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REPORT ON THE FEASIBILITY OF PROVIDING INSTREAM FLOW IN THE SOUTH PINEY CREEK INSTREAM FLOW SEGMENT NO. 1 TEMPORARY FILING NO. 27 1/186

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REPORT ON THE FEASIBILITY OF PROVIDING INSTREAM FLOW IN SOUTH PINEY CREEK INSTREAM FLOW SEGMENT NO. 1 TEMPORARY FILING NO. 27 1/186

Wyoming Water Development Commission
October, 1992

I. SUMMARY

The Wyoming Water Development Commission (WWDC) is required by W.S. 41-3-1004 (a) to determine the feasibility of providing various amounts of unappropriated direct flow of water for instream uses within stream segments requested by the Wyoming Game and Fish Department (WGFD). For South Piney Creek, WWDC contracted with Western Water Consultants, Inc. (WWC) of Laramie, Wyoming to prepare the technical study. WGFD has requested a direct flow water right for purposes of providing instream flow for fisheries in a segment of South Piney Creek. The amount of the flow requested is 9 cubic feet per second (cfs) for the period of October 1 through March 31, 15 cfs for the period of April 1 through June 30, and 15 cfs for the period of July 1 through September 30. The segment is called the South Piney Creek Instream Flow Segment Number 1 and is defined by an upstream point located on the west side of Section 17, Township 29 North, Range 115 West and a downstream point located on the U.S. Forest Service boundary on the east side of Section 12, Township 29 North, Range 115 West, all in Sublette County, Wyoming. The segment has a stream length of 7.0 miles and its location is shown on Figure 1.

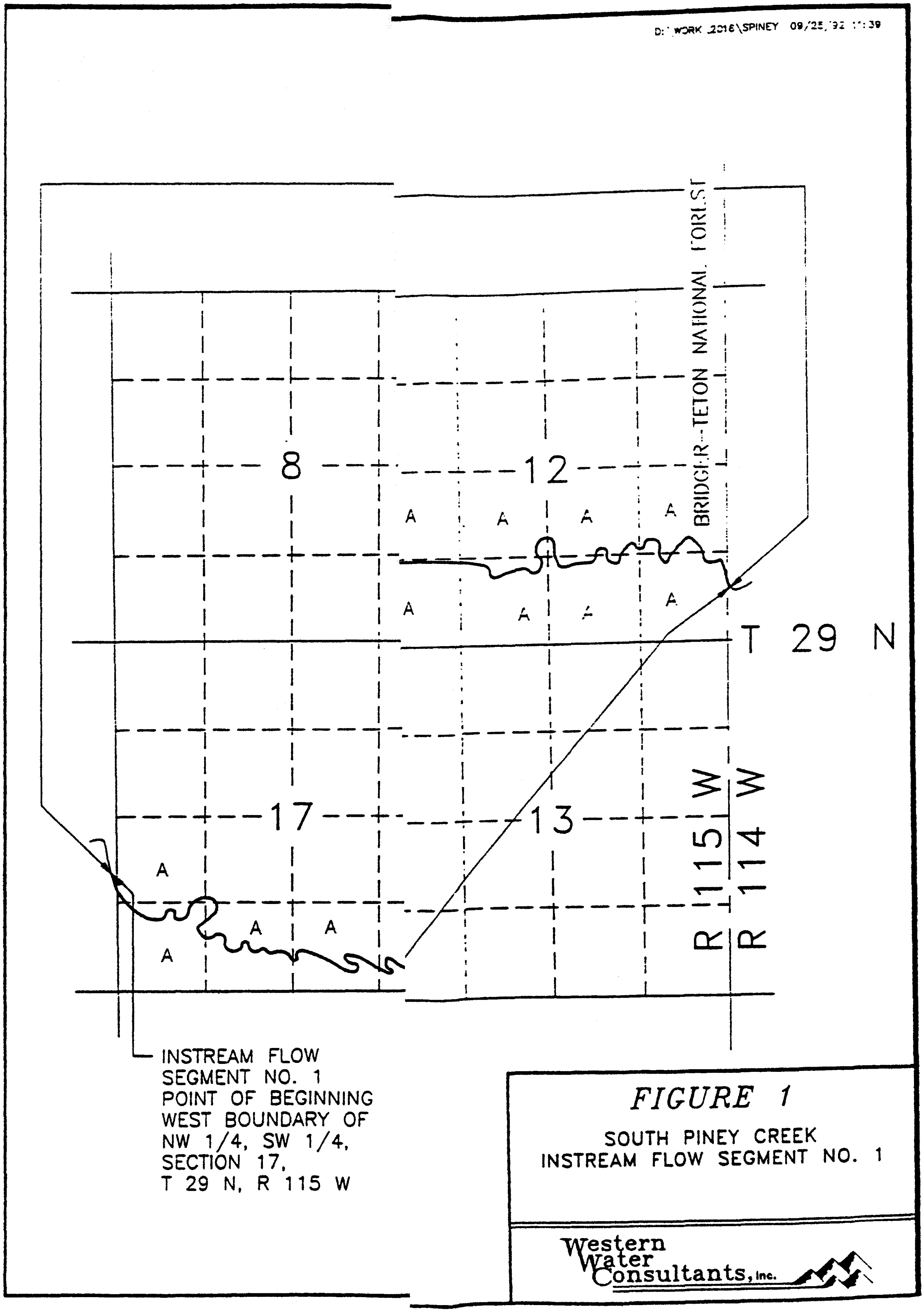

FIGURE 1

SOUTH PINEY CREEK
INSTREAM FLOW SEGMENT NO. 1

Mean monthly flow, dry year flow, and daily flow exceedence analyses were conducted. The mean monthly flow analysis shows that on the average on South Piney Creek, at the lower end of the proposed Instream Flow Segment No. 1, the requested flow of 9 cfs is available during the months of October through March. The flow of 15 cfs requested for the periods of April 1 through June 30 and July 1 through September 30 is also available. Daily flow exceedance analysis indicates that the requested flow of 9 cfs for the period of October 1 through March 31 is available 85% of the time, the requested flow of 15 cfs for the period of April 1 through June 30 is available 70% of the time, and the requested flow of 15 cfs for the period of July 1 through September 30 is available 88% of the time.

II. WATER RIGHTS

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Water rights upstream of the downstream end of the instream flow section are presented in Table 1. There are two diversion rights that are adjudicated, the Snyder Basin Ranger Station Pipeline and the Snider Basin Ranger Station Water Supply (Permit Nos. 17200 and 19467) for 0.002 and 0.011 cfs respectively, for domestic and stock purposes. Both amounts are considered insignificant to the analysis of flow in the instream flow segment.

There is one unadjudicated right for the South Piney Pipeline (Permit No. 17243) for 0.05 cfs for domestic purposes which is also considered insignificant to the instream flow segment.

TABLE 1

LISTING OF WATER RIGHTS ON SOUTH PINEY CREEK

Upstream of the Downstream End of Instream Flow Segment No. 1

Permit Number	Proof Number	Facility	Source	Priority Date Mo	Day	Year	Amount (cfs)	Acres	Use*	Status	Diversion Location Sec.	Twn.	Rng.	**
DIRECT FLOW														
17200	20073	Synder Basin Ranger Sta. Ppl.	Unnamed Spring	3	7	1927	0.002	---	2,3	Adj.	16	29	115	A
17243	---	South Piney Pipeline	South Piney Creek	7	9	1927	0.05	---	2	Unadj.	11	29	115	IN
19467	23119	Snider Basin R.S. Water Sply	Unnamed Spring	7	1	1940	0.011	---	2	Adj.	16	29	115	A

NOTE:

* Use Description
1=Irrigation, based on 1 cfs/70 acres
2=Domestic
3=Stock
4=Industrial

** A-Indicates diversion is above upper end of proposed Instream Flow Segment

IN-Indicates diversion is within

III. STREAMFLOW RECORDS

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Gaging stations on South Piney Creek and on similar drainage basins in the Wyoming Range are shown on Figure 2. Gaging stations considered for the analysis of flows on South Piney Creek are listed below:

1a. North Horse Creek at Sherman Ranger Station, Wyoming; Station Number 091895.00; 1956-1974.

1b. North Horse Creek above Sherman Ranger Station, Wyoming; Station Number 091894.95; 1983-1984, 1985-1991 irrigation season by SEO.

2. South Horse Creek near Merna, Wyoming; Station Number 091895.5; 1983-1985.

3. South Cottonwood Creek near Big Piney, Wyoming; Station Number 091913.00; 1983-1984, 1985-1991 irrigation season by SEO.

4. North Piney Creek above Apperson Creek near Mason, Wyoming; Station Number 092054.00; 1983-1984, 1985-1991 irrigation season by SEO.

5. Middle Piney Creek near Big Piney, Wyoming; Staff Gage upstream of Indian Creek; 1983-1991 irrigation season.

6. South Piney Creek near Big Piney, Wyoming; Recording Gage; 1981-1991 irrigation season by SEO.

7. La Barge Creek above Viola, Wyoming; Station Number 092084; 1983-1984, 1985-1991 irrigation season by SEO.

The records for the two stations, 091894.95 and 091895.00, on North Horse Creek were combined into a single record due to the closeness of the gage sites. The drainage areas are 42.80 and 43.00 square miles so any differences in flow rates are insignificant.

The mean monthly flow records of all seven gaging sites for 1983 through 1990 are presented in Table 2. Table 3 presents the mean monthly flow record for North Horse

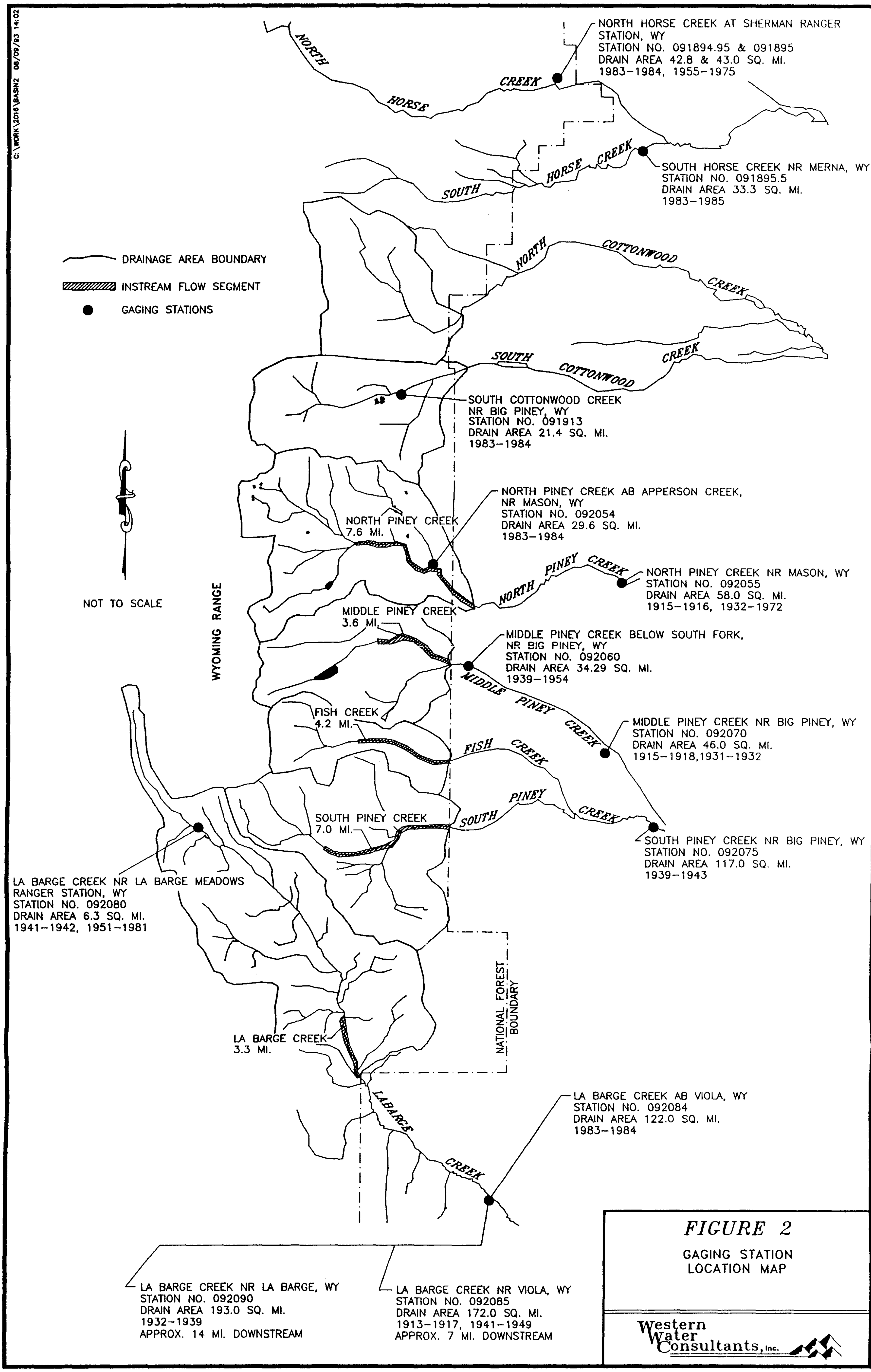

FIGURE 2

GAGING STATION LOCATION MAP

TABLE 2

MEAN MONTHLY STREAMFLOW DATA FOR GAGING STATIONS NEAR SOUTH PINEY CREEK

Units are cfs except for annual flow which is in acre-feet

North Horse Creek at Sherman Ranger Station, WY
Station No. 091894.95, Drainage Area = 42.85 sq mi

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Annual (AF)
1983	26.6	17.0	9.0	8.7	7.6	9.0	14.2	169.0	469.0	109.0	21.5	9.9	52469
1984	14.0	16.3	10.1	9.0	7.3	6.3	14.2	195.0	423.0	115.0	23.2	14.3	51152
1985									173.0	27.9	7.9	7.9	
1986								233.0	747.0	100.0	11.0	8.9	
1987								312.0	67.5	21.0	11.5	8.0	
1988								320.0	171.0	16.4	3.1	2.6	
1989								288.0	349.0	42.8	7.3	4.1	
1990								143.0	254.0	25.3	5.2	4.6	
1991								191.4	379.9	36.8	9.4	5.6	
Mean	20.3	16.6	9.5	8.9	7.4	7.7	14.2	231.4	337.0	54.9	11.1	7.3	

South Cottonwood Creek near Big Piney, WY
Station No. 091913, Drainage Area = 21.4 sq mi

	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Annual (AF)
1983	22.4	17.2	12.7	10.2	8.6	8.6	8.2	24.6	19.3	151.0	43.4	24.3	21364
1984	21.6	18.3	14.0	15.4	11.4	11.1	9.6	42.8	167.0	123.0	36.4	19.9	29666
1985									140.0	48.0	25.0	18.7	
1986									305.0	127.0	38.2	23.6	
1987													
1988									119.6	36.7	20.9	14.7	
1989									160.1	94.8	38.8	22.0	
1990									142.0	57.0	25.6	25.2	
1991									93.9	54.4	27.0	21.3	
Mean	22.0	17.8	13.4	12.8	10.0	9.9	8.9	33.7	143.4	86.5	31.9	21.2	

South Horse Creek near Merna, WY
Station No. 091895.50, Drainage Area = 33.3 sq mi

	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Annual (AF)
1983	7.9	5.7	1.8	1.5	1.1	1.8	18.6	122.0	138.0	44.6	13.5	6.0	21949
1984	10.6	8.4	3.9	2.1	1.3	4.0	85.0	98.4	89.4	34.6	12.9	6.5	21574
1985							52.0	87.7	29.7	4.0	2.3	2.7	
1986													
1987													
1988													
1989													
1990													
1991													
Mean	9.3	7.1	2.9	1.8	1.2	2.9	51.9	102.7	85.7	27.7	9.6	5.1	

TABLE 2

MEAN MONTHLY STREAMFLOW DATA FOR GAGING STATIONS NEAR SOUTH PINEY CREEK (CONTINUED)

Units are cfs except for annual flow which is in acre-feet

North Piney Creek above Apperson Creek near Mason, WY
Station No. 092054.90, Drainage Area 29.6 sq mi

	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Annual (AF)
1983	36.6	26.6	21.3	19.3	16.4	14.4	12.9	51.5	335.0	226.0	67.8	35.2	
1984	30.3	25.3	18.3	14.8	15.0	13.4	14.1	81.9	253.0	178.0	57.3	37.1	44666
1985									176.9	63.4	32.6	24.5	
1986									482.0	200.0	56.0	35.0	
1987								137.0	100.0	49.3	31.2	24.7	
1988													
1989										125.3	40.5		
1990									226.7	90.5	31.9	24.4	
1991									411.3	101.0	38.5	27.4	
Mean	33.5	26.0	19.8	17.1	15.7	13.9	13.5	90.1	283.6	129.2	44.5	29.8	

Middle Piney Creek near Big Piney, WY
Staff Gage upstream of Indian Creek, Drainage Area = 20.29 sq mi

	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Annual (AF)
1983													
1984													
1985	11.5								104.0	60.8	19.4		
1986								58.0		111.0	57.0		
1987							12.1	45.3	25.0				
1988									61.1	22.0	19.1	14.5	
1989							22.1	32.3	88.2	71.4	36.1	20.1	
1990							13.8	18.4	72.4	87.7	34.7		
1991								12.9	75.6	52.2	26.3	14.8	
Mean							16.0	33.4	71.0	67.5	32.1	16.5	

South Piney Creek near Big Piney, WY
Recording Gage, Drainage Area = 68.95 sq mi

	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Annual (AF)
1981							29.0	27.0	31.0	17.0	13.0	9.0	
1982								136.0	150.0	97.0	39.0	27.0	
1983								114.0	244.0	93.0	41.0	30.0	
1984								142.0	151.0	70.0	35.0	28.0	
1985									70.5	32.0	17.9	16.9	
1986								186.0	325.0	109.0	41.0	27.0	
1987								86.3	34.6	23.1	20.3	16.3	
1988									55.7	25.4	16.6	16.0	
1989								76.8	93.5	47.3	24.4	17.9	
1990								46.0	62.9	30.7	23.4	22.8	
1991									85.1	36.9	25.3	21.1	
Mean							29.0	101.8	118.5	52.9	27.0	21.1	

TABLE 2

MEAN MONTHLY STREAMFLOW DATA FOR GAGING STATIONS NEAR SOUTH PINEY CREEK (CONTINUED)

Units are cfs except for annual flow which is in acre-feet

La Barge Creek above Viola, WY
Station No. 092084, Drainage Area = 121.6 sq mi

	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Annual (AF)
1983	69.2	46.8	40.2	43.9	41.8	44.8	54.5	259.0	540.0	226.0	104.0	79.6	93616
1984	69.9	60.3	44.8	41.0	34.3	39.3	68.4	426.0	399.0	164.0	89.7	73.5	91463
1985								303.0		81.3	48.4	53.0	
1986							196.0					92.0	
1987							167.0	228.0	122.0	80.4	59.4	49.5	
1988								251.3	164.5	69.1	47.2	43.0	
1989	47.0	47.0							162.0	89.0	51.0		
1990							156.6	176.9	200.1	98.2	56.2	50.6	
1991								146.8	243.8	92.3	56.1	50.5	
Mean	62.0	51.4	42.5	42.5	38.1	42.1	128.5	255.9	261.6	112.5	64.0	61.5	

TABLE 3

NORTH HORSE CREEK AT SHERMAN RANGER STATION
Station No. 091894.95 and 091895.00, USGS Data
Average Monthly Flow (cfs)

YEAR	OCTOBER	NOVEMBER	DECEMBER	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	TOTAL(AF)
1955	4.75	3.46	3.50	3.50	3.50	6.00	16.00	226.97	241.27	34.48	8.83	4.20	33669
1956	5.07	5.05	4.50	4.00	5.00	6.00	77.55	491.42	539.50	46.77	7.58	4.77	72351
1957	4.83	4.81	4.50	4.00	3.80	3.93	16.13	205.10	490.20	89.06	3.49	6.85	50397
1958	4.59	3.10	2.50	2.50	3.00	4.00	8.00	369.65	227.53	22.94	7.72	3.93	40049
1959	3.13	6.07	4.48	3.00	3.46	5.81	25.00	108.13	457.60	35.23	9.03	7.41	40090
1960	12.43	4.58	4.25	4.01	3.50	5.53	25.71	181.97	233.57	24.28	6.39	4.36	30849
1961	6.96	6.11	4.69	4.00	4.30	5.23	18.33	264.77	141.30	12.46	7.45	17.45	29928
1962	14.19	15.00	8.00	8.65	8.07	7.00	45.67	345.87	381.73	51.58	10.90	5.85	54556
1963	6.83	4.54	4.21	4.74	4.93	5.52	10.95	258.29	306.27	38.13	8.49	12.21	40204
1964	5.16	3.31	3.11	2.83	2.86	3.97	5.97	196.25	436.87	85.35	12.47	5.68	46058
1965	4.17	4.97	4.57	4.82	5.49	4.06	14.69	200.74	579.53	163.97	25.68	15.16	61949
1966	9.36	6.37	7.02	6.63	5.79	12.00	44.73	368.55	171.37	24.24	5.81	7.28	40655
1967	4.16	4.93	4.71	4.32	3.11	2.84	6.80	174.23	561.03	125.32	14.61	7.83	55023
1968	7.67	7.00	7.53	8.14	8.17	7.50	6.29	143.00	420.87	54.81	20.19	10.24	42214
1969	9.06	7.61	6.13	5.35	4.68	4.82	37.61	421.32	178.53	35.74	9.10	5.70	44135
1970	7.75	7.32	5.64	2.71	4.19	5.71	9.95	242.87	519.57	67.48	11.09	9.64	53857
1971	7.17	7.51	4.55	5.15	5.95	6.60	13.44	354.35	809.47	159.39	24.84	9.53	84870
1972	13.04	8.63	6.13	6.19	6.20	6.75	22.81	317.32	770.70	125.39	20.26	13.11	79309
1973	15.39	10.04	8.38	5.80	4.38	4.55	7.33	292.35	288.10	34.16	10.41	11.29	41907
1974	7.90	7.84	5.96	4.61	4.80	4.95	30.30	321.71	650.80	75.97	13.20	6.48	68351
1983	26.55	17.03	9.00	8.67	7.56	8.95	14.23	169.23	469.30	108.74	21.46	9.88	52475
1984	14.05	16.30	10.08	8.98	7.41	6.28	14.21	195.06	422.53	114.55	23.23	14.27	51119
#RECORDS	22	22	22	22	22	22	22	22	22	22	22	22	22
MEAN	8.83	7.34	5.61	5.12	5.01	5.82	21.44	265.87	422.62	69.55	12.83	8.78	50637
STD DEV	5.27	3.90	1.94	1.96	1.61	1.91	16.84	95.75	183.37	44.64	6.54	3.75	14626
MIN	3.13	3.10	2.50	2.50	2.86	2.84	5.97	108.13	141.30	12.46	3.49	3.93	29928
MAX	26.55	17.03	10.08	8.98	8.17	12.00	77.55	491.42	809.47	163.97	25.68	17.45	84870

Creek for the years 1955-1984 (the period for which records are available for the entire year) with statistical information shown at the bottom.

IV. HYDROLOGY

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A hydrologic analysis was conducted to estimate the flows at the downstream end of the instream flow segment. The most reliable information to utilize is actual streamflow records for the stream being studied. For South Piney Creek this is a gage operated by the State Engineer's Office. This gage is essentially at the downstream end of the instream flow segment and has been operated from 1981 to the present for the months of May through September. No data are available for the other months. For these months it was necessary to examine adjacent drainages where records are available and develop relationships to estimate the record for South Piney Creek.

The months of May through September are examined first. Flow records are available for 1981 through 1991 for these months. The gage is located less than a mile downstream of the instream flow segment with no major tributaries intervening. Therefore, the gage should represent flows at the downstream end of the instream flow segment. Since the period of record is only eleven years long it is necessary to adjust the flows for long term averages.

For adjustment of the 1981-1991 flow records to long term averages, two methods were utilized which compare the short term record to long term records at other gages. First, the only long term record for Wyoming Range streams of similar drainage area which overlaps this period is North Horse Creek. The overlap period is 1983-1991 so only those data are utilized. Second, the flow contribution from the Wyoming Range was calculated by subtracting the flow in the Green River at Warren Bridge (Station 091885.00) and the flow in the New Fork River near Big Piney (Station 092050.00) from the flow in the Green River near LaBarge (Station 092094.00). This is represented as:

Wyoming Range Flow =
Sta. 092094.00 - Sta. 092050.00 - Sta. 091885.00.

For consistency with the first method, only the 1983-1991 period is utilized.

These two methods yield the following adjustments:

TABLE 4

RATIO OF 1983-1991 FLOWS TO LONG TERM AVERAGES

Month	Adjusted to N. Horse Ck.	Adjusted to Green River
Oct.*	2.3	2.2
Nov.*	1.8	1.9
Dec.*	2.4	2.0
Jan.*	2.5	1.2
Feb.*	2.0	1.3
Mar.*	1.7	1.2
Apr.*	0.42	1.3
May	0.88(0.79*)	1.9(0.87*)
Jun.	0.85	1.0
Jul.	0.88	1.0
Aug.	0.96	1.2
Sep.	0.90	1.1

* The 1983-1991 period only includes 1983 and 1984 for these data.

For adjustment of flow records to long term values, the Green River adjustment factors are believed to be more appropriate for the months of October through April. The period of record is longer and is less susceptible to abnormalities that may occur on one drainage. However, for the summer months there are irrigation withdrawals and return flow delays which make the Green River adjustment suspect. Therefore the North Horse Creek adjustment is utilized for the months of May through September.

The average monthly flows calculated from the gaging records are:

TABLE 5

MAY THROUGH SEPTEMBER ADJUSTED FLOWS

Month	Gage Average (1981-91)	Gage Average (1983-91)	Long Term Adjustment	Predicted Long Term Flow at Gage
May	101.8	108.5	1/0.88	123.3
Jun.	118.5	124.7	1/0.85	146.7
Jul.	52.9	51.9	1/0.88	59.0
Aug.	27.0	27.2	1/0.96	28.3
Sep.	21.1	21.8	1/0.90	24.2

For the months with no flow records, two methods were utilized to predict average monthly flows. Both methods are based on drainage area and basin elevation. These are two strong predictors of flows for high mountain drainages (Lowham, 1976). One procedure was to develop a multiple regression using drainage basin area and mean basin elevation as independent variables with flows standardized to North Horse Creek. The other procedure was to develop a relationship of flows based on the area within elevation increments.

The first procedure developed a multiple regression of streamflow at the available gaging stations with drainage basin area and mean basin elevation as independent variables. To accomplish this the mean monthly flow records from 1983 through 1984 or 1983 through 1991, depending on availability, for all streams were standardized to North Horse Creek. Thus North Horse Creek flows were unity and the other stations expressed as a percentage of the North Horse Creek flow. Using the standardized data, a multiple regression was performed for each month using drainage basin area and mean basin elevation as the independent variables. The areas and mean basin elevations of the gaging stations utilized are shown in Table 6:

TABLE 6

GAGING STATION DRAINAGE AREA AND MEAN BASIN ELEVATION

Location	Drainage Area (Sq. Mi)	Mean Basin Elevation (ft. above MSL)
North Horse Creek	42.8	8833
South Horse Creek	33.3	8461
South Cottonwood Creek	21.4	9353
North Piney Creek	29.6	9435
Middle Piney Creek	20.3	9357
South Piney Creek	69.0	8849
LaBarge Creek	122.0	8587

The gaging stations utilized are located high in the basins within National Forest boundaries and no significant diversions or storage facilities were found above the gages. The resulting general linear regression equations are presented in Table 7. Power and exponential regressions were also examined.

There was a slight improvement in the correlation coefficient for the months of October and November when using exponential equations. However, when the average flows for October and April estimated by the experimental equation are compared to surrounding months they do not provide as smooth yearly hydrograph as the linear equations so the linear equations were utilized.

TABLE 7

REGRESSION EQUATIONS FOR MEAN MONTHLY FLOW

Q = Mean Monthly Flow(cfs)	E = Mean Basin Elevation (FT-MSL)
IFS = Downstream End of Instream Flow Segment (cfs)	A = Drainage Basin Area (Sq. Mi.)
	NHC = North Horse Creek Mean Monthly Flow (cfs)

MONTH	GENERAL EQUATION
October	$Q = [-12.88+0.036(A)+0.0014(E)]NHC$ $R^2 = 0.77$
November	$Q = [-11.31+0.031(A)+0.0013(E)]NHC$ $R^2 = 0.94$
December	$Q = [-18.77+0.046(A)+0.0021(E)]NHC$ $R^2 = 0.98$
January	$Q = [-19.35+0.050(A)+0.0021(E)]NHC$ $R^2 = 0.97$
February	$Q = [-20.86+0.054(A)+0.0022(E)]NHC$ $R^2 = 0.97$
March	$Q = [-17.70+0.058(A)+0.0019(E)]NHC$ $R^2 = 0.94$
April	$Q = [23.57+0.0166(A)-0.00249(E)]NHC$ $R^2 = 0.56$

A good to excellent correlation was obtained for each of the winter months. The correlation for April was marginal while the correlation of the months of May through September was very poor. The difficulty with April can be explained by the fact that the spring runoff starts in April for the basins with more area at a lower elevation while the higher basins spring runoff does not start until May. Thus for April the spring runoff from the lower portions of some of the basins is being compared to base flow for some of the other basins with higher elevation zones. Because of the very poor correlation for the months of May through September they are not presented.

The second procedure utilized was to develop regressions for flows at the gaging stations based on the amount of drainage area within elevation increments. The years of 1983 through 1984 have records available for all months at the gaging stations, with 1983-1991 being available for the months of May through September.

The following is a break down of the drainage areas for each gage into elevation increments:

TABLE 8

AREA IN ELEVATION INCREMENTS

Area in Square Miles

Gage	Above 10,000	9,000-10,000	Below 9,000	Total
North Horse	1.1	14.2	27.5	42.8
South Horse	0.6	5.9	26.8	33.3
S. Cottonwood	6.0	8.1	7.3	21.4
North Piney	8.8	12.4	8.4	29.6
Middle Piney	6.4	7.8	6.1	20.3
South Piney	2.3	7.9	58.8	69.0
LaBarge	2.8	23.9	95.3	122.0

Multiple regressions were calculated using mean monthly flow as the dependent variable and the area in each of the three elevation increments as the independent variables. The regressions were calculated using linear, exponential, and power forms of the data. For each month the form of the equation with the highest coefficient of determination (r^2) was utilized. This results in linear equations for the months of December through June and power forms of the equations for October, November and July through September. The resulting equations are:

TABLE 9

REGRESSION EQUATIONS FOR DRAINAGE AREA IN ELEVATION INCREMENTS

Q = Mean Monthly Flow (cfs)
A1 = Area above 10,000 Ft. (Sq.Mi.)
A2 = Area between 9,000-10,000 Ft. (Sq. Mi.)
A3 = Area below 9,000 Ft. (Sq. Mi.)

October	Q = EXP[0.232+0.532(lnA1)+0.495(lnA2)+0.425(lnA3)] R^2 = 0.99
November	Q = EXP[-0.008+0.498(lnA1)+0.577(lnA2)+0.369(lnA3)] R^2 = 0.99
December	Q = -11.002+2.607(A1)+0.482(A2)+0.389(A3) R^2 = 0.99
January	Q = -11.880+2.462(A1)+0.487(A2)+0.400(A3) R^2 = 0.98
February	Q = -11.821+2.260(A1)+0.470(A2)+0.363(A3) R^2 = 0.99
March	Q = -11.121+2.214(A1)+0.264(A2)+0.456(A3) R^2 = 0.99
April	Q = 34.202+1.427(A1)-4.190(A2)+1.396(A3) R^2 = 0.93
May	Q = 77.600-19.166(A1)+12.729(A2)-0.685(A3) R^2 = 0.95
June	Q = 129.778-15.399(A1)+18.722(A2)-2.675(A3) R^2 = 0.66
July	Q = EXP[2.140+0.444(lnA1)+0.669(lnA2)+0.011(lnA3)] R^2 = 0.94
August	Q = EXP[0.005+1.014(lnA1)+0.310(lnA2)+0.461(lnA3)] R^2 = 0.96
September	Q = EXP[-1.304+1.140(lnA1)+0.386(lnA2)+0.663(lnA3)] R^2 = 0.96

These equations are valid only for the period of record used to develop the equations (1983-1984 for October through April and 1983-1991 for May through September) and must therefore be adjusted to long term averages as discussed for the gaging records.

Using these two methods the mean monthly flows for the months without gaging records were estimated.

TABLE 10

OCTOBER THROUGH APRIL ESTIMATED MEAN MONTHLY FLOWS

Month	Mean Basin Elevation, Drainage Area, Standardized to North Horse Creek	Area in Elevation Increments Adjusted to Long Term
October	17.6	14.0
November	17.1	11.6
December	16.8	11.4
January	13.5	18.4
February	11.7	14.4
March	18.1	19.9
April	56.2	65.9

As can be seen, the first method of utilizing mean basin elevation and drainage area with flows standardized to North Horse Creek yields a smoother hydrograph. Also, the October flow better corresponds to the September flow seen at the gage. Therefore, it is believed that the first method is the best predictor of flows for these months.

Combining the adjusted gaging station records and the estimated flows for the ungaged months yields the following estimates of mean monthly flow:

TABLE 11

ESTIMATED MEAN MONTHLY FLOWS

Month	Average Flow (cfs)
October	17.6
November	17.1
December	16.8
January	13.5
February	11.7
March	18.1
April	56.2
May	123.3
June	146.7
July	59.0
August	28.3
September	24.2

V. MEAN MONTHLY FLOW ANALYSIS

V. MEAN MONTHLY FLOW ANALYSIS

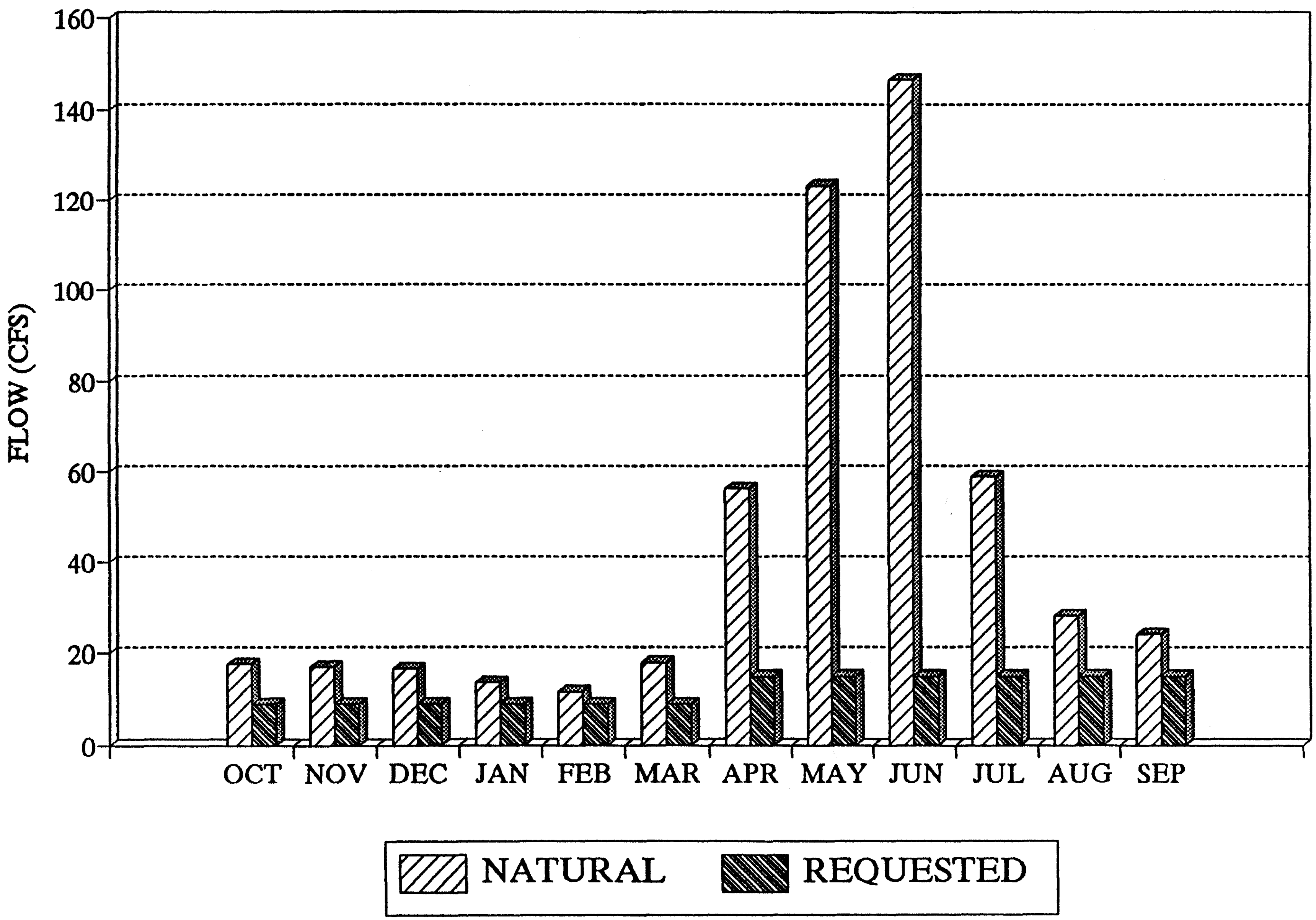
Utilizing the estimated mean monthly flows, a long term flow record was generated for South Piney Creek from the long term record at North Horse Creek. The North Horse Creek data was adjusted using a ratio of the estimated average monthly flow at South Piney Creek to the average monthly flow at North Horse Creek. These data along with a statistical analysis are presented in Table 12. Figure 3 graphically compares the estimated monthly flows to the requested flows. The requested flow is available, on average, for the entire year.

TABLE 12

SOUTH PINEY CREEK AT INSTREAM FLOW SEGMENT
Generated Flows at Downstream End
Average Monthly Flows (cfs)

YEAR	OCTOBER	NOVEMBER	DECEMBER	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	TOTAL(AF)
1955	9.45	8.06	10.47	9.24	8.17	18.66	41.94	105.26	83.75	29.25	19.48	11.57	10844
1956	10.09	11.77	13.46	10.56	11.68	18.66	203.28	227.90	187.27	39.67	16.72	13.14	23239
1957	9.61	11.21	13.46	10.56	8.87	12.22	42.28	95.12	170.15	75.55	7.70	18.87	14474
1958	9.13	7.22	7.48	6.60	7.01	12.44	20.97	171.43	78.98	19.46	17.03	10.83	11287
1959	6.23	14.14	13.40	7.92	8.08	18.07	65.53	50.15	158.84	29.88	19.92	20.42	12507
1960	24.74	10.67	12.71	10.59	8.17	17.20	67.39	84.39	81.08	20.60	14.09	12.01	11077
1961	13.85	14.24	14.02	10.56	10.04	16.27	48.05	122.79	49.05	10.57	16.43	48.08	11403
1962	28.24	34.95	23.92	22.84	18.85	21.77	119.71	160.40	132.50	43.75	24.04	16.12	19700
1963	13.59	10.58	12.59	12.51	11.51	17.17	28.70	119.78	106.31	32.34	18.73	33.64	12727
1964	10.27	7.71	9.30	7.47	6.68	12.35	15.65	91.01	151.64	72.40	27.51	15.65	13046
1965	8.30	11.58	13.66	12.72	12.82	12.63	38.51	93.09	201.16	139.09	56.64	41.77	19570
1966	18.63	14.84	20.99	17.50	13.52	37.32	117.25	170.91	59.48	20.56	12.82	20.06	15988
1967	8.28	11.49	14.08	11.40	7.26	8.83	17.82	80.80	194.74	106.30	32.23	21.57	15692
1968	15.26	16.31	22.51	21.49	19.08	23.33	16.49	66.32	146.09	46.49	44.53	28.21	14185
1969	18.03	17.73	18.33	14.12	10.93	14.99	98.59	195.39	61.97	30.32	20.07	15.70	15775
1970	15.42	17.06	16.86	7.15	9.78	17.76	26.08	112.63	180.35	57.24	24.46	26.56	15573
1971	14.27	17.50	13.60	13.60	13.90	20.53	35.23	164.33	280.98	135.21	54.79	26.26	24094
1972	25.95	20.11	18.33	16.34	14.48	20.99	59.79	147.16	267.52	106.36	44.69	36.12	23686
1973	30.63	23.39	25.06	15.31	10.23	14.15	19.21	135.58	100.00	28.98	22.96	31.11	13950
1974	15.72	18.27	17.82	12.17	11.21	15.39	79.43	149.19	225.90	64.44	29.12	17.85	19977
1983	52.83	39.68	26.91	22.89	17.65	27.83	37.30	78.48	162.90	92.24	47.34	27.22	19312
1984	27.96	37.98	30.14	23.71	17.30	19.53	37.25	90.46	146.67	97.17	51.24	39.32	18867
#RECORDS	22	22	22	22	22	22	22	22	22	22	22	22	22
MEAN	17.6	17.1	16.8	13.5	11.7	18.1	56.2	123.3	146.7	59.0	28.3	24.2	16226
STD DEV	10.50	9.08	5.81	5.16	3.76	5.94	44.14	44.40	63.65	37.86	14.43	10.33	4119
MIN	6.23	7.22	7.48	6.60	6.68	8.83	15.65	50.15	49.05	10.57	7.70	10.83	10844
MAX	52.83	39.68	30.14	23.71	19.08	37.32	203.28	227.90	280.98	139.09	56.64	48.08	24094
REQUESTED	9	9	9	9	9	9	15	15	15	15	15	15	

FIGURE 3: SOUTH PINEY CREEK
AVERAGE MONTHLY AND REQUESTED FLOWS



VI. DRY YEAR FLOW ANALYSIS

VI. DRY YEAR FLOW ANALYSIS

The ranking, in ascending order, of the estimated flows for the proposed instream flow segment are presented in Table 13. The table presents the flows ranked by yearly flow in acre-feet and ranked by flow during each instream flow period. Requested flows are compared to those available in the driest year on record determined by total annual flow.

To provide additional insight on low flows, the requested flows are compared to those available during the average of the lowest three years by instream flow period. This procedure was utilized because the lowest flow period on record does not necessarily correspond to the lowest year by total annual flow. Yearly flow volumes are dominated by the peak runoff months of May and June, therefore the driest year by annual volume are usually the ones with the lowest flow during these months. Comparison of annual flow volumes does not necessarily give an indication of what occurs during the summer or winter months which are important when considering fisheries. Examination of flows by periods gives a better indication of what can be expected as low flows during those periods. Because examination of short periods is more vulnerable to spurious data an average of the three lowest years is utilized.

Using annual total flow, the driest year on record for the generated flows is 1955. A summary of data for that year is presented in Table 14.

TABLE 13

RANKING OF FLOWS IN ASCENDING ORDER
South Piney Creek at Downstream
End of Instream Flow Segment
Annual and Period Flow in Acre-Feet

COMPLETE YEAR		OCT 1 - MAY 15		MAY 16 - JUN 30		JUL 1 - SEP 30	
Year	Acre-Feet	Year	Acre-Feet	Year	Acre-Feet	Year	Acre-Feet
1955	10844	1958	1518	1961	6719	1960	1436
1960	11077	1964	1639	1968	6933	1958	1456
1958	11287	1967	1869	1955	7034	1966	1636
1961	11403	1955	1953	1960	7070	1955	1858
1959	12507	1957	2006	1963	7764	1969	2033
1963	12727	1959	2065	1973	7779	1956	2142
1964	13046	1965	2173	1964	7840	1959	2156
1973	13950	1956	2316	1959	8286	1961	2279
1968	14185	1963	2371	1958	8313	1973	2543
1957	14474	1961	2404	1984	8322	1962	2585
1970	15573	1970	2559	1983	8439	1963	2592
1967	15692	1960	2571	1967	8882	1957	3147
1969	15775	1974	2756	1957	9322	1970	3330
1966	15988	1971	2836	1970	9684	1974	3436
1984	18867	1969	2868	1965	10076	1964	3567
1983	19312	1972	3539	1966	10600	1968	3668
1965	19570	1968	3584	1969	10874	1967	4942
1962	19700	1973	3628	1962	12539	1983	5143
1974	19977	1966	3751	1974	13785	1972	5766
1956	23239	1962	4576	1972	14381	1984	5780
1972	23686	1984	4765	1971	14580	1971	6678
1971	24094	1983	5729	1956	18781	1965	7321

TABLE 14

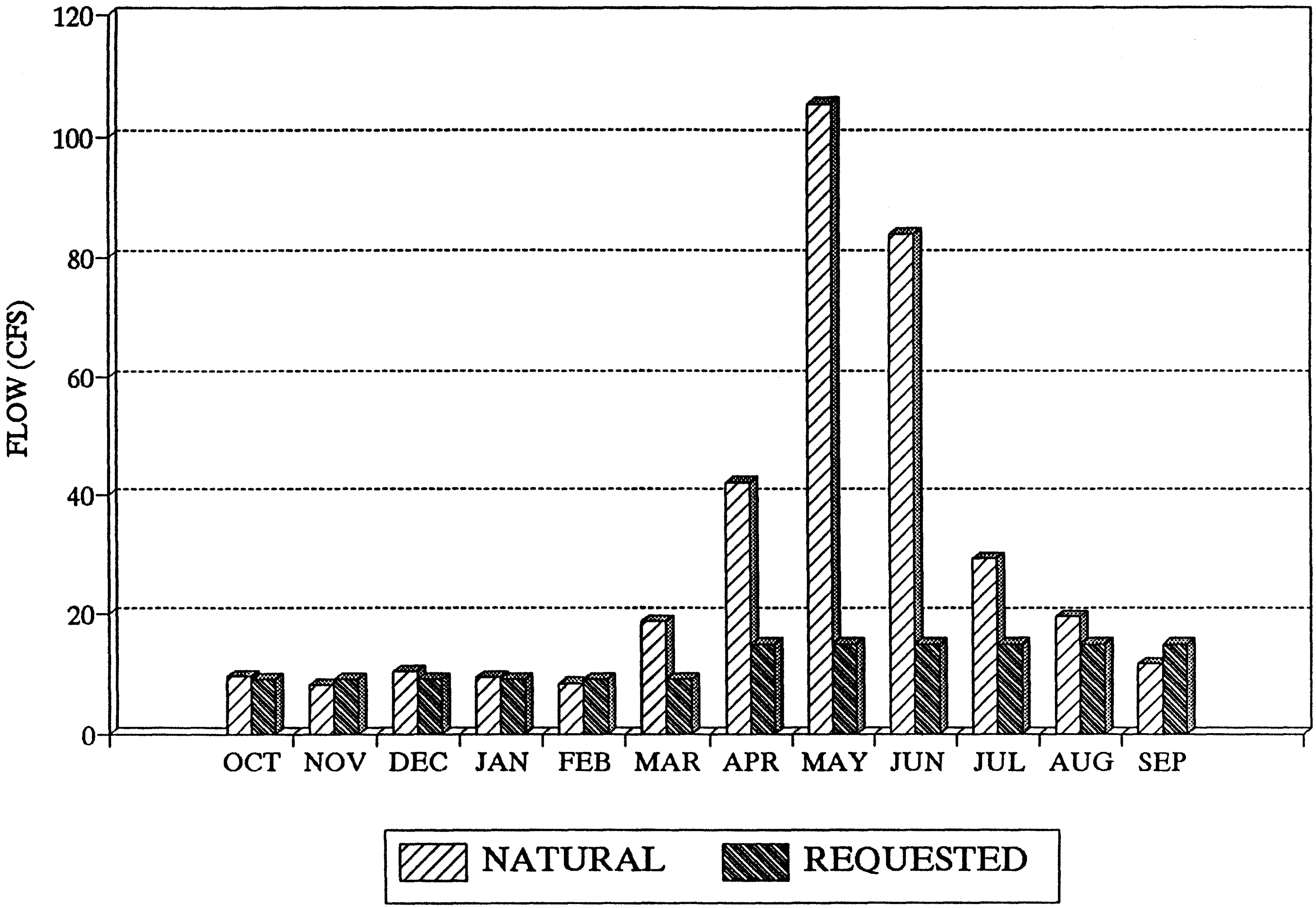
COMPARISON OF MONTHLY FLOW DURING DRIEST YEAR ON RECORD (1955) AND REQUESTED SOUTH PINEY CREEK FLOW AT DOWNSTREAM END OF INSTREAM FLOW SEGMENT

Month	Mean Monthly Flow (1955) (cfs)	Requested Flow (cfs)	Shortfall (cfs)	Shortfall (AF)
October	9.5	9	—	—
November	8.1	9	0.9	54
December	10.5	9	—	—
January	9.2	9	—	—
February	8.2	9	0.8	44
March	18.7	9	—	—
April	41.9	15	—	—
May	105.3	15	—	—
June	83.8	15	—	—
July	29.3	15	—	—
August	19.5	15	—	—
September	11.6	15	3.4	204
			TOTAL	302
			Total July 1 - Sept. 30	204

Shortages occur during the winter months of November and February, and in the summer month of September, but are not short during an average year. A bar graph comparing the 1955 monthly flows to the requested flows is presented on Figure 4.

Using the three lowest flow years by instream flow period, results in different years being utilized. By period, the three driest years are:

FIGURE 4: SOUTH PINEY CREEK
DRIEST YEAR (1955)AND REQUESTED FLOWS



October 1 - March 31	1958, 1964, 1967
April 1 - June 30	1961, 1968, 1955
July 1 - September 30	1960, 1958, 1966

Averages of the monthly flows for the three driest years by period are presented in Table 15.

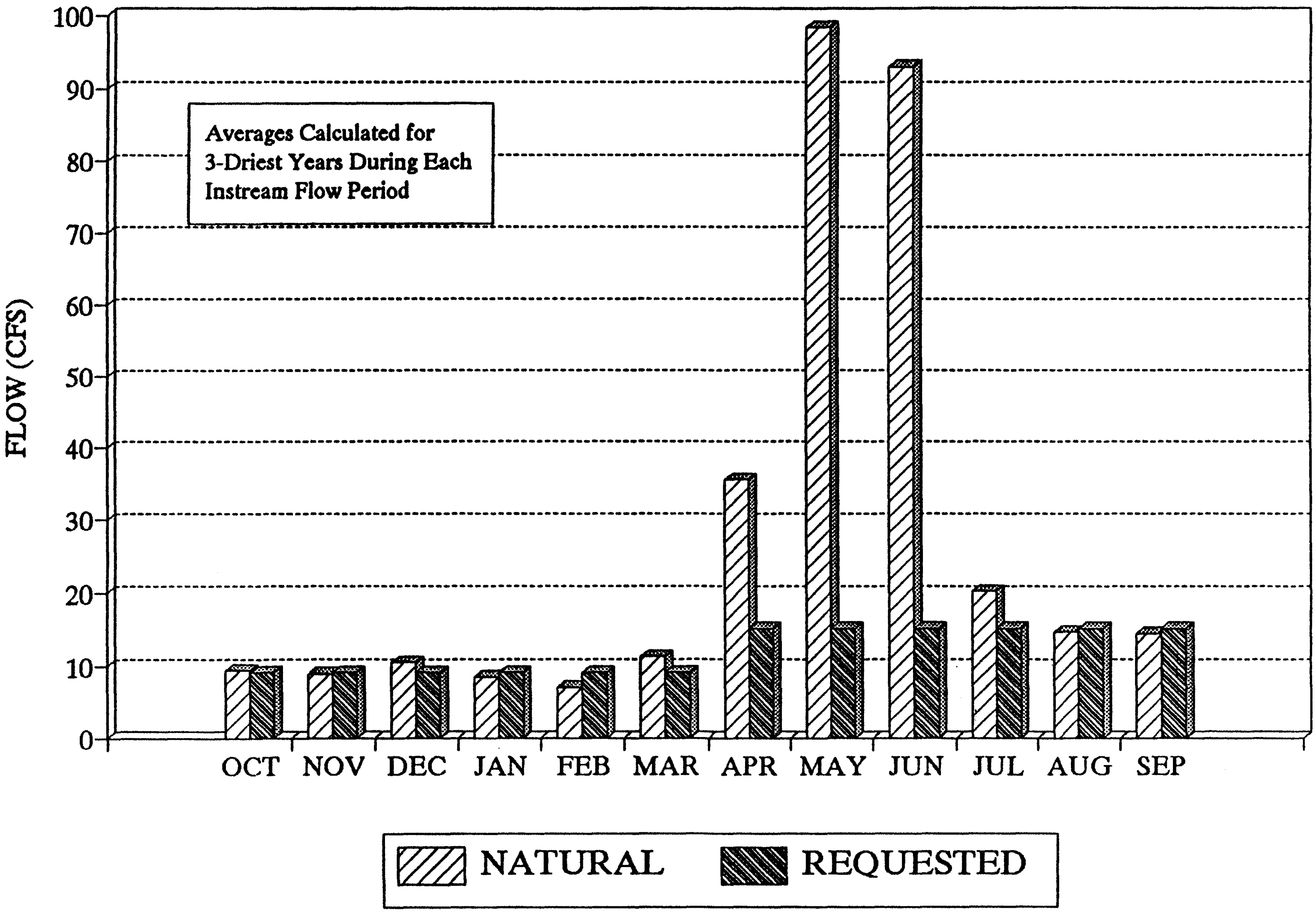
TABLE 15

COMPARISON OF REQUESTED FLOWS AND AVERAGE OF 3 DRIEST YEARS BY PERIOD FOR SOUTH PINEY CREEK - DOWNSTREAM END OF INSTREAM FLOW SEGMENT

Month	3-Year Mean Monthly Flow (cfs)	Requested Flow (cfs)	Average Shortfall (cfs)	Avg. Volume Shortfall (AF)
October	9.23	9	—	—
November	8.81	9	0.19	11
December	10.29	9	—	—
January	8.49	9	0.51	31
February	6.98	9	2.02	112
March	11.21	9	—	—
April	35.49	15	—	—
May	98.12	15	—	—
June	92.96	15	—	—
July	20.21	15	—	—
August	14.65	15	0.35	22
September	14.31	15	0.69	41
			TOTAL	217
		Total July 1 - Sept. 30		63

The winter months of November, January and February and the summer months of August and September depict a deficit in flow while the remaining months are positive. Figure 5 is a bar graph relating the average of the three lowest years by period to the requested flow.

FIGURE 5: SOUTH PINEY CREEK
3-DRIEST YEAR AVG. AND REQUESTED FLOWS



VII. DAILY FLOW EXCEEDANCE ANALYSIS

VII. DAILY FLOW EXCEEDENCE ANALYSIS

The WGFD considers that an instream flow request is "feasible" if, during the late summer period (July 1- September 30) the requested flow is available 50% of the time. Therefore a daily flow duration analysis was conducted. The daily flow duration analysis included all three instream flow periods. For South Piney Creek there are only records for the months of May through September. This only leaves the instream flow period of July through September with records for all months. Therefore the technique to develop a daily flow duration curve for this period is different than for the other periods.

For the two instream flow periods, October through March and April through June, there are no complete records so an index stream must be utilized. An index stream is one which has similar basin characteristics but has a long term flow record. For South Piney Creek the only gaging station with a long term record on a stream of similar drainage area is North Horse Creek. North Horse Creek was therefore chosen as the index stream. Since the area under the daily flow duration curve is the average volume of flow for the period a duration curve for the index stream can be shifted up or down (retaining the same shape), according to the volume under the curve. To accomplish this flow duration curves were developed for North Horse Creek for the instream flow periods. Then comparing the average volume of flow for both streams, during the instream flow period, the curves were shifted using the ratio of the average South Piney Creek flow to the average North Horse Creek flow. These flow duration curves are presented on Figures 6 and 7.

For the instream flow period of July through September there are 11 years of record available. From these data a daily flow duration curve was developed and is presented on

FIGURE 6: SOUTH PINEY CREEK
DAILY FLOW DURATION CURVES OCT1 - MAR31

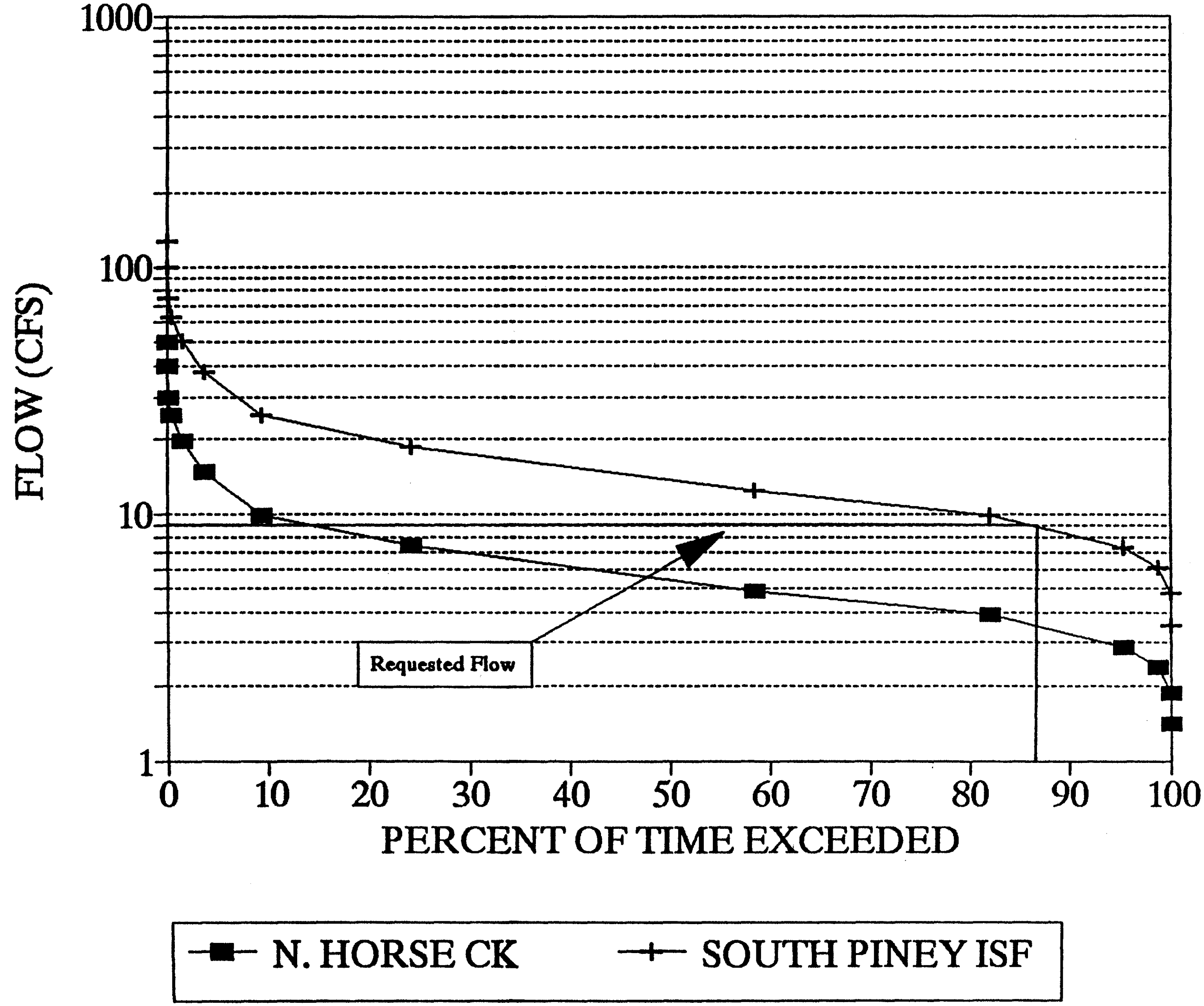


FIGURE 7: SOUTH PINEY CREEK

DAILY FLOW DURATION CURVES APR1 - JUN30

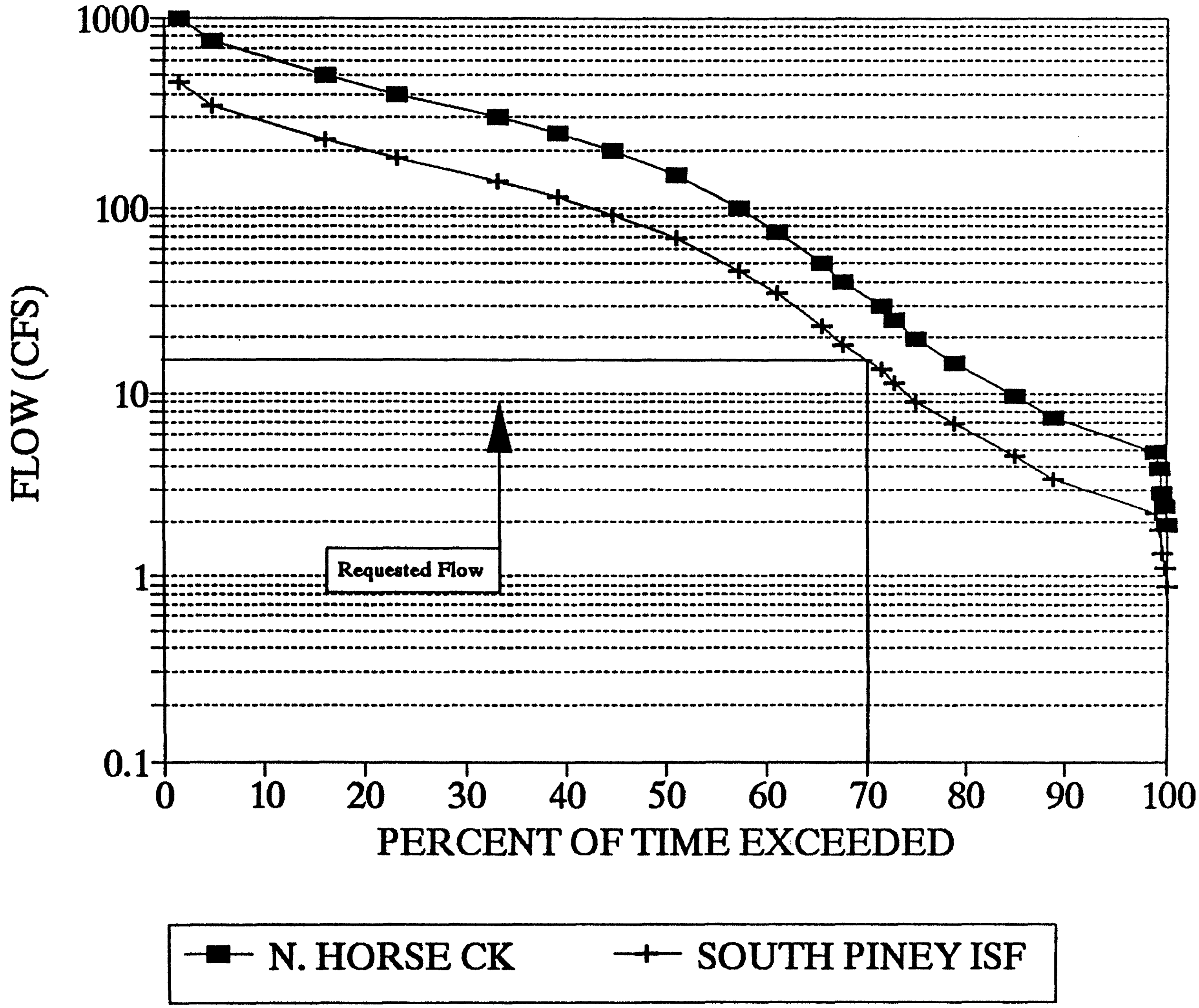


Figure 8. Ten years of record is not an exceptionally long period of record. Therefore to verify the flow duration curve the method developed by Searcy (1955) to generate long term daily flow duration curves from short term records was examined. Using this method long term flow duration curves are developed from short term data by comparing overlapping short term flow duration curves for the stream of interest and a stream that has a long term record. For this exercise North Horse Creek was utilized. This method generated a daily flow duration curve for South Piney Creek very similar to the flow duration curve for the ten years of data. From this it was concluded that the daily flow duration curve from the ten years of record is representative of long term trends.

There are no significant water rights above the instream flow segment. From the curves, a summary of exceedence values is presented in Table 16.

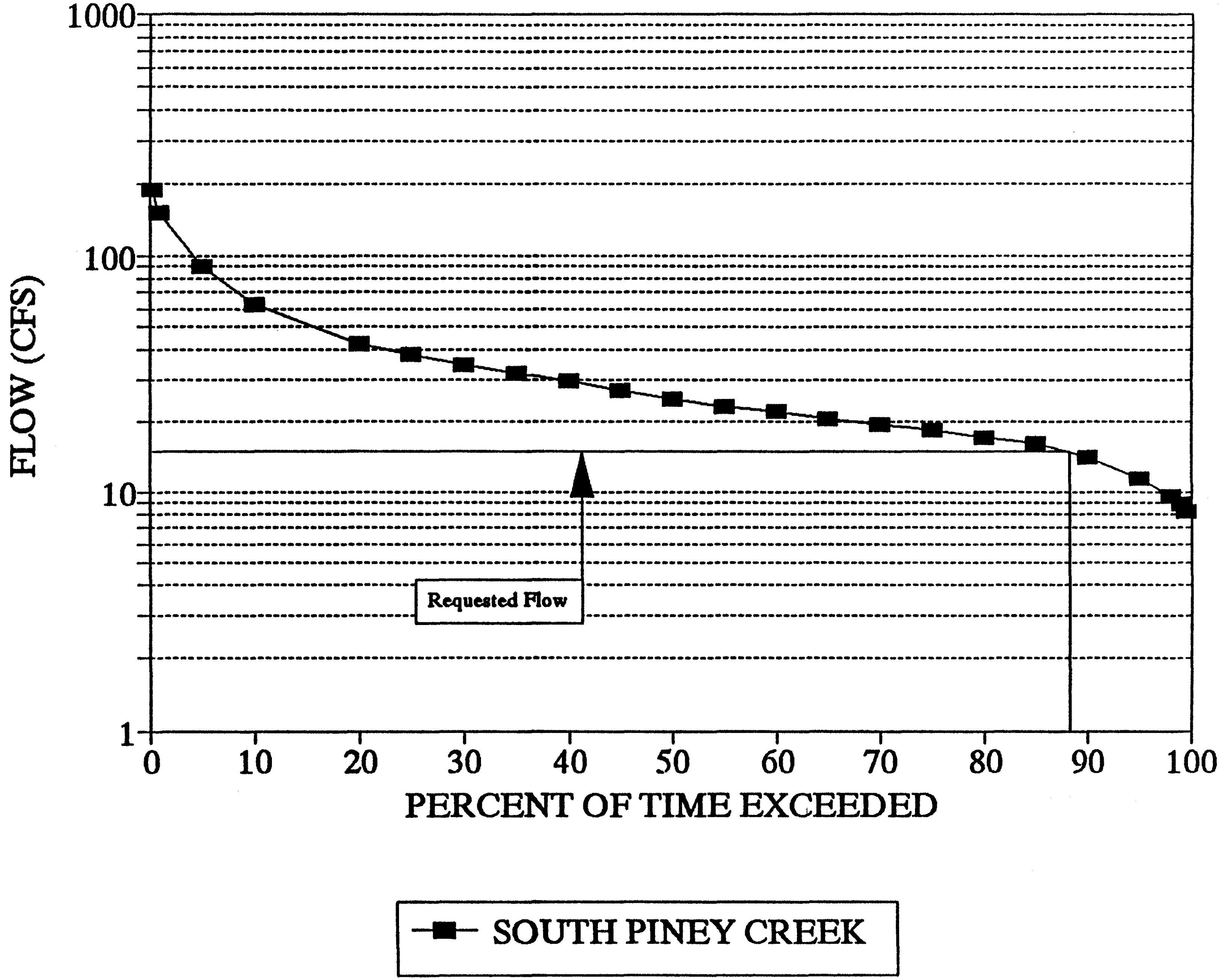
TABLE 16

DAILY FLOW EXCEEDENCE SUMMARY
SOUTH PINEY CREEK AT DOWNSTREAM END OF INSTREAM FLOW SEGMENT

Period	Requested Instream Flow (cfs)	WGFD Exceedence Criteria (% Time)	Exceedence During Period of Record (% Time)
Oct. 1 - Mar. 31	9	N/A	85%
Apr. 1 - Jun. 30	15	N/A	70%
Jul. 1 - Sep. 30	15	50%	88%

It should be noted that for the period of April 1 through June 30 that North Horse Creek and South Piney Creek have different flow characteristics. North Horse Creek has

FIGURE 8: SOUTH PINEY CREEK
DAILY FLOW DURATION CURVES JUL1 - SEP30



lower base flow in April and larger peaks in May and June than South Piney Creek. It is expected that the actual flow duration curve for South Piney Creek is more flat than that developed from North Horse Creek. This would result in the daily flow exceedance for 15 cfs being greater than the 70% predicted, however the data are too limited to develop flow duration curves from South Piney records.

VIII. CONCLUSIONS

VIII. CONCLUSIONS

The mean monthly flow analysis indicates that in an average year the flow request is met by direct flow for the entire year. During extremely dry years, the requested flow is not available in some winter months and the late summer months of August and September. Exceedence analysis shows that during the October 1 - March 31 period, the requested flow of 9 cfs is available or exceeded 85% of the time. For the two periods with a requested flow of 15 cfs, the requested flow is available or exceeded more than 70% of the time for the April 1 - June 30 period and 88% of the time for the July 1 - September 30 period.

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REFERENCES

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APPENDIX A

WYOMING GAME AND FISH REPORT
AND
APPLICATION TO STATE ENGINEER
TF NO. 27 1/186

WYOMING GAME AND FISH DEPARTMENT

FISH DIVISION

ADMINISTRATIVE REPORT

TITLE: South Piney Creek Instream Flow Report

PROJECT: IF-4090-07-8808

AUTHOR: William H. Bradshaw

DATE: November 1990

INTRODUCTION

Studies were conducted to obtain instream flow information from a segment of South Piney Creek west of Big Piney, Wyoming. These studies were designed to provide the basis for determining instream flows which would maintain or improve the existing fishery in the candidate section of South Piney Creek. Results of these studies apply to the stream segment extending upstream from the U.S. Forest Service boundary on the east side of Section 12, Range 115 West, Township 29 North, to the west side of the state school lands at Section 17, Range 115 West, Township 29 North. This stream section is 7.0 miles long.

This section of South Piney Creek is designated by the Wyoming Game and Fish Department (WGFD) as a Class 3 trout stream. Class 3 streams generally support regionally important fisheries. The stream is managed under the basic yield concept for rainbow trout. It is periodically stocked with juvenile rainbow trout during the spring and summer months and some natural recruitment of juveniles also occurs in the stream. Other species present include brook trout and cutthroat trout and mountain whitefish. This section of South Piney Creek supports significant recreational fisheries opportunities for both resident and non-resident anglers (R. Remmick, personal communication), and is highly accessible through public lands. For these reasons, this stream segment is considered a critical stream reach.

The management goal of WGFD is to maintain or improve the existing stream fishery. For South Piney Creek, three time periods are considered critical for realizing this goal. October 1 to March 31 is considered critical because this is a time period when low flows can cause degradation of hydraulic characteristics necessary for trout survival, fish passage and aquatic insect production. April 1 to June 30 is a critical period for maintaining physical habitat for juvenile rainbow trout that recruit to the stream; and from July 1 to September 30 it is critical to provide flows adequate for maintaining existing levels of adult trout production.

To address the management goal, objectives of this study were to determine instream flows necessary to 1) maintain or improve hydraulic characteristics in the winter that are important for survival of trout, fish passage and aquatic insect production, 2) maintain physical habitat for juvenile rainbow trout that recruit to South Piney Creek from tributaries and, 3) maintain or improve adult trout production during the late summer months.

METHODS

Data for these studies were collected from a site located at the Lander Cut-Off road crossing in Section 15, Range 115 West, Township 29 North (Figure 1). These studies were conducted between June and August 1988 within a 422 foot long study site that contained trout habitat typical of that found throughout the candidate section of South Piney Creek. Data were collected after peak runoff from a range of discharge rates (Table 1).

Table 1. Dates and discharge rates when instream flow data were collected from South Piney Creek during 1988.

Date	Discharge Cubic Feet Per Second (cfs)
06-08-88	50
06-30-88	24
08-23-88	13

The Habitat Retention method (Nehring 1979) was used to identify a maintenance flow. A maintenance flow is defined as a continuous flow needed to maintain minimum hydraulic criteria at riffle areas in a stream segment. Based on extensive research by Annear and Conder (1984), the maintenance flow is specifically defined as the discharge at which two of three hydraulic criteria are met for all riffles in the study area (Table 2). Meeting these criteria provides passage for all life stages of trout between different habitat types and maintains survival of trout and aquatic macroinvertebrates at all times of year.

Data were collected from transects placed across three riffles within the study area and analyzed using the IFG-1 computer program (Milhous 1978). Instream flow recommendations derived from this method are applicable to all times of year except when higher instream flows are required to meet other fishery management purposes.

Table 2. Hydraulic criteria used to obtain an instream flow recommendation using the Habitat Retention method.

Category	Criteria
Average Depth (ft)	Top width[1] X 0.01
Average Velocity (ft per sec)	1.00
Wetted Perimeter (percent)[2]	60

1 - At average daily flow
2 - Compared to wetted perimeter at bankfull conditions

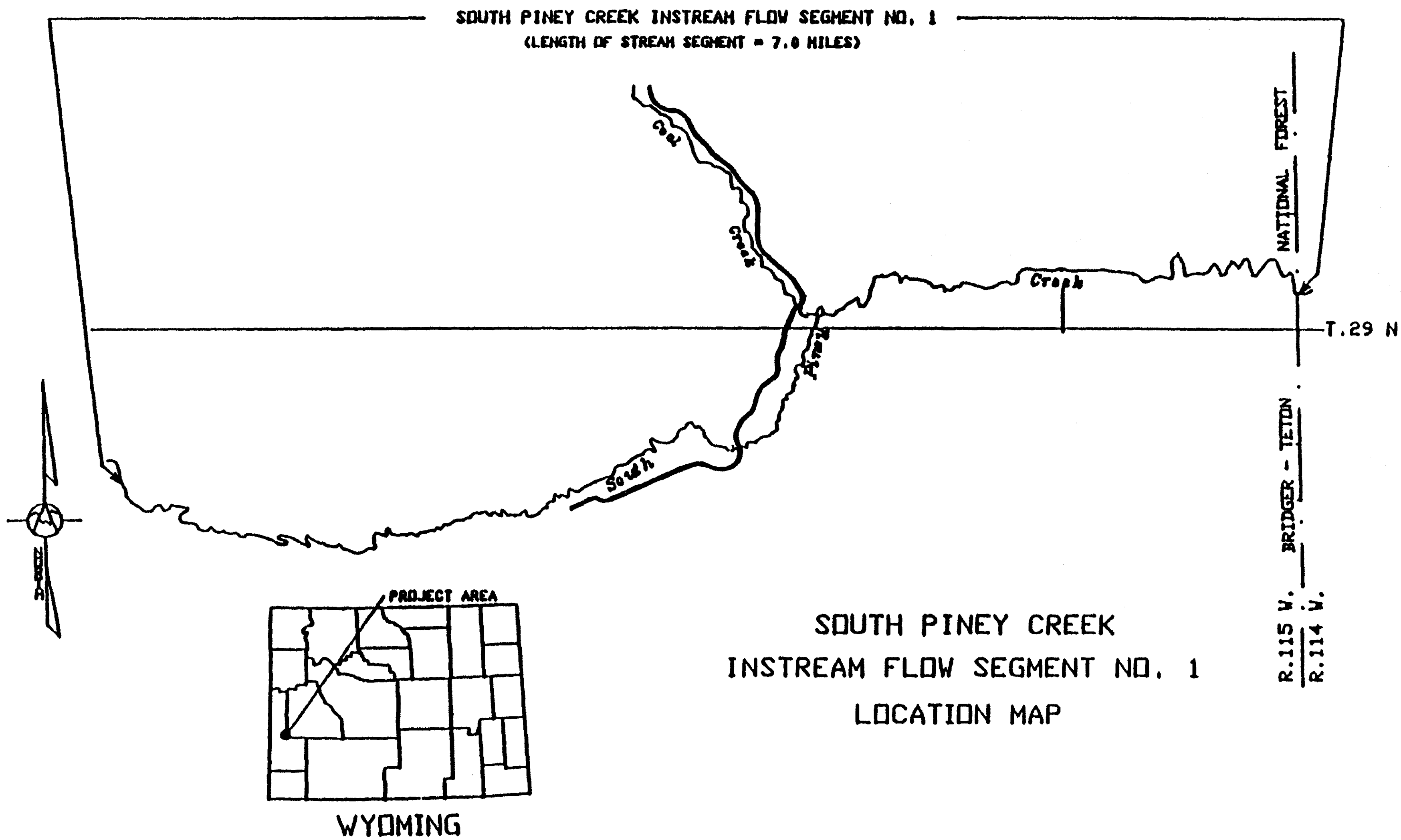

Figure 1. Location of Instream Flow filing reach on South Piney Creek.

A physical habitat simulation model (PHABSIM) developed by the Instream Flow Service Group of the U.S. Fish and Wildlife Service (Bovee and Milhous 1978) was used to examine incremental changes in the amount of physical habitat available for rainbow trout juveniles at various discharge rates. This model is generally regarded as state-of-the-art technology and is the most commonly used method in North America for quantifying changes in physical habitat with changes in discharge (Reiser et al. 1989).

The amount of physical habitat available at a given discharge is expressed in terms of weighted usable area (WUA) and reflects the composite suitability of depth, velocity and substrate at a given flow. Depth, velocity and substrate data were collected from seven transects in accordance with guidelines given by Bovee and Milhous (1978).

Because natural reproduction in this stream segment is insufficient to perpetuate this fishery, it is important to maintain suitable habitat for juveniles that are stocked into South Piney Creek by the WGFD or that recruit naturally to South Piney Creek as tributary flows drop during the summer. Maintenance of suitable physical habitat for this life stage is a critical part of ensuring adequate recruitment to this fishery. The WUA for rainbow trout juveniles was simulated for flows ranging from 5 to 100 cfs using calibration and modeling techniques outlined in Milhous (1984) and Milhous et al. (1984).

The Habitat Quality Index (HQI) developed by the Wyoming Game and Fish Department (Binns and Eiserman 1979) was used to estimate potential changes in trout production over a range of late summer flow conditions. The model incorporates seven attributes that address chemical, physical and biological components of trout habitat. Results are expressed in habitat units (HU), with one HU defined as the amount of habitat quality which will support 1 pound of trout. This model was developed by the WGFD after several years of testing and model refinement. The HQI has been reliably used on many Wyoming streams to assess habitat unit gains or losses associated with projects that modify instream flow regimes.

By measuring habitat attributes at various flow events as if associated habitat features were typical of late summer flow conditions (Conder and Annear 1987), HU estimates were made for hypothetical summer flows ranging from 5 to 125 cfs. To better define the potential impact of these other late summer flow levels on trout production, some attributes were derived mathematically for flows other than those which were measured. Results of the HQI model apply to the time of year that determines trout production. Results of the HQI model apply to the time of year that determines trout production. For South Piney Creek this period is from July 1 to September 30.

RESULTS AND DISCUSSION

The Habitat Retention method was developed to identify a flow that would maintain existing survival rates of trout, provide passage for trout between different habitat types in streams, and maintain survival rates of aquatic insects in riffle areas. Maintenance of these features is important year round except when higher flows are needed at specific times to meet other requirements.

Results from the Habitat Retention model showed that flows of 3, 7 and 9 cfs are necessary to maintain aquatic insect production and fish passage at riffles 1, 2 and 3 respectively (Table 3). The maintenance flow derived from this method is defined as the flow at which two of the three hydraulic criteria are met for all riffles in the study site. Based on this criteria, the maintenance flow for this segment of South Piney Creek is 9 cfs.

Table 3. Results from IFG-1 modeling at the South Piney Creek study site.

Discharge (cfs)	Average Depth (ft)	Average Velocity (ft/sec)	Wetted Perimeter
		Riffle 1	
1.7	0.18	0.55	16.0[1]
2.7[2]	0.22[1]	0.67	17.8
3.9	0.27	0.79	19.0
6.9	0.35	1.00[1]	19.9
12.5	0.46	1.31	21.1
21.7	0.59	1.69	22.1
30.9	0.70	2.01	22.5
40.3	0.79	2.30	22.9
50.2	0.86	2.57	23.4
64.1	0.95	2.90	24.0
94.8	1.10	3.53	25.1
140.4	1.26	4.28	26.7
		Riffle 2	
0.3	0.19	0.22	8.1
0.7	0.21[1]	0.29	9.3
2.1	0.28	0.55	13.7
3.9	0.36	0.75	14.6
6.9[2]	0.42	1.00[1]	17.1
10.3	0.49	1.23	17.9[1]
16.1	0.55	1.54	19.9
21.7	0.58	1.78	21.9
29.8	0.66	2.08	22.4
39.8	0.73	2.40	23.5
51.8	0.79	2.74	24.6
66.1	0.81	3.08	28.8
82.9	0.84	3.41	29.9
140.4	1.00	4.35	33.2

Table 3. (continued).

Discharge (cfs)	Average Depth (ft)	Average Velocity (ft/sec)	Wetted Perimeter
		Riffle 3	
1.7	0.21	0.55	15.2
2.6	0.21	0.61	20.0[1]
3.8	0.20	0.69	27.2
8.6[2]	0.31[1]	0.95	29.4
9.7	0.33	1.00[1]	29.7
11.1	0.35	1.07	30.1
21.7	0.47	1.52	31.0
34.3	0.56	1.97	31.5
51.7	0.65	2.52	31.9
75.3	0.74	3.18	32.4
106.3	0.83	3.95	32.9
140.4	0.91	4.72	33.3

1 - Hydraulic criteria from Table 2 met
2 - Flow meets two of three criteria for individual transect

Natural mortality that occurs during the winter can often be a significant factor limiting a trout population. Kurtz (1980) found that the loss of winter habitat due to low flow conditions was an important factor affecting mortality rates of trout in the upper Green River, with mortality approaching 90% during some years. Needham et al. (1945) documented average overwinter brown trout mortality of 60% and extremes as high as 80% in a California stream. Butler (1979) reported significant trout and aquatic insect losses caused by anchor ice formation. Reimers (1957) considered anchor ice, collapsing snow banks and fluctuating flows resulting from the periodic formation and breakup of ice dams as the primary causes of winter trout mortality.

Causes of winter mortality discussed above are all greatly influenced by the quantity of winter flow in terms of its ability to minimize anchor ice formation (increased velocity and temperature loading) and dilute and prevent snow bank collapses and ice dam formation respectively. Any reduction of natural winter stream flows would increase trout mortality and effectively reduce the number of fish that the stream could support. The fishery management objective for the time period from October 1 to March 31 is subsequently to protect all available natural stream flows in the instream flow segment up to the maintenance flow, which is 9 cfs for this stream segment.

Stream flow data are unavailable for this section of South Piney Creek and it is possible that the discharge of 9 cfs identified by the Habitat Retention method may not be present at times during the winter. Because the existing fishery is adapted to natural conditions, occasional periods of shortfall during the winter do not imply the need for storage. Rather, such shortfalls illustrate the need to maintain all natural winter streamflows, up to 9 cfs, in order to maintain existing survival rates of trout populations.

It is important to maintain physical habitat for juvenile rainbow trout that are stocked by WGFD or that recruit naturally to South Piney Creek. Results from the PHABSIM analysis show that a flow of 15 cfs will maintain 100 percent of the physical habitat for rainbow trout juveniles (Figure 2). Reductions in physical habitat occur rapidly at flows below 15 cfs. Flows may be in excess of 15 cfs from April 1 to July 31, and at these times, physical habitat for juvenile rainbow trout will be less than optimum. The current fishery management objectives for this section of South Piney Creek are to maintain or improve physical habitat for juvenile rainbow trout and meet or exceed the hydraulic criteria addressed by the Habitat Retention method. A flow of 15 cfs is the minimum amount necessary to accomplish these objectives from April 1 to June 30.

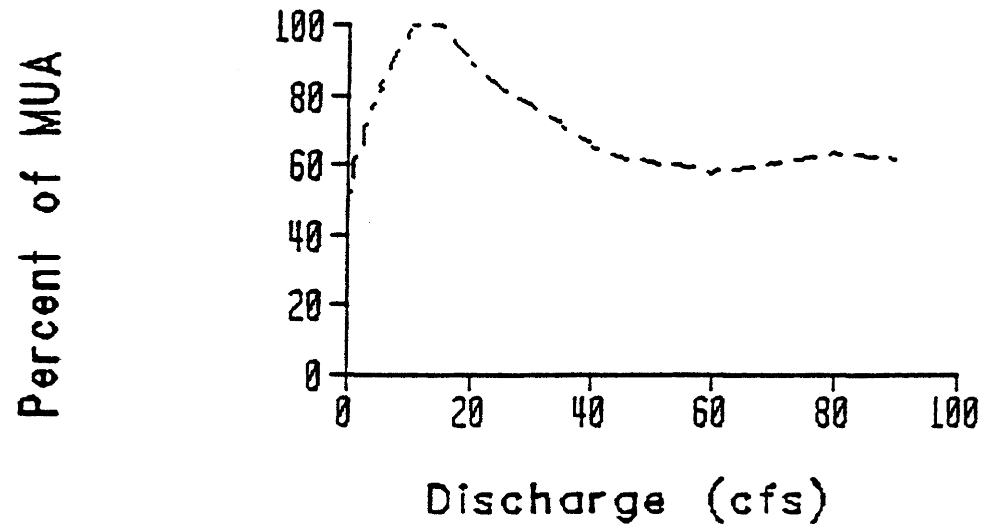

Figure 2. Percent of maximum weighted usable area (MUA) for juvenile rainbow trout at the South Piney Creek study site as a function of discharge.

Results from the HQI model indicate that under existing average late summer conditions, this segment of South Piney Creek supports approximately 39 trout Habitat Units per acre (Figure 3). A flow of 15 cfs is the minimum flow that will maintain this existing level of HU's. At lower flows, trout habitat units would be reduced by approximately 25 percent or more. Fishery management objectives for the late summer are to maintain the existing number of habitat units, and meet or exceed the hydraulic criteria addressed by the Habitat Retention method. A flow of 15 cfs is the minimum streamflow which will accomplish these objectives for the period from July 1 through September 30.

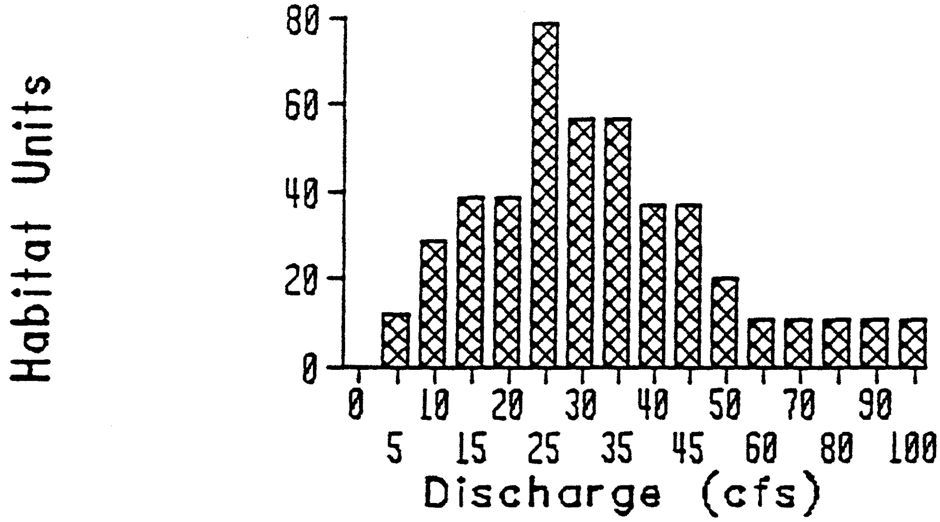

Figure 3. Adult trout habitat units (HU) as a function of discharge at the South Piney Creek study site.

SUMMARY

The instream flow regime in Table 4 is based on results from the Habitat Retention, HQI and PHABSIM models, and displays the minimum stream flows needed to maintain or improve existing trout production levels in a section of South Piney Creek at critical times of year. This stream section extends for a distance of 7.0 miles; from the U.S. Forest Service boundary on the east side of Section 12, Range 115 West, Township 29 North, upstream to the west side of state school lands at Section 17, Range 115 West, Township 29 North.

Table 4. Summary of instream flow recommendations for South Piney Creek west of Big Piney.

Time Period	Instream Flow Recommendation (cfs)
October 1 to March 31	9*
April 1 to June 30	15
July 1 to September 30	15

* - To maintain existing natural flows

REFERENCES

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Butler, R. 1979. Anchor ice, its formation and effects on aquatic life. Science in Agriculture, Vol XXVI, Number 2, Winter, 1979.

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Form S.W. 1
Rev. 9-88

NOTE: Do not fold this form. Use typewriter or print neatly with black ink.

STATE OF WYOMING

OFFICE OF THE STATE ENGINEER

APPLICATION FOR PERMIT TO APPROPRIATE SURFACE WATER

THIS SECTION IS NOT TO BE FILLED IN BY APPLICANT

Filing/Priority Date

THE STATE OF WYOMING, }
STATE ENGINEER'S OFFICE } SS.

This instrument was received and filed for record on the ________ day of ____________________ A.D. 19 ______ at ____________ o'clock ________ M.

____
State Engineer

Recorded in Book ____________________ of Ditch Permits, on Page ____________.

Fee Paid $____________. Map Filed ____________

WATER DIVISION NO. ________________ DISTRICT NO. ____________ Temp. Filing No. ____________

PERMIT NO. ____________

NAME OF FACILITY South Piney Creek-Instream Flow Segment 1

1. Name(s), mailing address and phone no. of applicant(s) is/are Wyoming Water Development Commission, Herschler Building, Cheyenne, WY 82002

(If more than one applicant, designate one to act as Agent for the others)

2. Name & address of agent to receive correspondence and notices Wyoming Game & Fish Dept., 5400 Bishop Blvd., Cheyenne, WY 82002

3. (a) The use to which the water is to be applied is Instream Flow

(b) If more than one beneficial use of water is applied for, the location and ownership of the point of use must be shown in item 10 of the application and the details of the facilities used to divert and convey the appropriation must be shown on the map in sufficient detail to allow the State Engineer to establish the amount of appropriation. In multiple use applications, stock and domestic purposes are limited to 0.056 cubic feet per second.

4. The source of the proposed appropriation is South Piney Creek, a tributary of Green River

5. The instream flow segment extends from ~~point of diversion of the proposed works is located~~ the west boundary of ~~feet distant~~ ~~from the~~ NW1/4SW1/4 ~~corner of~~ Section 17 T. 29 N., R. 115 W., ~~and is in the~~ to the east boundary of SE1/4SE1/4 of Section 12 T. 29 N., R. 115 W.

6. Are any of the lands crossed by the proposed facility owned by the State or Federal Government? If so, describe lands and indicate whether State or Federally owned.
Section 16, T.29N., R.115W., is State owned; all of rest is Federally owned.

7. The carrying capacity of the ditch, canal, pipeline or other facility at the point of diversion is see remarks cubic feet per second.

8. The accompanying map is prepared in accordance with the State Engineer's Manual of Regulations and Instructions for filing applications and is hereby declared a part of this application. The State Engineer may require the filing of detailed construction plans.

9. The estimated time required for the commencement of work is 30 days, for completion of construction is 30 days and to complete the applicaton of water to the beneficial uses stated in this application is 30 days from issue.

10. The land to be irrigated under this permit is described in the following tabulation. (Give irrigable acreage in each 40-acre subdivision. Designate ownership of land, Federal, State or private. If private, list names of owners and land owned separately.) If application is for stock, domestic, or for purposes other than irrigation, indicate point of use by 40-acre subdivision and owner.

			NE¼				NW¼				SW¼				SE¼				
Township	Range	Sec.	NE¼	NW¼	SW¼	SE¼	NE¼	NW¼	SW¼	SE¼	NE¼	NW¼	SW¼	SE¼	NE¼	NW¼	SW¼	SE¼	TOTALS
29N	115W	17										X	X	X			X	X	
		16											X	X	X		X	X	
		15	X		X	X			X	X	X	X			X				
		10																X	
		11											X	X	X		X	X	
		12									X	X	X	X	X	X	X	X	

Number of acres to receive original supply ______

Number of acres to receive supplemental supply ______

Total number of acres to be irrigated ______

REMARKS

Item 7-Based on the results of a study conducted in 1988 by the Wyoming Game and Fish Department:

MONTH	FLOW(cfs)
October	9
November	9
December	9
January	9
February	9
March	9
April	15
May	15
June	15
July	15
August	15
September	15

Based on the results of a study conducted in 1988 by the Wyoming Game and Fish Department, a flow right of 9 cfs is requested from October 1 to March 31 to ensure hydraulic conditions needed to maintain or improve existing levels of trout survival, fish passage and insect production. A flow of 15 cfs is requested from April 1 to June 30 to maintain existing levels of habitat for juvenile trout that recruit to South Piney Creek from tributaries. A flow of 15 cfs is requested from July 1 to September 30 to maintain or improve existing levels of adult trout production.

Stream segment length is 7.0 miles

This is an ungaged stream. If additional information is required a gage will be installed.

See map for intervening ditches.

Under penalties of perjury, I declare that I have examined this application and to the best of my knowledge and belief it is true, correct and complete.

Michael [illegible] ______ 3/11/91

Signature of Applicant or Agent — Date