United States Department of the Interior
BUREAU OF LAND MANAGEMENT
Colorado State Office
2850 Youngfield Street
Lakewood, Colorado 80215-7093
www.blm.gov/co

TAKE PRIDE IN AMERICA

RECEIVED
JAN 12 2009
Colorado Water Conservation Board

In Reply Refer To:
7250 (CO-932)

JAN 08 2009

Ms. Linda Bassi
Colorado Water Conservation Board
1313 Sherman Street, Room 721
Denver, Colorado 80203

Dear Ms. Bassi:

The Bureau of Land Management (BLM) is recommending an instream flow enlargement on the lower portion of East Elk Creek, located in Water Division 4. Colorado Division of Wildlife (CDOW) assisted in developing this instream flow recommendation, and CDOW will also be sending a recommendation letter.

This recommendation pertains to the reach that begins at the confluence with Bear Wallow Gulch and extends downstream to the confluence with Blue Mesa Reservoir, a distance of approximately 4.5 miles. The existing instream flow water right on East Elk Creek is 1.5 cubic feet per second (cfs), year round, from the headwaters to the confluence with Blue Mesa Reservoir. The existing instream flow water right was established in 1984.

Location and Land Status: East Elk is tributary to Blue Mesa Reservoir approximately 16 miles southwest of the City of Gunnison. The entire creek is located within Gunnison County. The land along the stream reach is a mixture of BLM land, the Colorado Division of Wildlife's Sapinero State Wildlife Area, and less than ¼ mile of Forest Service land.

Biological Summary: Overall, East Elk Creek is a moderate gradient stream with small substrate size. The lower sections of the creek near Blue Mesa Reservoir are characterized by extensive beaver activity. Upper portions of the creek are characterized by a narrower canyon, less channel movement, and large substrate size. The creek supports a very vigorous willow-alder cottonwood riparian community. The creek also supports a healthy and diverse aquatic insect community, including caddisfly, stonefly, and mayfly. Fishery surveys indicate that the creek supports a self-sustaining population of brook trout.

R2Cross Analysis: The BLM's data analysis, developed with the Division of Wildlife, indicates that the following flows are needed to protect the fishery and natural environment to a reasonable degree.

- A 0.7 cfs enlargement is recommended during the high temperature period from April 1 through October 31, bringing the total instream flow up to 2.3 cfs during this time period.

Justification for Instream Flow Enlargement: The BLM and CDOW were prompted to re-examine the instream flow on East Elk because of heavy use of the creek. The existence of a state wildlife area, combined with proximity to Blue Mesa Reservoir, draws a large number of hunters and fisherman. In addition, the BLM has removed this area from grazing use to better supports riparian and fish management objectives. Finally, the BLM and CDOW noted during the recent drought cycle that flow rates on East Elk Creek became almost too low to support fish life. Additional appropriations on the creek, exercised during dry periods, may result in loss of the fishery.

Cross section analysis revealed that the current instream flow rate of 1.5 cfs is not fully protective. The BLM and CDOW note that while this flow rate meets the depth and wetted perimeter criteria in most riffle locations, it does not come close to meeting the velocity criteria. The BLM and CDOW believe the velocity criterion is important in this stream for maintaining suitable stream temperatures for salmonids. Much of the stream reach doesn't have shade cover in open meadows and areas where beaver activity is significant; creating higher stream temperatures. In addition, the slowing of water in beaver ponds creates more unshaded water and longer residence time; resulting in higher temperatures. While stream temperatures at this elevation may not become so high that fish kills result, high temperatures can result in dramatically reduced fish recruitment and size.

The BLM and CDOW note that the extensive beaver activity, while increasing the width and health of the riparian community, dramatically reduces the amount of riffle habitat available for spawning. The BLM and CDOW believe that the limited habitat should provide the velocities preferred by salmonids. The combination of adequate riffle habitat, combined with substantial pond habitat, is what makes East Elk Creek a successful fishery despite the small stream size.

Water Availability: For water availability analysis, the BLM and CDOW recommend using a combination of methods. First, a synthetic hydrograph should be developed using the equations provided in *Estimation of Natural Streamflow Characteristics in Western Colorado, USGS Water Resources Investigation Report 85-4086, 1985.* This method incorporates data about basin size and elevation. This synthetic hydrograph should then be reconciled against historic gage data. The most relevant historic gage is USGS gage 09123000 and 09122500 (Soap Creek at Sapinero, CO). Soap Creek has very similar slope, elevation, and aspect to East Elk Creek, and is located only a few miles to the west. It is important to note that gage 09122500 is located higher on Soap Creek than gage 09123500, because the construction of Blue Mesa Reservoir inundated the site of gage 09123500. As such, gage 09122500 does not incorporate inflows from

some large tributaries, such as Cow Creek, because the gage is located higher in the watershed.

There are multiple decreed water rights located at the lower terminus of this stream reach. The BLM and CDOW believe that most of these water rights are inactive, and were formerly used to irrigate lands that were inundated by the construction of Blue Mesa Reservoir. The BLM is not aware of any decreed surface diversions either within or upstream of the reach proposed for the enlargement.

Conclusion: The BLM and CDOW believe that there is strong justification for an additional instream flow appropriation on this small, highly accessible creek. As noted above, additional appropriations on this creek during dry periods could imperil the ability of the creek to support fish. Our initial water availability analysis indicates that there is sufficient water to support the appropriation without material injury to existing water rights. Accordingly, we urge the board to make an initial appropriation at its regular board meeting in January 2009.

Data sheets, R2Cross output, fishery survey information, and photographs of the cross section to support this recommendation were provided with the draft recommendation in February 2008. We thank the Colorado Water Conservation Board for its cooperation in this effort.

If you have any questions regarding our instream flow recommendation, please contact Roy Smith at 303-239-3940.

Sincerely,

Linda Anania
Deputy State Director, Resources and Fire

cc:
Matt Malick, Gunnison FO
Art Hayes, Gunnison FO
Tom Fresques, Glenwood Springs FO

DRAFT INSTREAM FLOW RECOMMENDATION – EAST ELK CREEK, WD 4

Feb. 13, 2008

Ms. Linda Bassi
Colorado Water Conservation Board
1313 Sherman Street, Room 721
Denver, Colorado 80203

Dear Ms. Bassi:

The Bureau of Land Management (BLM) is writing this letter to formally communicate its recommendation for an instream flow enlargement on the lower portion of East Elk Creek, located in Water Division 4. Colorado Division of Wildlife assisted in developing this instream flow recommendation, and will also be sending a supporting recommendation letter.

This recommendation pertains to the reach that begins at the confluence with Bear Wallow Gulch and extends downstream to the confluence with Blue Mesa Reservoir, a distance of approximately 4.5 miles. The existing instream flow water right on East Elk Creek is 1.5 cubic feet per second, year round, from the headwaters to the confluence with Blue Mesa Reservoir. The existing instream flow water right was established in 1984.

Location and Land Status. East Elk is tributary to Blue Mesa Reservoir approximately 16 miles southwest of the City of Gunnison. The entire creek is located within Gunnison County. The land along the stream reach is a mixture of BLM land, the Colorado Division of Wildlife's Sapinero State Wildlife Area, and less than ¼ mile of Forest Service land.

Biological Summary. Overall, East Elk Creek is a moderate gradient stream with small substrate size. The lower sections of the creek near Blue Mesa Reservoir are characterized by extensive beaver activity. Upper portions of the creek are characterized by a narrower canyon, less channel movement, and large substrate size. The creek supports a very vigorous willow-alder cottonwood riparian community. The creek also supports a healthy and diverse aquatic insect community, including caddisfly, stonefly, and mayfly. Fishery surveys indicate that the creek supports a self-sustaining population of brook trout.

R2Cross Analysis. BLM's data analysis, developed with the Division of Wildlife, indicates that the following flows are needed to protect the fishery and natural environment to a reasonable degree.

> A 0.7 cubic feet per second enlargement is recommended during the high temperature period from April 1 through October 31, bringing the total instream flow right up to 2.3 cubic feet per second during this time period.

Justification for Instream Flow Enlargement. BLM and CDOW were prompted to re-examine the instream flow on East Elk because of heavy use of the creek. The existence

of a state wildlife area, combined with proximity to Blue Mesa Reservoir, draws a large number of hunters and fisherman. In addition, BLM has removed this area from grazing use so that it better supports riparian and fish management objectives. Finally, BLM and CDOW noted during the recent drought cycle that flow rates on East Elk Creek became almost too low to support fish life. Additional appropriations on the creek, exercised during dry periods, may result in loss of the fishery.

Cross section analysis revealed that the current instream flow rate of 1.5 cfs is not fully protective. BLM and CDOW note that while this flow rate meets the depth and wetted perimeter criteria in most riffle locations, it does not come close to meeting the velocity criteria. BLM and CDOW believe the velocity criterion is important in this stream for maintaining suitable stream temperatures for salmonids. Much of the stream reach doesn't have shade cover in open meadows and where beaver activity is significant, which creates higher stream temperatures. In addition, the slowing of water in beaver ponds creates more unshaded water and longer residence time, resulting in higher temperatures. While stream temperatures at this elevation may not become so high that fish kills result, high temperatures can result in dramatically reduced fish recruitment and size.

Finally, BLM and CDOW note that the extensive beaver activity, while increasing the width and health of the riparian community, dramatically reduces the amount of riffle habitat available for spawning. BLM and CDOW believe that the limited habitat should provide the velocities preferred by salmonids. The combination of adequate riffle habitat, combined with substantial pond habitat, is what makes East Elk Creek a successful fishery despite the small stream size.

Water Availability. For water availability analysis, BLM and CDOW recommend using a combination of methods. First, a synthetic hydrograph should be developed using the equations provided in *Estimation of Natural Streamflow Characteristics in Western Colorado, USGS Water Resources Investigation Report 85-4086, 1985.* This method incorporates data about basin size and elevation. This synthetic hydrograph should then be reconciled against historic gage data. The most relevant historic gage is USGS gage 09123000 and 09122500 (Soap Creek at Sapinero, CO). Soap Creek has very similar slope, elevation, and aspect to East Elk Creek, and is located only a few miles to the west. It is important to note that gage 09122500 is located higher on Soap Creek than gage 09123500, because the construction of Blue Mesa Reservoir inundated the site of gage 09123500. As such, gage 09122500 does not incorporate inflows from some large tributaries, such as Cow Creek, because the gage is located higher in the watershed.

There are multiple decreed water rights located at the lower terminus of this stream reach. BLM and CDOW believes that most of these water rights are inactive, and were formerly used to irrigate lands that were inundated by the construction of Blue Mesa Reservoir. (Fill in data from NPS here about these water rights.) BLM is not aware of any decreed surface diversions either within or upstream of the reach proposed for the enlargement.

Conclusion. BLM and CDOW believe that there is strong justification for an additional instream flow appropriation on this small, highly accessible creek. As noted above, additional appropriations on this creek during dry periods could imperil the ability of the creek to support fish. Our initial water availability analysis indicates there is sufficient water to support the appropriation without material injury to existing water rights. Accordingly, we urge the board to make an initial appropriation at its regular board meeting in January 2009.

Data sheets, R2Cross output, fishery survey information, and photographs of the cross section are enclosed to support this recommendation. We thank the Colorado Water Conservation Board for its cooperation in this effort.

If you have any questions regarding our instream flow recommendation, please contact Roy Smith at 303-239-3940.

Sincerely,

Linda Anania
Deputy State Director
Resources and Fire

4 Enclosures

cc: Kenny McDaniel, Gunnison FO
Art Hayes, Gunnison FO
Tom Fresques, Glenwood Springs FO

COLORADO WATER CONSERVATION BOARD

FIELD DATA FOR INSTREAM FLOW DETERMINATIONS

LOCATION INFORMATION

STREAM NAME: East Elk Creek						CROSS-SECTION NO.: 1
CROSS-SECTION LOCATION: 0.6 mi. upstream from Blue Mesa Res.						
DATE: 7-20-07	OBSERVERS: R. Smith, N. Boyum					
LEGAL DESCRIPTION	¼ SECTION: NE	SECTION: 22	TOWNSHIP: 49 (N)/S	RANGE: 3 E/W	PM: NM	
COUNTY: Gunnison	WATERSHED: Gunnison	WATER DIVISION: 4	DOW WATER CODE: 37102			
MAP(S): USGS: Carpenter Ridge 7.5'		Zone 13	0310878			
USFS:		4262733	7648 ft.			

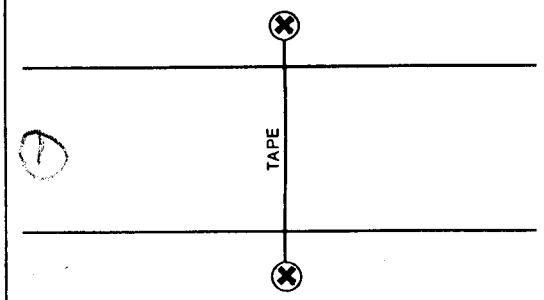
SUPPLEMENTAL DATA

SAG TAPE SECTION SAME AS DISCHARGE SECTION: YES / NO	METER TYPE: Marsh - McBirney			
METER NUMBER:	DATE RATED:	CALIB/SPIN: ____ sec	TAPE WEIGHT: surveyed ____ lbs/foot	TAPE TENSION: surveyed ____ lbs
CHANNEL BED MATERIAL SIZE RANGE: 2" cobbles to 1-foot boulders	PHOTOGRAPHS TAKEN: (YES)/NO	NUMBER OF PHOTOGRAPHS: 3		

CHANNEL PROFILE DATA

STATION	DISTANCE FROM TAPE (ft)	ROD READING (ft)
⊗ Tape @ Stake LB	0.0	
⊗ Tape @ Stake RB	0.0	
① WS @ Tape LB/RB	0.0	4.56 / 4.55
② WS Upstream	17.0'	4.20
③ WS Downstream	24.0'	5.20
SLOPE	1.00 / 41.0' = .024	

SKETCH



LEGEND:
- Stake ⊗
- Station ①
- Photo ①→
- Direction of Flow

AQUATIC SAMPLING SUMMARY

STREAM ELECTROFISHED: (YES)/NO	DISTANCE ELECTROFISHED: ____ft	FISH CAUGHT: (YES)/NO	WATER CHEMISTRY SAMPLED: (YES)/NO

LENGTH - FREQUENCY DISTRIBUTION BY ONE-INCH SIZE GROUPS (1.0-1.9, 2.0-2.9, ETC.)

SPECIES (FILL IN)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	>15	TOTAL

AQUATIC INSECTS IN STREAM SECTION BY COMMON OR SCIENTIFIC ORDER NAME:

mayfly, caddisfly, stonefly

COMMENTS

Ph = 7.8
TDS: 110
Temp: 15°C

DISCHARGE/CROSS SECTION NOTES

STREAM NAME: East Elk Creek	CROSS-SECTION NO.: 1	DATE: 7-20-07	SHEET 1 OF 1
BEGINNING OF MEASUREMENT	EDGE OF WATER LOOKING DOWNSTREAM: (0.0 AT STAKE) LEFT / RIGHT	Gage Reading: _____ ft	TIME: 9:30 am

Features (Stake (S), Grassline (G), Waterline (W), Rock (R))	Distance From Initial Point (ft)	Width (ft)	Total Vertical Depth From Tape/Inst (ft)	Water Depth (ft)	Depth of Observation (ft)	Revolutions	Time (sec)	Velocity (ft/sec) At Point	Velocity (ft/sec) Mean in Vertical	Area (ft^2)	Discharge (cfs)
RS	0.0		3.60								
G	1.9		4.00								
W	3.9		4.55								
	4.5		4.59	.05				0			
	5.0		4.82	.25				0.75			
	5.5		4.81	.25				0.70			
	6.0		4.68	.15				0.58			
	6.5		4.73	.20				0.14			
	7.0		4.84	.30				0.38			
	7.5		4.90	.35				1.18			
	8.0		4.81	.25				1.60			
	8.5		4.79	.25				0.62			
	9.0		5.03	.45				0.21			
	9.5		5.00	.45				1.21			
	10.0		5.02	.45				1.16			
	10.5		5.02	.45				2.35			
	11.0		5.06	.50				1.88			
	11.5		4.87	.30				1.61			
	12.0		4.75	.20				1.00			
	12.5		4.72	.15				0.25			
	13.0		4.71	.15				0.90			
	13.5		4.72	.15				0.26			
W	13.8		4.56								
G	14.5		3.94								
LS	17.3		3.46								
TOTALS:											

End of Measurement	Time: 9:45	Gage Reading: _____ ft	CALCULATIONS PERFORMED BY:	CALCULATIONS CHECKED BY:

COLORADO WATER CONSERVATION BOARD

FIELD DATA FOR INSTREAM FLOW DETERMINATIONS

LOCATION INFORMATION

STREAM NAME: East [illegible] Creek						CROSS-SECTION NO.: 2
CROSS-SECTION LOCATION: 0.6 miles upstream from Blue Mesa Res.						
DATE: [illegible]	OBSERVERS: [illegible]					
LEGAL DESCRIPTION	¼ SECTION: NE	SECTION: 22	TOWNSHIP: 47 N/S	RANGE: 3 E/W	PM: NM	
COUNTY: [illegible]	WATERSHED: Gunnison	WATER DIVISION: 4	DOW WATER CODE: 37762			
MAP(S): USGS: Carpenter Ridge 7.5'						
USFS:						

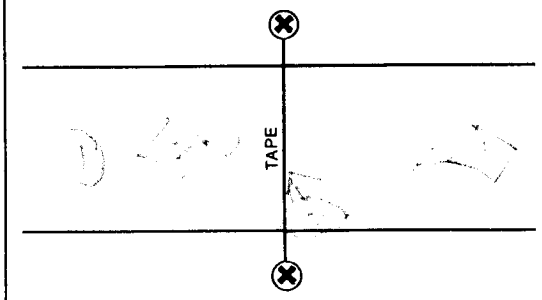
SUPPLEMENTAL DATA

SAG TAPE SECTION SAME AS DISCHARGE SECTION: YES / NO	METER TYPE: Marsh-McBirney			
METER NUMBER:	DATE RATED:	CALIB/SPIN: _____ sec	TAPE WEIGHT: _____ lbs/foot	TAPE TENSION: _____ lbs
CHANNEL BED MATERIAL SIZE RANGE: gravel to [illegible] boulders	PHOTOGRAPHS TAKEN: YES/NO	NUMBER OF PHOTOGRAPHS: 3		

CHANNEL PROFILE DATA

STATION	DISTANCE FROM TAPE (ft)	ROD READING (ft)
⊗ Tape @ Stake LB	0.0	
⊗ Tape @ Stake RB	0.0	
① WS @ Tape LB/RB	0.0	[illegible]
② WS Upstream	[illegible]	[illegible]
③ WS Downstream	[illegible]	[illegible]
SLOPE	0.72 [illegible] = .024	

SKETCH



LEGEND:
- Stake ⊗
- Station ①
- Photo ◇①→
- Direction of Flow ← →

AQUATIC SAMPLING SUMMARY

STREAM ELECTROFISHED: YES/NO	DISTANCE ELECTROFISHED: _____ft	FISH CAUGHT: YES/NO	WATER CHEMISTRY SAMPLED: YES/NO

LENGTH - FREQUENCY DISTRIBUTION BY ONE-INCH SIZE GROUPS (1.0-1.9, 2.0-2.9, ETC.)

SPECIES (FILL IN)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	>15	TOTAL
[illegible]																	

AQUATIC INSECTS IN STREAM SECTION BY COMMON OR SCIENTIFIC ORDER NAME:

[illegible]

COMMENTS

[illegible] 110
[illegible] 15°C
[illegible] 7.8

FORM #ISF FD 1-85

DISCHARGE/CROSS SECTION NOTES

STREAM NAME: [illegible] Creek	CROSS-SECTION NO.: 2	DATE: 7-[illegible]	SHEET 1 OF 1
BEGINNING OF MEASUREMENT	EDGE OF WATER LOOKING DOWNSTREAM: (0.0 AT STAKE) LEFT / RIGHT	Gage Reading: ______ft	TIME: [illegible] am

Features: Stake (S) Grassline (G) Waterline (W) Rock (R)	Distance From Initial Point (ft)	Width (ft)	Total Vertical Depth From Tape/Inst (ft)	Water Depth (ft)	Depth of Observation (ft)	Revolutions	Time (sec)	Velocity (ft/sec) At Point	Velocity (ft/sec) Mean in Vertical	Area (ft²)	Discharge (cfs)
[illegible]	[illegible]		[illegible]								
[illegible]	2.6		[illegible]								
[illegible]	2.7		[illegible]					0			
	3.5		5.25	.30				0.67			
	[illegible]		5.25	.30				[illegible]			
	4.5		5.15	.20				[illegible]			
	[illegible]		5.10	.15				1.38			
	[illegible]		5.19	.25				1.54			
	6.0		5.21	.25				2.07			
	6.5		[illegible]	.35				2.[illegible]			
	7.0		5.11	.20				1.74			
	[illegible]		5.30	.35				1.15			
	8.0		5.28	[illegible]				.76			
	8.5		5.25	.40				.34			
	9.0		5.22	.25				[illegible]			
	[illegible]		5.20	.25				1.49			
	[illegible]		5.21	.25				[illegible]			
	[illegible]		5.16	.20				.31			
	[illegible]		5.09	.10				.23			
	[illegible]		5.01	.05				0			
W	11.7		[illegible]								
	[illegible]		[illegible]								
G	[illegible]		4.46								
	17.1		[illegible]								
[illegible]	[illegible]		[illegible]								
TOTALS:											

End of Measurement	Time:	Gage Reading: ______ ft	CALCULATIONS PERFORMED BY:	CALCULATIONS CHECKED BY:

COLORADO WATER CONSERVATION BOARD
INSTREAM FLOW / NATURAL LAKE LEVEL PROGRAM
STREAM CROSS-SECTION AND FLOW ANALYSIS

LOCATION INFORMATION

STREAM NAME:	East Elk Creek
XS LOCATION:	0.5 miles upstream from Blue Mesa Res.
XS NUMBER:	1
DATE:	20-Jul-07
OBSERVERS:	R. Smith, A. Hayes
1/4 SEC:	NE
SECTION:	22
TWP:	49N
RANGE:	3W
PM:	NM
COUNTY:	Gunnison
WATERSHED:	Gunnison
DIVISION:	4
DOW CODE:	39962
USGS MAP:	Carpenter Ridge 7.5'
USFS MAP:	0

SUPPLEMENTAL DATA

TAPE WT:	0.0106
TENSION:	99999

*** NOTE ***
Leave TAPE WT and TENSION at defaults for data collected with a survey level and rod

CHANNEL PROFILE DATA

SLOPE:	0.024

INPUT DATA CHECKED BY: .....DATE.....

ASSIGNED TO: ….....……….....DATE.....

STREAM NAME: East Elk Creek
XS LOCATION: 0.5 miles upstream from Blue Mesa Res.
XS NUMBER: 1

DATA POINTS= 25

VALUES COMPUTED FROM RAW FIELD DATA

	FEATURE	DIST	VERT DEPTH	WATER DEPTH	VEL	WETTED PERIM.	WATER DEPTH	AREA (Am)	Q (Qm)	% Q CELL
	RS	0.00	3.60			0.00		0.00	0.00	0.0%
1	G	1.90	4.00			0.00		0.00	0.00	0.0%
	W	3.90	4.55			0.00		0.00	0.00	0.0%
		4.50	4.59	0.05	0.00	0.60	0.05	0.03	0.00	0.0%
		5.00	4.82	0.25	0.75	0.55	0.25	0.13	0.09	3.3%
		5.50	4.81	0.25	0.70	0.50	0.25	0.13	0.09	3.1%
		6.00	4.68	0.15	0.58	0.52	0.15	0.08	0.04	1.6%
		6.50	4.73	0.20	0.14	0.50	0.20	0.10	0.01	0.5%
		7.00	4.84	0.30	0.38	0.51	0.30	0.15	0.06	2.0%
		7.50	4.90	0.35	1.18	0.50	0.35	0.18	0.21	7.4%
		8.00	4.81	0.25	1.60	0.51	0.25	0.13	0.20	7.1%
		8.50	4.79	0.25	0.62	0.50	0.25	0.13	0.08	2.8%
		9.00	5.03	0.45	0.21	0.55	0.45	0.23	0.05	1.7%
		9.50	5.00	0.45	1.21	0.50	0.45	0.23	0.27	9.7%
		10.00	5.02	0.45	1.16	0.50	0.45	0.23	0.26	9.3%
		10.50	5.02	0.45	2.35	0.50	0.45	0.23	0.53	18.9%
		11.00	5.06	0.50	1.88	0.50	0.50	0.25	0.47	16.8%
		11.50	4.87	0.30	1.61	0.53	0.30	0.15	0.24	8.6%
		12.00	4.75	0.20	1.00	0.51	0.20	0.10	0.10	3.6%
		12.50	4.72	0.15	0.25	0.50	0.15	0.08	0.02	0.7%
		13.00	4.71	0.15	0.90	0.50	0.15	0.08	0.07	2.4%
		13.50	4.72	0.15	0.26	0.50	0.15	0.06	0.02	0.6%
	W	13.80	4.56			0.34		0.00	0.00	0.0%
1	G	14.50	3.94			0.00		0.00	0.00	0.0%
	LS	17.30	3.46			0.00		0.00	0.00	0.0%
	TOTALS ----------					10.14	0.5 (Max.)	2.64	2.80	100.0%

Manning's n = 0.0883
Hydraulic Radius= 0.260042152

STREAM NAME: East Elk Creek
XS LOCATION: 0.5 miles upstream from Blue Mesa Res.
XS NUMBER: 1

WATER LINE COMPARISON TABLE

WATER LINE	MEAS AREA	COMP AREA	AREA ERROR
	2.64	2.65	0.4%
4.31	2.64	5.27	99.7%
4.33	2.64	5.05	91.4%
4.35	2.64	4.83	83.1%
4.37	2.64	4.61	74.9%
4.39	2.64	4.40	66.7%
4.41	2.64	4.18	58.6%
4.43	2.64	3.97	50.6%
4.45	2.64	3.76	42.7%
4.47	2.64	3.56	34.8%
4.49	2.64	3.35	27.0%
4.51	2.64	3.15	19.3%
4.52	2.64	3.05	15.5%
4.53	2.64	2.95	11.7%
4.54	2.64	2.85	7.9%
4.55	2.64	2.75	4.1%
4.56	2.64	2.65	0.4%
4.57	2.64	2.55	-3.3%
4.58	2.64	2.45	-7.0%
4.59	2.64	2.36	-10.5%
4.60	2.64	2.27	-14.0%
4.61	2.64	2.18	-17.5%
4.63	2.64	1.99	-24.5%
4.65	2.64	1.81	-31.3%
4.67	2.64	1.63	-38.1%
4.69	2.64	1.45	-44.9%
4.71	2.64	1.28	-51.4%
4.73	2.64	1.13	-57.3%
4.75	2.64	0.99	-62.4%
4.77	2.64	0.87	-67.1%
4.79	2.64	0.75	-71.6%
4.81	2.64	0.64	-75.7%

WATERLINE AT ZERO
AREA ERROR = 4.556

STREAM NAME: East Elk Creek
XS LOCATION: 0.5 miles upstream from Blue Mesa Res.
XS NUMBER: 1 Constant Manning's n

GL = lowest Grassline elevation corrected for sag
STAGING TABLE *WL* = Waterline corrected for variations in field measured water surface elevations and sag

	DIST TO WATER (FT)	TOP WIDTH (FT)	AVG. DEPTH (FT)	MAX. DEPTH (FT)	AREA (SQ FT)	WETTED PERIM. (FT)	PERCENT WET PERIM (%)	HYDR RADIUS (FT)	FLOW (CFS)	AVG. VELOCITY (FT/SEC)
GL	4.00	12.53	0.71	1.06	8.87	13.06	100.0%	0.68	17.87	2.01
	4.01	12.50	0.70	1.05	8.79	13.03	99.8%	0.67	17.65	2.01
	4.06	12.27	0.67	1.00	8.17	12.77	97.7%	0.64	15.84	1.94
	4.11	12.03	0.63	0.95	7.57	12.50	95.7%	0.61	14.12	1.87
	4.16	11.79	0.59	0.90	6.97	12.24	93.7%	0.57	12.49	1.79
	4.21	11.55	0.55	0.85	6.39	11.97	91.7%	0.53	10.96	1.72
	4.26	11.31	0.51	0.80	5.82	11.71	89.7%	0.50	9.51	1.64
	4.31	11.07	0.47	0.75	5.26	11.45	87.6%	0.46	8.16	1.55
	4.36	10.84	0.43	0.70	4.71	11.18	85.6%	0.42	6.90	1.47
	4.41	10.60	0.39	0.65	4.17	10.92	83.6%	0.38	5.73	1.37
	4.46	10.36	0.35	0.60	3.65	10.65	81.6%	0.34	4.66	1.28
	4.51	10.12	0.31	0.55	3.14	10.39	79.5%	0.30	3.68	1.17
WL	4.56	9.81	0.27	0.50	2.64	10.06	77.0%	0.26	2.82	1.07
	4.61	9.18	0.24	0.45	2.17	9.41	72.0%	0.23	2.12	0.98
	4.66	8.98	0.19	0.40	1.71	9.18	70.3%	0.19	1.46	0.85
	4.71	8.41	0.15	0.35	1.27	8.59	65.8%	0.15	0.93	0.73
	4.76	6.20	0.15	0.30	0.92	6.35	48.6%	0.15	0.67	0.72
	4.81	5.03	0.13	0.25	0.63	5.15	39.4%	0.12	0.41	0.65
	4.86	3.53	0.12	0.20	0.43	3.62	27.7%	0.12	0.27	0.63
	4.91	2.66	0.10	0.15	0.28	2.72	20.8%	0.10	0.16	0.57
	4.96	2.43	0.06	0.10	0.15	2.47	18.9%	0.06	0.06	0.40
	5.01	1.94	0.02	0.05	0.04	1.96	15.0%	0.02	0.01	0.18
	5.06	0.06	0.00	0.00	0.00	0.06	0.5%	0.00	0.00	0.04

STREAM NAME: East Elk Creek
XS LOCATION: 0.5 miles upstream from Blue Mesa Res.
XS NUMBER: 1

SUMMARY SHEET

MEASURED FLOW (Qm)=	2.80	cfs
CALCULATED FLOW (Qc)=	2.82	cfs
(Qm-Qc)/Qm * 100 =	-0.6	%
MEASURED WATERLINE (WLm)=	4.56	ft
CALCULATED WATERLINE (WLc)=	4.56	ft
(WLm-WLc)/WLm * 100 =	0.0	%
MAX MEASURED DEPTH (Dm)=	0.50	ft
MAX CALCULATED DEPTH (Dc)=	0.50	ft
(Dm-Dc)/Dm * 100	-0.8	%
MEAN VELOCITY=	1.07	ft/sec
MANNING'S N=	0.088	
SLOPE=	0.024	ft/ft
.4 * Qm =	1.1	cfs
2.5 * Qm=	7.0	cfs

RECOMMENDED INSTREAM FLOW:
=============================

FLOW (CFS)	PERIOD
===========	========
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________

RATIONALE FOR RECOMMENDATION:
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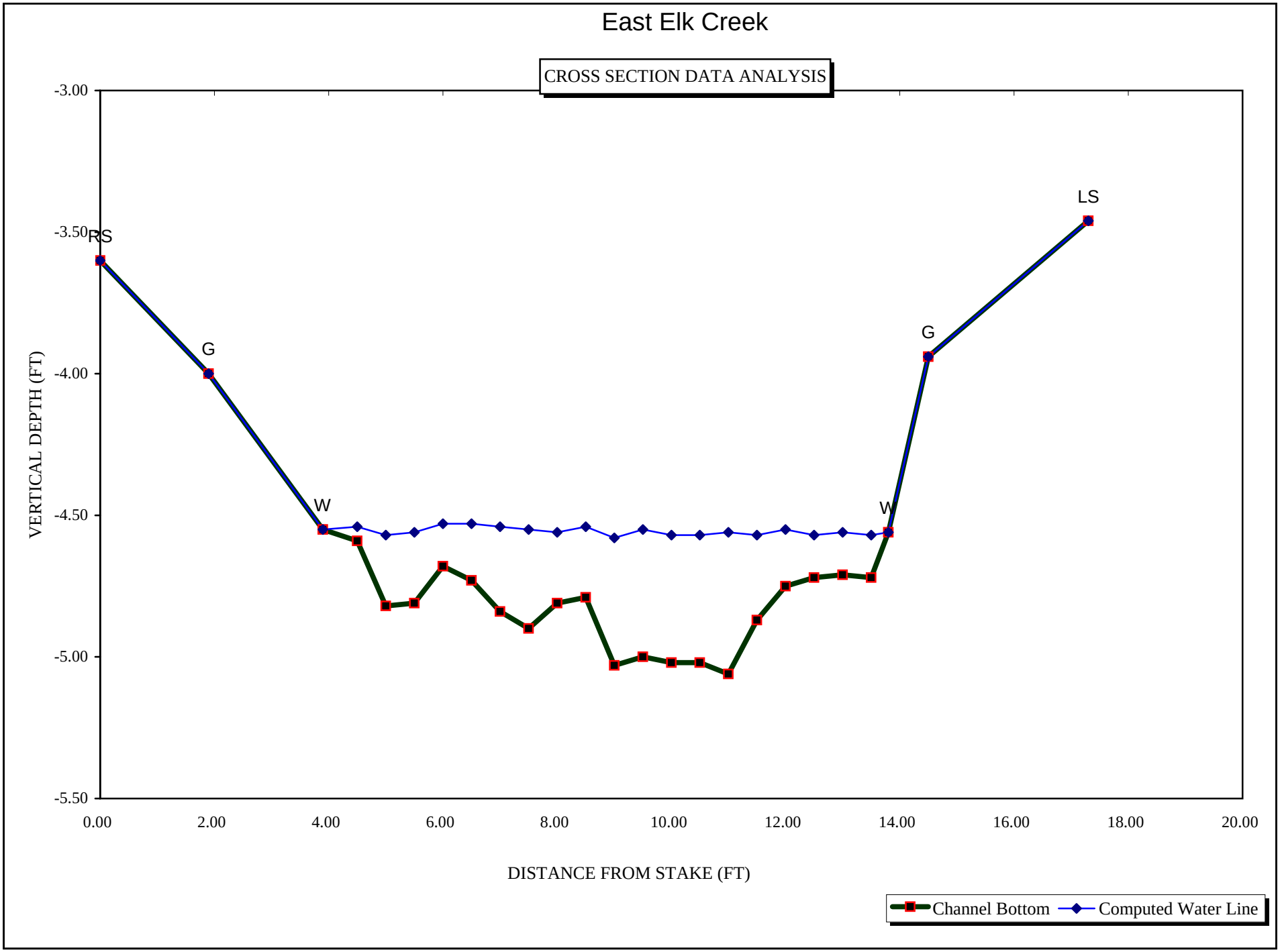
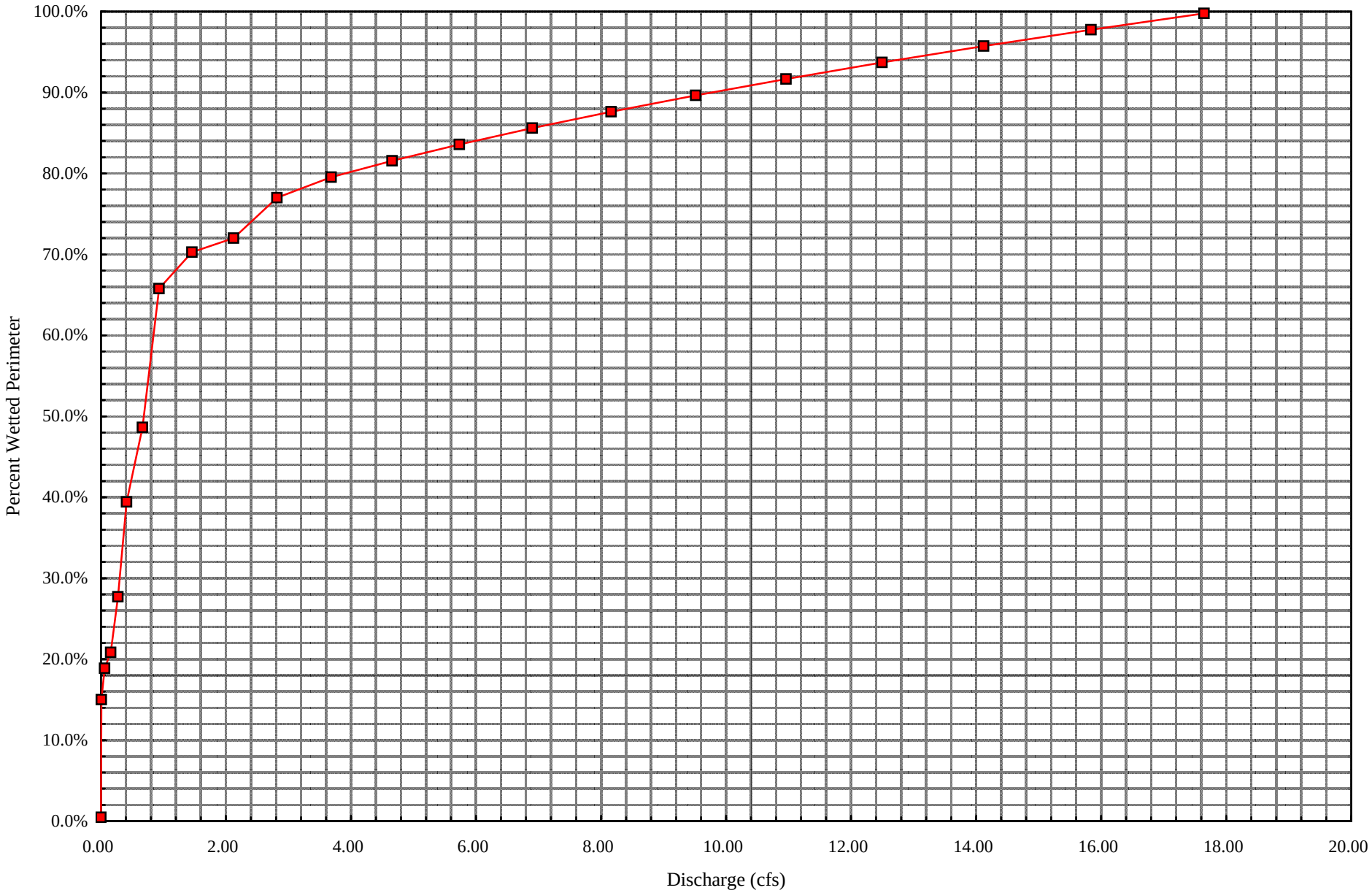
RECOMMENDATION BY: …………………...………..……............................... AGENCY..……………………….....…….....…....…....... DATE:.......…...…......…………

CWCB REVIEW BY: ..……………………………....……………………………………………………...…............... DATE:..................…………….....


East Elk Creek
CROSS SECTION DATA ANALYSIS
-3.00
-3.50
-4.00
-4.50
-5.00
-5.50
VERTICAL DEPTH (FT)
RS
G
W
W
G
LS
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
DISTANCE FROM STAKE (FT)
Channel Bottom
Computed Water Line

Percent Wetted Perimeter vs. Discharge



COLORADO WATER CONSERVATION BOARD
INSTREAM FLOW / NATURAL LAKE LEVEL PROGRAM
STREAM CROSS-SECTION AND FLOW ANALYSIS

LOCATION INFORMATION

STREAM NAME:	East Elk Creek
XS LOCATION:	0.6 miles upstream from Blue Mesa Res.
XS NUMBER:	2
DATE:	20-Jul-07
OBSERVERS:	R. Smith, A. Hayes
1/4 SEC:	NE
SECTION:	22
TWP:	49N
RANGE:	3W
PM:	NM
COUNTY:	Gunnison
WATERSHED:	Gunnison
DIVISION:	4
DOW CODE:	39962
USGS MAP:	Carpenter Ridge 7.5'
USFS MAP:	0

SUPPLEMENTAL DATA

TAPE WT:	0.0106
TENSION:	99999

*** NOTE ***
Leave TAPE WT and TENSION at defaults for data collected with a survey level and rod

CHANNEL PROFILE DATA

SLOPE:	0.024

INPUT DATA CHECKED BY: .....DATE.....

ASSIGNED TO: ….....……….....DATE.....

STREAM NAME: East Elk Creek
XS LOCATION: 0.6 miles upstream from Blue Mesa Res.
XS NUMBER: 2

WATER LINE COMPARISON TABLE

WATER LINE	MEAS AREA	COMP AREA	AREA ERROR
	2.11	2.12	0.6%
4.70	2.11	5.19	146.5%
4.72	2.11	4.92	133.7%
4.74	2.11	4.66	120.9%
4.76	2.11	4.39	108.2%
4.78	2.11	4.12	95.6%
4.80	2.11	3.86	82.9%
4.82	2.11	3.59	70.4%
4.84	2.11	3.33	58.0%
4.86	2.11	3.08	46.1%
4.88	2.11	2.84	34.9%
4.90	2.11	2.62	24.3%
4.91	2.11	2.51	19.2%
4.92	2.11	2.41	14.3%
4.93	2.11	2.31	9.6%
4.94	2.11	2.21	5.0%
4.95	2.11	2.12	0.6%
4.96	2.11	2.03	-3.6%
4.97	2.11	1.94	-7.8%
4.98	2.11	1.86	-11.9%
4.99	2.11	1.77	-16.0%
5.00	2.11	1.69	-20.0%
5.02	2.11	1.52	-28.0%
5.04	2.11	1.35	-35.9%
5.06	2.11	1.19	-43.6%
5.08	2.11	1.03	-51.2%
5.10	2.11	0.87	-58.6%
5.12	2.11	0.72	-65.6%
5.14	2.11	0.59	-72.0%
5.16	2.11	0.47	-77.9%
5.18	2.11	0.35	-83.3%
5.20	2.11	0.25	-88.2%

WATERLINE AT ZERO
AREA ERROR = 4.951

STREAM NAME: East Elk Creek
XS LOCATION: 0.6 miles upstream from Blue Mesa Res.
XS NUMBER: 2

DATA POINTS= 25

VALUES COMPUTED FROM RAW FIELD DATA

FEATURE	DIST	VERT DEPTH	WATER DEPTH	VEL	WETTED PERIM.	WATER DEPTH	AREA (Am)	Q (Qm)	% Q CELL
RS	0.00	4.12			0.00		0.00	0.00	0.0%
1 G	2.60	4.53			0.00		0.00	0.00	0.0%
W	2.90	4.94			0.00		0.00	0.00	0.0%
	3.50	5.25	0.30	0.69	0.68	0.30	0.17	0.11	3.7%
	4.00	5.25	0.30	1.49	0.50	0.30	0.15	0.22	7.2%
	4.50	5.13	0.20	0.27	0.51	0.20	0.10	0.03	0.9%
	5.00	5.10	0.15	1.38	0.50	0.15	0.08	0.10	3.4%
	5.50	5.19	0.25	1.57	0.51	0.25	0.13	0.20	6.4%
	6.00	5.21	0.25	2.07	0.50	0.25	0.13	0.26	8.4%
	6.50	5.32	0.35	2.41	0.51	0.35	0.18	0.42	13.7%
	7.00	5.11	0.20	1.74	0.54	0.20	0.10	0.17	5.6%
	7.50	5.30	0.35	1.15	0.53	0.35	0.18	0.20	6.5%
	8.00	5.28	0.35	1.96	0.50	0.35	0.18	0.34	11.1%
	8.50	5.35	0.40	1.33	0.50	0.40	0.20	0.27	8.6%
	9.00	5.22	0.25	1.49	0.52	0.25	0.13	0.19	6.0%
	9.50	5.20	0.25	1.49	0.50	0.25	0.13	0.19	6.0%
	10.00	5.21	0.25	1.52	0.50	0.25	0.13	0.19	6.2%
	10.50	5.16	0.20	1.31	0.50	0.20	0.10	0.13	4.2%
	11.00	5.09	0.10	1.23	0.50	0.10	0.05	0.06	2.0%
	11.50	5.01	0.05	0.00	0.51	0.05	0.02	0.00	0.0%
W	11.70	4.96			0.21		0.00	0.00	0.0%
	16.00	4.83			0.00		0.00	0.00	0.0%
1 G	16.70	4.46			0.00		0.00	0.00	0.0%
	17.10	3.45			0.00		0.00	0.00	0.0%
LS	18.40	2.84			0.00		0.00	0.00	0.0%
TOTALS ----------					9.03	0.4 (Max.)	2.11	3.08	100.0%

Manning's n = 0.0596
Hydraulic Radius= 0.233380458

STREAM NAME: East Elk Creek
XS LOCATION: 0.6 miles upstream from Blue Mesa Res.
XS NUMBER: 2 Constant Manning's n

GL = lowest Grassline elevation corrected for sag
STAGING TABLE *WL* = Waterline corrected for variations in field measured water surface elevations and sag

	DIST TO WATER (FT)	TOP WIDTH (FT)	AVG. DEPTH (FT)	MAX. DEPTH (FT)	AREA (SQ FT)	WETTED PERIM. (FT)	PERCENT WET PERIM (%)	HYDR RADIUS (FT)	FLOW (CFS)	AVG. VELOCITY (FT/SEC)
GL	4.53	13.97	0.54	0.82	7.53	14.48	100.0%	0.52	18.80	2.50
	4.55	13.91	0.52	0.80	7.23	14.41	99.5%	0.50	17.63	2.44
	4.60	13.78	0.47	0.75	6.54	14.24	98.3%	0.46	15.03	2.30
	4.65	13.65	0.43	0.70	5.85	14.07	97.2%	0.42	12.59	2.15
	4.70	13.52	0.38	0.65	5.17	13.90	96.0%	0.37	10.34	2.00
	4.75	13.39	0.34	0.60	4.50	13.73	94.8%	0.33	8.26	1.84
	4.80	13.26	0.29	0.55	3.84	13.56	93.7%	0.28	6.38	1.66
	4.85	12.45	0.26	0.50	3.18	12.73	87.9%	0.25	4.88	1.53
	4.90	10.76	0.24	0.45	2.60	11.01	76.1%	0.24	3.84	1.48
WL	4.95	9.06	0.23	0.40	2.11	9.29	64.1%	0.23	3.03	1.44
	5.00	8.52	0.20	0.35	1.67	8.73	60.2%	0.19	2.15	1.28
	5.05	8.12	0.15	0.30	1.26	8.32	57.4%	0.15	1.38	1.09
	5.10	7.67	0.11	0.25	0.86	7.85	54.2%	0.11	0.76	0.88
	5.15	6.17	0.08	0.20	0.52	6.31	43.5%	0.08	0.38	0.73
	5.20	4.52	0.05	0.15	0.24	4.62	31.9%	0.05	0.13	0.54
	5.25	1.98	0.04	0.10	0.09	2.03	14.0%	0.04	0.04	0.48
	5.30	0.66	0.02	0.05	0.01	0.68	4.7%	0.02	0.00	0.29

STREAM NAME: East Elk Creek
XS LOCATION: 0.6 miles upstream from Blue Mesa Res.
XS NUMBER: 2

SUMMARY SHEET

MEASURED FLOW (Qm)=	3.08	cfs
CALCULATED FLOW (Qc)=	3.03	cfs
(Qm-Qc)/Qm * 100 =	1.9	%
MEASURED WATERLINE (WLm)=	4.95	ft
CALCULATED WATERLINE (WLc)=	4.95	ft
(WLm-WLc)/WLm * 100 =	0.0	%
MAX MEASURED DEPTH (Dm)=	0.40	ft
MAX CALCULATED DEPTH (Dc)=	0.40	ft
(Dm-Dc)/Dm * 100	0.4	%
MEAN VELOCITY=	1.44	ft/sec
MANNING'S N=	0.060	
SLOPE=	0.024	ft/ft
.4 * Qm =	1.2	cfs
2.5 * Qm=	7.7	cfs

RECOMMENDED INSTREAM FLOW:
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FLOW (CFS)	PERIOD
===========	========
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________

RATIONALE FOR RECOMMENDATION:
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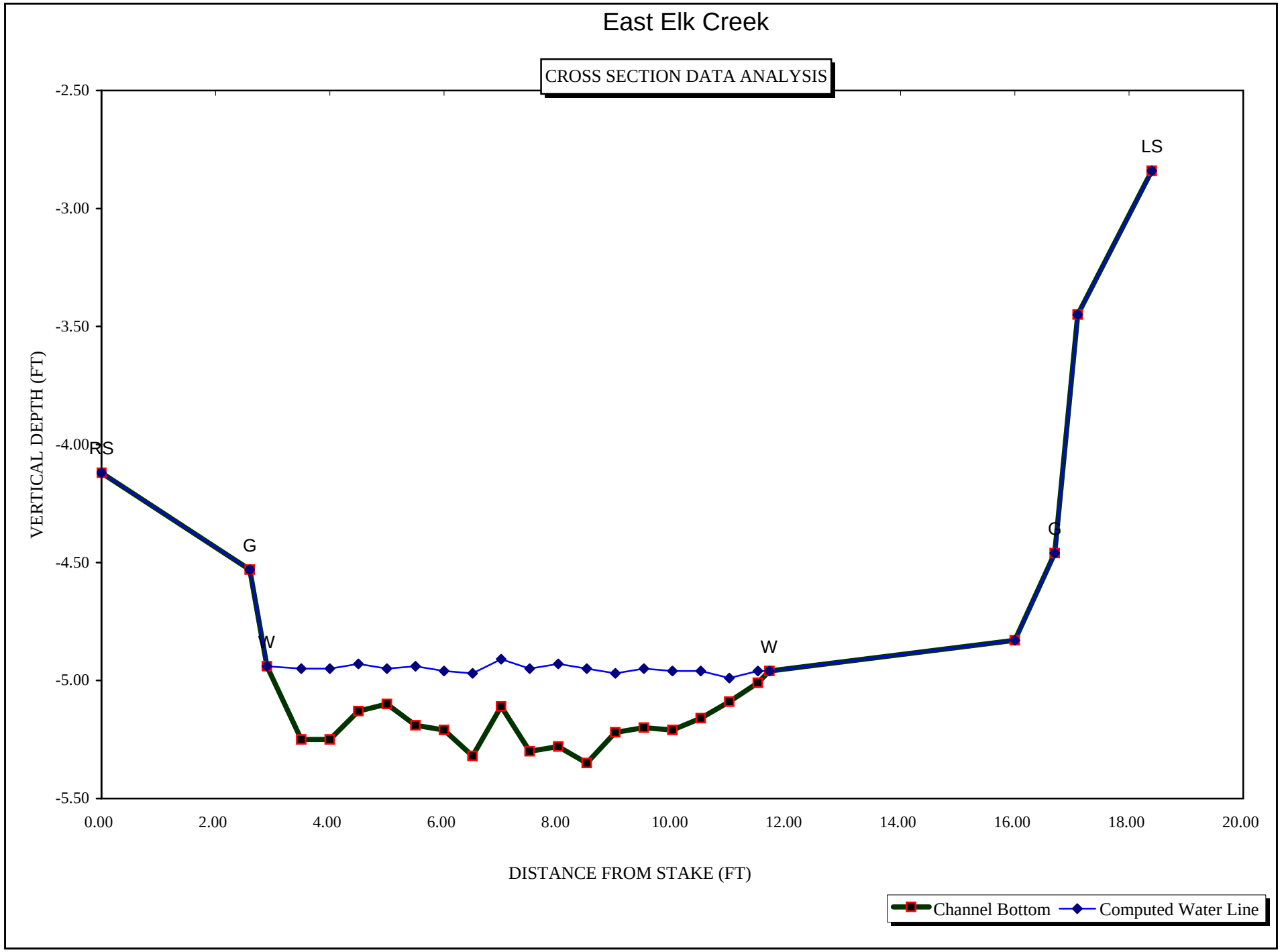
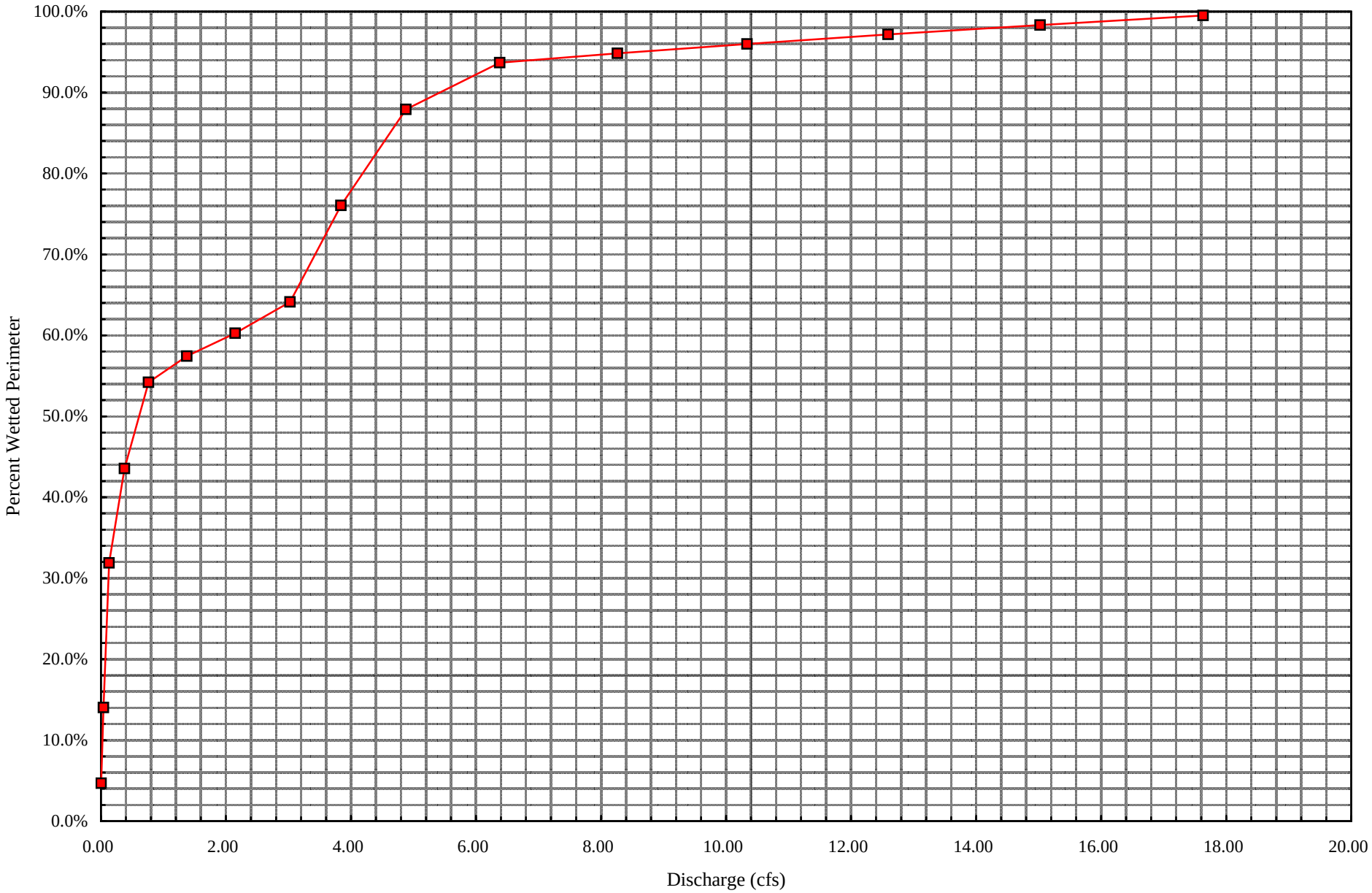
RECOMMENDATION BY: ………………...…………..……............................... AGENCY...……………………......……......…....…...... DATE:......….....……......……………

CWCB REVIEW BY: ..…………………………......…………………………………………………...…............. DATE:..................……………..….


East Elk Creek
CROSS SECTION DATA ANALYSIS
VERTICAL DEPTH (FT)
-2.50
-3.00
-3.50
-4.00
-4.50
-5.00
-5.50
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
DISTANCE FROM STAKE (FT)
RS
G
W
W
G
LS
Channel Bottom
Computed Water Line

Percent Wetted Perimeter vs. Discharge



Stream: East Elk Creek

Executive Summary

Water Division: 4
Water District: 59
CDOW#: 39962
CWCB ID: 09/4/A-002

Segment: Confluence with Bear Wallow Gulch to Confluence with Blue Mesa Reservoir

Upper Terminus: CONFLUENCE WITH BEAR WALLOW GULCH
(Latitude 38° 32’ 42.0”N) (Longitude 107° 10’ 13.0”W)

Lower Terminus: CONFLUENCE WITH BLUE MESA RESERVOIR
(Latitude 38° 28’ 58.4”N) (Longitude 107° 10’ 19.6”W)

Watershed: Upper Gunnison (HUC#: 14020002)
Counties: Gunnison
Length: 4.5 miles
USGS Quad(s): Carpenter Ridge, West Elk Peak SW
Existing ISF: 4-84CW378, 1.5 cfs (1/1-12/31)
Flow Recommendation (increase): 0.7 cfs (April 1 to October 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 Bureau of Land Management (BLM) and the Colorado Division of Wildlife (CDOW) recommended this segment of East Elk Creek to the CWCB for an increased water right under the Instream Flow Program. East Elk Creek is being considered for an increase because it has a natural environment that can be preserved to a reasonable degree with an increased instream flow water right.

East Elk Creek is approximately 12.3 miles long, begins within the Gunnison National Forest at an elevation of approximately 10,900 feet, and terminates at the confluence with Blue Mesa Reservoir at an elevation of approximately 7519 feet. The 4.5 mile segment addressed by this report is 100% publicly owned. East Elk Creek is located within Gunnison County and the total drainage area of the creek is approximately 22 square miles. East Elk Creek generally flows in a southwesterly direction.

The subject of this report is a segment of East Elk Creek beginning at the confluence with Bear Wallow Gulch and extending downstream to the confluence with Blue Mesa Reservoir. The proposed segment is located approximately 16 miles southwest of Gunnison. The staff has received one joint recommendation for this segment, from the BLM and CDOW. The recommendation for this segment is discussed below.

Instream Flow Recommendation

The BLM recommended 0.7 cfs (April 1 to October 31), based on its July 20, 2007 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 Bear Wallow Gulch	Confluence with Blue Mesa Reservoir	4.5	0%	100%

3% of the lands are USFS, 33% of the lands are BLM and the remaining 63% are State Wildlife Area.

Biological Data

Overall, East Elk Creek is a moderate gradient stream with small substrate size. The lower sections of the creek near Blue Mesa Reservoir are characterized by extensive beaver activity. Upper portions of the creek are characterized by a narrower canyon, less channel movement, and large substrate size. The creek supports a very vigorous willow-alder cottonwood riparian community. The creek also supports a healthy and diverse aquatic insect community, including caddisfly, stonefly, and mayfly. Fishery surveys indicate that the creek supports a self-sustaining population of brook trout.

Justification for Instream Flow Increase

BLM and CDOW were prompted to re-examine the instream flow on East Elk because of heavy use of the creek. The existence of a state wildlife area, combined with proximity to Blue Mesa Reservoir, draws a large number of hunters and fisherman. In addition, BLM has removed this area from grazing use so that it better supports riparian and fish management objectives. Finally, BLM and CDOW noted during the recent drought cycle that flow rates on East Elk Creek became almost too low to support fish life. Additional appropriations on the creek, exercised during dry periods, may result in loss of the fishery.

Cross section analysis revealed that the current instream flow rate of 1.5 cfs is not fully protective. BLM and CDOW note that while this flow rate meets the depth and wetted perimeter criteria in most riffle locations, it does not come close to meeting the velocity criteria. BLM and CDOW believe the velocity criterion is important in this stream for maintaining suitable stream temperatures for salmonids. Much of the stream reach doesn't have shade cover in open meadows and where beaver activity is significant, which creates higher stream temperatures. In addition, the slowing of water in beaver ponds creates more unshaded water and longer residence time, resulting in higher temperatures. While stream temperatures at this elevation may not become so high that fish kills result, high temperatures can result in dramatically reduced fish recruitment and size.

Finally, BLM and CDOW note that the extensive beaver activity, while increasing the width and health of the riparian community, dramatically reduces the amount of riffle habitat available for spawning. BLM and CDOW believe that the limited habitat should provide the velocities preferred by salmonids. The combination of adequate riffle habitat, combined with substantial pond habitat, is what makes East Elk Creek a successful fishery despite the small stream size.

Field Survey Data

BLM and 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, 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	7/20/2007	3.08	7.7 – 1.2	2.15	1.11
BLM	7/20/2007	2.80	7.0 – 1.1	2.28	1.59

BLM = Bureau of Land Management
(1) Predicted flow outside of the accuracy range of Manning's Equation. ? = Criteria never met in R2CROSS Staging Table.

The summer flow, which meets 3 of 3 criteria and is within the accuracy range of the R2CROSS model is 2.2 cfs. This flow was derived by averaging the results of the two data sets. The recommended summer flow increase of 0.7 cfs, when added to the existing ISF of 1.5 cfs is equal to 2.2 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 **East Elk Creek** no such gage is available at the LT. In fact, there is no gage on East Elk Creek. It is thus necessary to describe the normal flow regime at East Elk Creek above the LT through a "representative" gage station. The gage station selected for this purpose was SOAP CREEK NEAR SAPINERO, CO. (USGS 09122500), a gage with an 11 year period of record (POR) collected between 1954 and 1966. The gage is at an elevation of 7,790 ft above mean sea level (amsl) and has a drainage area of 57.4 mi^2. In this instance, due to the absence of existing significant upstream consumptive irrigation uses or transbasin diversions, the hydrograph (plot of discharge over time) produced from this gage was not "adjusted". To make the measured data from Soap Creek transferrable to East Elk Creek above the LT, all that was required was multiplication of the measured hydrograph by an area ratio; specifically, the area of East Elk Creek above the LT (22.19 mi^2 above the LT) to Soap Creek near Sapinero, CO (57.4 mi^2 above the gage). Unlike the situation in Soap Creek, there were a few diversions in the watershed above East Elk Creek above the LT. Consequently, the resulting proportioned hydrograph had to be "adjusted" (decreased) to reflect existing consumptive irrigation depletions on East Elk Creek. The final hydrograph thus represents a distribution of flow over time that has been reduced to reflect existing human uses.

{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 East Elk Creek above the LT was to compute the Geometric Mean of the area-prorated data values from the Soap Creek near Sapinero, 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 an enlargement displayed in figure 2. The data displayed in this hydrograph follow in Table 1.

Fig. 1. Geometric Mean Daily Discharge East Elk Cr abv LT (proportioned on Soap Cr) & ISFs

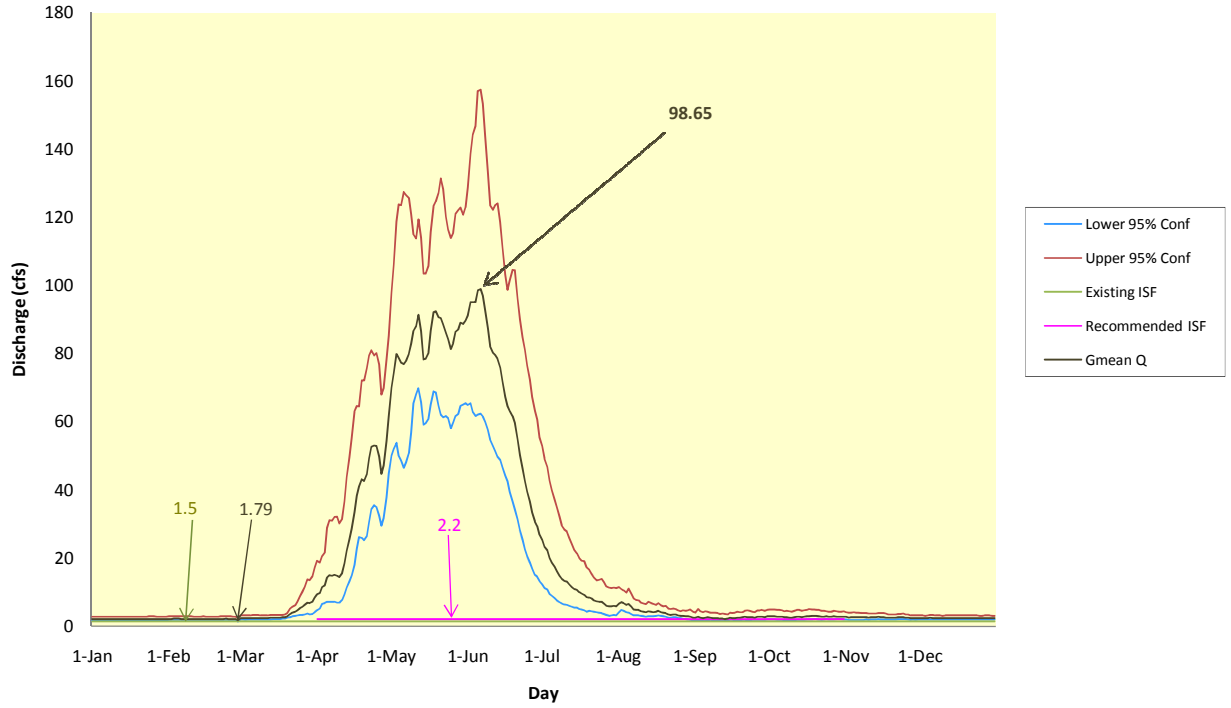


Fig. 2. Geometric Mean Daily Discharge East Elk Cr abv LT (proportioned on Soap Cr) & ISFs

Table 1. Geometric Mean Discharge and Recommended Instream Flows

Date	Existing ISF	Recommended ISF	Proportioned Adjusted GM (abv gage) Adj (-) for Irr & OoB in East Elk Cr abv LT
1-Jan	1.5		2.192931836
2-Jan	1.5		2.192931836
3-Jan	1.5		2.192931836
4-Jan	1.5		2.192931836
5-Jan	1.5		2.192931836
6-Jan	1.5		2.192931836
7-Jan	1.5		2.192931836
8-Jan	1.5		2.192931836
9-Jan	1.5		2.192931836
10-Jan	1.5		2.192931836
11-Jan	1.5		2.192931836
12-Jan	1.5		2.192931836
13-Jan	1.5		2.192931836
14-Jan	1.5		2.192931836
15-Jan	1.5		2.192931836

16-Jan	1.5	2.174013122
17-Jan	1.5	2.174013122
18-Jan	1.5	2.174013122
19-Jan	1.5	2.192931836
20-Jan	1.5	2.174013122
21-Jan	1.5	2.165960115
22-Jan	1.5	2.174013122
23-Jan	1.5	2.192931836
24-Jan	1.5	2.210346989
25-Jan	1.5	2.210346989
26-Jan	1.5	2.210346989
27-Jan	1.5	2.192931836
28-Jan	1.5	2.192931836
29-Jan	1.5	2.192931836
30-Jan	1.5	2.192931836
31-Jan	1.5	2.192931836
1-Feb	1.5	2.248343309
2-Feb	1.5	2.248343309
3-Feb	1.5	2.266198512
4-Feb	1.5	2.266198512
5-Feb	1.5	2.266198512
6-Feb	1.5	2.248343309
7-Feb	1.5	2.248343309
8-Feb	1.5	2.248343309
9-Feb	1.5	2.248343309
10-Feb	1.5	2.248343309
11-Feb	1.5	2.228946553
12-Feb	1.5	2.228946553
13-Feb	1.5	2.228946553
14-Feb	1.5	2.228946553
15-Feb	1.5	2.248343309
16-Feb	1.5	2.224397493
17-Feb	1.5	2.224397493
18-Feb	1.5	2.205207321
19-Feb	1.5	2.205207321
20-Feb	1.5	2.224397493
21-Feb	1.5	2.224397493
22-Feb	1.5	2.24206253
23-Feb	1.5	2.258436646
24-Feb	1.5	2.273703302
25-Feb	1.5	2.258436646
26-Feb	1.5	2.24206253
27-Feb	1.5	2.224397493
28-Feb	1.5	2.224397493
29-Feb	1.5	1.794438243
1-Mar	1.5	2.480990836
2-Mar	1.5	2.480990836
3-Mar	1.5	2.454790265
4-Mar	1.5	2.4668091

5-Mar	1.5		2.4668091
6-Mar	1.5		2.499109881
7-Mar	1.5		2.499109881
8-Mar	1.5		2.499109881
9-Mar	1.5		2.483484319
10-Mar	1.5		2.49993467
11-Mar	1.5		2.461369318
12-Mar	1.5		2.500693607
13-Mar	1.5		2.540877027
14-Mar	1.5		2.578367692
15-Mar	1.5		2.594153072
16-Mar	1.5		2.624476139
17-Mar	1.5		2.642982002
18-Mar	1.5		2.699216914
19-Mar	1.5		2.787818692
20-Mar	1.5		3.039557207
21-Mar	1.5		3.691669994
22-Mar	1.5		4.001794379
23-Mar	1.5		4.306369536
24-Mar	1.5		4.763354131
25-Mar	1.5		5.39782351
26-Mar	1.5		5.748369342
27-Mar	1.5		6.336471414
28-Mar	1.5		7.061263671
29-Mar	1.5		6.827318566
30-Mar	1.5		7.282315287
31-Mar	1.5		8.436593323
1-Apr	1.5	2.2	9.409393963
2-Apr	1.5	2.2	9.860886855
3-Apr	1.5	2.2	11.57756516
4-Apr	1.5	2.2	12.10804735
5-Apr	1.5	2.2	14.37704025
6-Apr	1.5	2.2	15.01707782
7-Apr	1.5	2.2	14.85505964
8-Apr	1.5	2.2	15.10775655
9-Apr	1.5	2.2	14.83866407
10-Apr	1.5	2.2	14.46402789
11-Apr	1.5	2.2	15.63317936
12-Apr	1.5	2.2	18.46936591
13-Apr	1.5	2.2	22.22630548
14-Apr	1.5	2.2	25.5147813
15-Apr	1.5	2.2	28.70130904
16-Apr	1.5	2.2	33.63881712
17-Apr	1.5	2.2	38.34693408
18-Apr	1.5	2.2	41.09037979
19-Apr	1.5	2.2	43.22538745
20-Apr	1.5	2.2	42.65124617
21-Apr	1.5	2.2	44.71580564
22-Apr	1.5	2.2	49.28578409

23-Apr	1.5	2.2	52.73634785
24-Apr	1.5	2.2	53.08894874
25-Apr	1.5	2.2	52.91607837
26-Apr	1.5	2.2	49.88634562
27-Apr	1.5	2.2	44.76140791
28-Apr	1.5	2.2	47.1617836
29-Apr	1.5	2.2	54.41881798
30-Apr	1.5	2.2	61.78360392
1-May	1.5	2.2	69.98913198
2-May	1.5	2.2	74.33345645
3-May	1.5	2.2	79.97256592
4-May	1.5	2.2	78.67377112
5-May	1.5	2.2	77.45601335
6-May	1.5	2.2	76.93856652
7-May	1.5	2.2	77.95872285
8-May	1.5	2.2	79.92175291
9-May	1.5	2.2	82.94424246
10-May	1.5	2.2	86.76330377
11-May	1.5	2.2	88.04282686
12-May	1.5	2.2	91.36264163
13-May	1.5	2.2	86.60214267
14-May	1.5	2.2	78.26863469
15-May	1.5	2.2	78.59995446
16-May	1.5	2.2	80.28081137
17-May	1.5	2.2	86.74589292
18-May	1.5	2.2	92.20933941
19-May	1.5	2.2	92.5226161
20-May	1.5	2.2	90.7114464
21-May	1.5	2.2	90.4244189
22-May	1.5	2.2	88.67972126
23-May	1.5	2.2	86.1709012
24-May	1.5	2.2	84.31022209
25-May	1.5	2.2	81.37846555
26-May	1.5	2.2	83.17093815
27-May	1.5	2.2	86.49501199
28-May	1.5	2.2	87.17692395
29-May	1.5	2.2	89.09095139
30-May	1.5	2.2	88.70897381
31-May	1.5	2.2	89.7359528
1-Jun	1.5	2.2	91.323475
2-Jun	1.5	2.2	95.20909772
3-Jun	1.5	2.2	95.16456245
4-Jun	1.5	2.2	95.09939536
5-Jun	1.5	2.2	98.64891157
6-Jun	1.5	2.2	99.02650551
7-Jun	1.5	2.2	97.04177446
8-Jun	1.5	2.2	92.9122578
9-Jun	1.5	2.2	87.45440811
10-Jun	1.5	2.2	82.18568897

11-Jun	1.5	2.2	80.29411258
12-Jun	1.5	2.2	79.67154145
13-Jun	1.5	2.2	78.57236547
14-Jun	1.5	2.2	75.93849506
15-Jun	1.5	2.2	71.87225493
16-Jun	1.5	2.2	67.3917853
17-Jun	1.5	2.2	64.74875043
18-Jun	1.5	2.2	63.12732749
19-Jun	1.5	2.2	61.70288866
20-Jun	1.5	2.2	59.8129993
21-Jun	1.5	2.2	54.88926304
22-Jun	1.5	2.2	50.34171977
23-Jun	1.5	2.2	46.44889261
24-Jun	1.5	2.2	42.60024084
25-Jun	1.5	2.2	39.58313927
26-Jun	1.5	2.2	36.7085471
27-Jun	1.5	2.2	33.46706982
28-Jun	1.5	2.2	30.76644864
29-Jun	1.5	2.2	29.49875033
30-Jun	1.5	2.2	26.90093241
1-Jul	1.5	2.2	25.39199141
2-Jul	1.5	2.2	23.47277449
3-Jul	1.5	2.2	22.40450724
4-Jul	1.5	2.2	20.07977944
5-Jul	1.5	2.2	18.75464124
6-Jul	1.5	2.2	17.54681685
7-Jul	1.5	2.2	16.22897826
8-Jul	1.5	2.2	14.92264126
9-Jul	1.5	2.2	14.01007059
10-Jul	1.5	2.2	13.42395019
11-Jul	1.5	2.2	13.13272328
12-Jul	1.5	2.2	12.37034517
13-Jul	1.5	2.2	11.59971834
14-Jul	1.5	2.2	11.02496213
15-Jul	1.5	2.2	10.70848522
16-Jul	1.5	2.2	10.05835386
17-Jul	1.5	2.2	9.617961399
18-Jul	1.5	2.2	9.285234648
19-Jul	1.5	2.2	8.584679109
20-Jul	1.5	2.2	8.521772697
21-Jul	1.5	2.2	8.169211557
22-Jul	1.5	2.2	7.669336226
23-Jul	1.5	2.2	7.353639007
24-Jul	1.5	2.2	7.290285991
25-Jul	1.5	2.2	7.280672646
26-Jul	1.5	2.2	6.773396138
27-Jul	1.5	2.2	6.127568802
28-Jul	1.5	2.2	5.881671895
29-Jul	1.5	2.2	5.94665488

30-Jul	1.5	2.2	6.034292108
31-Jul	1.5	2.2	5.945152296
1-Aug	1.5	2.2	6.731056528
2-Aug	1.5	2.2	7.11437503
3-Aug	1.5	2.2	6.82417642
4-Aug	1.5	2.2	6.284130231
5-Aug	1.5	2.2	6.571232098
6-Aug	1.5	2.2	5.740366806
7-Aug	1.5	2.2	5.019931529
8-Aug	1.5	2.2	4.811490553
9-Aug	1.5	2.2	4.825412378
10-Aug	1.5	2.2	4.483665449
11-Aug	1.5	2.2	4.291099265
12-Aug	1.5	2.2	4.171398532
13-Aug	1.5	2.2	4.463683977
14-Aug	1.5	2.2	4.310044747
15-Aug	1.5	2.2	4.197433577
16-Aug	1.5	2.2	4.30227406
17-Aug	1.5	2.2	4.572439519
18-Aug	1.5	2.2	4.242827684
19-Aug	1.5	2.2	4.074942622
20-Aug	1.5	2.2	3.921382912
21-Aug	1.5	2.2	3.55485477
22-Aug	1.5	2.2	3.444216069
23-Aug	1.5	2.2	3.579496767
24-Aug	1.5	2.2	3.530644775
25-Aug	1.5	2.2	3.231436524
26-Aug	1.5	2.2	3.120596686
27-Aug	1.5	2.2	3.138827402
28-Aug	1.5	2.2	2.969690856
29-Aug	1.5	2.2	2.962298283
30-Aug	1.5	2.2	2.875875668
31-Aug	1.5	2.2	2.622778675
1-Sep	1.5	2.2	2.558437136
2-Sep	1.5	2.2	2.826486074
3-Sep	1.5	2.2	2.647917811
4-Sep	1.5	2.2	2.504484581
5-Sep	1.5	2.2	2.546551206
6-Sep	1.5	2.2	2.663454916
7-Sep	1.5	2.2	2.589103554
8-Sep	1.5	2.2	2.528756126
9-Sep	1.5	2.2	2.475174677
10-Sep	1.5	2.2	2.431716527
11-Sep	1.5	2.2	2.283476562
12-Sep	1.5	2.2	2.375372387
13-Sep	1.5	2.2	2.259605236
14-Sep	1.5	2.2	2.343279043
15-Sep	1.5	2.2	2.604935122
16-Sep	1.5	2.2	2.509915207

17-Sep	1.5	2.2	2.469892905
18-Sep	1.5	2.2	2.574812014
19-Sep	1.5	2.2	2.585320465
20-Sep	1.5	2.2	2.711963795
21-Sep	1.5	2.2	2.797114052
22-Sep	1.5	2.2	2.735467316
23-Sep	1.5	2.2	2.737763209
24-Sep	1.5	2.2	2.71637959
25-Sep	1.5	2.2	2.646311839
26-Sep	1.5	2.2	2.824321781
27-Sep	1.5	2.2	2.849510743
28-Sep	1.5	2.2	2.867428773
29-Sep	1.5	2.2	2.770001449
30-Sep	1.5	2.2	3.001229498
1-Oct	1.5	2.2	3.042571698
2-Oct	1.5	2.2	2.994666307
3-Oct	1.5	2.2	2.994460027
4-Oct	1.5	2.2	2.879130762
5-Oct	1.5	2.2	2.915942155
6-Oct	1.5	2.2	2.844891
7-Oct	1.5	2.2	2.678855044
8-Oct	1.5	2.2	2.695132364
9-Oct	1.5	2.2	2.614070084
10-Oct	1.5	2.2	2.638287373
11-Oct	1.5	2.2	2.767558013
12-Oct	1.5	2.2	2.834065653
13-Oct	1.5	2.2	2.842144596
14-Oct	1.5	2.2	2.770849434
15-Oct	1.5	2.2	2.832792537
16-Oct	1.5	2.2	2.950369035
17-Oct	1.5	2.2	3.06041559
18-Oct	1.5	2.2	3.075894098
19-Oct	1.5	2.2	3.181526913
20-Oct	1.5	2.2	3.084813917
21-Oct	1.5	2.2	2.949601415
22-Oct	1.5	2.2	2.857035405
23-Oct	1.5	2.2	2.896221314
24-Oct	1.5	2.2	2.943675199
25-Oct	1.5	2.2	2.885458411
26-Oct	1.5	2.2	2.844261742
27-Oct	1.5	2.2	2.937316955
28-Oct	1.5	2.2	2.90115143
29-Oct	1.5	2.2	2.924079133
30-Oct	1.5	2.2	2.890332744
31-Oct	1.5	2.2	2.884280301
1-Nov	1.5		2.800232614
2-Nov	1.5		2.646594397
3-Nov	1.5		2.665032787
4-Nov	1.5		2.744219781

5-Nov	1.5	2.702564885
6-Nov	1.5	2.702163106
7-Nov	1.5	2.707353921
8-Nov	1.5	2.666711838
9-Nov	1.5	2.697454306
10-Nov	1.5	2.608084669
11-Nov	1.5	2.670504548
12-Nov	1.5	2.68789395
13-Nov	1.5	2.694728946
14-Nov	1.5	2.820116797
15-Nov	1.5	2.777166577
16-Nov	1.5	2.695695977
17-Nov	1.5	2.660189521
18-Nov	1.5	2.563833553
19-Nov	1.5	2.562108674
20-Nov	1.5	2.590723583
21-Nov	1.5	2.603458067
22-Nov	1.5	2.741990427
23-Nov	1.5	2.752610192
24-Nov	1.5	2.759210229
25-Nov	1.5	2.658921958
26-Nov	1.5	2.592030215
27-Nov	1.5	2.429957414
28-Nov	1.5	2.458673682
29-Nov	1.5	2.452621304
30-Nov	1.5	2.52485109
1-Dec	1.5	2.457218725
2-Dec	1.5	2.422653325
3-Dec	1.5	2.433506314
4-Dec	1.5	2.49595035
5-Dec	1.5	2.530148983
6-Dec	1.5	2.520092563
7-Dec	1.5	2.485252984
8-Dec	1.5	2.49895078
9-Dec	1.5	2.49983521
10-Dec	1.5	2.460438986
11-Dec	1.5	2.463202013
12-Dec	1.5	2.509112555
13-Dec	1.5	2.473663713
14-Dec	1.5	2.475100643
15-Dec	1.5	2.461824764
16-Dec	1.5	2.470762007
17-Dec	1.5	2.479357199
18-Dec	1.5	2.507644034
19-Dec	1.5	2.49595035
20-Dec	1.5	2.479357199
21-Dec	1.5	2.479357199
22-Dec	1.5	2.500155969
23-Dec	1.5	2.479357199

24-Dec	1.5	2.452911435
25-Dec	1.5	2.433506314
26-Dec	1.5	2.438067904
27-Dec	1.5	2.446549361
28-Dec	1.5	2.4575094
29-Dec	1.5	2.444038761
30-Dec	1.5	2.420063047
31-Dec	1.5	2.420063047

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 are several decreed surface diversion within this reach of stream, but most of these water rights are inactive or have been abandoned because of the construction of Blue Mesa Reservoir. One active diversion within the reach is the Rhamy Ditch (4 cfs with a 1892 appropriation). Staff has determined that water is available for appropriation on East Elk Creek, between the confluence with Bear Wallow Gulch and the confluence with Blue Mesa Reservoir, 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:

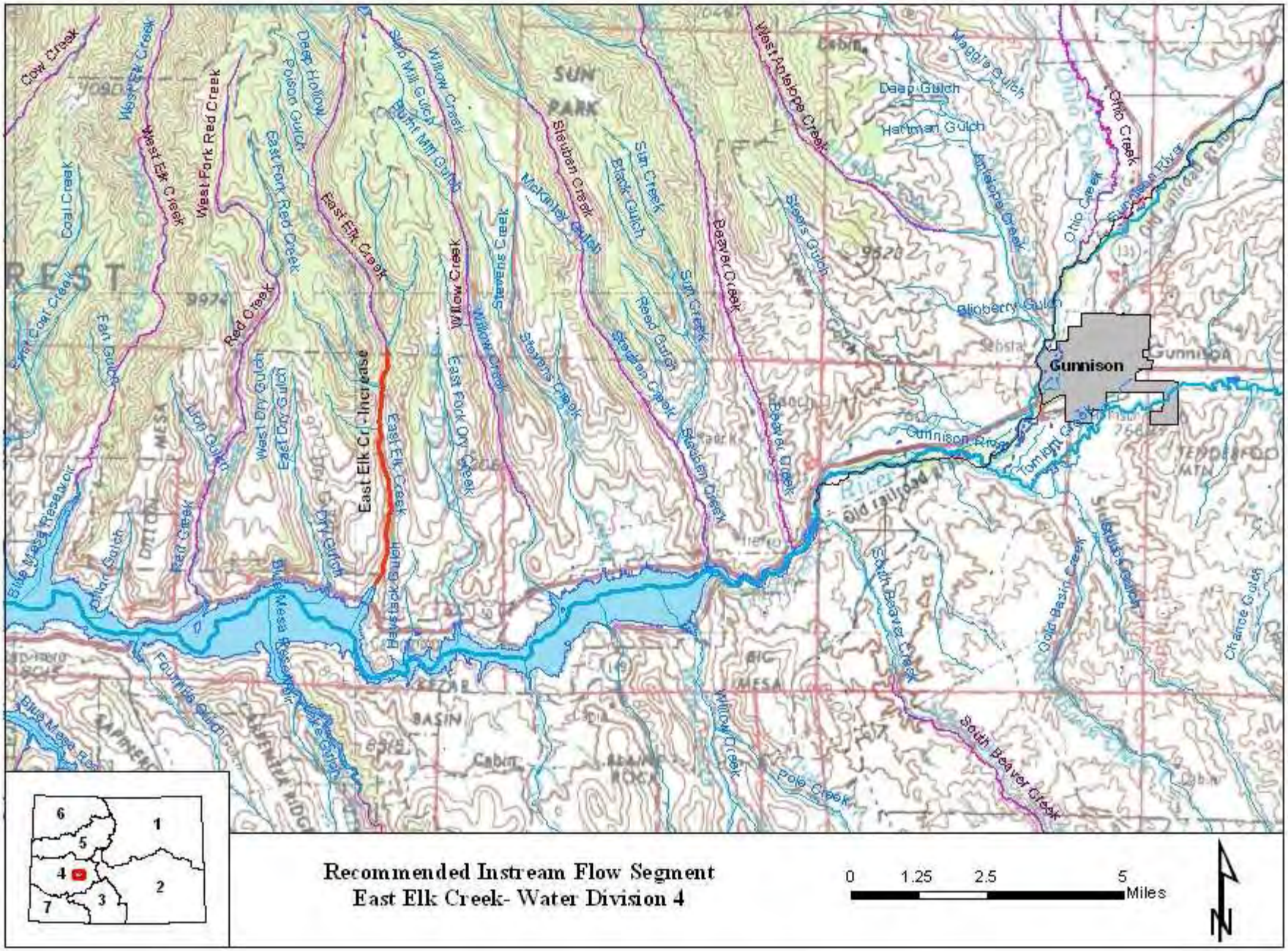
Segment: Confluence with Bear Wallow Gulch to Confluence with Blue Mesa Reservoir

Upper Terminus: CONFLUENCE WITH BEAR WALLOW GULCH
(Latitude 38° 32' 42.0"N) (Longitude 107° 10' 13.0"W)
UTM North: 4268520.7 UTM East: 310864.1
SW SE S34 T50N R3W NMPM
1431' West of the East Section Line; 564' North of the South Section Line

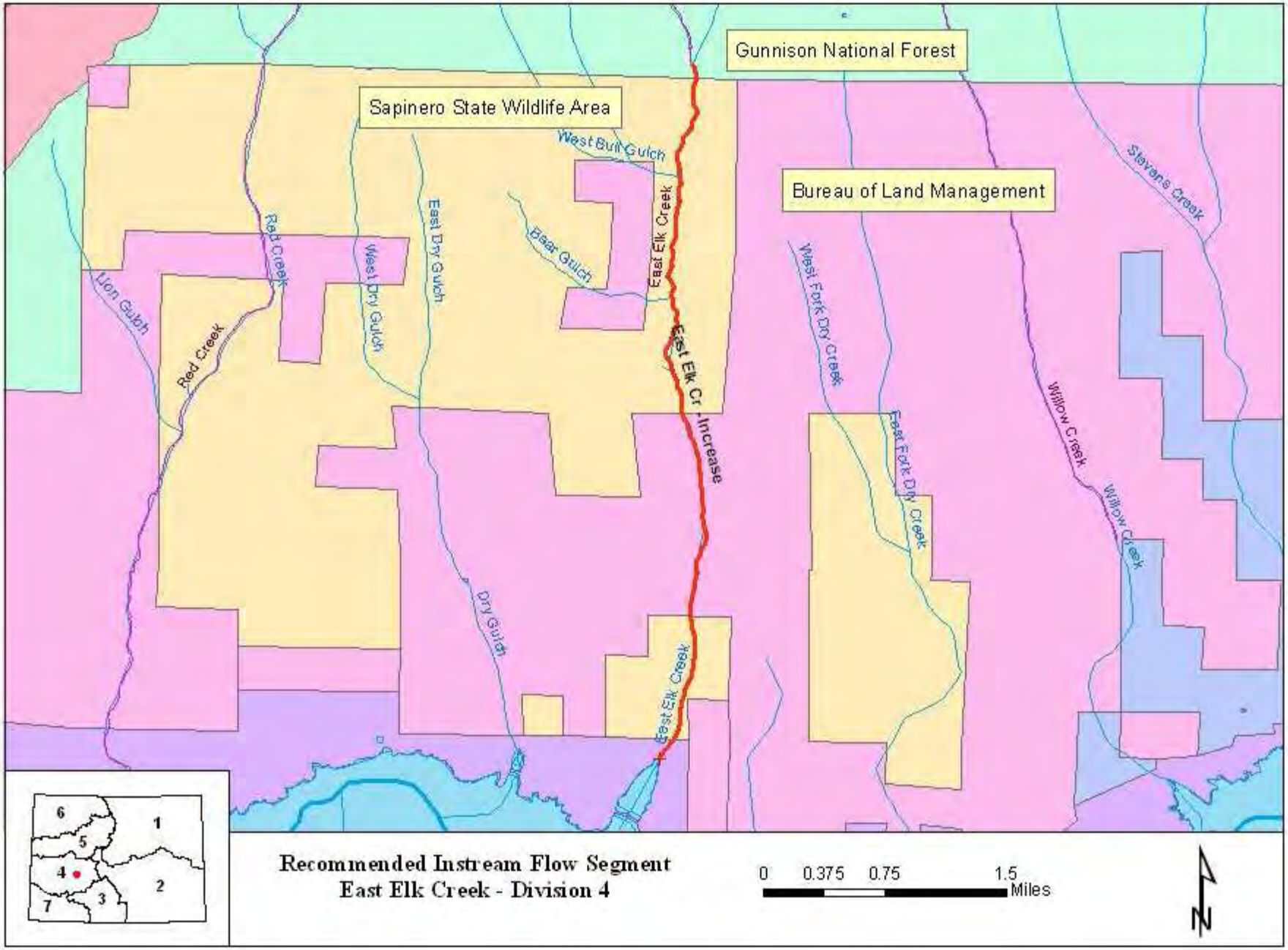
Lower Terminus: CONFLUENCE WITH BLUE MESA RESERVOIR
(Latitude 38° 28' 58.4"N) (Longitude 107° 10' 19.6"W)
UTM North: 4261630.9 UTM East: 310542.0
NW NE S27 T49N R3W NMPM
2196' West of the East Section Line; 625' South of the North Section Line

Watershed: Upper Gunnison (HUC#: 14020002)
Counties: Gunnison
Length: 4.5 miles
USGS Quad(s): Carpenter Ridge, West Elk Peak SW
Existing ISF: 4-84CW378, 1.5 cfs (1/1-12/31)
Flow Recommendation: 0.7 cfs (April 1 to October 31)

Vicinity Map



Land Use


Gunnison National Forest
Sapinero State Wildlife Area
Bureau of Land Management
West Bull Gulch
East Elk Creek
Bear Gulch
East Dry Gulch
West Dry Gulch
Red Creek
Lion Gulch
East Elk Cr - Increase
Dry Gulch
East Elk Creek
West Fork Dry Creek
East Fork Dry Creek
Willow Creek
Stevens Creek
6
5
1
4
3
2
7
Recommended Instream Flow Segment
East Elk Creek - Division 4
0 0.375 0.75 1.5
Miles
N

Topographic & Water Rights