

Subject: **Powder/Tongue River Basin Plan
Surface Water Hydrology
Tasks 3A and 3B**

Date: February 2002

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INTRODUCTION

Water availability models are to be developed to represent dry year, normal year, and wet year hydrologic conditions throughout the Powder/Tongue River Basin Planning area. Several key inputs are necessary to model the water availability including the current irrigated land base, crop water requirements, municipal and industrial surface water demands, and regulation by reservoir storage facilities. This information was developed through the Task 2 work effort. Schematic representations of the water availability models have been developed identifying the appropriate location of model nodes in relation to the various surface water demands, return flows, and storage regulation. Model nodes are located, in large part, at historic streamflow gaging stations in order to take advantage of the historic records of streamflow at these locations. Additionally, it is necessary to locate model nodes at locations with no record of streamflow, to appropriately simulate water use in the various drainages. This memorandum summarizes the methodology used to collect the historic records of streamflow, establish a study period for modeling, and to extend or fill-in the streamflow data where records are unavailable. The methodology used to estimate natural (virgin) streamflow at ungaged model nodes is also discussed in this memorandum.

HISTORIC STREAMFLOW RECORDS

HKM inventoried the available records of streamflow in the Powder/Tongue River Basin. Data from the following four sources were used for this study:

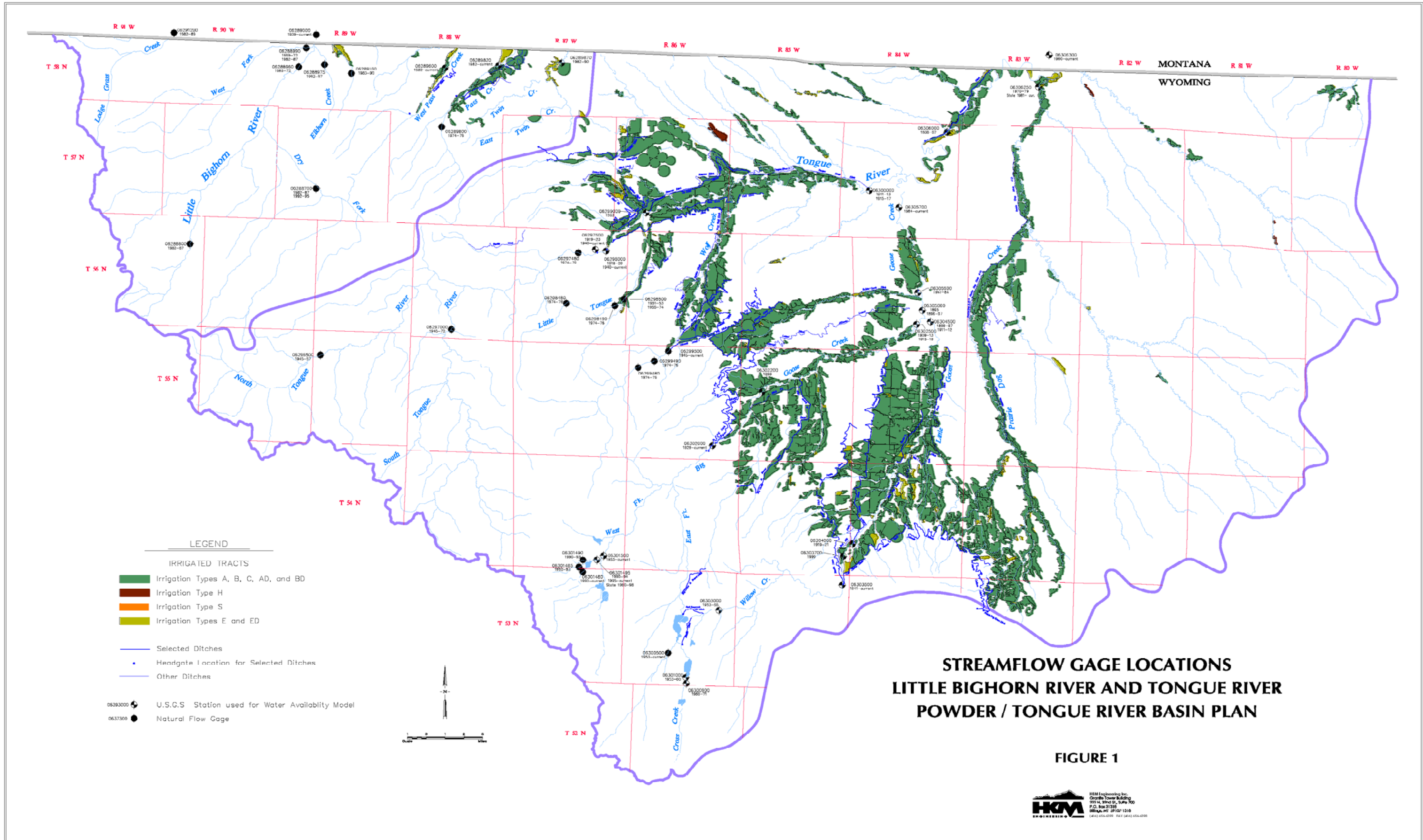
1. Wyoming USGS digital database in Cheyenne
2. USGS Water Resources Data Books for Wyoming
3. Records from State Engineers Office Hydrographers Annual Reports as compiled by HKM
4. Water Resources Data System (WRDS) database

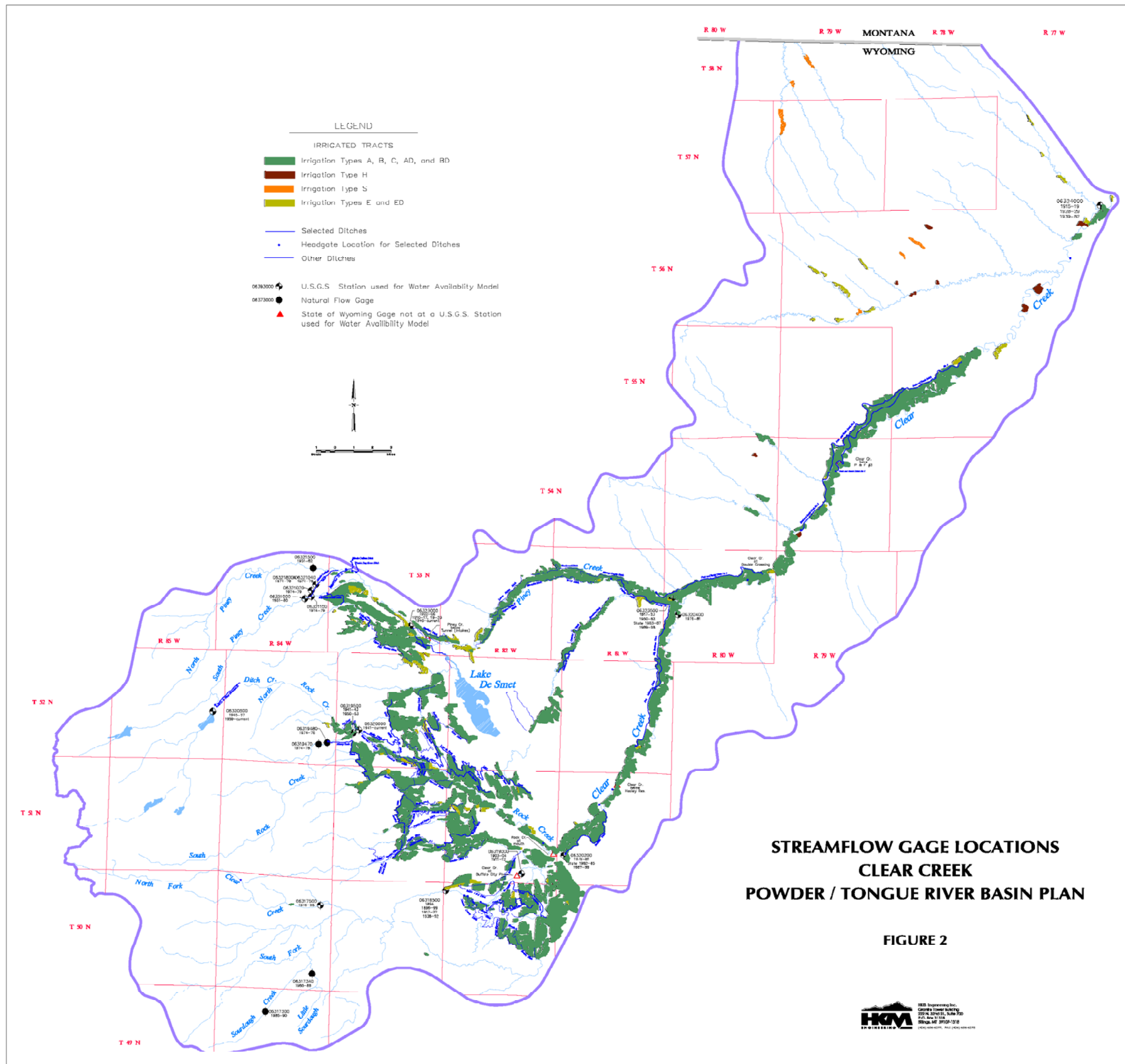
The order of priority for use of data available from multiple sources was as numbered above.

The location of the various streamflow gaging stations are plotted in relation to the significant storage reservoirs and the irrigated lands mapped by HKM (Figures 1 through 4). The streamflow gages that are relatively free from the influence of depletions or storage regulations are characterized as natural flow stations. Where reasonably possible, those gages that are impacted by upstream irrigation depletions were adjusted to remove these effects. The list of streamflow gages inventoried for this study is provided in Table 1.

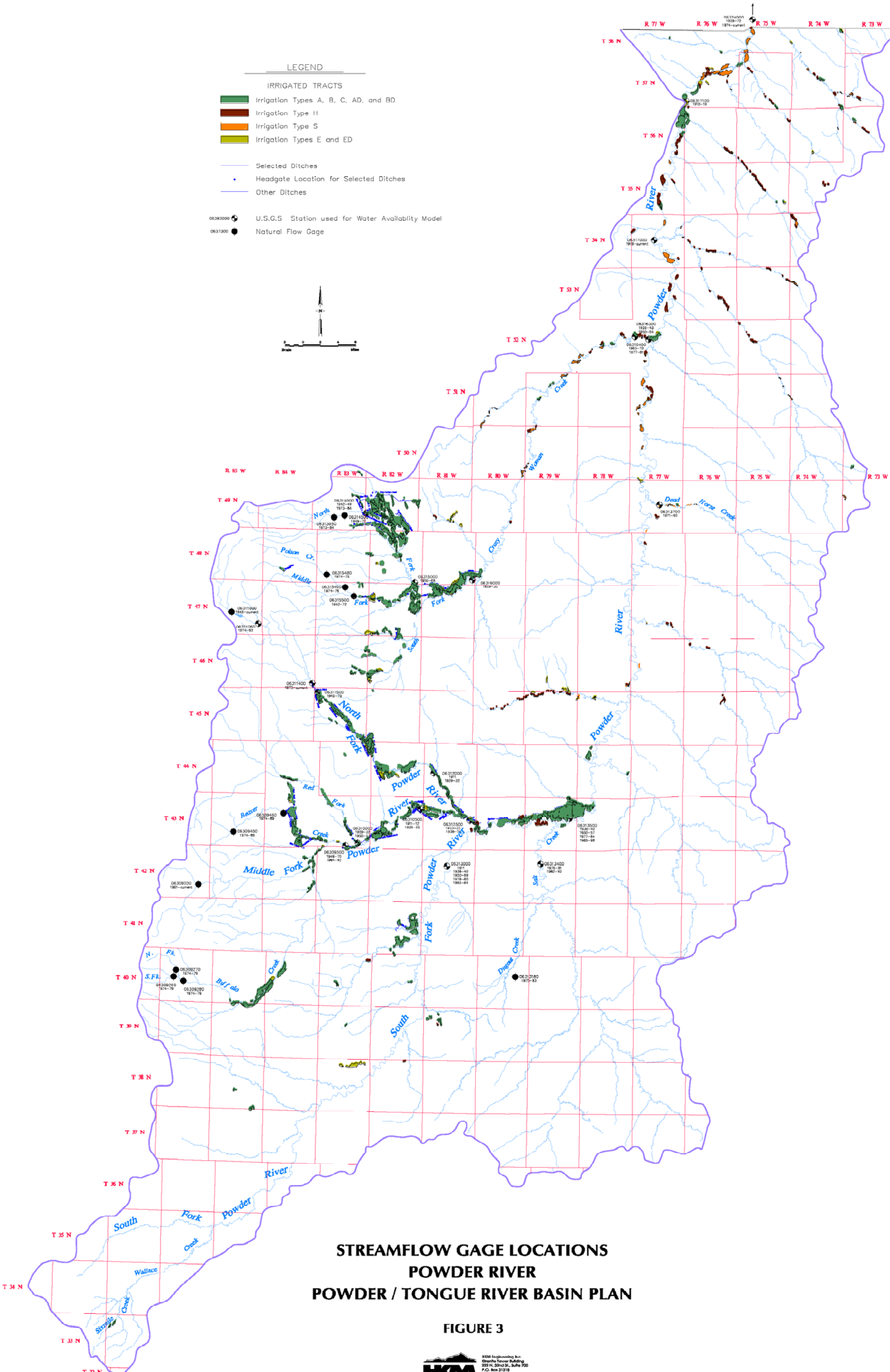
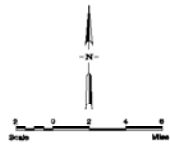
Figure 5 illustrates the period of record for all of the natural flow stations available in the basins. Figure 6 shows the period of record for the non-natural flow stations at model nodes. Figure 7 summarizes the records available for stations not selected for use in the water availability models. These records were typically excluded either because the stations were discontinued many years ago or because records for stations on the same stream at more appropriate locations are available.

As shown in Figures 5 and 6, records from 40 to 50 streamflow gaging stations are available beginning in the 1970s and 1980s in addition to those existing prior to that time.





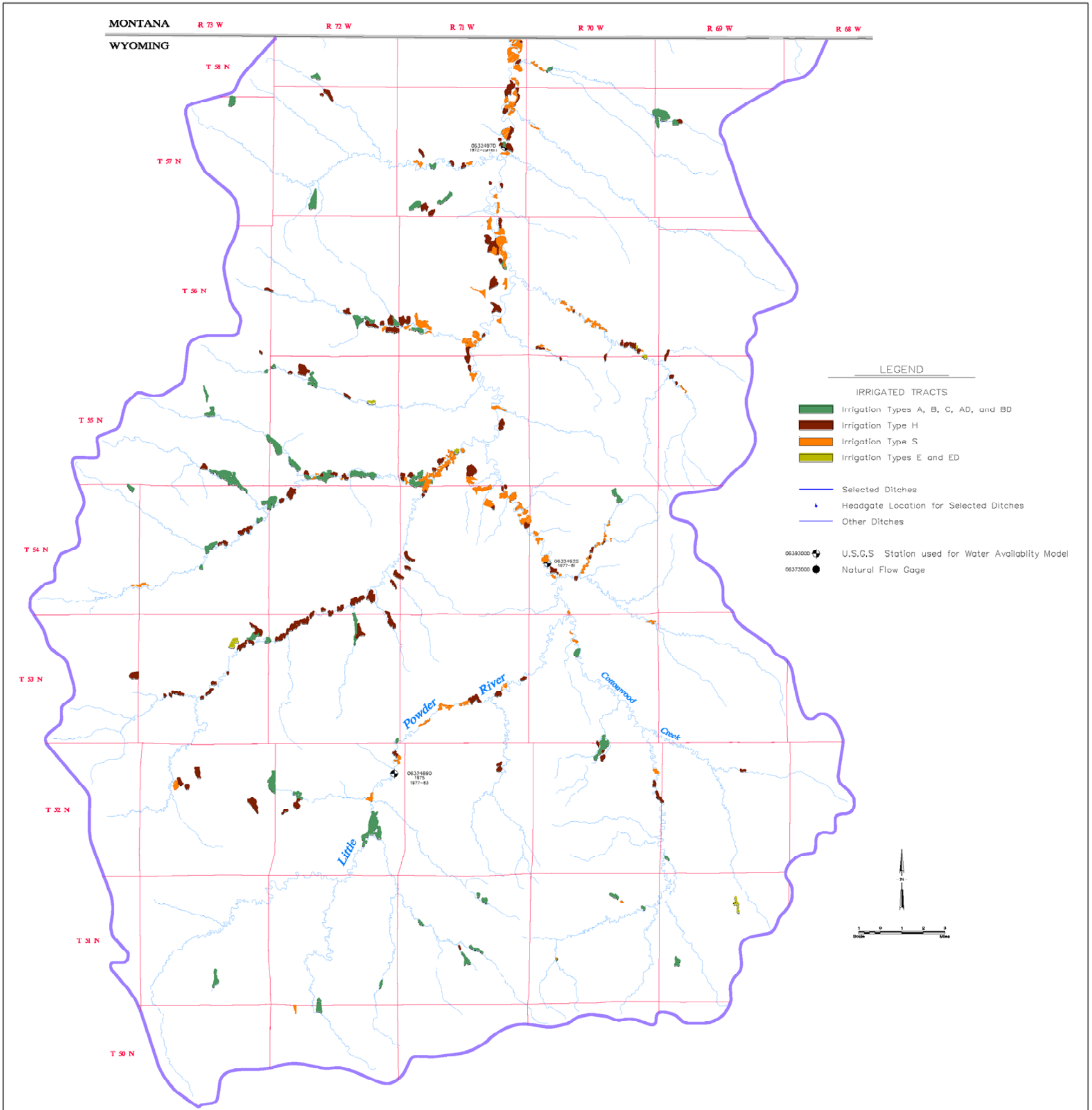
- LEGEND**
- IRRIGATED TRACTS**
- Irrigation Types A, B, C, AD, and BD
 - Irrigation Type H
 - Irrigation Type S
 - Irrigation Types E and ED
- Selected Ditches
- Headgate Location for Selected Ditches
- Other Ditches
- U.S.G.S Station used for Water Availability Model
- Natural Flow Gage



**STREAMFLOW GAGE LOCATIONS
POWDER RIVER
POWDER / TONGUE RIVER BASIN PLAN**

FIGURE 3





**STREAMFLOW GAGE LOCATIONS
LITTLE POWDER RIVER
POWDER / TONGUE RIVER BASIN PLAN**

FIGURE 4



**TABLE 1
STREAMFLOW STATIONS IN THE POWDER-TONGUE RIVER BASINS**

Basin	Station Number	Station Name	Natural Flow	Period of Record in Water Years **	Note
Little Bighorn	06288600	Little Bighorn River Below Dayton Gulch Near Burgess Junction, WY	YES	1983-1987	
	06288700	Dry Fork Little Bighorn Below Lick Creek Near Burgess Junction, WY	YES	1983-1987, 1993-1995	
	06288960	Little Bighorn River Near Parkman, WY	YES	1970-1972	
	06288975	Elkhorn Creek Above Fuller Ranch Ditch Near Parkman, WY	YES	1983-1987	No winter records in 1985
	06288990	West Fork Little Bighorn River Near Parkman, WY	YES	1970-72, 1983-1987	No winter records in 1987
	06289000	Little Bighorn River at State Line Near Wyola, MT	YES	1939-current	
	06289100	Red Canyon Creek Near Parkman, WY	YES	1982-1990	No winter records in 1985, 1987
	06289500	Little Bighorn River Near Wyola, MT	NO	1912-1924	No winter records; Abt. 7 mi. into MT
	06289600	West Pass Creek Near Parkman, WY	NO	1983-current	No winter records 1985-1987
	06289800	East Pass Creek Near Parkman, WY	YES	1975-1976	
	06289820	East Pass Creek Near Dayton, WY	NO	1983-current	
	06289870	Twin Creek Near Parkman, WY	NO	1983-1990	No winter records 1985-1987
	06290000	Pass Creek Near Wyola, MT	NO	1939-1975	Winter records incomplete before 1939; Abt. 4 mi. into MT
	06290500	Little Bighorn River Below Pass Creek Near Wyola, MT	NO	1939-1975	Abt. 13 mi. into MT
	06291200	Lodge Grass Creek at State Line Near Wyola, MT	YES	1982-1989	No winter records 1986
Tongue	06296500	North Fork Tongue River Near Dayton, WY	YES	1945-1958	No winter records before 1950
	06297000	South Fork Tongue River Near Dayton, WY	YES	1945-1972	
	06297480	Tongue River at Tongue Canyon Campground Near Dayton, WY	YES	1975-1979	
	06298000	Tongue River Near Dayton, WY	YES	1919-1929, 1941-current	Adjusted using Highline Ditch Near Dayton, WY (06297500) as published
	06298480	Little Tongue River at Steamboat Point Near Dayton, WY	YES	1975-1976	
	06298490	Little Tongue River Above South Fork Little Tongue River Near Dayton, WY	YES	1975-1976	
	06298500	Little Tongue River Near Dayton, WY	YES	1951-1974	
	06299000	Tongue River at Dayton, WY	NO	1903-1904	Seasonal (May 1903 to Oct. 1904)
	06299480	Wolf Creek Below Alden Creek Near Wolf, WY	YES	1975-1976	
	06299490	Wolf Creek Above Red Canyon Creek at Wolf, WY	YES	1975-1976	
	06299500	Wolf Creek at Wolf, WY	YES	1945-current	No winter records after 1971
	06300000	Tongue River at Carneyville, WY	NO	1911-1917	Seasonal only
	06300500	East Fork Big Goose Creek Near Big Horn, WY	YES	1954-current	No winter records after 1973
	06300900	Cross Creek Above Big Horn Reservoir Near Big Horn, WY	NO	1961-1971	
	06301000	Cross Creek Near Big Horn, WY	NO	1954-1960	
	06301480	Coney Creek Above Twin Lakes Near Big Horn, WY	YES	1991-current	No winter records 1993, 1996, 1998, 1999
	06301485	Lost Lake Creek Near Big Horn, WY	YES	1991-1993	
	06301490	Snail Creek Near Big Horn, WY	YES	1991-1993	
	06301495	Coney Creek Below Twin Lakes Near Big Horn, WY	NO	1991-1994, 1996-current	No winter records some years
	06301500	West Fork Big Goose Creek Near Big Horn, WY	NO	1954-current	No winter records after 1971
	06302000	Big Goose Creek Near Sheridan, WY	NO	1929-current	No winter records after 1971; Adjusted for diversions using PK Ditch & Sheridan City Intake Ditch
	06302200	Big Goose Creek Above Park Creek Near Sheridan, WY	NO	1999-current	Jul. - Sep. 1999
	06302500	Goose Creek at Sheridan, WY	NO	1909-1916	No winter records
	06303000	Willow Creek Near Big Horn, WY	NO	1954-1955	
	06303500	Little Goose Creek in Canyon Near Big Horn, WY	NO	1941-current	No winter records after 1971
	06303700	Little Goose Creek Above Davis Creek Near Big Horn, WY	NO	1999-current	Jul. - Sep. 1999
	06304000	Little Goose Creek Near Big Horn, WY	NO	1919-1922	No winter records 1919
	06304500	Little Goose Creek at Sheridan, WY	NO	1896-1897, 1911-1913	No winter records
	06305000	Goose Creek Below Little Goose Creek at Sheridan, WY	NO	1896-1897	No winter records
	06305500	Goose Creek Below Sheridan, WY	NO	1942-1984	
	06305700	Goose Creek Near Acme, WY	NO	1984-current	
	06306000	Tongue River Near Acme, WY	NO	1939-1957	
	06306100	Squirrel Creek Near Decker, MT	NO	1975-1986	Abt. 3.5 mi. into MT
06306250	Prairie Dog Creek Near Acme, WY	NO	WRDS: 1965-1970; USGS: 1971-1980; SEO: 1981-1999	State data seasonal only	
06306300	Tongue River at State Line Near Decker, MT	NO	1960-current		
Powder	06309200	Middle Fork Powder River Near Barnum, WY	YES	1961-current	
	06309260	Buffalo Creek Above North Fork Buffalo Creek Near Arminto, WY	YES	1975-1979	
	06309270	North Fork Buffalo Creek Near Arminto, WY	YES	1975-1979	
	06309280	Buffalo Creek Below North Fork Buffalo Creek Near Arminto, WY	YES	1975-1979	
	06309450	Beaver Creek Below Bayer Creek Near Barnum, WY	YES	1975-1989	
	06309460	Beaver Creek Above White Panther Ditch Near Barnum, WY	YES	1975-1989	
	06309500	Middle Fork Powder River Above Kaycee, WY	NO	1949-1970, 1984-1992	
	06310000	Red Fork Powder River Near Barnum, WY	NO	1929-1932, 1950-1954	
	06310500	Middle Fork Powder River at Kaycee, WY	NO	1911-1913, 1929-1932	
	06311000	North Fork Powder River Near Hazelton, WY	YES	1946-current	
	06311060	North Fork Powder River Below Bull Creek Near Hazelton, WY	YES	1975-1992	
	06311400	North Fork Powder River Below Pass Creek Near Mayoworth, WY	NO	1974-current	
	06311500	North Fork Powder River Near Mayoworth, WY	NO	1941-1973	
	06312000	North Fork Powder River Near Kaycee, WY	NO	1911-1912, 1929-1932	
	06312500	Powder River Near Kaycee, WY	NO	1934-1935, 1938-1971, 1979-1980	
	06313000	South Fork Powder River Near Kaycee, WY	NO	1911-1912, 1938-1940, 1950-1969, 1979-1980, 1983-1984	
	06313180	Dugout Creek Tributary Near Midwest, WY	YES	1975-1983	
	06313400	Salt Creek Near Sussex, WY	NO	1976-1981, 1983-1993	
	06313500	Powder River at Sussex, WY	NO	1938-1940, 1950-1957, 1978-1999	
	06313700	Dead Horse Creek Near Buffalo, WY	NO	1972-1990	
	06313950	North Fork Crazy Woman Creek Below Pole Creek Near Buffalo, WY	YES	1974-1984	
	06314000	North Fork Crazy Woman Creek Near Buffalo, WY	YES	1942-1949, 1974-1984	
	06314500	North Fork Crazy Woman Creek Below Spring Draw Near Buffalo, WY	YES	1949-1972	
	06315000	North Fork Crazy Woman Near Greub, WY	NO	1950-1968	
	06315480	Poison Creek Below Tetley Spring Near Mayoworth, WY	YES	1975-1976	
	06315490	Poison Creek Near Mayoworth, WY	YES	1975-1976	
	06315500	Middle Fork Crazy Woman Creek Near Greub, WY	YES	1942-1972	No winter records 1972
	06316000	Crazy Woman Creek Near Buffalo, WY	NO	1929-1932	No winter records some years
	SEO Gage	Crazy Woman Creek at Trabling Bridge Near Buffalo, WY	NO	SEO: 1982-current	Seasonal data only
	06316400	Crazy Woman Creek at Upper Station Near Arvada, WY	NO	1963-1970, 1978-1981	
	06316500	Crazy Woman Creek Near Arvada, WY	NO	1940-1944, 1950-1964	
	06317000	Powder River at Arvada, WY	NO	1919-current	No winter records 1919-1930, 1934
	06317100	Powder River Near Arvada, WY	NO	1915-1919	No winter records
	06317300	Sourdough Creek Near Buffalo, WY	YES	1985-1990	
	06317340	Little Sourdough Creek Near Buffalo, WY	YES	1985-1988	
	06317500	North Fork Clear Creek Near Buffalo, WY	NO	1950-1968	
	06318500	Clear Creek Near Buffalo, WY	NO	1894, 1896, 1897-1900, 1917-1928, 1938-1992	Records after Oct. 1987 not equivalent due to diversion by City of Buffalo; Adjusted for diversions using 100 acres of irrigated lands upstream and 6 cfs diversion by Buffalo
	SEO Gage	Clear Creek in Buffalo City Park Buffalo, WY	NO	WRDS: 1971-1978; SEO: 1987-1999	Seasonal data only
	06319000	Clear Creek at Buffalo, WY	NO	1903-1905, 1911-1912	No winter records
	06319470	South Rock Creek at Forest Boundary Near Buffalo, WY	YES	1975-1976	
	06319480	South Rock Creek Above Red Canyon Near Buffalo, WY	YES	1975-1976	
	06319500	South Fork Rock Creek Near Buffalo, WY	NO	1941-1943, 1950-1954	No winter records 1941-1943
	06320000	Rock Creek Near Buffalo, WY	NO	1941-current	No winter records after 1971; Adjusted for irrigation using Mowry Basin Ditch
	SEO Gage	Rock Creek at Mouth Near Buffalo, WY	NO	WRDS: 1971-1975, 1977-1978; SEO: 1980-1981, 1983, 1985-1988, 1990-1999	Seasonal data only
	06320200	Clear Creek Below Rock Creek Near Buffalo, WY	NO	USGS: 1976-1981; SEO: 1982-1985, 1987-1999	State data mostly seasonal
	06320400	Clear Creek at Ucross, WY	NO	1976-1981	
	SEO Gage	Clear Creek Below Healy Reservoir Near Buffalo, WY	NO	1977-1999	State data mostly seasonal
	06320500	South Piney Creek at Willow Park Reservoir, WY	NO	1945-1957, 1960-current	No winter records before 1948 and after 1971
	06321000	South Piney Creek Near Story, WY	NO	1951-1980	No winter records 1972-1974
	06321100	South Piney Creek Below Mead-Coffeen Ditch Near Story, WY	NO	1975-1979	
	06321500	North Piney Creek Near Story, WY	YES	1951-1982	
	06321800	Spring Creek Near Story, WY	NO	1975-1979	
	06323000	Piney Creek at Kearney, WY	NO	1902-1906, 1910-1917, 1919-1923, 1941-current	No winter records some years
SEO Gage	Little Piney Creek, WY	NO	SEO: 1981, 1983, 1985-1986, 1988, 1991-1999	Seasonal data only; from spot measurements	
SEO Gage	Piney Creek Below Lake DeSmet Tunnel Intake Near Story, WY	NO	WRDS: 1971-1973, 1977, 1979; SEO: 1980-1984, 1986-1996	Mostly seasonal data	
06323500	Piney Creek at Ucross, WY	NO	USGS: 1917-1923, 1980-1982; SEO: 1983-1987, 1989-1998	No winter records 1917-1923; State data seasonal only	
SEO Gage	Clear Creek at Double Crossing Near Clearmont, WY	NO	WRDS: 1973-1978; SEO: 1980-1996, 1998-1999	Seasonal data only	
SEO Gage	Clear Creek Below P&F#3 Ditch Near Clearmont, WY	NO	WRDS: 1978; SEO: 1980-1999	Seasonal data only	
06324000	Clear Creek Near Arvada, WY	NO	1915-1919, 1928-1929, 1940-1982	No winter records before 1929	
06324500	Powder River at Moorhead, MT	NO	1929-1972, 1975-current	Abt. 4 mi. into MT	
Little Powder	06324890	Little Powder River Below Corral Creek Near Weston, WY	NO	1978-1981	
	06324925	Little Powder River Near Weston, WY	NO	1977-1981	
	06324970	Little Powder River Above Dry Creek Near Weston, WY	NO	1973-current	
Belle Fourche	06426500	Belle Fourche River Below Moorcroft, WY	NO	1943-1970, 1976-1983, 1986-1987, 1991-current	

** Unless otherwise noted, records were obtained from the USGS.

STUDY PERIOD

It is important in any water availability evaluation to select a study period that is long enough to include a variety of hydrologic conditions including an extended period of dry years as well as wet years and normal years. At the same time, it is also important not to select a study period so long that many streamflows must be synthesized to fill-in missing data.

The USGS has maintained a streamflow station on the Tongue River near Dayton (#06298000) since 1919 and continuous records are available from 1941 to present (Table 1). This station is impacted by diversions to the Highline Ditch just upstream of the gage. Natural flow at this station is therefore determined by adding these recorded diversions to the recorded streamflow. The 59-year period of continuous record for this station (1941 through 1999) is selected as the best single representation of long term natural hydrologic conditions in the basin. Figure 8 is a Cumulative Surplus/Deficit plot for the Tongue River near Dayton and represents a running total of the annual deviations from the long-term mean annual streamflow. Downward sloping lines (left to right) represent periods of time during which annual streamflow is less than the long-term mean. Conversely, upward sloping lines represent years which are wetter than average. As shown on Figure 8, the periods from 1941 through 1947 and from 1962 through 1978 can be generally characterized as wet periods, whereas the periods from 1948 through 1961 and from 1979 through 1989 can be generally characterized as dry periods. The period from 1990 through 1999 can generally be characterized as near average. Exceptions to each of these generalities exist within each period. By way of example, 1966 is a dry year within a generally wet period of years and 1984 is a wet year within a generally dry period. Based on an evaluation of the long-term hydrologic conditions on the Tongue River, together with the an understanding of the availability of historic streamflow records, the 30-year period 1970 through 1999 is selected as a candidate study period. Selection of this potential study period is also influenced by the fact that ditch diversion records are available predominantly for the period after 1970. Both streamflow records and ditch diversions records will be needed to develop water availability models that accurately simulate existing water use in the basin. As shown on Figure 8, the average annual flow of the Tongue River near Dayton, for the period 1970 – 1999, is essentially equal to the long-term (1941 – 1999) average annual flow (133,175 AF vs. 133,210 AF).

The representativeness of the potential 1970 to 1999 study period is further evaluated by reviewing long-term natural flow gages that more completely represent the entire Powder/Tongue River Basin, including the Little Bighorn River, the Tongue River, and the Powder River. Three gages with relatively long periods of record are selected for this purpose: 1) Little Bighorn River at State Line (#06289000); 2) Tongue River near Dayton (#06298000); and North Fork Powder River near Hazelton (#06311000). The recorded streamflow at each of these sites either reflects or is adjusted to reflect natural flow, without the influence of man. The annual streamflow at each of these stations for the longest concurrent period of record (1947 – 1999) are summarized in Table 2.

The average annual flow for the period 1970 to 1999 is relatively close to the average annual flow for the longer-term period (1% to 4% wetter) for the three stations. Surplus / Deficit plots for each of these three stations for the 1947 to 1999 period are shown on Figures 9, 10, and 11.

On the Little Bighorn River, the period 1970 to 1999 includes the extended dry periods from 1979 through 1983 and 1985 through 1994 as well as the wet period from 1971 through 1978. This period also contains three out of six of the driest years of the 1947 – 1999 records including 1985, 1987, and 1989. The period also contains three out of six of the wettest years of record in 1970, 1975, and 1978. The driest and wettest years are defined here as those with exceedance or non-exceedance probabilities of less than approximately 10 percent.

On the Tongue River, the period 1970 to 1999 includes the extended dry periods 1979 to 1982 and 1985 to 1989 as well as the wet period from 1971 to 1978. Similar to the Little Bighorn, this period contains three out of six of the driest years of the 1947 – 1999 records for the Tongue River including 1985, 1987, and 1989. The period also contains three out of six of the wettest years of record in 1970, 1975, and 1978.

FIGURE 8
CUMULATIVE SURPLUS/DEFICIT OF ANNUAL HISTORIC FLOWS
 TONGUE RIVER NEAR DAYTON, WY (Station 06298000) — 1941 TO 1999

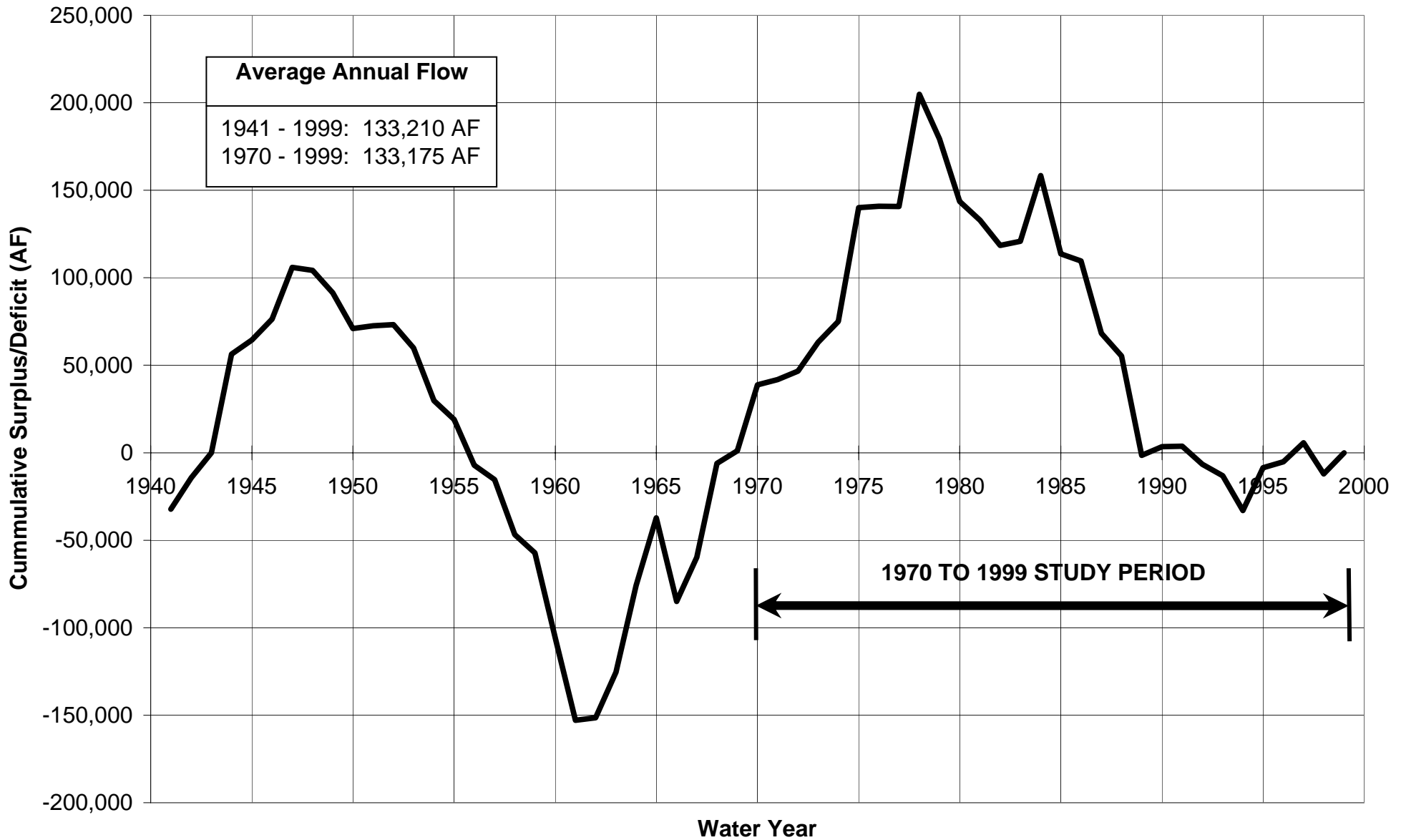


TABLE 2
AVERAGE ANNUAL FLOW
COMPARISON TO 1970-1999
STUDY PERIOD AVERAGE

YEAR	Annual Flow in Acre-Feet		
	Little Bighorn River at State Line Near Wyola, MT 06289000	Tongue Near Dayton 06298000	North Fork Powder Near Hazelton 06311000
1947	132,030	162,878	13,906
1948	102,260	131,476	9,462
1949	93,250	120,409	10,017
1950	78,340	112,752	8,873
1951	94,970	134,751	7,763
1952	98,470	133,919	11,231
1953	92,550	119,860	9,382
1954	88,230	103,095	5,178
1955	98,040	122,448	10,253
1956	80,480	107,076	8,116
1957	114,990	124,900	11,243
1958	87,300	101,807	9,414
1959	104,190	122,788	9,191
1960	71,260	84,561	5,812
1961	65,400	86,151	5,006
1962	95,040	134,761	15,031
1963	126,220	159,248	12,706
1964	157,060	182,715	13,592
1965	146,190	171,865	13,469
1966	83,510	85,379	5,694
1967	133,180	158,525	19,339
1968	142,730	186,786	15,748
1969	118,280	140,406	10,297
1970	159,600	170,984	10,137
1971	121,810	136,242	11,584
1972	111,430	138,031	8,818
1973	133,310	149,701	9,131
1974	130,710	145,021	8,001
1975	182,880	198,294	15,883
1976	123,370	134,000	12,204
1977	115,910	133,134	8,882
1978	170,730	197,249	18,963
1979	93,400	107,713	10,405
1980	81,830	97,481	7,931
1981	95,510	122,507	7,608
1982	97,200	118,780	13,633
1983	106,830	135,628	13,118
1984	136,970	170,772	14,335
1985	72,360	88,393	6,974
1986	101,170	129,213	10,860
1987	77,020	91,860	9,735
1988	93,900	120,159	7,889
1989	68,060	76,527	8,693
1990	103,430	138,184	9,213
1991	110,400	133,469	12,926
1992	90,470	122,866	12,580
1993	96,740	126,667	13,847
1994	98,000	113,240	8,105
1995	126,540	157,750	15,254
1996	113,090	136,583	13,603
1997	121,120	144,068	15,384
1998	107,010	115,427	12,443
1999	127,190	145,292	17,182
Avg 47-99	108,905	131,770	11,057
Avg 70-99	112,266	133,175	11,511

FIGURE 9
CUMULATIVE SURPLUS/DEFICIT OF ANNUAL HISTORIC FLOWS
LITTLE BIGHORN RIVER AT STATE LINE NEAR WYOLA, MT (Station 06289000)

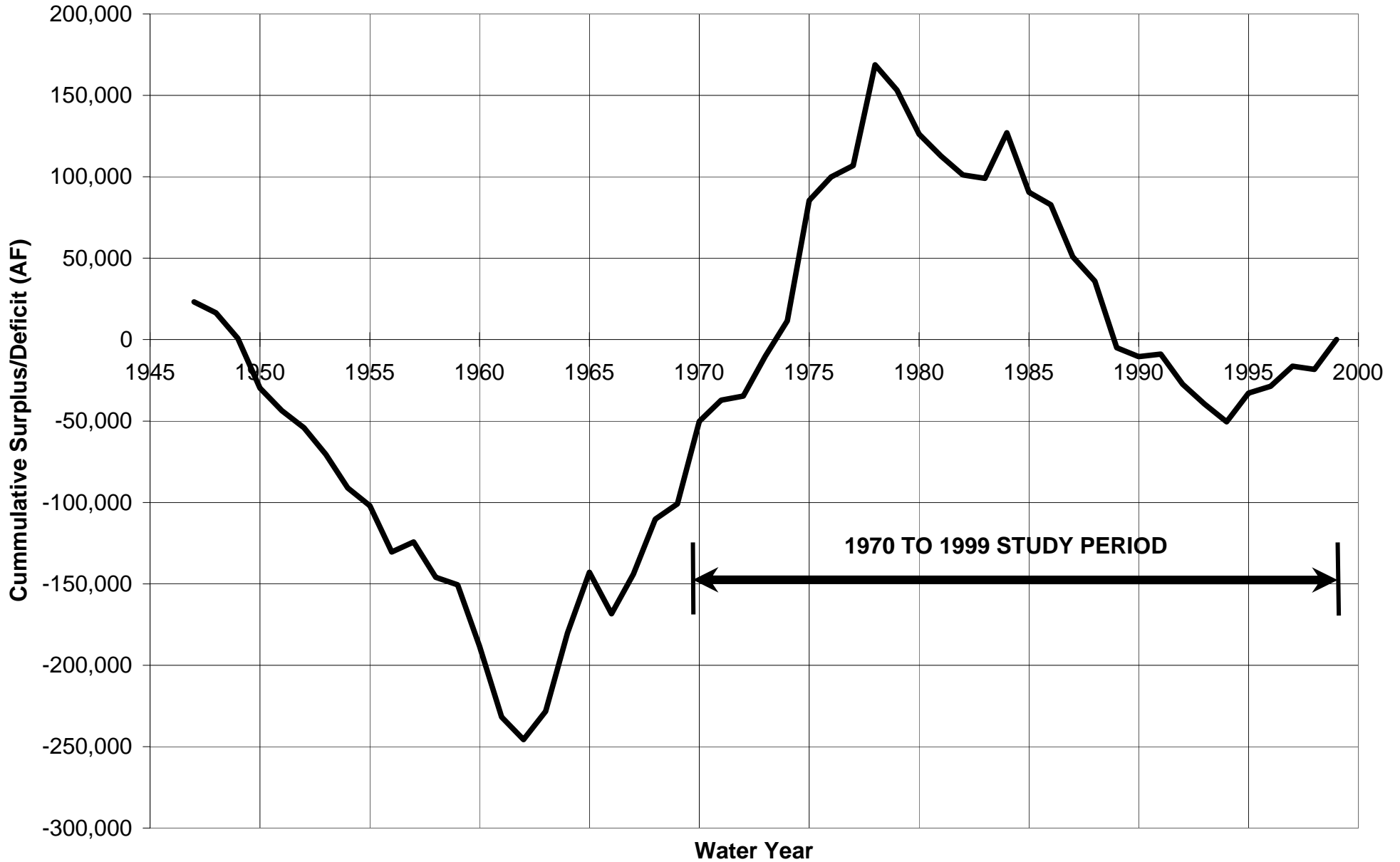


FIGURE 10
CUMULATIVE SURPLUS/DEFICIT OF ANNUAL HISTORIC FLOWS
TONGUE RIVER NEAR DAYTON, WY (Station 06298000)

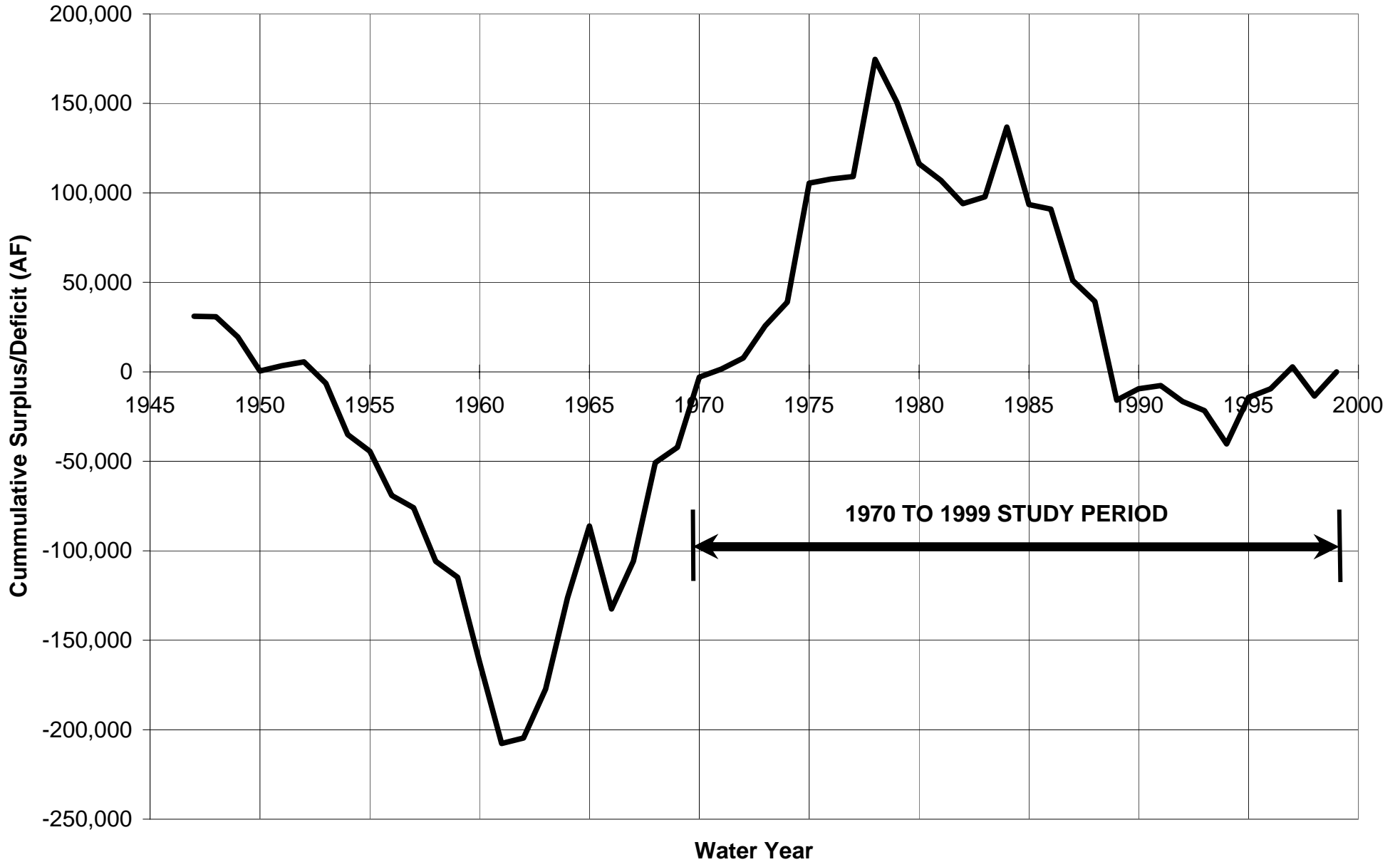
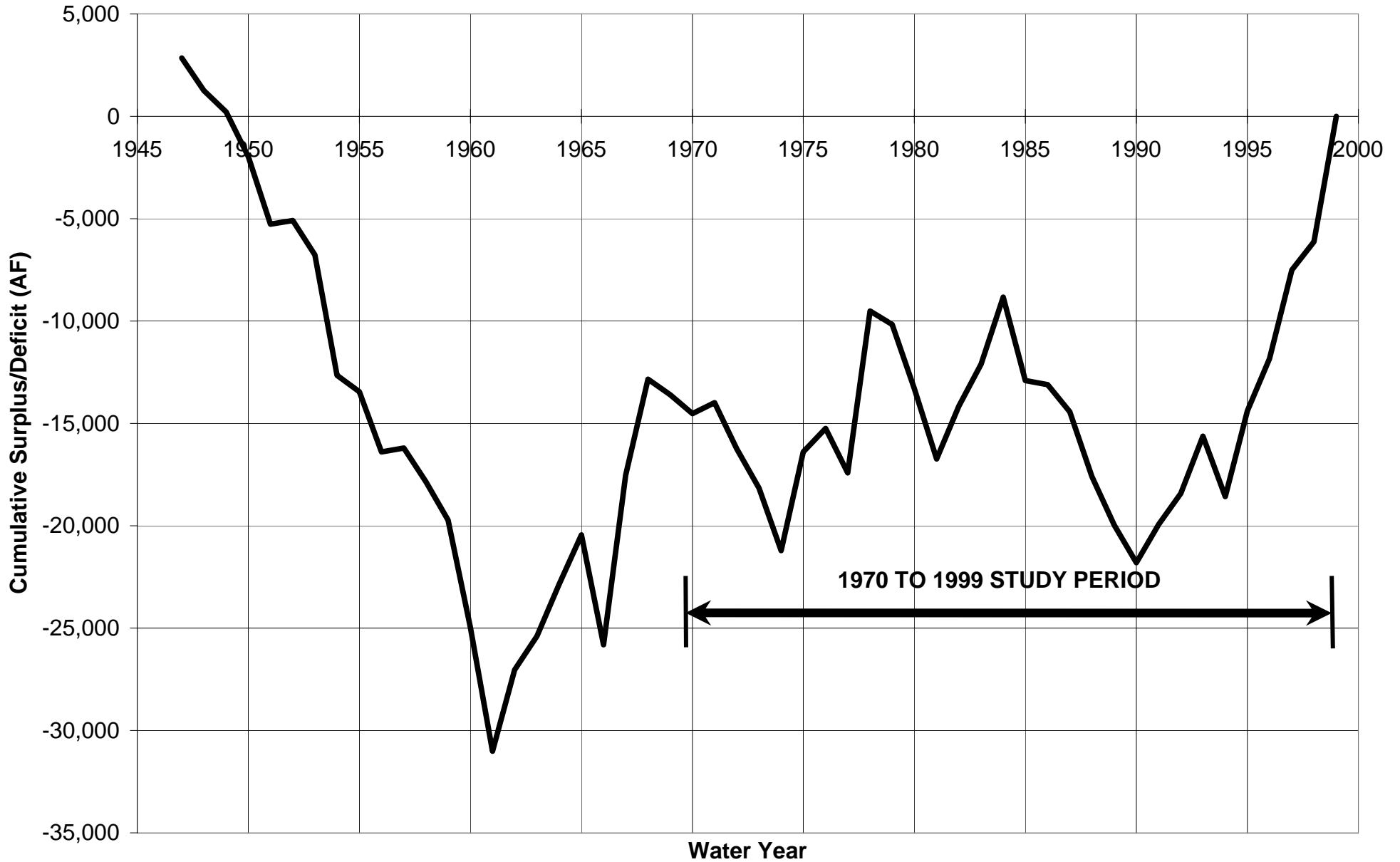


FIGURE 11
CUMULATIVE SURPLUS/DEFICIT OF ANNUAL HISTORIC FLOWS
NORTH FORK POWDER RIVER NEAR HAZELTON, WY (Station 06311000)



The 1970 to 1999 period on the North Fork Powder River contains the dry periods from 1972 through 1974, 1979 through 1981 and 1985 through 1990 as well as the wet period 1995 through 1999. This period also contains two of the six driest years of the 1947 – 1999 records in 1981 and 1985 and 4 of the six wettest years of record in 1975, 1978, 1997, and 1999.

In summary, the period 1970 through 1999 contains extended periods of dry years including some of the driest years of record as well as periods of normal and wet hydrologic conditions. This period also has the greatest abundance of recorded streamflow data and ditch diversion data and therefore requires less data synthesis. A study period of 1970 through 1999 is therefore appropriate for purposes of water availability modeling for the Powder/Tongue River Basin Plan.

The remainder of this memorandum describes the methodologies used to determine the typical dry year, normal year, and wet year monthly flows required at each of the model nodes.

DATA EXTENSION



The spreadsheet modeling approach used for the Basin Plan relies on both records of natural flow as well as records from stations impacted by upstream diversions or regulation. Natural flow is supplied to the model, where available, at the headwater nodes and non-natural flow records at downstream gaging stations are used to calibrate the model to historic conditions. Monthly streamflows must therefore be estimated for both categories of gaging stations for those months, during the study period, with no recorded streamflow data.

The monthly record extension approach used in this study follows the procedure used by the USGS in recent studies in Montana (USGS WRI 89-4165, 1989; USGS WRI 89-4082, 1989). This mixed-station procedure uses the best base station from among all available base stations to fill in each month of missing data for a given gage. It is therefore possible that several different base stations may be used to fill in different months of missing data for a given station. The base station producing the smallest standard error of prediction is used for each particular month. The monthly record extension procedure also offers the option of using cyclic or noncyclic equations to fill in missing records. If the cyclic option is selected, an extension equation is computed for each month using only concurrent streamflows for the month. If the noncyclic option is selected, a single extension equation is computed using all concurrent streamflows. The smallest standard error criterion is used to select between the cyclic or noncyclic option for each month of missing record. For this study, the cyclic option is used only if the base station and the short record station have at least five concurrent monthly streamflows. The noncyclic option is used in all other cases. The technique used to estimate missing values in this study was developed by Hirsch and is referred to as MOVE.1 (Maintenance of Variance Extension, Type 1). This technique offers the advantage over ordinary least-squares regression of preserving the variance of the unextended records (Alley and Burns, 1983). The MOVE.1 technique differs from ordinary least-squares regression in that ordinary regression minimizes the squared vertical deviations of the response variable from the regression line, whereas the MOVE.1 technique minimizes the areas of the right triangles formed by the horizontal and vertical deviations from the regression line (USGS WRI 89-4165, 1989). This procedure is carried out using a computer program developed by the USGS.

The USGS and SEO streamflow stations are first divided into natural flow stations and non-natural flow stations. The stations are then further divided into hydrologically similar groups with each group having at least one gage with sufficient data to develop relationships based on concurrent streamflow for the entire study period. The monthly flow extension procedure is performed for each of these groupings of monthly streamflow data. There is a certain amount of overlap in hydrologic similarity among the various groupings. Some streamflow stations are therefore included in multiple groups. Records from the long-term natural flow stations are also included with some of the non-natural flow groupings where appropriate to provide adequate data for extending the records through the entire study period. The station groupings and the resulting coefficients of determination (R^2) are provided in Table 3 and Table 4 respectively for the natural flow stations and the non-natural flow stations. The coefficient of determination is defined as the proportion of variation in the independent variable that can be explained by variation in the dependent variable (DeVore, 1987). The higher the value of R^2 , the stronger the



**TABLE 3
CORRELATION RESULTS BASED ON MONTHLY DATA
NATURAL FLOW STATIONS IN THE POWDER-TONGUE BASIN**

Basin	Station Number	Station Name	USGS MOVE.1 EXTENSION GROUPINGS										Wtd. Avg. R ² Value	Notes				
			LBIGNAT7	LBIENAT7	LBIDNAT7	TONANAT7	TONBNAT7	POWANAT7	POWDNAT7	CRAANAT7	CRABNAT7	CLEANAT7			CLERNAT7			
Little Bighorn	06288600	Little Bighorn River Below Dayton Gulch Near Burgess Junction, WY															0.95	
	06288700	Dry Fork Little Bighorn Below Lick Creek Near Burgess Junction, WY															0.98	
	06288960	Little Bighorn River Near Parkman, WY															0.99	
	06288975	Elkhorn Creek Above Fuller Ranch Ditch Near Parkman, WY															0.83	
	06288990	West Fork Little Bighorn River Near Parkman, WY															0.96	
	06289000	Little Bighorn River at State Line Near Wyola, MT															N/A	Records available for entire study period
	06289100	Red Canyon Creek Near Parkman, WY															No Correlation	See Table 5
	06289800	East Pass Creek Near Parkman, WY															0.88	
06291200	Lodge Grass Creek at State Line Near Wyola, MT															0.96		
Tongue	06297000	South Fork Tongue River Near Dayton, WY															0.96	
	06297480	Tongue River at Tongue Canyon Campground Near Dayton, WY															0.99	
	06298000	Tongue River Near Dayton, WY															N/A	Records available for entire study period
	06298480	Little Tongue River at Steamboat Point Near Dayton, WY															0.97	
	06298480	Little Tongue River Above South Fork Little Tongue River Near Dayton, WY															0.98	
	06298500	Little Tongue River Near Dayton, WY															0.95	
	06299480	Wolf Creek Below Alden Creek Near Wolf, WY															0.99	
	06299490	Wolf Creek Above Red Canyon Creek at Wolf, WY															0.99	
	06299500	Wolf Creek at Wolf, WY															0.97	
	06300500	East Fork Big Goose Creek Near Big Horn, WY															0.88	
	06301480	Coney Creek Above Twin Lakes Near Big Horn, WY															0.94	
Powder	06309200	Middle Fork Powder River Near Barnum, WY															N/A	Records available for entire study period
	06309260	Buffalo Creek Above North Fork Buffalo Creek Near Arminto, WY															0.98	
	06309270	North Fork Buffalo Creek Near Arminto, WY															0.96	
	06309280	Buffalo Creek Below North Fork Buffalo Creek Near Arminto, WY															0.85	
	06309450	Beaver Creek Below Bayer Creek Near Barnum, WY															0.88	
	06309460	Beaver Creek Above White Panther Ditch Near Barnum, WY															0.83	
	06311000	North Fork Powder River Near Hazelton, WY															N/A	Records available for entire study period
	06313180	Dugout Creek Tributary Near Midwest, WY															No Correlation	See Table 5
	06313950	North Fork Crazy Woman Creek Below Pole Creek Near Buffalo, WY															0.94	
	06314000	North Fork Crazy Woman Creek Near Buffalo, WY															0.94	
	06314500	North Fork Crazy Woman Creek Below Spring Draw Near Buffalo, WY															0.92	
	06315480	Poison Creek Below Tetley Spring Near Mayoworth, WY															0.80	
	06315490	Poison Creek Near Mayoworth, WY															0.82	
	06315500	Middle Fork Crazy Woman Creek Near Greub, WY															0.86	
	06317300	Sourdough Creek Near Buffalo, WY															0.85	
	06317340	Little Sourdough Creek Near Buffalo, WY															No Correlation	See Table 5
	06319470	South Rock Creek at Forest Boundary Near Buffalo, WY															0.98	
06319480	South Rock Creek Above Red Canyon Near Buffalo, WY															0.98		
06321500	North Piney Creek Near Story, WY															0.90		

LEGEND	
	USGS MOVE.1 Group resulting in best R ² value
	Station included in USGS MOVE.1 group

**TABLE 4
CORRELATION RESULTS BASED ON MONTHLY DATA
NON-NATURAL FLOW STATIONS IN THE POWDER-TONGUE BASIN**

Basin	Station Number	Station Name	USGS MOVE.1 EXTENSION GROUPINGS										Wtd. Avg. R ² Value	Notes		
			TONDN07	TONBN07	NONTNC7	POWCNC7	POWAN07	CLEBN07	CLEAN07	PINAN07	NONPOWC7	NONPOWH7			NONPOWB7	BELBN07
Little Bighorn	06289600	West Pass Creek Near Parkman, WY													0.83	
	06289000	Little Bighorn River at State Line Near Wyola, MT													N/A	Natural Flow Station; Records available for entire study period
	06289820	East Pass Creek Near Dayton, WY													0.88	
	06289870	Twin Creek Near Parkman, WY													No Correlation	See Table 5
Tongue	06298000	Tongue River Near Dayton, WY													N/A	Natural Flow Station; Records available for entire study period
	06302000	Big Goose Creek Near Sheridan, WY													0.90	
	06303500	Little Goose Creek Near Big Horn, WY													0.76	
	06305500	Goose Creek Below Sheridan, WY													0.99	
	06305700	Goose Creek Near Acme, WY													0.99	
	06306250	Prairie Dog Creek Near Acme, WY													No Correlation	See Table 5
	06306300	Tongue River at State Line Near Decker, MT													N/A	Records available for entire study period
Powder	06309200	Middle Fork Powder River Near Barnum, WY													N/A	Natural Flow Station; Records available for entire study period
	06309500	Middle Fork Powder River Above Kaycee, WY													0.88	
	06311000	North Fork Powder River Near Hazelton, WY													N/A	Natural Flow Station; Records available for entire study period
	06311060	North Fork Powder River Below Bull Creek Near Hazelton, WY													No Correlation	See Table 5
	06311400	North Fork Powder River Below Pass Creek Near Mayoworth, WY													No Correlation	See Table 5
	06313500	Powder River at Sussex, WY													0.85	
	SEO Gage	Crazy Woman Creek at Trabing Bridge Near Buffalo, WY													0.78	
	06316400	Crazy Woman Creek at Upper Station Near Arvada, WY													0.83	
	06317000	Powder River at Arvada, WY													N/A	Records available for entire study period
	06318500	Clear Creek Near Buffalo, WY													No Correlation	See Table 5
	06318550	Clear Creek in Buffalo City Park, Buffalo, WY													0.84	
	06320000	Rock Creek Near Buffalo, WY													0.81	
	SEO Gage	Rock Creek at Mouth Near Buffalo, WY													0.73	
	06320200	Clear Creek Below Rock Creek Near Buffalo, WY													0.85	
	SEO Gage	Clear Creek Below Healy Reservoir Near Buffalo, WY													0.72	
	SEO Gage	Clear Creek at Double Crossing Near Clearmont, WY													0.76	
	SEO Gage	Clear Creek Below P&F#3 Ditch Near Clearmont, WY													0.89	
	06324000	Clear Creek Near Arvada, WY													0.77	
	06321000	South Piney Creek Near Story, WY													No Correlation	See Table 5
	06323000	Piney Creek at Kearney, WY													0.81	
SEO Gage	Little Piney Creek, WY													0.78		
SEO Gage	Piney Creek Below Lake DeSmet Tunnel Intake Near Story, WY													No Correlation	See Table 5	
06323500	Piney Creek at Ucross, WY													No Correlation	See Table 5	
06324500	Powder River at Moorhead, MT													0.86		
Little Powder	06324890	Little Powder River Below Corral Creek Near Weston, WY													No Correlation	See Table 5
	06324925	Little Powder River Near Weston, WY													0.80	
	06324970	Little Powder River Above Dry Creek Near Weston, WY													No Correlation	See Table 5
Belle Fourche	06426500	Belle Fourche River Below Moorcroft, WY												N/A	See Table 5	

LEGEND	
	USGS MOVE.1 Group resulting in best R ² value
	Station included in USGS MOVE.1 group

relationship between the two variables. A perfect relationship would have an $R^2 = 1.0$. Regression of hydrologic data resulting in $R^2 > 0.7$ is typically considered strong enough for data estimating. This criterion was used in evaluating the results of the regression analyses. The results of the MOVE.1 analyses are provided in Appendix A.

As shown in Tables 3 and 4, in some instances no significant correlation ($R^2 < 0.7$) could be found using concurrent monthly streamflows between any base station and the short record station. Annual flow regression rather than monthly flow regression was performed in these instances to fill-in the missing streamflow data. The results of this analysis including the base station record used to fill-in the missing data at the short record station, the regression equation, and the resulting coefficient of determination (R^2) are summarized in Table 5. The supporting computations and graphic displays of the results of the annual flow regression analyses are provided in Appendix B. As noted in Table 5, in a few cases, no significant correlation ($R^2 < 0.7$) could be found using the annual flow regression either. These stations were dropped from the study. The monthly streamflows for the years of missing data were estimated by applying the average monthly distribution for the period of recorded streamflow to the estimated total annual flow. For those instances when records for some months are available, the recorded streamflows are used and subtracted from the estimated annual total. The remaining months of missing data are then filled-in using the average monthly distribution for these months applied to the total remaining streamflow for the partial year.

The average monthly and annual streamflows for the 1970 to 1999 study period, for the natural flow streamflow stations and the non-natural flow streamflow stations are summarized in Table 6 and Table 7 respectively. The recorded and extended monthly streamflows for each year of the 1970 to 1999 study period are provided in Appendix C for each gaging station selected for use in the water availability models.

NATURAL FLOW AT UNGAGED MODEL NODES

Records of streamflow are used to the extent available to represent natural flow at model nodes. However, to fully represent water use in the various drainages, estimates of natural flow are also required at several model nodes where records from USGS or SEO streamflow stations are unavailable. HKM evaluated several alternatives for estimating natural flow at these locations including:

1. Use the recorded streamflow at a downstream streamflow station, adjusting for depletions and storage regulation as well as for the smaller drainage area to estimate natural flow at an upstream location.
2. Develop a regression equation based on recorded and extended natural flow for 1970 to 1999 developed through this study (Table 6), relating drainage area and average annual precipitation or mean basin elevation to natural flow.
3. Use the regression equations developed by the USGS in WRIR 88-4045 relating drainage area and either average annual precipitation or mean basin elevation to natural flow.

The downstream streamflow stations are typically highly influenced by irrigation depletions, transbasin diversions, and storage regulation. To develop natural flows using Alternative 1, the records for the downstream station would first need to be adjusted to remove these influences. Insufficient transbasin diversion and reservoir operation data is, typically, available to make these adjustments. It is also questionable, in many cases, whether the downstream gages, which represent runoff from a much larger area, are representative of the unit runoff rates from the smaller and higher elevation drainages of the ungaged model nodes. It is therefore concluded that the first alternative does not yield reliable estimates of natural flow in most cases. The two exceptions are Prairie Dog Creek in the Tongue River basin and Little Piney Creek in the Powder River basin. Alternative 1 yielded the most reasonable estimates of natural flow for these two locations as evaluated during the calibration of the water availability models. Natural flow at the upstream location is estimated as natural flow at the downstream location multiplied by the proportion of the upstream drainage area to the downstream drainage area. The depletions

**TABLE 5
CORRELATION RESULTS BASED ON ANNUAL DATA
STATIONS IN THE POWDER-TONGUE BASIN**

Basin	Station Number	Station Name	Natural Flow	Station Used in Regression	R ² Value	Regression Equation	Notes
Little Bighorn	06289100	Red Canyon Creek Near Parkman, WY	YES	Little Bighorn River at State Line, Near Wyola, MT (Station 06289000)	0.90	Y = 0.025398X - 1391.2	
	06289870	Twin Creek Near Parkman, WY	NO	Little Bighorn River at State Line, Near Wyola, MT (Station 06289000)	0.74	Y = 0.11280X - 7152.9	
Tongue	06301485	Lost Lake Creek Near Big Horn, WY	YES		No Correlation		Unable to find significant correlation with any available station
	06301490	Snail Creek Near Big Horn, WY	YES		No Correlation		Unable to find significant correlation with any available station
	06306250	Prairie Dog Creek Near Acme, WY	NO	Powder River at Arvada, WY (Station 06317000)	0.87	Y = 0.072738X + 15381	
Powder	06311060	North Fork Powder River Below Bull Creek Near Hazelton, WY	NO	North Fork Powder River Near Hazelton, WY (Station 06311000)	0.83	Y = 0.95976X + 2154.2	
	06311400	North Fork Powder River Below Pass Creek Near Mayoworth, WY	NO	North Fork Powder River Near Hazelton, WY (Station 06311000)	0.79	Y = 1.4351X + 9453.4	
	06312500	Powder River Near Kaycee, WY	NO	Middle Fork Powder River Near Barnum, WY (Station 06309200)	0.87	Y = 2.6695X + 36671	
	06313000	South Fork Powder River Near Kaycee, WY	NO	Powder River at Arvada, WY (Station 06317000)	0.91	Y = 0.13407X + 307.34	
	06313180	Dugout Creek Tributary Near Midwest, WY	YES		No Correlation		Unable to find significant correlation with any available station
	06313400	Salt Creek Near Sussex, WY	NO	Powder River at Sussex, WY (Station 06313500)	0.75	Y = 0.14172X + 10815	
	06317340	Little Sourdough Creek Near Buffalo, WY	YES	Powder River at Arvada, WY (Station 06317000)	0.99	Y = 0.0047854X - 207.81	
	06318500	Clear Creek Near Buffalo, WY	NO	Clear Creek in Buffalo City Park, Buffalo, WY (SEO Gage)	0.80	Y = 0.73548X + 24886	
	06321000	South Piney Creek Near Story, WY	NO	North Fork Powder River Near Hazelton, WY (Station 06311000)	0.84	Y = 2.8480X + 28319	
	SEO Gage	Piney Creek Below Lake DeSmet Tunnel Intake Near Story, WY	NO	Piney Creek at Kearney, WY (Station 06323000)	0.88	Y = 0.97670X - 10655	Irrigation Season Regression
06323500	Piney Creek at Ucross, WY	NO	Piney Creek at Kearney, WY (Station 06323000)	0.78	Y = 1.0792X - 3636.2	Irrigation Season Regression	
Little Powder	06324890	Little Powder River Below Corral Creek Near Weston, WY	NO	Belle Fourche River Below Moorcroft, WY (Station 06426500)	0.99	Y = 0.18483X - 463.92	
	06324970	Little Powder River Above Dry Creek Near Weston, WY	NO	Belle Fourche River Below Moorcroft, WY (Station 06426500)	0.80	Y = 0.90409X + 475.71	
Belle Fourche	06426500	Belle Fourche River Below Moorcroft, WY	NO	Inflow to Keyhole Reservoir (USBR Gage)	0.87	Y = 0.57098X - 386.15	Applied to Monthly Values

TABLE 6
SUMMARY OF AVERAGE MONTHLY AND ANNUAL FLOWS (1970 TO 1999)
NATURAL FLOW STATIONS IN THE POWDER-TONGUE RIVER BASINS

Basin	Station Number	Station Name	AVERAGE STREAMFLOW FOR 1970-1999 IN ACRE-FEET												
			OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANNUAL
Little Bighorn	06288600	Little Bighorn River Below Dayton Gulch Near Burgess Junction, WY	414	301	268	238	195	215	358	3,600	6,008	1,685	779	463	14,524
	06288700	Dry Fork Little Bighorn River Below Lick Creek Near Burgess Junction, WY	1,855	1,599	1,498	1,383	1,223	1,326	1,709	6,248	9,433	4,505	2,644	2,029	35,452
	06288960	Little Bighorn River near Parkman, WY	4,011	3,353	3,098	2,864	2,479	2,777	3,771	17,119	27,107	11,347	6,045	4,433	88,404
	06288975	Elkhorn Creek Above Fuller Ranch Ditch Near Parkman, WY	114	100	92	86	75	88	141	486	618	202	135	124	2,261
	06288990	West Fork Little Bighorn River Near Parkman, WY	939	794	734	672	593	671	896	3,868	5,800	2,421	1,355	1,040	19,783
	06289000	Little Bighorn River at State Line Near Wyola, MT	5,420	4,574	4,258	3,958	3,479	3,880	5,154	21,093	32,321	14,270	7,902	5,957	112,266
	06289100	Red Canyon Creek Near Parkman, WY	35	32	26	28	23	42	216	561	242	65	32	28	1,330
	06289800	East Pass Creek Near Parkman, WY	469	389	366	338	303	328	547	1,899	2,298	1,062	638	508	9,145
	06291200	Lodge Grass Creek at State Line Near Wyola, MT	464	352	316	288	242	271	558	3,619	5,268	1,760	780	531	14,449
Tongue	06297000	South Fork Tongue River Near Dayton, WY	1,424	1,033	942	803	652	741	1,839	14,823	22,367	6,444	2,527	1,656	55,251
	06297480	Tongue River at Tongue Canyon Campground Near Dayton, WY	5,064	3,935	3,623	3,295	2,824	3,107	6,129	31,109	42,528	15,621	7,855	5,653	130,743
	06298000	Tongue River Near Dayton, WY	5,130	3,954	3,642	3,315	2,825	3,117	6,186	31,983	43,180	16,162	7,951	5,730	133,175
	06298480	Little Tongue River at Steamboat Point Near Dayton, WY	134	94	83	72	58	69	249	2,165	3,088	726	274	167	7,179
	06298490	Little Tongue River Above South Fork Little Tongue River Near Dayton, WY	98	67	58	50	40	46	139	1,641	2,643	591	200	118	5,691
	06298500	Little Tongue River Near Dayton, WY	225	158	139	124	105	118	402	3,299	4,503	1,144	427	268	10,912
	06299480	Wolf Creek Below Alden Creek Near Wolf, WY	471	341	304	267	219	255	784	6,063	8,521	2,214	855	537	20,831
	06299490	Wolf Creek Above Red Canyon Creek Near Wolf, WY	536	404	364	329	276	308	784	5,804	8,126	2,169	849	540	20,489
	06299500	Wolf Creek at Wolf, WY	539	399	356	317	271	298	854	5,767	7,980	2,237	926	603	20,547
	06300500	East Fork Big Goose Creek Near Big Horn, WY	426	284	220	204	154	171	557	5,296	10,978	3,740	1,096	698	23,824
06301480	Coney Creek Above Twin Lakes Near Big Horn, WY	30	18	14	10	8	9	49	1,091	1,781	534	83	48	3,675	
Powder	06309200	Middle Fork Powder River Near Barnum, WY	457	416	370	331	295	424	2,125	9,807	5,212	1,061	527	433	21,457
	06309260	Buffalo Creek Above North Fork Buffalo Creek Near Arminto, WY	31	28	23	20	17	28	218	1,350	649	101	38	28	2,531
	06309270	North Fork Buffalo Creek Near Arminto, WY	86	79	70	62	55	79	370	1,639	915	200	103	84	3,742
	06309280	Buffalo Creek Below North Fork Buffalo Creek Near Arminto, WY	0	0	0	0	0	0	34	1,918	950	51	2	1	2,956
	06309450	Beaver Creek Below Bayer Creek Near Barnum, WY	185	166	143	126	111	156	519	1,787	1,141	429	247	192	5,202
	06309460	Beaver Creek Above White Panther Ditch Near Barnum, WY	612	568	546	518	476	561	997	2,211	1,674	911	695	610	10,379
	06311000	North Fork Powder River Near Hazelton, WY	294	220	180	144	120	142	603	3,864	4,037	1,111	471	325	11,511
	06313950	North Fork Crazy Woman Creek Below Pole Creek Near Buffalo, WY	629	474	387	307	257	301	1,142	5,582	5,774	1,983	918	645	18,399
	06314000	North Fork Crazy Woman Creek Near Buffalo, WY	640	481	395	316	265	307	1,152	5,490	5,637	1,987	924	655	18,249
	06314500	North Fork Crazy Woman Creek Below Spring Draw Near Buffalo, WY	558	412	337	264	217	269	1,184	7,726	8,139	2,222	917	624	22,869
	06315480	Poison Creek Below Tetley Spring Near Mayoworth, WY	214	175	150	127	112	126	346	1,172	1,155	490	279	218	4,564
	06315490	Poison Creek Near Mayoworth, WY	246	202	176	150	132	151	387	1,232	1,220	542	320	251	5,009
	06315500	Middle Fork Crazy Woman Creek Near Greub, WY	707	551	470	391	334	411	1,290	5,891	6,016	2,072	1,031	759	19,923
	06317300	Sourdough Creek Near Buffalo, WY	70	52	44	34	28	34	107	775	905	265	112	78	2,504
	06317340	Little Sourdough Creek Near Buffalo, WY	37	22	7	3	2	5	206	214	139	36	16	25	712
	06319470	South Rock Creek at Forest Boundary Near Buffalo, WY	447	341	280	227	187	217	900	5,431	5,744	1,722	714	491	16,701
	06319480	South Rock Creek Above Red Canyon Near Buffalo, WY	426	325	264	213	177	205	870	5,367	5,703	1,675	689	471	16,385
06321500	North Piney Creek Near Story, WY	800	626	511	423	354	439	1,817	10,506	10,318	2,733	1,139	842	30,508	

TABLE 7
SUMMARY OF AVERAGE MONTHLY AND ANNUAL FLOWS (1970 TO 1999)
NON-NATURAL FLOW STATIONS IN THE POWDER-TONGUE RIVER BASINS

Basin	Station Number	Station Name	AVERAGE STREAMFLOW FOR 1970-1999 IN ACRE-FEET												
			OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANNUAL
Little Bighorn	06289600	West Pass Creek Near Parkman, WY	522	476	441	419	407	497	770	2,023	2,007	810	488	495	9,355
	06289820	East Pass Creek Near Dayton, WY	621	575	543	531	519	629	958	2,666	2,800	905	469	530	11,746
	06289870	Twin Creek Near Parkman, WY	108	92	119	328	236	741	847	1,656	349	154	115	87	4,833
Tongue	06302000	Big Goose Creek Near Sheridan, WY	2,307	1,727	1,576	1,427	1,199	1,336	2,247	13,175	27,034	8,560	4,642	3,625	68,855
	06303500	Little Goose Creek in Canyon Near Big Horn, WY	1,855	1,396	1,274	1,147	968	1,076	2,082	10,835	14,826	6,582	5,236	3,425	50,702
	06305500	Goose Creek Below Sheridan, WY	6,692	5,855	5,109	4,570	4,971	6,223	8,284	26,807	40,099	10,115	4,047	5,595	128,367
	06305700	Goose Creek Near Acme, WY	6,848	5,984	5,215	4,660	5,076	6,364	8,494	27,713	41,776	10,431	4,120	5,725	132,406
	06306250	Prairie Dog Creek Near Acme, WY	2,785	2,192	1,835	1,286	2,567	5,705	2,784	3,701	2,327	1,416	1,730	2,350	30,678
	06306300	Tongue River at State Line Near Decker, MT	16,187	13,719	11,317	11,134	13,110	19,427	21,867	73,969	98,409	29,613	11,756	13,340	333,850
Powder	06309500	Middle Fork Powder River Above Kaycee, WY	2,812	2,642	2,490	2,387	2,235	2,693	5,676	14,882	9,586	3,978	2,759	2,581	54,721
	06311060	North Fork Powder River Below Bull Creek Near Hazelton, WY	240	169	159	129	119	143	367	3,188	4,121	2,014	1,524	1,028	13,202
	06311400	North Fork Powder River Below Pass Creek Near Mayoworth, WY	1,326	1,138	1,139	1,110	994	1,089	1,613	4,891	5,510	2,835	2,410	1,917	25,972
	06312500	Powder River Near Kaycee, WY	5,062	6,385	6,481	5,606	6,441	8,416	8,944	27,066	15,875	1,006	888	1,783	93,950
	06313000	South Fork Powder River Near Kaycee, WY	172	237	163	190	1,350	7,672	5,987	9,131	2,072	602	1,729	11	29,316
	06313400	Salt Creek Near Sussex, WY	2,257	1,820	1,706	1,849	2,577	4,243	3,003	5,395	4,120	3,062	1,940	1,853	33,825
	06313500	Powder River at Sussex, WY	10,088	8,646	7,430	7,200	10,592	17,746	17,475	38,478	26,121	9,211	4,476	4,899	162,362
	SEO Gage	Crazy Woman Creek at Trabling Bridge Near Buffalo, WY	329	223	218	196	150	189	1,697	8,924	13,287	3,211	1,242	978	30,644
	06316400	Crazy Woman Creek at Upper Station Near Arvada, WY	1,688	1,356	1,036	885	1,627	2,517	3,386	9,747	8,975	2,196	1,151	769	35,333
	06317000	Powder River at Arvada, WY	11,144	9,646	7,235	6,773	11,517	23,619	21,176	52,067	42,800	14,235	6,162	5,400	211,773
	06318500	Clear Creek Near Buffalo, WY	2,253	1,583	1,220	909	759	1,009	2,710	12,305	17,834	8,639	3,929	2,749	55,899
	SEO Gage	Clear Creek in Buffalo City Park, Buffalo, WY	1,886	1,397	1,138	947	1,277	1,972	2,407	9,746	14,070	4,659	1,414	1,254	42,167
	06320000	Rock Creek Near Buffalo, WY	894	653	587	525	437	490	993	7,108	9,142	3,800	2,729	1,558	28,916
	SEO Gage	Rock Creek at Mouth Near Buffalo, WY	1,572	1,322	1,026	927	1,272	2,245	1,360	5,460	7,121	1,755	929	918	25,907
	06320200	Clear Creek Below Rock Creek Near Buffalo, WY	3,672	3,132	2,571	2,386	2,774	4,084	5,349	17,212	23,059	7,586	3,034	3,074	77,933
	SEO Gage	Clear Creek below Healy Reservoir Near Buffalo, WY	2,601	1,730	1,299	1,079	1,454	2,483	3,739	14,926	20,747	7,964	3,380	2,772	64,174
	06321000	South Piney Creek Near Story, WY	2,068	1,539	1,514	1,257	961	1,032	1,555	5,964	20,205	12,621	9,042	5,535	63,293
	06323000	Piney Creek at Kearney, WY	1,886	2,307	2,059	1,875	1,607	2,038	4,072	15,796	23,765	6,122	2,061	1,265	64,853
	SEO Gage	Little Piney Creek, WY	784	751	591	583	709	964	945	1,620	1,489	881	602	689	10,608
	SEO Gage	Piney Creek below Lake DeSmet Tunnel Intake Near Story, WY	1,524	1,056	741	664	613	864	1,953	10,657	20,258	5,591	2,118	1,431	47,470
	06323500	Piney Creek at Ucross, WY	3,450	3,413	2,641	2,362	1,632	2,969	3,928	12,580	20,834	7,887	5,206	3,718	70,620
	SEO Gage	Clear Creek at Double Crossing Near Clearmont, WY	8,484	7,580	6,042	5,208	5,866	9,456	9,217	27,303	42,211	14,623	7,589	6,807	150,386
SEO Gage	Clear Creek below P&F#3 Ditch Near Clearmont, WY	6,464	5,750	3,619	3,474	5,276	9,697	8,968	24,292	38,482	10,460	4,558	4,444	125,484	
06324000	Clear Creek Near Arvada, WY	7,050	6,494	4,356	4,151	5,773	9,919	10,332	25,700	38,174	11,742	5,498	5,462	134,651	
06324500	Powder River at Moorhead, MT	18,021	16,072	10,330	10,928	18,963	36,118	29,810	73,536	79,314	27,131	11,758	10,494	342,475	
Little Powder	06324890	Little Powder River Below Corral Creek Near Weston, WY	8	16	23	57	182	1,022	138	1,239	103	267	38	0	3,093
	06324925	Little Powder River Near Weston, WY	637	128	74	360	2,640	4,275	1,982	3,093	1,600	463	275	161	15,688
	06324970	Little Powder River Above Dry Creek Near Weston, WY	823	260	174	580	2,501	4,299	1,602	4,205	1,992	748	404	284	17,873
Belle Fourche	06426500	Belle Fourche River Below Moorcroft, WY	682	203	149	420	1,761	4,664	2,268	5,169	2,134	997	515	281	19,243

(diversions minus return flows) used to make the adjustments to the downstream gage records are based on three representative hydrologic conditions (wet, normal, and dry years) and are taken from the water availability modeling work. The natural flow estimates for these two locations are therefore provided for these three representative hydrologic conditions only. This is in contrast to the estimates of natural flow at the other ungaged node locations for which natural flow estimates are provided for each month and each year within the 1970 to 1999 study period. The selection of the years used to represent wet, normal, and dry conditions are discussed in the next section. The derivation of natural flow at these two locations is provided in Appendix D.

Monthly natural flows have been developed through this study at 40 streamflow stations in the Powder/Tongue River Basin. A second alternative is therefore to utilize this data to develop a localized regression equation for estimating natural flow at the ungaged sites. Unfortunately the mean basin elevation for these natural flow stations are typically greater than 7,000 feet. Whereas, the majority of the drainages contributing to the ungaged model nodes have mean basin elevations less than 7,000 feet. A regression equation developed from the recorded natural flow data set would not be applicable to the sites where natural flow estimates are required. Alternative 2 was therefore not selected.

The USGS is currently updating the work originally developed by Lowham in the report “Streamflows in Wyoming” (USGS, 1988). Unfortunately, at the time of this writing, that work is several months away from completion. The 1988 USGS report however presents regression equations, which rely on drainage area and average annual precipitation or mean basin elevation to estimate mean annual flow. The equation for the mountainous region is applicable for drainages with mean basin elevations from 5,000 to 10,800 feet. Only one ungaged model node has a mean basin elevation less than 5,000 feet (Prairie Dog Creek with a MBE of 4550). The USGS regression equation for the mountainous region is selected as the most appropriate alternative for estimating natural flow at most of the ungaged model nodes. The regression equation is as follows:

$$Q_a = 0.0015 A^{1.01} (\text{ELEV}/1,000)^{2.88}$$

Where: Q_a is mean annual flow in cubic feet per second,
A is contributing drainage area in square miles, and
ELEV is mean basin elevation in feet.

The reasonableness of the estimates of average annual flow are evaluated by comparing the estimated unit runoff (acre-feet per square mile) to the recorded unit runoff at the nearest natural flow station during the 1970 to 1999 study period. The average annual natural flow is, in some instances, adjusted based on this comparison. The estimated average annual flow and the comparison to unit runoff at the nearest natural flow station are summarized in Table 8 for the ungaged model nodes. The locations of these nodes are shown on Figure 12.

In addition to average annual natural flow at the ungaged model nodes, it is necessary to generate sequential monthly flows at these sites for all years of the study period. This is accomplished by selecting a natural flow gaging station having similar hydrologic characteristics and multiplying the sequential monthly flows at the gaged location by the ratio of the ungaged average annual natural flow to the gaged average annual natural flow. The time distribution of monthly flows at the ungaged sites is, therefore, represented by the streamflow at similar gaged sites. The average monthly and annual streamflows for the 1970 to 1999 study period, for the ungaged model nodes are summarized in Table 9. The estimated monthly natural flows for each year of the 1970 to 1999 study period are provided in Appendix E for each ungaged model node.

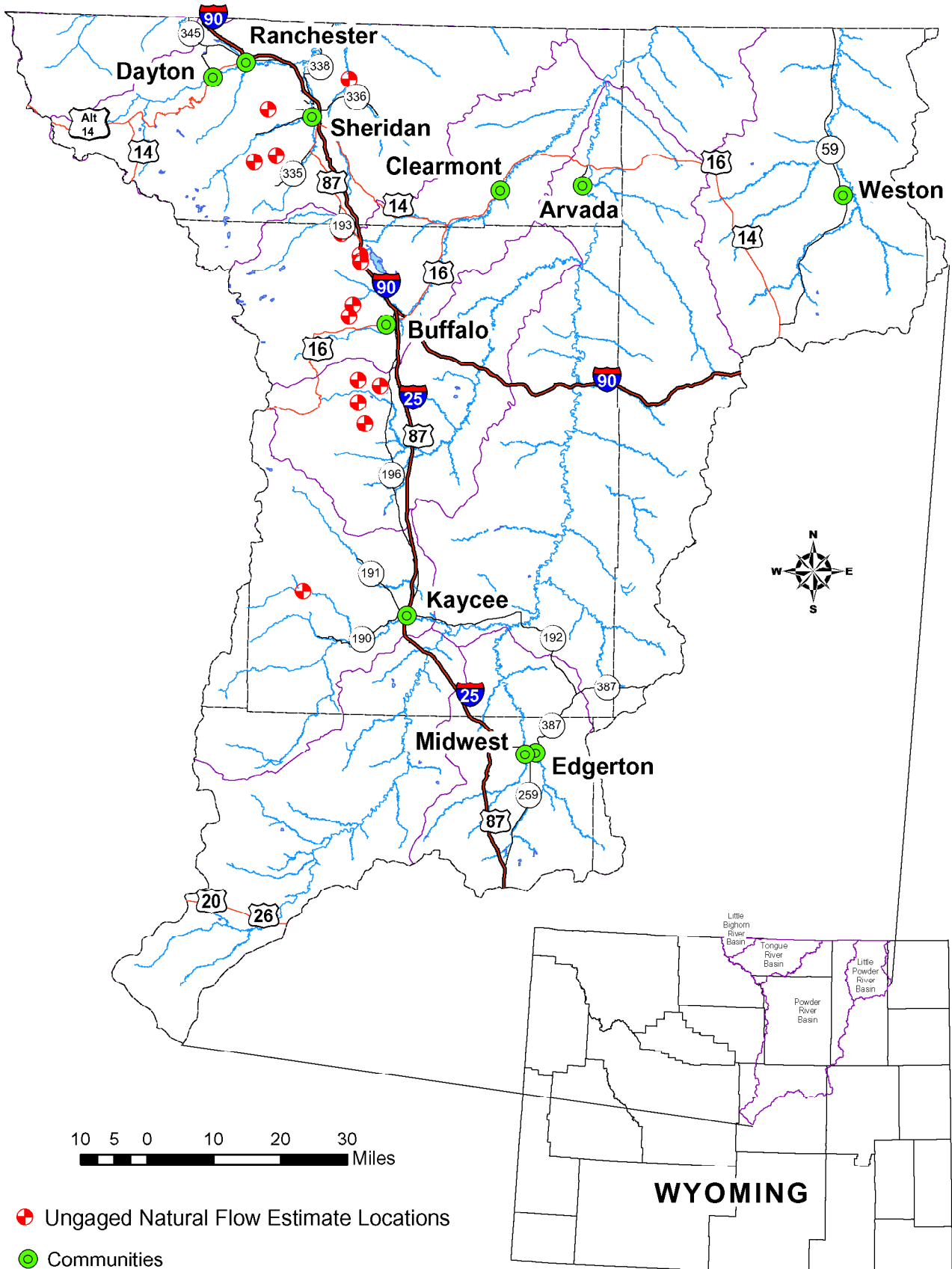
WET, DRY, AND NORMAL YEARS

Water availability models are to be developed to represent dry year, normal year, and wet year hydrologic conditions throughout the Powder/Tongue River Basin. To this end, the annual streamflows for the 1970 to 1999 study period developed through the surface water hydrology work are ranked and divided into these three hydrologic categories. Indicator gages are selected for this purpose, to represent hydrologic

**TABLE 8
ESTIMATED AVERAGE ANNUAL NATURAL FLOW AT UNGAGED MODEL NODES**

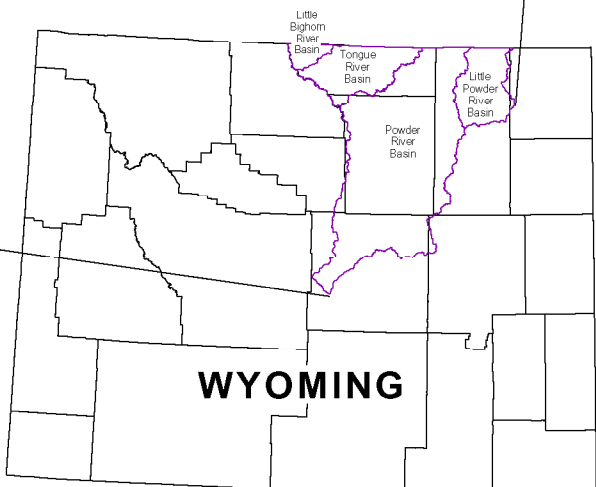
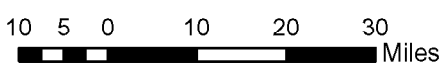
Basin	Site	Stream Type	Drainage Area (sq. mi.)	Mean Basin Elevation (ft)	Estimated Average Annual Runoff		1970-1999 Average Annual Flow at Nearest Natural Flow Gage			Note	Selected Average Annual AF
					Annual AF	AF/sq. mi.	Gage #	MBE	Runoff/sq. mi.		
Tongue	Rapid Creek Just Below Little Rapid Creek in Section 32, T55N, R85W	Perennial	13.9	6720	3742	269	06299500	7700	544	Flow from USGS equation seems reasonable	3,742
	Beaver Creek at Bottom of Section 26, T55N, R85W	Perennial	8.26	5160	1034	125	06299500	7700	544	Flow from USGS equation seems reasonable	1,034
	Soldier Creek at Right Edge of Section 28, T56N, R85W	Perennial	18.7	5100	2281	122	06299500	7700	544	Flow from USGS equation seems reasonable	2,281
	Prairie Dog Creek Just Above Dutch Creek in Section 34, T57N, R83W	Perennial	122.7	NA	20,332 ⁴	166 ⁴	06306250 ³	NA	166 ⁴	Flow transferred from naturalized USGS Station 06306250	20,332 ⁴
Powder	Red Fork Powder River Just Below North & South Forks Red Fork Powder River in Section 29, T44N, R84W	Perennial	114	7670	45866	402	06309460	7180	429	Flow from USGS equation seems reasonable	45,866
	Kelly Creek at Top of Section 21, T49N, R82W	Perennial	10.9	5980	2092	192	06314000	8440	406	Flow from USGS equation seems reasonable	2,092
	Little North Fork Crazy Woman Creek Just Below Grossett Canyon in Section 14, T49N, R83W	Perennial	12.5	7570	4737	379	06314000	8440	406	Flow from USGS equation seems reasonable	4,737
	Muddy Creek at Diversion Near East Side of Section 35, T49N, R83W	Perennial	11.8	7500	4351	369	06314000	8440	406	Flow from USGS equation seems reasonable	4,351
	Billy Creek at Diversion to O'Malley Draw in Section 13, T48N, R83W	Perennial	9.64	7410	3426	355	06315490	7820 est	203	Flow from USGS equation too high — use 203 AF/sq. mi. from upstream gage 06315490	1,957
	Little Piney Creek Just Below Bear Gulch in Section 28, T53N, R83W	Perennial	14.8	NA	7,336 ⁴	496 ⁴	SEO Gage ³	NA	496 ⁴	Flow transferred from naturalized SEO Station on Little Piney Creek	7,336 ⁴
	North & South Forks Shell Creek (Combined), at Confluence of Little North Fork Shell Creek and North Fork Shell Creek in Section 11, and Confluence of Unnamed Tributary & South Fork Shell Creek in Section 14; all in T52N, R83W	Perennial	15.4	5340	2141	139	06319480	9200 est	405	Flow from USGS equation seems reasonable	2,141
	Johnson Creek at Top of Section 22, T51N, R83W	Perennial	7.26	6850	2052	283	06319480	9200 est	405	Flow from USGS equation seems reasonable	2,052
	French Creek at Penrose Ditch Diversion in Section 27, T51N, R83W	Perennial	13.4	7490	4928	368	06319480	9200 est	405	Flow from USGS equation seems reasonable	4,928

- Notes: 1. USGS equation for average annual flow, from WRIR 88-4045 = $0.0015A^{1.01}(MBE/1000)^{2.88}$.
2. Average annual flow at USGS natural flow gages based on recorded and/or filled in data for 1970-99 study period.
3. Naturalized gage flow based on recorded and filled in data for the 1970-99 study period.
4. These values use the average of the dry, normal, and wet year values.



Ungaged Natural Flow Estimate Locations

- + Ungaged Natural Flow Estimate Locations
- Communities



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Figure 12

TABLE 9
SUMMARY OF AVERAGE MONTHLY AND ANNUAL FLOWS (1970 TO 1999)
UNGAGED NATURAL FLOW NODES IN THE POWDER-TONGUE RIVER BASINS

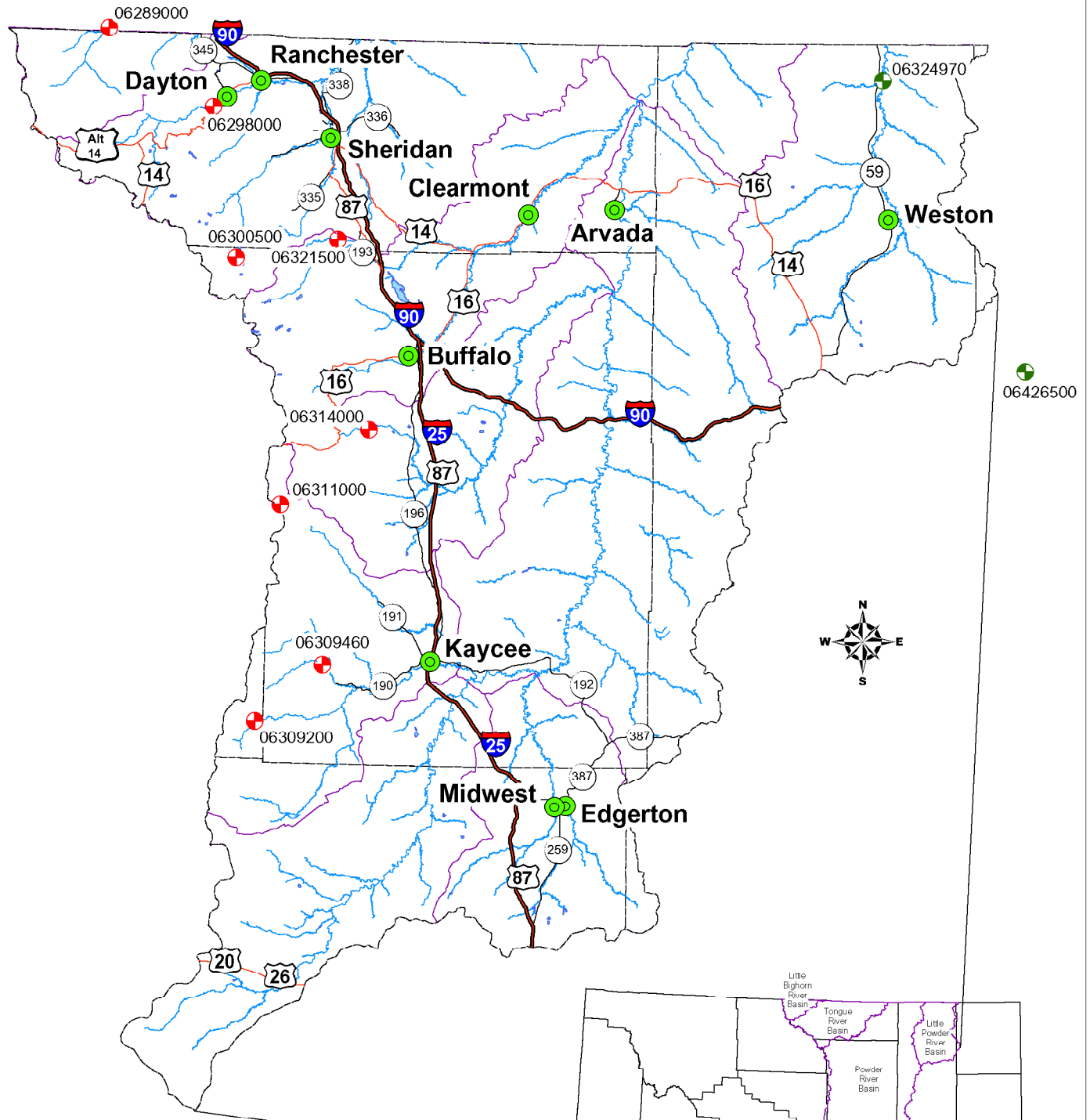
Basin	Station Name	ESTIMATED AVERAGE STREAMFLOW FOR 1970-1999 IN ACRE-FEET												
		OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANNUAL
Tongue	Rapid Creek Just Below Little Rapid Creek in Section 32, T55N, R85W	98	73	65	58	49	54	156	1,050	1,453	407	169	110	3,742
	Beaver Creek at Bottom of Section 26, T55N, R85W	27	20	18	16	14	15	43	290	402	113	47	30	1,034
	Soldier Creek at Right Edge of Section 28, T56N, R85W	60	44	39	35	30	33	95	640	886	248	103	67	2,281
	Prairie Dog Creek Just Above Dutch Creek in Section 34, T57N, R83W	487	1,314	3,453	2,229	3,493	2,296	1,963	1,560	1,253	886	725	673	20,332 ¹
Powder	Red Fork Powder River Just Below North & South Forks Red Fork Powder River in Section 29, T44N, R84W	2,706	2,511	2,415	2,290	2,104	2,477	4,405	9,771	7,396	4,024	3,071	2,695	45,866
	Kelly Creek at Top of Section 21, T49N, R82W	73	55	45	36	30	35	132	629	646	228	106	75	2,092
	Little North Fork Crazy Woman Creek Just Below Grossett Canyon in Section 14, T49N, R83W	166	125	103	82	69	80	299	1,425	1,463	516	240	170	4,737
	Muddy Creek at Diversion Near East Side of Section 35, T49N, R83W	153	115	94	75	63	73	275	1,309	1,344	474	220	156	4,351
	Billy Creek at Diversion to O'Malley Draw in Section 13, T48N, R83W	96	79	69	59	52	59	151	481	477	212	125	98	1,957
	Little Piney Creek Just Below Bear Gulch in Section 28, T53N, R83W	324	421	625	676	1,295	1,250	811	544	470	309	338	273	7,336 ¹
	North & South Forks Shell Creek (Combined), at Confluence of Little North Fork Shell Creek and North Fork Shell Creek in Section 11, and Confluence of Unnamed Tributary & South Fork Shell Creek in Section 14; all in T52N, R83W	56	42	35	28	23	27	114	701	745	219	90	62	2,141
	Johnson Creek at Top of Section 22, T51N, R83W	53	41	33	27	22	26	109	672	714	210	86	59	2,052
	French Creek at Penrose Ditch Diversion in Section 27, T51N, R83W	128	98	80	64	53	62	262	1,614	1,715	504	207	142	4,928

Note: 1. The monthly and annual flows for Prairie Dog Creek and Little Piney Creek are the average of the dry, normal, and wet year monthly and annual flows.

conditions for the entire geographic area of the Powder/Tongue River Basin. To the extent possible, natural flow stations, free from transbasin diversion, irrigation depletions, or storage regulation are selected. One exception, Little Powder River above Dry Creek (#06324970) which is impacted by irrigation depletions was selected to represent hydrologic conditions in the Little Powder drainage. The nine indicator gages are shown on Figure 13. The years with non-exceedance probabilities of 20 percent or less (the driest 20 percent) were selected as dry years. Similarly, the years with exceedance probabilities of 20 percent or less (the wettest 20 percent) were selected as wet years. The remaining 60 percent of the years represent normal years. The dry years, normal years, and wet years for the indicator gages are illustrated on Figure 14. As can be seen, the hydrologic conditions from year to year vary from location to location (i.e. dry years, wet years, and normal years do not occur at all locations simultaneously). Some general conclusions are however evident. For example, 1980, 1985, 1988, and 1989 are dry years at most locations. Whereas, 1975, 1978, 1984, and 1995 are wet years at most locations.

Water use in the Tongue River and Powder River are interrelated through transbasin diversions including the Mead Coffeen Ditch, Piney Cruse Ditch, and the Prairie Dog Ditch. Because of this interrelationship, the years selected to represent the various hydrologic conditions must be consistent for all locations within each of these two river basins. Water use in the Little Bighorn River is essentially independent of water use in the other river basins. Similarly, water use in the Little Powder River drainage is also independent of water use in the other drainages. The driest 20 percent and wettest 20 percent of the years at each of the indicator gages are listed in Figure 15. The years selected to represent dry years, wet years, and normal years for the Little Bighorn River basin, the Tongue and Powder River basins, and the Little Powder River basin are also summarized in Figure 15.

The average monthly and annual streamflow for the natural flow stations for dry years, normal years, and wet years are provided in Tables 10, 11, and 12 respectively. The average monthly and annual streamflow for the non-natural flow stations for dry years, normal years, and wet years are provided in Tables 13, 14, and 15 respectively. Finally, the average monthly and annual streamflow for the ungaged model nodes for dry years, normal years, and wet years are provided in Tables 16, 17, and 18 respectively.



10 5 0 10 20 30 Miles

- + U.S.G.S. Natural Flow Station
- + U.S.G.S. Non-Natural Flow Station
- o Communities

Indicator Gages for Selection of Dry, Normal, & Wet Years



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Figure 13

FIGURE 14
WET, DRY AND NORMAL YEARS FOR INDICATOR STATIONS IN THE POWDER-TONGUE RIVER BASINS

Basin	Station Number	Station Name	Natural Flow	YEAR																												
				1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Little Bighorn	06289000	Little Bighorn River at State Line Near Wyola, MT	YES	Wet	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal
Tongue	06298000	Tongue River Near Dayton, WY	YES	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	
	06300500	East Fork Big Goose Creek Near Big Horn, WY	YES	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	
Powder	06309200	Middle Fork Powder River Near Barnum, WY	YES	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	
	06309460	Beaver Creek Above White Panther Ditch Near Barnum, WY	YES	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	
	06311000	North Fork Powder River Near Hazelton, WY	YES	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	
	06314000	North Fork Crazy Woman Creek Near Buffalo, WY	YES	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	
Powder	06321500	North Piney Creek Near Story, WY	YES	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	
	06324970	Little Powder River Above Dry Creek Near Weston, WY	NO	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	

LEGEND	
Wet	Black
Normal	Grey
Dry	White

FIGURE 15
SELECTION OF WET, DRY, AND NORMAL YEARS FOR MODELING
INDICATOR STATIONS FOR THE POWDER-TONGUE RIVER BASINS

Rank	Weibull Plotting Position	Little Bighorn	
		Little Bighorn River at State Line, Near WyoLa, MT	
		Year	06289000
1	3.23%	1989	68,060
2	6.45%	1985	72,360
3	9.68%	1987	77,020
4	12.90%	1980	81,830
5	16.13%	1992	90,470
6	19.35%	1979	93,400
7	22.58%	1988	93,900
8	25.81%	1981	95,510
9	29.03%	1993	96,740
10	32.26%	1982	97,200
11	35.48%	1994	98,000
12	38.71%	1986	101,170
13	41.94%	1990	103,430
14	45.16%	1983	106,830
15	48.39%	1998	107,010
16	51.61%	1991	110,400
17	54.84%	1972	111,430
18	58.06%	1996	113,090
19	61.29%	1977	115,910
20	64.52%	1997	121,120
21	67.74%	1971	121,810
22	70.97%	1976	123,370
23	74.19%	1995	126,540
24	77.42%	1999	127,190
25	80.65%	1974	130,710
26	83.87%	1973	133,310
27	87.10%	1984	136,970
28	90.32%	1970	159,600
29	93.55%	1978	170,730
30	96.77%	1975	182,880

Rank	Weibull Plotting Position	Tongue River Basin				Powder River Basin									
		Tongue River Near Dayton, WY		East Fork Big Goose Creek Near Big Horn, WY		Middle Fork Powder River Near Barnum, WY		Beaver Creek Above White Panther Ditch, Near Barnum, WY		North Fork Powder River Near Hazelton, WY		North Fork Crazy Woman Creek Near Buffalo, WY		North Piney Creek Near Story, WY	
		Year	06298000	Year	06300500	Year	06309200	Year	06309460	Year	06311000	Year	06314000	Year	06321500
1	3.23%	1989	76,527	1985	15,754	1989	9,469	1989	6,634	1985	6,974	1977	10,122	1985	18,786
2	6.45%	1985	88,393	1988	17,616	1985	10,915	1981	7,204	1981	7,608	1981	11,608	1980	19,694
3	9.68%	1987	91,860	1994	17,717	1980	11,564	1980	7,893	1988	7,889	1985	12,404	1988	21,032
4	12.90%	1980	97,481	1987	18,242	1981	12,890	1985	8,016	1980	7,931	1988	13,511	1994	21,652
5	16.13%	1979	107,713	1977	18,318	1994	13,243	1982	8,040	1974	8,001	1994	13,978	1979	21,655
6	19.35%	1994	113,240	1980	18,340	1979	13,665	1986	8,325	1994	8,105	1989	14,551	1982	22,230
7	22.58%	1998	115,427	1989	18,387	1992	13,731	1988	8,506	1989	8,693	1974	14,671	1989	23,038
8	25.81%	1982	118,780	1991	19,455	1982	15,847	1987	8,963	1972	8,818	1972	14,752	1981	24,199
9	29.03%	1988	120,159	1981	20,437	1974	16,281	1994	9,036	1977	8,882	1973	15,375	1990	24,437
10	32.26%	1981	122,507	1998	20,660	1976	16,609	1974	9,387	1973	9,131	1990	15,464	1987	25,989
11	35.48%	1992	122,866	1979	20,850	1987	16,928	1992	9,635	1990	9,213	1982	15,982	1976	26,899
12	38.71%	1993	126,667	1982	21,839	1988	18,445	1991	9,722	1987	9,735	1970	16,319	1972	27,025
13	41.94%	1986	129,213	1993	22,222	1990	20,436	1990	10,269	1970	10,137	1980	16,411	1971	27,648
14	45.16%	1977	133,134	1983	22,330	1991	20,530	1976	10,299	1979	10,405	1979	16,564	1986	28,593
15	48.39%	1991	133,469	1970	23,062	1986	20,626	1979	10,329	1986	10,860	1987	16,707	1977	29,148
16	51.61%	1976	134,000	1996	23,340	1998	20,860	1998	10,491	1971	11,584	1986	17,730	1974	31,480
17	54.84%	1983	135,628	1990	23,717	1996	20,941	1996	10,511	1976	12,204	1971	18,160	1998	32,568
18	58.06%	1971	136,242	1992	24,316	1972	21,715	1971	10,558	1998	12,443	1998	19,877	1992	33,073
19	61.29%	1996	136,583	1971	24,586	1993	22,499	1972	10,609	1992	12,580	1991	20,064	1991	33,574
20	64.52%	1972	138,031	1997	24,639	1971	22,626	1993	10,710	1991	12,926	1976	20,131	1983	34,423
21	67.74%	1990	138,184	1976	24,826	1997	23,239	1997	10,875	1983	13,118	1992	20,391	1996	35,321
22	70.97%	1997	144,068	1986	24,899	1977	24,757	1973	10,877	1996	13,603	1996	21,093	1993	36,058
23	74.19%	1974	145,021	1973	25,555	1973	26,807	1977	11,016	1982	13,633	1983	21,296	1970	36,073
24	77.42%	1999	145,292	1999	25,853	1970	29,218	1970	11,042	1993	13,847	1993	21,679	1975	36,325
25	80.65%	1973	149,701	1972	27,268	1975	29,477	1983	11,976	1984	14,335	1995	23,013	1984	37,158
26	83.87%	1995	157,750	1974	28,147	1983	30,407	1975	12,565	1995	15,254	1975	23,229	1973	37,710
27	87.10%	1984	170,772	1978	28,491	1984	30,471	1995	12,975	1997	15,384	1997	23,681	1995	39,315
28	90.32%	1970	170,984	1975	30,620	1978	35,430	1999	13,206	1975	15,883	1984	24,218	1997	39,885
29	93.55%	1978	197,249	1995	38,229	1995	36,855	1984	13,707	1999	17,182	1999	25,986	1999	44,332
30	96.77%	1975	198,294	1984	44,963	1999	37,229	1978	17,984	1978	18,963	1978	28,477	1978	45,924

Rank	Weibull Plotting Position	Little Powder	
		Little Powder River Above Dry Creek, Near Weston, WY	
		Year	06324970
1	3.23%	1992	1,084
2	6.45%	1991	2,905
3	9.68%	1989	2,924
4	12.90%	1988	4,005
5	16.13%	1973	4,062
6	19.35%	1980	4,155
7	22.58%	1981	4,414
8	25.81%	1977	6,511
9	29.03%	1985	6,953
10	32.26%	1998	7,776
11	35.48%	1979	7,949
12	38.71%	1976	9,241
13	41.94%	1990	10,057
14	45.16%	1970	10,277
15	48.39%	1975	10,586
16	51.61%	1974	11,634
17	54.84%	1987	11,882
18	58.06%	1983	13,608
19	61.29%	1986	13,884
20	64.52%	1993	17,653
21	67.74%	1982	19,220
22	70.97%	1999	19,251
23	74.19%	1994	21,031
24	77.42%	1984	24,547
25	80.65%	1971	37,031
26	83.87%	1997	39,292
27	87.10%	1972	40,495
28	90.32%	1996	40,534
29	93.55%	1995	41,091
30	96.77%	1978	92,138

LEGEND	
	WET
	DRY

SELECTION OF WET, DRY, & NORMAL YEARS			
Hydrologic Condition	MODEL AREA		
	Little Bighorn Model	Tongue & Powder Models	Little Powder Model
WET	1970, 1973, 1974, 1975, 1978, 1984	1975, 1978, 1984, 1995, 1997, 1999	1971, 1972, 1978, 1995, 1996, 1997
DRY	1979, 1980, 1985, 1987, 1989, 1992	1980, 1981, 1985, 1988, 1989, 1994	1973, 1980, 1988, 1989, 1991, 1992
AVERAGE	All Other Years Between 1970 and 1999	All Other Years Between 1970 and 1999	All Other Years Between 1970 and 1999

TABLE 10
SUMMARY OF DRY YEAR MONTHLY AND ANNUAL FLOWS (1970 TO 1999)
NATURAL FLOW STATIONS IN THE POWDER-TONGUE RIVER BASINS

Basin	Station Number	Station Name	AVERAGE STREAMFLOW FOR 1970-1999 IN ACRE-FEET												ANNUAL
			OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	
Little Bighorn	06288600	Little Bighorn River Below Dayton Gulch Near Burgess Junction, WY	383	293	270	230	186	199	396	2,737	2,400	1,220	631	406	9,348
	06288700	Dry Fork Little Bighorn River Below Lick Creek Near Burgess Junction, WY	1,781	1,540	1,467	1,330	1,157	1,254	1,685	4,567	4,393	2,990	2,106	1,666	25,935
	06288960	Little Bighorn River near Parkman, WY	3,804	3,159	2,990	2,746	2,375	2,648	3,934	12,923	11,513	6,948	4,513	3,536	61,087
	06288975	Elkhorn Creek Above Fuller Ranch Ditch Near Parkman, WY	104	97	90	81	70	83	145	327	258	145	119	101	1,621
	06288990	West Fork Little Bighorn River Near Parkman, WY	911	765	710	645	563	627	872	2,647	2,377	1,526	1,041	824	13,505
	06289000	Little Bighorn River at State Line Near Wyola, MT	5,168	4,347	4,130	3,815	3,330	3,687	5,332	16,225	14,538	9,057	6,063	4,832	80,523
	06289100	Red Canyon Creek Near Parkman, WY	23	24	19	21	16	23	126	260	103	34	20	21	689
	06289800	East Pass Creek Near Parkman, WY	450	377	359	329	293	315	616	1,506	1,362	863	587	468	7,524
06291200	Lodge Grass Creek at State Line Near Wyola, MT	445	356	322	284	238	262	607	2,835	2,606	1,242	690	464	10,349	
Tongue	06297000	South Fork Tongue River Near Dayton, WY	1,253	926	859	714	604	671	2,638	15,853	9,285	2,993	1,616	1,228	38,639
	06297480	Tongue River at Tongue Canyon Campground Near Dayton, WY	4,618	3,659	3,455	2,989	2,624	2,850	8,122	32,437	20,874	8,460	5,619	4,552	100,258
	06298000	Tongue River Near Dayton, WY	4,654	3,681	3,473	3,002	2,633	2,862	8,224	33,196	21,910	9,160	5,672	4,587	103,051
	06298480	Little Tongue River at Steamboat Point Near Dayton, WY	119	85	79	65	54	60	335	2,105	1,413	441	190	128	5,073
	06298490	Little Tongue River Above South Fork Little Tongue River Near Dayton, WY	85	59	54	44	36	41	209	1,748	926	239	115	83	3,639
	06298500	Little Tongue River Near Dayton, WY	200	143	132	108	90	101	528	3,159	2,144	692	306	208	7,811
	06299480	Wolf Creek Below Alden Creek Near Wolf, WY	423	313	291	241	205	227	1,036	5,941	4,067	1,352	610	419	15,122
	06299490	Wolf Creek Above Red Canyon Creek Near Wolf, WY	499	380	355	300	258	284	1,025	5,696	3,926	1,334	610	423	15,089
	06299500	Wolf Creek at Wolf, WY	496	370	344	287	244	270	1,106	5,662	3,972	1,426	678	478	15,331
	06300500	East Fork Big Goose Creek Near Big Horn, WY	355	243	221	176	143	163	918	6,291	6,407	1,855	700	573	18,042
06301480	Coney Creek Above Twin Lakes Near Big Horn, WY	25	15	13	10	8	9	88	1,282	1,059	153	46	38	2,746	
Powder	06309200	Middle Fork Powder River Near Barnum, WY	366	344	335	299	259	320	2,163	5,973	1,485	523	351	336	12,754
	06309260	Buffalo Creek Above North Fork Buffalo Creek Near Arminto, WY	23	22	21	18	15	20	211	755	132	36	22	21	1,294
	06309270	North Fork Buffalo Creek Near Arminto, WY	70	65	64	57	50	61	387	1,033	269	98	67	64	2,284
	06309280	Buffalo Creek Below North Fork Buffalo Creek Near Arminto, WY	0	0	0	0	0	0	10	932	123	3	0	0	1,067
	06309450	Beaver Creek Below Bayer Creek Near Barnum, WY	167	145	128	110	89	119	461	804	454	252	180	153	3,060
	06309460	Beaver Creek Above White Panther Ditch Near Barnum, WY	600	544	538	521	456	513	889	1,247	860	647	558	508	7,882
	06311000	North Fork Powder River Near Hazelton, WY	271	200	155	121	97	116	961	2,983	1,847	587	305	226	7,867
	06313950	North Fork Crazy Woman Creek Below Pole Creek Near Buffalo, WY	596	463	368	276	227	260	1,652	4,799	3,037	1,122	596	451	13,847
	06314000	North Fork Crazy Woman Creek Near Buffalo, WY	599	475	373	285	232	264	1,648	4,661	3,031	1,127	598	451	13,744
	06314500	North Fork Crazy Woman Creek Below Spring Draw Near Buffalo, WY	510	374	287	222	177	212	1,878	6,015	3,677	1,130	577	423	15,483
	06315480	Poison Creek Below Tetley Spring Near Mayoworth, WY	209	173	145	117	100	111	453	1,024	717	339	209	169	3,766
	06315490	Poison Creek Near Mayoworth, WY	241	202	171	139	120	133	502	1,091	777	382	242	197	4,195
	06315500	Middle Fork Crazy Woman Creek Near Greub, WY	659	513	416	339	282	327	1,881	4,814	3,223	1,256	730	569	15,009
	06317300	Sourdough Creek Near Buffalo, WY	64	45	36	25	22	28	153	457	433	152	75	56	1,545
	06317340	Little Sourdough Creek Near Buffalo, WY	16	11	3	1	1	2	106	95	55	12	5	8	314
	06319470	South Rock Creek at Forest Boundary Near Buffalo, WY	414	308	240	189	152	181	1,425	4,299	2,691	882	466	347	11,594
	06319480	South Rock Creek Above Red Canyon Near Buffalo, WY	395	293	227	178	143	170	1,383	4,239	2,637	850	445	330	11,288
06321500	North Piney Creek Near Story, WY	751	587	459	371	295	342	2,571	8,859	4,307	1,475	776	606	21,400	

TABLE 11
SUMMARY OF NORMAL YEAR MONTHLY AND ANNUAL FLOWS (1970 TO 1999)
NATURAL FLOW STATIONS IN THE POWDER-TONGUE RIVER BASINS

Basin	Station Number	Station Name	AVERAGE STREAMFLOW FOR 1970-1999 IN ACRE-FEET												ANNUAL
			OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	
Little Bighorn	06288600	Little Bighorn River Below Dayton Gulch Near Burgess Junction, WY	422	303	267	237	196	220	361	3,862	6,199	1,629	778	463	14,937
	06288700	Dry Fork Little Bighorn River Below Lick Creek Near Burgess Junction, WY	1,854	1,591	1,477	1,379	1,227	1,329	1,722	6,442	9,677	4,367	2,630	2,024	35,720
	06288960	Little Bighorn River near Parkman, WY	4,002	3,337	3,079	2,837	2,458	2,766	3,732	17,480	27,873	10,893	6,005	4,414	88,877
	06288975	Elkhorn Creek Above Fuller Ranch Ditch Near Parkman, WY	116	101	92	86	75	88	139	470	602	186	136	123	2,213
	06288990	West Fork Little Bighorn River Near Parkman, WY	932	790	731	671	589	675	901	3,871	5,812	2,315	1,355	1,037	19,677
	06289000	Little Bighorn River at State Line Near Wyola, MT	5,412	4,543	4,226	3,927	3,465	3,879	5,112	21,438	33,132	13,750	7,872	5,948	112,704
	06289100	Red Canyon Creek Near Parkman, WY	35	31	25	27	23	42	214	545	241	64	31	27	1,304
	06289800	East Pass Creek Near Parkman, WY	474	391	365	339	303	331	552	1,928	2,318	1,057	644	510	9,211
06291200	Lodge Grass Creek at State Line Near Wyola, MT	466	351	310	282	238	273	581	3,838	5,310	1,658	784	529	14,620	
Tongue	06297000	South Fork Tongue River Near Dayton, WY	1,462	1,069	976	816	655	749	1,756	14,632	20,914	5,932	2,554	1,700	53,216
	06297480	Tongue River at Tongue Canyon Campground Near Dayton, WY	5,140	3,987	3,650	3,349	2,827	3,124	5,922	31,052	40,989	14,721	7,889	5,768	128,419
	06298000	Tongue River Near Dayton, WY	5,232	4,031	3,687	3,369	2,853	3,163	6,003	31,944	41,798	15,382	8,019	5,825	131,306
	06298480	Little Tongue River at Steamboat Point Near Dayton, WY	137	96	85	74	59	71	239	2,024	2,889	689	280	176	6,819
	06298490	Little Tongue River Above South Fork Little Tongue River Near Dayton, WY	102	70	60	52	40	47	133	1,615	2,453	532	202	121	5,427
	06298500	Little Tongue River Near Dayton, WY	228	162	140	127	111	124	392	3,153	4,156	1,074	427	278	10,372
	06299480	Wolf Creek Below Alden Creek Near Wolf, WY	481	347	306	269	221	261	757	5,691	8,097	2,060	859	561	19,909
	06299490	Wolf Creek Above Red Canyon Creek Near Wolf, WY	537	404	362	330	272	308	753	5,442	7,717	2,019	857	564	19,565
	06299500	Wolf Creek at Wolf, WY	543	405	355	321	281	301	827	5,443	7,591	2,118	934	627	19,746
	06300500	East Fork Big Goose Creek Near Big Horn, WY	434	279	208	210	153	169	516	4,890	10,683	3,453	1,208	777	22,980
06301480	Coney Creek Above Twin Lakes Near Big Horn, WY	31	19	13	10	7	9	46	1,069	1,782	423	84	55	3,548	
Powder	06309200	Middle Fork Powder River Near Barnum, WY	458	392	362	328	296	434	2,192	9,883	4,450	1,052	528	430	20,805
	06309260	Buffalo Creek Above North Fork Buffalo Creek Near Arminto, WY	31	26	23	20	18	29	229	1,337	562	91	37	28	2,429
	06309270	North Fork Buffalo Creek Near Arminto, WY	87	74	68	61	55	81	383	1,674	775	195	102	83	3,639
	06309280	Buffalo Creek Below North Fork Buffalo Creek Near Arminto, WY	0	0	0	0	0	0	51	1,904	700	41	3	1	2,700
	06309450	Beaver Creek Below Bayer Creek Near Barnum, WY	183	160	144	127	117	163	545	1,824	1,026	395	238	186	5,106
	06309460	Beaver Creek Above White Panther Ditch Near Barnum, WY	603	555	539	513	479	566	1,040	2,191	1,524	876	673	595	10,154
	06311000	North Fork Powder River Near Hazelton, WY	305	230	190	148	127	143	546	3,946	3,634	1,076	481	347	11,173
	06313950	North Fork Crazy Woman Creek Below Pole Creek Near Buffalo, WY	670	487	403	316	261	305	1,062	5,365	5,452	1,909	946	698	17,873
	06314000	North Fork Crazy Woman Creek Near Buffalo, WY	681	494	412	327	273	313	1,079	5,238	5,249	1,878	934	700	17,577
	06314500	North Fork Crazy Woman Creek Below Spring Draw Near Buffalo, WY	581	430	358	268	229	273	1,081	7,809	7,212	2,176	946	671	22,032
	06315480	Poison Creek Below Tetley Spring Near Mayoworth, WY	224	179	155	129	114	128	321	1,133	1,112	490	290	233	4,508
	06315490	Poison Creek Near Mayoworth, WY	256	207	181	153	134	152	362	1,195	1,174	541	331	268	4,954
	06315500	Middle Fork Crazy Woman Creek Near Greub, WY	728	568	492	398	350	426	1,222	5,982	5,545	2,015	1,045	796	19,565
	06317300	Sourdough Creek Near Buffalo, WY	73	56	47	36	30	33	96	822	847	265	115	84	2,504
	06317340	Little Sourdough Creek Near Buffalo, WY	34	20	7	3	2	5	188	201	133	35	16	25	668
	06319470	South Rock Creek at Forest Boundary Near Buffalo, WY	461	353	296	234	199	220	818	5,550	5,256	1,631	730	520	16,268
	06319480	South Rock Creek Above Red Canyon Near Buffalo, WY	439	336	278	216	186	208	790	5,473	5,219	1,595	706	502	15,949
06321500	North Piney Creek Near Story, WY	829	650	535	441	374	472	1,688	10,668	9,908	2,619	1,137	897	30,217	

TABLE 12
SUMMARY OF WET YEAR MONTHLY AND ANNUAL FLOWS (1970 TO 1999)
NATURAL FLOW STATIONS IN THE POWDER-TONGUE RIVER BASINS

Basin	Station Number	Station Name	AVERAGE STREAMFLOW FOR 1970-1999 IN ACRE-FEET												
			OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANNUAL
Little Bighorn	06288600	Little Bighorn River Below Dayton Gulch Near Burgess Junction, WY	406	293	265	246	199	212	299	3,733	10,128	2,551	981	538	19,851
	06288700	Dry Fork Little Bighorn River Below Lick Creek Near Burgess Junction, WY	1,921	1,678	1,583	1,455	1,301	1,407	1,696	7,747	15,057	7,010	3,406	2,525	46,785
	06288960	Little Bighorn River near Parkman, WY	4,222	3,588	3,245	3,076	2,707	2,977	3,723	21,474	45,028	18,889	8,210	5,703	122,841
	06288975	Elkhorn Creek Above Fuller Ranch Ditch Near Parkman, WY	118	102	95	89	81	92	136	715	1,125	327	159	157	3,196
	06288990	West Fork Little Bighorn River Near Parkman, WY	984	836	764	707	647	710	901	5,327	10,134	4,021	1,785	1,335	28,152
	06289000	Little Bighorn River at State Line Near Wyola, MT	5,667	4,890	4,467	4,217	3,748	4,120	5,097	26,348	52,728	23,118	10,465	7,502	152,367
	06289100	Red Canyon Creek Near Parkman, WY	55	48	40	44	36	66	346	1,002	424	109	51	42	2,263
	06289800	East Pass Creek Near Parkman, WY	464	387	372	344	313	330	455	2,223	3,454	1,392	706	557	10,995
06291200	Lodge Grass Creek at State Line Near Wyola, MT	466	344	322	308	257	270	427	3,807	8,850	2,869	913	624	19,456	
Tongue	06297000	South Fork Tongue River Near Dayton, WY	1,479	1,030	923	856	690	786	1,288	14,366	39,809	11,430	3,358	1,954	77,970
	06297480	Tongue River at Tongue Canyon Campground Near Dayton, WY	5,280	4,056	3,710	3,440	3,012	3,311	4,758	29,952	68,799	25,483	9,988	6,407	168,195
	06298000	Tongue River Near Dayton, WY	5,301	3,998	3,673	3,465	2,930	3,237	4,697	30,887	68,594	25,504	10,027	6,591	168,904
	06298480	Little Tongue River at Steamboat Point Near Dayton, WY	139	97	84	74	62	72	194	2,648	5,358	1,124	339	177	10,367
	06298490	Little Tongue River Above South Fork Little Tongue River Near Dayton, WY	98	65	56	52	41	49	90	1,614	4,929	1,122	280	141	8,538
	06298500	Little Tongue River Near Dayton, WY	240	161	143	132	104	120	303	3,874	7,901	1,805	548	296	15,626
	06299480	Wolf Creek Below Alden Creek Near Wolf, WY	488	351	314	284	228	267	617	7,299	14,248	3,542	1,089	585	29,311
	06299490	Wolf Creek Above Red Canyon Creek Near Wolf, WY	568	429	380	357	304	332	636	6,999	13,552	3,453	1,068	586	28,664
	06299500	Wolf Creek at Wolf, WY	568	412	369	336	272	317	683	6,843	13,155	3,405	1,153	657	28,171
	06300500	East Fork Big Goose Creek Near Big Horn, WY	471	342	254	217	169	187	320	5,517	16,433	6,483	1,155	587	32,133
06301480	Coney Creek Above Twin Lakes Near Big Horn, WY	33	19	15	12	9	11	21	965	2,498	1,252	116	37	4,987	
Powder	06309200	Middle Fork Powder River Near Barnum, WY	543	561	427	373	329	497	1,886	13,410	11,223	1,624	703	542	32,117
	06309260	Buffalo Creek Above North Fork Buffalo Creek Near Arminto, WY	38	40	27	22	19	33	194	1,984	1,426	194	58	36	4,070
	06309270	North Fork Buffalo Creek Near Arminto, WY	102	109	81	70	60	91	313	2,141	1,981	317	143	111	5,518
	06309280	Buffalo Creek Below North Fork Buffalo Creek Near Arminto, WY	0	0	0	0	0	0	7	2,947	2,525	133	1	0	5,612
	06309450	Beaver Creek Below Bayer Creek Near Barnum, WY	209	204	155	138	118	174	499	2,662	2,173	708	343	251	7,634
	06309460	Beaver Creek Above White Panther Ditch Near Barnum, WY	652	633	577	531	487	593	975	3,236	2,937	1,278	898	756	13,553
	06311000	North Fork Powder River Near Hazelton, WY	286	213	174	157	120	169	415	4,497	7,433	1,738	607	360	16,167
	06313950	North Fork Crazy Woman Creek Below Pole Creek Near Buffalo, WY	542	449	359	315	272	329	874	7,018	9,478	3,068	1,159	683	24,544
	06314000	North Fork Crazy Woman Creek Near Buffalo, WY	557	448	366	314	275	331	875	7,077	9,409	3,174	1,220	724	24,767
	06314500	North Fork Crazy Woman Creek Below Spring Draw Near Buffalo, WY	539	398	324	291	221	314	798	9,188	15,384	3,455	1,171	684	32,766
	06315480	Poison Creek Below Tetley Spring Near Mayoworth, WY	192	165	140	130	116	136	314	1,436	1,721	642	318	222	5,530
	06315490	Poison Creek Near Mayoworth, WY	222	191	167	153	139	165	350	1,485	1,805	704	365	253	5,997
	06315500	Middle Fork Crazy Woman Creek Near Greub, WY	692	540	460	422	338	447	903	6,697	10,221	3,060	1,289	838	25,906
	06317300	Sourdough Creek Near Buffalo, WY	66	50	41	37	29	40	94	953	1,555	379	137	83	3,462
	06317340	Little Sourdough Creek Near Buffalo, WY	65	39	13	5	3	9	359	373	242	62	28	43	1,242
	06319470	South Rock Creek at Forest Boundary Near Buffalo, WY	437	337	274	244	187	244	621	6,203	10,264	2,837	914	545	23,106
	06319480	South Rock Creek Above Red Canyon Near Buffalo, WY	417	325	262	238	180	232	599	6,175	10,222	2,742	882	516	22,788
06321500	North Piney Creek Near Story, WY	763	595	490	422	353	437	1,450	11,665	17,560	4,334	1,506	916	40,490	

TABLE 13
SUMMARY OF DRY YEAR MONTHLY AND ANNUAL FLOWS (1970 TO 1999)
NON-NATURAL FLOW STATIONS IN THE POWDER-TONGUE RIVER BASINS

Basin	Station Number	Station Name	AVERAGE STREAMFLOW FOR 1970-1999 IN ACRE-FEET												
			OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANNUAL
Little Bighorn	06289600	West Pass Creek Near Parkman, WY	522	485	460	421	377	469	647	1,126	1,038	584	406	415	6,949
	06289820	East Pass Creek Near Dayton, WY	620	578	551	506	458	592	790	1,407	1,317	673	398	475	8,364
	06289870	Twin Creek Near Parkman, WY	71	64	81	213	155	472	573	664	160	93	70	59	2,676
Tongue	06302000	Big Goose Creek Near Sheridan, WY	2,116	1,637	1,536	1,310	1,136	1,244	2,545	14,220	14,547	5,167	3,833	2,937	52,227
	06303500	Little Goose Creek in Canyon Near Big Horn, WY	1,738	1,352	1,271	1,087	945	1,033	2,160	9,517	7,440	5,127	3,802	2,395	37,866
	06305500	Goose Creek Below Sheridan, WY	6,048	5,421	4,763	4,009	3,664	6,136	6,965	20,947	16,605	3,094	2,118	2,882	82,651
	06305700	Goose Creek Near Acme, WY	6,185	5,536	4,858	4,084	3,730	6,277	7,133	21,677	17,157	3,147	2,146	2,927	84,857
	06306250	Prairie Dog Creek Near Acme, WY	2,437	1,924	1,611	1,129	2,253	5,008	2,043	1,678	1,279	878	1,552	1,928	23,719
	06306300	Tongue River at State Line Near Decker, MT	14,045	12,138	8,888	8,018	8,497	16,247	19,902	61,280	43,982	10,638	6,433	7,775	217,843
Powder	06309500	Middle Fork Powder River Above Kaycee, WY	2,616	2,537	2,419	2,362	2,125	2,471	5,738	10,427	4,480	2,483	2,065	2,177	41,898
	06311060	North Fork Powder River Below Bull Creek Near Hazelton, WY	238	137	131	117	104	134	415	2,289	2,342	2,011	1,313	719	9,949
	06311400	North Fork Powder River Below Pass Creek Near Mayoworth, WY	1,348	1,128	1,160	1,145	1,008	1,105	1,672	3,450	2,843	2,598	2,122	1,548	21,128
	06312500	Powder River Near Kaycee, WY	3,984	5,116	5,210	4,358	5,231	6,568	7,052	18,405	10,431	643	850	1,268	69,116
	06313000	South Fork Powder River Near Kaycee, WY	86	118	116	102	1,136	3,680	2,856	5,383	1,170	269	1,000	6	15,923
	06313400	Salt Creek Near Sussex, WY	1,962	1,848	1,795	1,885	2,721	2,888	2,282	2,930	2,355	2,618	1,773	1,885	26,941
	06313500	Powder River at Sussex, WY	6,572	7,446	7,294	6,924	9,824	12,733	11,749	17,875	6,632	5,191	3,572	2,639	98,450
	SEO Gage	Crazy Woman Creek at Trabing Bridge Near Buffalo, WY	330	204	221	210	153	193	1,013	1,442	1,788	852	607	293	7,307
	06316400	Crazy Woman Creek at Upper Station Near Arvada, WY	1,073	1,174	1,125	1,024	1,198	1,904	2,181	3,773	2,521	792	423	278	17,466
	06317000	Powder River at Arvada, WY	7,643	8,622	7,085	7,065	10,102	18,663	13,967	21,182	9,420	5,767	2,810	2,314	114,639
	06318500	Clear Creek Near Buffalo, WY	1,806	1,397	1,062	778	621	912	2,633	9,770	11,330	5,321	2,680	1,977	40,287
	SEO Gage	Clear Creek in Buffalo City Park, Buffalo, WY	1,168	1,174	1,195	949	1,419	1,700	2,507	6,059	5,297	1,360	525	600	23,951
	06320000	Rock Creek Near Buffalo, WY	826	623	581	489	419	461	1,248	5,991	4,429	2,886	2,113	990	21,055
	SEO Gage	Rock Creek at Mouth Near Buffalo, WY	1,054	1,042	961	822	1,067	1,851	1,141	3,790	1,495	616	506	708	15,052
	06320200	Clear Creek Below Rock Creek Near Buffalo, WY	3,157	2,766	2,312	1,853	2,020	3,282	4,667	9,945	7,571	2,407	1,211	1,518	42,708
	SEO Gage	Clear Creek below Healy Reservoir Near Buffalo, WY	1,647	1,448	1,248	1,052	1,480	2,101	3,662	8,955	6,790	3,071	1,722	1,527	34,703
	06321000	South Piney Creek Near Story, WY	1,735	1,225	1,214	1,033	803	895	1,370	4,880	16,184	9,925	7,096	4,360	50,719
	06323000	Piney Creek at Kearney, WY	1,401	1,985	1,785	1,713	1,514	1,740	4,029	12,630	8,558	2,033	784	497	38,670
	SEO Gage	Little Piney Creek, WY	766	760	636	627	589	941	809	1,082	623	660	538	586	8,616
	SEO Gage	Piney Creek below Lake DeSmet Tunnel Intake Near Story, WY	974	552	422	387	356	458	2,180	8,305	6,194	2,871	1,073	1,094	24,865
	06323500	Piney Creek at Ucross, WY	3,235	3,416	3,367	3,181	1,307	1,717	3,657	7,110	8,503	7,061	4,634	3,715	50,904
	SEO Gage	Clear Creek at Double Crossing Near Clearmont, WY	7,063	7,196	6,881	6,323	5,321	6,584	7,413	15,042	12,668	8,499	6,054	5,085	94,127
	SEO Gage	Clear Creek below P&F#3 Ditch Near Clearmont, WY	10,045	7,190	3,181	3,300	7,712	9,831	10,268	38,389	61,603	13,948	5,051	4,132	174,649
06324000	Clear Creek Near Arvada, WY	6,687	6,744	5,449	5,313	4,172	8,956	8,859	13,104	9,400	4,922	3,449	3,796	80,849	
06324500	Powder River at Moorhead, MT	15,447	16,172	10,265	11,567	13,510	27,822	22,040	33,420	20,735	10,368	6,822	5,603	193,770	
Little Powder	06324890	Little Powder River Below Corral Creek Near Weston, WY	2	12	16	22	89	278	41	296	39	63	9	0	868
	06324925	Little Powder River Near Weston, WY	19	26	30	24	319	399	284	474	220	64	169	13	2,041
	06324970	Little Powder River Above Dry Creek Near Weston, WY	41	54	69	60	481	630	480	737	383	127	111	17	3,189
Belle Fourche	06426500	Belle Fourche River Below Moorcroft, WY	26	70	61	41	464	1,460	299	443	212	1,189	183	71	4,517

TABLE 14
SUMMARY OF NORMAL YEAR MONTHLY AND ANNUAL FLOWS (1970 TO 1999)
NON-NATURAL FLOW STATIONS IN THE POWDER-TONGUE RIVER BASINS

Basin	Station Number	Station Name	AVERAGE STREAMFLOW FOR 1970-1999 IN ACRE-FEET												ANNUAL
			OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	
Little Bighorn	06289600	West Pass Creek Near Parkman, WY	504	467	437	411	417	498	799	2,160	2,006	825	529	501	9,554
	06289820	East Pass Creek Near Dayton, WY	596	562	544	528	542	635	982	2,882	2,855	883	494	512	12,016
	06289870	Twin Creek Near Parkman, WY	124	105	137	370	270	783	909	1,820	398	173	129	98	5,316
Tongue	06302000	Big Goose Creek Near Sheridan, WY	2,326	1,735	1,570	1,430	1,194	1,339	2,282	12,149	25,660	7,537	4,754	3,721	65,698
	06303500	Little Goose Creek in Canyon Near Big Horn, WY	1,847	1,384	1,250	1,126	945	1,057	2,189	10,298	14,356	6,323	5,629	3,521	49,924
	06305500	Goose Creek Below Sheridan, WY	6,814	5,975	5,231	4,636	5,507	5,947	8,728	23,311	37,384	8,686	4,240	6,047	122,506
	06305700	Goose Creek Near Acme, WY	6,974	6,107	5,341	4,729	5,627	6,080	8,953	24,129	38,842	8,919	4,325	6,185	126,210
	06306250	Prairie Dog Creek Near Acme, WY	2,839	2,208	1,848	1,309	2,689	5,514	2,968	2,928	2,289	1,335	1,630	2,521	30,078
06306300	Tongue River at State Line Near Decker, MT	16,788	14,097	12,116	12,437	15,372	19,950	22,686	66,751	92,276	27,317	11,874	14,461	326,123	
Powder	06309500	Middle Fork Powder River Above Kaycee, WY	2,833	2,582	2,475	2,381	2,258	2,727	5,709	15,043	9,203	3,998	2,751	2,576	54,536
	06311060	North Fork Powder River Below Bull Creek Near Hazelton, WY	240	178	167	130	119	141	363	3,099	3,867	1,850	1,470	1,096	12,720
	06311400	North Fork Powder River Below Pass Creek Near Mayoworth, WY	1,303	1,116	1,119	1,084	971	1,069	1,688	4,781	5,035	2,692	2,343	1,915	25,116
	06312500	Powder River Near Kaycee, WY	4,911	6,163	6,250	5,456	6,193	8,182	8,671	27,220	16,087	1,025	811	1,775	92,743
	06313000	South Fork Powder River Near Kaycee, WY	159	215	149	166	1,198	7,158	5,540	8,230	1,974	608	1,676	11	27,086
	06313400	Salt Creek Near Sussex, WY	2,235	1,706	1,580	1,726	2,412	3,985	3,012	4,564	4,661	2,916	1,876	1,750	32,423
	06313500	Powder River at Sussex, WY	8,804	8,411	7,030	6,999	11,096	18,936	19,424	33,736	24,225	8,661	4,715	5,703	157,741
	SEO Gage	Crazy Woman Creek at Trabing Bridge Near Buffalo, WY	324	221	215	186	144	182	1,589	8,734	10,816	2,724	959	1,084	27,177
	06316400	Crazy Woman Creek at Upper Station Near Arvada, WY	1,419	1,319	961	811	1,793	2,626	3,724	8,073	7,100	2,075	1,083	974	31,956
	06317000	Powder River at Arvada, WY	9,874	9,343	6,922	6,424	12,141	24,059	23,302	44,564	38,014	13,330	6,608	6,543	201,124
	06318500	Clear Creek Near Buffalo, WY	2,258	1,534	1,184	881	742	970	2,622	11,564	17,291	7,889	3,941	2,840	53,714
	SEO Gage	Clear Creek in Buffalo City Park, Buffalo, WY	1,413	1,131	871	736	924	1,738	2,159	9,095	13,292	4,229	1,565	1,501	38,653
	06320000	Rock Creek Near Buffalo, WY	893	651	578	519	431	485	946	6,726	8,800	3,682	2,774	1,684	28,169
	SEO Gage	Rock Creek at Mouth Near Buffalo, WY	1,401	1,292	952	870	1,214	2,267	1,322	4,706	6,204	1,592	957	925	23,702
	06320200	Clear Creek Below Rock Creek Near Buffalo, WY	3,910	3,267	2,698	2,618	3,170	4,190	5,369	16,040	22,192	7,063	3,307	3,584	77,409
	SEO Gage	Clear Creek below Healy Reservoir Near Buffalo, WY	1,916	1,373	996	831	1,044	2,262	3,532	13,057	19,113	7,319	3,615	3,025	58,083
	06321000	South Piney Creek Near Story, WY	2,011	1,524	1,491	1,217	908	968	1,493	5,891	19,901	11,386	8,790	5,621	61,201
	06323000	Piney Creek at Kearney, WY	1,866	2,259	2,118	1,854	1,603	2,138	4,087	15,123	22,767	4,996	1,897	1,497	62,203
	SEO Gage	Little Piney Creek, WY	744	722	580	549	707	950	954	1,428	1,428	803	584	718	10,166
	SEO Gage	Piney Creek below Lake DeSmet Tunnel Intake Near Story, WY	1,463	1,057	713	642	595	861	1,678	9,173	18,866	4,704	2,047	1,432	43,231
06323500	Piney Creek at Ucross, WY	3,045	3,150	2,126	1,851	1,543	2,979	3,926	12,380	17,789	5,885	4,958	3,896	63,527	
SEO Gage	Clear Creek at Double Crossing Near Clearmont, WY	7,147	6,939	5,087	4,263	5,128	9,624	9,332	24,775	37,299	11,948	7,645	7,449	136,634	
SEO Gage	Clear Creek below P&F#3 Ditch Near Clearmont, WY	6,599	5,483	4,320	4,630	6,173	10,641	7,800	19,529	38,577	12,655	6,281	5,376	128,064	
06324000	Clear Creek Near Arvada, WY	6,461	6,176	4,147	3,680	5,852	10,041	10,320	23,374	34,407	9,106	5,364	6,169	125,097	
06324500	Powder River at Moorhead, MT	16,672	14,954	10,739	10,319	20,648	36,869	31,922	62,461	71,190	23,837	11,879	12,535	324,023	
Little Powder	06324890	Little Powder River Below Corral Creek Near Weston, WY	8	14	21	60	187	713	138	837	84	296	41	0	2,399
	06324925	Little Powder River Near Weston, WY	283	144	65	405	1,109	1,553	1,119	1,970	1,683	625	309	246	9,511
	06324970	Little Powder River Above Dry Creek Near Weston, WY	450	254	142	548	1,493	2,209	1,519	2,318	2,026	812	453	360	12,582
Belle Fourche	06426500	Belle Fourche River Below Moorcroft, WY	846	276	205	494	1,513	3,406	2,128	2,920	1,675	804	418	376	15,059

TABLE 15
SUMMARY OF WET YEAR MONTHLY AND ANNUAL FLOWS (1970 TO 1999)
NON-NATURAL FLOW STATIONS IN THE POWDER-TONGUE RIVER BASINS

Basin	Station Number	Station Name	AVERAGE STREAMFLOW FOR 1970-1999 IN ACRE-FEET												
			OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANNUAL
Little Bighorn	06289600	West Pass Creek Near Parkman, WY	580	489	427	437	397	554	790	2,821	3,336	1,121	468	608	12,027
	06289820	East Pass Creek Near Dayton, WY	710	600	520	549	484	684	1,035	3,727	4,598	1,411	517	721	15,555
	06289870	Twin Creek Near Parkman, WY	201	171	218	631	444	1,621	1,779	3,801	735	309	233	170	10,314
Tongue	06302000	Big Goose Creek Near Sheridan, WY	2,438	1,792	1,633	1,532	1,276	1,423	1,844	15,206	43,642	15,021	5,115	4,027	94,948
	06303500	Little Goose Creek in Canyon Near Big Horn, WY	1,998	1,477	1,349	1,267	1,059	1,178	1,681	13,765	23,622	8,813	5,493	4,168	65,872
	06305500	Goose Creek Below Sheridan, WY	6,969	5,930	5,088	4,932	4,673	7,138	8,270	43,156	71,740	21,424	5,397	6,955	191,672
	06305700	Goose Creek Near Acme, WY	7,133	6,062	5,193	5,033	4,767	7,306	8,477	44,499	75,198	22,253	5,480	7,142	198,542
	06306250	Prairie Dog Creek Near Acme, WY	3,018	2,448	2,050	1,394	2,556	7,069	3,027	8,112	3,531	2,223	2,239	2,303	39,972
	06306300	Tongue River at State Line Near Decker, MT	16,527	14,165	11,352	10,340	10,940	21,038	21,378	108,313	171,233	55,478	16,727	15,543	473,035
Powder	06309500	Middle Fork Powder River Above Kaycee, WY	2,946	2,927	2,605	2,432	2,273	2,817	5,514	18,856	15,840	5,414	3,479	3,002	68,105
	06311060	North Fork Powder River Below Bull Creek Near Hazelton, WY	241	175	161	139	133	159	332	4,356	6,662	2,508	1,899	1,134	17,899
	06311400	North Fork Powder River Below Pass Creek Near Mayoworth, WY	1,370	1,215	1,178	1,153	1,048	1,133	1,330	6,663	9,603	3,500	2,898	2,293	33,386
	06312500	Powder River Near Kaycee, WY	6,596	8,318	8,443	7,304	8,391	10,965	11,653	35,264	20,683	1,310	1,157	2,323	122,407
	06313000	South Fork Powder River Near Kaycee, WY	277	394	234	331	1,879	12,398	9,830	14,619	3,052	854	2,431	15	46,315
	06313400	Salt Creek Near Sussex, WY	2,618	2,134	1,994	2,179	2,928	6,372	3,697	10,353	4,264	3,944	2,299	2,130	44,913
	06313500	Powder River at Sussex, WY	17,455	10,548	8,768	8,082	9,846	19,191	17,354	73,310	51,299	14,882	4,663	4,747	240,144
	SEO Gage	Crazy Woman Creek at Trabing Bridge Near Buffalo, WY	342	248	227	213	167	205	2,705	16,980	32,197	7,031	2,723	1,346	64,382
	06316400	Crazy Woman Creek at Upper Station Near Arvada, WY	3,113	1,647	1,174	970	1,556	2,802	3,577	20,742	21,055	3,967	2,082	646	63,330
	06317000	Powder River at Arvada, WY	18,455	11,577	8,322	7,527	11,060	27,253	22,005	105,460	90,540	25,422	8,175	5,057	340,852
	06318500	Clear Creek Near Buffalo, WY	2,683	1,917	1,485	1,122	948	1,224	3,052	17,066	25,968	14,208	5,142	3,249	78,065
	SEO Gage	Clear Creek in Buffalo City Park, Buffalo, WY	4,025	2,420	1,881	1,577	2,194	2,946	3,054	15,386	25,177	9,248	1,853	1,168	70,930
	06320000	Rock Creek Near Buffalo, WY	964	688	622	579	474	535	878	9,368	14,881	5,068	3,209	1,747	39,012
	SEO Gage	Rock Creek at Mouth Near Buffalo, WY	2,602	1,694	1,311	1,205	1,650	2,571	1,691	9,391	15,501	3,386	1,269	1,104	43,372
	06320200	Clear Creek Below Rock Creek Near Buffalo, WY	3,474	3,091	2,449	2,224	2,341	4,567	5,969	27,998	41,149	14,336	4,037	3,100	114,733
	SEO Gage	Clear Creek below Healy Reservoir Near Buffalo, WY	5,612	3,084	2,263	1,852	2,658	3,530	4,435	26,501	39,607	14,794	4,335	3,255	111,926
	06321000	South Piney Creek Near Story, WY	2,333	1,720	1,708	1,457	1,168	1,244	1,749	6,581	22,873	17,609	10,733	5,829	75,004
	06323000	Piney Creek at Kearney, WY	2,432	2,775	2,159	2,103	1,710	2,037	4,070	20,980	41,967	13,590	3,830	1,340	98,991
	SEO Gage	Little Piney Creek, WY	925	830	582	642	833	1,030	1,054	2,734	2,540	1,336	722	707	13,933
	SEO Gage	Piney Creek below Lake DeSmet Tunnel Intake Near Story, WY	2,259	1,558	1,144	1,004	927	1,280	2,549	17,464	38,497	10,973	3,374	1,762	82,791
	06323500	Piney Creek at Ucross, WY	4,880	4,201	3,459	3,078	2,221	4,190	4,203	18,650	42,300	14,719	6,525	3,190	111,616
	SEO Gage	Clear Creek at Double Crossing Near Clearmont, WY	13,916	9,888	8,067	6,929	8,629	11,825	10,678	47,150	86,491	28,773	8,955	6,602	247,901
	SEO Gage	Clear Creek below P&F#3 Ditch Near Clearmont, WY	5,842	5,553	2,924	2,797	4,373	12,829	12,513	17,547	3,355	2,034	589	1,452	71,807
	06324000	Clear Creek Near Arvada, WY	9,179	7,200	3,891	4,404	7,135	10,514	11,838	45,277	78,252	26,470	7,949	5,007	217,115
	06324500	Powder River at Moorhead, MT	24,643	19,325	9,172	12,118	19,360	42,163	31,243	146,877	162,267	53,775	16,330	9,263	546,537
Little Powder	06324890	Little Powder River Below Corral Creek Near Weston, WY	11	27	37	83	261	2,693	233	3,385	225	387	58	1	7,400
	06324925	Little Powder River Near Weston, WY	2,316	180	143	562	9,553	16,317	6,268	9,079	2,733	377	279	53	47,860
	06324970	Little Powder River Above Dry Creek Near Weston, WY	2,722	485	375	1,195	7,548	14,241	2,977	13,336	3,498	1,177	553	323	48,430
Belle Fourche	06426500	Belle Fourche River Below Moorcroft, WY	850	118	70	577	3,802	11,643	4,656	16,641	5,432	1,384	1,138	208	46,519

TABLE 16
SUMMARY OF DRY YEAR MONTHLY AND ANNUAL FLOWS (1970 TO 1999)
UNGAGED NATURAL FLOW NODES IN THE POWDER-TONGUE RIVER BASINS

Basin	Station Name	ESTIMATED AVERAGE STREAMFLOW FOR 1970-1999 IN ACRE-FEET												
		OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANNUAL
Tongue	Rapid Creek Just Below Little Rapid Creek in Section 32, T55N, R85W	90	67	63	52	44	49	201	1,031	723	260	123	87	2,792
	Beaver Creek at Bottom of Section 26, T55N, R85W	25	19	17	14	12	14	56	285	200	72	34	24	771
	Soldier Creek at Right Edge of Section 28, T56N, R85W	55	41	38	32	27	30	123	628	441	158	75	53	1,702
	Prairie Dog Creek Just Above Dutch Creek in Section 34, T57N, R83W	462	1,322	3,269	2,125	1,827	1,432	1,401	1,314	1,134	748	612	610	16,255
Powder	Red Fork Powder River Just Below North & South Forks Red Fork Powder River in Section 29, T44N, R84W	24	24	19	20	15	23	118	335	105	33	18	17	752
	Kelly Creek at Top of Section 21, T49N, R82W	49	37	28	22	18	21	173	531	330	106	56	41	1,414
	Little North Fork Crazy Woman Creek Just Below Grossett Canyon in Section 14, T49N, R83W	156	123	97	74	60	68	428	1,210	787	292	155	117	3,568
	Muddy Creek at Diversion Near East Side of Section 35, T49N, R83W	143	113	89	68	55	63	393	1,111	723	269	143	108	3,277
	Billy Creek at Diversion to O'Malley Draw in Section 13, T48N, R83W	2,116	1,637	1,536	1,310	1,136	1,244	2,545	14,220	14,547	5,167	3,833	2,937	52,227
	Little Piney Creek Just Below Bear Gulch in Section 28, T53N, R83W	332	336	601	616	820	626	564	407	341	245	309	282	5,480
	North & South Forks Shell Creek (Combined), at Confluence of Little North Fork Shell Creek & North Fork Shell Creek in Section 11, and Confluence of Unnamed Tributary & South Fork Shell Creek in Section 14; all in T52N, R83W	52	38	30	23	19	22	181	554	345	111	58	43	1,475
	Johnson Creek at Top of Section 22, T51N, R83W	49	37	28	22	18	21	173	531	330	106	56	41	1,414
	French Creek at Penrose Ditch Diversion in Section 27, T51N, R83W	119	88	68	53	43	51	416	1,275	793	256	134	99	3,395

TABLE 17
SUMMARY OF NORMAL YEAR MONTHLY AND ANNUAL FLOWS (1970 TO 1999)
UNGAGED NATURAL FLOW NODES IN THE POWDER-TONGUE RIVER BASINS

Basin	Station Name	ESTIMATED AVERAGE STREAMFLOW FOR 1970-1999 IN ACRE-FEET												
		OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANNUAL
Tongue	Rapid Creek Just Below Little Rapid Creek in Section 32, T55N, R85W	99	74	65	58	51	55	151	991	1,382	386	170	114	3,596
	Beaver Creek at Bottom of Section 26, T55N, R85W	27	20	18	16	14	15	42	274	382	107	47	32	994
	Soldier Creek at Right Edge of Section 28, T56N, R85W	60	45	39	36	31	33	92	604	843	235	104	70	2,192
	Prairie Dog Creek Just Above Dutch Creek in Section 34, T57N, R83W	559	1,529	3,372	2,321	2,368	2,074	1,852	1,470	1,202	1,066	830	752	19,396
Powder	Red Fork Powder River Just Below North & South Forks Red Fork Powder River in Section 29, T44N, R84W	34	31	25	27	23	41	215	515	238	64	32	28	1,272
	Kelly Creek at Top of Section 21, T49N, R82W	55	42	35	27	23	26	99	685	654	200	88	63	1,998
	Little North Fork Crazy Woman Creek Just Below Grossett Canyon in Section 14, T49N, R83W	177	128	107	85	71	81	280	1,360	1,363	488	243	182	4,563
	Muddy Creek at Diversion Near East Side of Section 35, T49N, R83W	162	118	98	78	65	75	257	1,249	1,252	448	223	167	4,191
	Billy Creek at Diversion to O'Malley Draw in Section 13, T48N, R83W	2,326	1,735	1,570	1,430	1,194	1,339	2,282	12,149	25,660	7,537	4,754	3,721	65,698
	Little Piney Creek Just Below Bear Gulch in Section 28, T53N, R83W	289	422	610	672	1,086	1,143	678	483	465	271	309	264	6,691
	North & South Forks Shell Creek (Combined), at Confluence of Little North Fork Shell Creek & North Fork Shell Creek in Section 11, and Confluence of Unnamed Tributary & South Fork Shell Creek in Section 14; all in T52N, R83W	57	44	36	28	24	27	103	715	682	208	92	66	2,084
	Johnson Creek at Top of Section 22, T51N, R83W	55	42	35	27	23	26	99	685	654	200	88	63	1,998
	French Creek at Penrose Ditch Diversion in Section 27, T51N, R83W	132	101	84	65	56	63	237	1,646	1,570	480	212	151	4,797

TABLE 18
SUMMARY OF WET YEAR MONTHLY AND ANNUAL FLOWS (1970 TO 1999)
UNGAGED NATURAL FLOW NODES IN THE POWDER-TONGUE RIVER BASINS

Basin	Station Name	ESTIMATED AVERAGE STREAMFLOW FOR 1970-1999 IN ACRE-FEET												
		OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANNUAL
Tongue	Rapid Creek Just Below Little Rapid Creek in Section 32, T55N, R85W	103	75	67	61	50	58	124	1,246	2,396	620	210	120	5,130
	Beaver Creek at Bottom of Section 26, T55N, R85W	29	21	19	17	14	16	34	344	662	171	58	33	1,418
	Soldier Creek at Right Edge of Section 28, T56N, R85W	63	46	41	37	30	35	76	760	1,460	378	128	73	3,127
	Prairie Dog Creek Just Above Dutch Creek in Section 34, T57N, R83W	439	1,090	3,718	2,241	6,284	3,382	2,637	1,896	1,423	845	733	657	25,344
Powder	Red Fork Powder River Just Below North & South Forks Red Fork Powder River in Section 29, T44N, R84W	50	44	36	41	33	60	316	925	390	100	46	39	2,081
	Kelly Creek at Top of Section 21, T49N, R82W	52	41	33	30	23	29	75	773	1,280	343	110	65	2,854
	Little North Fork Crazy Woman Creek Just Below Grossett Canyon in Section 14, T49N, R83W	145	116	95	81	71	86	227	1,837	2,442	824	317	188	6,429
	Muddy Creek at Diversion Near East Side of Section 35, T49N, R83W	133	107	87	75	66	79	209	1,687	2,243	757	291	173	5,905
	Billy Creek at Diversion to O'Malley Draw in Section 13, T48N, R83W	2,438	1,792	1,633	1,532	1,276	1,423	1,844	15,206	43,642	15,021	5,115	4,027	94,948
	Little Piney Creek Just Below Bear Gulch in Section 28, T53N, R83W	351	505	664	740	1,979	1,982	1,190	741	604	411	397	271	9,837
	North & South Forks Shell Creek (Combined), at Confluence of Little North Fork Shell Creek & North Fork Shell Creek in Section 11, and Confluence of Unnamed Tributary & South Fork Shell Creek in Section 14; all in T52N, R83W	54	42	34	31	24	30	78	807	1,336	358	115	67	2,978
	Johnson Creek at Top of Section 22, T51N, R83W	52	41	33	30	23	29	75	773	1,280	343	110	65	2,854
French Creek at Penrose Ditch Diversion in Section 27, T51N, R83W	125	98	79	71	54	70	180	1,857	3,074	825	265	155	6,854	

REFERENCES

- Alley, William M and Burns, Alan W. "Mixed-Station Extension of Monthly Streamflow Records", American Society of Civil Engineers, Journal of Hydraulic Engineering, Vol. 109, No. 10, October 1983
- Devore, Jay L., "Probability and Statistics for Engineering and the Sciences", Brooks/Cole Publishing Company. Belmont, California, 1987
- United States Geological Society, "Streamflows in Wyoming", Water-Resources Investigations Report 88-4045. Cheyenne, Wyoming, 1988