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Scientific Investigations Report 2005-5216

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

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Conversion Factors and Datum

Multiply	By	To obtain
acre	4,047	square meter (m^2)
acre	0.4047	hectare (ha)
acre-foot (acre-ft)	1,233	cubic meter (m^3)
acre-foot (acre-ft)	0.001233	cubic hectometer (hm^3)
acre-foot per month (acre-ft/mon)	0.001233	cubic hectometer per month (hm^3/mon)
acre-foot per year (acre-ft/yr)	0.001233	cubic hectometer per year (hm^3/yr)
foot (ft)	0.3048	meter (m)
square mile (mi^2)	259.0	hectare (ha)
square mile (mi^2)	2.590	square kilometer (km^2)

Horizontal coordinate information is referenced to the North American Datum of 1927 (NAD 27).

Water year refers to the 12 month period beginning October 1 and ending September 30.

Acronyms

IJC International Joint Commission
SRSP Streamflow-Record Synthesis Program
USGS U.S. Geological Survey

Synthesis of Monthly and Annual Streamflow Records (Water Years 1950-2003) for Big Sandy, Clear, Peoples, and Beaver Creeks in the Milk River Basin, Montana

By Charles Parrett

Abstract

To address concerns expressed by the State of Montana about the apportionment of water in the St. Mary and Milk River basins between Canada and the United States, the International Joint Commission requested information from the United States government about water that originates in the United States but does not cross the border into Canada. In response to this request, the U.S. Geological Survey synthesized monthly and annual streamflow records for Big Sandy, Clear, Peoples, and Beaver Creeks, all of which are in the Milk River basin in Montana, for water years 1950-2003.

This report presents the synthesized values of monthly and annual streamflow for Big Sandy, Clear, Peoples, and Beaver Creeks in Montana. Synthesized values were derived from recorded and estimated streamflows. Statistics, including long-term medians and averages and flows for various exceedance probabilities, were computed from the synthesized data.

Beaver Creek had the largest median annual discharge (19,490 acre-feet), and Clear Creek had the smallest median annual discharge (6,680 acre-feet). Big Sandy Creek, the stream with the largest drainage area, had the second smallest median annual discharge (9,640 acre-feet), whereas Peoples Creek, the stream with the second smallest drainage area, had the second largest median annual discharge (11,700 acre-feet). The combined median annual discharge for the four streams was 45,400 acre-feet. The largest combined median monthly discharge for the four creeks was 6,930 acre-feet in March, and the smallest combined median monthly discharge was 48 acre-feet in January. The combined median monthly values were substantially smaller than the average monthly values.

Overall, synthesized flow records for the four creeks are considered to be reasonable given the prevailing climatic conditions in the region during the 1950-2003 base period. Individual estimates of monthly streamflow may have large errors, however.

Linear regression was used to relate logarithms of combined annual streamflow to water years 1950-2003. The results of the regression analysis indicated a significant downward trend (regression line slope was -0.00977) for combined annual streamflow. A regression analysis using data from 1956-2003 indicated a slight, but not significant, downward trend for combined annual streamflow.

Introduction

Water in the Milk and St. Mary Rivers in northern Montana and southern Canada is apportioned between the United States and Canada in accordance with the Boundary Waters Treaty of 1909. The International Joint Commission (IJC) Order of 1921 further clarified how the water of the two rivers would be apportioned. The Order provides for the measurement of water that flows across the boundary but does not call for the measurement of water that originates in one country but does not cross the boundary. Increasing use of water from the Milk River and recent drought conditions have raised concerns by the State of Montana about how apportionment under the Treaty is being implemented. In 2003, the State of Montana formally expressed concerns to the IJC about the apportionment. To assist it in carrying out its responsibilities under the Treaty, the IJC asked the Canadian and United States governments to provide it with an accounting of water in the two basins that originates in one country but does not cross the boundary. The U.S. Geological Survey (USGS) is assisting the United States government in responding to the request by providing estimates of the amount of streamflow in selected tributaries of the Milk River that originate in the United States and do not cross the international boundary. Specifically, the USGS estimated monthly and annual streamflow for Big Sandy, Clear, Peoples, and Beaver Creeks (fig. 1) for water years 1950-2003.

Big Sandy Creek has the largest drainage area (1,805 mi^2) of the four creeks. Sage Creek, the largest of the Big Sandy Creek tributaries, drains a small portion of the Sweet Grass Hills and flows through plains for most of its length on the western side of the Big Sandy Creek basin. Big Sandy Creek drains a small portion of the Bears Paw Mountains before flowing for most of its length through plains on the east side of the basin. Big Sandy Creek arises on and flows through the Rocky Boys Indian Reservation.

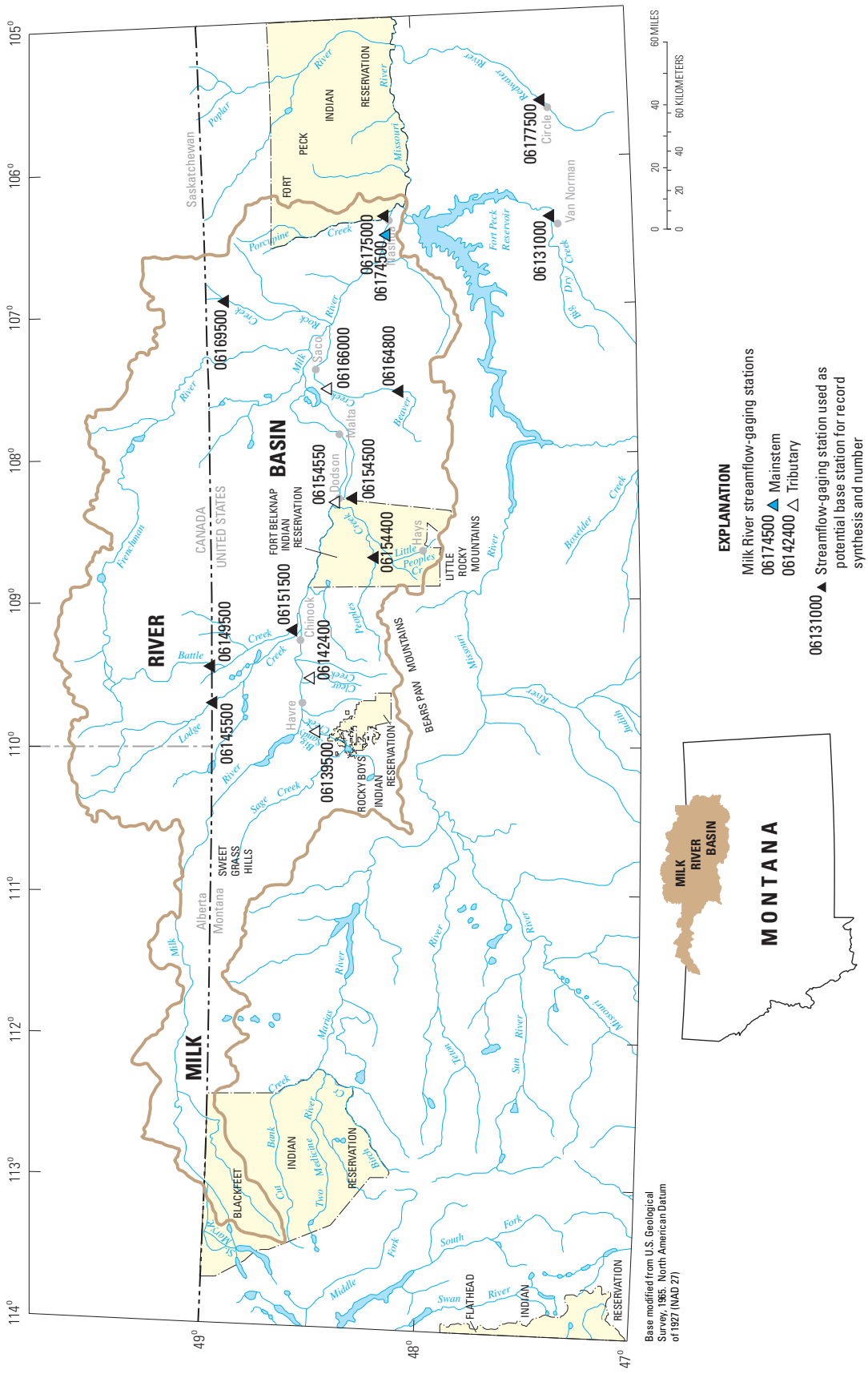

Figure 1. Location of study area, Milk River and tributary streamflow-gaging stations for which records were synthesized and streamflow-gaging stations used for record synthesis, Milk River basin of Montana, Alberta, and Saskatchewan.

Clear Creek also drains a small portion of the Bears Paw Mountains before flowing almost all of its length through plains east of the Big Sandy Creek basin. Clear Creek, which has the smallest drainage area of the four creeks (135 mi^2), does not drain any land on Indian reservations.

Peoples Creek also drains a small portion of the Bears Paw Mountains on the western edge of the basin. Little Peoples Creek, a major tributary, drains a portion of the Little Rocky Mountains near the southern boundary of the basin. Peoples Creek has a drainage area of 675 mi^2 and flows through plains on the Fort Belknap Indian Reservation for much of its length.

Beaver Creek drains a small portion of the Little Rocky Mountains near the southern edge of the basin. Beaver Creek and its tributaries flow through plains for most of their length. Beaver Creek drains about 1,200 mi^2, none of which is on Indian reservations.

All four creeks have some irrigation use, although the use is sporadic and relatively minor. Streamflows on all four creeks generally are intermittent and undependable for sustained use.

This report presents synthesized monthly and annual streamflow records (in acre-ft/mon and acre-ft/yr). Recorded monthly and annual streamflow data were used when available (table 1) for Big Sandy, Clear, Peoples, and Beaver Creeks in Montana; monthly and annual streamflows for water years 1950-2003 were estimated only for intervals during which recorded streamflow data either did not exist or were incomplete. Statistics, including long-term medians and averages and flows for various exceedance probabilities, were computed from the synthesized records. The synthesized values of monthly and annual streamflow for all four creeks were combined for each water year and exceedance probabilities for the combined annual streamflow also were determined. In addition, the combined annual streamflow values were analyzed for systematic increases or decreases.

Synthesis of Streamflow Records

Existing Data and Method of Synthesis

Big Sandy, Clear, Peoples, and Beaver Creeks all have been gaged, at least on a seasonal basis, for several years by the USGS. Peoples Creek and Beaver Creek have had streamflow-gaging stations at more than one location. The streamflow-gaging stations farthest downstream on Peoples Creek (station 06154550) and Beaver Creek (station 06166000) were used for estimation of long-term flow for those streams. The locations of these streams and gaging stations are shown on figure 1, and the station location, drainage area, and periods of streamflow record at the stations are indicated on table 1.

As indicated by table 1, Big Sandy, Clear, Peoples, and Beaver Creeks all have different periods of record, and two of the four streams have flow record only on a seasonal basis, beginning either in April, May, or June and continuing through September. Accordingly, a streamflow-record synthesis program (SRSP) developed by Alley and Burns (1983) was used to synthesize streamflow record for those months with missing streamflow data for all four sites. The SRSP is based on correlation of recorded monthly flows at the site requiring synthesized monthly flow data with concurrent monthly flows at a nearby streamflow-gaging station with similar streamflow characteristics. Streamflow-gaging stations (base stations) located in northeastern Montana that are considered to have streamflow characteristics similar to those for Big Sandy, Clear, Peoples, and Beaver Creeks are shown in figure 1. The selected base period for synthesis of the streamflow record represents a long-term period during which both droughts and high runoff have occurred in northeastern Montana and during which several streams in the general area have had nearly complete monthly flow record available for correlation analysis. Although all streams shown in table 1 have some irrigation water use, the use generally is small. Streamflows during times of irrigation use are reduced, but streamflows may be increased somewhat later in the season from irrigation return flow. Water use from and subsequent return flow to these streams probably has not changed substantially during the 1950-2003 base period, except in response to the variable climatic and runoff conditions. The effects of any irrigation water use were not considered separately as part of this study.

The SRSP selects the best base stations from all those available in a region to estimate missing streamflow data for sites where the record was synthesized. Thus, several different base stations might be used for making estimates for a single site. The criterion for selection of the best base station is to use the station with a streamflow record that results in the smallest standard error of prediction for that month. Only stations with streamflow record for a particular month and year were used to estimate missing streamflow data for other sites for that same month and year. Previously estimated monthly flows were not used to estimate missing streamflow data for this report. Each of the four sites requiring synthesized flow records also was used as a potential base station for making estimates for the other three sites. For example, flow record for Peoples Creek may have been used to estimate a month of missing flow data for Clear Creek.

In addition to the capability of using more than one base station to estimate missing monthly flow data, the SRSP also has the option of using a cyclic or noncyclic equation to estimate missing monthly flow data. If the cyclic option is selected, an equation is computed for each month using only concurrent flow data for that month. If the noncyclic option is selected, a single equation is computed for all months using all concurrent monthly flow data. For example, for 2 stations with 20 years of concurrent monthly flow record, the cyclic option would result in 12 monthly estimation equations, each based on 20 concurrent flows. The noncyclic option for the same 2 sites would result in 1 estimation equation based on 240 concurrent monthly flows. The criterion of having the smallest standard error of prediction also was used to select

the cyclic or noncyclic option for each estimate. Streamflow records from base stations were not used to synthesize record for another station unless records of the two stations had at least 20 concurrent monthly streamflow values.

The correlation procedure used to estimate missing flow data for all sites was the Maintenance of Variance Extension, Type 1 (MOVE.1) procedure described by Hirsch (1982). This procedure is analogous to Ordinary Least Squares regression but it has the important advantage that it produces a synthesized flow record with a variance similar to that of the short flow record.

Data for base stations that were used to synthesize flow record for each of the four Milk River tributary stations and a measure of the overall reliability of the estimated monthly flows (average standard error of prediction) calculated by the SRSP are shown in table 2. For clarity, only the three base stations that were most often used to estimate missing monthly flows are presented in table 2. Thus, data from the three base stations most often used for estimation of monthly flows for Big Sandy Creek (station 06139500) were used to make 463 out of 477 monthly flow estimates, the three most often used base stations for Clear Creek (station 06142400) were used to

Table 1. Data for selected streamflow-gaging stations in the Milk River basin and streamflow-gaging stations used as base stations for record synthesis, Montana.

[All sites in Montana except as indicated]

Station number (fig. 1)	Station name	Latitude	Longitude	Drainage area, square miles	Period of monthly flow record
Sites for which streamflow record was synthesized[1]					
06139500	Big Sandy Creek near Havre	48°31’36”	109°50’27”	1,805	2/1946–9/1953; 10/1984; 5/1984–9/2003 (seasonal)
06142400	Clear Creek near Chinook	48°34’44”	109°23’26”	135	6/1984–9/2003 (seasonal)
06154550	Peoples Creek below Kuhr Coulee, near Dodson	48°21’49”	108°21’20”	675	4/1918–9/1921 (seasonal); 6/1951–9/1973; 10/1982–9/2003
06166000	Beaver Creek below Guston Coulee, near Saco	48°21’24”	107°34’56”	1,208	4/1920–9/1921; 4/1981–9/2003 (seasonal)
Sites for which streamflow record was used for record synthesis					
06131000	Big Dry Creek near Van Norman	47°20’58”	106°21’26”	2,554	10/1939–9/1947; 4/1949–9/2003
06145500	Lodge Creek below McRae Creek, at international boundary	49°00’19”	109°43’02”	825	10/1951; 3/1952–9/2003 (seasonal)
06149500	Battle Creek at international boundary	49°00’07”	109°25’18”	997	9/1917–11/1917; 3/1918–9/2003 (seasonal)
06151500	Battle Creek near Chinook	48°38’58”	109°13’54”	1,623	4/1905–9/1921 (seasonal); 5/1944; 6/1984–9/2003 (seasonal)
06154400	Peoples Creek near Hays	48°13’25”	108°42’48”	220	12/1966–9/2003
06154500	Peoples Creek near Dodson	48°20’34”	108°21’32”	670	4/1918–9/1921 (seasonal); 10/1950–12/1950; 6/1951–9/1973; 10/1980–12/1980; 10/1982–9/1988
06164800	Beaver Creek above Dix Creek, near Malta	48°05’20”	107°33’18”	929	10/1966–9/1969; 10/1976–9/1982
06169500	Rock Creek below Horse Creek, near international boundary	48°58’10”	106°50’20”	328	5/1916–9/1926 (seasonal); 10/1955–9/2003 (seasonal)
06175000	Porcupine Creek at Nashua	48°08’09”	106°20’32”	725	8/1908–11/1915 (seasonal); 4/1916–10/1921; 5/1922–9/1924 (seasonal); 10/1980; 10/1982–9/1992
06177500	Redwater River at Circle	47°24’51”	105°34’30”	547	4/1929–9/1935 (seasonal); 10/1935–12/1936; 4/1937–6/1972; 10/1975–9/2003

[1]Records from these stations also were used for record synthesis.

make 483 out of 521 monthly estimates, the three most often used base stations for Peoples Creek (station 06154550) were used to make 105 out of 114 monthly flow estimates, and the three most often used base stations for Beaver Creek (station 06166000) were used to make 409 out of 483 monthly estimates. Table 2 indicates that Clear Creek required the most estimates of monthly flow (521), whereas Peoples Creek required the fewest (114).

Table 2 also indicates that the average standard error of prediction for monthly streamflow ranged from 571 percent for Peoples Creek to 5,678 percent for Beaver Creek. These large values are, in part, due to the difficulty in computing percentage errors when stations have numerous values of monthly streamflow that are zero or near-zero. Logarithms of streamflow are used within the program for calculation, and because the logarithm of zero is undefined, the program adds 0.01 to zero values of streamflow. Consequently, differences between small values of estimated and true streamflow (errors) can be very large when expressed as percentages, particularly when the estimated value is larger than the true value. For example, if an estimated monthly streamflow is 1 when the true streamflow is zero (assumed value of 0.01 for use in the program), the error (1 minus 0.01, or 0.99) is 9,900 percent of the true value. On the other hand, if an estimated monthly streamflow

Table 2. Summary of selected information for synthesis of flow records for Big Sandy, Clear, Peoples, and Beaver Creeks, Milk River basin, Montana, water years 1950-2003.

[All sites in Montana; others, all other base stations used for record synthesis]

Number of monthly streamflows, water years 1950-2003		Base stations used for record synthesis	Number of monthly streamflow estimates from base station	Standard error of prediction, in percent[1]
Recorded	Estimated			
06139500 Big Sandy Creek near Havre				
171	477	06154400	255	
		06154550	199	
		06149500	9	
		Others	14	
		Total	477	1,183
06142400 Clear Creek near Chinook				
127	521	06154400	283	
		06154500	188	
		06169500	12	
		Others	38	
		Total	521	680
06154550 Peoples Creek below Kuhr Coulee, near Dodson				
534	114	06154400	85	
		06139500	12	
		06169500	8	
		Others	9	
		Total	114	571
06166000 Beaver Creek below Guston Coulee, near Saco				
165	483	06154500	232	
		06154400	120	
		06145500	57	
		Others	74	
		Total	483	5,678

[1]Value is average for all monthly flow estimates for each site where streamflow record was synthesized.

is zero (assumed value of 0.01 for use in the program) when the true streamflow is 1, the error (0.99) is only 99 percent of the true value. Thus, the average error for the two estimates is 5,000 percent, even though the average magnitude of the error is zero. On this basis, the large average standard errors of prediction (which are analogous to the percentage errors just described) for the four Milk River tributary sites are believed to have a relatively small effect on the synthesized long-term streamflow records.

Synthesized Monthly and Annual Streamflow Records for Big Sandy, Clear, Peoples, and Beaver Creeks

The synthesized monthly values of streamflow for the four Milk River tributary streams for water years 1950-2003 are shown in tables 3-6 (at the back of the report). In addition, synthesized monthly flows were summed for each water year to provide estimates of annual streamflow. Similarly, the synthesized monthly and annual values of streamflow for all four Milk River tributary streams were combined (table 7, at the back of the report) to provide monthly and annual totals for these tributaries for each water year. The values for annual streamflow for each site and for the combined total were statistically summarized, and the long-term median and average flows and flows for various exceedance probabilities are shown in figures 2 and 3. Statistics also were computed for the long-term combined monthly streamflows. The long-term flows with an exceedance probability of 0.10 and median and average flows are shown in the form of bar charts in figure 4.

Data shown in the tables and figures indicate that all streams had many months during the 1950-2003 water years of zero or near-zero flows, especially in fall and winter. All streams generally had their largest values of monthly flow in either March or April, coinciding with spring snowmelt; however, all streams also had several large values of monthly flow in summer resulting from large rainstorms. The long-term median monthly flow for all streams was substantially less than the average monthly flow. The large differences between median and average values are typical of streams with highly variable monthly flow from year to year (fig. 4). For example, Big Sandy Creek had only 22 of 54 values of October monthly flow greater than zero (table 3). Nevertheless, the long-term monthly average flow for October was 490 acre-ft compared to a median value of zero. Estimates of long-term median monthly or annual flow are likely to be more reliable than estimates of long-term average monthly or annual flow. Averages are more sensitive to the effects of outliers than are medians and are thus more likely to be affected by individual monthly values that may be outliers simply because of large estimation errors.

Beaver Creek had the largest median annual flow (19,490 acre-ft), and Clear Creek had the smallest median annual flow (6,680 acre-ft). Big Sandy Creek, the stream with the largest drainage area, had the second smallest median annual flow (9,640 acre-ft), whereas Peoples Creek, the stream with the second smallest drainage area, had the second largest median annual flow (11,700 acre-ft). The somewhat larger flow from Peoples Creek relative to flow from Big Sandy Creek may be partly attributable to somewhat greater precipitation and runoff from headwater areas of Peoples Creek than from headwater areas of Big Sandy Creek.

The combined median annual flow for the four streams was 45,400 acre-ft (table 7). For comparison, the median annual flow for the USGS streamflow-gaging station Milk River at Nashua (station 06174500) for the 1950-2003 period was 366,000 acre-ft. The largest combined median monthly flow for the four creeks was 6,930 acre-ft in March, and the smallest combined median monthly flow was 48 acre-ft in January. The combined median monthly values were substantially smaller than the average monthly values.

Limitations of the Method of Streamflow Synthesis

As previously described, streamflows in northeastern Montana are highly variable, both temporally and spatially. For example, flow for a given month in a particular stream may vary from zero in one year to several thousand acre-ft in the next year. This large temporal variability in streamflow is illustrated graphically in figure 5. The bars in figure 5 show the maximum, median, and minimum values of recorded monthly streamflow at Big Dry Creek near Van Norman, Montana (station 06131000), a base station used for synthesis of monthly flow records, for the 1950-2003 base period. As indicated on figure 5, the minimum flow for most months is zero, whereas the maximum flow for those same months ranges from almost 1,000 acre-ft to more than 55,000 acre-ft. Likewise, flow for a given month might be several thousand acre-ft at one site subject to a large synoptic storm, but nearly zero at a nearby site outside the path of the storm. Figure 6 graphically illustrates the large spatial variability in recorded daily and monthly streamflow at Big Sandy, Clear, Peoples, and Beaver Creeks during May 1999. Figure 6 indicates that all four streams had about the same flow at the beginning and end of May, but Beaver Creek had much larger flow from storm runoff in the middle of May. The resultant total flow for May 1999 was much larger for Beaver Creek than any of the other Milk River tributary streams. Individual estimates of monthly flow at any of the Milk River tributary sites may thus have large errors and need to be used with caution. Estimates of annual flow for any year or long-term median or average monthly or annual flow are likely to be more reliable than individual monthly estimates, because adding the individual monthly flows tends to dampen individual errors. Overall, the synthesized flow records, which comprise both recorded and estimated monthly data, for Big Sandy, Clear, Peoples, and Beaver Creek are believed to be reasonable and plausible, given the climatic conditions of the region during the 1950-2003 base period.

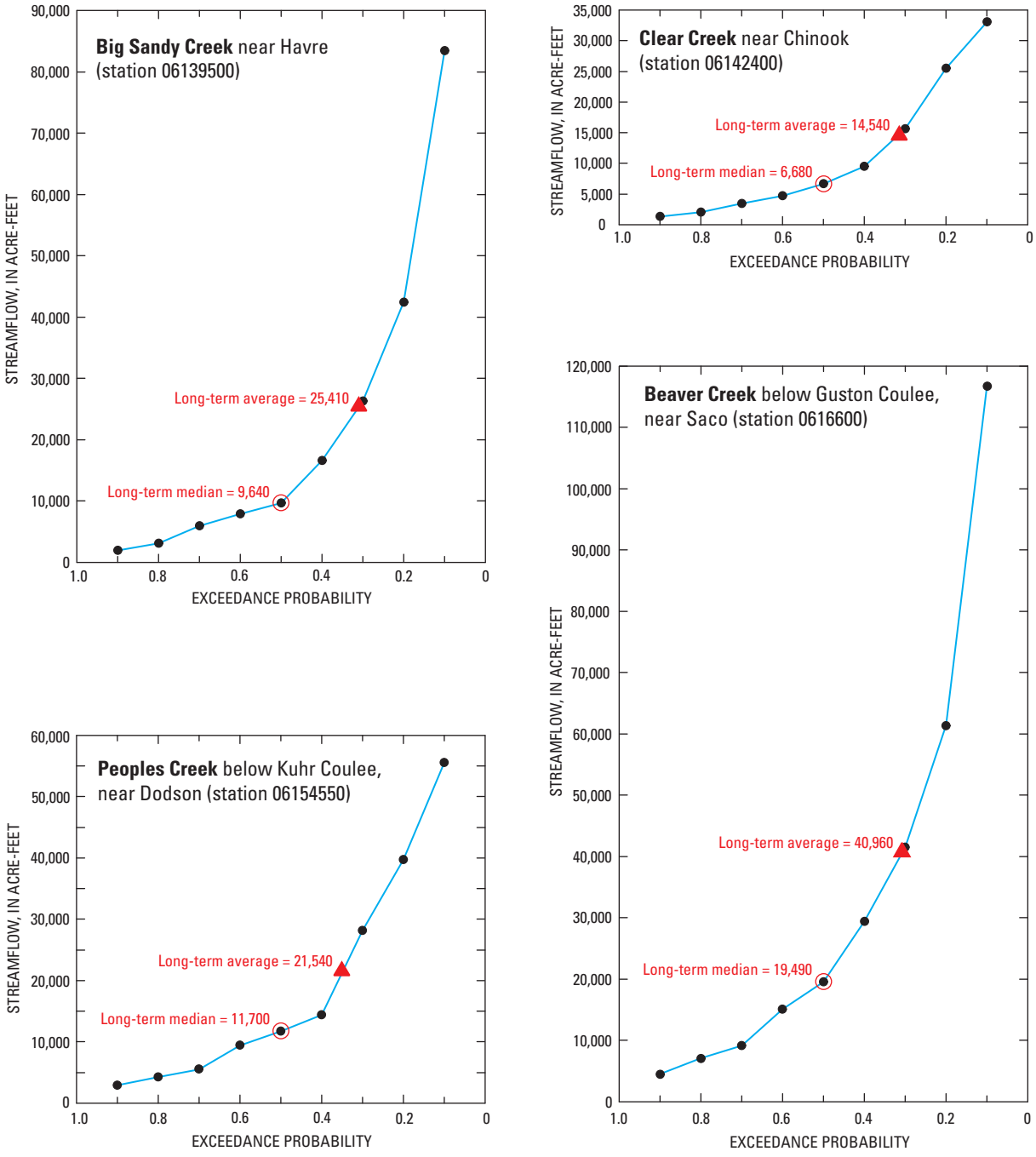

Figure 2. Synthesized annual streamflow for various exceedance probabilities for Big Sandy, Clear, Peoples, and Beaver Creeks, Milk River basin, Montana, water years 1950-2003.

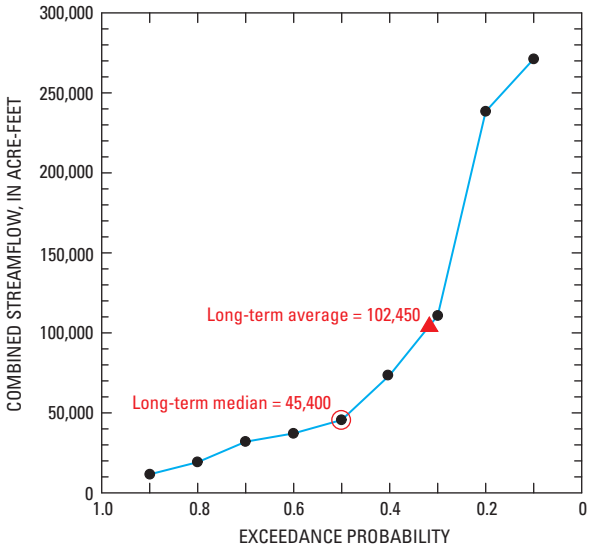

Figure 3. Combined synthesized annual streamflow for various exceedance probabilities for Big Sandy, Clear, Peoples, and Beaver Creeks, Milk River basin, Montana, water years 1950-2003.

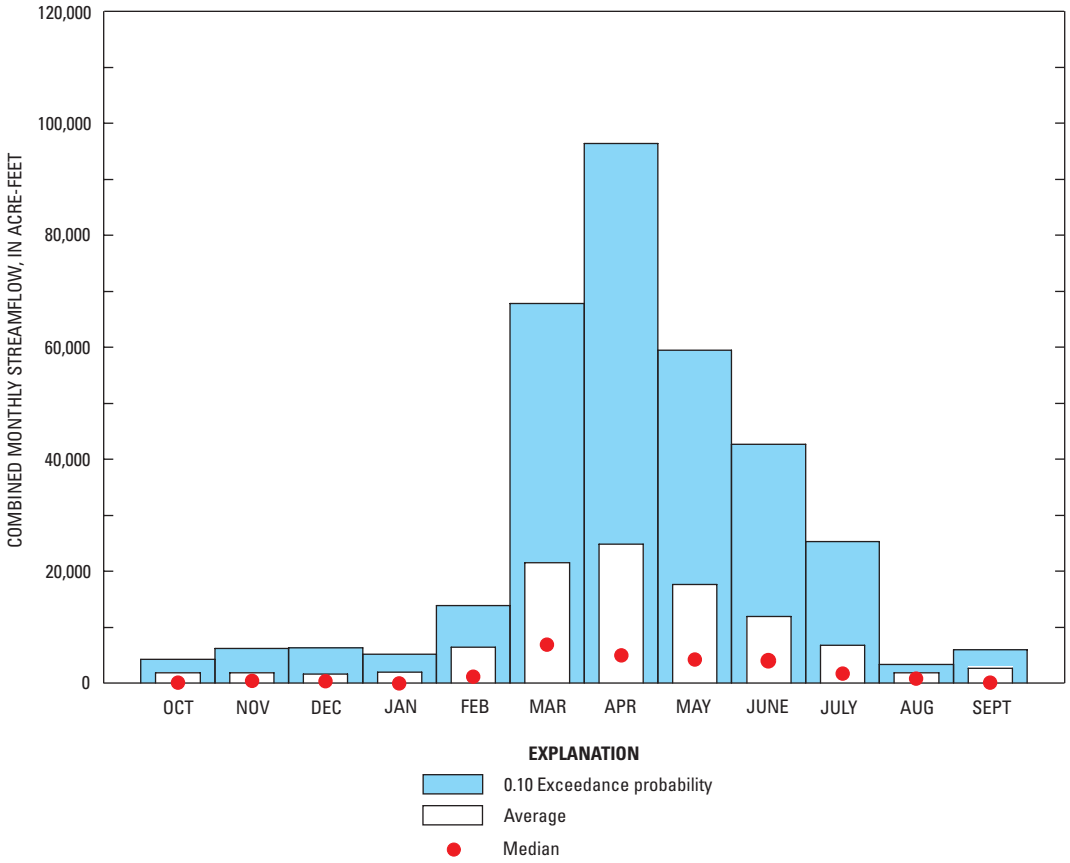

Figure 4. Variation of combined synthesized monthly streamflow for Big Sandy, Clear, Peoples, and Beaver Creeks, Milk River Basin, Montana, water years 1950-2003.

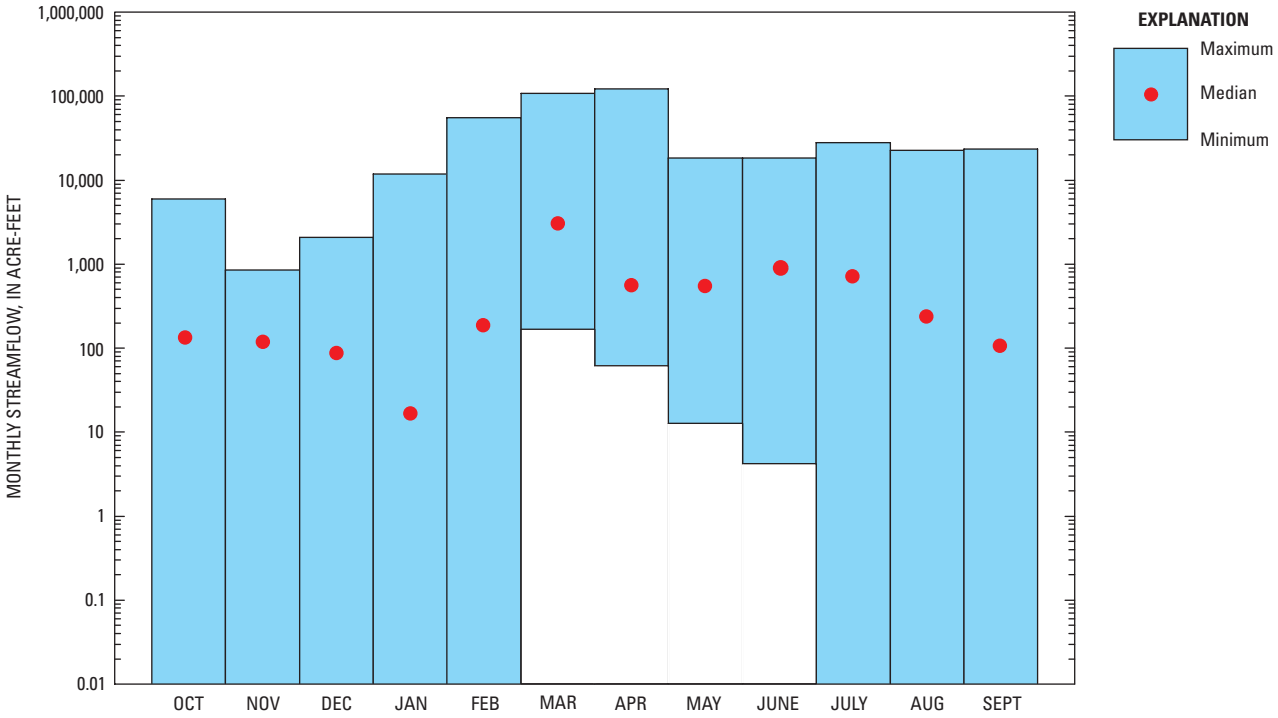

Figure 5. Variation in monthly streamflow for Big Dry Creek near Van Norman, Montana (station 06131000), for water years 1950-2003. Minimum values for October through February and July through September are zero.

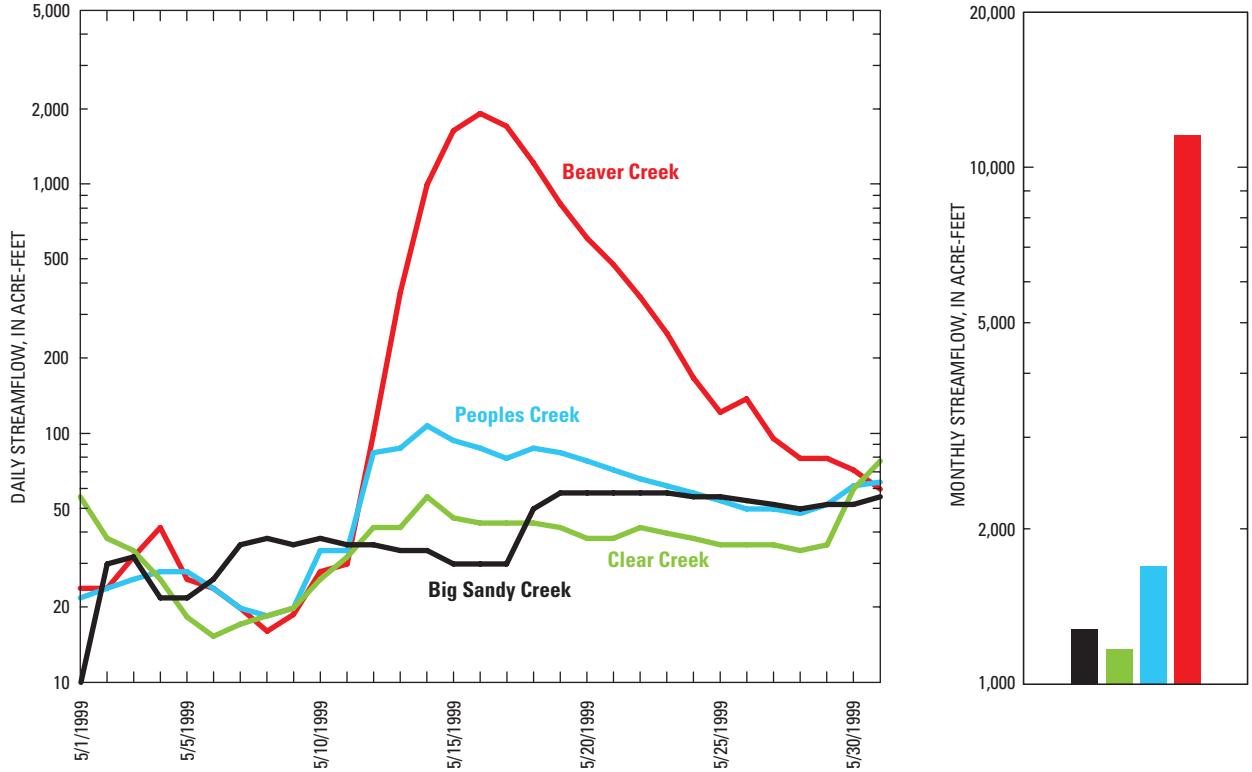

Figure 6. Variation in daily and monthly streamflow in May 1999 for Big Sandy, Clear, Peoples, and Beaver Creeks, Milk River basin, Montana.

Analysis of Trends in Combined Annual Streamflow for Big Sandy, Clear, Peoples, and Beaver Creeks

Although the period of water years 1950-2003 is long enough to contain periods of both drought and high runoff, the recent drought condition in northeastern Montana has been especially persistent and might have biased the synthesized records of long-term streamflow. Accordingly, the synthesized record of combined annual streamflow was analyzed to determine whether a significant trend was evident during water years 1950-2003. Linear regression was used to relate logarithms of combined annual streamflow to water years 1950-2003. The slope of the regression line, if statistically significant, provides an indication of trend in combined annual streamflow. The results of the regression analysis indicated a downward trend (regression line slope is –0.00977) for combined annual streamflow (fig. 7). The *p* value, or attained level of significance (Helsel and Hirsch, 1992), was 0.05, indicating that the trend is significant at the 95-percent confidence level (*p* value less than or equal to 0.05). The downward trend appears to be the result of persistent low-flow conditions over the last 4 years in combination with persistent high-flow conditions during the early 1950s. To further test the effects of the high-flow conditions in the early 1950s on the trend of combined annual streamflow, the regression analysis was repeated for only water years 1956-2003. The slope of the regression line for this analysis (fig. 8) was still slightly downward (-0.00863), but the *p* value was 0.15, indicating that the downward trend is not significant. On this basis, the significant downward trend for combined annual streamflow for water years 1950-2003 can likely be largely attributed to the high flows during the early part of the period.

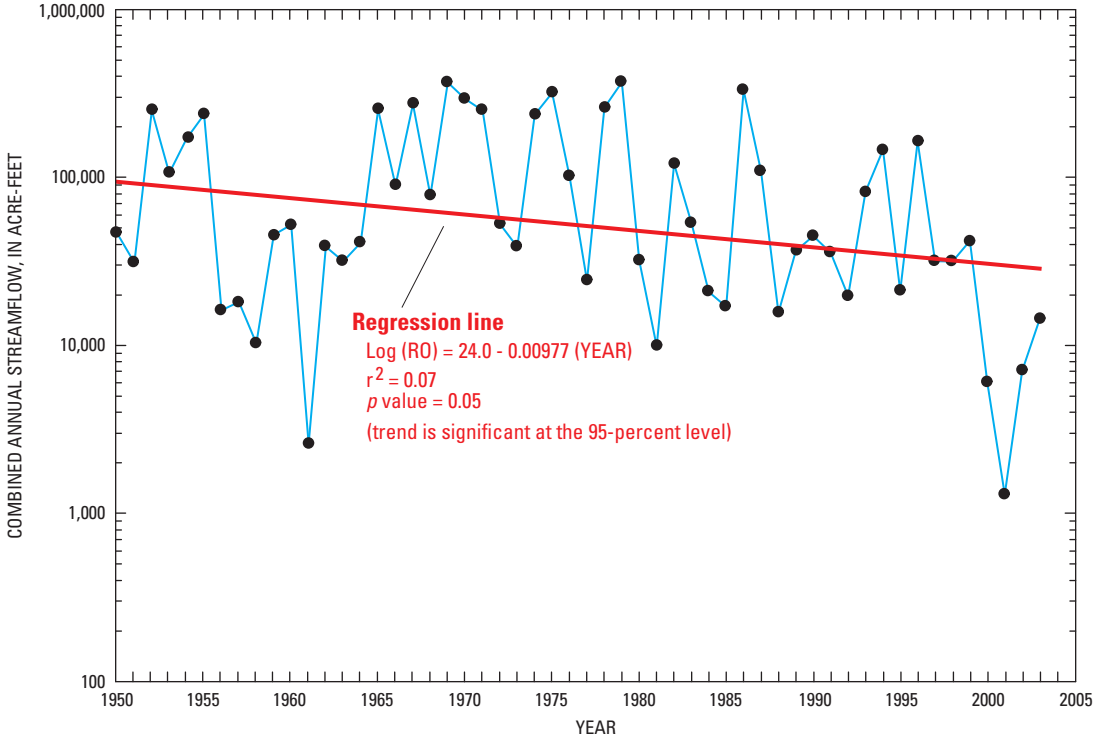

Figure 7. Analysis of trend in combined synthesized annual streamflow for Big Sandy, Clear, Peoples, and Beaver Creeks, Milk River basin, Montana, water years 1950-2003.

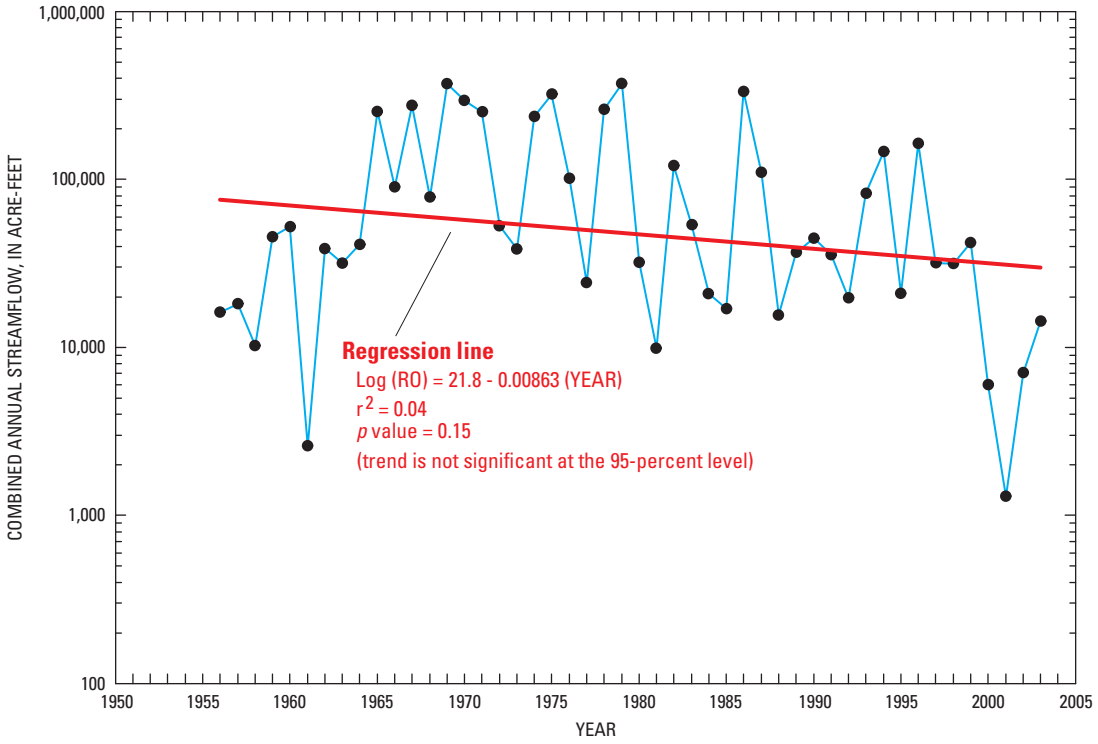

Figure 8. Analysis of trend in combined synthesized annual streamflow for Big Sandy, Clear, Peoples, and Beaver Creeks, Milk River basin, Montana, water years 1956-2003.

Summary

To address concerns expressed by the State of Montana about the apportionment of water in the St. Mary and Milk River basins between Canada and the United States, the International Joint Commission requested information from the United States government about water that originates in the United States but does not cross the border into Canada. In response to this request, the U.S. Geological Survey synthesized monthly and annual streamflow records for Big Sandy, Clear, Peoples, and Beaver Creeks, all of which are in the Milk River basin in Montana, for the period 1950-2003. Peoples Creek and Beaver Creek have had streamflow-gaging stations at more than one location. The streamflow-gaging stations farthest downstream on Peoples Creek (station 06154550) and Beaver Creek (station 06166000) were used for synthesis of recorded and estimated monthly and annual streamflow for those streams.

A streamflow-record synthesis program, based on correlation of recorded monthly flows at the site requiring monthly flow estimates with concurrent monthly flows at some nearby base station, was used to estimate missing months of streamflow during the 1950-2003 period. Only stations with streamflow record for a particular month and year were used to estimate missing streamflow data for other sites for that month and year; previously estimated monthly flows were not used to estimate any other missing monthly flows.

In addition to the capability of using more than one base station to estimate missing monthly flow record, the record-synthesis program also has the option of using a cyclic or noncyclic equation to estimate monthly flow data. Streamflow records from base stations were not used to estimate missing record for another station unless records of the two stations had at least 20 concurrent monthly streamflow values.

Clear Creek required the most estimates of monthly flow (521), whereas Peoples Creek required the fewest (114). Average standard errors of prediction for the estimated monthly flows ranged from 571 to 5,678 percent. These large values are, in part, due to the difficulty in computing percentage errors when stations have a large number of zero or near-zero values of monthly streamflow.

The values for monthly and annual streamflow for each site and for the combined total flows for the four sites were statistically summarized, and the long-term median and average flows and flows for various exceedance probabilities were computed. Data show that all streams had many months during the 1950-2003 water years of zero or near-zero flows, especially in fall and winter. All streams generally had their largest values of monthly flow in either March or April, coinciding with spring snowmelt; however, all streams also had

several large values of monthly flow in summer resulting from large rainstorms. The long-term median monthly flow for all streams was substantially less than the average monthly flow. The large differences between median and average values are typical of streams with highly variable monthly flow from year to year. For example, Big Sandy Creek had only 22 of 54 values of October monthly flow greater than zero. Nevertheless, the long-term monthly average flow for October was 490 acre-feet compared to a median value of zero.

Beaver Creek had the largest median annual flow (19,490 acre-ft), and Clear Creek had the smallest median annual flow (6,680 acre-ft). Big Sandy Creek, the stream with the largest drainage area, had the second smallest median annual flow (9,640 acre-ft), whereas Peoples Creek, the stream with the second smallest drainage area, had the second largest median annual flow (11,700 acre-ft). The somewhat larger flow from Peoples Creek relative to flow from Big Sandy Creek may be partly attributable to somewhat greater precipitation and runoff from headwater areas of Peoples Creek than from headwater areas of Big Sandy Creek.

The combined median annual flow for the four streams was 45,400 acre-ft. The largest combined monthly median flow for the four creeks was 6,930 acre-ft in March, and the smallest combined monthly median flow was 48 acre-ft in January. The combined monthly median values were substantially smaller than the monthly average values.

Overall, synthesized flow records for the four Milk River tributary streams are considered to be reasonable given the climatic conditions in the region during the 1950-2003 base period. Individual monthly estimates may have large errors, however, and need to be used with caution.

Linear regression was used to relate logarithms of combined annual streamflow to water years 1950-2003. The results of the regression analysis indicated a slight downward trend (regression line slope = -0.00977) for combined annual streamflow. The *p* value, or attained level of significance, was 0.05, indicating that the trend is significant at the 95-percent confidence level (*p* value less than or equal to 0.05). The regression analysis was repeated for water years 1956-2003, and the slight downward trend (regression line slope = -0.00863) was determined to be not significant (*p* value = 0.15). On this basis, the significant downward trend for combined annual streamflow for water years 1950-2003 can likely be largely attributed to the high flows during the early part of the period.

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Hirsch, R.M., 1982, A comparison of four streamflow-record extension techniques: Water Resources Research, v. 18, no. 4, p. 1081-1088.

Data

Table 3. Recorded and estimated monthly and annual streamflow for Big Sandy Creek (station 06139500), Milk River basin, Montana, water years 1950-2003.

[Streamflow values are in acre-feet. **Bold text** indicates recorded streamflow data]

Water year	October	November	December	January	February	March	April	May	June	July	August	September	Annual total
1950	**0**	**0**	**0**	**0**	**0**	**1,110**	**809**	**0**	**1**	**0**	**0**	**0**	1,920
1951	**0**	**0**	**0**	**0**	**0**	**2,310**	**899**	**12**	**1**	**0**	**7**	**3**	3,230
1952	**0**	**0**	**0**	**0**	**983**	**4,420**	**72,480**	**1,720**	**293**	**61**	**16**	**9**	79,980
1953	**12**	**18**	**9**	**0**	**0**	**242**	**92**	**137**	**13,210**	**2,200**	**267**	**12**	16,200
1954	68	399	289	141	1,910	898	12,910	861	1,100	467	68	208	19,320
1955	289	321	252	68	61	3,310	82,360	8,080	4,520	2,290	141	30	101,710
1956	31	65	0	0	0	1,110	1,570	228	36	86	0	0	3,120
1957	0	0	0	0	28	1,280	1,570	430	155	0	0	30	3,490
1958	0	0	0	0	228	1,280	262	0	0	0	0	0	1,770
1959	0	0	141	0	0	6,910	1,470	166	434	246	0	65	9,430
1960	68	30	68	105	228	6,860	1,670	584	434	295	31	30	10,400
1961	0	0	0	0	0	68	12	197	89	0	0	0	366
1962	0	0	0	0	94	1,280	12	375	226	639	0	0	2,630
1963	0	0	0	0	4,790	695	262	135	60	141	0	30	6,110
1964	0	0	0	31	0	31	89	2,770	5,420	701	178	173	9,400
1965	289	280	31	0	1,470	1,320	4,970	5,820	9,700	8,500	1,030	1,570	34,980
1966	941	708	449	31	61	11,940	3,800	375	155	141	68	0	18,670
1967	0	30	264	529	478	12,650	13,560	3,270	2,290	523	0	512	34,090
1968	1,060	1,540	793	3,200	7,510	6,430	1,380	228	1,210	191	1,320	1,280	26,130
1969	1,320	1,280	1,590	264	239	23,240	16,910	1,520	4,840	7,020	1,060	0	59,280
1970	1,590	2,320	2,130	0	2,410	6,970	5,550	48,360	17,280	2,020	1,320	1,020	90,960
1971	1,590	2,060	1,320	8,040	18,290	7,510	10,470	769	482	141	0	0	50,680
1972	0	0	0	0	0	6,700	1,380	314	5,500	191	0	0	14,080
1973	0	0	0	0	0	793	4,500	769	672	141	0	0	6,870
1974	0	0	0	5,080	1,190	4,000	1,020	39,330	25,910	492	5,080	2,830	84,940
1975	2,660	2,580	1,860	1,060	716	1,590	2,720	51,640	25,650	166	5,620	3,610	99,870
1976	4,540	3,360	2,660	3,470	3,860	5,080	1,340	793	1,020	1,650	0	0	27,770
1977	0	0	0	0	3,370	1,060	95	793	0	609	0	0	5,930
1978	0	0	264	0	0	42,060	4,380	27,600	11,710	3,430	1,860	3,610	94,910

Table 3. Recorded and estimated monthly and annual streamflow for Big Sandy Creek (station 06139500), Milk River basin, Montana, water years 1950-2003.—Continued

Water year	October	November	December	January	February	March	April	May	June	July	August	September	Annual total
1979	2,660	1,800	2,660	1,320	1,440	77,690	2,760	24,600	5,700	5,850	264	256	126,990
1980	0	512	1,590	0	1,190	4,540	286	529	0	74	0	0	8,730
1981	0	512	264	264	0	264	24	793	768	166	0	0	3,060
1982	0	0	0	0	1,190	5,080	1,670	1,550	16,280	1,760	529	0	28,050
1983	1,320	1,280	1,060	793	955	1,060	315	861	36	8,730	264	0	16,670
1984	6	256	264	1,320	1,680	1,860	631	**293**	**171**	**0**	**0**	**0**	6,480
1985	**0**	0	0	0	0	1,860	**196**	**290**	**0**	**0**	**0**	**103**	2,450
1986	1,320	2,060	793	2,130	12,890	7,240	**625**	**6,640**	**7,200**	**1,830**	**389**	**2,330**	45,440
1987	**3,350**	5,180	3,470	1,320	2,160	3,470	**2,230**	**762**	**500**	**232**	**26**	**11**	22,700
1988	264	512	264	0	239	1,060	**177**	**21**	**1**	**0**	**0**	**0**	2,540
1989	0	0	0	0	0	3,730	**577**	**173**	**323**	**97**	**7**	**1**	4,910
1990	0	1,540	1,320	1,590	1,190	793	**1,550**	**2,300**	**3,580**	**1,270**	**275**	**11**	15,420
1991	0	0	0	0	0	0	**161**	**836**	**2,280**	**2,160**	**392**	**74**	5,900
1992	793	1,280	1,320	793	955	529	**192**	**6**	**0**	**179**	**1**	**0**	6,050
1993	0	0	0	0	478	4,810	**1,370**	**369**	**1,400**	**8,420**	**5,280**	**3,240**	25,370
1994	**2,020**	2,060	2,130	1,860	1,190	20,520	**4,280**	**3,320**	**2,160**	**658**	**132**	**54**	40,380
1995	0	0	0	0	0	529	**637**	**410**	**1,990**	**4,290**	**1,320**	**666**	9,840
1996	264	0	0	529	15,830	21,610	**7,680**	**3,410**	**3,090**	**1,170**	**175**	**96**	53,860
1997	0	0	0	0	716	3,730	**1,770**	**1,110**	**916**	**520**	**118**	**37**	8,920
1998	0	0	0	0	0	0	**184**	**60**	**548**	**6,520**	**928**	**359**	8,600
1999	0	0	0	264	239	264	**306**	**1,280**	**3,700**	**1,230**	**307**	**105**	7,690
2000	0	0	264	0	239	793	**206**	**230**	**189**	**65**	**0**	**0**	1,990
2001	0	0	0	0	0	31	**293**	**20**	**0**	**160**	**0**	**0**	505
2002	0	0	0	0	0	0	**9**	**52**	**292**	**2**	**2**	**0**	357
2003	0	0	0	0	0	0	**361**	**291**	**236**	**1**	**0**	**0**	890
Monthly average													
	490	592	510	633	1,680	6,010	5,130	4,580	3,400	1,440	527	414	25,410
Monthly median													
	0	0	4	0	239	1,730	1,180	673	610	271	21	11	9,640

Table 4. Recorded and estimated monthly and annual streamflow for Clear Creek (station 06142400), Milk River basin, Montana, water years 1950-2003.

[Streamflow values are in acre-feet. **Bold text** indicates recorded streamflow data]

Water year	October	November	December	January	February	March	April	May	June	July	August	September	Annual total
1950	0	0	0	0	0	590	446	0	0	0	0	0	1,040
1951	55	107	123	0	0	1,260	476	0	65	0	0	54	2,140
1952	55	54	166	31	1,790	10,150	12,090	775	303	37	31	0	25,470
1953	31	30	0	0	28	498	107	3,910	7,740	849	277	30	13,500
1954	55	298	221	111	1,270	639	2,550	805	1,100	252	55	161	7,510
1955	221	244	197	55	50	2,150	8,230	6,750	3,460	1,050	111	30	22,540
1956	31	54	0	0	0	775	672	221	65	55	0	0	1,870
1957	0	0	0	0	28	885	672	418	220	0	0	30	2,250
1958	0	0	0	0	178	885	214	0	0	0	0	0	1,280
1959	0	0	111	0	0	4,240	643	166	512	178	0	54	5,900
1960	55	30	55	86	178	4,210	696	553	512	86	31	30	6,520
1961	0	0	0	0	0	55	30	197	143	0	0	0	425
1962	0	0	0	0	78	885	30	363	303	805	0	0	2,460
1963	0	0	0	0	2,990	498	214	141	107	756	0	30	4,740
1964	0	0	0	31	0	31	107	2,440	4,010	86	141	137	6,990
1965	221	214	31	0	1,000	916	13,640	4,940	6,440	277	719	1,070	29,480
1966	664	512	332	31	50	7,050	1,180	363	220	178	55	0	10,630
1967	0	30	135	277	250	7,000	5,740	9,750	1,980	86	0	268	25,520
1968	560	821	418	1,730	4,130	3,520	1,670	560	1,180	43	707	684	16,020
1969	707	684	849	135	122	12,990	6,920	3,520	3,660	3,150	560	0	33,300
1970	849	1,240	1,140	0	1,290	3,810	5,300	27,360	10,310	135	707	541	52,700
1971	849	1,110	707	4,420	10,200	4,110	5,150	1,880	559	43	0	0	29,020
1972	0	0	0	0	0	3,670	1,390	560	4,060	86	0	0	9,760
1973	0	0	0	0	0	418	1,390	849	732	86	0	0	3,470
1974	0	0	0	2,770	639	2,170	1,960	22,180	14,520	228	2,770	1,530	48,760
1975	1,430	1,390	996	560	378	849	10,030	29,260	14,370	86	3,070	1,960	64,370
1976	2,470	1,820	1,430	1,880	2,090	2,770	1,530	418	541	658	0	0	15,600
1977	0	0	0	0	1,830	560	1,110	418	0	277	0	0	4,190
1978	0	0	135	0	0	23,750	8,550	15,470	6,470	1,240	996	1,960	58,570

Table 4. Recorded and estimated monthly and annual streamflow for Clear Creek (station 06142400), Milk River basin, Montana, water years 1950-2003.—Continued

Water year	October	November	December	January	February	March	April	May	June	July	August	September	Annual total
1979	1,430	964	1,430	707	766	44,320	17,980	13,760	3,110	1,990	135	131	86,730
1980	0	268	849	0	639	2,470	1,390	277	0	43	0	0	5,930
1981	0	268	135	135	0	135	131	418	405	86	0	0	1,710
1982	0	0	0	0	639	2,770	1,530	4,110	9,820	135	277	0	19,290
1983	707	684	560	418	505	560	405	2,770	65	43	135	0	6,850
1984	0	131	135	707	900	996	1,240	560	**39**	**0**	**0**	**0**	4,710
1985	**0**	0	0	0	0	996	**443**	**1,320**	**314**	**0**	**0**	**380**	3,450
1986	707	1,110	418	1,140	7,150	3,970	**714**	**8,420**	**4,400**	**1,300**	**256**	**2,820**	32,410
1987	**2,640**	2,820	1,880	707	1,160	1,880	**2,140**	**1,130**	**552**	**143**	**34**	**33**	15,110
1988	135	268	135	0	122	560	**59**	**11**	**0**	**0**	**0**	**0**	1,290
1989	0	0	0	0	0	2,020	**101**	**744**	**1,530**	**331**	**2**	**47**	4,780
1990	0	821	707	849	639	418	**1,170**	**2,150**	**1,150**	**322**	**9**	**0**	8,240
1991	0	0	0	0	0	0	**129**	**2,560**	**3,390**	**1,890**	**438**	**139**	8,550
1992	418	684	707	418	505	277	**33**	**9**	**2**	**47**	**6**	**2**	3,110
1993	0	0	0	0	250	2,620	**443**	**43**	**517**	**3,160**	**2,150**	**1,150**	10,330
1994	**824**	1,110	1,140	996	639	11,440	**2,740**	**1,910**	**982**	**103**	**2**	**0**	21,880
1995	0	0	0	0	0	277	**266**	**343**	**1,170**	**1,560**	**306**	**235**	4,160
1996	135	0	0	277	8,810	12,060	**2,590**	**1,570**	**881**	**146**	**3**	**1**	26,480
1997	0	0	0	0	378	2,020	**690**	**350**	**412**	**149**	**1**	**5**	4,010
1998	0	0	0	0	0	0	**58**	**11**	**397**	**972**	**8**	**2**	1,450
1999	0	0	0	135	122	135	**381**	**1,160**	**1,880**	**383**	**5**	**2**	4,210
2000	0	0	135	0	122	418	**277**	**309**	**221**	**101**	**2**	**0**	1,580
2001	0	0	0	0	0	31	**2**	**0**	**0**	**0**	**0**	**0**	33
2002	0	0	0	0	0	0	**0**	**0**	**578**	**251**	**205**	**7**	1,040
2003	0	0	0	0	0	0	577	836	161	0	0	0	1,570
Monthly average													
	283	329	283	344	961	3,550	2,370	3,320	2,140	443	263	250	14,540
Monthly median													
	0	15	43	0	150	956	693	652	546	135	4	2	6,680

Table 5. Recorded and estimated monthly and annual streamflow for Peoples Creek (station 06154550), Milk River basin, Montana, water years 1950-2003.

[Streamflow values are in acre-feet. **Bold text** indicates recorded streamflow data]

Water year	October	November	December	January	February	March	April	May	June	July	August	September	Annual total
1950	0	0	0	0	0	3,730	994	861	6	0	0	0	5,590
1951	123	238	369	0	955	7,950	1,040	154	**100**	**183**	**22**	**116**	11,250
1952	**94**	**145**	**367**	**61**	**3,980**	**23,000**	**27,430**	**1,690**	**1,070**	**664**	**81**	**10**	58,590
1953	**87**	**46**	**0**	**8**	**32**	**1,130**	**213**	**8,790**	**19,760**	**3,250**	**621**	**42**	33,980
1954	**139**	**637**	**521**	**212**	**2,840**	**1,410**	**5,710**	**1,780**	**1,540**	**576**	**130**	**378**	15,860
1955	**487**	**550**	**446**	**119**	**117**	**4,780**	**18,630**	**15,250**	**4,480**	**2,310**	**261**	**54**	47,490
1956	**85**	**114**	**0**	**0**	**0**	**1,720**	**1,490**	**466**	**125**	**127**	**10**	**5**	4,140
1957	**23**	**0**	**0**	**0**	**39**	**2,000**	**1,500**	**916**	**328**	**17**	**0**	**43**	4,860
1958	**4**	**18**	**33**	**0**	**410**	**2,000**	**471**	**21**	**2**	**0**	**0**	**0**	2,960
1959	**0**	**0**	**224**	**21**	**0**	**9,530**	**1,420**	**392**	**756**	**307**	**0**	**98**	12,740
1960	**151**	**47**	**123**	**192**	**392**	**9,470**	**1,520**	**1,250**	**780**	**386**	**68**	**41**	14,420
1961	**28**	**4**	**0**	**0**	**0**	**143**	**71**	**405**	**205**	**0**	**0**	**0**	855
1962	**0**	**0**	**0**	**2**	**170**	**1,990**	**34**	**805**	**506**	**744**	**29**	**0**	4,280
1963	**0**	**0**	**29**	**8**	**6,720**	**1,080**	**507**	**280**	**167**	**184**	**10**	**59**	9,050
1964	**0**	**0**	**0**	**66**	**18**	**47**	**262**	**5,480**	**5,090**	**799**	**281**	**323**	12,370
1965	**493**	**459**	**81**	**0**	**2,240**	**2,030**	**31,000**	**11,130**	**7,910**	**7,690**	**1,570**	**2,400**	67,010
1966	**1,490**	**1,130**	**756**	**89**	**123**	**15,930**	**2,600**	**781**	**327**	**159**	**105**	**1**	23,490
1967	**0**	**35**	**83**	**168**	**499**	**19,430**	**5,870**	**6,390**	**2,700**	**639**	**220**	**1,610**	37,660
1968	**683**	**512**	**337**	**2,250**	**2,640**	**3,010**	**1,370**	**513**	**1,640**	**272**	**548**	**413**	14,180
1969	**490**	**420**	**205**	**6**	**7**	**12,240**	**6,780**	**3,040**	**4,720**	**6,460**	**481**	**93**	34,950
1970	**695**	**857**	**805**	**113**	**600**	**5,130**	**3,320**	**28,470**	**12,200**	**2,110**	**498**	**416**	55,210
1971	**867**	**738**	**410**	**3,940**	**20,490**	**8,790**	**4,970**	**1,590**	**863**	**179**	**0**	**0**	42,850
1972	**3**	**169**	**8**	**0**	**24**	**4,490**	**1,360**	**701**	**5,160**	**232**	**2**	**0**	12,140
1973	**88**	**286**	**34**	**9**	**54**	**1,050**	**2,900**	**1,620**	**1,080**	**199**	**0**	**20**	7,330
1974	0	0	0	4,610	1,140	4,110	1,950	18,050	9,110	676	4,610	2,620	46,880
1975	2,470	2,390	1,750	1,020	689	2,000	4,740	22,920	9,050	234	5,090	3,310	55,650
1976	4,140	3,080	2,470	3,190	3,530	4,950	1,700	584	863	2,220	0	0	26,720
1977	0	0	0	0	3,090	1,460	1,420	584	12	830	0	0	7,400
1978	0	0	264	0	0	25,750	4,340	13,230	5,110	4,540	1,750	3,310	58,300

Table 5. Recorded and estimated monthly and annual streamflow for Peoples Creek (station 06154550), Milk River basin, Montana, water years 1950-2003.—Continued

Water year	October	November	December	January	February	March	April	May	June	July	August	September	Annual total
1979	2,470	1,690	2,470	1,260	1,360	41,560	6,510	11,960	3,020	7,690	264	256	80,520
1980	0	500	1,500	0	1,140	4,530	1,610	412	12	105	0	0	9,810
1981	123	60	61	264	0	492	446	584	702	234	0	0	2,970
1982	**143**	**84**	**66**	**2**	**3,190**	**6,000**	**1,540**	**3,130**	**11,660**	**1,830**	**140**	**64**	27,850
1983	**670**	**409**	**294**	**218**	**307**	**670**	**547**	**1,780**	**149**	**7,870**	**111**	**18**	13,040
1984	**32**	**144**	**18**	**228**	**1,400**	**1,170**	**867**	**321**	**100**	**0**	**0**	**0**	4,280
1985	**0**	**1**	**9**	**0**	**1,280**	**1,600**	**1,110**	**381**	**134**	**0**	**213**	**316**	5,040
1986	**1,160**	**456**	**108**	**357**	**9,330**	**7,130**	**1,960**	**35,360**	**7,740**	**2,550**	**327**	**28,560**	95,040
1987	**11,990**	**3,780**	**3,780**	**1,400**	**1,080**	**2,600**	**4,520**	**1,680**	**1,190**	**577**	**332**	**223**	33,160
1988	**299**	**422**	**175**	**16**	**108**	**762**	**409**	**550**	**5**	**0**	**0**	**0**	2,750
1989	**0**	**0**	**0**	**5**	**1**	**3,500**	**1,080**	**1,670**	**2,230**	**707**	**7**	**57**	9,260
1990	**164**	**928**	**1,300**	**818**	**578**	**1,420**	**1,510**	**2,340**	**1,810**	**280**	**16**	**0**	11,160
1991	**39**	**130**	**43**	**0**	**102**	**555**	**368**	**1,840**	**3,640**	**2,990**	**202**	**17**	9,920
1992	**176**	**295**	**338**	**261**	**384**	**478**	**227**	**23**	**233**	**1,130**	**5**	**0**	3,550
1993	**34**	**198**	**88**	**53**	**605**	**6,390**	**1,010**	**434**	**337**	**5,770**	**1,920**	**1,340**	18,190
1994	**1,310**	**1,210**	**1,110**	**738**	**489**	**16,420**	**2,680**	**2,790**	**3,890**	**315**	**4**	**7**	30,950
1995	**189**	**253**	**26**	**41**	**232**	**738**	**643**	**756**	**982**	**769**	**110**	**8**	4,750
1996	**812**	**130**	**48**	**364**	**10,000**	**23,670**	**4,020**	**2,100**	**1,160**	**146**	**416**	**368**	43,230
1997	**29**	**36**	**39**	**1,550**	**2,330**	**2,990**	**809**	**916**	**845**	**719**	**150**	**0**	10,410
1998	**31**	**112**	**69**	**23**	**183**	**434**	**197**	**6**	**1,100**	**1,160**	**438**	**0**	3,750
1999	**31**	**194**	**83**	**658**	**482**	**1,090**	**482**	**1,700**	**2,640**	**426**	**7**	**0**	7,790
2000	**1**	**6**	**48**	**43**	**61**	**339**	**115**	**331**	**105**	**318**	**0**	**0**	1,370
2001	**0**	**0**	**0**	**0**	**0**	**85**	**148**	**36**	**0**	**454**	**9**	**0**	732
2002	**0**	**0**	**0**	**0**	**0**	**0**	**123**	**41**	**232**	**0**	**437**	**0**	833
2003	**0**	**4**	**5**	**3**	**5**	**3,670**	**234**	**339**	**189**	**0**	**0**	**0**	4,450
Monthly average													
	599	425	389	451	1,580	5,720	3,130	4,070	2,590	1,330	398	863	21,540
Monthly median													
	86	137	75	42	401	2,320	1,400	916	922	440	74	18	11,700

Table 6. Recorded and estimated monthly and annual streamflow for Beaver Creek (station 06166000), Milk River basin, Montana, water years 1950-2003.

[Streamflow values are in acre-feet. **Bold text** indicates recorded streamflow data]

Water year	October	November	December	January	February	March	April	May	June	July	August	September	Annual total
1950	0	0	0	0	0	1,580	33,630	31	2,670	12	203	0	38,120
1951	148	143	467	0	0	3,440	2,730	6,900	48	228	375	143	14,620
1952	74	71	0	74	5,660	35,020	42,170	2,340	1,520	879	375	0	88,180
1953	148	851	633	0	67	1,470	6	12,830	20,820	4,550	1,640	71	43,080
1954	633	690	547	307	3,940	1,900	112,430	2,420	2,240	713	2,740	452	129,020
1955	74	143	0	148	133	6,810	28,140	22,800	2,380	3,210	2,880	71	66,790
1956	0	0	0	0	0	2,340	1,530	633	577	148	1,870	0	7,090
1957	0	0	0	0	67	2,690	1,530	1,220	1,060	0	953	71	7,580
1958	0	0	307	0	494	2,690	42	0	220	0	547	0	4,300
1959	148	71	148	0	0	13,950	1,350	467	744	387	289	143	17,690
1960	0	0	0	228	494	13,860	1,730	1,640	1,960	467	713	71	21,170
1961	0	0	0	0	0	148	0	547	48	0	203	0	946
1962	0	0	0	0	205	2,690	0	1,050	24,550	965	0	0	29,450
1963	0	0	0	0	9,730	1,470	42	387	6	228	0	71	11,930
1964	633	613	74	74	0	74	6	7,820	1,520	1,050	0	375	12,230
1965	1,990	1,510	965	0	3,060	2,770	47,920	16,410	32,890	11,150	1,270	3,280	123,200
1966	0	71	74	74	133	23,860	9,310	1,050	1,210	228	1,270	0	37,270
1967	879	690	467	228	644	29,370	124,040	9,200	5,490	3,510	793	2,180	177,490
1968	633	530	228	3,120	3,700	4,190	1,170	633	2,920	3,510	873	530	22,050
1969	879	1,100	1,050	0	0	18,120	194,640	4,280	3,330	18,350	713	143	242,600
1970	1,130	934	547	148	794	7,360	20,110	43,770	8,500	11,720	953	530	96,500
1971	0	220	0	5,540	31,190	12,830	73,400	2,160	2,020	1,480	953	0	129,790
1972	74	375	74	0	0	6,350	1,170	879	6,760	12	1,270	0	16,970
1973	6	0	0	0	67	1,380	13,130	2,160	2,490	775	1,030	0	21,040
1974	6	0	0	6,570	1,500	4,270	2,870	18,290	11,390	11,720	1,110	6	57,730
1975	6	3,290	2,350	1,320	889	6	5,350	41,380	11,310	31,790	3,870	6	101,550
1976	6	4,300	3,390	4,450	4,980	6,570	3,140	2,010	1,130	12	873	893	31,750
1977	6	0	0	0	4,340	6	179	2,260	18	12	0	6	6,830
1978	6	0	314	0	0	6	8,290	10,140	6,450	23,670	0	1,420	50,290

Table 6. Recorded and estimated monthly and annual streamflow for Beaver Creek (station 06166000), Milk River basin, Montana, water years 1950-2003.—Continued

Water year	October	November	December	January	February	March	April	May	June	July	August	September	Annual total
1979	6	2,270	3,390	1,660	1,810	41,580	5,450	12,160	3,850	4,170	713	6	77,070
1980	922	625	2,010	0	1,500	6	71	2,010	18	12	461	6	7,630
1981	148	71	74	314	0	338	**1**	**732**	**267**	**51**	**87**	**89**	2,170
1982	879	530	387	0	4,430	8,650	**3,430**	**5,660**	**18,740**	**1,570**	**762**	**690**	45,720
1983	0	143	0	307	422	879	**99**	**4,100**	**317**	**10,020**	**775**	**94**	17,160
1984	0	0	0	307	1,720	1,560	**406**	**0**	**1,420**	**17**	**16**	**0**	5,440
1985	**0**	613	148	0	1,720	2,160	**994**	**8**	**161**	**1**	**207**	**91**	6,100
1986	**1,600**	5,360	5,360	467	13,710	**12,540**	**538**	**44,150**	**1,630**	**3,870**	**524**	**70,630**	160,380
1987	**21,030**	530	228	1,900	1,480	**1,200**	**8,330**	**978**	**1,150**	**285**	**873**	**631**	38,610
1988	**151**	625	314	0	133	**64**	**20**	**3,840**	**1,130**	**2,790**	**73**	**0**	9,130
1989	**0**	0	0	0	0	**8,360**	**4,880**	**3,270**	**1,180**	**50**	**53**	**17**	17,810
1990	**2**	1,940	1,660	2,010	1,500	**1,450**	**146**	**836**	**386**	**30**	**150**	**106**	10,210
1991	**47**	0	0	0	0	**2**	**43**	**55**	**2,930**	**8,240**	**53**	**77**	11,450
1992	**66**	1,610	1,660	984	6	**31**	**1**	**42**	**19**	**2,320**	**271**	**19**	7,020
1993	**0**	0	0	0	583	**10,020**	**549**	**12**	**1,090**	**13,220**	**2,500**	**1,050**	29,030
1994	338	2,610	2,700	2,350	1,500	27,560	10,000	3,540	2,920	12	461	6	53,990
1995	6	0	0	0	0	**0**	**0**	**5**	**53**	**2,270**	**29**	**19**	2,380
1996	**366**	0	0	646	21,090	**11,740**	**4,480**	**1,550**	**655**	**166**	**194**	**387**	41,280
1997	**68**	0	0	0	889	**2,210**	**389**	**501**	**3,180**	**146**	**775**	**390**	8,550
1998	**160**	0	0	0	0	**87**	**258**	**422**	**2,390**	**13,710**	**452**	**472**	17,950
1999	**393**	0	0	314	283	**1,730**	**732**	**11,560**	**5,880**	**39**	**339**	**1,120**	22,390
2000	**83**	0	314	0	283	**0**	**0**	**0**	**267**	**113**	**28**	**0**	1,090
2001	**0**	0	0	0	0	6	**0**	**0**	**0**	**17**	**0**	**0**	23
2002	**0**	0	0	0	0	**0**	**0**	**0**	**2,110**	**646**	**1,440**	**649**	4,850
2003	**6**	0	0	0	0	**3,170**	**420**	**2,730**	**569**	**379**	**129**	**0**	7,400
						Monthly average							
Averages	625	602	553	621	2,320	6,340	14,280	5,810	3,860	3,610	725	1,610	40,960
						Monthly median							
Medians	26	71	74	0	353	2,280	1,170	1,820	1,520	556	492	71	19,490

Table 7. Combined recorded and estimated monthly and annual streamflows for Big Sandy, Clear, Peoples, and Beaver Creeks, Milk River basin, Montana, water years 1950-2003.

[Streamflow values are in acre-feet. Combined average and median values may not agree with average and median values (tables 3-6) due to independent rounding]

Water year	October	November	December	January	February	March	April	May	June	July	August	September	Annual total
1950	0	0	0	0	0	7,010	35,880	892	2,680	12	203	0	46,670
1951	326	488	959	0	955	14,960	5,150	7,070	214	411	404	316	31,240
1952	223	270	533	166	12,410	72,590	154,170	6,530	3,190	1,640	503	19	252,220
1953	278	945	642	8	127	3,340	418	25,670	61,530	10,850	2,810	155	106,760
1954	895	2,020	1,580	771	9,960	4,850	133,600	5,870	5,980	2,010	2,990	1,200	171,710
1955	1,070	1,260	895	390	361	17,050	137,360	52,880	14,840	8,860	3,390	185	238,530
1956	147	233	0	0	0	5,950	5,260	1,550	803	416	1,880	5	16,220
1957	23	0	0	0	162	6,860	5,270	2,980	1,760	17	953	174	18,180
1958	4	18	340	0	1,310	6,860	989	21	222	0	547	0	10,310
1959	148	71	624	21	0	34,630	4,880	1,190	2,450	1,120	289	360	45,760
1960	274	107	246	611	1,290	34,400	5,620	4,030	3,690	1,230	843	172	52,510
1961	28	4	0	0	0	414	113	1,350	485	0	203	0	2,590
1962	0	0	0	2	547	6,850	76	2,590	25,590	3,150	29	0	38,820
1963	0	0	29	8	24,230	3,740	1,030	943	340	1,310	10	190	31,830
1964	633	613	74	202	18	183	464	18,510	16,040	2,640	600	1,010	40,990
1965	2,990	2,460	1,110	0	7,770	7,040	97,530	38,300	56,940	27,620	4,590	8,320	254,670
1966	3,100	2,420	1,610	225	367	58,780	16,890	2,570	1,910	706	1,500	1	90,060
1967	879	785	949	1,200	1,870	68,450	149,210	28,610	12,460	4,760	1,010	4,570	274,760
1968	2,940	3,400	1,780	10,300	17,980	17,150	5,590	1,930	6,950	4,020	3,450	2,910	78,380
1969	3,400	3,480	3,690	405	368	66,590	225,250	12,360	16,550	34,980	2,810	236	370,130
1970	4,260	5,350	4,620	261	5,090	23,270	34,280	147,960	48,290	15,990	3,480	2,510	295,370
1971	3,310	4,130	2,440	21,940	80,170	33,240	93,990	6,400	3,920	1,840	953	0	252,340
1972	77	544	82	0	24	21,210	5,300	2,450	21,480	521	1,270	0	52,950
1973	94	286	34	9	121	3,640	21,920	5,400	4,970	1,200	1,030	20	38,710
1974	6	0	0	19,030	4,470	14,550	7,800	97,850	60,930	13,120	13,570	6,990	238,310
1975	6,570	9,650	6,960	3,960	2,670	4,450	22,840	145,200	60,380	32,280	17,650	8,890	321,440
1976	11,160	12,560	9,950	12,990	14,460	19,370	7,710	3,810	3,550	4,540	873	893	101,840
1977	6	0	0	0	12,630	3,090	2,800	4,060	30	1,730	0	6	24,350
1978	6	0	977	0	0	91,570	25,560	66,440	29,740	32,880	4,610	10,300	262,070

Table 7. Combined recorded and estimated monthly and annual streamflows for Big Sandy, Clear, Peoples, and Beaver Creeks, Milk River basin, Montana, water years 1950-2003.—Continued

Water year	October	November	December	January	February	March	April	May	June	July	August	September	Annual total
1979	6,570	6,720	9,950	4,950	5,380	205,150	32,700	62,480	15,680	19,700	1,380	649	371,310
1980	922	1,910	5,950	0	4,470	11,550	3,360	3,230	30	234	461	6	32,100
1981	271	911	534	977	0	1,230	602	2,530	2,140	537	87	89	9,910
1982	1,020	614	453	2	9,450	22,500	8,170	14,450	56,500	5,300	1,710	754	120,910
1983	2,700	2,520	1,910	1,740	2,190	3,170	1,370	9,510	567	26,660	1,290	112	53,720
1984	38	531	417	2,560	5,700	5,590	3,140	1,170	1,730	17	16	0	20,910
1985	0	614	157	0	3,000	6,620	2,740	2,000	609	1	420	890	17,040
1986	4,790	8,990	6,680	4,090	43,080	30,880	3,840	94,570	20,970	9,550	1,500	104,340	333,270
1987	39,010	12,310	9,360	5,330	5,880	9,150	17,220	4,550	3,390	1,240	1,270	898	109,580
1988	849	1,830	888	16	602	2,450	665	4,420	1,140	2,790	73	0	15,710
1989	0	0	0	5	1	17,610	6,640	5,860	5,260	1,190	69	122	36,760
1990	166	5,230	4,990	5,270	3,910	4,080	4,380	7,630	6,930	1,900	450	117	45,030
1991	86	130	43	0	102	557	701	5,290	12,240	15,280	1,090	307	35,820
1992	1,450	3,870	4,030	2,460	1,850	1,320	453	80	254	3,680	283	21	19,730
1993	34	198	88	53	1,920	23,840	3,370	858	3,340	30,570	11,850	6,780	82,920
1994	4,490	6,990	7,080	5,940	3,820	75,940	19,700	11,560	9,950	1,090	599	67	147,200
1995	195	253	26	41	232	1,540	1,550	1,510	4,200	8,890	1,770	928	21,130
1996	1,580	130	48	1,820	55,730	69,080	18,770	8,630	5,790	1,630	788	852	164,850
1997	97	36	39	1,550	4,310	10,950	3,660	2,880	5,350	1,530	1,040	432	31,890
1998	191	112	69	23	183	521	697	499	4,440	22,360	1,830	833	31,750
1999	424	194	83	1,370	1,130	3,220	1,900	15,700	14,100	2,080	658	1,230	42,080
2000	84	6	761	43	705	1,550	598	870	782	597	30	0	6,030
2001	0	0	0	0	0	153	443	56	0	631	9	0	1,290
2002	0	0	0	0	0	0	132	93	3,210	899	2,080	656	7,080
2003	6	4	5	3	5	6,840	1,590	4,200	1,160	380	129	0	14,310
						Monthly average							
Averages	2,000	1,950	1,730	2,050	6,540	21,620	24,910	17,780	11,990	6,830	1,910	3,140	102,450
						Monthly median							
Medians	247	510	493	48	1,300	6,930	5,010	4,310	4,060	1,790	953	188	45,400

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