	552	3.7	40.60	.0341	.12	3.774	.572	.95	.162	.503	.42	.0386	.682	.41	50.4	139	3.9	2.9	18
13073000	5.02	762	5.4	39.50	.0449	.54	25.15	.370	.94	.0395	.631	.98	.637	.325	.94	53.2	293	2.6	5.5	11
13075000	4.76	247	1.5	30.37	.0543	.34	2.589	.695	.95	.400	.297	.78	.0847	.643	.98	41.0	120	2.1	2.9	8
13075300	5.81	26.1	2.0	5.524	.153	.81	.978	.642	.99	1.024	.355	.96	.177	.490	.97	9.09	7.94	3.3	.9	11
13075500	5.5	650	1.7	16.48	.202	.93	3.279	.678	.99	.316	.316	.93	.199	.476	.97	61.0	265	2.5	4.3	11
13079000	2.75	274	1.8	8.708	.231	.67	3.091	.458	.88	.324	.542	.91	.355	.227	.66	31.8	40.4	6.8	1.3	48
13079100	2.13	27.4	1.8	4.072	.336	.81	1.455	.573	.93	.685	.428	.87	.355	.238	.56	12.4	9.70	2.8	.8	11
13082300	4.03	64	1.1	7.282	.187	.20	4.517	.435	.59	.219	.567	.71	.616	.247	.28	15.9	27.6	2.3	1.7	10
13082500	4.46	480	5.0	9.269	.216	.54	2.493	.631	.95	.400	.370	.87	.269	.415	.93	35.1	122	3.9	3.5	23
13083000	6.00	175	36	5.201	.266	.63	2.191	.546	.86	.457	.454	.82	.423	.278	.48	20.6	36.8	4.8	1.8	19
13092000	3.08	243	2.9	11.048	.170	.40	3.170	.527	.93	.339	.446	.66	.305	.336	.57	28.1	57.4	3.9	2.0	24
13105000	6.42	339	1.2	2.946	.545	.92	.928	.820	.99	.929	.212	.70	.246	.326	.87	70.7	110	3.2	1.6	18
13112000	4.31	325	1.8	8.151	.373	.76	1.318	.828	.90	.761	.171	.27	.161	.456	.79	70.4	159	2.0	2.2	16
13113000	4.77	286	1.8	7.859	.305	.55	2.425	.602	.83	.413	.397	.82	.248	.350	.79	44.0	73.1	3.9	1.8	15
13114000	3.39	152	4.0	12.42	.141	.58	6.051	.397	.85	.166	.602	.93	.485	.257	.76	25.2	44.5	3.4	1.8	20
13117300	4.30	770	47	10.98	.208	.61	4.390	.450	.87	.227	.550	.91	.397	.243	.72	43.8	87.4	8.8	2.0	14
13118700	3.10	229	1.4	12.06	.196	.69	4.112	.474	.91	.244	.525	.92	.343	.277	.72	35.0	54.1	4.2	1.5	14
13120000	3.56	388	1.04	19.10	.114	.55	5.064	.477	.97	.198	.523	.97	.201	.402	.52	37.7	87.1	4.5	2.2	19
13120500	4.31	2,250	2.4	50.14	.0834	.78	5.432	.529	.98	.179	.476	.98	.114	.426	.82	95.4	322	7.1	3.0	20
13130900	3.78	314	1.1	5.252	.361	.73	1.989	.636	.92	.252	.507	.81	.378	.276	.81	41.8	77.0	4.7	1.8	12
13135500*	--	--	--	27.92	.0995	.83	7.212	.440	.99	.139	.560	.99	.258	.341	.99	--	--	--	--	14
13141000	5.58	2,240	3.5	7.845	.431	.82	3.828	.583	.84	.314	.382	.76	.405	.187	.68	219	344	6.0	1.7	11
13141500*	--	--	--	5.573	.410	.96	.505	.884	.99	1.984	.116	.68	.0632	.524	.95	--	--	--	--	17
13147900	4.08	740	1.6	26.49	.101	.85	4.720	.496	.99	.212	.503	.99	.178	.396	.97	51.5	125	5.9	2.4	20
13151000	4.12	455	4.0	29.01	.0881	.36	5.183	.506	.97	.212	.478	.97	.168	.428	.91	49.7	115	4.0	2.3	14

Table 2. Station summary of channel-geometry data (Continued)

Station number	SB	QB	RIQB	W=AQ^B A	B	r^2	AR=GQ^H G	H	r^2	V=KQ^M K	M	r^2	D=CQ^F C	F	r^2	WB	AB	VB	DB	n
13154000	11.37	380	1.1	13.26	0.220	0.49	0.817	0.845	0.97	1.223	0.155	0.51	0.613	0.626	0.86	49.1	124	3.1	2.5	14
13154500	9.42	17,650	1.3	79.25	.154	.85	36.54	.472	.99	.0327	.511	.98	.522	.304	.93	358	3,670	4.8	10.2	19
13155300	3.36	96	2.4	14.81	.123	.81	2.634	.533	.99	.379	.468	.98	.180	.407	.97	26.0	30.0	3.2	1.2	11
13161500	5.82	611	1.7	22.08	.109	.84	1.200	.765	.96	.803	.241	.67	.0544	.656	.94	44.4	162	3.8	3.7	21
13162500	5.32	403	1.7	16.63	.149	.77	3.430	.496	.95	.291	.504	.96	.206	.348	.95	40.5	67.4	6.0	1.7	15
13167500	4.46	249	2.8	12.39	.175	.39	1.919	.704	.94	.520	.296	.72	.155	.529	.86	32.4	93.3	2.7	2.9	18
13168500*	--	--	--	57.63	.0555	.36	3.523	.603	.96	.274	.965	.93	.0667	.522	.57	--	--	--	--	17
13178000	7.30	1,870	1.9	16.64	.230	.84	2.258	.676	.98	.441	.324	.94	.136	.446	.96	94.1	377	5.1	3.9	15
13185000	8.25	6,805	2.2	49.28	.136	.28	5.499	.575	.99	.182	.425	.98	.174	.375	.94	163	879	7.7	4.8	16
13186000*	--	--	--	47.51	.122	.77	8.047	.524	.99	.124	.476	.99	.169	.402	.98	--	--	--	--	13
13235000	5.25	3,080	1.1	72.38	.101	.64	12.98	.460	.98	.0777	.538	.98	.182	.357	.96	163	523	5.9	3.2	14
13239000	4.55	1,260	<1.01	32.00	.169	.94	10.57	.486	.98	.0953	.512	.98	.330	.318	.97	107	340	3.7	3.2	15
13240000	5.38	316	<1.01	38.29	.0876	.58	5.684	.579	.98	.172	.424	.97	.148	.491	.96	63.4	159	2.0	2.5	12
13243500	4.31	808	1.03	34.87	.0426	.83	5.386	.536	.99	.187	.463	.99	.154	.494	.99	46.4	195	4.1	4.2	9
13245000	3.33	3,030	1.3	132.7	.0511	.85	14.00	.542	.98	.0608	.478	.98	.153	.441	.98	200	1,080	2.8	5.3	13
13246000	10.98	5,330	≈3.6	90.84	.070	.94	14.46	.520	.98	.0672	.484	.98	.159	.450	.98	166	1,250	4.3	7.5	16
13247500	11.51	12,370	~1.8	131.8	.0680	.83	24.57	.473	.99	.0411	.526	.99+	.186	.405	.99	250	2,120	5.8	8.5	17
13250600	5.17	598	1.3	14.34	.156	.64	4.120	.496	.96	.236	.502	.93	.288	.339	.88	38.9	97.9	5.8	2.5	13
13251300	3.67	34.5	1.9	6.352	.0894	.27	2.496	.539	.80	.240	.646	.57	.395	.440	.88	8.72	16.8	2.4	1.9	15
13251500	2.41	34.6	<1.01	5.074	.369	.83	2.328	.658	.91	.433	.340	.74	.459	.289	.64	18.8	24.0	1.4	1.3	16
13258500	--	4,460	≈1.8	51.97	.0925	.85	10.68	.492	.99	.0951	.506	.99	.254	.370	.98	113	667	6.7	5.7	--
13261000	3.88	719	2.0	16.86	.192	.73	1.911	.660	.91	.523	.340	.74	.114	.466	.88	59.7	147	4.9	2.5	17
13265500	4.86	1,100	1.9	17.06	.248	.85	10.25	.442	.81	.119	.523	.85	.599	.195	.39	97.0	227	4.6	2.4	33
13266000	7.79	4,960	1.1	79.11	.0944	.52	14.74	.487	.99	.0680	.513	.99	.252	.356	.99	177	931	5.3	5.2	15
13269000	7.17	33,800	1.4	421.3	.0570	.75	18.94	.568	.99	.0529	.432	.99	.0488	.511	.99	763	7,060	4.8	9.2	14
13292400		[1]194	8.5	7.482	.305	.76	2.060	.557	.94	.534	.421	.94	.250	.274	.64	37.3	38.8	4.9	1.1	17
13295000		[1]1,000	3.1	59.52	.0409	.61	12.27	.396	.98	.0817	.603	.99	.205	.356	.96	78.9	190	5.3	2.4	11
13295500	3.2	2,750	1.7	83.48	.0906	.93	5.900	.560	.99	.170	.439	.99	.0704	.470	.98	171	499	5.5	2.9	16
13296000		[1]712	1.0	15.65	.162	.98	6.424	.487	.99	.155	.513	.99	.411	.324	.98	45.5	158	4.5	3.5	15
13296500		[1]3,740	1.3	26.33	.180	.98	9.889	.518	.99	.099	.484	.99	.376	.339	.99	115	703	5.3	6.1	11
13297100		[1]222	130	3.471	.397	.77	1.215	.565	.90	.824	.434	.85	.349	.168	.32	29.7	25.7	8.6	.9	17
13297300		[1]97.2	>500	4.132	.228	.83	.811	.608	.93	1.234	.391	.85	.197	.381	.81	11.7	13.1	7.4	1.1	13
13298000		[1]1,856	1.9	12.53	.308	.55	8.310	.437	.93	.120	.564	.96	.124	.464	.90	127	222	8.4	4.1	13
13298500		[1]5,500	1.3	47.36	.146	.94	7.488	.547	.99	.134	.453	.99+	.158	.402	.99	166	834	6.6	5.0	15
13302500	5.50	7,100	1.5	6.091	.402	.98	8.045	.530	.98	.124	.471	.98	1.324	.127	.78	215	881	8.1	4.1	15
13307000	7.9	11,300	1.5	75.93	.106	.98	25.01	.460	99	.0332	.559	.97	.329	.354	.98	204	1,830	6.2	9.0	14
13308500	5.25	1,320	1.4	15.52	.193	.92	8.780	.450	.99	.282	.406	.76	.562	.258	.94	62.0	224	5.2	3.6	8
13310700	6.46	2,800	1.2	49.94	.106	.96	8.952	.541	.99	.0984	.472	.90	.180	.434	.99	116	656	4.2	5.6	12
13313000	3.66	1,120	<1.01	21.36	.182	.94	4.088	.570	.99	.245	.429	.99	.191	.389	.98	76.5	224	5.0	2.9	9
13316500	4.97	1,200	<1.01	29.98	.118	.78	3.175	.591	.97	.320	.406	.93	.106	.473	.96	69.2	210	5.7	3.0	16
13317000	24.95	48,600	1.3	152.1	.0889	.68	9.615	.592	.99	.106	.406	.99	.132	.434	.99	397	5,740	8.5	14.4	12
13336100	6.35	4,400	1.7	53.70	.0866	.67	17.23	.390	.88	.0585	.608	.95	.320	.304	.82	111	454	9.6	4.1	30
13336500	10.66	23,900	1.7	167.7	.0619	.93	28.40	.455	.94	.0519	.507	.99	.117	.430	.99	313	2,790	8.6	8.9	31
13336600	13.18	70.9	1.9	8.878	.118	.53	2.210	.447	.93	.453	.552	.95	.249	.329	.86	14.7	14.9	4.8	1.0	22
13336850	16.72	137	1.1	4.131	.426	.92	1.978	.562	.86	.418	.470	.91	.298	.289	.74	33.6	31.4	4.2	1.2	17
13337000	9.25	16,840	1.6	129.5	.0725	.96	38.53	.424	.98	.0259	.576	.99	.297	.352	.99	262	2,390	7.0	9.1	15
13337500	4.7	1,400	1.3	41.20	.0722	.93	1.833	.493	.99	.147	.507	.99	.165	.422	.99	69.5	243	5.8	3.5	10
13337700	9.64	65.7	1.3	7.603	.183	.40	1.004	.687	.81	.995	.313	.48	.126	.505	.81	16.4	17.8	3.7	1.0	15
13338200	8.33	114	1.1	8.036	.135	.27	2.174	.423	.62	.460	.578	.75	.270	.288	.55	15.2	16.1	7.1	1.1	23
13338500	6.22	5,020	1.5	107.9	.0438	.93	3.818	.610	.99	.262	.390	.99	.0352	.567	.99	157	691	7.3	4.4	10
13339700	12.08	45.7	1.1	6.328	.247	.71	1.364	.695	.94	.734	.305	.75	.265	.345	.75	16.3	19.4	2.4	1.0	14
13340500	7.59	14,760	1.6	102.7	.0512	.83	41.78	.414	.99	.0240	.585	.99	.407	.363	.99	168	2,230	6.6	13.3	13
13340600	13.86	19,840	1.7	99.95	.107	.97	42.49	.424	.99	.0235	.576	.99	.424	.318	.99	287	2,830	7.0	9.8	12
13341300	2.97	118	11	5.345	.225	.68	1.795	.518	.94	.559	.481	.94	.336	.292	.83	15.6	21.2	5.6	1.4	13
13341400	4.13	496	1.4	16.45	.143	.50	6.938	.416	.96	.144	.584	.98	.420	.274	.76	40.1	91.9	5.4	2.3	14
13341500	9.93	6,080	1.9	32.60	.181	.66	16.10	.448	.92	.0622	.522	.95	.495	.267	.67	158	797	7.6	5.1	34
13344800	12.46	1,100	3.5	4.301	.392	.86	1.798	.653	.96	.331	.428	.99	.0567	.686	.97	67.0	174	6.6	6.9	9
13345000	12.55	2,990	1.4	36.57	.105	.73	4.392	.640	.98	.229	.360	.92	.120	.535	.94	84.4	734	4.1	8.7	12

[1]From Emmett (1975, p. A32, table 12).

FORM 9-207
(Rev. 11-69)

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)
DISCHARGE MEASUREMENT SUMMARY SHEET

Station No. 13245000

Discharge measurements of North Fork Payette River at Cascade, Idaho, during the year ending Sept. 30, 1971

No.	Date	Made by—	Width	Area	Mean velocity	Gage height	Discharge	Rating No. 5 Shift adj.	Rating No. 5 Percent diff.	Method	Number meas. sections	Gage height change	Time	Meas. rated	Water Temp. °C		REMARKS
	1970		Feet	Sq ft	Fps	Feet	Cfs	Feet				Feet	Hr				
332	Sep. 8	RAS	195	658	2.13	2.47	1400	-.06	0	.6 .2&.8	31	0	1.3	G	18.5		
333	Oct. 5	BBB	194	792	2.03	2.62	1610	-.06	+.6	.6 .2&.8	30	-.01	1.9	G	13.5		
334	Nov. 16	RAS	190	558	1.40	1.96	784	-.06	-.8	.6 .2&.8	26	0	.7	G	5.0		
335	Dec. 14	RAS	180	499	1.46	1.85	729	-.01	-.1	.6 .2&.8	25	0	1.	F	0.5		
336	1971 Jan 22	RAS	195	690	2.10	2.44	1450	0 Rating No. 6 -.06	+.7 0	.6 .2&.8	28	0	1.	G	1.0		
337	Feb 23	RAS	200	1110	2.86	3.42	3180	0	0	.2&.8	36	0	1.2	G	1.5		
338	Mar 22	RAS	232	1360	2.99	3.94	4060	0	-1.2	.6 .2&.8	33	-.01	1.2	G	3.0		
339	Apr 26	RAS	200	986	2.40	2.96	2370	0	+.4	.2&.8	32	+.02	1.2	G	3.0		
340	May 23	BBB	197	889	2.41	2.84	2140	0	-.5	.2&.8	30	0	1.4	G	12.0		
341	June 28	BBB	340	2390	2.96	5.80	7070	-.05	-.1	.6 .2&.8	45	+.01	2.5	G	14.0		
342	June 29	BBB	340	2380	3.00	5.78	7150	-.05	+.1	.6 .2&.8	45	0	2.5	G	–		
343	Sep 13	AWR & JH	195	800	2.02	2.58	1620	-.07	0	.6 .2&.8	28	0	1.8	G	19.0		
344	Oct 20	JH	188	529	1.43	1.78	758	0	-.1	.6 .2&.8	32	0	1.3	G	8.0		

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Figure 5.—Discharge measurement summary sheet. (Circled data are used for plotting hydraulic-geometry curves in figure 6)

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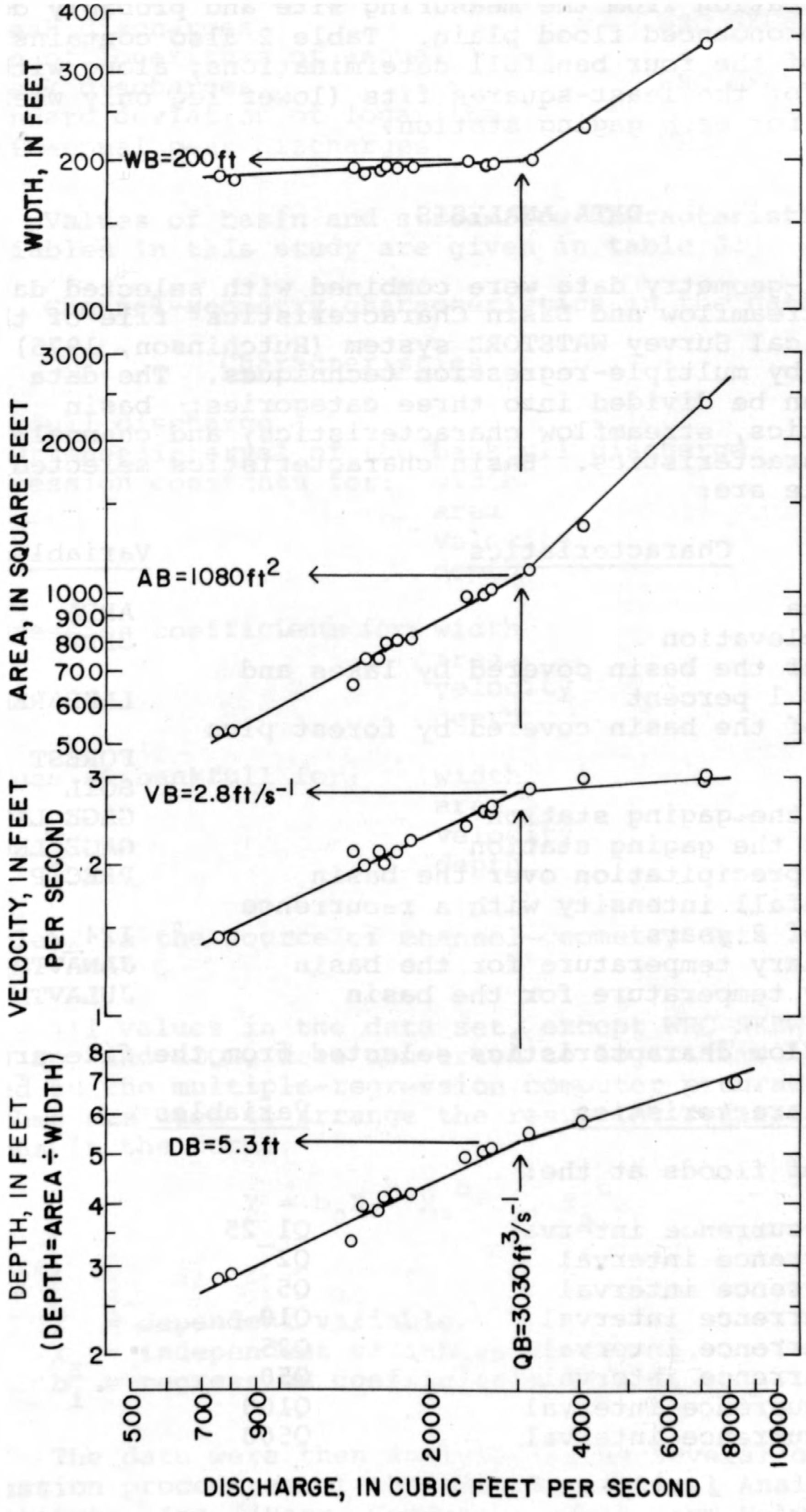

Figure 6.--Width, area, velocity, and depth versus discharge curves for North Fork Payette River at Cascade, Idaho.

different location from the measuring site and probably does not have a pronounced flood plain. Table 2 also contains the values of the four bankfull determinations, along with parameters for the least-squares fits (lower leg only where applicable) for each gaging station.

DATA ANALYSIS

Channel-geometry data were combined with selected data from the "Streamflow and Basin Characteristics" file of the U.S. Geological Survey WATSTORE system (Hutchinson, 1975) to be analyzed by multiple-regression techniques. The data base used can be divided into three categories: basin characteristics, streamflow characteristics, and channel-geometry characteristics. Basin characteristics selected from the file are:

Characteristics	Variables
Drainage area	AREA
Mean basin elevation	ELEV
Percentage of the basin covered by lakes and ponds plus 1 percent	LAKEAREA
Percentage of the basin covered by forest plus 1 percent	FOREST
Soils index	SOIL
Latitude of the gaging station	GAGE_LAT
Longitude of the gaging station	GAGE_LNG
Mean annual precipitation over the basin	PRECIP
24-hour rainfall intensity with a recurrence interval of 2 years	I24_2
Average January temperature for the basin	JANAVTMP
Average July temperature for the basin	JULAVTMP

Streamflow characteristics selected from the file are:

Characteristics	Variables
Magnitudes of floods at the:	
1.25-year recurrence interval	Q1_25
2-year recurrence interval	Q2
5-year recurrence interval	Q5
10-year recurrence interval	Q10
25-year recurrence interval	Q25
50-year recurrence interval	Q50
100-year recurrence interval	Q100
500-year recurrence interval	Q500

Skew value of logarithms of annual peak discharges	WRC_SKEW
Mean of logarithms of annual peak discharges	WRC_MEAN
Standard deviation of logarithms of annual peak discharges	WRC_SD

Values of basin and streamflow characteristics used as variables in this study are given in table 3.

Channel-geometry characteristics in the data set are:

Characteristics		Variables
Bankfull discharge		QB
Recurrence interval of the bankfull discharge		RIQB
Regression constants for:	width	A
	area	G
	velocity	K
	depth	C
Regression coefficients for:	width	B
	area	H
	velocity	M
	depth	F
Values at bankfull for:	width	WB
	area	AB
	velocity	VB
	depth	DB

Table 2 is the source of channel-geometry data in the data set.

All values in the data set, except WRC_SKEW, WRC_MEAN, WRC_SD, and RIQB, were converted to logarithms before being used in the multiple-regression computer programs. Logarithms are used to arrange the resulting regression equations in the form:

$$Y = b_0 X_1^{b_1} X_2^{b_2} \ldots X_n^{b_n},$$

where,

Y = dependent variable,
X_i = independent variables ($i = 1, 2, \ldots, n$), and
b_i = regression coefficients ($i = 0, 1, 2, \ldots, n$).

The data were then analyzed using several of the regression procedures of the SAS (Statistical Analysis Systems) Institute, Inc. (Barr, Goodnight, Sall, and Helwig, 1976).

Headnotes for Table 3

STA_NO	- Gaging-station number
AREA	- Drainage area, in square miles
ELEV	- Mean elevation of drainage basin, in feet (NGVD)
LAKEAREA	- Percentage of drainage basin covered by lakes and ponds plus 1 percent
FOREST	- Percentage of drainage basin covered by forests plus 1 percent
SOIL	- Soils index assigned by Soil Conservation Service (mean value for basin)
GAGE_LAT	- Latitude of gaging station
GAGE_LNG	- Longitude of gaging station
PRECIP	- mean annual precipitation over drainage basin, in inches
I24_2	- Precipitation intensity for 24-hour period with a recurrence interval of 2 years, in inches
JANAVTMP	- Mean monthly temperature for January, in degrees Fahrenheit
JULAVTMP	- Mean monthly temperature for July, in degrees Fahrenheit
Q1_25	- Peak discharge with recurrence interval of 1.25 years, in cubic feet per second
Q2 to Q500	- Peak discharges for recurrence intervals 2 to 500 years
WRC_SKEW	- Adjusted skew for flood-frequency distribution used to estimate discharges at selected recurrence intervals
WRC_MEAN	- Mean of logarithms of peak discharges at station used to estimate discharges at selected recurrence intervals
WRC_SD	- Standard deviation of peak discharge at station used to estimate discharges at selected recurrence intervals
.	- Missing data

Table 3. Basin and streamflow characteristics

STA_NO	AREA	ELEV	LAKEAREA	FOREST	SOIL	GAGE_LAT	GAGE_LNG	PRECIP	I24_2	JANAVTMP	JULAVTMP
10039500	2486.0	7360	1.2	20	.	42.210	111.05	15.0	1.68	.	.
10040000	45.3	7170	3.0	28	4.9	42.390	110.98	19.0	1.20	.	.
10040500	37.6	7390	1.0	46	6.7	42.400	110.99	32.9	1.22	.	.
10041000	113.0	7290	2.0	40	5.9	42.400	111.02	29.0	1.20	.	.
10047500	49.5	7370	1.0	44	5.4	42.330	111.24	26.7	1.20	.	.
10058600	24.0	7860	1.0	18	5.5	42.180	111.42	31.0	1.20	.	.
10072800	22.6	7710	1.0	94	6.5	42.540	111.57	24.0	1.60	.	.
10076400	51.7	6250	1.0	2	4.5	42.730	111.62	24.0	1.40	.	.
12305500	53.0	4980	1.0	101	6.7	48.600	116.09	40.0	1.80	15	55
12306500	570.0	4870	2.0	101	6.0	49.000	116.18	33.0	1.10	16	55
12307500	755.0	4710	2.0	101	6.0	48.770	116.16	28.0	1.30	16	55
12310800	16.1	3340	1.0	99	6.7	48.570	116.39	30.0	2.10	21	61
12311000	133.0	3400	1.0	96	6.0	48.630	116.40	36.0	1.40	20	59
12316800	23.0	4800	1.0	96	6.7	48.930	116.33	22.0	1.40	16	55
12321500	97.0	4650	1.0	101	6.7	49.000	116.57	45.0	2.00	16	56
12392000	22073.0	.	.	93	.	48.090	116.07	.	.	.	.
12392300	124.0	4210	1.0	101	6.7	48.420	116.50	46.0	2.00	20	57
12393600	10.7	3310	1.0	101	6.7	48.470	116.92	38.0	2.00	22	62
12394000	611.0	4050	.	89	.	48.451	116.89	43.0	1.90	.	.
12395000	902.0	3820	5.5	96	6.3	48.210	116.91	41.0	2.10	21	59
12411000	335.0	4120	1.0	91	6.7	47.710	115.98	52.0	2.20	22	62
12413100	3.1	5140	2.0	78	6.7	47.470	115.79	55.0	2.30	19	59
12413140	14.9	4380	1.0	98	6.7	47.460	115.94	52.0	2.42	18	62
12413200	4.5	3520	1.0	49	6.7	47.550	116.07	40.0	2.10	23	64
12414500	1030.0	4210	1.0	96	6.7	47.270	116.19	51.0	2.00	22	61

STA_NO	Q1_25	Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q500	WRC_SKEW	WRC_MEAN	WRC_SD
10039500	1300.0	1920	2740	3250	3870	4310	4730	5140	5660	-0.3260	3.2730	0.1930
10040000	68.0	137	261	358	493	600	713	830	993	-0.3000	2.1200	0.3480
10040500	85.0	162	293	392	526	630	738	850	1000	-0.3000	2.1940	0.3200
10041000	230.0	432	769	1020	1350	1610	1880	2150	2530	-0.3080	2.6190	0.3120
10047500	63.0	97	145	176	215	242	270	296	330	-0.3070	1.9770	0.2160
10058600	126.0	161	200	223	248	266	282	297	316	-0.3000	2.2000	0.1190
10072800	88.0	112	140	157	175	188	199	210	224	-0.3000	2.0430	0.1220
10076400	66.0	78	90	97	105	110	115	119	124	-0.3000	1.8850	0.0830
12305500	928.0	1280	1740	2040	2410	2680	2940	3200	3540	-0.1100	3.1040	0.1620
12306500	3990.0	5510	7270	8260	9350	10100	10700	11300	12000	-0.3000	3.7273	0.1568
12307500	4750.0	6490	8460	9540	10700	11500	12100	12700	13400	-0.5899	3.7977	0.1514
12310800	107.0	171	261	322	398	453	508	562	633	-0.3000	2.2200	0.2310
12311000	728.0	1030	1420	1670	1990	2260	2650	3180	4030	-0.0781	2.5923	0.3640
12316800	269.0	344	432	483	541	580	617	651	694	-0.3000	2.5310	0.1230
12321500	1490.0	1970	2540	2870	3250	3510	3750	3980	4260	-0.3276	3.2866	0.1381
12392000	65800.0	91700	123400	142200	163900	178700	192500	205500	221700	-0.3883	4.9518	0.1632
12392300	790.0	1130	1600	2000	2760	3560	4450	5450	6950	-0.1182	2.7733	0.3908
12393600	48.0	74	110	133	162	182	202	222	248	-0.3000	1.8580	0.2130
12394000	5020.0	5960	6990	7560	8190	8600	8970	9320	9750	-0.2920	3.7710	0.0860
12395000	5430.0	6720	8120	8870	9690	10200	10700	11100	11700	-0.4300	3.8200	0.1040
12411000	4900.0	6200	8700	10600	13700	17200	21200	25700	32300	-0.3225	3.7372	0.1654
12413100	75.6	107	147	172	201	222	241	260	284	-0.3000	2.0204	0.1720
12413140	270.0	430	660	820	1020	1170	1320	1460	1650	-0.3000	2.6204	0.2372
12413200	45.0	76	122	155	197	228	260	291	333	-0.3000	1.8650	0.2610
12414500	10900.0	15700	22400	26600	31900	35800	39600	43300	48200	-0.1930	4.1910	0.1860

Table 3. Basin and streamflow characteristics (Continued)

STA_NO	AREA	ELEV	LAKEAREA	FOREST	SOIL	GAGE_LAT	GAGE_LNG	PRECIP	I24_2	JANAVTMP	JULAVTMP
12414900	275.0	3740	.	98	.	47.18	116.49	42	2.10	.	.
12415000	437.0	3560	1.0	96	5.7	47.33	116.62	40	2.00	24	63
12415200	2.1	2960	1.0	74	6.7	47.34	116.89	24	1.60	25	66
12416000	22.0	3580	1.0	101	6.7	47.82	116.65	35	1.50	23	62
12419000	3840.0	3670	3.0	85	6.2	47.70	116.98	.	.	23	63
13011000	824.0	8040	8.0	71	7.1	43.86	110.59	.	.	7	53
13011500	169.0	8160	3.0	82	7.4	43.85	110.52	30	1.40	9	53
13011900	323.0	9270	.	54	.	43.84	110.44	41	1.50	.	.
13022500	3465.0	8150	3.5	66	6.1	43.30	110.78	.	.	7	53
13023000	448.0	8080	1.0	76	6.7	43.14	110.98	40	1.60	7	53
13027500	829.0	8470	1.0	51	5.2	43.08	111.04	31	1.40	6	51
13029500	108.0	6960	1.0	66	6.1	43.18	111.10	24	1.30	15	60
13030000	36.8	7790	1.0	66	6.3	43.26	111.07	30	1.40	13	57
13030500	59.2	7670	1.0	71	6.2	43.32	111.11	32	1.40	13	57
13032000	77.1	7130	1.0	71	5.6	43.28	111.22	24	1.30	14	59
13032500	5225.0	.	.	66	.	43.35	111.22	.	.	.	.
13037500	5752.0	7770	2.5	61	6.0	43.63	111.68	.	.	11	56
13038900	20.8	8300	2.0	90	6.1	44.65	111.34	27	1.40	6	58
13039500	99.3	7475	9.5	46	5.3	44.59	111.35	.	.	11	56
13042500	481.0	7080	5.0	66	6.0	44.42	111.39	.	.	12	58
13046000	1040.0	6710	3.0	81	6.3	44.07	111.50	.	.	12	59
13047500	351.0	7520	2.0	81	6.7	44.07	111.24	46	2.23	10	56
13049500	520.0	6970	.	61	.	44.02	111.57	.	.	.	.
13050500	1770.0	6670	.	71	.	43.97	111.67	.	.	.	.
13052200	335.0	7350	.	36	.	43.78	111.21	36	1.40	.	.

STA_NO	Q1_25	Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q500	WRC_SKEW	WRC_MEAN	WRC_SD
12414900	1720	3080	5270	6840	8920	10500	12100	13800	16000	-0.3000	3.4750	0.2900
12415000	3050	4870	7870	10200	13400	16100	18900	22000	26500	0.0950	3.6920	0.4230
12415200	49	72	103	123	147	164	180	196	217	-0.3000	1.8470	0.1940
12416000	210	363	598	763	978	1140	1300	1470	1690	-0.3000	2.5460	0.2700
12419000	19310	26420	34340	38630	43210	46120	48680	50960	53620	-0.6273	4.4063	0.1511
13011000	6050	7790	9950	11260	12830	13930	15000	16030	17350	-0.1207	3.8891	0.1282
13011500	1970	2450	3000	3310	3680	3930	4160	4380	4650	-0.2109	3.3847	0.1079
13011900	3790	4370	5010	5360	5750	6010	6240	6470	6740	-0.2000	3.6380	0.0720
13022500	14500	18500	23000	25500	28500	30500	32300	34000	38800	-0.3000	4.2601	0.1183
13023000	2640	3530	4620	5260	6010	6530	7010	7470	8050	-0.3000	3.5410	0.1450
13027500	1610	2270	3110	3640	4250	4690	5100	5500	6010	-0.3000	3.3473	0.1713
13029500	626	901	1260	1480	1750	1940	2120	2300	2520	-0.3000	2.9460	0.1810
13030000	156	207	268	304	345	373	400	425	456	-0.3000	2.3090	0.1390
13030500	359	476	618	702	799	866	928	987	1060	-0.3000	2.6710	0.1410
13032000	387	509	654	740	838	905	967	1030	1100	-0.3000	2.7000	0.1360
13032500	16300	20200	24700	27300	30300	32300	34100	35800	38000	-0.2598	4.3009	0.1086
13037500	17700	23100	30400	35200	41200	45700	50100	54700	60800	-0.0997	4.3664	0.1391
13038900	216	277	351	396	447	483	517	549	590	-0.2000	2.4390	0.1260
13039500	234	334	460	540	630	700	760	820	900	-0.3180	2.5140	0.1762
13042500	1510	1850	2210	2400	2600	2730	2850	2960	3080	-0.4627	3.2587	0.0990
13046000	2880	3700	4640	5180	5780	6180	6550	6900	7320	-0.3578	3.5611	0.1238
13047500	2800	3480	4300	4790	5360	5760	6140	6500	6970	-0.1221	3.5395	0.1112
13049500	2660	3500	4390	4920	5520	5920	6300	6650	7080	-0.3471	3.5315	0.1293
13050500	4020	5630	7530	8610	9820	10600	11300	12000	12800	-0.5104	3.7365	0.1635
13052200	1070	1450	1940	2230	2570	2800	3030	3240	3510	-0.3000	3.1560	0.1540

Table 3. Basin and streamflow characteristics (Continued)

STA_NO	AREA	ELEV	LAKEAREA	FOREST	SOIL	GAGE_LAT	GAGE_LNG	PRECIP	I24_2	JANAVTMP	JULAVTMP
13055000	890.0	6900	1.0	46	4.50	43.930	111.62	26.0	1.30	14	60
13056500	2920.0	.	.	51	.	43.830	111.90	.	.	.	.
13058000	627.0	6390	7.0	16	5.20	43.590	111.77	16.0	1.20	15	63
13060000	9790.0	.	.	56	.	43.410	112.13	.	.	.	.
13062700	13.9	7000	1.0	44	5.00	42.830	111.34	18.0	1.30	11	63
13063000	360.0	6940	1.0	46	5.50	42.820	111.51	25.0	1.30	12	59
13068500	1295.0	.	.	38	.	43.130	112.48	.	.	.	.
13069500	11310.0	.	.	36	.	43.130	112.52	.	.	.	.
13072000	260.0	.	.	18	.	42.790	111.98	.	.	.	.
13073000	570.0	6080	1.0	16	4.70	42.620	112.09	.	.	19	65
13075000	355.0	5630	1.0	16	4.20	42.630	112.22	19.0	1.50	22	66
13075300	14.7	6950	1.0	21	6.00	42.740	112.39	27.0	1.70	16	63
13075500	1250.0	5850	.	16	.	42.870	112.47	.	.	.	.
13079000	20.2	7870	1.0	36	1.90	41.970	113.29	28.0	1.60	16	60
13079100	7.3	6540	1.0	25	3.10	42.250	113.65	36.0	1.91	17	64
13082300	86.0	5800	1.0	18	3.20	42.460	113.52	23.0	1.50	19	67
13082500	633.0	6030	1.0	11	3.30	42.120	113.94	22.0	1.20	24	66
13083000	53.7	6360	1.0	16	3.00	42.170	113.97	18.0	1.20	23	65
13092000	80.0	6330	1.0	21	3.20	42.360	114.30	15.0	1.40	22	65
13105000	1450.0	6020	.	2	.	41.940	114.69	15.0	1.30	.	.
13112000	400.0	.	.	16	.	44.000	112.22	.	.	.	.
13113000	120.0	7110	1.0	26	5.40	44.360	112.18	25.0	1.40	13	63
13114000	510.0	.	.	11	.	44.010	112.22	.	.	.	.
13117300	74.3	8390	1.0	77	5.80	44.310	113.34	35.0	1.30	13	58
13118700	440.0	.	.	16	.	44.140	113.24	.	.	.	.

STA_NO	Q1_25	Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q500	WRC_SKEW	WRC_MEAN	WRC_SD
13055000	2340	3310	4540	5290	6170	6790	7370	7930	8630	-0.3290	3.5110	0.1710
13056500	4530	6330	8330	9410	10500	11300	11900	12400	13100	-0.6825	3.7833	0.1603
13058000	1170	1760	2550	3070	3690	4140	4570	5000	5540	-0.3000	3.2340	0.2020
13060000	14300	21600	31820	38500	46800	52800	54700	64500	72100	-0.2594	4.3262	0.2072
13062700	149	287	524	703	948	1140	1340	1540	1830	-0.3000	2.4414	0.3258
13063000	921	1320	1830	2150	2530	2790	3050	3300	3610	-0.3000	3.1104	0.1776
13068500	480	650	880	1040	1230	1370	1510	1650	1840	-0.0288	2.8125	0.1590
13069500	11600	19200	28700	34000	39800	43400	46600	49400	52500	-0.7928	4.2524	0.2392
13072000	390	470	560	610	660	700	730	760	800	-0.3000	2.6657	0.0935
13073000	321	490	790	1040	1420	1750	2120	2550	3220	0.4410	2.7070	0.2340
13075000	219	316	443	522	617	684	748	811	890	-0.3000	2.4910	0.1820
13075300	13	23	39	51	67	79	91	103	120	-0.3000	1.3496	0.2890
13075500	530	760	1110	1370	1720	2010	2310	2640	3100	0.2326	2.8875	0.1911
13079000	76	120	183	227	284	326	369	412	470	-0.1860	2.0710	0.2260
13079100	20	31	46	55	67	76	84	92	103	-0.2500	1.4820	0.2066
13082300	120	240	460	630	880	1070	1280	1500	1810	-0.2500	2.3687	0.3454
13082500	122	244	508	761	1190	1600	2090	2690	3680	0.2340	2.4010	0.3680
13083000	33	53	86	111	148	177	210	245	296	0.1040	1.7260	0.2480
13092000	111	195	328	423	549	644	742	840	973	-0.2810	2.2780	0.2800
13105000	430	712	1140	1440	1830	2130	2430	2740	3150	-0.2290	2.8430	0.2520
13112000	200	380	690	910	1180	1390	1590	1790	2040	-0.4923	2.5581	0.3281
13113000	229	334	472	558	663	737	808	877	965	-0.3000	2.5140	0.1870
13114000	69	110	170	210	250	280	310	340	370	-0.4999	2.0305	0.2364
13117300	261	376	526	619	731	810	886	959	1050	-0.3000	2.5660	0.1810
13118700	210	310	430	510	600	670	730	790	870	-0.3000	2.4783	0.1838

Table 3. Basin and streamflow characteristics (Continued)

STA_NO	AREA	FLEV	LAKEAREA	FOREST	SOIL	GAGE_LAT	GAGE_LNG	PRECIP	I24_2	JANAVTMP	JULAVTMP
13120000	114.0	8540	1.0	41	5.00	43.930	114.11	39.0	1.90	8	52
13120500	450.0	8590	1.0	26	4.80	44.000	114.02	38.0	1.20	8	52
13130900	93.4	7960	1.0	24	5.00	43.680	113.63	34.0	1.85	12	52
13135500	137.0	8120	1.0	51	5.80	43.790	114.42	41.0	1.80	8	49
13141000	824.0	.	.	16	.	43.330	114.34	.	.	.	.
13141500	648.0	5600	2.5	6	3.90	43.330	114.54	18.0	1.30	14	63
13147900	248.0	7220	1.0	11	4.40	43.490	114.06	28.0	2.00	16	61
13151000	570.0	.	.	11	.	43.050	114.13	.	.	.	.
13154000	140.0	4700	1.0	1	1.90	43.020	115.01	10.0	1.10	23	69
13154500	35800.0	6040	.	6	.	43.002	115.20	.	.	.	.
13155300	14.2	5960	1.0	13	5.00	43.150	115.31	15.0	0.90	16	64
13161500	382.0	6790	.	1	.	41.930	115.67	10.6	1.20	.	.
13162500	84.6	7600	1.0	26	3.20	42.030	115.37	19.0	1.30	15	61
13167500	620.0	.	.	1	.	42.560	115.51	.	.	.	.
13168500	2630.0	5600	1.0	6	4.10	42.770	115.72	.	.	25	69
13178000	440.0	5780	1.0	31	4.30	42.870	116.95	15.0	1.30	24	68
13185000	830.0	6350	1.0	76	5.90	43.660	115.73	42.0	2.20	19	58
13186000	635.0	6840	1.0	21	6.40	43.490	115.31	37.0	2.20	18	63
13235000	456.0	6780	1.0	91	4.40	44.080	115.62	40.0	1.80	14	54
13239000	144.0	6520	6.5	91	6.30	44.910	116.12	38.0	2.20	14	57
13240000	48.9	6950	2.0	101	6.70	44.910	115.99	39.0	2.20	13	55
13243500	143.0	6250	1.0	94	3.00	44.690	116.00	33.0	1.50	15	59
13245000	626.0	5960	8.0	76	6.20	44.510	116.03	.	.	16	59
13246000	933.0	5800	5.5	81	6.40	44.110	116.11	.	.	16	60
13247500	2230.0	5850	3.0	86	6.10	43.940	116.20	.	.	16	59

STA_NO	Q1_25	Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q500	WRC_SKEW	WRC_MEAN	WRC_SD
13120000	548.0	764.0	1040	1210	1410	1550	1690	1820	1990	-0.2680	2.8750	0.1660
13120500	1450.0	2120.0	2960	3460	4020	4410	4760	5090	5500	-0.4830	3.3120	0.1860
13130900	370.0	500.0	660	760	870	950	1020	1090	1180	-0.3000	2.6916	0.1510
13135500	648.0	928.0	1290	1520	1780	1970	2160	2330	2550	-0.3000	2.9580	0.1780
13141000	990.0	1650.0	2630	3280	4080	4660	5230	5790	6500	-0.3999	3.2018	0.2547
13141500	1420.0	2900.0	5480	7410	10000	12000	14000	16000	18800	-0.4170	3.4380	0.3510
13147900	588.0	950.0	1480	1830	2280	2610	2940	3260	3690	-0.3000	2.9660	0.2390
13151000	220.0	340.0	510	620	770	890	1000	1110	1270	-0.1705	2.5203	0.2178
13154000	688.0	1600.0	3540	5270	7960	10300	12900	15900	20200	-0.2000	3.1890	0.4240
13154500	17000.0	23800.0	31900	36600	41800	45200	48400	51300	54700	-0.5065	4.3627	0.1651
13155300	49.0	92.0	166	233	303	366	434	504	604	-0.2000	1.9540	0.3130
13161500	455.0	763.0	1260	1630	2130	2530	2950	3390	4000	-0.1000	2.8780	0.2630
13162500	315.0	447.0	622	734	872	971	1070	1160	1290	-0.2000	2.6440	0.1760
13167500	109.0	200.0	356	475	639	770	908	1050	1250	-0.2000	2.2920	0.3060
13168500	1410.0	2270.0	3540	4430	5580	6450	7330	8220	9420	-0.1990	3.3480	0.2370
13178000	1270.0	1980.0	3050	3810	4810	5580	6360	7170	8280	-0.1000	3.2930	0.2270
13185000	4710.0	6680.0	9280	10900	13000	14400	15900	17300	19100	-0.2000	3.8186	0.1752
13186000	3560.0	4670.0	6040	6870	7840	8520	9170	9790	10600	-0.2090	3.6650	0.1370
13235000	3400.0	4370.0	5540	6230	7020	7570	8080	8570	9190	-0.2360	3.6360	0.1260
13239000	2370.0	2950.0	3550	3860	4190	4400	4580	4750	4940	-0.5580	3.4600	0.1060
13240000	1090.0	1400.0	1790	2030	2300	2500	2690	2870	3110	-0.1320	3.1440	0.1280
13243500	1250.0	1590.0	1880	2010	2130	2200	2240	2280	2320	-0.3000	3.1810	0.1102
13245000	2950.0	4060.0	5430	6270	7260	7960	8630	9270	10100	-0.2471	3.6021	0.1558
13246000	3210.0	4490.0	6130	7150	8350	9190	10000	10800	11800	-0.2812	3.6448	0.1677
13247500	9630.0	13200.0	17700	20400	23500	25700	27800	29800	32200	-0.3112	4.1133	0.1578

Table 3. Basin and streamflow characteristics (Continued)

STA_NO	AREA	FLEV	LAKEAREA	FOREST	SOIL	GAGE_LAT	GAGE_LNG	PRECIP	I24_2	JANAVTMP	JULAVTMP
13250600	47.4	3990	1.0	1	44.12	44.07	116.49	3	1.40	22	68
13251300	4.0	4940	1.0	96	6.70	45.02	116.43	35	2.10	19	65
13251500	36.5	4690	1.0	86	6.70	44.95	116.38	34	2.10	20	65
13258500	605.0	4650	1.0	56	5.80	44.58	116.64	34	1.80	20	66
13261000	81.9	5300	1.0	51	5.50	44.50	116.40	34	1.80	15	64
13265500	288.0	.	.	1	.	44.29	116.78	.	.	.	.
13266000	1460.0	.	.	26	.	44.27	116.77	.	.	.	.
13269000	69200.0	5400	.	6	.	44.25	116.98	.	.	.	.
13292400	15.0	8200	1.0	60	6.00	43.92	114.81	43	2.14	9	59
13295000	147.0	7400	2.0	76	5.10	44.22	114.93	26	1.60	13	55
13295500	501.0	7800	2.5	61	4.90	44.23	114.92	33	1.80	12	53
13296000	195.0	7980	1.0	91	4.80	44.29	114.72	32	1.70	11	53
13296500	802.0	7790	2.0	71	4.90	44.27	114.73	34	1.70	12	53
13297100	7.6	7800	1.0	95	5.70	44.26	114.65	36	1.91	10	60
13297300	6.1	7300	1.0	59	5.60	44.25	114.53	22	1.40	12	62
13298000	497.0	8100	1.1	31	5.70	44.22	114.28	33	1.70	11	52
13298500	1800.0	7820	1.5	56	5.20	44.38	114.25	38	1.70	12	53
13302500	3760.0	7380	1.3	41	5.30	45.18	113.89	26	1.60	13	58
13307000	6270.0	7140	1.2	41	5.40	45.32	114.44	24	1.60	15	56
13308500	138.0	7370	1.1	96	4.60	44.42	115.18	28	1.60	13	54
13310700	330.0	.	.	96	.	44.99	115.73	.	.	.	.
13313000	211.0	7170	1.3	101	5.60	44.96	115.50	38	1.80	13	55
13316500	576.0	5430	1.2	81	6.40	45.41	116.32	32	1.90	25	60
13317000	13550.0	6720	1.2	61	5.50	45.75	116.32	28	1.60	15	57
13336100	241.0	5030	1.0	97	6.70	46.03	115.29	45	2.20	17	58

STA_NO	Q1_25	Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q500	WRC_SKEW	WRC_MEAN	WRC_SD
13250600	618.0	921.0	1340	1620	1970	2230	2480	2730	3060	-0.2000	2.9570	0.2010
13251300	27.0	42.0	61	74	89	100	111	122	136	-0.3000	1.6090	0.2080
13251500	327.0	480.0	681	808	961	1070	1170	1280	1400	-0.3070	2.6710	0.1900
13258500	3580.0	5010.0	6880	8060	9510	10500	11500	12500	13800	-0.1900	3.6940	0.1680
13261000	501.0	732.0	1050	1260	1530	1730	1920	2110	2370	-0.1570	2.8590	0.1920
13265500	730.0	1130.0	1700	2090	2570	2930	3290	3640	4110	-0.2279	3.0455	0.2183
13266000	6900.0	10100.0	14400	17100	20500	23000	25400	27700	30700	-0.2397	3.9961	0.1899
13269000	32300.0	45500.0	62800	73800	86900	96400	105400	114300	125800	-0.2301	4.6517	0.1722
13292400	110.0	140.0	180	210	230	250	270	280	300	-0.3000	2.1478	0.1321
13295000	717.0	990.0	1330	1540	1780	1950	2110	2260	2450	-0.3050	2.9870	0.1600
13295500	2240.0	3050.0	4050	4660	5360	5850	6310	6750	7300	-0.3060	3.4760	0.1540
13296000	953.0	1480.0	2260	2800	3500	4020	4550	5090	5810	-0.1640	3.1650	0.2240
13296500	3630.0	5100.0	6960	8110	9470	10400	11300	12200	13300	-0.2970	3.6990	0.1690
13297100	17.0	33.0	61	81	110	130	150	180	210	-0.3000	1.5067	0.3235
13297300	5.2	9.1	15	20	25	30	34	39	45	-0.3000	0.9450	0.2800
13298000	929.0	1610.0	2660	3400	4360	5080	5810	6550	7530	-0.3000	3.1920	0.2720
13298500	5480.0	7670.0	10500	12300	14400	15800	17300	18600	20400	-0.2590	3.8780	0.1680
13302500	6000.0	8710.0	12200	14300	16800	18500	20100	21700	23600	-0.3820	3.9290	0.1840
13307000	9940.0	13800.0	18600	21500	25000	27400	29600	31800	34600	-0.3060	4.1310	0.1620
13308500	1200.0	1640.0	2170	2500	2870	3130	3380	3620	3910	-0.2970	3.2060	0.1530
13310700	3020.0	4030.0	5260	6000	6840	7430	7970	8490	9150	-0.3000	3.5985	0.1441
13313000	2290.0	3070.0	4050	4630	5320	5800	6260	6690	7250	-0.2580	3.4810	0.1480
13316500	4100.0	5440.0	7060	8010	9110	9870	10600	11300	12100	-0.3000	3.7280	0.1410
13317000	47000.0	63600.0	83600	95400	109000	118000	127000	135000	145000	-0.3500	4.7940	0.1490
13336100	2320.0	3130.0	4120	4710	5400	5880	6330	6750	7290	-0.3000	3.4876	0.1491

Table 3. Basin and streamflow characteristics (Continued)

STA_NO	AREA	ELEV	LAKEAREA	FOREST	SOIL	GAGE_LAT	GAGE_LNG	PRECIP	I24_2	JANAVTMP	JULAVTMP
13336500	1910.00	5640	1	96	6.0	46.09	115.51	46	2.2	18	56
13336600	115.63	3800	1	101	6.7	46.12	115.57	35	1.6	23	64
13336850	12.20	4800	1	101	6.7	46.46	115.03	48	2.1	20	60
13337000	1180.00	5250	1	101	6.0	46.15	115.59	50	2.2	17	55
13337500	261.00	5150	1	101	6.3	45.82	115.53	30	1.8	23	61
13337700	14.20	4900	1	101	6.7	45.82	115.82	28	1.8	20	60
13338200	13.90	3100	1	12	6.5	46.01	115.96	25	1.6	26	66
13338500	1150.00	3610	.	65	.	46.09	115.98	28	1.7	.	.
13339700	5.90	3500	1	101	6.7	46.50	115.79	45	2.0	24	65
13340500	996.00	4930	1	101	6.5	46.63	115.51	58	2.4	19	59
13340600	1360.00	.	.	101	.	46.84	115.62	.	.	.	.
13341300	3.15	3700	1	101	6.7	46.86	116.29	45	2.2	23	63
13341400	41.60	3600	1	53	6.5	46.84	116.39	46	2.2	23	64
13341500	425.00	2980	1	76	4.2	46.61	116.66	38	1.8	26	66
13344800	36.60	2970	1	57	2.7	46.96	116.93	25	1.6	25	66
13345000	317.00	3080	1	79	4.0	45.92	116.95	31	1.7	26	64

STA_NO	Q1_25	Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q500	WRC_SKEW	WRC_MEAN	WRC_SD
13336500	20400	26700	34400	39100	44500	48300	51900	55400	59800	-0.211	4.4220	0.1350
13336600	46	74	114	142	177	202	228	253	286	-0.300	1.8550	0.2390
13336850	170	271	418	516	639	729	818	906	1020	-0.300	2.4220	0.2330
13337000	14700	19600	25600	29200	33500	36600	39400	42200	45800	-0.209	4.2860	0.1430
13337500	1390	1940	2650	3090	3600	3970	4310	4640	5070	-0.292	3.2800	0.1680
13337700	62	98	147	180	220	250	279	308	345	-0.300	1.9780	0.2220
13338200	138	188	250	288	331	361	390	417	452	-0.300	2.2670	0.1540
13338500	4420	6490	9250	11000	13100	14600	16000	17400	19200	-0.300	3.8029	0.1912
13339700	76	119	181	222	274	312	348	385	432	-0.300	2.0650	0.2270
13340500	13200	16600	20600	22900	25500	27200	28800	30300	32200	-0.300	4.2150	0.1160
13340600	16000	24200	35400	42600	51400	57700	63900	69900	77700	-0.300	4.3733	0.2054
13341300	35	56	87	108	134	153	172	190	215	-0.300	1.7380	0.2360
13341400	450	653	919	1090	1290	1430	1560	1700	1870	-0.300	2.8060	0.1850
13341500	4190	6390	9460	11500	14000	15800	17600	19400	21700	-0.256	3.7970	0.2100
13344800	565	866	1280	1550	1890	2130	2360	2590	2890	-0.300	2.9270	0.2120
13345000	2660	3770	5200	6090	7140	7880	8590	9270	10100	-0.300	3.5680	0.1740

Most regression runs were made by using the backward elimination process. The first runs used both untransformed data and log data. Estimates of peak flood discharge obtained from equations computed by using the log data had slightly lower standard errors than those computed by using untransformed data, so subsequent runs were made using only the log data. When basin characteristics were used as the independent variables, all were included. When channel characteristics were used as the independent variables, only one or two at a time were used because of the high degree of correlation between characteristics. When both basin and channel characteristics were used as independent variables, it was done with the realization that a high degree of correlation exists between drainage area (AREA) and bankfull width (WB) or bankfull area (AB). Even so, the regression equations were computed and included in this report because of the lower standard error. Equations were used only if all regression coefficients were significant at the 0.05 level or higher.

RESULTS

Regression equations using the two types of independent variables were computed. Equations using one basin characteristic are:

$$Q1.25 = 10.8\ AREA^{.80} \qquad SE = 182\%, -64\%$$

$$Q2 = 17.1\ AREA^{.78} \qquad SE = 166\%, -62\%$$

$$Q5 = 26.4\ AREA^{.77} \qquad SE = 155\%, -61\%$$

$$Q10 = 32.8\ AREA^{.76} \qquad SE = 150\%, -60\%$$

$$Q25 = 40.8\ AREA^{.75} \qquad SE = 147\%, -59\%$$

$$Q50 = 46.8\ AREA^{.75} \qquad SE = 145\%, -59\%$$

$$Q100 = 53.0\ AREA^{.74} \qquad SE = 145\%, -59\%$$

Equations using two basin characteristics are:

$$Q1.25 = 2.79\ AREA^{.88} I24\_2^{2.17} \qquad SE = 126\%, -56\%$$

$$Q2 = 5.04\ AREA^{.86} I24\_2^{1.97} \qquad SE = 116\%, -54\%$$

$$Q5 = 8.63\ AREA^{.84} I24\_2^{1.78} \qquad SE = 111\%, -53\%$$

$$Q10 = 11.3\ AREA^{.83} I24\_2^{1.68} \qquad SE = 109\%, -52\%$$

$Q25 = 14.7\ AREA^{.83}\ I24\_2^{1.60}$ SE = 109%, -52%

$Q50 = 17.3\ AREA^{.82}\ I24\_2^{1.55}$ SE = 109%, -52%

$Q100 = 20.0\ AREA^{.82}\ I24\_2^{1.51}$ SE = 110%, -52%

Equations using the channel characteristic WB are:

$Q1.25 = 0.43\ WB^{1.78}$ SE = 98%, -49%

$Q2 = 0.76\ WB^{1.73}$ SE = 92%, -48%

$Q5 = 1.31\ WB^{1.68}$ SE = 90%, -47%

$Q10 = 1.73\ WB^{1.66}$ SE = 90%, -47%

$Q25 = 2.29\ WB^{1.64}$ SE = 92%, -48%

$Q50 = 2.73\ WB^{1.62}$ SE = 93%, -48%

$Q100 = 3.21\ WB^{1.61}$ SE = 95%, -49%

Equations using two basin characteristics and the channel characteristic WB are:

$Q1.25 = 0.48\ AREA^{.33}\ I24\_2^{1.21}\ WB^{1.22}$ SE = 79%, -44%

$Q2 = 0.94\ AREA^{.34}\ I24\_2^{1.06}\ WB^{1.16}$ SE = 74%, -42%

$Q5 = 1.74\ AREA^{.35}\ I24\_2^{.93}\ WB^{1.10}$ SE = 72%, -42%

$Q10 = 2.37\ AREA^{.35}\ I24\_2^{.86}\ WB^{1.07}$ SE = 73%, -42%

$Q25 = 3.24\ AREA^{.36}\ I24\_2^{.81}\ WB^{1.03}$ SE = 75%, -43%

$Q50 = 3.92\ AREA^{.37}\ I24\_2^{.78}\ WB^{1.01}$ SE = 77%, -43%

$Q100 = 4.65\ AREA^{.37}\ I24\_2^{.76}\ WB^{.99}$ SE = 79%, -44%

Variables in the above equations are defined on page 25 of this report. SE is the standard error reported in percent. The two figures following SE show the plus and minus percentages and result because the dependent variables were computed in logarithmic form.

In an attempt to refine the above equations and lower the standard errors, residuals for Q10 were computed and plotted on a map of the State. No regional patterns were definable and no other methods of regionalization were considered valid, especially when using channel characteristics.

Equations using Q200 and Q500 as dependent variables are not presented because of the uncertainties associated with extending the frequency curve too far. Most of the gaging stations used have less than 25 years of record.

APPLICATION TO UNGAGED SITES

A suggested procedure for using bankfull width to estimate peak discharges at ungaged sites follows:

1. At site of interest, make 5 to 10 measurements of bankfull width and average them. The measurements should be at least a channel width apart and at the level of bankfull discharge. Riggs (1974), in describing his whole-channel section, said "The reference level for this section is variously defined by breaks in bank slope, by the edges of the flood plain, or by the lower limits of permanent vegetation." Wahl (1977) pointed out that on perennial streams, this is virtually the same as bankfull stage as described by Leopold, Wolman, and Miller (1964). More detailed descriptions are available in Emmett (1975) and Lowham (1976).

2. Use either of the sets of equations below to solve an estimate of the peak of interest:

$$Q1.25 = 0.43\ WB^{1.78}$$

$$Q2 = 0.76\ WB^{1.73}$$

$$Q5 = 1.31\ WB^{1.68}$$

$$Q10 = 1.73\ WB^{1.66}$$

$$Q25 = 2.29\ WB^{1.64}$$

$$Q50 = 2.73\ WB^{1.62}$$

$$Q100 = 3.21\ WB^{1.61}$$

or:

$$Q1.25 = 0.48\ AREA^{.33}\ I24\_2^{1.21}\ WB^{1.22}$$

$$Q2 = 0.94\ AREA^{.34}\ I24\_2^{1.06}\ WB^{1.16}$$

$$Q5 = 1.74\ AREA^{.35}\ I24\_2^{.93}\ WB^{1.10}$$

$$Q10 = 2.37\ AREA^{.35}\ I24\_2^{.86}\ WB^{1.07}$$

$$Q25 = 3.24\ AREA^{.36}\ I24\_2^{.81}\ WB^{1.03}$$

$$Q50 = 3.92\ AREA^{.37}\ I24\_2^{.78}\ WB^{1.01}$$

$$Q100 = 4.65\ AREA^{.37}\ I24\_2^{.76}\ WB^{.99}$$

The first set of equations requires that only WB be measured to make an estimate of the selected peak discharge(s). The second set requires that AREA and I24_2 also be obtained. The second set is included because the estimated peaks may be better estimates, as indicated by the lower standard error.

If the second set of equations is used, an estimate of I24_2 must be made. The map on plate 1 can be used to determine the correct value for each drainage basin of interest. The drainage basin should be located on the map and an average value of I24_2 selected.

CONCLUSIONS

This study shows that estimates of flood flows can be made at ungaged sites in Idaho by using regression equations that relate selected floods to bankfull width or bankfull area.

The study indicates that estimates of flood flow made by using channel measurements as the independent variable are slightly better than estimates made by using basin characteristics as the independent variable. The study also indicates that estimates made by using both basin and channel characteristics as the independent variables are even better.

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