Mailing Address:
Water Resources Data System
University of Wyoming, Dept 3943
1000 E University Avenue
Laramie, WY 82071

Physical Address:
Wyoming Hall, Room 249
University of Wyoming
Laramie, WY 82071

Phone: (307) 766-6651
Fax: (307) 766-3785

Funding for WRDS and the creation of this electronic document was provided by the Wyoming Water Development Commission (http://wwdc.state.wy.us)

REPORT

ON THE FEASIBILITY OF PROVIDING

INSTREAM FLOW IN THE MEDICINE LODGE CREEK

INSTREAM FLOW SEGMENT NO. 1

Temporary Filing No. 27 2/146

Wyoming Water Development Commission

April, 1998

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES (cont.)

REPORT
ON THE FEASIBILITY OF PROVIDING
INSTREAM FLOW IN THE MEDICINE LODGE CREEK
INSTREAM FLOW SEGMENT NO. 1
TEMPORARY FILING NO. 27 2/146

Wyoming Water Development Commission
May, 1996

SUMMARY

As required by W. S. 41-3-1004(a), the Wyoming Water Development Commission has completed a determination of the feasibility of providing various amounts of unappropriated direct flow in a segment of the Medicine Lodge Creek. Medicine Lodge Creek - Instream Flow Segment Number 1 is defined by a point located at the north boundary of the south half of the southeast quarter of section 21, Township 50 North, Range 89 West upstream to the Bureau of Land Management-U.S. Forest Service boundary in the southeast quarter of the southwest quarter of Section 28, Township 51 North, Range 88 West, a stream length of approximately 7.5 miles, all in Big Horn County, Wyoming. The instream flow segment is shown on Figure 1. A schematic of the project area is shown on Figure 2.

The following analysis is made pursuant to W. S. 41-3-1004 (a) which states, "Immediately after permits have been applied for under W. S. 41-3-1003 (c), the water development commission shall determine the feasibility of providing instream flows for the recommended segments of streams from unappropriated direct flows or from existing storage facilities or from new facilities etc."

The Wyoming Game and Fish Department (G&F) has requested a direct flow water right, as shown in Table 1, for the purpose of instream flow for fisheries in this segment of Medicine Lodge Creek.

Table 1
Direct Flow Requests in CFS

OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
15	15	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9

This report's analysis indicates that the requested mean monthly unappropriated direct flows were not met three months of the average year. Further, the requested flows were not met ten months of the dry year and the twelve driest months. These shortages are shown in Table 2.

Table 2
Direct Flow Shortages in CFS

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Mean	0.1	2.2	0.0	0.0	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0
Dry Year	5.7	6.1	0.2	1.0	0.9	0.2	8.4	0.0	0.0	1.2	5.6	3.6
Driest Month	5.7	6.1	0.2	1.0	0.9	1.2	8.9	0.0	0.0	1.2	5.6	3.6

The daily flow exceedance analysis determined that the requested flows did not meet the WWDC 50% exceedance criteria for four months as shown in Table 3.

Table 3
Direct Flow Exceedance Values by Percentage
(Percent of days the unappropriated flows equal or exceed the requested flows)

OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
33 *	**12** *	96	87	82	73	**5** *	78	100	91	**21** *	63

* Direct Flow Exceedance Values below 50%

The flow shortage and storage analysis indicated that an additional 232 acre-feet of active storage would be required to fulfill the instream flow request in the average year. The dry year analysis indicates that an additional 1,980 acre-feet of active storage would be needed to fulfill the instream flow request. The twelve driest months analysis indicates that an additional 2,072 acre-feet of active storage is needed to fulfill the instream flow request.

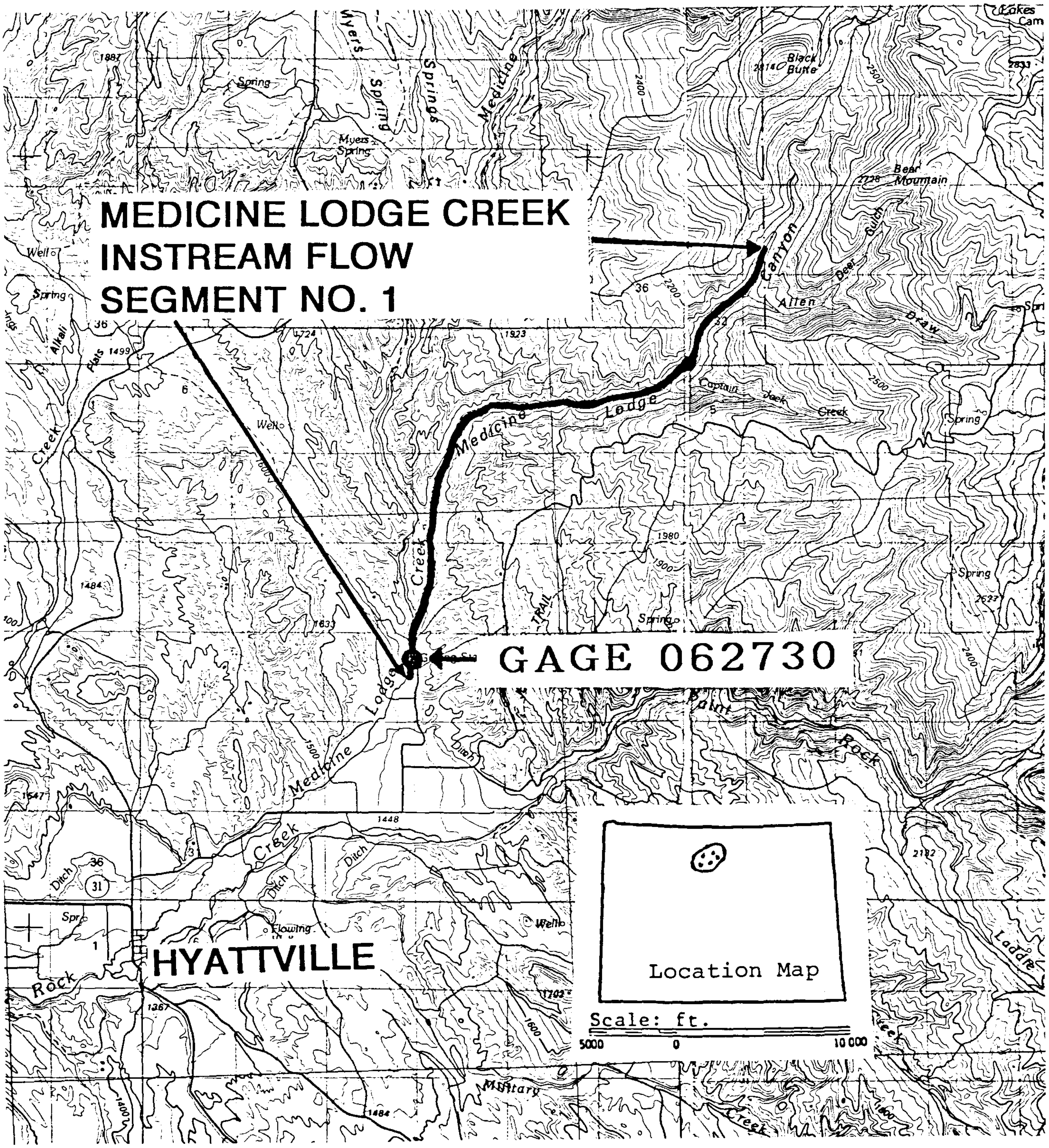


Figure 1.
Map of the Medicine Lodge Creek Instream Flow Segment No. 1.

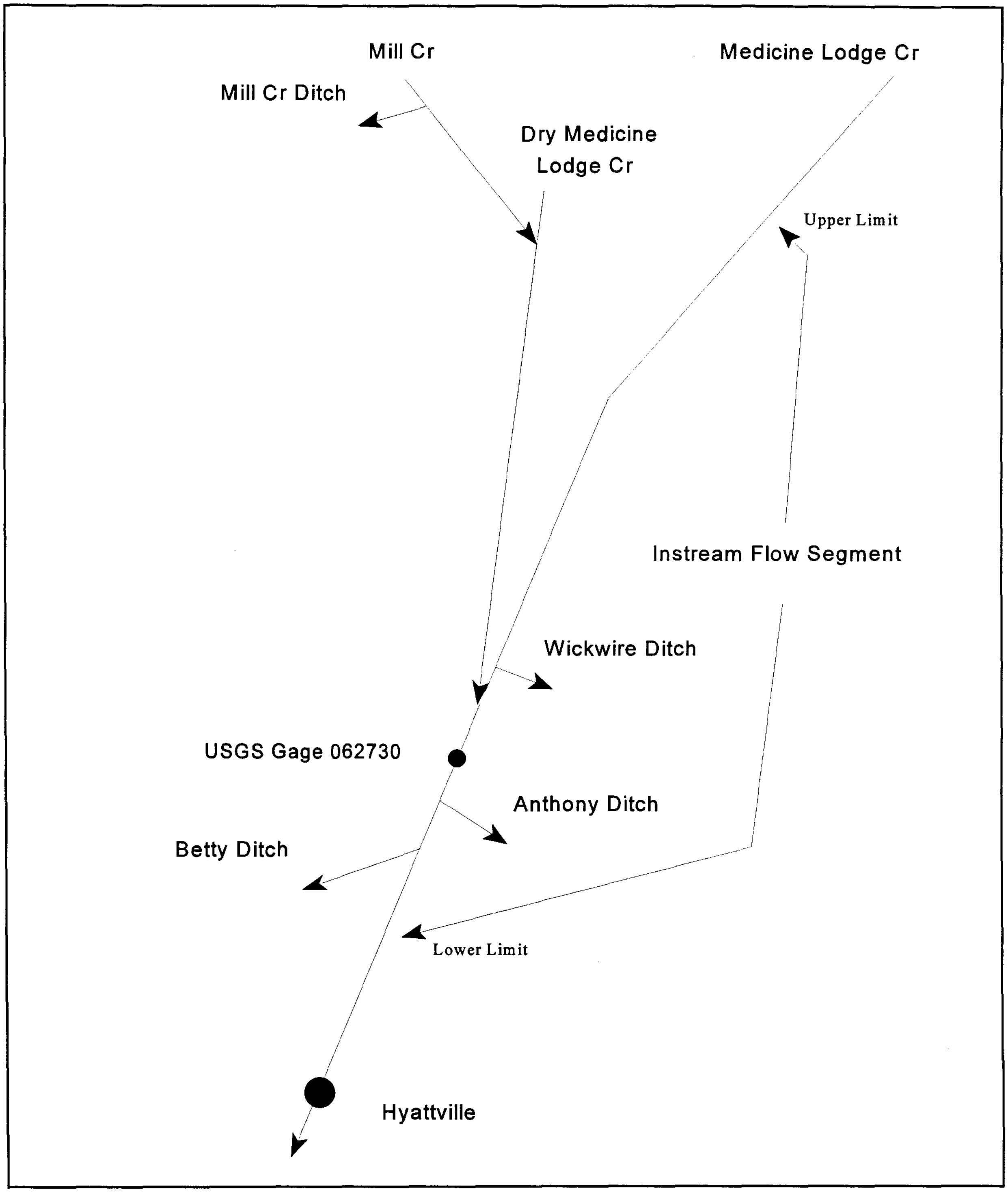


Figure 2.
Schematic of Medicine Lodge Creek Instream Flow Segment No. 1.

WATER RIGHTS

Table 4 lists the direct flow water rights which are located within and upstream of the instream flow segment. These water rights include the first cfs and second cfs water supply of 1 cfs/70 acres for a total of 2 cfs/70 acres. All water rights analyzed in this report are for flows located within the Medicine Lodge Creek drainage basin above Hyattville. The water right information used in this analysis was provided by the Wyoming State Engineer's Office. The second cfs, surplus and excess, irrigation diversions are determined by Wyoming State Statues 41-4-317 through 41-4-331.

TABLE 4.
Direct Flow Water Rights and Permits Located Within and Upstream of Instream Flow Segment No. 1 of the Medicine Lodge Creek as of January, 1990.

Permit No.	Facility	Source	Priority Date Month Day Year	Amount First cfs	Amount Second cfs	Use	Adj. Unadj.	Headgate Location Sec Twn Rng
Terr.	Wickwire Ditch	Medicine Lodge Creek	1885	0.36	0.36	Irri.*	Adj.	15 50 89
Terr.	Anthony Ditch	Medicine Lodge Creek	09 20 1888	3.58	3.58	Irri.	Adj.	22 50 89
11315	Betty Ditch	Medicine Lodge Creek	01 27 1911	0.91	0.91	Irri.	Adj.	21 50 89
13735	Mill Creek Ditch	Mill Cr Tributary Medicine Lodge Cr	08 20 1915	0.42	0.42	Irri.	Adj.	29 52 88
6732 E.	Anthony Ditch Enlargement	Medicine Lodge Creek	01 13 1984	0.23	0.23	Irri.	Adj.	22 50 89

* Irri.- Irrigation Right

FLOW RECORDS

The historic flow records of the United States Geological Survey stream flow gaging station, 062730, located on Medicine Lodge Creek above Hyattville, located approximately 3200 feet above the lower end of the instream flow segment, provided thirty years of daily gage flow data recorded from 1944 to 1973. From these data the gage site's mean monthly flows (data item number (1A) as listed in the following Tables), the twelve driest consecutive months (1B) and the driest monthly flows (1C) were determined. These values are shown in the following Tables 5, 6, 7 and 8. The gage station is shown on Figures 1 and 2. The mean monthly flows for the gage's period of record are listed in Table 5.

The downstream end of the instream flow segment is located approximately 3200 feet downstream from the gage station. There are two water right diversions above the gage, the Mill Creek Ditch and the Wickwire Ditch. The flow records at the gage reflect the historic diversions and return flows of the Mill and Wickwire diversions above the gage. There are also two water right diversions below the gage and above the bottom of the instream flow segment. They are the Betty Ditch and the Anthony Ditch (B&A). The B&A diversions divert water above the bottom of the instream flow segment and a percentage of their return flows reenter the creek above the bottom of the segment. The local water commissioners indicate that the irrigation season usually ranges from April through September.

Table 5

MEDICINE LODGE CREEK INSTREAM FLOW SEGMENT NO. 1.
MEAN MONTHLY FLOWS AT USGS GAGE SITE 062730 IN CFS

Item	YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL AC-FT
	1944	11.7	11.5	10.7	10.7	9.8	9.6	9.5	107.1	207.4	72.6	17.8	15.3	29,811
	1945	14.5	11.7	10.4	11.1	10.7	10.0	9.6	54.1	172.0	97.5	22.1	22.5	26,924
	1946	21.0	16.0	12.5	11.1	10.7	11.2	37.3	94.8	174.7	49.6	16.0	22.2	28,767
	1947	19.8	17.4	14.9	12.9	11.1	12.9	13.1	122.8	156.6	75.1	20.0	17.0	29,869
	1948	17.7	14.3	13.6	12.8	12.1	11.9	11.6	115.7	95.2	29.9	16.1	12.1	21,978
	1949	12.5	12.3	11.2	10.9	11.0	10.0	12.3	107.1	156.0	34.9	14.0	14.0	24,508
	1950	13.2	11.6	9.8	10.0	10.4	10.0	12.7	52.8	177.6	50.0	17.8	15.1	23,548
	1951	16.4	13.4	12.1	11.0	11.0	11.5	10.8	100.9	116.8	51.8	20.8	16.5	23,778
	1952	15.0	12.3	11.6	10.8	11.0	10.5	20.1	117.7	123.7	52.2	21.3	13.8	25,417
	1953	12.2	11.5	10.5	9.8	9.9	10.0	9.9	24.0	235.0	50.6	19.5	14.2	25,046
	1954	13.6	12.5	11.7	10.5	10.0	10.0	10.4	89.8	74.2	22.3	11.2	9.8	17,312
	1955	10.2	11.0	9.7	8.8	8.5	8.6	10.0	75.1	193.4	43.2	15.7	12.5	24,505
	1956	11.9	11.5	12.0	10.5	9.8	12.2	11.9	131.3	127.4	22.0	13.0	11.9	23,308
	1957	10.6	11.2	9.8	9.5	10.1	8.9	9.2	50.4	142.9	40.3	15.0	16.6	20,141
	1958	13.8	12.8	10.6	9.6	9.8	9.2	9.6	122.5	67.1	28.2	19.4	11.7	19,669
	1959	11.6	10.9	10.4	9.1	9.0	10.0	10.1	38.0	230.6	39.3	14.7	12.0	24,369
	1960	12.5	10.9	9.8	9.0	8.6	9.9	12.5	68.7	88.3	18.8	12.6	11.4	16,488
	1961	11.9	10.4	9.5	8.4	8.4	7.6	7.7	92.6	76.7	16.2	11.8	15.8	16,747
	1962	21.9	14.5	10.7	10.0	9.4	9.1	25.3	97.8	171.1	40.2	18.3	15.6	26,788
	1963	13.4	11.6	9.9	9.0	8.6	8.4	10.0	96.0	202.2	27.7	13.0	11.9	25,407
	1964	10.5	11.3	9.6	9.5	9.5	9.9	10.1	82.5	284.4	91.0	20.3	19.1	34,194
	1965	14.5	12.6	11.7	9.9	9.4	10.2	9.7	42.2	298.9	73.5	20.6	16.0	31,798
	1966	17.0	12.4	10.2	9.5	8.7	8.6	9.1	85.2	54.9	15.7	11.1	9.3	15,245
	1967	9.2	8.8	8.6	7.8	7.9	8.6	8.3	67.2	297.1	89.3	21.8	20.5	33,416
	1968	21.7	15.5	12.9	11.4	10.8	10.7	10.1	35.0	200.3	77.4	41.8	39.8	29,358
	1969	21.8	17.8	14.3	13.2	12.4	12.0	24.2	142.7	97.5	68.2	20.6	15.2	27,885
	1970	13.6	12.4	11.0	11.0	10.1	10.0	10.6	80.9	186.4	43.3	18.2	14.4	25,415
	1971	12.7	11.0	10.6	9.9	9.8	9.5	10.3	82.6	183.7	36.8	19.7	14.4	24,780
	1972	15.8	13.0	11.1	11.4	11.2	11.8	11.3	86.7	172.9	48.3	28.7	23.6	26,905
	1973	17.6	14.6	12.3	11.0	10.2	10.3	10.0	79.2	148.5	43.5	20.6	21.9	24,119
(1A)	MEAN	14.7	12.6	11.1	10.3	10.0	10.1	12.6	84.8	163.8	48.3	18.4	16.2	24,917
(1B)	DRY YEAR	9.2	8.8	8.6	7.8	7.9	8.6	8.3	67.2	54.9	15.7	11.1	9.3	13,154
(1C)	DRIEST MONTH	9.2	8.8	8.6	7.8	7.9	7.6	7.7	24.0	54.9	15.7	11.1	9.3	10,401

HYDROLOGY

The main objective of the hydrology analysis in this report is to determine if there is sufficient unappropriated flow passing the downstream end of the instream flow segment to provide the instream flows requested by the Wyoming Game and Fish Department.

The flow records of the USGS gage 062730, the SEO permits and field information, and the physical topography data of the drainage basin were used in this analysis. The conversion of these data to unappropriated flow at the lower end of the segment is detailed in the following paragraphs.

The major steps involved in this process are outlined in the flow analysis section of this report. Each step of the analysis is referenced by a data item number as shown on the left side of each flow analysis table and in the following paragraphs as shown in parentheses (X). The data item number (X), as referenced in the following paragraphs correspond to the data item number (Item) references in the corresponding Tables in this report. If more than one step has the same values in a Table or a data item is used more than one time in a Table, then those steps will all have the same data item number. The data item numbers in each Table relate to the data item values and not to the chronological order that they appear. The Tables with data item number references are 6, 7, 8, 9, 10 and 11.

The historic flow records used in this analysis are from the USGS stream flow gaging station, 062730, located approximately 3200 feet above the lower end of the instream flow segment. From these records, the gage site's mean monthly flows (1A), the driest year flows consisting of the twelve driest consecutive months (1B), and the driest monthly flows on record at the gage site (1C) were determined as outlined in the flow records section of this report.

The only diversions above the gage consist of the Mill Creek Ditch diversion of .42 cfs and the Wickwire Ditch diversion of .36 cfs. The flows at the gage (1A, 1B, 1C) already reflect the historic water diversions and return flows of these two water rights.

There are two water diversions below the gage and above the bottom of the instream flow segment, the Betty Ditch and the Anthony Ditch. The local water commissioners indicate that these irrigation diversions start around April and end approximately September. The irrigation demand slows down enough in September that the first cfs supply seems adequate to supply the irrigation needs without the need for the second cfs supply flow.

In Tables 6,7, and 8, the B&A irrigation diversions (4) of the stream segment below the gage consist of the first cfs (2) and second cfs (3) supply. The first cfs supply diversion rates (2) were established from the permitted flow rates obtained from the State Engineer's Office. The second cfs supply diversions (3) were established from Wyoming State Statues 41-4-317 through 41-4-331 on surplus and excess flow water rights.

Of the total flow diverted from the stream segment, part is consumed by the irrigated crops and part is lost in the conveyance process to evaporation, deep infiltration and other minor sources. The remainder of the diverted flow not consumed or lost, returns to the stream. The amount consumed by the irrigated crops (5) was estimated using the WWRC Publication #92-06, Consumptive Use and Consumptive Irrigation Requirements in

Wyoming, by Larry Pochop, Travis Teegarden, Greg Kerr, Ronald Delayey, and Victor Hasfurther. The irrigated crops in this area mainly consist of hay grasses. The non-consumptive conveyance losses (6) are estimated at 50% of the non-consumptive diverted flows. This leaves 50% of the non-consumptive diverted flows as return flow to the stream.

The return flows were determined for each diversion, located below the gage, which returned water to the stream above the end of the segment. Once the total return flows to the stream (7) were determined, the percentage of those return flows entering the stream (8) above the lower end of the segment were determined from the irrigated lands above the lower end of the segment located on the local area topography maps. The percentage of irrigated acres returning flows to the stream above the end of the instream flow segment is approximately 40% for the Anthony Ditch and 10% for the Betty Ditch.

The natural inflows (11) of the stream segment below the gage were estimated from the percentage of historic flows from the segment's basin area above the gage as they related to the flows from the segment's basin area below the gage. These basin areas were determined from local area topography maps and USGS gage data. The area of the stream basin below the gage and above the lower end of the stream segment is 1.4 square miles. The area above the gage is 86.8 square miles. This relates to a 1.6 percent adjustment of the flow data from the gage (1) to the lower end of the segment (11).

To adjust the flow data from the gage site (1) to the lower end of the segment (12), the flow values for the gage site had to be adjusted to compensate for flows below the gage site and flows above the lower end of the segment. The historic monthly averages at the gage site (1) were adjusted to reflect the consumptive uses and natural inflows between the gage and the downstream end of the segment. This was done by removing the irrigation diversions (9) and adding the diversion return flows (10) and the natural inflows (11), between the gage and the downstream end of the segment, to the historic Medicine Lodge direct flows (1) recorded at the gage site. The irrigation depletions were removed during the irrigation months of May through September. These irrigation depletions include the first cfs and second cfs amounts. This adjusted the average unappropriated flow data for the gage site (1) to the average monthly unappropriated flow data for the lower end of the segment (12).

The original Game and Fish instream flow monthly requests were developed by Gerald Vogt and presented in his 1990 Wyoming Game and Fish Department, Fish Division Administrative Report. The original Game and Fish instream flow report and flow requests (13) were then amended in 1997 by a Wyoming Game and Fish Department, Fish Division Amended Administrative Report by Gerald Vogt and Thomas Annear. This amended report is contained in this report as appendix A.

To determine if these requested flows are available or if storage will be required to provide the instream flow requests, the G&F instream flow requests (13) were subtracted from the unappropriated flow amounts (12). The last row of values (14) in Tables 6, 7 and 8 indicate the excesses and shortages after the instream flow request for each month were removed. Figure 3 graphically compares the average available flows (12) with the requested flows (13). The shortages listed (14) in each table indicate that a storage analysis is required.

The storage analysis took the unappropriated monthly excesses and shortages (14) from the segment and converted them from cfs to acre-feet as shown in Tables 9, 10 and 11. These values were then used to produce a simple reservoir mass balance (without evaporation considered) to determine the reservoir storage required to provide the requested instream flow amounts for the instream flow segment during an average year, a dry year and the driest months. The average analysis indicates it would require an additional 232 acre-feet of active storage to provide the instream flow request. The dry year analysis indicates it would require an additional 1,980 acre-feet of active storage to provide the instream flow request. The driest month analysis indicates it would require an additional 2,072 acre-feet of active storage to provide the instream flow request.

MEAN MONTHLY FLOW ANALYSIS

Table 6, shown at the end of this section, outlines the steps used to analyze the availability of the mean monthly unappropriated flow in the Medicine Lodge Creek instream flow segment to provide the requested instream flows. The details of these steps are located in the hydrology section of this report.

The bottom of Table 6 shows the excesses and shortages in the monthly flows (14A) after the instream flow requests (13) are removed from the mean monthly unappropriated flows (12A). Figure 3 graphically compares the mean monthly unappropriated flows (12A) with the requested flows (13). Both Table 6 and Figure 3 show a shortage of 0.1 cfs during October, 2.2 cfs during November, and 3.9 cfs during April.

Table 6

MEDICINE LODGE CREEK INSTREAM FLOW SEGMENT NO. 1.
MEAN MONTHLY FLOWS AT THE DOWNSTREAM END OF THE INSTREAM FLOW SEGMENT IN CFS

Item	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1A Mean Monthly Flows at the USGS Gage *	14.7	12.6	11.1	10.3	10.0	10.1	12.6	84.8	163.8	48.3	18.4	16.2
ANTHONY DIVERSION												
2 Original Diversions-							-3.81	-3.81	-3.81	-3.81	-3.81	-3.81
3 Surplus Diversions **							-3.81	-3.81	-3.81	-3.81	-3.81	0.00
4 Total Irr. Diversions							-7.62	-7.62	-7.62	-7.62	-7.62	-3.81
5 Consumptive use in CFS/Mo							1.13	1.83	2.50	2.80	2.28	1.25
6 Non-Consumptive use in CFS/Mo							6.49	5.79	5.12	4.82	5.34	2.56
7 Total Return to Stream							3.2	2.9	2.6	2.4	2.7	1.3
8 Total Return to Segment							1.3	1.2	1.0	1.0	1.1	0.5
BETTY DIVERSION												
2 Original Diversions							-0.91	-0.91	-0.91	-0.91	-0.91	-0.91
3 Surplus Diversions **							-0.91	-0.91	-0.91	-0.91	-0.91	0.00
4 Total Irr. Diversions							-1.82	-1.82	-1.82	-1.82	-1.82	-0.91
5 Consumptive use in CFS/Mo							0.27	0.44	0.60	0.67	0.55	0.30
6 Non-Consumptive use in CFS/Mo							1.55	1.28	1.22	1.15	1.27	0.61
7 Total Return to Stream							0.8	0.7	0.6	0.6	0.6	0.3
8 Total Return to Segment							0.3	0.3	0.2	0.2	0.3	0.1
9 B&A Total Diversions							-9.4	-9.4	-9.4	-9.4	-9.4	-4.7
10 B&A Total Return to Segment							1.6	1.5	1.2	1.2	1.4	0.6
11A Natural Inflow Below Gage	0.2	0.2	0.2	0.2	0.2	0.2	0.2	1.3	2.6	0.8	0.3	0.3
12A **AVERAGE AVAILABLE FLOW**	14.9	12.8	11.3	10.5	10.2	10.3	5.0	78.2	158.2	40.9	10.7	12.4
13 Game & Fish Request	-15.0	-15.0	-8.9	-8.9	-8.9	-8.9	-8.9	-8.9	-8.9	-8.9	-8.9	-8.9
14A Negative indicates Shortage	-0.1	-2.2	2.4	1.6	1.3	1.4	-3.9	69.3	149.3	32.0	1.8	3.5

* Gage flows assume virgin flows adjusted for full use of permitted water rights above the gage.
** Historically the surplus flows are not needed in this area in September.

DRY YEAR MONTHLY FLOW ANALYSIS

The driest year (continuous 12 months) on record for the years of 1944 to 1973, for gage 062730, was from June 1966 to May 1967. Table 7, shown at the end of this section, outlines the steps used to analyze the availability of the dry year unappropriated flow in the Medicine Lodge Creek instream flow segment to provide the requested instream flows. The details of these steps are located in the hydrology section of this report.

The bottom of Table 7 shows the excesses and shortages in the monthly flows (14B) after the instream flow requests (13) are removed from the mean monthly unappropriated flows (12B). Figure 3 graphically compares the dry year monthly unappropriated flows (12B) with the requested flows (13). Both Table 7 and Figure 3 show a shortage of 5.7 cfs during October, 6.1 cfs during November, 0.2 cfs during December, 1.0 cfs during January, 0.9 cfs during February, 0.2 cfs during March, 8.4 cfs during April, 1.2 cfs during July, 5.6 cfs during August and 3.6 cfs during September.

Table 7

MEDICINE LODGE CREEK INSTREAM FLOW SEGMENT NO. 1.
DRY YEAR FLOWS AT THE DOWNSTREAM END OF THE INSTREAM FLOW SEGMENT IN CFS
June 1966 to May 1967

Item		OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1B	Dry Year Flows at the USGS Gage *	9.2	8.8	8.6	7.8	7.9	8.6	8.3	67.2	54.9	15.7	11.1	9.3
	ANTHONY DIVERSION												
2	Original Diversions							-3.81	-3.81	-3.81	-3.81	-3.81	-3.81
3	Surplus Diversions **							-3.81	-3.81	-3.81	-3.81	-3.81	0.0
4	Total Irr. Diversions							-7.62	-7.62	-7.62	-7.62	-7.62	-3.81
5	Consumptive use in CFS/Mo							1.13	1.83	2.50	2.80	2.28	1.25
6	Non-Consumptive use in CFS/Mo							6.49	5.79	5.12	4.82	5.34	2.56
7	Total Return to Stream							3.2	2.9	2.6	2.4	2.7	1.3
8	Total Return to Segment							1.3	1.2	1.0	1.0	1.1	0.5
	BETTY DIVERSION												
2	Original Diversions							-0.91	-0.91	-0.91	-0.91	-0.91	-0.91
3	Surplus Diversions **							-0.91	-0.91	-0.91	-0.91	-0.91	0.00
4	Total Irr. Diversions							-1.82	-1.82	-1.82	-1.82	-1.82	-0.91
5	Consumptive use in CFS/Mo							0.27	0.44	0.60	0.67	0.55	0.30
6	Non-Consumptive use in CFS/Mo							1.55	1.28	1.22	1.15	1.27	0.61
7	Total Return to Stream							0.8	0.7	0.6	0.6	0.6	0.3
8	Total Return to Segment							0.3	0.3	0.2	0.2	0.3	0.1
9	B&A Total Diversions							-9.4	-9.4	-9.4	-9.4	-9.4	-4.7
10	B&A Total Return to Segment							1.6	1.5	1.2	1.2	1.4	0.6
11	Natural Inflow Below Gage	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.0	0.9	0.2	0.2	0.1
12B	**AVERAGE AVAILABLE FLOW**	9.3	8.9	8.7	7.9	8.0	8.7	0.5	60.3	47.6	7.7	3.3	5.3
13	Game & Fish Request	-15.0	-15.0	-8.9	-8.9	8.9	-8.9	-8.9	-8.9	-8.9	-8.9	-8.9	-8.9
14B	Negative indicates Shortage	-5.7	-6.1	-0.2	-1.0	-0.9	-0.2	-8.4	51.4	38.7	-1.2	-5.6	-3.6

* Gage flows assume virgin flows adjusted for full use of permitted water rights above the gage.
** Historically the surplus flows are not needed in this area in September.

TWELVE DRIEST MONTHS FLOW ANALYSIS

The driest months on record for each month of the year, for the years of record from 1944 to 1973, for gage 062730 (1C), were also analyzed and listed in Table 8. Table 8, shown at the end of this section, outlines the steps used to analyze the availability of the twelve driest monthly unappropriated flows in the Medicine Lodge Creek instream flow segment to provide the requested instream flows. The details of these steps are located in the hydrology section of this report.

The bottom of Table 8 shows the excesses and shortages in the monthly flows (14C) after the instream flow requests (13) are removed from the mean monthly unappropriated flows (12C). Figure 3 graphically compares the dry year monthly unappropriated flows (12C) with the requested flows (13). Both Table 8 and Figure 3 show a shortage of 5.7 cfs during October, 6.1 cfs during November, 0.2 cfs during December, 1.0 cfs during January, 0.9 cfs during February, 1.2 cfs during March, 8.9 cfs during April, 1.2 cfs during July, 5.6 cfs during August and 3.6 cfs during September.

The driest month flow analysis is the critical flow situation in the Instream Flow analysis. This is the period of the driest low flow conditions and the most critical time for a call for regulation on the stream segment.

Table 8

MEDICINE LODGE CREEK INSTREAM FLOW SEGMENT NO. 1.
DRIEST MONTH FLOWS AT THE DOWNSTREAM END OF THE INSTREAM FLOW SEGMENT IN CFS

Item		OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1C	Driest Month Flows at the USGS Gage *	9.2	8.8	8.6	7.8	7.9	7.6	7.7	24.0	54.9	15.7	11.1	9.3
	ANTHONY DIVERSION												
2	Original Diversions							-3.81	-3.81	-3.81	-3.81	-3.81	-3.81
3	Surplus Diversions **							-3.81	-3.81	-3.81	-3.81	-3.81	0.00
4	Total Irr. Diversions							-7.62	-7.62	-7.62	-7.62	-7.62	-3.81
5	Consumptive use in CFS/Mo							1.13	1.83	2.50	2.80	2.28	1.25
6	Non-Consumptive use in CFS/Mo							6.49	5.79	5.12	4.82	5.34	2.56
7	Total Return to Stream							3.2	2.9	2.6	2.4	2.7	1.3
8	Total Return to Segment							1.3	1.2	1.0	1.0	1.1	0.5
	BETTY DIVERSION												
2	Original Diversions							-0.91	-0.91	-0.91	-0.91	-0.91	-0.91
3	Surplus Diversions **							-0.91	-0.91	-0.91	-0.91	-0.91	0.00
4	Total Irr. Diversions							-1.82	-1.82	-1.82	-1.82	-1.82	-0.91
5	Consumptive use in CFS/Mo							0.27	0.44	0.60	0.67	0.55	0.30
6	Non-Consumptive use in CFS/Mo							1.55	1.28	1.22	1.15	1.27	0.61
7	Total Return to Stream							0.8	0.7	0.6	0.6	0.6	0.3
8	Total Return to Segment							0.3	0.3	0.2	0.2	0.3	0.1
9	B&A Total Diversions							-9.4	-9.4	-9.4	-9.4	-9.4	-4.7
10	B&A Total Return to Segment							1.6	1.5	1.2	1.2	1.4	0.6
11C	Natural Inflow Below Gage	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.0	0.9	0.2	0.2	0.1
12C	**AVERAGE AVAILABLE FLOW**	9.3	8.9	8.7	7.9	8.0	7.7	0.0	17.1	47.6	7.7	3.3	5.3
13	Game & Fish Request	-15.0	-15.0	-8.9	-8.9	-8.9	-8.9	-8.9	-8.9	-8.9	-8.9	-8.9	-8.9
14C	Negative indicates Shortage	-5.7	-6.1	-0.2	-1.0	-0.9	-1.2	-8.9	8.2	38.7	-1.2	-5.6	-3.6

* Gage flows assume virgin flows adjusted for full use of permitted water rights above the gage.
** Historically the second cfs surplus and excess flows are not needed in this area in September.

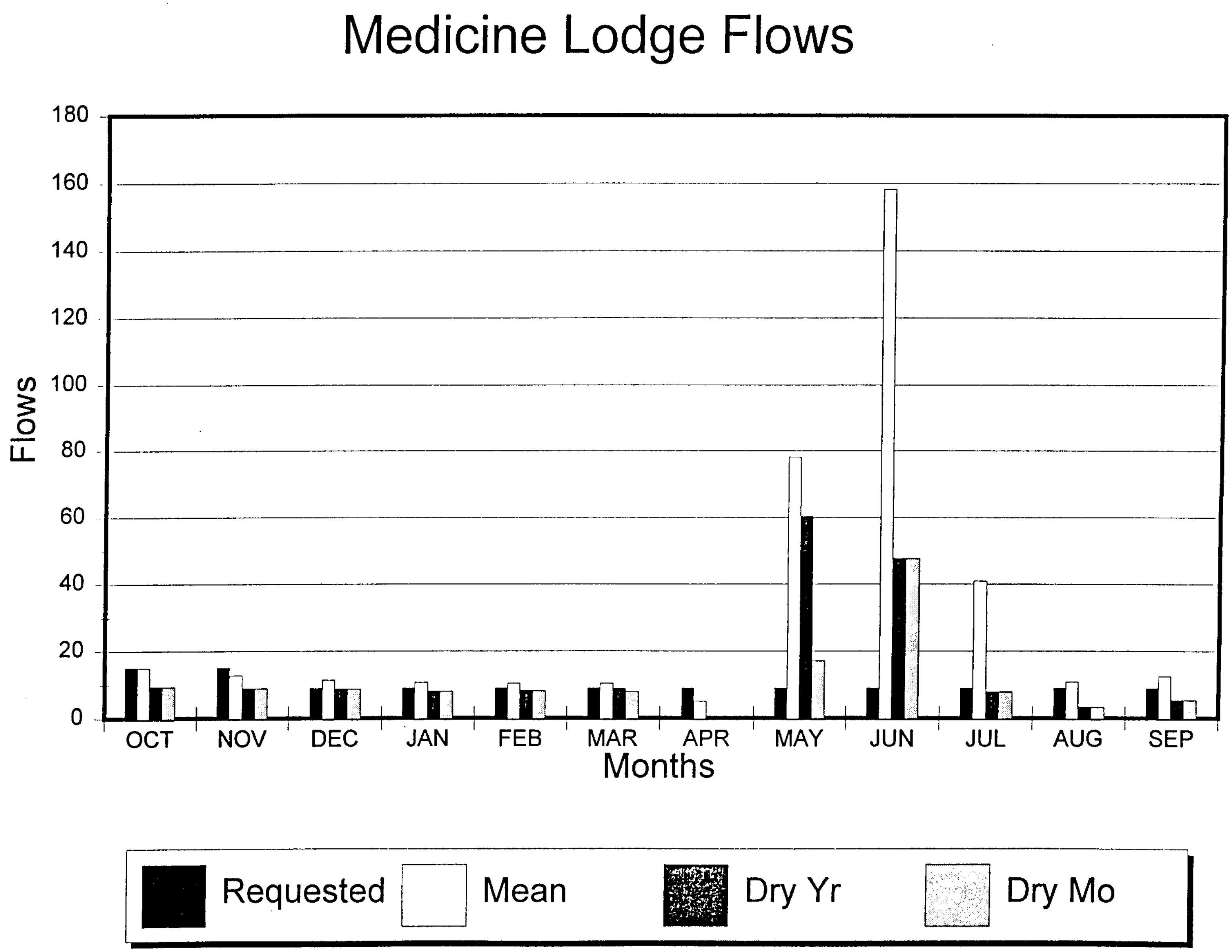

Medicine Lodge Flows
Flows
180
160
140
120
100
80
60
40
20
0
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
Months
Requested
Mean
Dry Yr
Dry Mo

Figure 3.

FLOW SHORTAGE AND STORAGE ANALYSIS

The Monthly Flow, Dry Year Monthly Flow and Twelve Driest Months Flow Analyses all indicate that there is not enough unappropriated direct flow in Medicine Lodge Creek to provide the requested instream flows. Therefore, a reservoir storage analysis was conducted.

The unappropriated monthly excesses and shortages (14) for the segment were converted from cfs to acre-feet (15) as shown in Tables 9, 10 and 11. These values were then used to produce a simple reservoir mass balance (16, 17) (without evaporation considered) to determine the reservoir storage required to provide the requested instream flow amounts for the instream flow segment. The average year analysis indicates it would require an additional 232 acre-feet of active storage to provide the instream flow request. The dry year analysis indicates it would require an additional 1,980 acre-feet of active storage to provide the instream flow request. The twelve driest month's analysis indicates it would require an additional 2,072 acre-feet of active storage to provide the instream flow request.

The topography of the area of the segment indicates that there are several storage sites capable of storing these amounts of water in the upper area of the basin.

Table 9
MEDICINE LODGE CREEK INSTREAM FLOW SEGMENT NO. 1.
MEAN MONTHLY INSTREAM FLOWS IN CFS AND ACRE-FEET
MEAN MONTHLY 232 ACRE-FEET RESERVOIR STORAGE OPERATION TOTALS

Item		OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
14A	Excess and Shortage in CFS	-0.1	-2.2	2.4	1.5	1.3	1.4	-3.9	69.3	149.3	32.0	1.8	3.5
15A	Excess and Shortage in Acre-Feet	-6.	-131.	148.	92.	72.	86.	-232.	4,261.	8,883.	1,968.	111.	215.
	Reservoir Operations												
16A	First Year Operations	0.	0.	148.	232.	232.	232.	0.	232.	232.	232.	232.	232.
17A	Subsequent Years Operations	226.	95.	232.	232.	232.	232.	0.	232.	232.	232.	232.	232.

Table 10
MEDICINE LODGE CREEK INSTREAM FLOW SEGMENT NO. 1.
DRY YEAR INSTREAM FLOWS IN CFS AND ACRE-FEET
DRY YEAR 1,980 ACRE-FEET RESERVOIR STORAGE OPERATION TOTALS

Item		OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
14B	Excess and Shortage in CFS	-5.0	6.1	-0.2	-1.0	-0.9	-0.2	-8.4	51.4	38.7	-1.2	-5.6	-3.6
15B	Excess and Shortage in Acre-Feet	-350.	-363.	-12.	-61.	-50.	-12.	-500.	3,160.	2,303.	-74.	-344.	-214.
	Reservoir Operations												
16B	First Year Operation	0.	0.	0.	0.	0.	0.	0.	1,980.	1,980.	1,906.	1,562.	1,348.
17B	Subsequent Years Operations	998.	635.	623.	562.	512.	500.	0.	1,980.	1,980.	1,906.	1,562.	1,348.

Table 11
MEDICINE LODGE CREEK INSTREAM FLOW SEGMENT NO. 1.
DRIEST MONTHS INSTREAM FLOWS IN CFS AND ACRE-FEET
DRIEST MONTHS 2,072 ACRE-FEET RESERVOIR STORAGE OPERATION TOTALS

Item		OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
14C	Excess and Shortage in CFS	-5.7	-6.1	-0.2	-1.0	-0.9	-1.2	-8.9	8.2	38.7	-1.2	-5.6	-3.6
15C	Excess and Shortage in Acre-Feet.	-350.	-363.	-12.	-61.	-50.	-74.	-530.	504.	2,303.	-74.	-344.	-214.
	Reservoir Operations												
16C	First Year Operations	0.	0.	0.	0.	0.	0.	0.	504.	2,072.	1,998.	1,654.	1,440.
17C	Subsequent Years Operations	1,090.	727.	715.	654.	604.	530.	0.	504.	2,072.	1,998.	1,654.	1,440.

DAILY FLOW EXCEEDANCE ANALYSIS

Flow exceedance analyses are conducted to determined the percentage of time flow rates are equal to or exceed a specific flow rate, measured at set intervals. The requests are then deemed feasible if the exceedance reaches an established percentage. In this report the results of the daily flow exceedance analyses are used to determine the percentage of days per month that the flow rate in the stream equaled or exceeded the requested instream flow rate, based on thirty years of daily flow data. The WWDC considers an instream flow request feasible if the requested flow is available at least 50% of the time from unappropriated flows.To perform this exceedance analysis, thirty years of daily flow duration records were obtained from the Wyoming Water Resources Center for the years 1944 through 1973. These data are from the USGS gage located approximately 3200 feet above the downstream end of the segment. To compensate for the gage location, these data were adjusted to reflect the consumptive water right uses and natural inflows between the gage and the downstream end of the segment. The natural inflows were added to their respective monthly values while the consumptive flows were removed during the irrigation months of May through September.

Daily flow duration curves were produced for each month of the year from these adjusted gage data. These curves are shown in Figures 4 through 15. These daily exceedance values were derived for each month and placed in Tables 12 and 13. Table 12 lists the monthly requested flows in cfs and the percent of time the flows are available. The flows that are not available at least 50% of the time are marked with an (*). Table 13 lists the actual unappropriated flows that are exceeded 50% of the time. The flow duration curves were developed using the daily flow exceedance techniques as described in the United States Geological Survey, Water Supply Paper 1542-A, "Flow Duration Curves" (Searcy, 1959).

Table 12
Medicine Lodge Creek Daily Flow Exceedance Table
Requested Unappropriated Flows and Their Available Percentage

Month	cfs Requested	% Available
October	15	33 *
November	15	12 *
December	8.9	96
January	8.9	87
February	8.9	82
March	8.9	73
April	8.9	5 *
May	8.9	78
June	8.9	100
July	8.9	91
August	8.9	21 *
September	8.9	63

* (Below 50%)

Table 13
Medicine Lodge Creek Daily Flow Exceedance Table
Unappropriated Flows Available 50% of the Time

Month	cfs Unappropriated	% Available
October	13	50
November	12	50
December	10	50
January	10	50
February	10	50
March	9	50
April	2	50
May	78	50
June	137	50
July	30	50
August	6	50
September	10	50

Daily Duration Curves

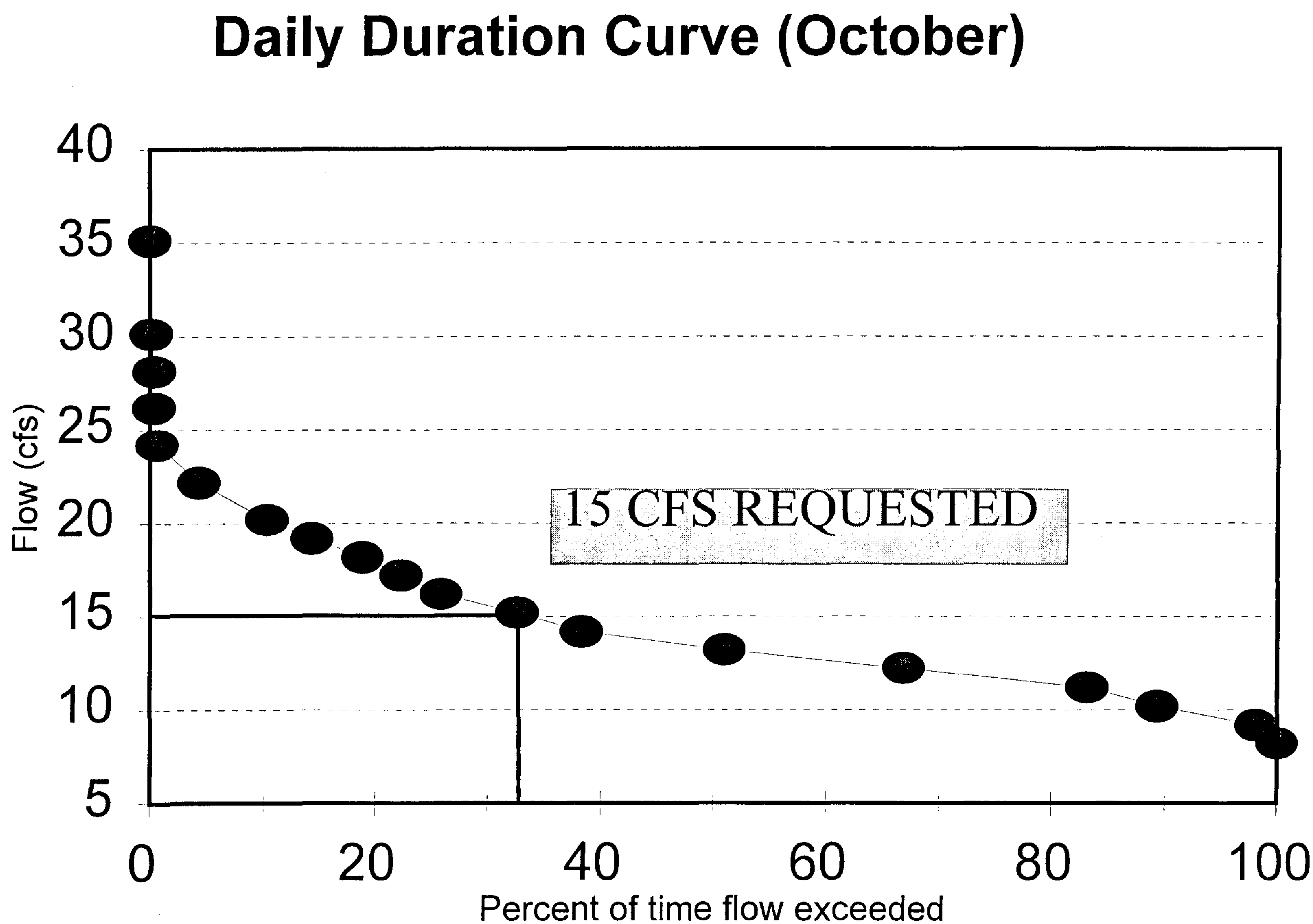

Daily Duration Curve (October)
40
35
30
25
20
15
10
5
Flow (cfs)
15 CFS REQUESTED
0
20
40
60
80
100
Percent of time flow exceeded

Figure 4.

Daily Duration Curve (November)

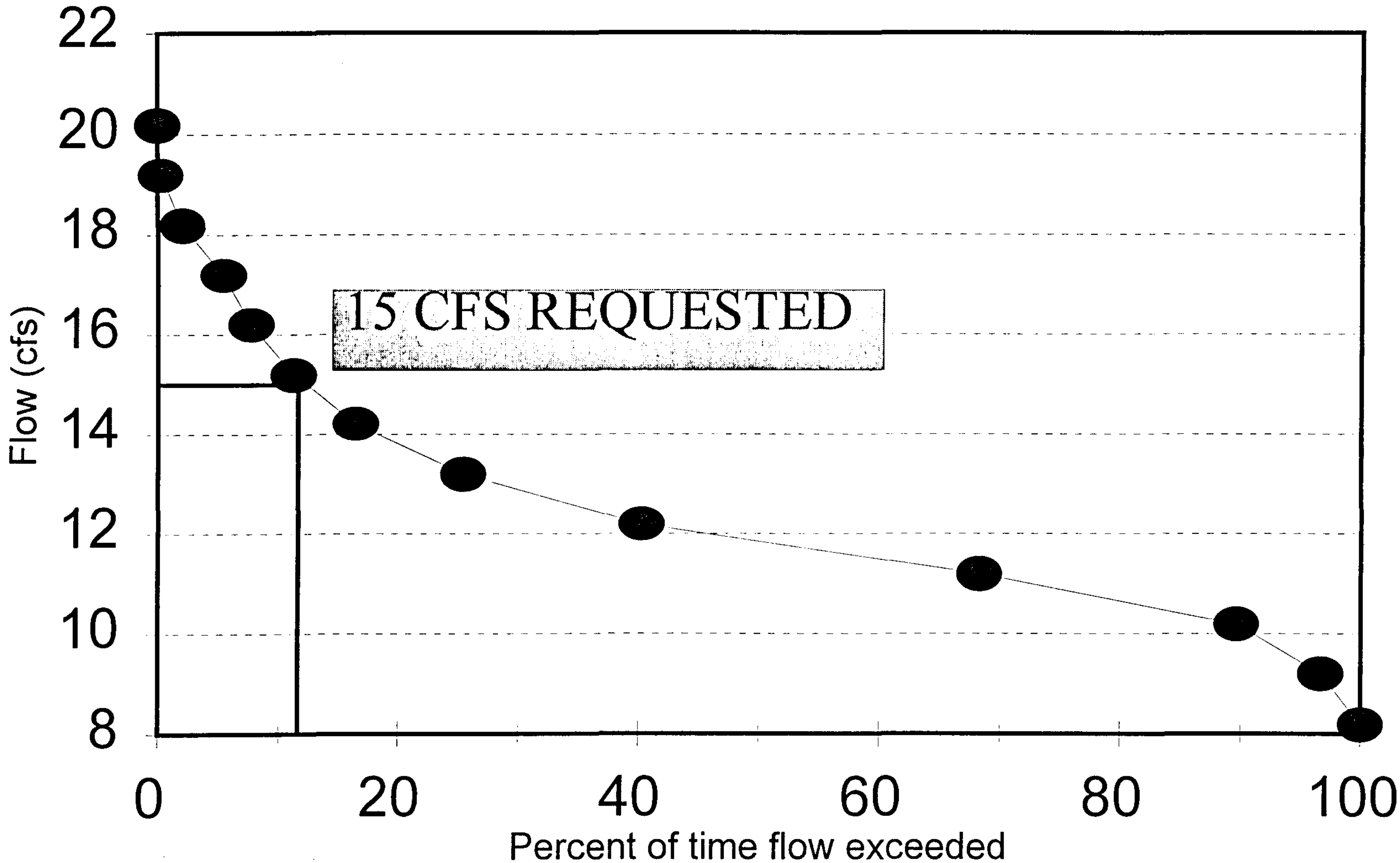


Figure 5.

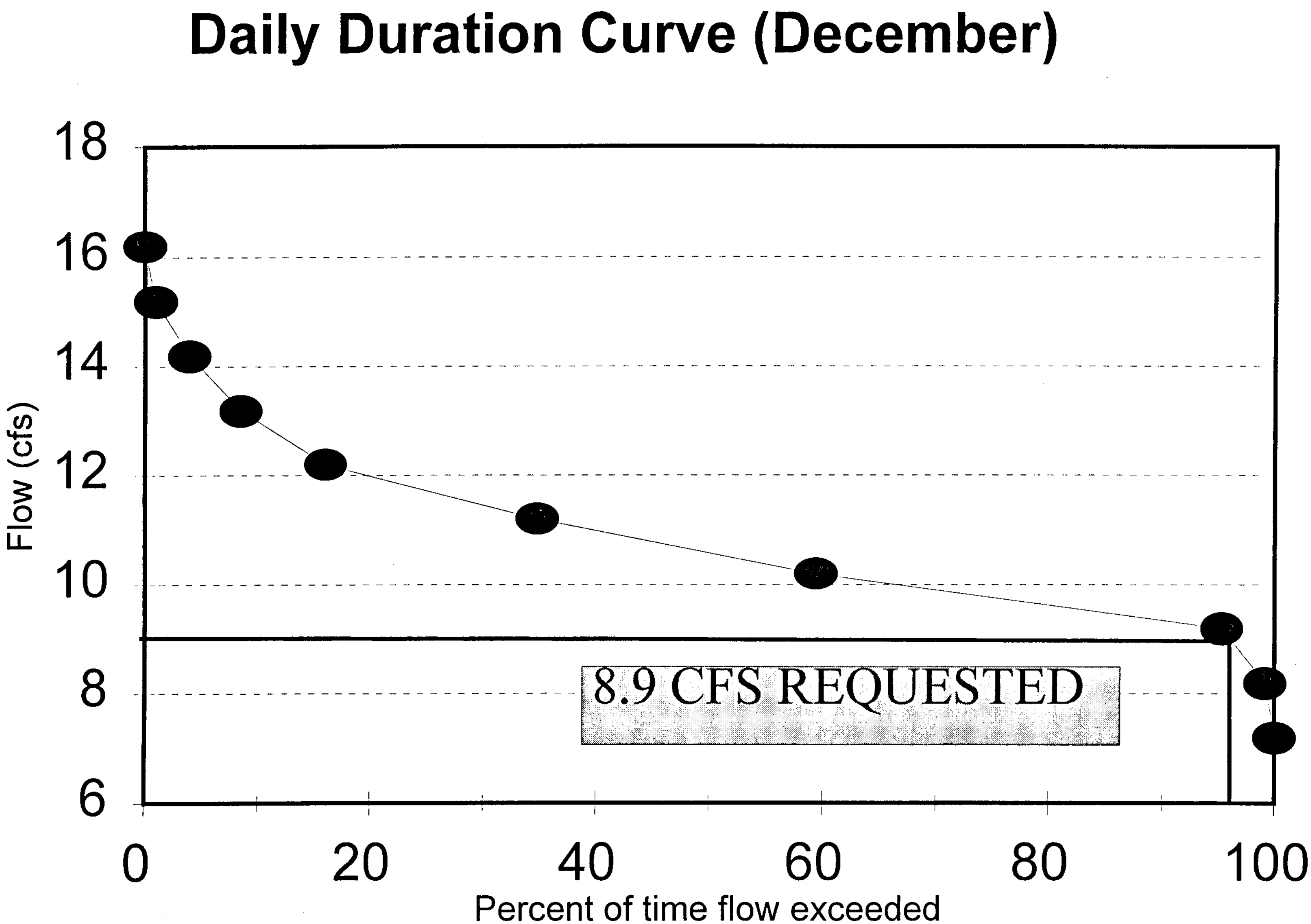

Daily Duration Curve (December)
18
16
14
12
10
8
6
Flow (cfs)
8.9 CFS REQUESTED
0
20
40
60
80
100
Percent of time flow exceeded

Figure 6.

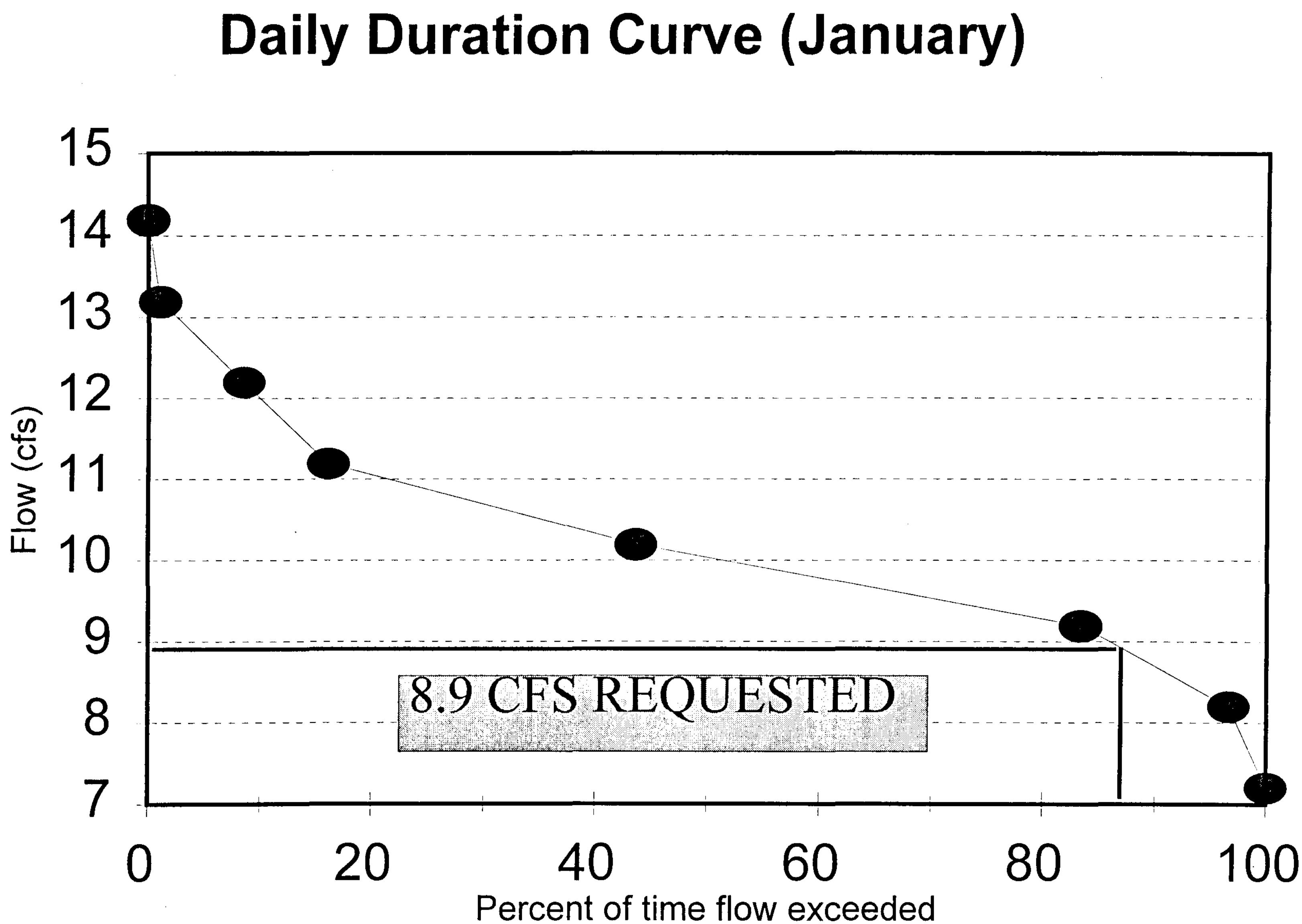

Daily Duration Curve (January)
15
14
13
12
11
10
9
8
7
Flow (cfs)
8.9 CFS REQUESTED
0
20
40
60
80
100
Percent of time flow exceeded

Figure 7.

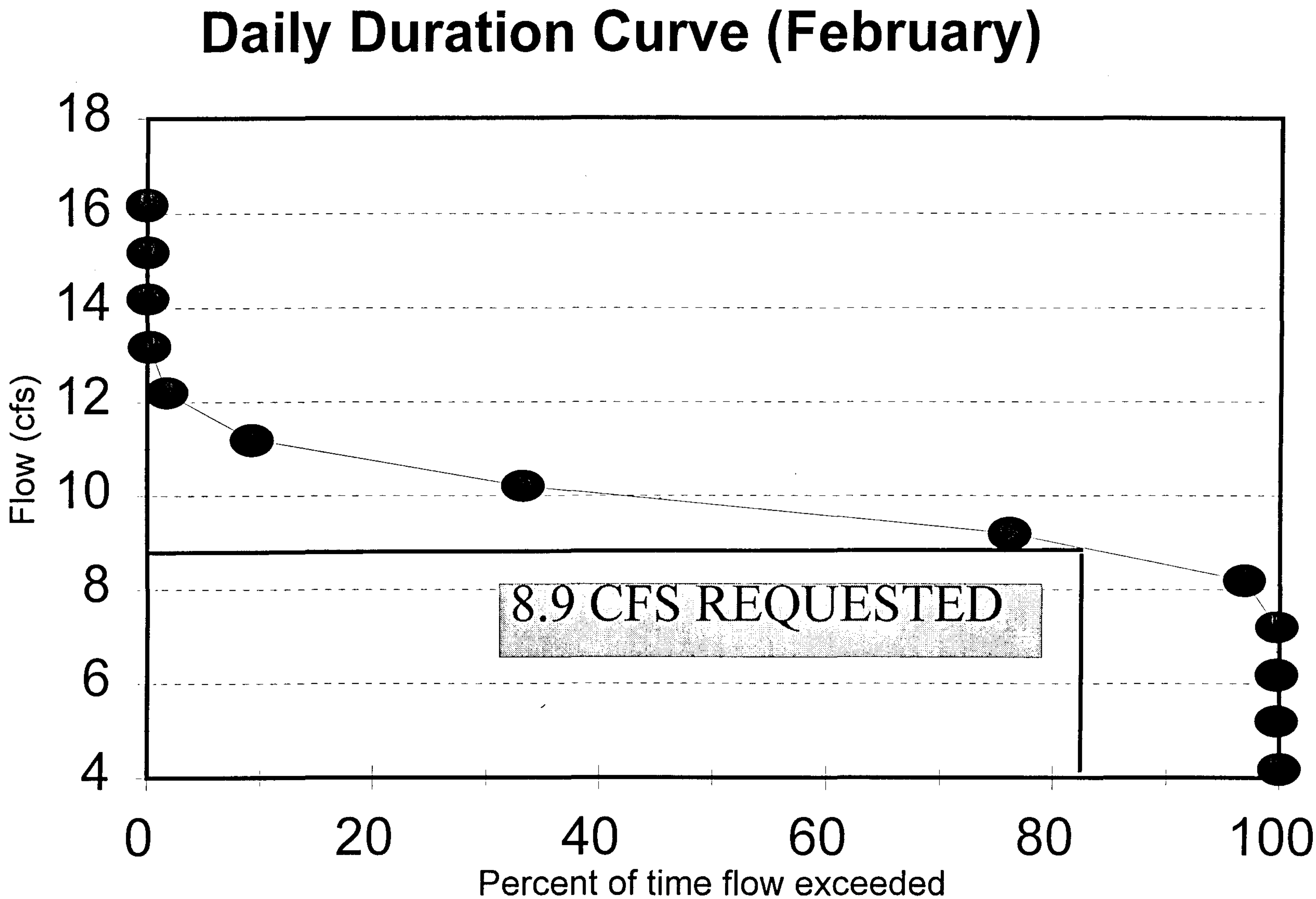
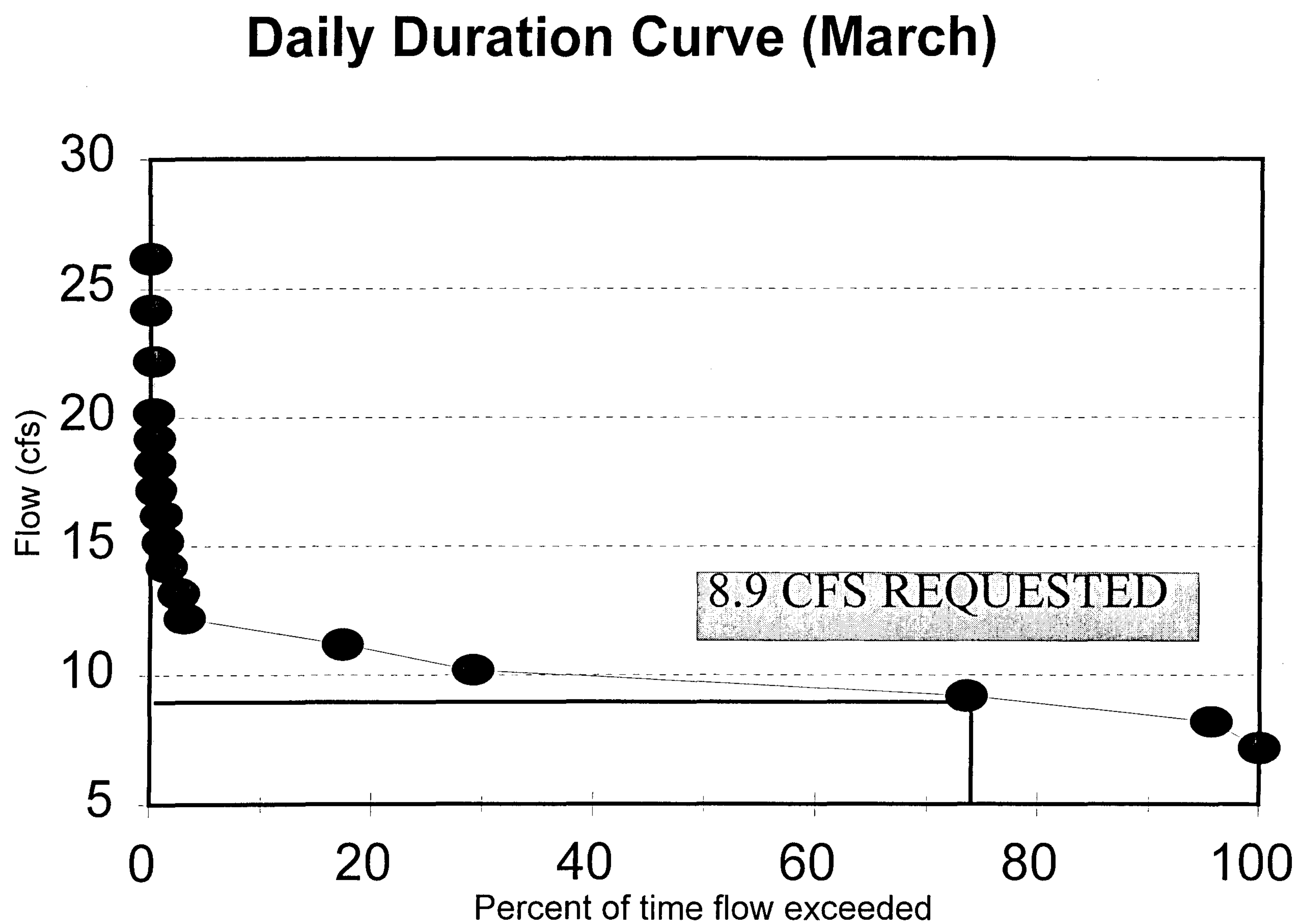

Daily Duration Curve (February)
18
16
14
12
10
8
6
4
Flow (cfs)
8.9 CFS REQUESTED
0
20
40
60
80
100
Percent of time flow exceeded

Figure 8.


Daily Duration Curve (March)
30
25
20
15
10
5
Flow (cfs)
8.9 CFS REQUESTED
0
20
40
60
80
100
Percent of time flow exceeded

33 Figure 9.

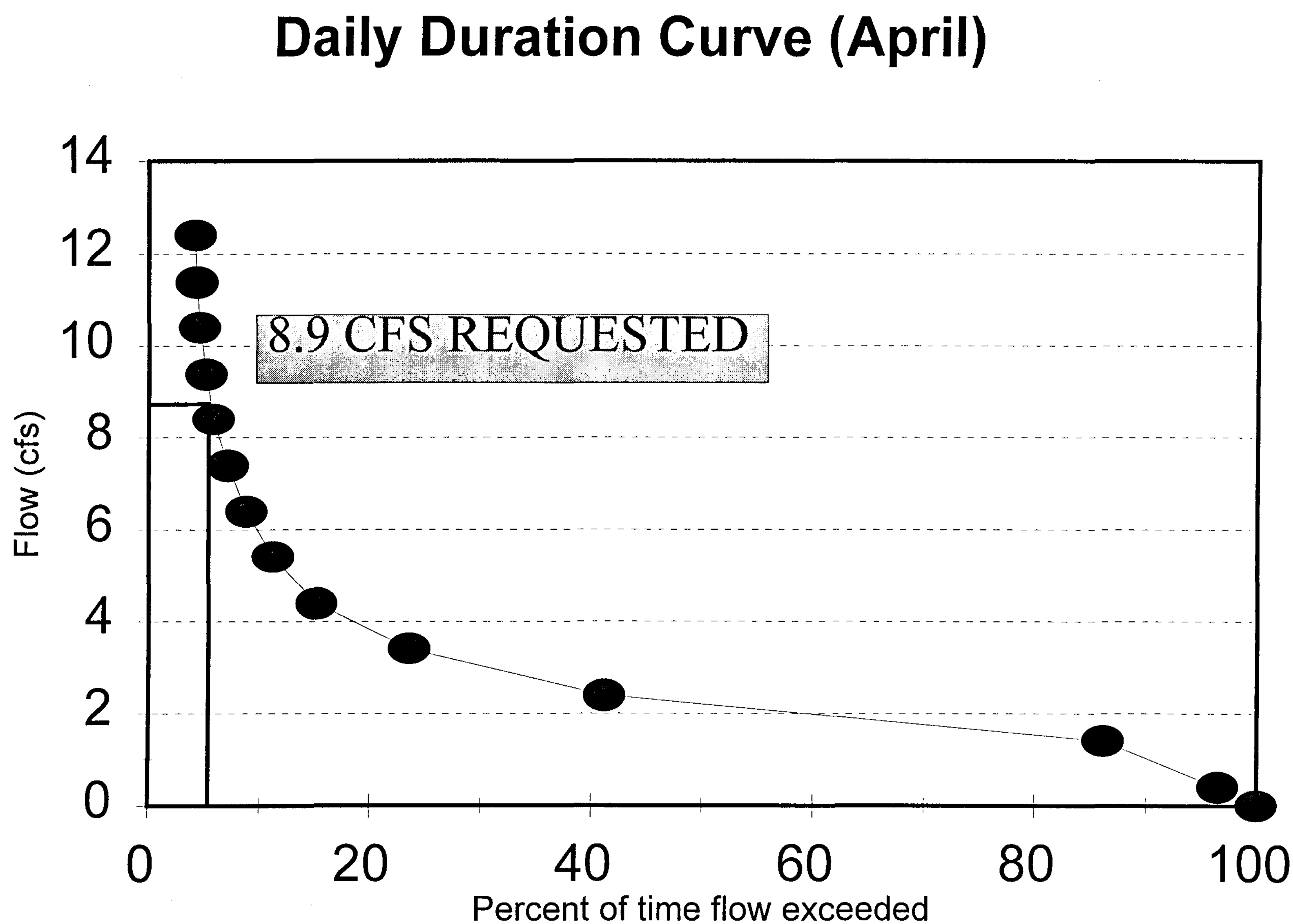

Daily Duration Curve (April)
14
12
10
8
6
4
2
0
Flow (cfs)
8.9 CFS REQUESTED
0
20
40
60
80
100
Percent of time flow exceeded

Figure 10.

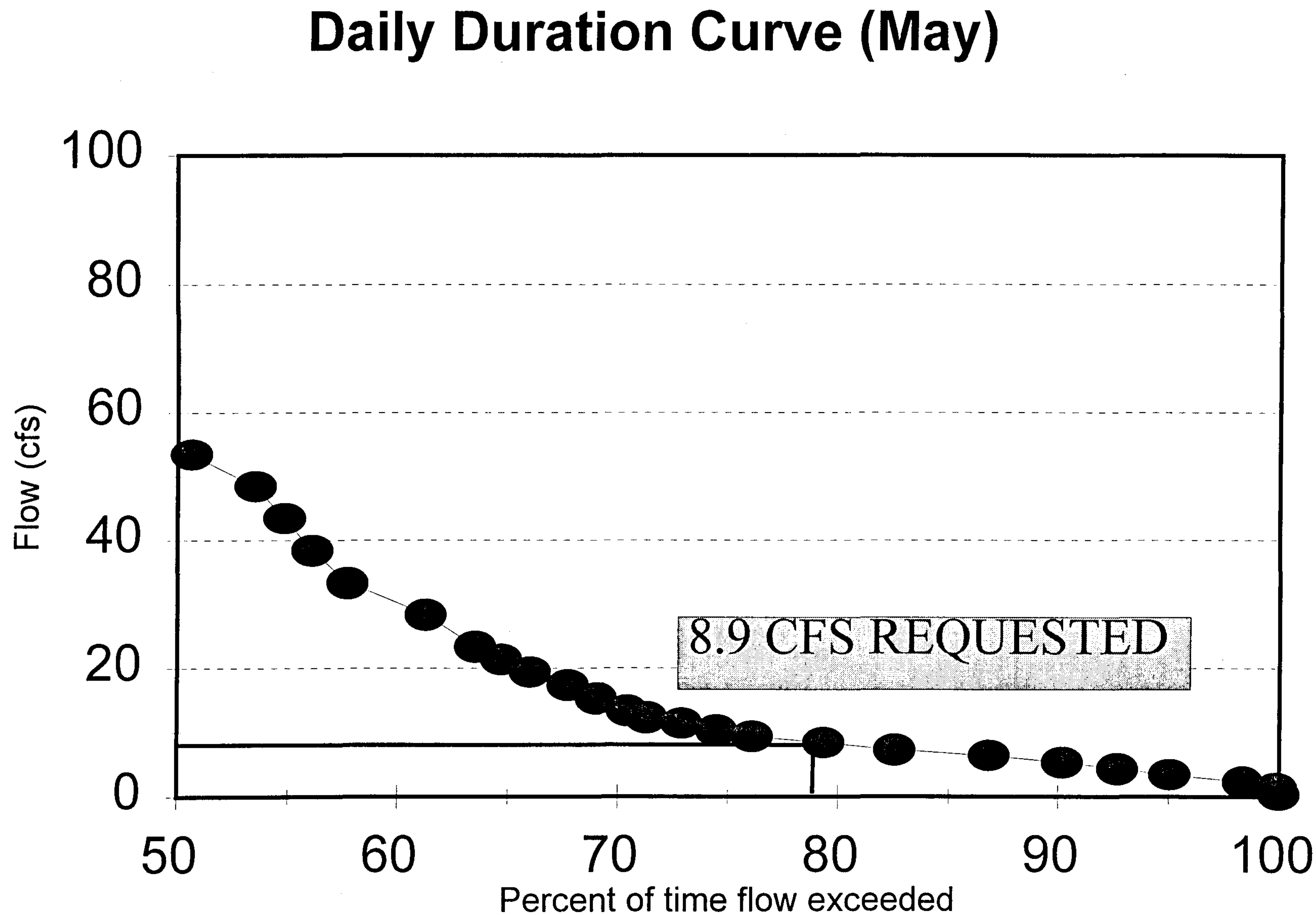

Daily Duration Curve (May)
100
80
60
40
20
0
Flow (cfs)
8.9 CFS REQUESTED
50
60
70
80
90
100
Percent of time flow exceeded

Figure 11.

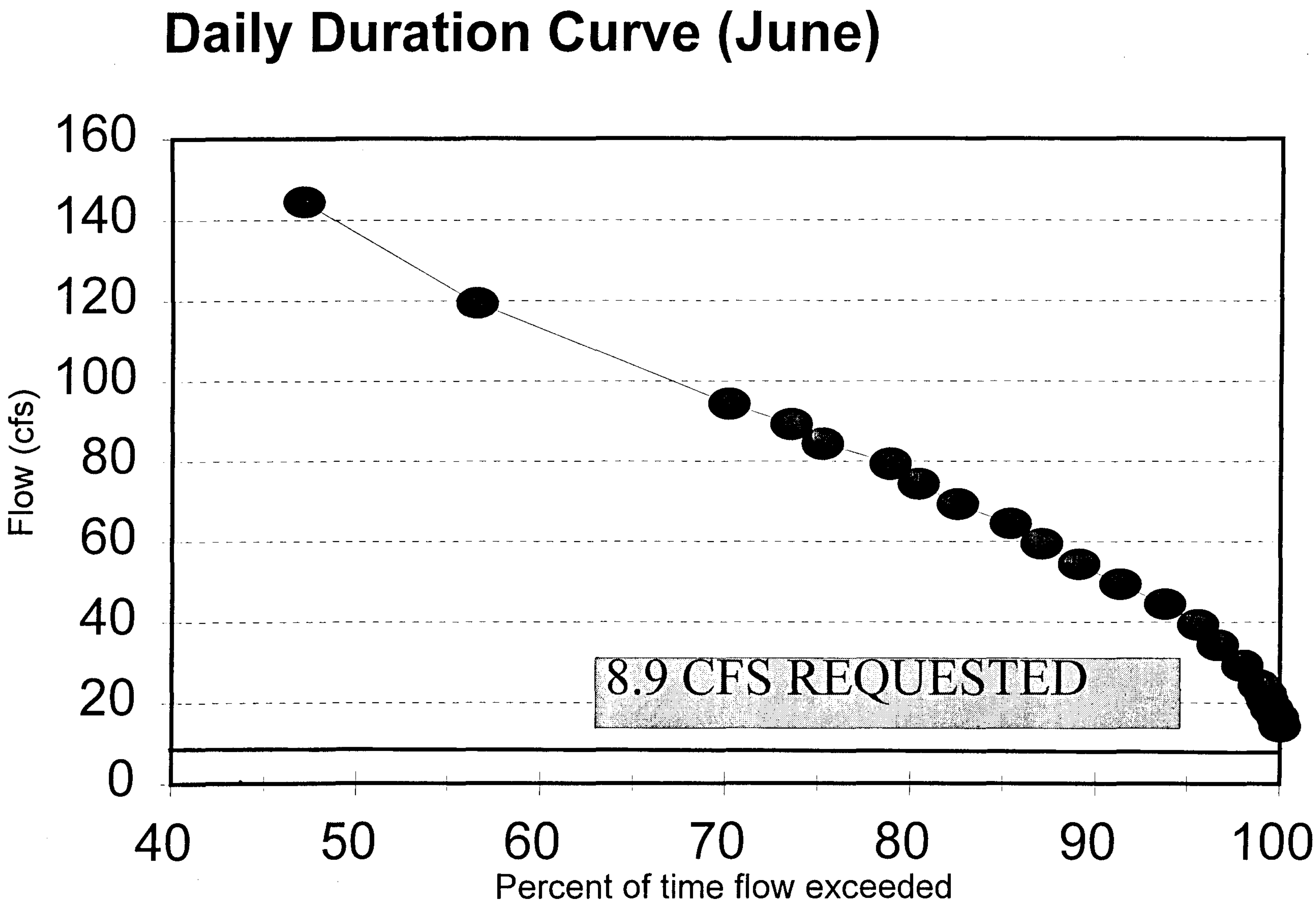

Daily Duration Curve (June)
160
140
120
100
80
60
40
20
0
Flow (cfs)
8.9 CFS REQUESTED
40
50
60
70
80
90
100
Percent of time flow exceeded

Figure 12.

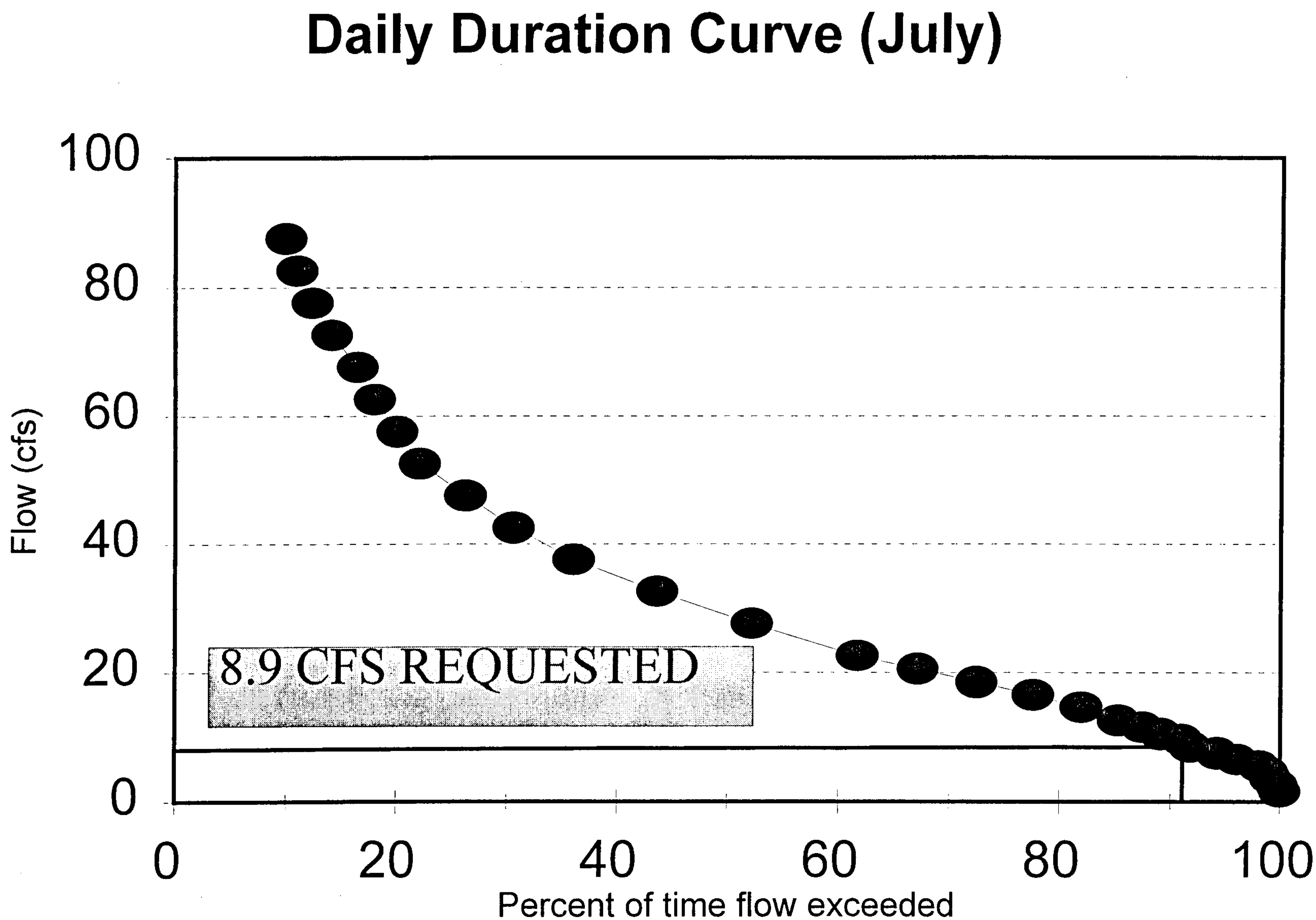
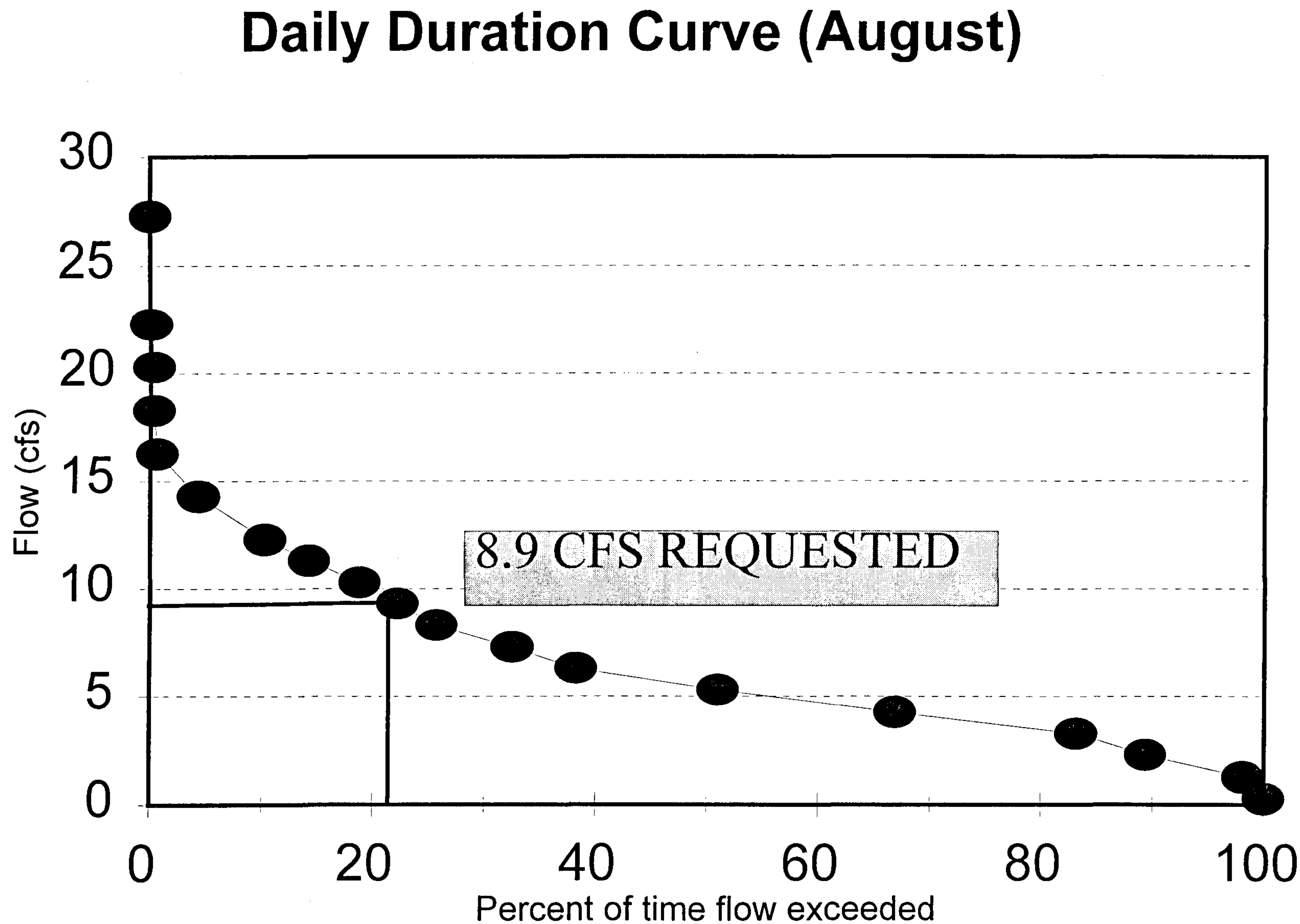
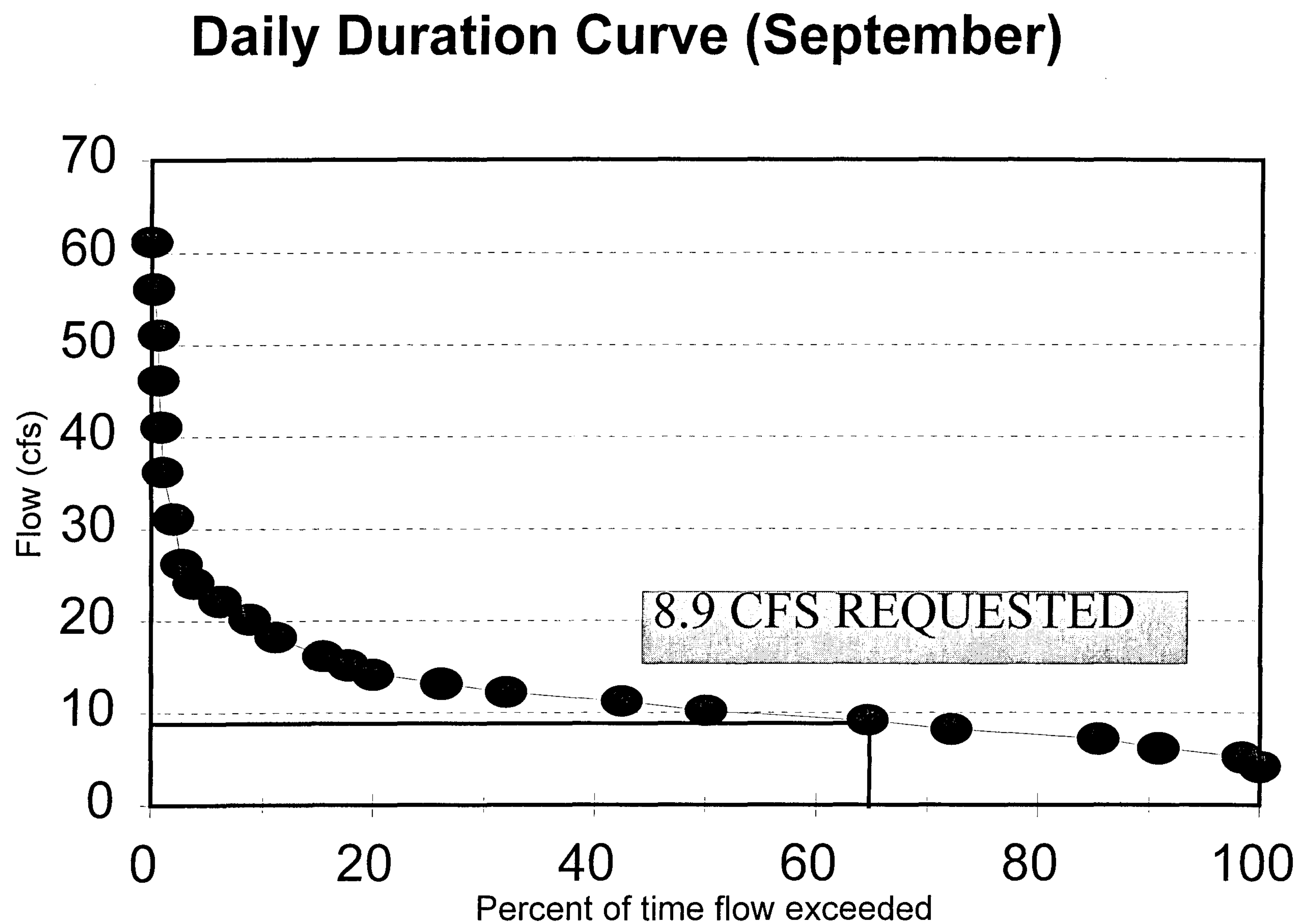

Daily Duration Curve (July)
100
80
60
40
20
0
Flow (cfs)
8.9 CFS REQUESTED
0
20
40
60
80
100
Percent of time flow exceeded

 Figure 13.



Daily Duration Curve (August)
30
25
20
15
10
5
0
Flow (cfs)
8.9 CFS REQUESTED
0
20
40
60
80
100
Percent of time flow exceeded

Figure 14.



Daily Duration Curve (September)
70
60
50
40
30
20
10
0
Flow (cfs)
8.9 CFS REQUESTED
0
20
40
60
80
100
Percent of time flow exceeded

Figure 15.

POTENTIAL WATER RIGHT IMPACTS

The existing water rights above the bottom of the Instream Flow segment consist of three irrigation diversions within the segment and two irrigation diversions above the segment for a total of 11.0 cfs. These water rights were filed between 1885 and 1984. Future potential water right filings in the Instream Flow segment area could consist of, but not be limited to, irrigation, stock and domestic type uses. The future potential uses are limited by the mountainous terrain of the area.

CONCLUSIONS

The mean monthly flow analysis, the dry year monthly flow analysis, the twelve driest months flow analyses and the daily flow exceedance analysis all show a shortage of flows available to provide the requested instream flows. The amounts of storage required to supply these requested flows were determined in the flow shortage and storage analysis.

The mean monthly flow analysis determined a shortage of 0.1 cfs during October, 2.2 cfs during November, and 3.9 cfs during April as shown in Table 6 and Figure 3.

The dry year monthly flow analysis determined a shortage of 5.7 cfs during October, 6.1 cfs during November, 0.2 cfs during December, 1.0 cfs during January, 0.9 cfs during February, 0.2 during March, 8.4 cfs during April, 1.2 cfs during July, 5.6 cfs during August and 3.6 cfs during September as shown in Table 7 and Figure 3.

The twelve driest months analysis determined a shortage of 5.7 cfs during October, 6.1 cfs during November, 0.2 cfs during December, 1.0 cfs during January, 0.9 cfs during February, 1.2 cfs during March, 8.9 cfs during April, 1.2 cfs during July, 5.6 cfs during August and 3.6 cfs during September.

The daily flow exceedance analysis determined that the 15 cfs request for October was only available 33% of the time and for November was only available 12% of the time, the 8.9 cfs request for April was only available 5% of the time and for August was only available 21% of the time.

The flow shortage and storage analysis indicates a reservoir would be required to provide the requested instream flows. This reservoir would require 232 acre-feet of minimum active capacity for the average year, 1,980 acre-feet of minimum active capacity for the historic dry year and 2,072 acre-feet of minimum active capacity for a year of the driest months.

Appendix A

Wyoming Game and Fish Department Report

WYOMING GAME AND FISH DEPARTMENT

FISH DIVISION

AMMENDED ADMINISTRATIVE REPORT

TITLE: Medicine Lodge Creek Instream Flow Report

PROJECT: IF-2289-07-8902

AUTHOR: Gerald F. Vogt, Jr. and Thomas C. Annear

DATE: January 1997

INTRODUCTION

Data were collected during the 1989 field season to conduct instream flow analyses for a segment of Medicine Lodge Creek located near the town of Hyattville, in north-central Wyoming. The study and this report were prepared in compliance with instream flow legislation to support a Wyoming Water Development Commission application for an instream flow water right.

METHODS

Study Area

Medicine Lodge Creek is considered a Class 2 trout stream by the Wyoming Game and Fish Department (WGFD). Trout stream classifications throughout Wyoming range from Class 1 (highest rating) to Class 5 (lowest rating). Class 2 trout streams are generally considered important trout fisheries on a statewide basis. Less than 6% of all streams in the state are Class 2 or better streams.

Medicine Lodge Creek contains a naturally reproducing population of brown trout and is managed as a wild fishery for that species. A small section of the stream at the Medicine Lodge State Park is stocked with catchable rainbow trout by the WGFD. However, these fish do not overwinter nor do they reproduce in Medicine Lodge Creek. The segment of Medicine Lodge Creek identified as the instream flow reach passes through land owned by the WGFD and federally owned lands administered by the Bureau of Land Management; it is highly accessible to the public. Because this section of Medicine Lodge Creek supports an important trout fishery and has public access, this segment was identified as a critical reach.

Data Collection

All of the field data used in this study were collected from a 309 foot long study site located on land owned by the WGFD in the SW 1/4 of Section 15, Township 50 North, Range 89 West. This site is located approximately 6 miles Northeast of the town of Hyattville (Figure 1). The study site contained a combination of pool and riffle habitat for trout that was representative of trout habitat features found throughout this portion of the stream. Results and recommendations were applied to a portion of the stream extending from the north boundary of the south 1/2 of the southeast 1/4 Section 21, Township 50 North, Range 89 West upstream to the Bureau of Land Management-U.S Forest Service boundary in the southeast 1/4 of the southwest 1/4 Section 28, Township 51 North, Range 88 West. This is a distance of approximately 7.5 stream miles.

In accordance with the 1986 instream flow legislation, the goal of this study was to determine instream flows necessary to maintain or improve the existing trout fishery. The specific objectives of this study were to determine instream flows necessary to 1) maintain or improve hydraulic characteristics year-round that are important for survival of trout, fish passage and aquatic insect production, 2) maintain or improve physical habitat for brown trout spawning during the fall, and 3) maintain or improve adult trout production during the late summer months. Three habitat models were used to make these determinations.

Models

A Habitat Retention method (Nehring 1979; Annear and Conder 1984) was used to identify a maintenance flow. A maintenance flow is defined as the lowest continuous flow that will maintain minimum hydraulic criteria at riffle areas in a stream segment. These criteria are important at all times of year to maintain passage between different habitat types for all life stages of trout. These criteria are also important for maintaining survival rates of fish and aquatic macroinvertebrates during the winter that approximate rates observed under natural stream flow conditions.

Data from single transects placed across three riffles within the study area were analyzed with the IFG-1 computer program (Milhous 1978). Flow data were collected at three different flow levels (Table 1). Based on comparison of instream flow methods on Wyoming streams by Annear and Conder (1984), the maintenance flow is specifically defined as the discharge at which two of the three criteria in Table 2 are met for all riffles in the study area. Maintenance flows apply to all times of the year except when higher stream flows are required to meet other fishery management objectives.

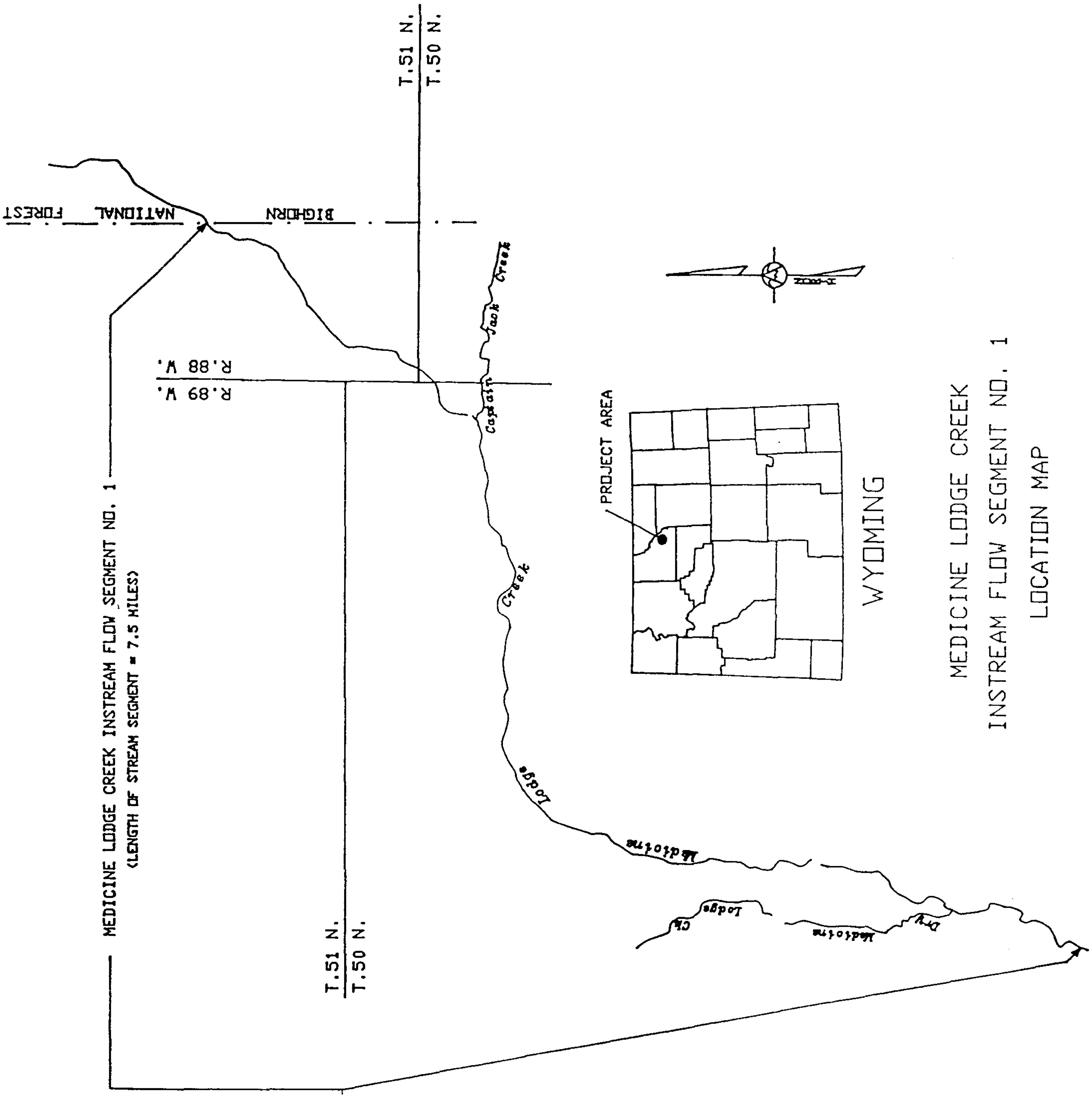


Figure 1. Location of Instream Flow filing reach on Medicine Lodge Creek.

Table 1. Dates and discharges when instream flow data were collected at Medicine Lodge Creek instream flow segment.

DATE	DISCHARGE (cfs)
June 7, 1989	110
June 30, 1989	53
August 17, 1989	10

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 quantify incremental changes in the amount of physical habitat available for brown trout spawning at various discharge rates. This model is generally considered to reflect state-of-the-art technology for evaluating fisheries physical habitat changes with changes in stream flows and is the most commonly used instream flow model in North America (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 at seven transects as described in Bovee and Milhous (1978). Dates and discharge rates when data were collected are given in Table 1. The WUA for brown trout spawning was simulated for flows ranging from 10 to 250 cubic feet per second (cfs) using calibration and modeling techniques outlined in Milhous (1984) and Milhous et al. (1984).

Because this brown trout fishery depends upon natural reproduction for continuation, it is important to maintain physical habitat for spawning that begins in October and continues into late fall. Maintenance of suitable physical habitat for this life stage is a critical part of ensuring adequate recruitment to this fishery. Results from the PHABSIM analysis were used to identify a flow from October 1 to March 31 which would maintain or improve physical habitat for brown trout spawning.

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

CATEGORY	CRITERIA
Average Depth (feet)	(Top Width[1]) X (0.01)
Average Velocity (feet per second)	1.00
Wetted Perimeter (percent of bank full)	60

1 - At average daily flow

2 - Compared to wetted perimeter at bank full conditions

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 standing crops over a range of average late summer flow conditions. 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 HU gains or losses associated with projects that modify instream flow regimes. This model incorporates seven attributes that address chemical, physical and biological components of trout habitat. Results are expressed in habitat units (HU). One HU is defined as the amount of habitat quality which will support 1 pound of trout. Analyses obtained from this method apply to the time of year that governs trout production. On Medicine Lodge Creek this time period is between July 1 and September 30.

By measuring habitat attributes at various flow events as if associated habitat features were typical of average late summer flow conditions, HU estimates can be made for a range of theoretical summer flows (Conder and Annear 1987). Habitat attributes on Medicine Lodge Creek were measured on the same dates and flow levels that data were collected for the PHABSIM and Habitat Retention models (Table 1). To better define the relationship of discharge and trout production, some attributes were derived mathematically or obtained from existing gage data for flows in addition to those shown in Table 1. Other data were obtained from a U.S. Geological Survey gage located on Medicine Lodge Creek for the period 1942 to 1973 (with some missing years).

RESULTS/DISCUSSION

Results from the Habitat Retention model showed that the hydraulic criteria in Table 2 are met at flows of 8.9, 7.4, and 7.6 cfs for 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 which in this case is 8.9 cfs.

Table 3. Simulated hydraulic criteria for three riffles on Medicine Lodge Creek. Estimated average daily flow = 34 cfs. Bank full discharge = 220 cfs.

RIFFLE #1

Average Depth (feet)	Average Velocity (feet/second)	Wetted Perimeter (percent)	Discharge (cfs)
0.94	5.2	44.5	220
0.86	4.4	44.2	164
0.67	3.0	43.6	87
0.58	2.5	43.1	61
0.44	1.8	42.0	34
0.42[1]	1.8	41.8	31
0.39	1.6	41.3	26
0.34	1.3	36.8	16
0.33	**1.0**[1]	27.1	**8.9**[2]
0.26	0.7	**22.2**[1]	4

Table 3. (continued)

Riffle 2

Average Depth (feet)	Average Velocity (feet/second)	Wetted Perimeter (percent)	Discharge (cfs)
1.33	5.8	30.7	220
1.27	5.5	30.5	196
1.12	4.6	27.1	128
1.10	4.1	23.1	94
1.08	3.5	19.9	67
0.90	2.5	16.5	34
0.91	2.3	**15.4**[1]	29
0.93	1.5	10.4	12
0.83	**1.0**[1]	8.7	**7.4**[2]
0.15[1]	0.0	2.3	0

Riffle 3

Average Depth (feet)	Average Velocity (feet/second)	Wetted Perimeter (percent)	Discharge (cfs)
1.06	5.9	34.8	220
1.03	5.4	34.7	189
0.93	4.5	34.5	141
0.84	3.7	34.2	103
0.74	3.0	34.0	73
0.56	1.8	33.4	34
0.45	1.3	33.0	20
0.38	**1.0**[1]	31.2	13
0.33[1]	0.8	29.6	**7.6**[2]
0.10	0.2	**17.4**[1]	

1 - Minimum hydraulic criteria met
2 - Discharge at which 2 of 3 hydraulic criteria are met

The maintenance flow is defined as a continuous flow that will maintain minimum hydraulic criteria in riffle areas within a stream segment. These criteria are important at all times of year to maintain passage between different habitat types for all life stages of trout. These criteria are also important for maintaining survival rates of fish and aquatic macroinvertebrates during the winter that approximate rates observed under natural stream flow conditions.

Low flow conditions during winter months (October through March) naturally limit the survival and growth of many trout populations (Cunkak 1996). The extent of these impacts is dependent upon several factors including but not limited to snow fall, cold intensity and the duration of intense cold periods. These factors vary from year to year and affect fish populations depending on the amount of frazile ice and anchor ice formation (which can plug the gills of fish), the extent of snow bank collapse (and stream damming) and increased metabolic demands on fish (and increased stress).

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.

The 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. Therefore protection of natural winter stream flows up to the recommended maintenance flow for each stream segment is necessary to maintain existing survival rates of trout populations.

It is possible that the discharge of 8.9 cfs identified by the Habitat Retention method may not be present at times during the winter. Because the existing fishery is adapted to natural flow patterns, occasional periods of shortfall during the winter do not necessarily imply the need for storage. Instead, they illustrate the need to maintain all natural winter streamflows, up to 8.9 cfs, in order to maintain existing survival rates of trout populations.

Gage data indicate that existing mean daily flows during October and November approximate 15 cfs. The majority of the brown trout spawning occurs during this time. At a discharge of 15 cfs, PHABSIM analyses indicate that physical habitat for brown trout spawning is just over 60% of the maximum amount available, which occurs at a discharge of 30 cfs (Figure 2). Reductions in flows below 15 cfs would result in reductions in existing levels of WUA for brown trout spawning. Increases in discharge up to about 80 cfs would result in increases in WUA for brown trout spawning from existing conditions; however, WUA is reduced below existing levels at flows higher than 80 cfs.

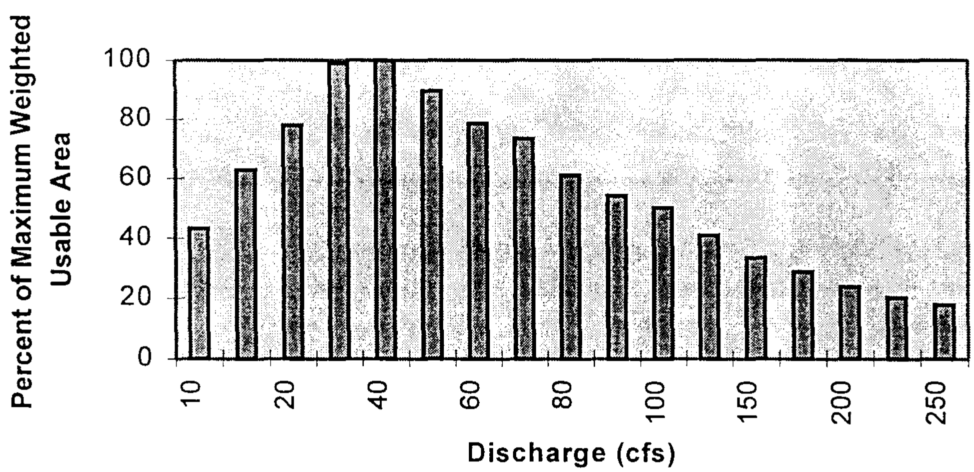


Figure 2. Percent of maximum weighted usable area for spawning life stage of brown trout.

Mean daily flows during the remainder of the winter (December through March) are reduced from flow levels in October and November and are fairly stable throughout that time period. During this time, some late brown trout spawning occurs, as well as the incubation of eggs deposited in October and November. Although flows less than 10 cfs were not simulated for this analysis, it appears that the maintenance flow recommendation of 8.9 cfs would provide about 40% of the maximum amount of WUA available at 40 cfs. Reductions in flow below 8.9 cfs would probably further reduce WUA.

Based on this analysis, an instream flow of 15 cfs is the minimum discharge which will maintain or improve the existing amount of physical habitat for brown trout spawning during October and November. Similarly, 8.9 cfs is the minimum discharge which will maintain or improve the existing amount of physical habitat for brown trout spawning during the remainder of the winter (December through March) while meeting the hydraulic criteria necessary for maintaining trout survival and passage at existing levels.

Results from the HQI analyses (Figure 3) indicate that under existing average late summer conditions (about 10 cfs), the stream presently supports about 109 HU's. The current fishery management objective is to maintain or improve the existing number of HU's. Although the existing number of habitat units would be maintained at this level at lower flows, the Habitat Retention method indicates that 8.9 cfs is the lowest flow that will maintain important channel characteristics. As a consequence a discharge of 8.9 cfs is the minimum flow that will accomplish the dual objectives of maintaining both trout habitat units and channel characteristics. Supplemental late summer flows of 20 cfs would increase the number of trout HU's in the segment. Increases in stream flow above 30 cfs would reduce trout HU's over present conditions.

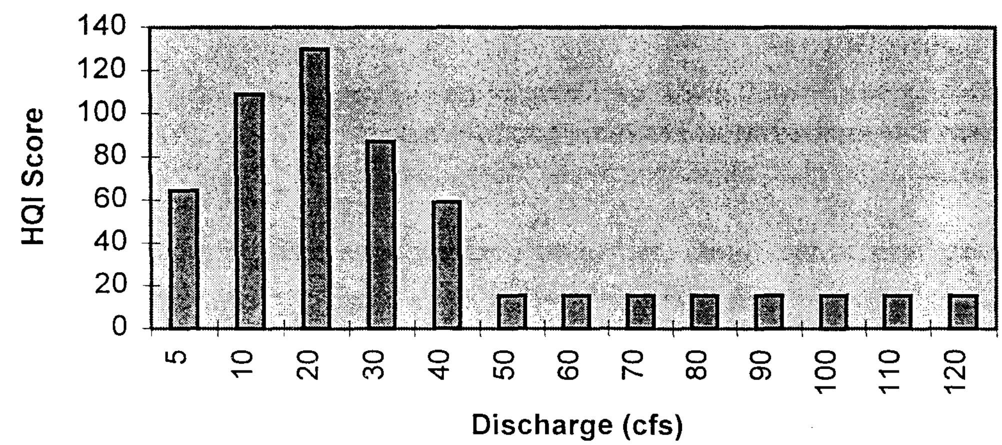


Figure 3. Potential trout habitat units at several average late summer flow levels in Medicine Lodge Creek instream flow segment.

Based on the results from the HQI analysis, a late summer flow of 8.9 cfs will maintain existing levels of trout production between July 1 and September 30 and will meet or exceed the hydraulic criteria addressed by the Habitat Retention Method.

CONCLUSIONS

Based on the analyses and results contained in this report, the instream flow recommendations (Table 4) apply to a 7.5 mile segment of Medicine Lodge Creek extending from the north boundary of the south 1/2 of the southeast 1/4 Section 21, Township 50 North, Range 89 West upstream to the Bureau of Land Management-U.S. Forest Service boundary in the southwest 1/4 Section 28, Township 51 North, Range 88 West.

Table 4. Summary of instream flow recommendations to maintain the existing trout fishery in Medicine Lodge Creek.

Time Period	Instream Flow Recommendation (cfs)
October 1 to November 30	15
December 1 to June 30	8.9
July 1 to September 30	8.9

LITERATURE CITED

Annear, T.C. and A.L. Conder. 1984. Relative bias of several fisheries instream flow methods. North American Journal of Fisheries Management. 4: 531-539.

Binns, N. and F. Eiserman. 1979. Quantification of fluvial trout habitat in Wyoming. Transactions of the American Fisheries Society 108:215-228.

Bovee, K. and R. Milhous. 1978. Hydraulic simulation in instream flow studies: theory and technique. Instream Flow Information Paper 5, FWS/OBS-78/33, Cooperative Instream Flow Service Group, U.S. Fish and Wildlife Service. Fort Collins, Colorado.

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

Conder, A.L. and T.C. Annear. 1987. Test of weighted usable area estimates derived from a PHABSIM model for instream flow studies on trout streams. North American Journal of Fisheries Management. 7(3):339-350.

Cunjak, R.A. 1988. Physiological consequences of overwintering in streams; the cost of acclimatization. Canadian Journal of Fisheries and Aquatic Sciences 45:443-452.

Kurtz, J. 1980. Fishery management investigations - a study of the upper Green River fishery, Sublette County, Wyoming (1975-1979). Completion Report. Wyoming Game and Fish Department, Fish Division, Cheyenne.

Milhous, R.T., D.L. Wegner, and T. Waddle. 1984. User's guide to the physical habitat simulation system. Instream Flow Paper 11, FWS/OBS-81/43, U.S. Fish and Wildlife Service, Fort Collins, Colorado.

Milhous, R.T. 1984. PHABSIM technical notes. Unpublished. U.S. Fish and Wildlife Service, Fort Collins, Colorado.

Milhous, R.T. 1978. A computer program for the determination of average hydraulic and shape parameters of a stream cross section. Washington State Dept of Ecology, Olympia.

Needham, P., J. Moffett, and D. Slater. 1945. Fluctuations in wild brown trout populations in Convict Creek, California. Journal of Wildlife Management 9(1):9-25.

Nehring, R. 1979. Evaluation of instream flow methods and determination of water quantity needs for streams in the state of Colorado. Colorado Division of Wildlife, Fort Collins.

Reimers, N. 1957. Some aspects of the relation between stream foods and trout survival. California Fish and Game 43(1):43-69.

Reiser, D.W., T.A. Wesche, and C. Estes. 1989. Status of instream flow legislation and practices in North America. Fisheries 14(2): 22-29.

Amounts of Instream Flow requested at the downstream end of stream segment No. 1

MONTH	FLOW (cfs)
October	15
November	15
December	8.9
January	8.9
February	8.9
March	8.9
April	8.9
May	8.9
June	8.9
July	8.9
August	8.9
September	8.9

Based on the results of a study conducted in 1988 by the Wyoming Game and Fish Department.

Location of instream flow control gage not identified. If one is needed the existing USGS gage in the NE 1/4, SE 1/4, NE 1/4, Section 21, T.50 N., R.89 W., will be reactivated at the expense of the Wyoming Game and Fish Department.

TABLE OF INTERVENING PERMITS

WICKWIRE DITCH

Adjudicated

Permit No.	Proof No.	Priority	Acres	CFS	Cert. No.
Terr.	2998	1885	25.0	0.36	CR 1, Pg 130

ANTHONY DITCH

Adjudicated

Permit No.	Proof No.	Priority	Acres	CFS	Cert. No.
Terr.	3004	09/20/1888	5.0	0.08	CR 1, Pg 133
Terr.	3005	09/20/1888	245.0	3.50	CR 37, Pg 630
6732E	34737	01/13/1984	15.9	0.23	CR 76, Pg 234

BETTY DITCH

Adjudicated

Permit No.	Proof No.	Priority	Acres	CFS	Cert. No.
11315	17381	01/27/1911	45.0	0.64	CR 42, Pg 552
11315	35182	01/27/1911	19.0	0.27	CR 77, Pg 149

CERTIFICATE OF SURVEYOR

STATE OF WYOMING) ss
COUNTY OF LARAMIE)

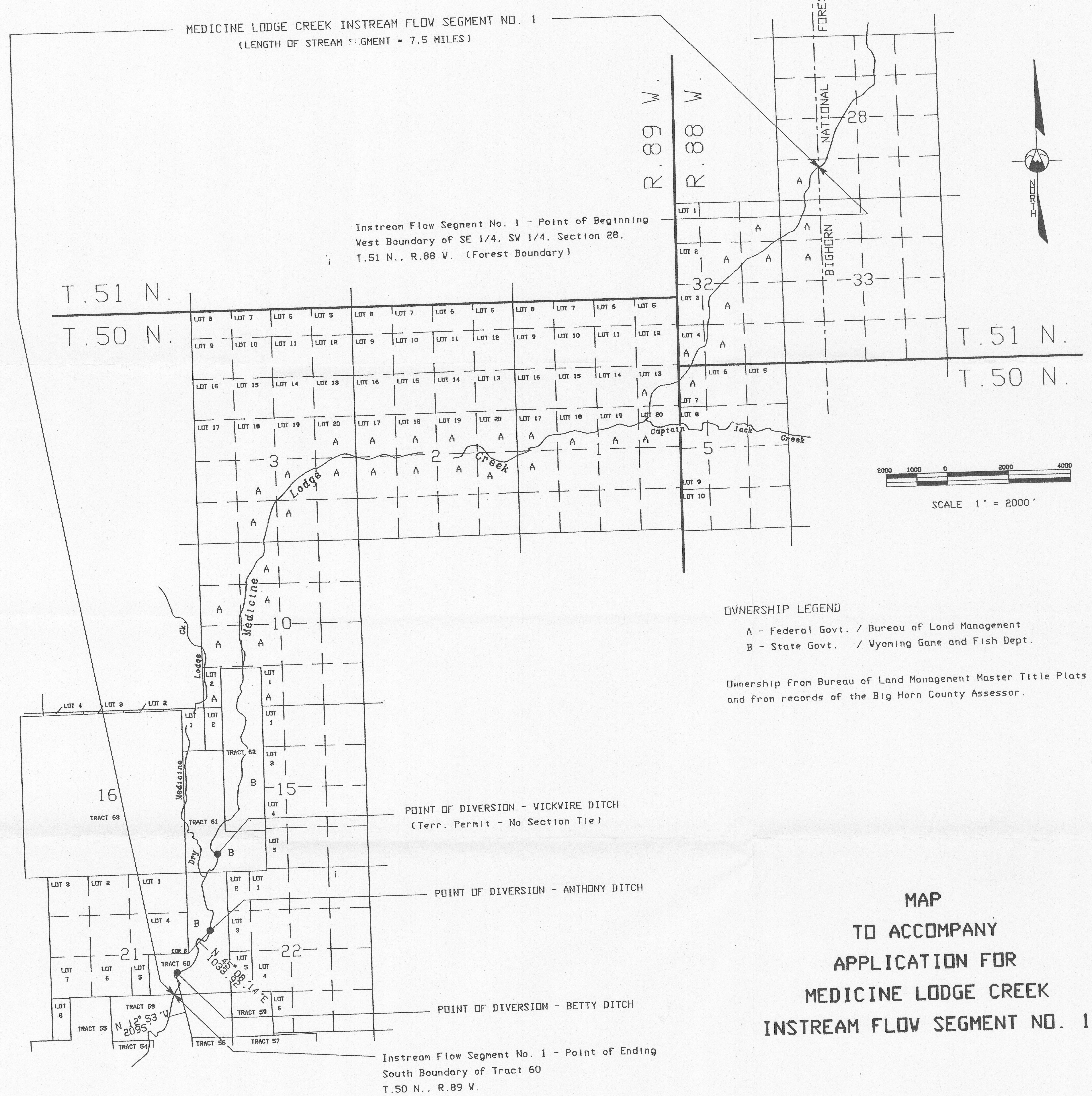
I, Becky J. Braman, a Professional Land Surveyor in the State of Wyoming do hereby certify that this map has been prepared from the U.S. Geological Survey Topographic Quadrangles, the Bureau of Land Management Surface Management Quadrangles and GLO Plats and Wyoming State Engineer's water right records and that it correctly represents the location of the creek and the lands that it flows through to the best of my belief and knowledge.

Becky J. Braman

Becky J. Braman, Wyo. L.S. 3881

Dated January 23, 1991

Professional Land Surveyor BECKY J. BRAMAN 3881 Date WYOMING



OWNERSHIP LEGEND

A - Federal Govt. / Bureau of Land Management
B - State Govt. / Wyoming Game and Fish Dept.

Ownership from Bureau of Land Management Master Title Plats and from records of the Big Horn County Assessor.

MAP TO ACCOMPANY APPLICATION FOR MEDICINE LODGE CREEK INSTREAM FLOW SEGMENT NO. 1

APPLICANT:

WYOMING WATER DEVELOPMENT COMMISSION
HERSCHLER BUILDING
CHEYENNE, WYOMING 82002

APPROVED ____________________

STATE ENGINEER

STATES WEST WATER RESOURCES CORPORATION
INTERMOUNTAIN PROFESSIONAL SERVICES, INC.
CHEYENNE, WYOMING

JOB NO. 2173 DATE 11/19/90

Amended per State Engineer's Office 1-10-91

27 2/146