

Stream: Middle Creek (Lower Segment)

Executive Summary

Water Division: 2

Water District: 15

CDOW#:30368

CWCB ID: 10/2/A-003

Segment: Confluence with Ophir Creek to Beulah Water Works Diversion

Upper Terminus: CONFLUENCE WITH OPHIR CREEK

(Latitude 38° 03' 55.58"N) (Longitude 105° 06' 20.10"W)

Lower Terminus: BEULAH WATER WORKS DIVERSION

(Latitude 38° 03' 55.58"N) (Longitude 105° 06' 20.10"W)

Watershed: Upper Arkansas (HUC#: 11020002)

Counties: Custer, Pueblo

Length: 6.72 miles

USGS Quad(s): St. Charles Peak

Flow Recommendation: 5.1 cfs (April 1 – August 31)
2.8 cfs (September 1 – March 31)



Staff Analysis and Recommendation

Summary

The information contained in this report and the associated instream flow file folder forms the basis for staff's instream flow recommendation to be considered by the Board. It is staff's opinion that the information contained in this report is sufficient to support the findings required in Rule 5.40.

Colorado's Instream Flow Program was created in 1973 when the Colorado State Legislature recognized "the need to correlate the activities of mankind with some reasonable preservation of the natural environment" (see 37-92-102 (3) C.R.S.). The statute vests the CWCB with the exclusive authority to appropriate and acquire instream flow and natural lake level water rights. In order to encourage other entities to participate in Colorado's Instream Flow Program, the statute directs the CWCB to request instream flow recommendations from other state and federal agencies. The Colorado Division of Wildlife (CDWO) recommended this segment of Middle Creek to the CWCB for inclusion into the Instream Flow Program. Middle Creek is being considered for inclusion into the Instream Flow Program because it has a natural environment that can be preserved to a reasonable degree with an instream flow water right.

Middle Creek is approximately 14.5 miles long. It begins on the northeast side of Deer Peak at an elevation of 10,200 feet and generally flows in an easterly direction until it terminates at the confluence with Squirrel Creek at an elevation of 6,780 feet. Of the 6.72 mile segment addressed by this report, approximately 66% of the segment is located on federal lands. Middle Creek is located within Custer and Pueblo.

The subject of this report is a segment of the Middle Creek beginning at the confluence with Ophir Creek and extending downstream to the Beulah Water Works Diversion. The proposed segment is located approximately 14 miles southeast of the town of Silver Cliff. Staff has received only one recommendation for this segment, from the CDOW. The recommendation for this segment is discussed below.

Instream Flow Recommendation

The CDOW is recommending 5.1 cfs (April 1 – August 31) and 2.8 cfs (September 1 – March 31), based on their data collection efforts and staff's water availability analyses.

Land Status Review

Upper Terminus	Lower Terminus	Total Length (miles)	Land Ownership	
			% Private	% Public
Confluence w/ Ophir Creek	Beulah Water Works Diversion	6.72	34%	66%

100% of the public lands are managed by the U.S. Forest Service

Biological Data

The USFS, in September of 1997, collected stream cross section information, natural environment data, and other data needed to quantify the instream flow needs for this reach of Middle Creek. Middle Creek is classified as a medium stream (between 20 to 35 feet wide) and fishery surveys indicate the stream environment of the Middle Creek supports rainbow trout (*Oncorhynchus mykiss*) and brook trout (*Salvelinus fontinalis*).

Field Survey Data

CDOW staff used the R2Cross methodology to quantify the amount of water required to preserve the natural environment to a reasonable degree. The R2Cross method requires that stream discharge and channel profile data be collected in a riffle stream habitat type. Riffles are most easily visualized, as the stream habitat types that would dry up first should streamflow cease. This type of hydraulic data collection consists of setting up a transect, surveying the stream channel geometry, and measuring the stream discharge.

Biological Flow Recommendation

The CWCB staff relied upon the biological expertise of the cooperating agencies to interpret output from the R2Cross data collected to develop the initial, biologic instream flow recommendation. This initial recommendation is designed to address the unique biologic requirements of each stream without regard to water availability. Three instream flow hydraulic parameters, average depth, percent wetted perimeter, and average velocity are used to develop biologic instream flow recommendations. The CDOW has determined that maintaining these three hydraulic parameters at adequate levels across riffle habitat types, aquatic habitat in pools and runs will also be maintained for most life stages of fish and aquatic invertebrates (Nehring 1979; Espegren 1996).

For this segment of stream, one data set was collected with the results shown in Table 1 below. Table 1 shows who collected the data (Party), the date the data was collected (Date), the measured discharge at the time of the survey (Q), the accuracy range of the predicted flows based on Manning's Equation (240% and 40% of Q), the summer flow recommendation based on meeting 3 of 3 hydraulic criteria and the winter flow recommendation based upon 2 of 3 hydraulic criteria. It is believed that recommendations that fall outside of the accuracy range of the model, over 250% of the measured discharge or under 40% of the measured discharge may not give an accurate estimate of the necessary instream flow required.

Table 1: Data

Party	Date	Q	250%-40%	Summer (3/3)	Winter (2/3)
USFS	9/5/1997	2.8	7.1 – 1.1	5.1	2.8

The summer flow recommendation, which met 3 of 3 criteria and is within the accuracy range of the R2CROSS model is 5.1 cfs. The winter flow amount, which meets 2 of 3 criteria, is 2.8 cfs.

Hydrologic Data and Analysis

After receiving the cooperating agency's biologic recommendation, the CWCB staff conducted an evaluation of the stream hydrology to determine if water was physically available for an instream flow appropriation. This evaluation was done through a computation that is, in essence,

a “water balance”. In concept a “water balance” computation can be viewed as an accounting exercise. When done in its most rigorous form, the water balance parses precipitation into all the avenues water pursues after it is deposited as rain, snow, or ice. In other words, given a specified amount of water deposition (input), the balance tries to account for all water depletions (losses) until a selected end point is reached. Water losses include depletions due to evaporation and transpiration, deliveries into ground water storage, temporary surface storage, incorporations into plant and animal tissue and so forth. These losses are individually or collectively subtracted from the input to reveal the net amount of stream runoff as represented by the discharge measured by stream gages. Of course, the measured stream flow need not be the end point of interest; indeed, when looking at issues of water use to extinction stream flow measurements may only describe intermediate steps in the complex accounting process that is a water balance carried out to a net value of zero.

In its analysis, CWCB staff has attempted to use this idea of balancing inputs and losses to determine if water is available for the recommended Instream Flow Appropriation. Of course, this analysis must be a practical exercise rather than a lengthy, and costly, scientific investigation. As a result, staff has simplified the process by lumping together some variables and employing certain rational and scientifically supportable assumptions. The process may be described through the following description of the steps used to complete the evaluation for this particular stream.

The first step required in determining water availability is a determination of the hydrologic regime at the Lower Terminus (LT) of the recommended ISF reach. In the best case this means looking at the data from a gage at the LT. Further, this data, in the best case, has been collected for a long period of time (the longer the better) including wet and dry periods. In the case of **Middle Creek - Lower** no such gage is available at the LT. In fact, there is no gage on Middle Creek. It is thus necessary to describe the normal flow regime at Middle Creek - Lower above the LT through a “representative” gage station. The gage station selected for this purpose was GREENHORN CREEK NEAR RYE, CO. (USGS 07107900), a gage with a 9 year period of record (POR) collected between 1973 and 2001. The gage is at an elevation of 7,220 ft above mean sea level (amsl) and has a drainage area of 9.56 mi². The hydrograph (plot of discharge over time) produced from this gage includes the consumptive use of some upstream diversions. However, the existence of these diversions is not a major limitation upon the use of the data from the gage. To make the measured data transferable to Middle Creek - Lower above the LT, the consumptive portions of these diversions were added back to the measured hydrograph. The resulting “adjusted” hydrograph could then be used on Middle Creek - Lower above the LT by multiplying the “adjusted” gage discharge values by an area ratio; specifically, the area of Middle Creek - Lower above the LT (26.58 mi²) to Greenhorn Creek near Rye, CO (9.56 mi²). In this instance, due to the absence of existing significant upstream consumptive irrigation uses or transbasin diversions on Middle Creek - Lower above the LT, the resulting proportioned “adjusted” hydrograph was not further “adjusted” (decreased). Nevertheless, the final hydrograph represents the existing distribution of flow over time.

{The Following discussion is based upon the US Geological Survey’s *Techniques of Water-Resources Investigations Series, Book 4: Hydrologic Analysis and Interpretation, Chapter A3: Statistical Methods in Water Resources* (Chapter 3: Describing Uncertainty) by D.R. Helsel and

R. M. Hirsch. This technical reference provides the scientific background and guidance important to the systematic interpretation of hydrologic data. The document is available online and is a valuable aid to understanding and interpreting the analyses described here.}

The next step in producing a representation of the discharge at Middle Creek - Lower above the LT was to compute the Geometric Mean of the area-prorated data values from the Greenhorn Creek near Rye, CO Hydrograph. This step is of value because of the inherent statistical weaknesses found in any collection of data intended to measure natural stream discharge. Without getting into the details of statistical theory, it is worth noting that a set of discharge measurements is inherently inaccurate, no matter how well collected, due to the difficulties attendant to data collection, especially hydrologic data. In this particular case, the short period of record lends even greater merit to the use of this statistical tool. To give deference to this fact and to increase the value of the hydrograph product of this analysis, the Geometric Means of the data were computed and plotted along with the 95% Confidence Intervals about the data. The resultant hydrograph, including recommended Instream Flow values, is displayed in Figure 1 with the data displayed in Table 2.

Figure 1

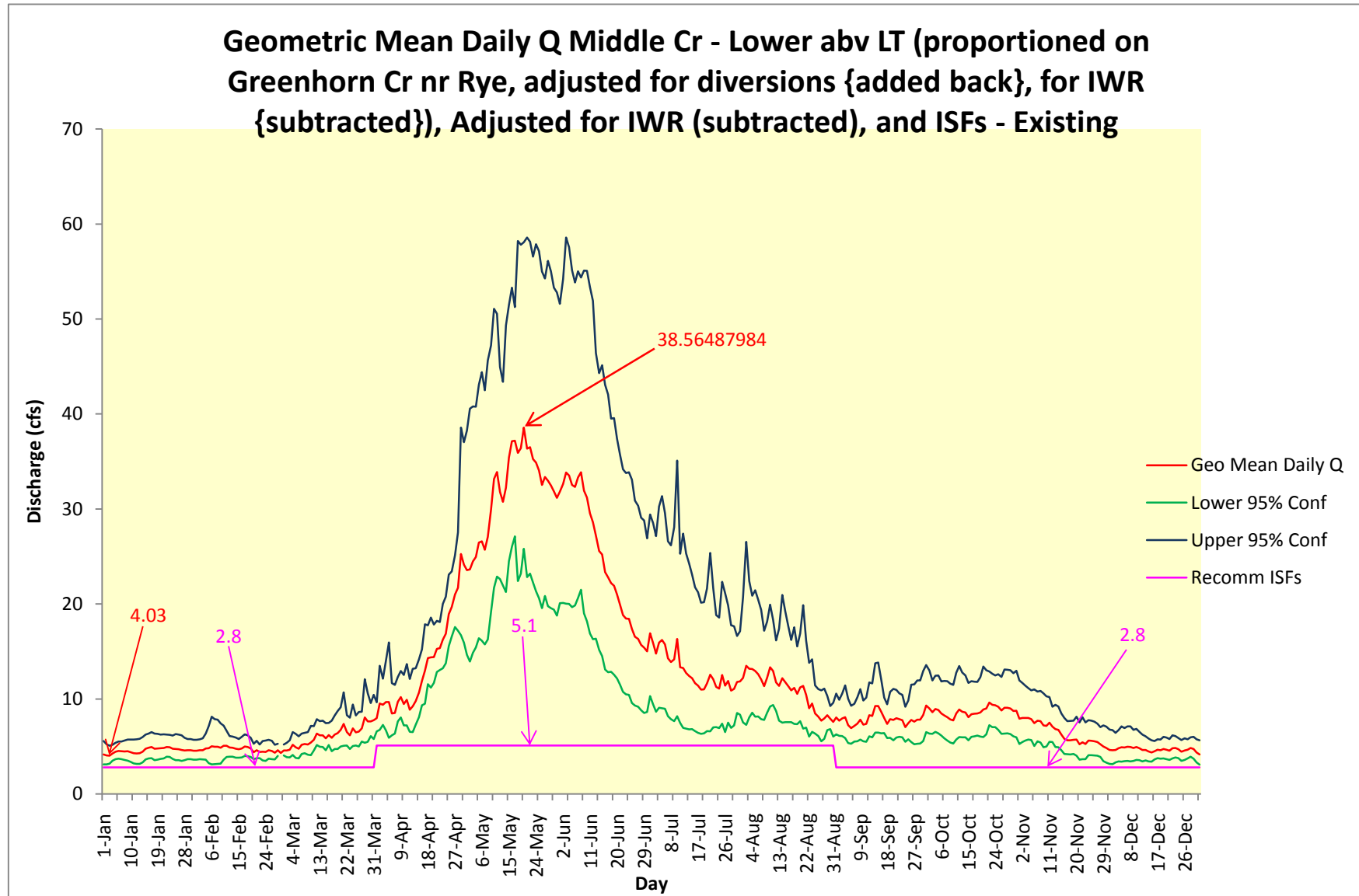


Table 2. Geometric Mean Discharge and Recommended Instream Flows			
Date	Existing ISF	Recommended ISF	Proportioned Adjusted GM (abv gage) Adj (-) for Irr & OoB in Middle Cr - Lower abv LT
1-Jan		2.8	4.16
2-Jan		2.8	4.04
3-Jan		2.8	4.03
4-Jan		2.8	4.25
5-Jan		2.8	4.44
6-Jan		2.8	4.53
7-Jan		2.8	4.49
8-Jan		2.8	4.48
9-Jan		2.8	4.48
10-Jan		2.8	4.39
11-Jan		2.8	4.29
12-Jan		2.8	4.27
13-Jan		2.8	4.28
14-Jan		2.8	4.45
15-Jan		2.8	4.76
16-Jan		2.8	4.87
17-Jan		2.8	4.94
18-Jan		2.8	4.76
19-Jan		2.8	4.78
20-Jan		2.8	4.81
21-Jan		2.8	4.85
22-Jan		2.8	4.95
23-Jan		2.8	4.91
24-Jan		2.8	4.76
25-Jan		2.8	4.74
26-Jan		2.8	4.71
27-Jan		2.8	4.64
28-Jan		2.8	4.58
29-Jan		2.8	4.60
30-Jan		2.8	4.60
31-Jan		2.8	4.54
1-Feb		2.8	4.54
2-Feb		2.8	4.60
3-Feb		2.8	4.61
4-Feb		2.8	4.78
5-Feb		2.8	4.80
6-Feb		2.8	5.03
7-Feb		2.8	4.97
8-Feb		2.8	4.97
9-Feb		2.8	4.87
10-Feb		2.8	5.08
11-Feb		2.8	5.08

12-Feb	2.8	4.89
13-Feb	2.8	4.86
14-Feb	2.8	4.76
15-Feb	2.8	4.70
16-Feb	2.8	4.79
17-Feb	2.8	5.01
18-Feb	2.8	4.95
19-Feb	2.8	4.79
20-Feb	2.8	4.40
21-Feb	2.8	4.60
22-Feb	2.8	4.42
23-Feb	2.8	4.43
24-Feb	2.8	4.42
25-Feb	2.8	4.61
26-Feb	2.8	4.52
27-Feb	2.8	4.35
28-Feb	2.8	4.60
29-Feb	2.8	4.31
1-Mar	2.8	4.58
2-Mar	2.8	4.57
3-Mar	2.8	4.66
4-Mar	2.8	5.17
5-Mar	2.8	4.91
6-Mar	2.8	4.76
7-Mar	2.8	5.18
8-Mar	2.8	5.24
9-Mar	2.8	5.20
10-Mar	2.8	5.40
11-Mar	2.8	5.70
12-Mar	2.8	6.36
13-Mar	2.8	6.17
14-Mar	2.8	6.17
15-Mar	2.8	5.85
16-Mar	2.8	6.20
17-Mar	2.8	5.90
18-Mar	2.8	6.26
19-Mar	2.8	6.42
20-Mar	2.8	6.75
21-Mar	2.8	7.37
22-Mar	2.8	6.51
23-Mar	2.8	6.17
24-Mar	2.8	6.90
25-Mar	2.8	6.49
26-Mar	2.8	6.56
27-Mar	2.8	6.91
28-Mar	2.8	8.06
29-Mar	2.8	7.63
30-Mar	2.8	7.64
31-Mar	2.8	7.76

1-Apr	5.1	7.97
2-Apr	5.1	9.53
3-Apr	5.1	9.38
4-Apr	5.1	9.67
5-Apr	5.1	9.67
6-Apr	5.1	8.46
7-Apr	5.1	8.52
8-Apr	5.1	9.69
9-Apr	5.1	10.20
10-Apr	5.1	9.46
11-Apr	5.1	9.90
12-Apr	5.1	8.87
13-Apr	5.1	9.22
14-Apr	5.1	9.79
15-Apr	5.1	10.66
16-Apr	5.1	11.89
17-Apr	5.1	12.96
18-Apr	5.1	14.30
19-Apr	5.1	14.39
20-Apr	5.1	14.41
21-Apr	5.1	15.27
22-Apr	5.1	15.36
23-Apr	5.1	16.24
24-Apr	5.1	16.86
25-Apr	5.1	18.92
26-Apr	5.1	19.68
27-Apr	5.1	20.99
28-Apr	5.1	21.70
29-Apr	5.1	25.26
30-Apr	5.1	24.13
1-May	5.1	23.57
2-May	5.1	23.64
3-May	5.1	24.48
4-May	5.1	24.95
5-May	5.1	26.47
6-May	5.1	26.61
7-May	5.1	25.71
8-May	5.1	27.06
9-May	5.1	29.95
10-May	5.1	33.15
11-May	5.1	33.89
12-May	5.1	31.80
13-May	5.1	30.75
14-May	5.1	32.24
15-May	5.1	35.40
16-May	5.1	37.13
17-May	5.1	37.19
18-May	5.1	35.90
19-May	5.1	36.41

20-May	5.1	38.56
21-May	5.1	36.35
22-May	5.1	36.50
23-May	5.1	35.26
24-May	5.1	34.90
25-May	5.1	34.05
26-May	5.1	32.52
27-May	5.1	33.37
28-May	5.1	32.99
29-May	5.1	32.48
30-May	5.1	31.86
31-May	5.1	31.17
1-Jun	5.1	31.83
2-Jun	5.1	32.65
3-Jun	5.1	33.85
4-Jun	5.1	33.53
5-Jun	5.1	32.54
6-Jun	5.1	32.31
7-Jun	5.1	33.32
8-Jun	5.1	33.86
9-Jun	5.1	31.94
10-Jun	5.1	31.19
11-Jun	5.1	29.56
12-Jun	5.1	28.60
13-Jun	5.1	27.21
14-Jun	5.1	25.57
15-Jun	5.1	25.20
16-Jun	5.1	23.34
17-Jun	5.1	22.81
18-Jun	5.1	22.21
19-Jun	5.1	21.92
20-Jun	5.1	21.01
21-Jun	5.1	19.93
22-Jun	5.1	18.83
23-Jun	5.1	18.46
24-Jun	5.1	18.43
25-Jun	5.1	17.36
26-Jun	5.1	16.56
27-Jun	5.1	16.33
28-Jun	5.1	15.69
29-Jun	5.1	15.40
30-Jun	5.1	15.01
1-Jul	5.1	16.92
2-Jul	5.1	15.90
3-Jul	5.1	14.79
4-Jul	5.1	15.92
5-Jul	5.1	16.22
6-Jul	5.1	15.74
7-Jul	5.1	14.28

8-Jul	5.1	13.89
9-Jul	5.1	14.17
10-Jul	5.1	16.31
11-Jul	5.1	13.33
12-Jul	5.1	13.26
13-Jul	5.1	12.75
14-Jul	5.1	12.43
15-Jul	5.1	12.18
16-Jul	5.1	11.67
17-Jul	5.1	11.39
18-Jul	5.1	10.98
19-Jul	5.1	11.01
20-Jul	5.1	11.64
21-Jul	5.1	12.56
22-Jul	5.1	12.07
23-Jul	5.1	11.26
24-Jul	5.1	11.09
25-Jul	5.1	12.54
26-Jul	5.1	11.39
27-Jul	5.1	11.91
28-Jul	5.1	10.87
29-Jul	5.1	11.05
30-Jul	5.1	11.80
31-Jul	5.1	11.84
1-Aug	5.1	12.22
2-Aug	5.1	13.50
3-Aug	5.1	13.18
4-Aug	5.1	13.15
5-Aug	5.1	12.94
6-Aug	5.1	12.61
7-Aug	5.1	12.07
8-Aug	5.1	11.35
9-Aug	5.1	12.25
10-Aug	5.1	13.34
11-Aug	5.1	12.93
12-Aug	5.1	11.75
13-Aug	5.1	11.37
14-Aug	5.1	12.19
15-Aug	5.1	11.77
16-Aug	5.1	11.34
17-Aug	5.1	10.90
18-Aug	5.1	11.17
19-Aug	5.1	10.54
20-Aug	5.1	11.21
21-Aug	5.1	11.39
22-Aug	5.1	10.43
23-Aug	5.1	9.02
24-Aug	5.1	9.53
25-Aug	5.1	8.46

26-Aug	5.1	8.14
27-Aug	5.1	7.71
28-Aug	5.1	7.94
29-Aug	5.1	8.30
30-Aug	5.1	7.93
31-Aug	5.1	7.57
1-Sep	2.8	8.05
2-Sep	2.8	7.72
3-Sep	2.8	7.94
4-Sep	2.8	8.08
5-Sep	2.8	7.24
6-Sep	2.8	6.92
7-Sep	2.8	7.15
8-Sep	2.8	7.41
9-Sep	2.8	7.81
10-Sep	2.8	7.29
11-Sep	2.8	7.36
12-Sep	2.8	8.30
13-Sep	2.8	8.20
14-Sep	2.8	9.26
15-Sep	2.8	9.26
16-Sep	2.8	8.64
17-Sep	2.8	8.00
18-Sep	2.8	7.38
19-Sep	2.8	7.86
20-Sep	2.8	7.80
21-Sep	2.8	7.97
22-Sep	2.8	7.88
23-Sep	2.8	7.78
24-Sep	2.8	7.03
25-Sep	2.8	7.45
26-Sep	2.8	7.78
27-Sep	2.8	7.62
28-Sep	2.8	7.81
29-Sep	2.8	7.81
30-Sep	2.8	8.31
1-Oct	2.8	9.30
2-Oct	2.8	8.99
3-Oct	2.8	8.61
4-Oct	2.8	8.94
5-Oct	2.8	8.84
6-Oct	2.8	8.46
7-Oct	2.8	8.26
8-Oct	2.8	8.08
9-Oct	2.8	7.84
10-Oct	2.8	7.74
11-Oct	2.8	8.47
12-Oct	2.8	8.89
13-Oct	2.8	8.65

14-Oct	2.8	8.57
15-Oct	2.8	8.09
16-Oct	2.8	8.40
17-Oct	2.8	8.43
18-Oct	2.8	8.48
19-Oct	2.8	8.56
20-Oct	2.8	8.89
21-Oct	2.8	8.99
22-Oct	2.8	9.63
23-Oct	2.8	9.40
24-Oct	2.8	9.33
25-Oct	2.8	9.18
26-Oct	2.8	8.79
27-Oct	2.8	9.07
28-Oct	2.8	9.08
29-Oct	2.8	9.01
30-Oct	2.8	8.74
31-Oct	2.8	8.76
1-Nov	2.8	7.92
2-Nov	2.8	8.00
3-Nov	2.8	8.00
4-Nov	2.8	7.99
5-Nov	2.8	7.86
6-Nov	2.8	7.45
7-Nov	2.8	7.72
8-Nov	2.8	7.66
9-Nov	2.8	7.21
10-Nov	2.8	7.16
11-Nov	2.8	7.49
12-Nov	2.8	7.07
13-Nov	2.8	6.82
14-Nov	2.8	6.73
15-Nov	2.8	6.25
16-Nov	2.8	5.81
17-Nov	2.8	5.66
18-Nov	2.8	5.65
19-Nov	2.8	5.71
20-Nov	2.8	5.71
21-Nov	2.8	5.22
22-Nov	2.8	5.45
23-Nov	2.8	5.25
24-Nov	2.8	5.63
25-Nov	2.8	5.60
26-Nov	2.8	5.55
27-Nov	2.8	5.46
28-Nov	2.8	5.23
29-Nov	2.8	5.00
30-Nov	2.8	4.82
1-Dec	2.8	4.63

2-Dec	2.8	4.60
3-Dec	2.8	4.62
4-Dec	2.8	4.81
5-Dec	2.8	4.92
6-Dec	2.8	4.88
7-Dec	2.8	4.96
8-Dec	2.8	4.93
9-Dec	2.8	4.84
10-Dec	2.8	4.95
11-Dec	2.8	4.82
12-Dec	2.8	4.63
13-Dec	2.8	4.64
14-Dec	2.8	4.47
15-Dec	2.8	4.37
16-Dec	2.8	4.49
17-Dec	2.8	4.65
18-Dec	2.8	4.61
19-Dec	2.8	4.74
20-Dec	2.8	4.66
21-Dec	2.8	4.55
22-Dec	2.8	4.80
23-Dec	2.8	4.83
24-Dec	2.8	4.69
25-Dec	2.8	4.45
26-Dec	2.8	4.58
27-Dec	2.8	4.65
28-Dec	2.8	4.84
29-Dec	2.8	4.72
30-Dec	2.8	4.37
31-Dec	2.8	4.17

Existing Water Right Information

Staff has analyzed the water rights tabulation and contacted the Division Engineer Office (DEO) to identify any potential water availability problems. There is one decreed surface diversion at the end of this reach of stream, the Beulah Water Works (0.70 cfs with an 1864 appropriation). Staff has determined that water is available for appropriation on Middle Creek, between the confluence with Ophir Creek Lake to the Beulah Water Works diversion, to preserve the natural environment to a reasonable degree without limiting or foreclosing the exercise of valid existing water rights.

CWCB Staff's Instream Flow Recommendation

Staff recommends the Board form its intent to appropriate on the following stream reach:

Segment: Confluence with Ophir Creek to Beulah Water Works Diversion

Upper Terminus: CONFLUENCE WITH OPHIR CREEK

(Latitude 38° 03' 55.58"N) (Longitude 105° 06' 20.10"W)

UTM North: 4213080.93 UTM East: 490738.21

NW NE S9 T23S R 69W 6th PM

1300' West of the East Section Line; 1290' South of the North Section Line

Lower Terminus: BEULAH WATER WORKS DIVERSION

(Latitude 38° 03' 55.58"N) (Longitude 105° 06' 20.10"W)

UTM North: 4214993.89 UTM East: 498600.25

NW NW S5 T23S R68W 6th PM

700' West of the East Section Line; 1790' South of the North Section Line

Watershed: Upper Arkansas (HUC#: 11020002)

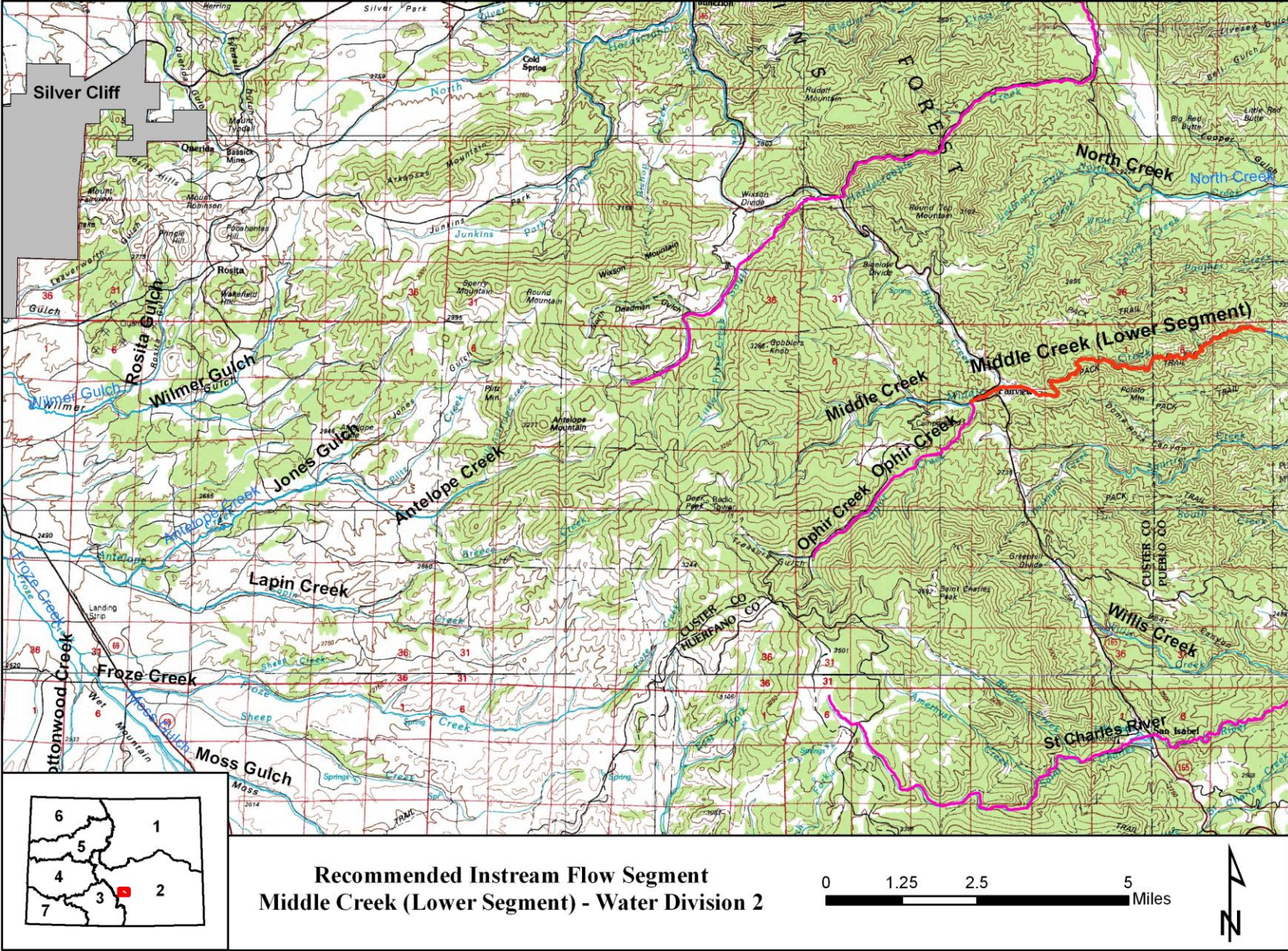
Counties: Custer, Pueblo

Length: 6.72 miles

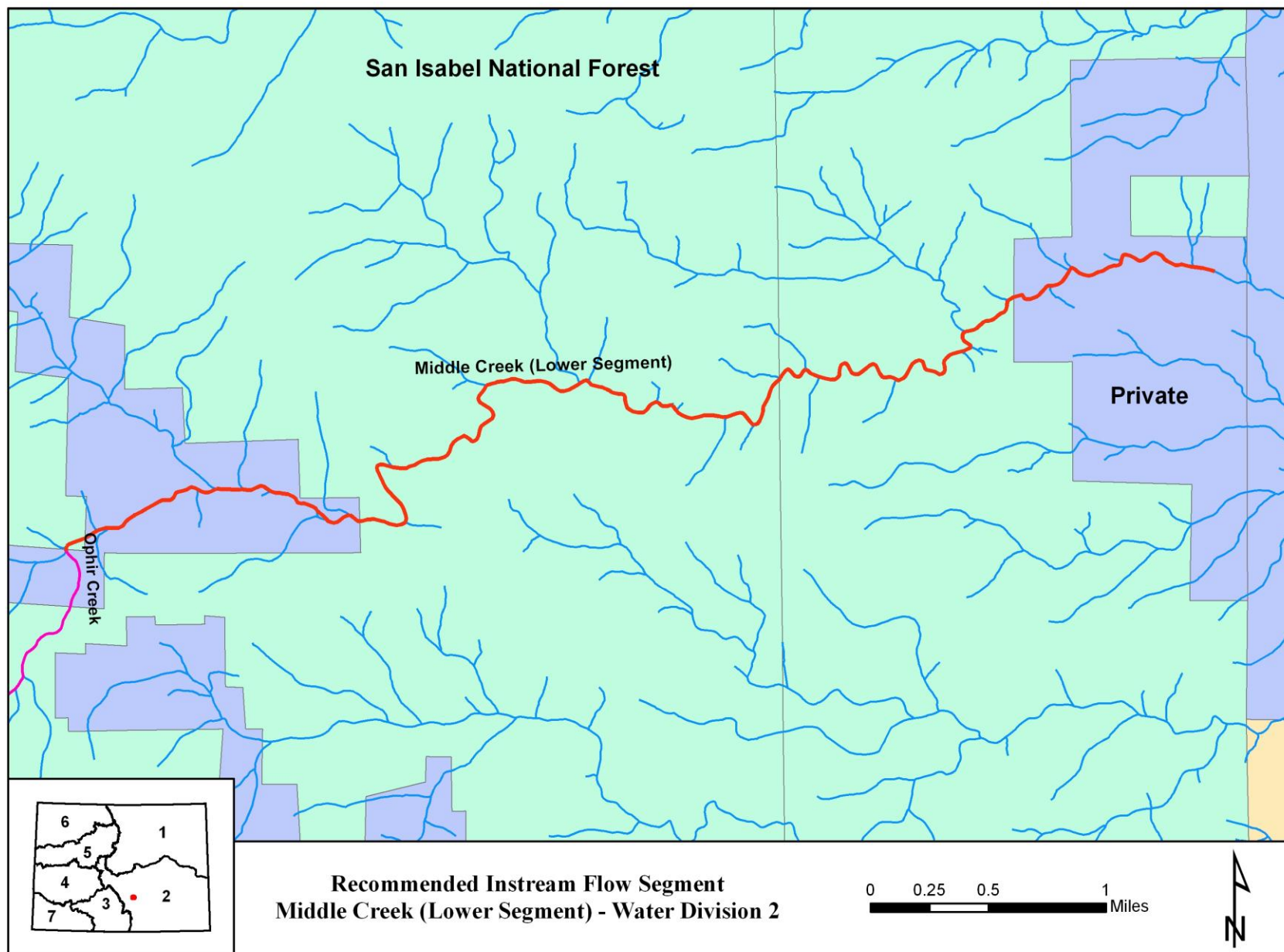
USGS Quad(s): St. Charles Peak

Flow Recommendation: 5.1 cfs (April 1 – August 31)
2.8 cfs (September 1 – March 31)

Vicinity Map



Land Use Map



Topographic and Water Rights Map

