Stream: Troublesome Creek (Upper Section)

Executive Summary

Water Division: 5
Water District: 50
CDOW#: 23521
CWCB ID: 08/5/A-009

Segment: Confluence with Glomerate Creek to Confluence with Rabbit Ears Creek

Upper Terminus: CONFLUENCE WITH GLOMERATE CREEK
(Latitude 40° 17’ 9.11”N) (Longitude 106° 17’ 50.76”W)

Lower Terminus: CONFLUENCE WITH RABBIT EARS CREEK
(Latitude 40° 15’ 45.93”N) (Longitude 106° 19’ 6.45”W)

Watershed: Colorado headwaters (HUC#:14010001)
Counties: Grand
Length: 2.2 miles
USGS Quad(s): Hyannis Peak
Flow Recommendation: 5.1 cfs (April 1 to October 31)
2.8 cfs (November 1 to March 31)

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 Bureau of Land Management recommended this segment of Troublesome Creek to the CWCB for inclusion into the Instream Flow Program. Troublesome 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.

Troublesome Creek is approximately 21.6 miles long and it begins at an elevation of approximately 8700 feet and terminates at the confluence with the Colorado River at an elevation of approximately 7350 feet. The 2.2-mile segment addressed by this report is 93 % publicly owned. Troublesome Creek is located within Grand County and has a total drainage area of approximately 45 square miles. Troublesome Creek generally flows in a southwesterly direction.

The subject of this report is a segment of Troublesome Creek beginning at the confluence with Glomerate Creek and extending downstream to the confluence with Rabbit Ears Creek. The proposed segment is located approximately 4 miles east of Kremmling. The staff has received only one recommendation for this segment, from the BLM. The recommendation for this segment is discussed below.

Instream Flow Recommendation(s)

BLM recommended 5.1 cfs, summer, and 2.8 cfs, winter, based on its October 13, 2006 data collection efforts. The modeling results from this survey effort are within the confidence interval produced by the R2Cross model.

Land Status Review

Upper Terminus	Lower Terminus	Total Length (miles)	Land Ownership	
			% Private	% Public
Confluence with Glomerate Creek	Confluence with Rabbit Ears Creek	2.2	7%	93%

100% of the public lands are owned by the BLM.

Biological Data

The BLM has conducted field surveys of the fishery resources on this stream and have found a natural environment that can be preserved. As reported in the letter from BLM to the CWCB "Troublesome Creek is a moderate gradient stream with moderate to small substrate size. The creek meanders through the bottom of a mountain valley. The willow riparian community associated with the creek often occupies the entire valley floor. The riparian community also provides substantial nutrients to the creek system and abundant bank overhangs for fish habitat. However, the riparian does not provide substantial shading for fish habitat because the channel is wide. Fishery surveys indicate that the creek supports a large and self-sustaining population of brown trout with a variety of age classes. The creek also supports small numbers of brook trout and mottled sculpin".

Field Survey Data

BLM 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, two data sets were 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)
BLM	10/13/2006	2.41	6.0 – 1.0	5.07	2.63
BLM	10/13/2006	2.27	5.7 – 0.9	Out of range	3.06

BLM = Bureau of Land Management

The summer flow recommendation, which meets 3 of 3 criteria and is within the accuracy range of the R2CROSS model is 5.1 cfs. The winter flow recommendation, which meets 2 or 3 criteria and is within the accuracy range of the R2Cross model is 2.8 cfs. These recommendations were derived by averaging the results of the two data sets.

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 **Upper Troublesome Creek** there is a USGS gage record of discharge on the stream. However, the gage station is downstream from the LT. The USGS gage is TROUBLESOME CREEK NEAR PEARMONT, CO (USGS 09039000); it has a period of record (POR) of 40 years collected between 1953 and 1993. The gage is at an elevation of 8,049 ft above mean sea level (amsl) and has a drainage area of 44.6 mi^2. The hydrograph (plot of discharge over time) produced from this gage includes the consumptive uses of numerous diversions. However, the existence of these diversions does not preclude use of the data from the gage. To make the measured data transferable to Upper Troublesome Creek 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 Upper Troublesome Creek above the LT by multiplying the "adjusted" gage discharge values by an area ratio; specifically, the area of Upper Troublesome Creek above the LT (18.8 mi^2) to Troublesome Creek near Pearmont, CO (44.6 mi^2). In this instance, due to the absence of existing significant upstream consumptive irrigation uses or transbasin diversions on Upper Troublesome

Creek 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 Upper Troublesome Creek is to compute the Geometric Mean of the area-prorated "adjusted" data values from the Troublesome Creek near Pearmont, 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. 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 an enlargement displayed in figure 2. The data displayed by this hydrograph follow in Table 1.

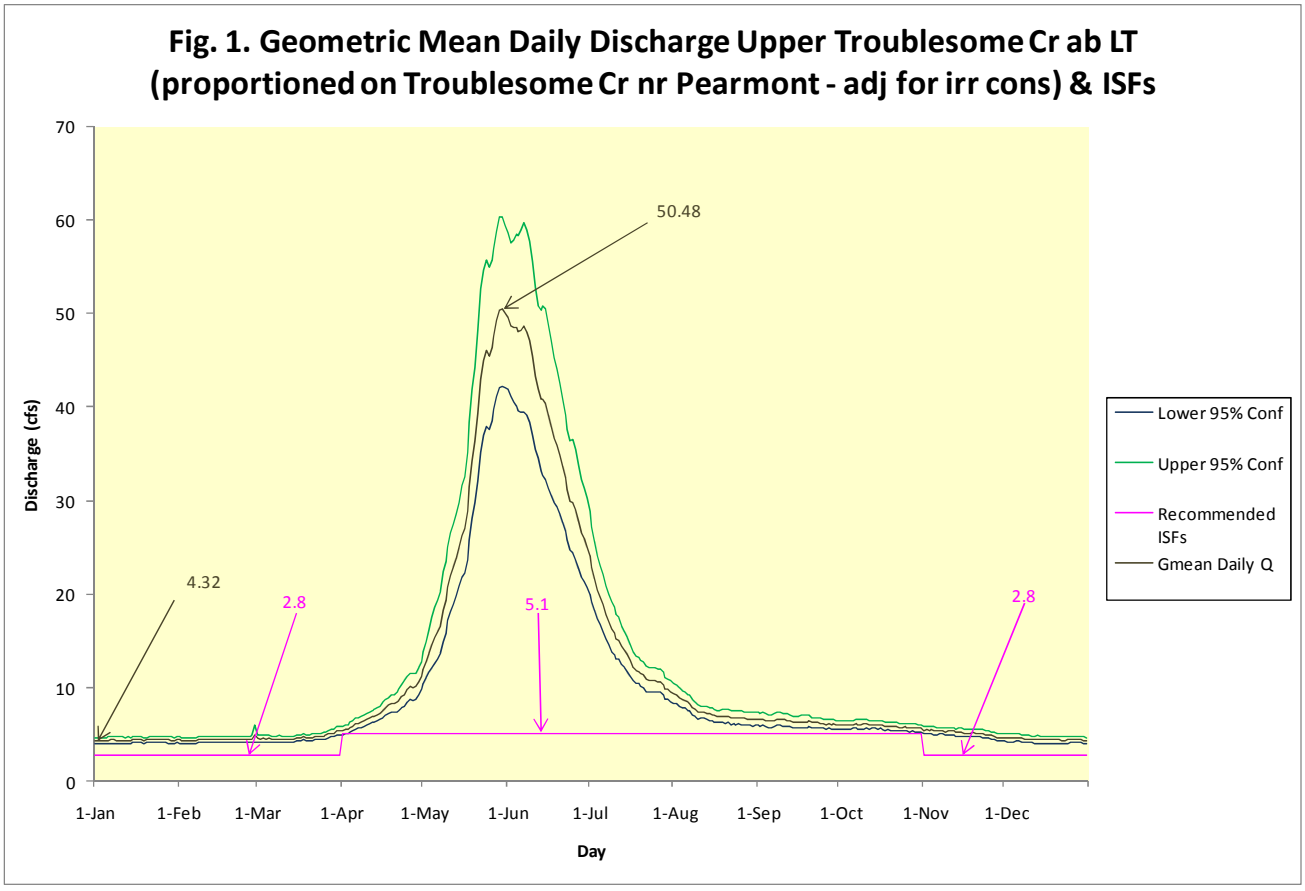


Fig. 2. Geometric Mean Daily Discharge Upper Troublesome Cr ab LT (proportioned on Troublesome Cr nr Pearmont - adj for irr cons) & ISFs

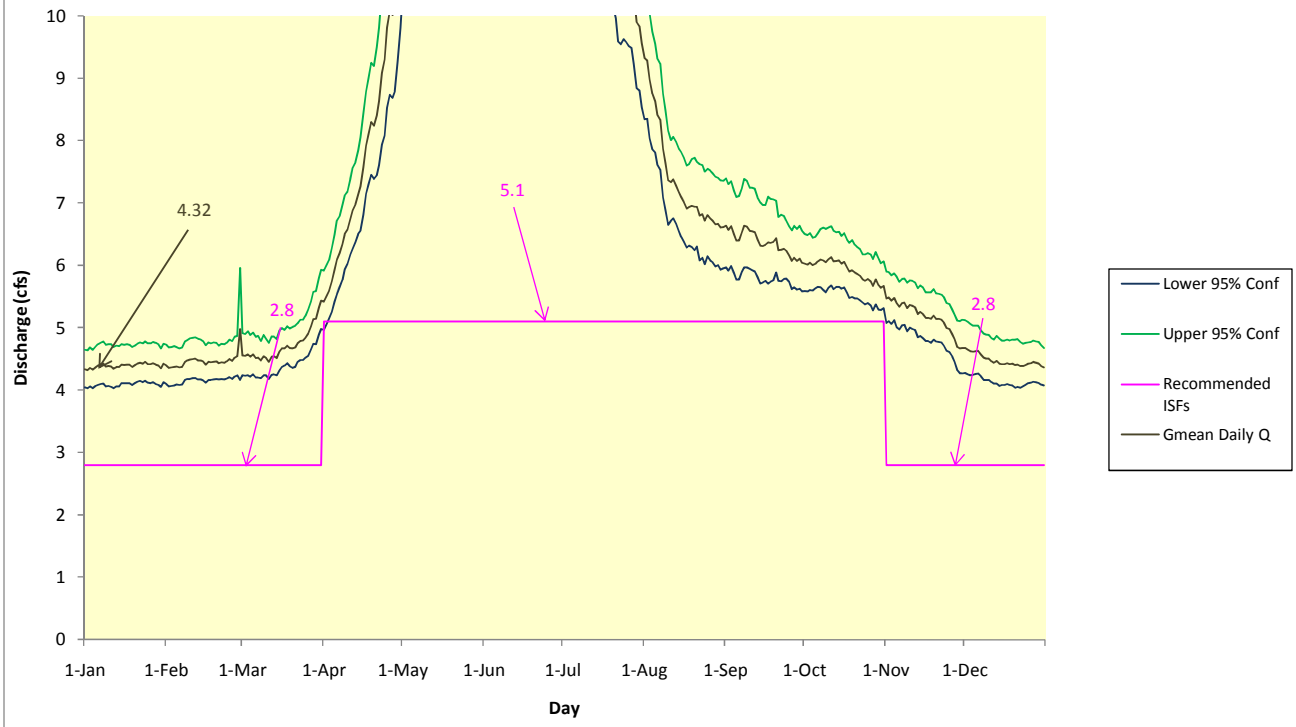


Table 1. Geometric Mean Discharge and Recommended Instream Flows		
Date	Recommended ISF	Proportioned Adjusted GM (abv gage) No Adj (-) for Irr & OoB in Upper Troublesome Creek abv LT
1-Jan	2.8	4.33
2-Jan	2.8	4.32
3-Jan	2.8	4.36
4-Jan	2.8	4.33
5-Jan	2.8	4.37
6-Jan	2.8	4.40
7-Jan	2.8	4.41
8-Jan	2.8	4.43
9-Jan	2.8	4.38
10-Jan	2.8	4.39
11-Jan	2.8	4.38
12-Jan	2.8	4.35
13-Jan	2.8	4.37
14-Jan	2.8	4.37
15-Jan	2.8	4.41
16-Jan	2.8	4.41

17-Jan	2.8	4.41
18-Jan	2.8	4.41
19-Jan	2.8	4.38
20-Jan	2.8	4.40
21-Jan	2.8	4.42
22-Jan	2.8	4.44
23-Jan	2.8	4.43
24-Jan	2.8	4.45
25-Jan	2.8	4.42
26-Jan	2.8	4.42
27-Jan	2.8	4.43
28-Jan	2.8	4.41
29-Jan	2.8	4.39
30-Jan	2.8	4.35
31-Jan	2.8	4.42
1-Feb	2.8	4.40
2-Feb	2.8	4.36
3-Feb	2.8	4.36
4-Feb	2.8	4.38
5-Feb	2.8	4.38
6-Feb	2.8	4.36
7-Feb	2.8	4.38
8-Feb	2.8	4.46
9-Feb	2.8	4.48
10-Feb	2.8	4.49
11-Feb	2.8	4.50
12-Feb	2.8	4.51
13-Feb	2.8	4.48
14-Feb	2.8	4.48
15-Feb	2.8	4.46
16-Feb	2.8	4.41
17-Feb	2.8	4.45
18-Feb	2.8	4.44
19-Feb	2.8	4.46
20-Feb	2.8	4.46
21-Feb	2.8	4.43
22-Feb	2.8	4.45
23-Feb	2.8	4.44
24-Feb	2.8	4.46
25-Feb	2.8	4.50
26-Feb	2.8	4.47
27-Feb	2.8	4.52
28-Feb	2.8	4.54
29-Feb	2.8	4.98
1-Mar	2.8	4.56
2-Mar	2.8	4.55
3-Mar	2.8	4.57
4-Mar	2.8	4.54
5-Mar	2.8	4.57
6-Mar	2.8	4.51

7-Mar	2.8	4.52
8-Mar	2.8	4.48
9-Mar	2.8	4.55
10-Mar	2.8	4.52
11-Mar	2.8	4.46
12-Mar	2.8	4.54
13-Mar	2.8	4.55
14-Mar	2.8	4.51
15-Mar	2.8	4.62
16-Mar	2.8	4.67
17-Mar	2.8	4.67
18-Mar	2.8	4.72
19-Mar	2.8	4.67
20-Mar	2.8	4.67
21-Mar	2.8	4.69
22-Mar	2.8	4.75
23-Mar	2.8	4.79
24-Mar	2.8	4.79
25-Mar	2.8	4.84
26-Mar	2.8	4.90
27-Mar	2.8	5.02
28-Mar	2.8	5.14
29-Mar	2.8	5.14
30-Mar	2.8	5.32
31-Mar	2.8	5.43
1-Apr	5.1	5.42
2-Apr	5.1	5.52
3-Apr	5.1	5.59
4-Apr	5.1	5.74
5-Apr	5.1	5.93
6-Apr	5.1	6.09
7-Apr	5.1	6.20
8-Apr	5.1	6.34
9-Apr	5.1	6.50
10-Apr	5.1	6.58
11-Apr	5.1	6.75
12-Apr	5.1	6.88
13-Apr	5.1	6.98
14-Apr	5.1	7.14
15-Apr	5.1	7.27
16-Apr	5.1	7.57
17-Apr	5.1	7.92
18-Apr	5.1	8.10
19-Apr	5.1	8.30
20-Apr	5.1	8.24
21-Apr	5.1	8.41
22-Apr	5.1	8.64
23-Apr	5.1	9.08
24-Apr	5.1	9.31
25-Apr	5.1	9.81

26-Apr	5.1	10.08
27-Apr	5.1	10.01
28-Apr	5.1	10.09
29-Apr	5.1	10.62
30-Apr	5.1	11.18
1-May	5.1	11.97
2-May	5.1	12.81
3-May	5.1	13.75
4-May	5.1	14.60
5-May	5.1	15.36
6-May	5.1	15.94
7-May	5.1	16.64
8-May	5.1	18.26
9-May	5.1	19.31
10-May	5.1	20.75
11-May	5.1	21.94
12-May	5.1	22.83
13-May	5.1	23.78
14-May	5.1	25.01
15-May	5.1	26.25
16-May	5.1	26.95
17-May	5.1	28.86
18-May	5.1	31.49
19-May	5.1	34.29
20-May	5.1	36.33
21-May	5.1	39.30
22-May	5.1	43.04
23-May	5.1	44.93
24-May	5.1	45.97
25-May	5.1	45.45
26-May	5.1	46.31
27-May	5.1	47.63
28-May	5.1	49.27
29-May	5.1	50.38
30-May	5.1	50.48
31-May	5.1	50.06
1-Jun	5.1	49.60
2-Jun	5.1	48.61
3-Jun	5.1	48.41
4-Jun	5.1	48.44
5-Jun	5.1	48.07
6-Jun	5.1	48.20
7-Jun	5.1	48.59
8-Jun	5.1	48.08
9-Jun	5.1	47.12
10-Jun	5.1	45.41
11-Jun	5.1	43.27
12-Jun	5.1	41.88
13-Jun	5.1	40.86
14-Jun	5.1	40.85

15-Jun	5.1	40.32
16-Jun	5.1	39.10
17-Jun	5.1	37.96
18-Jun	5.1	36.73
19-Jun	5.1	35.96
20-Jun	5.1	34.89
21-Jun	5.1	33.64
22-Jun	5.1	32.39
23-Jun	5.1	31.14
24-Jun	5.1	30.00
25-Jun	5.1	29.84
26-Jun	5.1	28.98
27-Jun	5.1	27.71
28-Jun	5.1	26.57
29-Jun	5.1	25.87
30-Jun	5.1	25.07
1-Jul	5.1	24.04
2-Jul	5.1	22.86
3-Jul	5.1	21.62
4-Jul	5.1	20.45
5-Jul	5.1	19.67
6-Jul	5.1	18.88
7-Jul	5.1	17.85
8-Jul	5.1	17.04
9-Jul	5.1	16.33
10-Jul	5.1	15.86
11-Jul	5.1	15.26
12-Jul	5.1	15.09
13-Jul	5.1	14.44
14-Jul	5.1	13.93
15-Jul	5.1	13.45
16-Jul	5.1	12.86
17-Jul	5.1	12.22
18-Jul	5.1	11.88
19-Jul	5.1	11.71
20-Jul	5.1	11.48
21-Jul	5.1	11.31
22-Jul	5.1	10.87
23-Jul	5.1	10.79
24-Jul	5.1	10.80
25-Jul	5.1	10.79
26-Jul	5.1	10.68
27-Jul	5.1	10.64
28-Jul	5.1	10.36
29-Jul	5.1	9.90
30-Jul	5.1	9.83
31-Jul	5.1	9.56
1-Aug	5.1	9.33
2-Aug	5.1	9.29
3-Aug	5.1	8.98

4-Aug	5.1	8.75
5-Aug	5.1	8.63
6-Aug	5.1	8.41
7-Aug	5.1	8.34
8-Aug	5.1	7.87
9-Aug	5.1	7.65
10-Aug	5.1	7.36
11-Aug	5.1	7.33
12-Aug	5.1	7.38
13-Aug	5.1	7.29
14-Aug	5.1	7.18
15-Aug	5.1	7.10
16-Aug	5.1	7.02
17-Aug	5.1	6.91
18-Aug	5.1	6.94
19-Aug	5.1	6.96
20-Aug	5.1	6.94
21-Aug	5.1	6.94
22-Aug	5.1	6.80
23-Aug	5.1	6.82
24-Aug	5.1	6.72
25-Aug	5.1	6.81
26-Aug	5.1	6.76
27-Aug	5.1	6.72
28-Aug	5.1	6.66
29-Aug	5.1	6.67
30-Aug	5.1	6.60
31-Aug	5.1	6.61
1-Sep	5.1	6.64
2-Sep	5.1	6.57
3-Sep	5.1	6.63
4-Sep	5.1	6.51
5-Sep	5.1	6.40
6-Sep	5.1	6.40
7-Sep	5.1	6.53
8-Sep	5.1	6.63
9-Sep	5.1	6.62
10-Sep	5.1	6.56
11-Sep	5.1	6.55
12-Sep	5.1	6.53
13-Sep	5.1	6.41
14-Sep	5.1	6.32
15-Sep	5.1	6.31
16-Sep	5.1	6.33
17-Sep	5.1	6.37
18-Sep	5.1	6.36
19-Sep	5.1	6.37
20-Sep	5.1	6.43
21-Sep	5.1	6.24
22-Sep	5.1	6.25

23-Sep	5.1	6.26
24-Sep	5.1	6.23
25-Sep	5.1	6.16
26-Sep	5.1	6.07
27-Sep	5.1	6.12
28-Sep	5.1	6.07
29-Sep	5.1	6.11
30-Sep	5.1	6.05
1-Oct	5.1	6.03
2-Oct	5.1	6.01
3-Oct	5.1	6.04
4-Oct	5.1	6.00
5-Oct	5.1	6.03
6-Oct	5.1	6.07
7-Oct	5.1	6.10
8-Oct	5.1	6.08
9-Oct	5.1	6.05
10-Oct	5.1	6.10
11-Oct	5.1	6.13
12-Oct	5.1	6.07
13-Oct	5.1	6.07
14-Oct	5.1	6.08
15-Oct	5.1	6.03
16-Oct	5.1	6.06
17-Oct	5.1	5.97
18-Oct	5.1	5.90
19-Oct	5.1	5.93
20-Oct	5.1	5.88
21-Oct	5.1	5.87
22-Oct	5.1	5.83
23-Oct	5.1	5.77
24-Oct	5.1	5.76
25-Oct	5.1	5.78
26-Oct	5.1	5.75
27-Oct	5.1	5.67
28-Oct	5.1	5.77
29-Oct	5.1	5.69
30-Oct	5.1	5.64
31-Oct	5.1	5.67
1-Nov	2.8	5.47
2-Nov	2.8	5.48
3-Nov	2.8	5.44
4-Nov	2.8	5.48
5-Nov	2.8	5.40
6-Nov	2.8	5.34
7-Nov	2.8	5.40
8-Nov	2.8	5.40
9-Nov	2.8	5.31
10-Nov	2.8	5.37
11-Nov	2.8	5.35

12-Nov	2.8	5.33
13-Nov	2.8	5.22
14-Nov	2.8	5.26
15-Nov	2.8	5.22
16-Nov	2.8	5.16
17-Nov	2.8	5.16
18-Nov	2.8	5.15
19-Nov	2.8	5.20
20-Nov	2.8	5.15
21-Nov	2.8	5.14
22-Nov	2.8	5.13
23-Nov	2.8	5.09
24-Nov	2.8	5.00
25-Nov	2.8	4.98
26-Nov	2.8	4.90
27-Nov	2.8	4.82
28-Nov	2.8	4.70
29-Nov	2.8	4.67
30-Nov	2.8	4.68
1-Dec	2.8	4.68
2-Dec	2.8	4.65
3-Dec	2.8	4.63
4-Dec	2.8	4.62
5-Dec	2.8	4.63
6-Dec	2.8	4.63
7-Dec	2.8	4.57
8-Dec	2.8	4.52
9-Dec	2.8	4.51
10-Dec	2.8	4.51
11-Dec	2.8	4.46
12-Dec	2.8	4.44
13-Dec	2.8	4.47
14-Dec	2.8	4.43
15-Dec	2.8	4.42
16-Dec	2.8	4.42
17-Dec	2.8	4.44
18-Dec	2.8	4.42
19-Dec	2.8	4.42
20-Dec	2.8	4.41
21-Dec	2.8	4.41
22-Dec	2.8	4.39
23-Dec	2.8	4.38
24-Dec	2.8	4.41
25-Dec	2.8	4.43
26-Dec	2.8	4.43
27-Dec	2.8	4.45
28-Dec	2.8	4.44
29-Dec	2.8	4.43
30-Dec	2.8	4.39
31-Dec	2.8	4.36

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. Matheson Reservoir is located just above the upper terminus of the upper reach of the proposed instream flow reach on Troublesome Creek. The reservoir is decreed for 475.83 acre feet conditional and 1,073.6 acre feet absolute. The reservoir releases water for diversion by the Pickering ditch, which is the proposed lower terminus for the lower reach of Troublesome Creek. Based on this analysis staff has determined that water is available for appropriation on Troublesome Creek, from the confluence with Glomerate Creek to the confluence with Rabbit Ears Creek, 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:

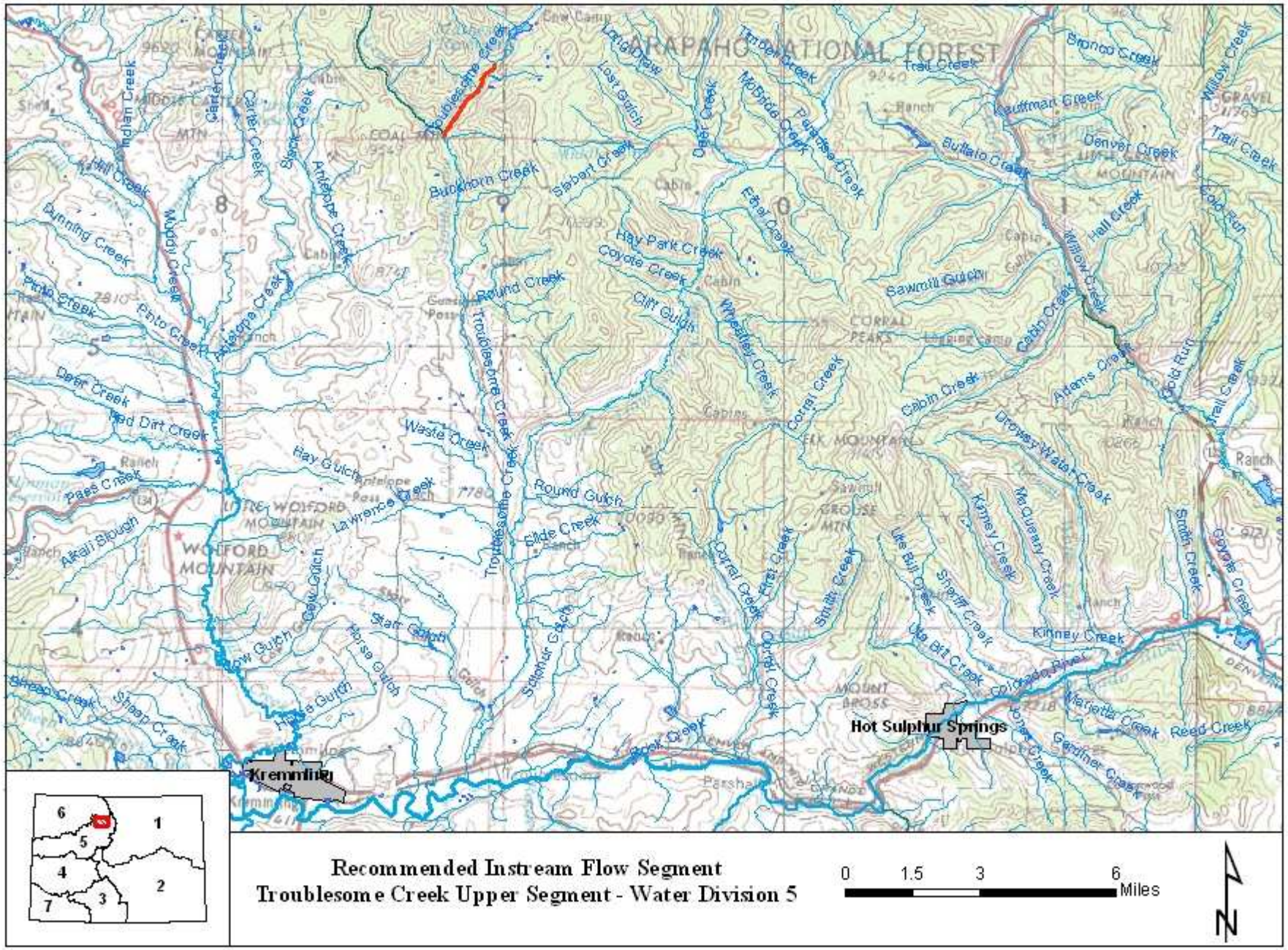
Segment: Confluence with Glomerate Creek to Confluence with Rabbit Ears Creek

Upper Terminus: CONFLUENCE WITH GLOMERATE CREEK
(Latitude 40° 17' 9.11"N) (Longitude 106° 17' 50.76"W)
UTM North: 4460293.5 N UTM East: 389713.17
SW NE S25 T4N R80W 6PM
1675' West of the East Section Line; 1365' South of the North Section Line

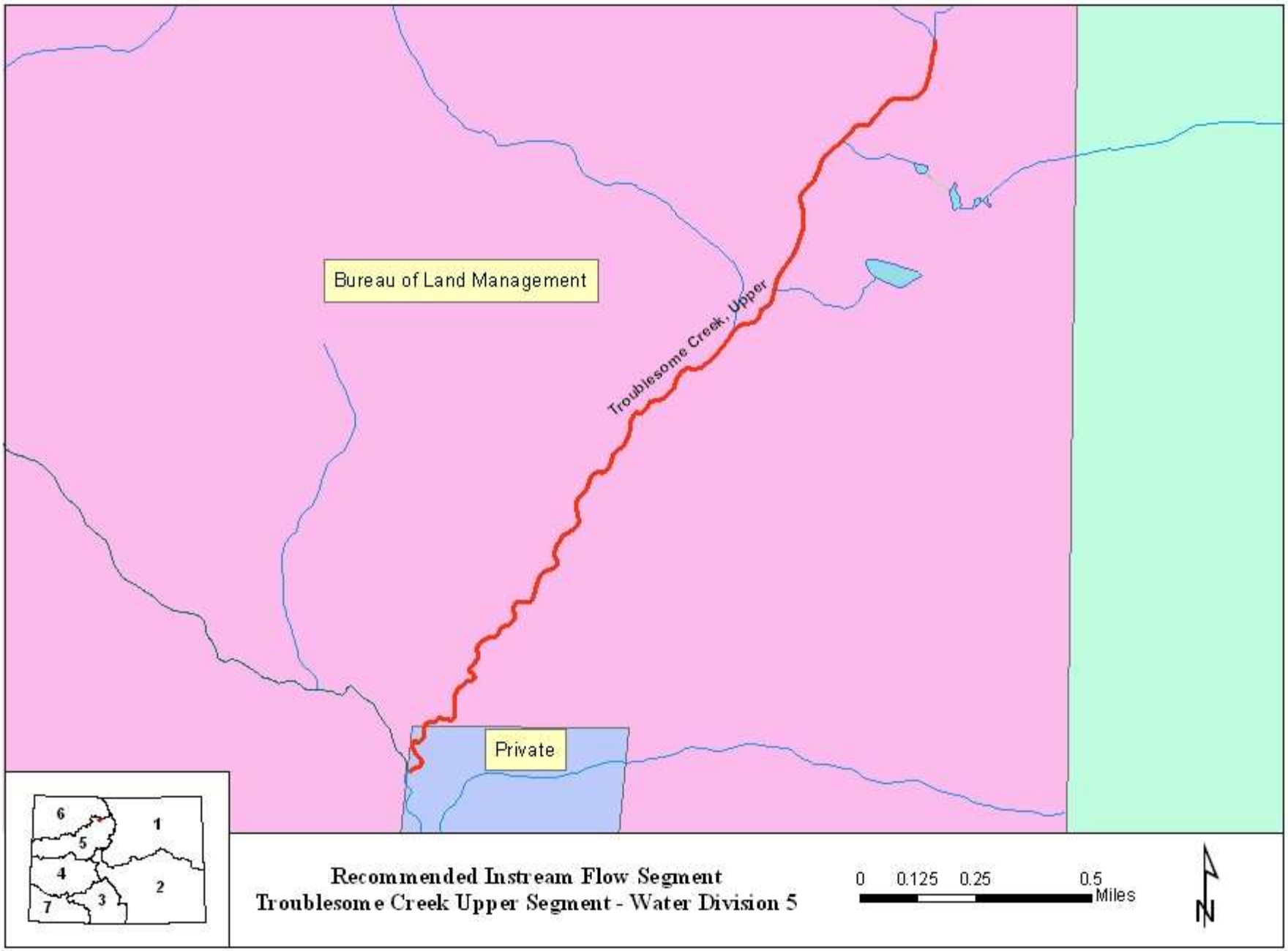
Lower Terminus: CONFLUENCE WITH RABBIT EARS CREEK
(Latitude 40° 15' 45.93"N) (Longitude 106° 19' 6.45"W)
UTM North: 4457755.2 N UTM East: 387887.6
SW SW S35 T4N R80W 6PM
2410' West of the East Section Line; 695' North of the South Section Line

Watershed: Colorado headwaters (HUC#:14010001)
Counties: Grand
Length: 2.2 miles
USGS Quad(s): Hyannis Peak
Flow Recommendation: 5.1 cfs (April 1 to October 31)
2.8 cfs (November 1 to March 31)

Vicinity Map



Land Use Map


Bureau of Land Management
Troublesome Creek, Upper
Private
6
1
5
4
2
7
3
Recommended Instream Flow Segment
Troublesome Creek Upper Segment - Water Division 5
0
0.125
0.25
0.5
Miles
N

Topographic & Water Rights Map