A METHOD FOR ESTIMATING MEAN ANNUAL RUNOFF OF UNGAGED STREAMS BASED ON BASIN CHARACTERISTICS IN CENTRAL AND EASTERN MONTANA

By R. J. Omang and Charles Parrett

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 84-4143

Prepared in cooperation with the

U.S. BUREAU OF LAND MANAGEMENT

Helena, Montana
June 1984

UNITED STATES DEPARTMENT OF THE INTERIOR

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CONVERSION FACTORS

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

Multiply inch-pound unit	By	To obtain SI unit
cubic foot per second	0.02832	cubic meter per second
foot per mile	0.1894	meter per kilometer
inch	25.40	millimeter
square mile	2.590	square kilometer

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ABSTRACT

Equations using basin characteristics were developed for estimating mean annual runoff at ungaged streams in central and eastern Montana. The study area was divided into three regions and separate multiple-regression equations were developed for each region. Drainage area was determined to be the most significant basin characteristic in all three regions.

The standard error of estimate was 31 percent in Region 1 based on data from 17 stations. The standard error of estimate ranged from 64 to 51 percent in Region 2 based on 27 stations and ranged from 103 to 37 percent in Region 3 based on 29 stations; the standard error decreased as more independent variables were added to the estimating equation.

Data from stations with less than 10 years of record were extended based on correlation with stations having long-term record. Coefficients of determination (R^2) and equivalent years of record were determined and used as a basis for adjusting the record.

INTRODUCTION

The purpose of this report is to describe a method for estimating mean annual runoff of ungaged streams in central and eastern Montana. The estimating equations were developed by relating physiographic and climatic characteristics of the drainage basin to mean annual runoff. The estimating relations of this report are based on a current (1982) data base and are considered to be more reliable than a previous report by Boner and Buswell (1970) because of more extensive streamflow-gaging records and improved analytical procedures.

The report is based on basin characteristics and data for 73 streamflow-gaging stations on unregulated streams having at least 5 years of streamflow record. Some streamflow-gaging sites having record in excess of 5 years were excluded from the analysis because the data were considered to be unreliable or unrepresentative of the region owing to stock dams, surface geology, or bad record.

Recent reports by Parrett and others (1983) and Omang and others (1983) provide methods for estimating mean annual runoff based on channel-geometry measurements. The report by Boner and Buswell is the only previous report that provides estimating equations for mean annual runoff based on basin characteristics. A report by Ferreira (1981) includes a mean annual runoff map for selected drainage basins in the coal area of southeastern Montana.

The estimating equations presented herein will be useful to land-use managers, water-rights administrators, designers, and others who need to estimate streamflow on an annual basis. This report was prepared in cooperation with the U.S. Bureau of Land Management.

GENERAL DESCRIPTION OF THE AREA

Montana is an area of 147,100 square miles having widely varying geographic and climatic conditions. East of the Rocky Mountains, in a broad belt extending generally north-south through the central part of the State, plains are interrupted by isolated mountain ranges. East of the isolated mountains the land is generally flat or rolling prairie with deeply incised larger streams. The location of the area studied is shown in figure 1.

The climate of central and eastern Montana is affected significantly by the topography. Annual precipitation in the mountainous areas ranges from 20 to 40 inches and much of this occurs as snow. Most of the yearly runoff from the mountainous areas results from snowmelt. In the eastern plains, precipitation ranges from 12 to 16 inches and is more variable, more intense, and generally less, on an annual basis, than in the mountains. Runoff generally results from snowmelt during the spring, thunderstorms during the summer, and occasionally a combination of late snowmelt and rain.

Because of the diverse topography and climate, the area was divided into three regions for the mean annual runoff analysis. These regions are illustrated in figure 1. Region 1 is predominantly flat plains north of the Missouri River. Runoff is variable, with most smaller streams being ephemeral or intermittent. Runoff is produced by snowmelt and rainfall. Region 2 is also mostly flat plains, but runoff tends to be more variable than in Region 1. The area north of the Yellowstone River is the area most affected by intense summer thunderstorms. The area south of the Yellowstone River has intense thunderstorms, but they generally are not as prevalent as in the area north of the Yellowstone River. Region 3 contains mountainous areas and is generally forested. Annual precipitation results in accumulated snowpack, and runoff occurs primarily as a result of snowmelt.

DATA USED

Streamflow data

Streamflow data from 73 streamflow-gaging stations with 5 or more years of continuous record were used in this study. Data from stations with less than 10 years of record were then extended based on correlation with stations having long-term record. Each correlation of short-term versus long-term records was examined closely to make sure that spurious correlation did not exist. These stations then were used to develop the final regression equations. Data through the 1982 water year were used in the analysis. Gaging stations where the flows are substantially affected by regulation or diversion were generally not used in the analysis. The location and station number of all gaging stations from which data were used are shown in figure 1. The mean annual runoff for each gaging station is listed in table 4 (at back of report). The mean annual runoff is the average daily discharge, in cubic feet per second, for the period of record.

Basin-characteristics data

Basin characteristics tested for inclusion as independent variables in the development of estimating equations for mean annual runoff included:

A	drainage area, in square miles;
P	mean annual precipitation, in inches;
F+10	forest cover index, in percent;
E/1000	mean basin elevation index, in feet above sea level;
HE+10	basin high-elevation index, in percent;
Jan+10	mean January minimum temperature index, in degrees Fahrenheit;
L	main channel length, in miles;
S	main channel slope, in feet per mile;
I_{24}	precipitation intensity index for a storm of 24 hours duration having an exceedance probability of 50 percent, in inches per hour; and
S_i	soil-infiltration index in inches.

Basin characteristics found to be important in the various estimating equations were drainage area, mean annual precipitation, forest cover index, and main channel slope. Drainage area is expressed in square miles and is determined for ungaged sites by planimetering the outline of the drainage basin on the best scale topographic map available. Mean annual precipitation is the basin average, in inches, determined from the maps contained in the report of the U.S. Soil Conservation Service (1977). The forest cover index is the percentage of the drainage basin covered by forest (F) plus 10; it is determined by planimetering the forest (green) areas shown on the best scale U.S. Geological Survey topographic maps, multiplying by 100, dividing the result by the total basin drainage area, and adding a value of 10. The value 10 is added to the percentage to ensure that values close to zero do not occur. Main channel slope, in feet per mile, is determined from the main channel elevations determined at points 10 and 85 percent of the main channel length. The difference in elevation at the two points is divided by 75 percent of the main channel length to obtain main channel slope. The values for each gaging station used in the analysis are listed in table 4 (at back of report).

METHOD OF ANALYSIS

Extension of streamflow records

The mean annual runoff record for gaging stations with less than 10 years of record was extended based on correlation between the record at the site of interest and the record at a nearby hydrologically similar long-term gaging station. The extension was done using simple linear regression (Riggs, 1968). Correlation coefficients (r) were computed for each set of stations that were correlated. If the coefficient of determination (R^2) was greater than 0.60, the station was considered to be a potential correlating station. These stations then were used to develop the final regression equations.

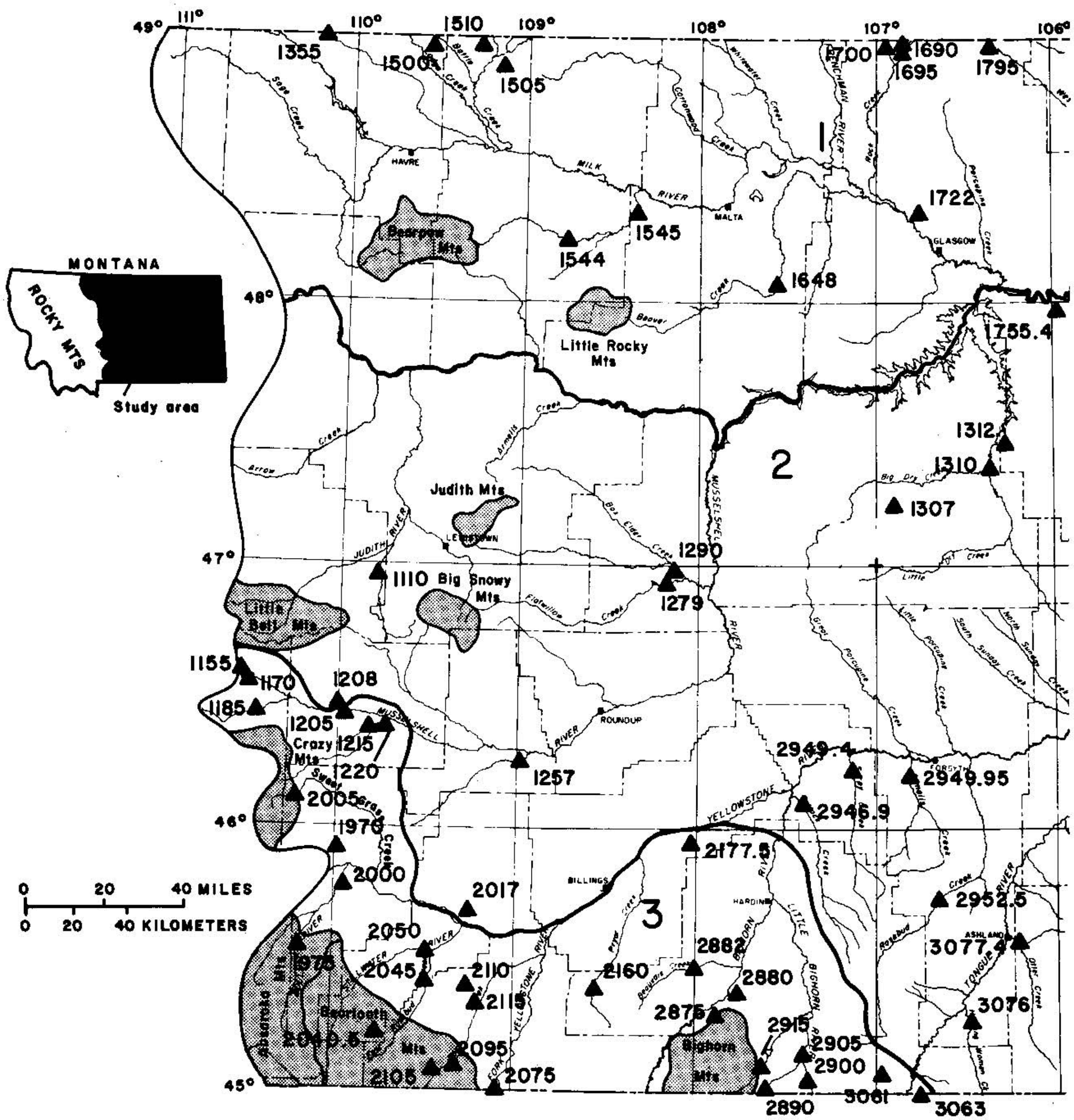
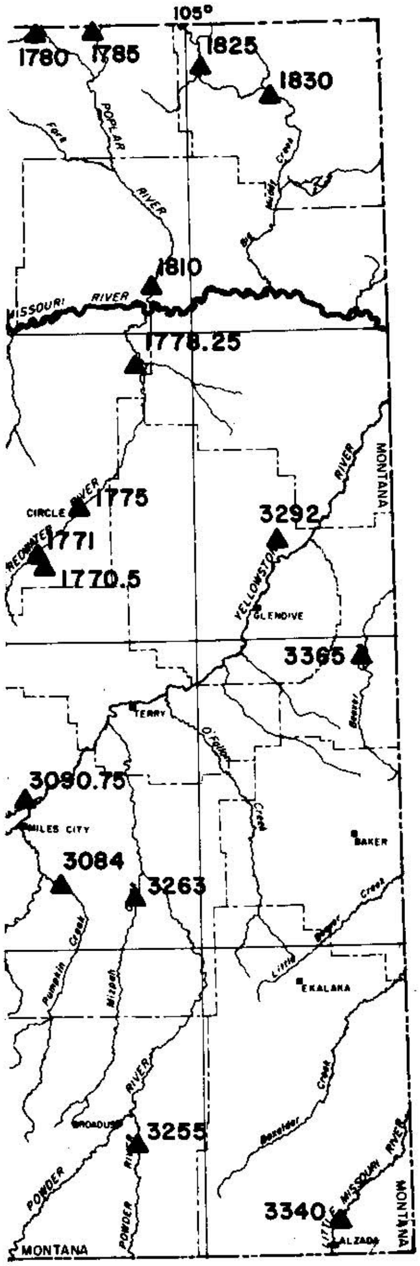


Figure 1.--Location of study area, region boundaries, and streamflow-

The reliability of the adjusted value was expressed in terms of equivalent length of record as shown by the U.S. Water Resources Council (1981). The equivalent record derived from a nearby station is obtained as follows:

$$Ne = \frac{N1}{1 - \left(\frac{N_2}{N1 + N2}\right)\left(r^2 - \frac{(1 - r^2)}{(N1 - 3)}\right)} \qquad (1)$$



EXPLANATION

1722 ▲ STREAMFLOW-GAGING STATION AND ABBREVIATED NUMBER--Number has been abbreviated from 06172200 by omitting the first two digits (06) and the last one or two digits if they are zeros

2 REGION BOUNDARY AND NUMBER

gaging stations selected for mean annual runoff analysis.

where

- Ne is the equivalent years of record,
- N_1 is the number of years of mean annual flow that occurred concurrently at the two stations,
- N_2 is the number of years that mean annual flow occurred at the long-record station but did not occur at the short-record station, and
- r is the correlation coefficient of the flows at the two stations for concurrent periods.

If by using the additional years of record at the correlating station, the equivalent years of record at the station of interest was increased to more than 10 years, then the adjusted value of mean annual runoff was used. This procedure was used to adjust the mean annual runoff at 27 gaging stations. A listing of the 27 gaging stations and the results of the long-term mean annual runoff adjustments are given in table 1.

Multiple regression techniques

Equations for estimating mean annual runoff were developed from multiple-regression analyses of streamflow and basin-characteristics data obtained at streamflow-gaging stations. The data were transformed to logarithms to help ensure a linear relationship among the variables, and regression equations of the following form were derived:

$$\text{Log } Q = \log a + b_1 \log B + b_2 \log C + \ldots b_m \log M \qquad (2)$$

where

Q (dependent variable) is Q_a, the mean annual runoff in cubic feet per second;

a is the multiple-regression constant;

$b_1, b_2 \ldots b_m$ are the regression coefficients; and

$B, C, \ldots M$ are values of the drainage-basin characteristics (independent variables).

After taking antilogarithms, the resulting equations have the following non-linear form:

$$Q = aB^{b_1} C^{b_2} \ldots M^{b_m} \qquad (3)$$

The regression analyses were performed by digital computer using Statistical Analysis System (SAS) programs (SAS Institute, Inc., 1979). These programs provide various statistical measures of the applicability of the derived regression equations such as standard errors of estimate, coefficients of determination (R^2), and tests for the significance of each independent variable.

In developing equations using basin characteristics, a "maximum R^2 improvement" routine for adding or deleting independent variables was used. The procedure determines the "best" one-independent-variable equation, the best two-independent-variable equation, and so forth until all independent variables have been added to the model. This technique does not necessarily keep the previous independent variables in the equation as additional independent variables are added, if a larger R^2 results. In this study, a variable was included in the model if the test statistic for significance was 5 percent or less. In general, the smaller the test statistic for significance, the more significant is the variable in the equation.

Mean annual runoff analysis

An initial mean annual regression analysis was made for the entire study area. The study area then was divided into three regions based on the topography, climate, and surface geology. The regression residuals (difference between actual mean an-

Table 1.--*Mean annual runoff adjustments for selected gaging stations*

[ft³/s, cubic feet per second]

Station number	Stream name and gaging station number	Years of record (*N*)	Index station number	Equivalent years of record (*Ne*)	Unadjusted mean annual runoff (ft³/s)	Adjusted mean annual runoff (ft³/s)	Coefficient of determination (R^2)
06117000	Checkerboard Creek	9	06120500	35	8.36	8.62	0.88
06120800	Antelope Creek trib. No. 2	5	06115500	11	.91	.54	.74
06121500	Lebo Creek	9	06120500	22	13.2	13.6	.85
06125700	Big Coulee	14	06120500	32	7.38	10.2	.72
06130700	Sand Creek	10	06177500	16	5.19	6.11	.60
06131200	Nelson Creek	7	06131000	28	2.45	2.01	.94
06164800	Beaver Creek above Dix Creek	10	06131000	30	53.3	48.2	.90
06172200	Buggy Creek	10	06111000	12	5.38	5.32	.62
06175540	Prairie Elk Creek	7	06329200	12	20.1	17.3	.74
06177050	East Fork Duck Creek	6	06131000	10	.44	.72	.68
06177100	Duck Creek	6	06131000	19	.91	2.20	.90
06177825	Redwater River	7	06329200	17	49.6	41.8	.98
06183000	Big Muddy Creek	5	06131000	14	61.4	60.5	.88
06197000	Big Timber Creek	11	06200500	27	76.9	75.5	.85
06201700	Hump Creek	6	06125700	12	.24	.15	.92
06210500	West Fork Rock Creek	10	06200500	20	66.5	76.9	.76
06288000	Rotten Grass Creek	5	06216000	10	31.2	36.5	.79
06288200	Beauvais Creek	10	06129000	16	23.6	17.8	.94
06294690	Tullock Creek	8	06306300	13	10.5	10.5	.66
06294940	Sarpy Creek	9	06329200	14	7.54	6.03	.86
06294995	Armells Creek	8	06329200	14	7.08	5.36	.86
06295250	Rosebud Creek	8	06290500	17	48.8	41.8	.72
06306100	Squirrel Creek	7	06131000	18	3.77	3.34	.79
06307600	Hanging Woman Creek	9	06306300	18	4.78	5.04	.86
06308400	Pumpkin Creek	10	06131000	19	16.1	15.8	.67
06309075	Sunday Creek	8	06131000	20	42.8	39.1	.79
06326300	Mizpah Creek	8	06131000	16	17.1	15.2	.71

nual runoff and computed mean annual runoff) were plotted on a map and used as a guide in determining the three regions. Drainage divides were used as regional boundaries where feasible.

Separate multiple-regression analyses were then made for each of the three regions. Region 1 contained 17 gaging stations, and drainage area was determined to be the only significant independent variable. Region 2 contained 27 gaging stations, with drainage area, mean annual precipitation, and forest cover index being the significant independent variables. Region 3 contained 29 gaging stations, with drainage area, mean annual precipitation, and main channel slope being the significant independent variables. The final regression equations developed for each region, the standard errors of estimate, and the coefficient of determination (R^2) are given in table 2.

Table 2.--*Results of regression analysis for mean annual runoff using basin characteristics*

Mean annual runoff (cubic feet per second)		Equations	Average standard error of estimate (SE) (percent)	Coefficient of determination (R^2)
		Region 1 (17 stations)		
Q_a	=	$0.044\ A^{1.02}$	31	0.94
		Region 2 (27 stations)		
Q_a	=	$0.039\ A^{0.94}$	64	.85
Q_a	=	$0.0014\ A^{0.95}\ P^{1.25}$	62	.86
Q_a	=	$0.00013\ A^{0.99}\ P^{2.69}\ (F+10)^{-0.59}$	51	.90
		Region 3 (29 stations)		
Q_a	=	$0.426\ A^{1.03}$	103	.66
Q_a	=	$0.00053\ A^{1.08}\ P^{2.08}$	43	.92
Q_a	=	$0.00022\ A^{1.15}\ P^{1.75}\ S^{0.33}$	37	.94

LIMITATIONS OF DEFINITION

The estimating relations in this report are known to apply only within the range of variables tested or sampled. Equations were defined from data on streams virtually unaffected by urbanization or any large amount of regulation or diversion, and do not apply to streams subject to those conditions. The range of basin characteristics used is given in table 3. Values outside the ranges listed may not give reliable results.

Table 3.--*Range of basin characteristics used*

Region (fig. 1)	Drainage area (*A*) (square miles)	Mean annual precip- itation (*P*) (inches)	Forest cover (*F*+10) (percent)	Main channel slope (*S*) (feet per mile)
1	60.2 - 3,174	--	--	--
2	7.61 - 2,554	11-17	0-48	--
3	23.9 - 1,477	13-55	--	10.7 - 304

Comparing the equations that relate mean annual runoff to drainage area alone shows that the results for Regions 1 and 2 are similar. The equation for Region 3, however, yields mean annual discharges that are approximately 10 times greater for a given size drainage area. If mean annual runoff needs to be estimated for a stream near or on a regional boundary or for a stream that crosses regional boundaries, the discharge needs to be weighted according to respective drainage areas in each region.

ACCURACY OF ESTIMATING RELATIONSHIPS

The accuracy of a regression equation generally is measured by the standard error of estimate. The standard error of estimate is a measure of the standard deviation of the residuals about the regression line and is usually expressed in percentage of the estimated value when log-transformed variables are used. Thus, if the standard error of estimate of a regression equation is 50 percent, about two-thirds of all observed values of the dependent variable will be within 50 percent the estimated value. The standard error of estimate is a measure of how well the regression line fits the data that were used to derive the line and is not necessarily a measure of how well the equation can be used to estimate or predict from data not used in the regression analysis.

The standard error of estimate for each regression equation is given in table 2. These standard errors are smaller than the standard errors of estimate computed for the mean annual runoff analysis by Boner and Buswell (1970). They are also slightly smaller than those determined in channel geometry studies (Omang and others, 1983; Parrett and others, 1983) completed for the same area. The two methods are considered to be reliable, and each can be used to supplement or check the other.

CONCLUSIONS

Multiple-regression equations for estimating mean annual runoff at ungaged reams using basin characteristics were developed for three regions in central and eastern Montana. Basin characteristics determined to be important in the various estimating equations were drainage area, mean annual precipitation, forest cover index, and main channel slope. The maximum number of basin characteristics found to be significant in the equation in any region was three. The minimum number of basin characteristics included in any of the equations was one. Drainage area was the most significant basin characteristic in all regions.

The standard error of estimate in Region 1, based on data from 17 stations, was 31 percent using only drainage area in the estimating equation. The standard error of estimate in Region 2, based on 27 stations, was 64 percent using only drainage area. It improved to 62 percent with the addition of mean annual precipitation and to 51 percent with the addition of mean annual precipitation and forest cover index. The standard error of estimate in Region 3, based on 29 stations, was 103 percent using only drainage area. It improved to 43 percent with the addition of mean annual precipitation and to 37 percent with the addition of mean annual precipitation and main channel slope.

Mean annual runoff record at gaging stations with 10 years of record or less was extended based on correlation with a nearby hydrologically similar long-term gaging station. Coefficients of determination and equivalent years of record were determined at 27 gaging stations and used as an indicator of whether or not the short-term record needed to be adjusted.

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Table 4.--*Streamflow and basin characteristics at selected gaging stations*

Station number	Station name	Region	Length of equiv-alent record (years)	Mean annual runoff (cubic feet per second)	Drainage area (*A*) (square miles)	Mean annual precip-itation (*P*) (inches)	Forest cover (*F*) (per-cent)	Main channel slope (*S*) (feet per mile)
06111000	Ross Fork near Hobson, Mont.	2	14	14.0	337	17	5.3	40.6
06115500	North Fork Musselshell River near Delpine, Mont.	3	38	12.2	31.4	21	52.4	131
06117000	Checkerboard Creek at Delpine, Mont.	3	35	8.62	23.9	21	50.0	118
06118500	South Fork Musselshell River above Martins-dale, Mont.	3	36	91.3	287	20	46.6	58.7
06120500	Musselshell River at Harlowton, Mont.	3	72	167	1,125	18	34.4	28.9
06120800	Antelope Creek trib. No. 2 near Harlowton, Mont.	2	11	.54	21.2	13	.0	59.4
06121500	Lebo Creek near Harlow-ton, Mont.	3	22	13.6	59.1	14	.0	54.6
06122000	American Fork below Lebo Creek, near Harlowton, Mont.	3	21	31.0	166	19	10.5	65.8
25700	Big Coulee near Lavina, Mont.	2	32	10.2	232	14	4.8	24.4
06127900	Flatwillow Creek near Flatwillow, Mont.	2	24	14.3	188	25	42.0	57.4
06129000	Box Elder Creek near Winnett, Mont.	2	17	23.0	684	14	3.9	12.7
06130700	Sand Creek near Jordan, Mont.	2	16	6.11	317	11	.0	17.2
06131000	Big Dry Creek near Van Norman, Mont.	2	39	56.7	2,554	11	.0	19.3
06131200	Nelson Creek near Van Norman, Mont.	2	28	2.01	100	14	.0	12.7
06135500	Sage Creek at Q Ranch, near Wild Horse, Alberta	1	44	10.3	175	13	.0	19.2
06150000	Woodpile Coulee near international boundary	1	49	3.16	60.2	12	.0	11.9
06150500	East Fork Battle Creek near inter-national boundary	1	49	2.92	89.5	12	.0	14.0
06151000	Lyons Creek at inter-national boundary	1	52	2.49	66.7	12	.0	26.3

Table 4.--*Streamflow and basin characteristics at selected gaging stations*--Continued

Station number	Station name	Region	Length of equivalent record (years)	Mean annual runoff (cubic feet per second)	Drainage area (*A*) (square miles)	Mean annual precipitation (*P*) (inches)	Forest cover (*F*) (percent)	Main channel slope (*S*) (feet per mile)
06154400	Peoples Creek near Hays, Mont.	1	15	18.3	220	16	.0	26.4
06154500	Peoples Creek near Dodson, Mont.	1	23	32.7	670	15	2.7	20.5
06164800	Beaver Creek above Dix Creek, near Malta, Mont.	1	30	48.2	929	13	4.0	11.5
06169000	Horse Creek at international boundary	1	48	4.49	73.5	13	.0	20.8
06169500	Rock Creek below Horse Creek, near international boundary	1	33	23.5	328	13	.0	12.3
06170000	McEachern Creek at international boundary	1	53	10.8	182	13	.0	20.2
06172200	Buggy Creek near Glasgow, Mont.	1	12	5.32	105	12	.0	35.9
06175540	Prairie Elk Creek near Oswego, Mont.	2	12	17.3	352	14	.0	14.6
06177050	East Fork Duck Creek near Brockway, Mont.	2	10	.72	12.4	14	.0	53.7
06177100	Duck Creek near Brockway, Mont.	2	19	2.20	54.0	13	.0	38.5
06177500	Redwater River at Circle, Mont.	2	44	13.5	547	13	.0	43.9
06177825	Redwater River near Vida, Mont.	2	17	41.8	1,974	14	.0	6.50
06178000	Middle Fork Poplar River at international boundary	1	48	18.6	362	14	.0	15.3
06178500	East Poplar River at international boundary	1	48	16.1	534	16	.0	5.90
06179500	West Fork Poplar River at international boundary	1	22	4.50	139	13	.0	11.5
06181000	Poplar River near Poplar, Mont.	1	38	140	3,174	12	.0	6.43
06182500	Big Muddy Creek at Daleview, Mont.	1	24	15.7	279	15	.0	11.4
06183000	Big Muddy Creek at Plentywood, Mont.	1	14	60.5	850	14	.0	6.40
06197000	Big Timber Creek near Big Timber, Mont.	3	27	75.5	74.9	25	42.9	304

Table 4.--*Streamflow and basin characteristics at selected gaging stations*--Continued

Station number	Station name	Region	Length of equivalent record (years)	Mean annual runoff (cubic feet per second)	Drainage area (*A*) (square miles)	Mean annual precipitation (*P*) (inches)	Forest cover (*F*) (percent)	Main channel slope (*S*) (feet per mile)
06197500	Boulder River near Contact, Mont.	3	25	383	226	37	65.3	104
06200000	Boulder River at Big Timber, Mont.	3	33	614	523	30	57.9	55.6
06200500	Sweet Grass Creek above Melville, Mont.	3	43	86.5	63.8	33	48.7	106
06201700	Hump Creek near Reed Point, Mont.	2	12	.15	7.61	15	23.0	131
06204050	West Rosebud Creek near Roscoe, Mont.	3	17	129	52.1	55	16.0	186
06204500	Rosebud Creek near Absarokee, Mont.	3	34	407	394	32	29.0	123
06205000	Stillwater River near Absarokee, Mont.	3	47	968	975	32	54.6	73.3
06207500	Clarks Fork Yellowstone River near Belfry, Mont.	3	61	955	1,154	17	60.9	76.3
06209500	Rock Creek near Red Lodge, Mont.	3	48	174	124	40	40.0	243
06210500	West Fork Rock Creek near Red Lodge, Mont.	3	20	76.9	66.9	36	60.0	191
06211000	Red Lodge Creek above Cooney Reservoir, near Boyd, Mont.	3	43	62.3	143	22	30.0	98.0
06211500	Willow Creek near Boyd, Mont.	3	43	29.2	53.3	20	15.3	91.1
06216000	Pryor Creek at Pryor, Mont.	3	16	40.2	117	16	23.0	116
06217750	Fly Creek at Pompeys Pillar, Mont.	3	13	38.1	285	13	5.5	10.7
06287500	Soap Creek near St. Xavier, Mont.	3	19	30.6	98.3	18	2.8	282
06288000	Rotten Grass Creek near St. Xavier, Mont.	3	10	36.5	147	16	11.0	45.1
06288200	Beauvais Creek near St. Xavier, Mont.	3	16	17.8	100	15	.0	70.2
06289000	Little Bighorn River at State line, near Wyola, Mont.	3	43	155	193	20	87.0	196
06290000	Pass Creek near Wyola, Mont.	3	18	36.1	111	22	26.8	127

Table 4.--*Streamflow and basin characteristics at selected gaging stations*--Continued

Station number	Station name	Region	Length of equivalent record (years)	Mean annual runoff (cubic feet per second)	Drainage area (*A*) (square miles)	Mean annual precipitation (*P*) (inches)	Forest cover (*F*) (percent)	Main channel slope (*S*) (feet per mile)
06290500	Little Bighorn River below Pass Creek, near Wyola, Mont.	3	41	214	428	20	45.9	135
06291500	Lodge Grass Creek above Willow Creek diversion, near Wyola, Mont.	3	35	49.9	80.7	22	33.3	238
06294690	Tullock Creek near Bighorn, Mont.	2	13	10.5	446	14	14.0	15.0
06294940	Sarpy Creek near Hysham, Mont.	2	14	6.03	453	14	35.0	12.9
06294995	Armells Creek near Forsyth, Mont.	2	14	5.36	370	14	21.0	12.5
06295250	Rosebud Creek near Colstrip, Mont.	2	17	41.8	799	15	48.0	10.3
06306100	Squirrel Creek near Decker, Mont.	3	18	3.34	33.6	15	13.0	52.0
06306300	Tongue River at State line, near Decker, Mont.	3	22	496	1,477	16	37.0	76.2
06307600	Hanging Woman Creek near Birney, Mont.	2	18	5.04	470	14	17.0	18.4
06307740	Otter Creek at Ashland, Mont.	2	13	7.19	707	15	43.0	15.6
06308400	Pumpkin Creek near Miles City, Mont.	2	19	15.8	697	15	16.0	11.9
06309075	Sunday Creek near Miles City, Mont.	2	20	39.1	714	12	.0	7.70
06325500	Little Powder River near Broadus, Mont.	2	20	39.6	1,974	15	7.4	8.00
06326300	Mizpah Creek near Mizpah, Mont.	2	16	15.2	797	14	4.3	8.00
06329200	Burns Creek near Savage, Mont.	2	17	6.82	233	13	.0	27.2
06334000	Little Missouri River near Alzada, Mont.	2	49	77.2	904	16	8.0	9.27
06336500	Beaver Creek at Wibaux, Mont.	2	34	21.5	351	14	.0	5.00