Instream Flow Recommendation:

Elkhead Creek (First Creek to the North Fork of Elkhead Creek)

Contact Information:

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Introduction:

This document contains the necessary information to form the scientific and biological basis for an instream flow (ISF) recommendation for Elkhead Creek in Routt County, Colorado. This recommendation, along with two other 2017 ISF recommendations in the Elkhead Creek basin, represents a continuation of a multi-year effort by Colorado Parks and Wildlife (CPW) to secure ISF protection for important streams in the Elkhead Creek basin. This ISF effort was initiated many years ago (in the 1970s) and was recently renewed in 2006 and 2015; these efforts resulted in several ISF water rights on numerous segments in the basin. CWCB currently has ISF water rights on two segments of Elkhead Creek (6-06CW034 and 6-15CW0352) and a number of headwater tributaries (Torso Creek (6-77W1343), Circle Creek (6-77W1344), Jokodowski Creek (6-77W1345), Armstrong Creek (6-77W1345), and First Creek (6-77W1348)). The Elkhead Creek basin supports a high value fishery that has been designated by both CPW and the US Forest Service (the primary land management agency in the basin) as a prime location for native species conservation. CPW believes that the information compiled in this document provides the basis for the findings necessary for an ISF appropriation stated in the ISF statutes and in ISF Program Rule 5(i).

The State of Colorado's Instream Flow and Natural Lake Level Program (ISF/NLL Program) was created in 1973 when the Colorado General Assembly passed Senate Bill 97. This bill recognized, "the need to correlate the activities of mankind with some reasonable preservation of the natural environment (C.R.S. §37-92-102 (3))." Creation of this state program identified the CWCB as the only state agency with the ability to appropriate and acquire instream flow and natural lake level water rights. In an effort to promote participation in the ISF/NLL Program by other entities, the state statute requires the Board to consider instream flow recommendations by local, state, or federal agencies. CPW is recommending this reach of Elkhead Creek for inclusion in the ISF/NLL Program because we believe that there is a natural environment that can be preserved to a reasonable degree with an instream flow water right.

CPW is sending this instream flow recommendation to the Board in order to meet CPW's legislative declaration, "… that the wildlife and their environment are to be protected, preserved, enhanced, and managed for the use, benefit, and enjoyment of the people of this

state and it's visitors… and that, to carry out such program and policy, there shall be a continuous operation of planning, acquisition, and development of wildlife habitats and facilities for wildlife-related opportunities (C.R.S. § 33-1-101 (1)),” and, “… that the natural, scenic, scientific, and outdoor recreation areas of this state are to be protected, preserved, enhanced and managed for the use, benefit, and enjoyment of the people of this state and visitors of this state… and that to carry such program and policy there shall be a continuous operation of acquisition, development, and management of outdoor recreation lands, waters, and facilities (C.R.S. §33-10-101 (1)).”

In addition to these broad statutory guidelines, CPW's current strategic planning document (*CPW Strategic Plan*, 2015) explains current agency goals to, “[c]onserve wildlife and habitat to ensure healthy sustainable populations and ecosystems.” In order to, “protect and enhance water resources for fish and wildlife populations,” by pursuing, “partnerships and agreements to enhance instream flows, protect reservoir levels, and influence water management activities,” and to, “[a]dvocate for water quality and quantities to conserve aquatic resources.” In addition to the CPW strategic plan, the agency's fish and wildlife conservation activities are also directed by the State Wildlife Action Plan (2002, Revised 2015). The goals and priorities from these documents direct CPW to advocate for the preservation of the state's fish and wildlife resources and natural environment, and therefore link CPW's mission to the goals and priorities of CWCB's ISF/NLL Program.

Stream Reach and Location Information

Recommended Reach: Elkhead Creek, from the confluence with First Creek to the confluence with the North Fork of Elkhead Creek (Figure 1)

Upper Terminus: Confluence with First Creek
UTM North: 4511465.46724; UTM East: 317014.135348
Elevation: 7,785 feet

Lower terminus: Confluence with the North Fork of Elkhead Creek
UTM North: 4504451.44952; UTM East: 306665.084031
Elevation: 6, 833 feet

Water Division: 6
Water District: 44
CPW Water Code: 23165
Approximate segment length: 10.9 miles
County: Routt County
Major Drainage Basin: Yampa River
USGS quad maps: Quaker Mountain and Slide Mountain

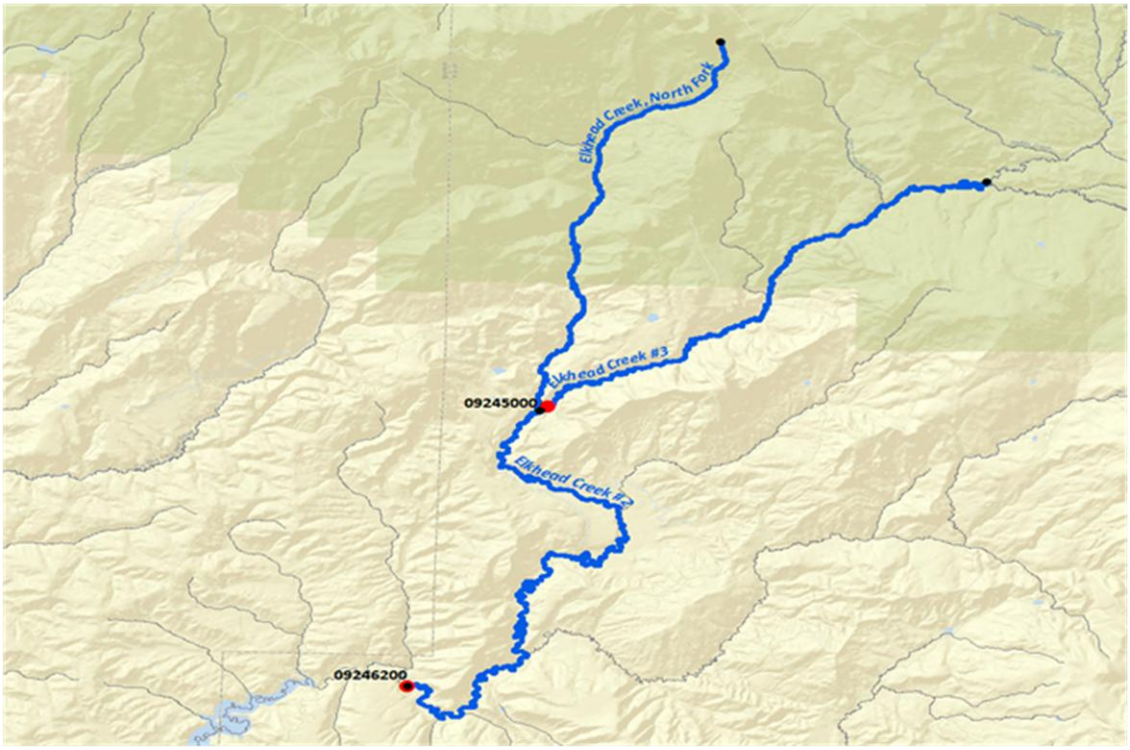


Figure 1. Map showing the location of the 2017 Elkhead Creek recommended reaches. Black dots represent the reach termini. The red dots are gaging stations within or near the recommended reaches.

Natural Environment

In 2001, CPW entered into a multi-state and multi-agency conservation agreement and strategy concerning Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*). Colorado's partners in this plan and agreement include the natural resource management agencies from Utah and Wyoming, and a number of federal agencies including the USFS, USFWS, BLM and NPS. The Ute Indian Tribe of the Uintah and Ouray Reservation has also signed onto the agreement and plan for conservation. This conservation agreement and strategy was developed in order to encourage cooperation and collaboration on conservation measures among various natural resource management agencies to minimize threats to Colorado River cutthroat trout that might result in actions under the Endangered Species Act of 1973. Essentially, the parties to the overall plan agreed that in order to prevent listing of the subspecies, and to reach desired recovery goals without hindering further development of our state resources, continued implementation of the conservation strategy was necessary. The stated goal of the conservation strategy is as follows:

> "To assure the long-term viability of CRCT throughout their historic range, areas that currently support CRCT will be maintained, while other areas will be managed for increased abundance. New populations will be established where ecologically and economically feasible, while the genetic diversity of the species is maintained. The

cooperators envision a future where threats to wild CRCT are either eliminated or reduced to the greatest extent possible."(CRCT Conservation Team 2006)

One of the main threats to Colorado River cutthroat trout conservation is the depletion of stream flows that results in degradation of habitat and the overall health of the subspecies. Another major threat to cutthroat fisheries is the fragmentation of habitat. CPW believes that both of these threats can be partially addressed with instream flow protection by the Colorado Water Conservation Board.

Elkhead Creek basin:

The Elkhead Creek Basin is located in CPW's Northwest Region, Water Division 6, northwest of Steamboat Springs, CO, and north of Hayden, CO. The headwaters of Elkhead Creek are located at an elevation of around 8,900 feet, and the creek's confluence with the Yampa River is found at an elevation of 6,200 feet approximately 56 miles downstream. Hydrology of the creek is primarily snow melt driven with perennial flow; the average annual precipitation in the basin is approximately 26 inches. The mean basin elevation is 7,660 feet. The total basin area is 223 square miles. The physical environment of the Elkhead Creek basin is mostly a sage-brush shrub community. Overall, the aquatic environment and fishery of Elkhead Creek is quite diverse from the headwaters all the way down to Elkhead Reservoir.

Recommended Segment:

This ISF recommendation is for a reach of Elkhead Creek from the confluence with First Creek down to the confluence with the North Fork of Elkhead Creek. Throughout this reach, Elkhead Creek is a third order stream. The stream channel is primarily a single thread channel flowing through a variety of valley types. Stream cover includes both forested cover and open lands (meadows and pasture lands). Connection to the floodplain most likely only occurs during spring runoff, which provides lateral connectivity to the terrestrial environment and input of terrestrial organic matter into the stream. Peak runoff likely removes the majority of the smaller sediment like sand and silt from stream substrates. Stream banks are largely intact, but areas of erosion are also present. Despite the areas of eroding banks there is still a prominent riparian community throughout the reach. As is typical of streams in this nature, the riparian zone contributes nutrients and terrestrial insects to the aquatic environment, providing food for aquatic species of invertebrates and fish. The riparian corridor consists of willows, alders, and cottonwoods. Throughout this reach of Elkhead Creek there is an abundance of pool, riffle, and glide habitat. Substrate ranges from large boulders to small cobble.

Table 1. Estimate of the percentage of public and private land within the recommended reach of Elkhead Creek.

Upper Terminus	Lower Terminus	Total Length (miles)	Approximate Land Ownership	
			%Private	%Public
Confluence with First Creek	Confluence with North Fork	10.9	50	50+

+ = Public lands are managed by the USFS

Aquatic Environment

As noted earlier, the Elkhead Creek basin has been identified both by CPW and the U.S. Forest Service (USFS) as a priority basin for native species conservation projects. The target fish species in upper Elkhead Creek basin is the Colorado River cutthroat trout (CRCT) (see Table 2). Also, CPW and the USFS are engaged in small scale habitat protection projects for boreal toad (*Bufo boreas boreas*), a state endangered species in the Elkhead basin. The Colorado River cutthroat trout has been designated by Colorado, Wyoming, and Utah State fish and wildlife management agencies and various federal agencies as either "sensitive" or "of concern" (CRCT Conservation Team 2006). While CRCT is the main species of concern in this basin, other native species (listed in Table 2) should also benefit from the conservation efforts towards the cutthroats – namely mottled sculpin (*Cottus bairdi*), speckled dace (*Rhinichthys osculus*), and mountain sucker (*Catostomus playtrhynchus,* also a SSC) in this recommended reach (CRCT Conservation Team, 2006). The entire Elkhead Creek basin going upstream from the confluence with the North Fork of Elkhead creek, including all of the tributary streams, is being enhanced through a variety of interagency projects to restore both cutthroat trout and boreal toad habitat. The Elkhead metapopulation of CRCT was identified in the conservation planning documents as a population of high genetic purity (Purity A- meaning pure, but slightly different from norm) (see Appendix A). This genetic purity means that the Elkhead CRCT population is considered at least a conservation population (CRCT Task Force 2001).

Another critical aspect to CRCT conservation efforts is to reduce non-native competition and interspecific hybridization. All non-native salmonids have been removed from the basin upstream from the confluence with the North Fork of Elkhead Creek, and there are two fish migration barriers that have been constructed on Elkhead Creek. All brook trout (*Salvelinus fontinalis*) and rainbow trout (*Oncorrhynchus mykiss*) have been removed from the system - brook trout are strong competitors for food and habitat and rainbow trout also compete for food and habitat. Also, rainbow trout are in the same genus as CRCT (*Oncorynchus spp.*) and therefore have been known to readily hybridize with cutthroat (NRCS 2007) and weaken overall genetic purity.

A key component to habitat protection is flow protection. Flow reduction can impact habitat availability and quality, can cause water quality and temperature issues, and can reduce overall population and habitat connectivity. The hydrology of Elkhead Creek will likely continue to

provide a high annual peak flow for this spring spawning species (since minimal water uses presently occur in the basins above the potential ISF segment), but one major issue that begs for the protection that comes with an ISF water right is the protection of the minimal base flows that seem to be present in most years (Figure 2). Over-wintering adult habitat for CRCT is often a limiting factor for these fish populations. We believe that this reach of Elkhead Creek provides some of the best habitat for the larger fish in the population. In addition, the upper portions of this segment of Elkhead Creek have been the focus of CPW and USFS projects (barriers, fencing, and fish removal projects) and we believe that these investments should also be considered as part of the natural environment to be protected with an ISF water right.

Table 2. Natural environment information for Elkhead Creek (all are native to western Colorado rivers and streams).

Species Name	Scientific Name	Status
Colorado River cutthroat trout	*Oncorhynchus clarki pleuriticus*	State Species of Special Concern Federal Sensitive Species
mottled sculpin	*Cottus bairdi*	none
speckled dace	*Rhinichthys osculus*	none
mountain sucker	*Catostomus playtrhynchus*	State Species of Special Concern

ISF Quantification

R2CROSS Results:

In 2014 and 2015, CPW and CWCB staff collected stream cross-section data at three sites within this reach of Elkhead Creek. Initial biological instream flow recommendations were developed utilizing the standard application of the R2CROSS methodology (Espegren 1996). R2CROSS uses field data that has been collected in a riffle stream habitat types; riffles are the limiting habitat type in streams during low flow events. The field data includes a survey of stream channel geometry, a longitudinal slope of the water surface, and a streamflow measurement at the designated cross section. After processing this data with R2CROSS, winter and summer flow recommendations were developed utilizing the typical R2CROSS criteria described in Nehring (1979) and Espergren (1996); the R2CROSS hydraulic criteria of interest are average depth, average velocity, and wetted perimeter. Maintaining these hydraulic parameters at adequate levels across riffle habitat types will also maintain aquatic habitat in pools and runs for most life stages of fish and aquatic invertebrates (Nehring 1979). Table 3 (below) summarizes the R2CROSS results for the three sites within this segment of Elkhead Creek.

Table 3. Summary of R2CROSS transect measurements and the resulting flow recommendations for Elkhead Creek. Q measured is the discharge measured in the field, 40%-250% is the confidence interval in which flow criteria should be met, flow meeting two criteria means a winter flow recommendation, and flow meeting three criteria is a summer flow recommendation.

Entity	Date Measured	Q measured	40%-250%	Flow Meeting Two Criteria	Flow Meeting Three Criteria
CPW/CWCB	9/30/2014	9.04 cfs	3.6-22.6 cfs	3.1[1] cfs	22.6[2] cfs
CPW/CWCB	10/28/2015	9.13 cfs	3.7-22.8 cfs	4.8 cfs	12.5 cfs
CPW/CWCB	10/28/2015	7.25 cfs	2.9-18.1 cfs	4.0 cfs	7.28 cfs
			Mean	**4.4 cfs**	**14.1 cfs**

1= Flow recommendation falls outside the range of accuracy for R2CROSS's estimate for Manning's n; these values cannot be used in the calculation of the recommended flow (winter season only).
2= Flow recommendation falls outside the range of accuracy for R2CROSS's estimate for Manning's n; highest flow that R2CROSS can predict with accuracy used for averaging purposes (summer season only).

ISF Recommendation:

From the above table, the R2CROSS-based winter flow recommendation is 4.4 cubic feet per second - this flow is the average of the "in-range" results that meet two of the three hydraulic criteria. Similarly, the R2CROSS-based summer flow recommendation is 14 cubic feet per second - this flow is the average of the "in-range" results that meet all three of the hydraulic criteria and the flow that was derived from the upper limit of R2CROSS (see table footnote, above). As noted above, while the summer flow from the 9/30 R2CROSS run is slightly less than the flow needed to meet all three hydraulic criteria, this flow is used in the averaging exercise to develop the overall summer flow recommendation, because it is within the R2CROSS modeling accuracy and (in our opinion) provides usable information for the development of a flow recommendation to preserve the natural environment. CPW believes that the Elkhead Creek natural environment is important enough for CRCT conservation, and that an ISF water right is critical at this point in time. If future data collection efforts yield usable in-range data, CPW reserves the right to initiate an enlargement recommendation for the summer season.

Preliminary Water Availability Analysis:

In order to make a preliminary determination whether water is available for the R2CROSS-based flow recommendations and to determine the appropriate seasonal transition dates, CPW examines basic hydrologic data and basic water rights information for the basin in question.

We found one relevant stream gage near the lower terminus of this ISF segment, and this stream gage is Elkhead Creek near Elkhead, CO (USGS 09245000). Also, Division of Water Resources data indicates that there are only two active water rights located in the proposed reach. These water rights are the Kitchens & Kleckner Ditch (structure ID: 2479) and the Elkhead Canal (structure ID: 2007). Both of these water rights appear to be irrigation water rights. Since these water rights are above the lower terminus of this recommended ISF segment, the use of these water rights are reflected in the USGS stream gage records used to

generate the hydrograph below. Diversion records for these two ditches appear to be non-existent at this point in time. There are no other major diversion features such as reservoirs or transbasin imports or exports that alter the hydrology of Elkhead Creek. The USGS stream gage "Elkhead Creek near Elkhead, Colorado" has more than 20 years of data (from 1953 to 1996). This streamgage provides relevant information with respect to year-round water availability in this ISF reach. The seasonal ISF recommendations from the above R2ROSS analysis along with the mean daily data from the above referenced gage are displayed below (Figure 2).

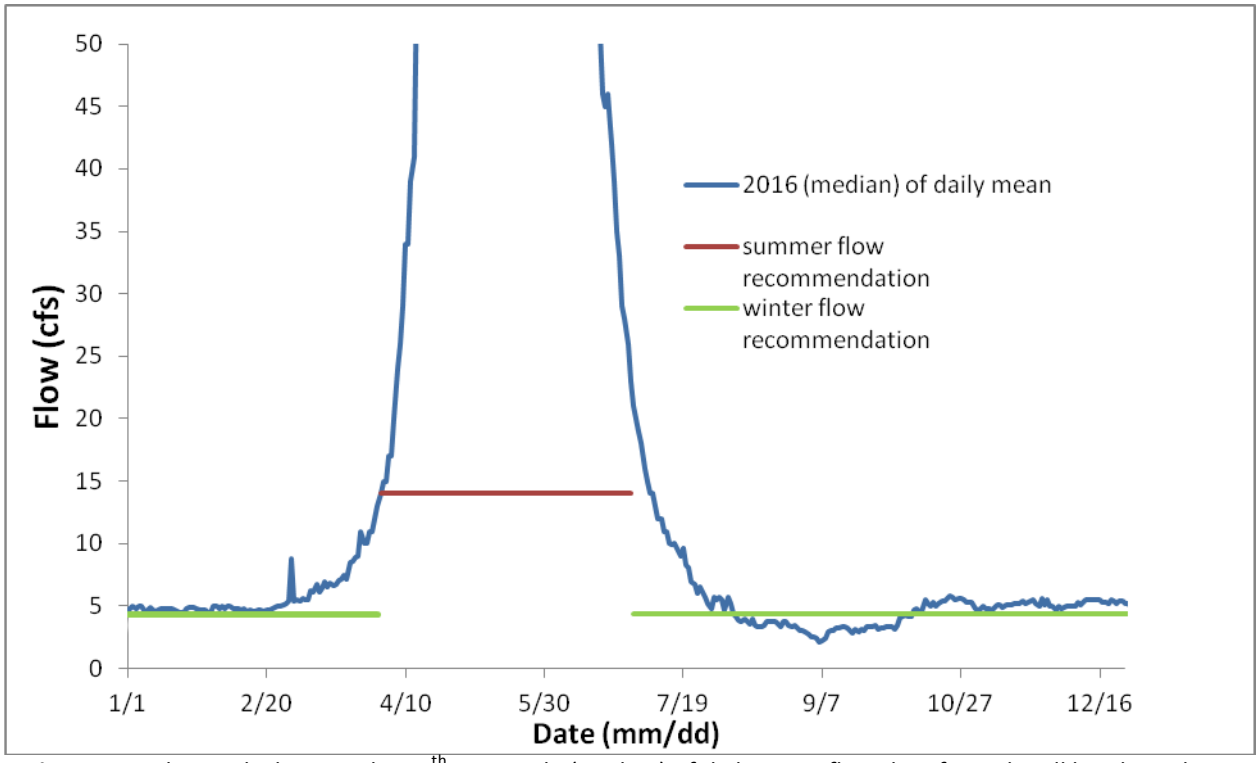


Figure 2. Hydrograph showing the 50th percentile (median) of daily mean flow data from the Elkhead Creek near Elkhead, CO gage (USGS 09245000), with a period of record from 1953-1996, and the winter and summer seasonal recommended flows.

Seasonal ISF Recommendation

The above preliminary water availability analysis (Figure 2) leads CPW to determine that water appears to be generally available to meet the R2CROSS-based flow recommendations. The gage data allows us to determine seasonality for the flow recommendations. It appears that there may be late summer/early fall water availability issues that will need to be addressed via consultation with CWCB staff. It is CPW staff's opinion that the following flows are both available and necessary to preserve the fishery and natural environment to a reasonable degree. At least 14 cubic feet per second is needed for the snowmelt runoff period from April 1st through June 30th. This flow should provide adequate minimal protection for CRCT spawning and fry emergence. Similarly, at least 4.4 cubic feet per second is needed for the base flow period from July 1st to March 31st. This flow should also provide minimal adequate protection

for overwintering habitat for the native species present in the drainage. The overall goal of this ISF recommendation is to provide a minimum level of protection for native fish spawning and overwintering habitat. CPW reserves the right to recommend enlargement flows if additional future data suggests that additional flow is needed to protect this valuable fishery resource.

Citations

CRCT Conservation Team. 2006. Conservation agreement for Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*) in the states of Colorado, Utah, and Wyoming. Colorado Division of Wildlife, Fort Collins. 10p.

CRCT Conservation Team. 2006. Conservation strategy for Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*) in the states of Colorado, Utah, and Wyoming. Colorado Division of Wildlife, Fort Collins. 24p.

CRCT Task Force. 2001. Conservation agreement and strategy for Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*) in the states of Colorado, Utah, and Wyoming. Colorado Division of Wildlife, Fort Collins. 87p.

Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

Nehring, B.R., 1979, Evaluation of Instream Flow Methods and Determination of Water Quantity Needs for Streams in the State of Colorado, Colorado Division of Wildlife.

Natural Resource Conservation Services (NRCS), 2007, Cutthroat trout (*Oncorhynchus clarki*). Fish and Wildlife Habitat management Leaflet 47.

Appendices

Appendices A: Information of Known and potential Colorado River Cutthroat Trout Populations in Colorado, Utah, and Wyoming.

Appendices B: R2CROSS output for the three cross-sections performed on this reach of Elkhead Creek.

Photos:

Figure 3. Cross-section number one (2014), downstream of First Creek on Elkhead Creek, looking downstream.

Figure 4. Cross-section number one (2014), downstream of First Creek on Elkhead Creek, looking upstream.

Figure 5. Elkhead Creek above North Fork Elkhead Creek (2015), natural environment number one.

Figure 6. Elkhead Creek above North Fork Elkhead Creek (2015); cross-section number two looking across tape.

Figure 7. Elkhead Creek above North Fork Elkhead Creek (2015); cross-section number two looking downstream.

Figure 8. Elkhead Creek above North Fork Elkhead Creek (2015); cross-section number two looking downstream.

Figure 9. Elkhead Creek above North Fork Elkhead Creek (2015); cross-section number two looking upstream.

Figure 10. Elkhead Creek above North Fork Elkhead Creek (2015); cross-section number two looking upstream.

Figure 11. Elkhead Creek above North Fork Elkhead Creek (2015); cross-section number three looking across tape.

Figure 12. Elkhead Creek above North Fork of Elkhead Creek (2015); cross-section number three looking upstream.

Figure 13. Natural Environment of Elkhead Creek Basin.

Figure 14. Natural Environment of Elkhead Creek Basin.

Figure 15. Natural Environment of Elkhead Creek Basin.

Figure 16. Natural Environment of Elkhead Creek Basin.

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

LOCATION INFORMATION

STREAM NAME:	Elkhead Creek Upper
XS LOCATION:	Ab confl with N Fk
XS NUMBER:	1
DATE:	28-Oct-15
OBSERVERS:	js rv sm
1/4 SEC:	0
SECTION:	0
TWP:	306776.039
RANGE:	4504531.49
PM:	0
COUNTY:	Routt
WATERSHED:	0
DIVISION:	0
DOW CODE:	0
USGS MAP:	0
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:	0.003

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

ASSIGNED TO: ….....……..…….....DATE.....

STREAM NAME: Elkhead Creek Upper
XS LOCATION: Ab confl with N Fk
XS NUMBER: 1

DATA POINTS= 29

VALUES COMPUTED FROM RAW FIELD DATA

	FEATURE	DIST	VERT DEPTH	WATER DEPTH	VEL	WETTED PERIM.	WATER DEPTH	AREA (Am)	Q (Qm)	% Q CELL
1	s gl	0.00	7.45			0.00		0.00	0.00	0.0%
		7.00	8.73			0.00		0.00	0.00	0.0%
		11.00	9.41			0.00		0.00	0.00	0.0%
	wl	13.80	9.65	0.00	0.00	0.00		0.00	0.00	0.0%
		14.00	9.69	0.15	0.00	0.20	0.15	0.09	0.00	0.0%
		15.00	9.71	0.30	0.17	1.00	0.30	0.30	0.05	0.6%
		16.00	9.71	0.20	0.13	1.00	0.20	0.20	0.03	0.3%
		17.00	9.98	0.40	0.18	1.04	0.40	0.40	0.07	0.8%
		18.00	10.08	0.50	0.98	1.00	0.50	0.50	0.49	5.4%
		19.00	10.06	0.75	1.06	1.00	0.75	0.75	0.80	8.7%
		20.00	10.05	0.50	1.11	1.00	0.50	0.50	0.56	6.1%
		21.00	10.18	0.80	1.15	1.01	0.80	0.80	0.92	10.1%
		22.00	10.36	0.70	0.75	1.02	0.70	0.70	0.53	5.8%
		23.00	10.27	0.55	0.53	1.00	0.55	0.55	0.29	3.2%
		24.00	10.19	0.60	0.72	1.00	0.60	0.60	0.43	4.7%
		25.00	10.01	0.55	1.37	1.02	0.55	0.55	0.75	8.3%
		26.00	10.22	0.50	1.24	1.02	0.50	0.50	0.62	6.8%
		27.00	10.05	0.50	1.31	1.01	0.50	0.50	0.66	7.2%
		28.00	10.25	0.50	1.28	1.02	0.50	0.50	0.64	7.0%
		29.00	10.21	0.65	1.37	1.00	0.65	0.65	0.89	9.8%
		30.00	10.13	0.60	1.16	1.00	0.60	0.60	0.70	7.6%
		31.00	9.94	0.35	1.15	1.02	0.35	0.35	0.40	4.4%
		32.00	9.94	0.35	0.84	1.00	0.35	0.35	0.29	3.2%
		33.00	9.76	0.30	0.07	1.02	0.30	0.30	0.02	0.2%
	wl	34.00	9.64	0.00	0.00	1.01		0.00	0.00	0.0%
		36.00	9.18			0.00		0.00	0.00	0.0%
		38.00	8.73			0.00		0.00	0.00	0.0%
1	gl	41.00	8.37			0.00		0.00	0.00	0.0%
	s	48.20	8.05			0.00		0.00	0.00	0.0%
	TOTALS ----------					20.39	0.8 (Max.)	9.69	9.13	100.0%

Manning's n = 0.0526
Hydraulic Radius= 0.47513758

STREAM NAME: Elkhead Creek Upper
XS LOCATION: Ab confl with N Fk
XS NUMBER: 1

WATER LINE COMPARISON TABLE

WATER LINE	MEAS AREA	COMP AREA	AREA ERROR
	9.69	7.87	-18.8%
9.40	9.69	13.43	38.6%
9.42	9.69	12.95	33.6%
9.44	9.69	12.47	28.7%
9.46	9.69	12.00	23.9%
9.48	9.69	11.54	19.1%
9.50	9.69	11.09	14.4%
9.52	9.69	10.64	9.8%
9.54	9.69	10.19	5.2%
9.56	9.69	9.76	0.7%
9.58	9.69	9.33	-3.8%
9.60	9.69	8.90	-8.1%
9.61	9.69	8.69	-10.3%
9.62	9.69	8.48	-12.4%
9.63	9.69	8.28	-14.6%
9.64	9.69	8.07	-16.7%
9.65	9.69	7.87	-18.8%
9.66	9.69	7.67	-20.9%
9.67	9.69	7.47	-22.9%
9.68	9.69	7.27	-25.0%
9.69	9.69	7.07	-27.0%
9.70	9.69	6.88	-29.0%
9.72	9.69	6.51	-32.8%
9.74	9.69	6.16	-36.4%
9.76	9.69	5.82	-39.9%
9.78	9.69	5.49	-43.4%
9.80	9.69	5.16	-46.8%
9.82	9.69	4.83	-50.2%
9.84	9.69	4.50	-53.5%
9.86	9.69	4.18	-56.8%
9.88	9.69	3.87	-60.1%
9.90	9.69	3.55	-63.3%

WATERLINE AT ZERO
AREA ERROR = 9.558

STREAM NAME: Elkhead Creek Upper
XS LOCATION: Ab confl with N Fk
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	8.37	35.97	1.22	1.99	43.82	36.39	100.0%	1.20	76.75	1.75
	8.56	33.37	1.12	1.80	37.30	33.76	92.8%	1.10	61.67	1.65
	8.61	32.68	1.09	1.75	35.64	33.06	90.9%	1.08	57.99	1.63
	8.66	31.99	1.06	1.70	34.03	32.37	89.0%	1.05	54.44	1.60
	8.71	31.30	1.04	1.65	32.45	31.67	87.0%	1.02	51.02	1.57
	8.76	30.71	1.01	1.60	30.90	31.07	85.4%	0.99	47.63	1.54
	8.81	30.19	0.97	1.55	29.37	30.54	83.9%	0.96	44.29	1.51
	8.86	29.68	0.94	1.50	27.88	30.02	82.5%	0.93	41.06	1.47
	8.91	29.16	0.91	1.45	26.41	29.49	81.0%	0.90	37.96	1.44
	8.96	28.64	0.87	1.40	24.96	28.96	79.6%	0.86	34.98	1.40
	9.01	28.13	0.84	1.35	23.54	28.44	78.2%	0.83	32.12	1.36
	9.06	27.61	0.80	1.30	22.15	27.91	76.7%	0.79	29.38	1.33
	9.11	27.10	0.77	1.25	20.78	27.39	75.3%	0.76	26.75	1.29
	9.16	26.58	0.73	1.20	19.44	26.86	73.8%	0.72	24.25	1.25
	9.21	26.07	0.70	1.15	18.12	26.34	72.4%	0.69	21.86	1.21
	9.26	25.55	0.66	1.10	16.83	25.81	70.9%	0.65	19.58	1.16
	9.31	25.04	0.62	1.05	15.57	25.29	69.5%	0.62	17.43	1.12
	9.36	24.53	0.58	1.00	14.33	24.77	68.1%	0.58	15.39	1.07
	9.41	24.02	0.55	0.95	13.11	24.25	66.6%	0.54	13.47	1.03
	9.46	23.23	0.51	0.90	11.93	23.45	64.5%	0.51	11.77	0.99
	9.51	22.43	0.48	0.85	10.79	22.64	62.2%	0.48	10.19	0.94
WL	9.56	21.63	0.45	0.80	9.69	21.84	60.0%	0.44	8.72	0.90
	9.61	20.83	0.41	0.75	8.63	21.03	57.8%	0.41	7.37	0.85
	9.66	20.01	0.38	0.70	7.61	20.20	55.5%	0.38	6.14	0.81
	9.71	18.53	0.36	0.65	6.63	18.71	51.4%	0.35	5.14	0.77
	9.76	16.84	0.34	0.60	5.77	17.01	46.8%	0.34	4.34	0.75
	9.81	16.37	0.30	0.55	4.94	16.54	45.4%	0.30	3.42	0.69
	9.86	15.91	0.26	0.50	4.13	16.06	44.1%	0.26	2.59	0.63
	9.91	15.44	0.22	0.45	3.35	15.59	42.8%	0.21	1.86	0.56
	9.96	13.99	0.19	0.40	2.61	14.12	38.8%	0.18	1.31	0.50
	10.01	13.36	0.14	0.35	1.92	13.48	37.1%	0.14	0.81	0.42
	10.06	11.14	0.12	0.30	1.29	11.25	30.9%	0.11	0.47	0.37
	10.11	8.02	0.10	0.25	0.83	8.10	22.3%	0.10	0.28	0.34
	10.16	6.11	0.08	0.20	0.48	6.16	16.9%	0.08	0.13	0.28
	10.21	3.98	0.06	0.15	0.22	4.01	11.0%	0.06	0.05	0.22
	10.26	1.72	0.05	0.10	0.09	1.73	4.8%	0.05	0.02	0.21
	10.31	0.87	0.03	0.05	0.02	0.87	2.4%	0.03	0.00	0.13
	10.36	0.03	0.00	0.00	0.00	0.03	0.1%	0.00	0.00	0.01

STREAM NAME: Elkhead Creek Upper
XS LOCATION: Ab confl with N Fk
XS NUMBER: 1

SUMMARY SHEET

MEASURED FLOW (Qm)=	9.13	cfs
CALCULATED FLOW (Qc)=	8.72	cfs
(Qm-Qc)/Qm * 100 =	4.5	%
MEASURED WATERLINE (WLm)=	9.65	ft
CALCULATED WATERLINE (WLc)=	9.56	ft
(WLm-WLc)/WLm * 100 =	0.9	%
MAX MEASURED DEPTH (Dm)=	0.80	ft
MAX CALCULATED DEPTH (Dc)=	0.80	ft
(Dm-Dc)/Dm * 100	-0.2	%
MEAN VELOCITY=	0.90	ft/sec
MANNING'S N=	0.053	
SLOPE=	0.003	ft/ft
.4 * Qm =	3.7	cfs
2.5 * Qm=	22.8	cfs

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

FLOW (CFS)	PERIOD
___________________	___________________
___________________	___________________
___________________	___________________
___________________	___________________

RATIONALE FOR RECOMMENDATION:
=============================

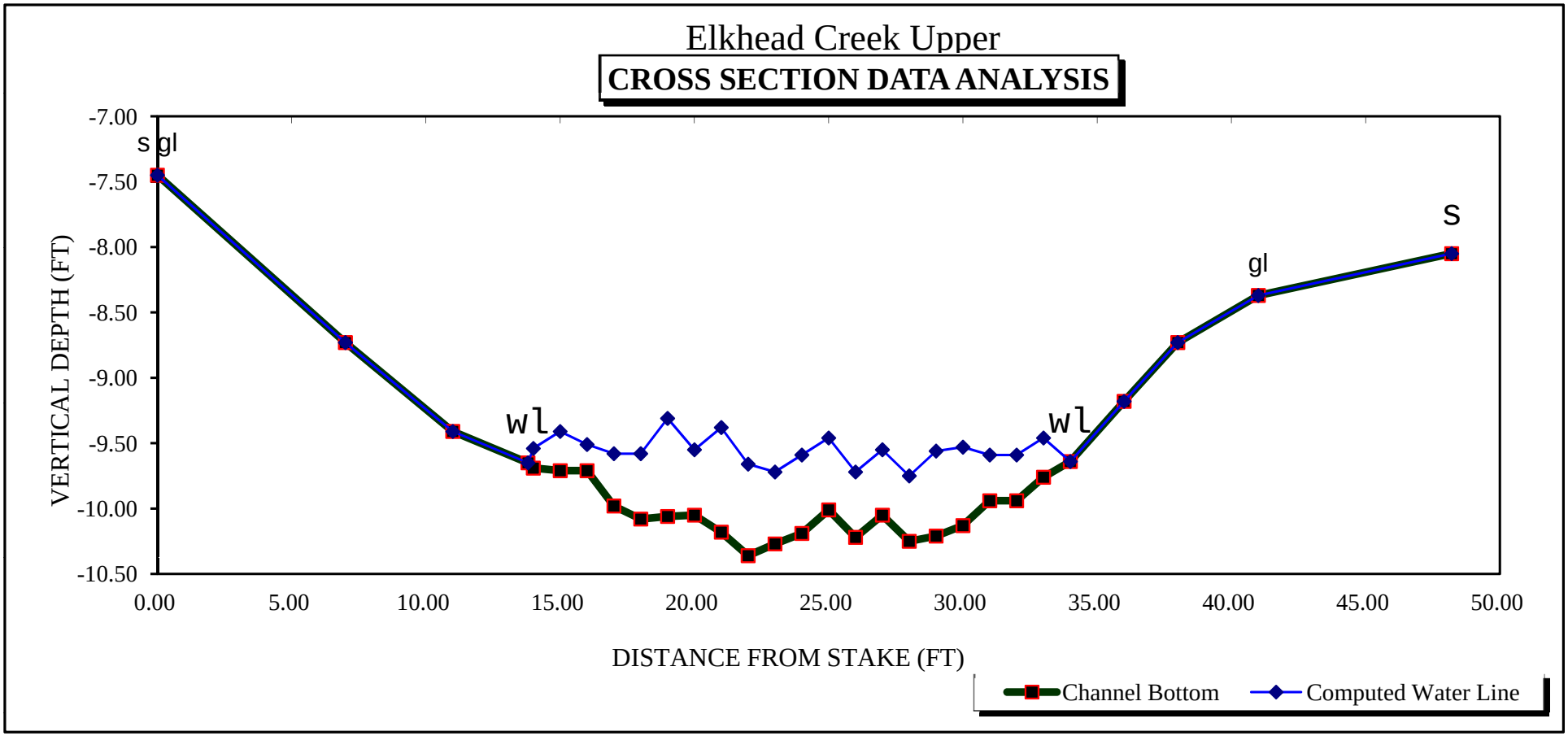
RECOMMENDATION BY: ……………………..……….…….............................. AGENCY..………………………....…....…...…....... DATE:......…...….......……………

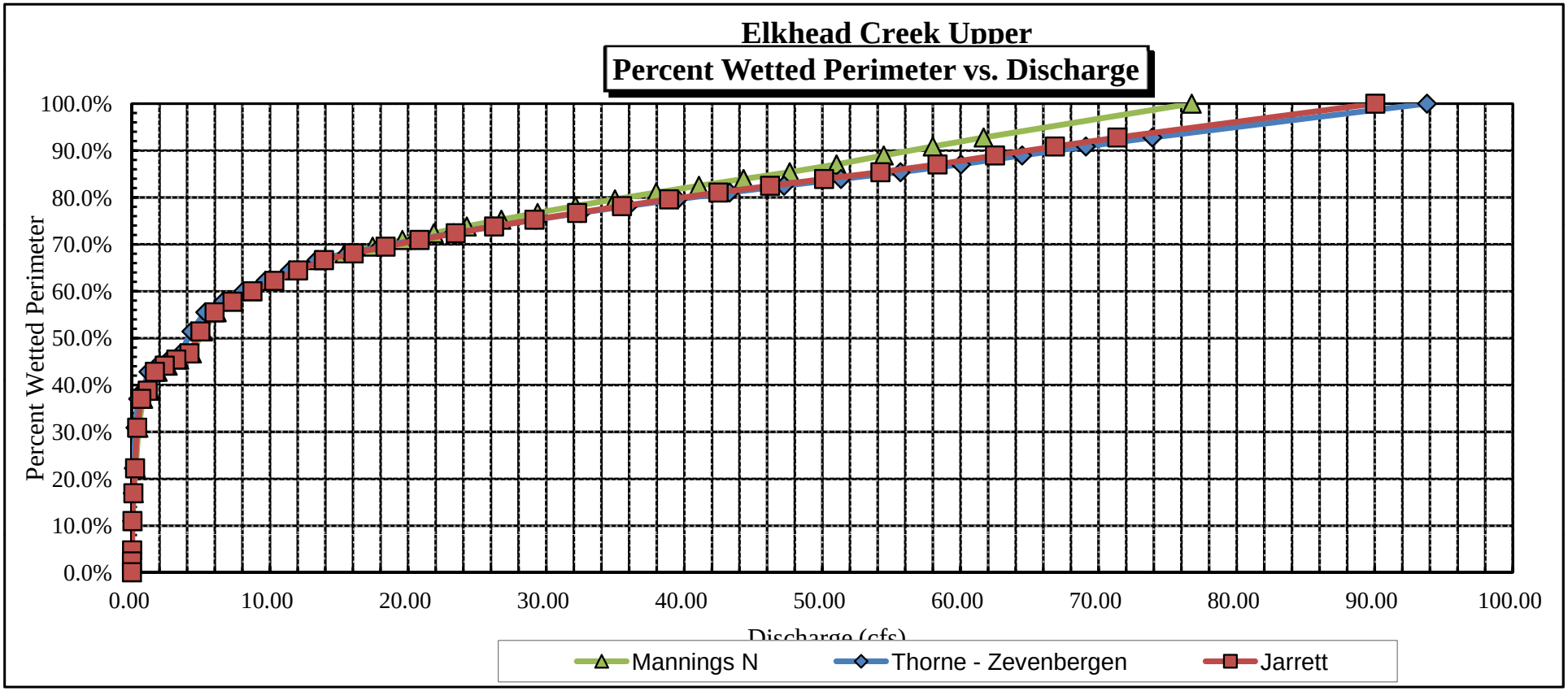
CWCB REVIEW BY: ..…………………………....………………………………………………...….............. DATE:.................…………….…

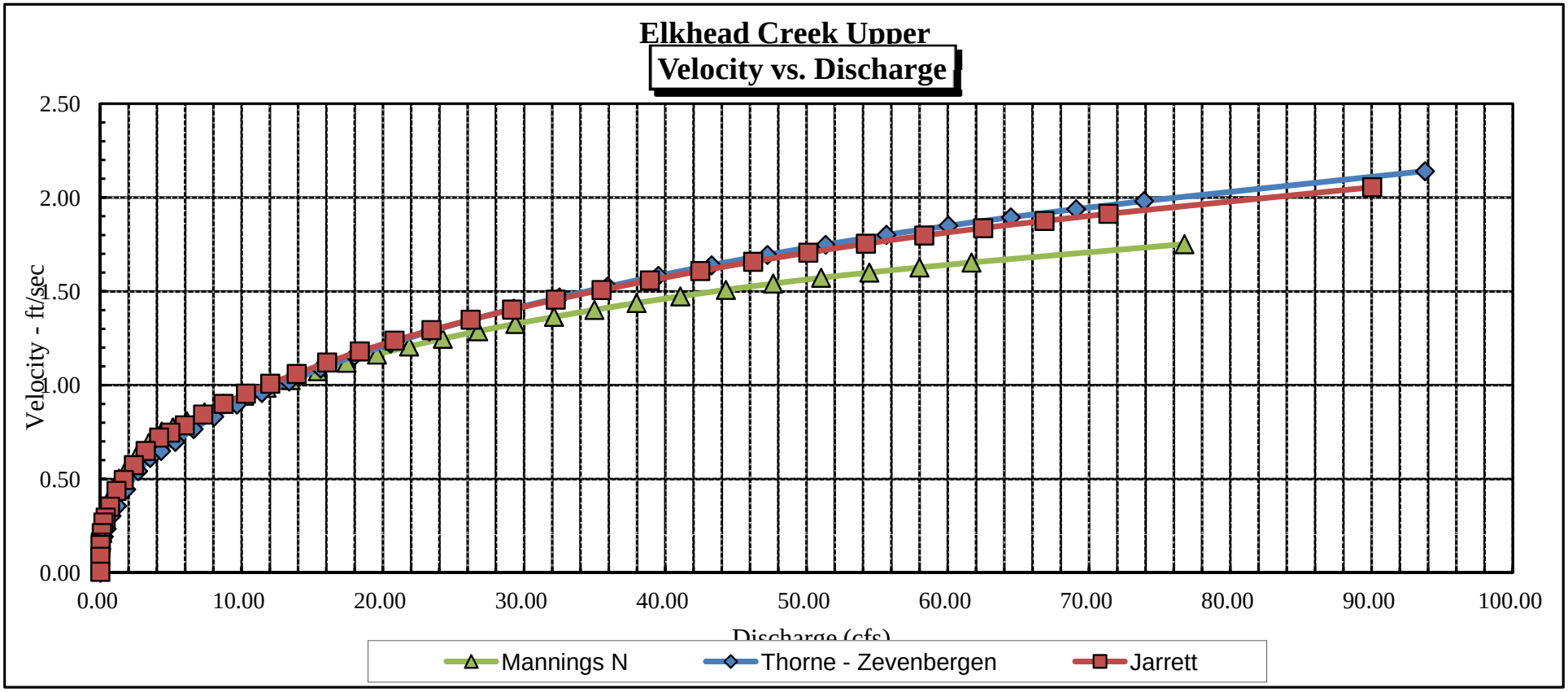
STREAM NAME: Elkhead Creek Upper
XS LOCATION: Ab confl with N Fk
XS NUMBER: 1 Jarrett Variable Manning's n Correction Applied

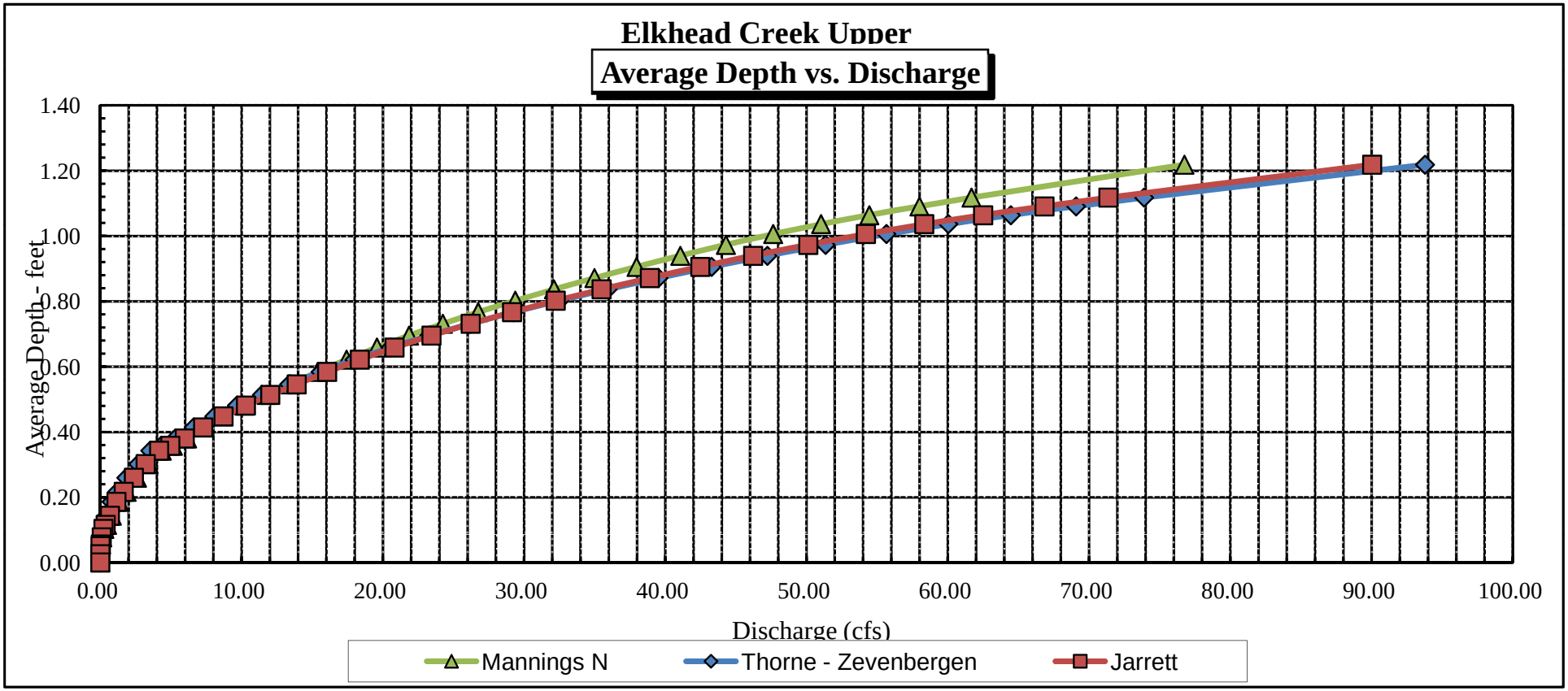
GL = lowest Grassline elevation corrected for sag
STAGING TABLE *WL* = Waterline corrected for variations in field measured water surface elevations and sag

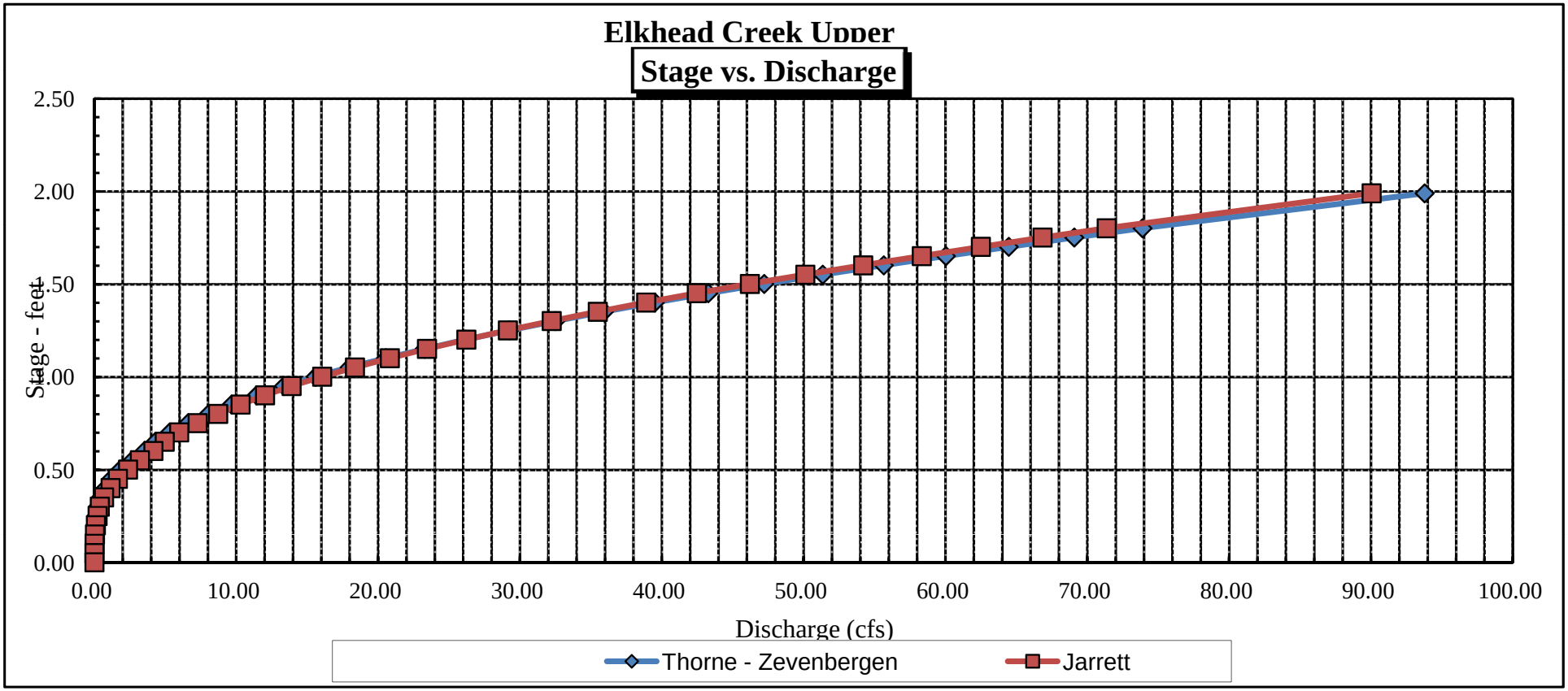
	DIST TO WATER (FT)	TOP WIDTH (FT)	AVG. DEPTH (FT)	MAX. DEPTH (FT)	AREA (SQ FT)	WETTED PERIM. (FT)	PERCENT WET PERIM (%)	HYDR RADIUS (FT)	FLOW (CFS)	AVG. VELOCITY (FT/SEC)
GL	8.37	35.97	1.22	1.99	43.82	36.39	100.0%	1.20	90.04	2.05
	8.56	33.37	1.12	1.80	37.30	33.76	92.8%	1.10	71.36	1.91
	8.61	32.68	1.09	1.75	35.64	33.06	90.9%	1.08	66.84	1.88
	8.66	31.99	1.06	1.70	34.03	32.37	89.0%	1.05	62.50	1.84
	8.71	31.30	1.04	1.65	32.45	31.67	87.0%	1.02	58.33	1.80
	8.76	30.71	1.01	1.60	30.90	31.07	85.4%	0.99	54.20	1.75
	8.81	30.19	0.97	1.55	29.37	30.54	83.9%	0.96	50.12	1.71
	8.86	29.68	0.94	1.50	27.88	30.02	82.5%	0.93	46.21	1.66
	8.91	29.16	0.91	1.45	26.41	29.49	81.0%	0.90	42.47	1.61
	8.96	28.64	0.87	1.40	24.96	28.96	79.6%	0.86	38.90	1.56
	9.01	28.13	0.84	1.35	23.54	28.44	78.2%	0.83	35.49	1.51
	9.06	27.61	0.80	1.30	22.15	27.91	76.7%	0.79	32.24	1.46
	9.11	27.10	0.77	1.25	20.78	27.39	75.3%	0.76	29.15	1.40
	9.16	26.58	0.73	1.20	19.44	26.86	73.8%	0.72	26.22	1.35
	9.21	26.07	0.70	1.15	18.12	26.34	72.4%	0.69	23.45	1.29
	9.26	25.55	0.66	1.10	16.83	25.81	70.9%	0.65	20.83	1.24
	9.31	25.04	0.62	1.05	15.57	25.29	69.5%	0.62	18.37	1.18
	9.36	24.53	0.58	1.00	14.33	24.77	68.1%	0.58	16.06	1.12
	9.41	24.02	0.55	0.95	13.11	24.25	66.6%	0.54	13.90	1.06
	9.46	23.23	0.51	0.90	11.93	23.45	64.5%	0.51	12.03	1.01
	9.51	22.43	0.48	0.85	10.79	22.64	62.2%	0.48	10.30	0.95
WL	9.56	21.63	0.45	0.80	9.69	21.84	60.0%	0.44	8.72	0.90
	9.61	20.83	0.41	0.75	8.63	21.03	57.8%	0.41	7.28	0.84
	9.66	20.01	0.38	0.70	7.61	20.20	55.5%	0.38	5.98	0.79
	9.71	18.53	0.36	0.65	6.63	18.71	51.4%	0.35	4.96	0.75
	9.76	16.84	0.34	0.60	5.77	17.01	46.8%	0.34	4.16	0.72
	9.81	16.37	0.30	0.55	4.94	16.54	45.4%	0.30	3.21	0.65
	9.86	15.91	0.26	0.50	4.13	16.06	44.1%	0.26	2.37	0.57
	9.91	15.44	0.22	0.45	3.35	15.59	42.8%	0.21	1.66	0.49
	9.96	13.99	0.19	0.40	2.61	14.12	38.8%	0.18	1.14	0.44
	10.01	13.36	0.14	0.35	1.92	13.48	37.1%	0.14	0.68	0.35
	10.06	11.14	0.12	0.30	1.29	11.25	30.9%	0.11	0.38	0.29
	10.11	8.02	0.10	0.25	0.83	8.10	22.3%	0.10	0.22	0.27
	10.16	6.11	0.08	0.20	0.48	6.16	16.9%	0.08	0.10	0.21
	10.21	3.98	0.06	0.15	0.22	4.01	11.0%	0.06	0.04	0.16
	10.26	1.72	0.05	0.10	0.09	1.73	4.8%	0.05	0.01	0.15
	10.31	0.87	0.03	0.05	0.02	0.87	2.4%	0.03	0.00	0.09
	10.36	0.03	0.00	0.00	0.00	0.03	0.1%	0.00	0.00	0.01


Elkhead Creek Upper
CROSS SECTION DATA ANALYSIS
-7.00
-7.50
-8.00
-8.50
-9.00
-9.50
-10.00
-10.50
VERTICAL DEPTH (FT)
s gl
wl
wl
gl
s
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
DISTANCE FROM STAKE (FT)
Channel Bottom
Computed Water Line


Elkhead Creek Upper
Percent Wetted Perimeter vs. Discharge
Percent Wetted Perimeter
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


Elkhead Creek Upper
Velocity vs. Discharge
Velocity - ft/sec
2.50
2.00
1.50
1.00
0.50
0.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


Elkhead Creek Upper
Average Depth vs. Discharge
Average Depth - feet
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


Elkhead Creek Upper
Stage vs. Discharge
Stage - feet
2.50
2.00
1.50
1.00
0.50
0.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
Discharge (cfs)
Thorne - Zevenbergen
Jarrett

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

LOCATION INFORMATION

STREAM NAME:	Elkhead Creek Upper
XS LOCATION:	Ab confl with N Fk
XS NUMBER:	2
DATE:	1028/15
OBSERVERS:	js rv sm
1/4 SEC:	0
SECTION:	0
TWP:	40 40 9.40
RANGE:	107 17 10.26
PM:	0
COUNTY:	Routt
WATERSHED:	0
DIVISION:	0
DOW CODE:	0
USGS MAP:	0
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:	0.013

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

ASSIGNED TO: ….....……..…….....DATE.....

STREAM NAME: Elkhead Creek Upper
XS LOCATION: Ab confl with N Fk
XS NUMBER: 2

DATA POINTS= 30

VALUES COMPUTED FROM RAW FIELD DATA

FEATURE	DIST	VERT DEPTH	WATER DEPTH	VEL	WETTED PERIM.	WATER DEPTH	AREA (Am)	Q (Qm)	% Q CELL
1 s gl	0.50	8.22			0.00		0.00	0.00	0.0%
	0.90	9.21			0.00		0.00	0.00	0.0%
wl	1.70	9.52	0.00	0.00	0.00		0.00	0.00	0.0%
	2.40	9.83	0.30	0.03	0.77	0.30	0.21	0.01	0.1%
	3.10	9.91	0.35	0.07	0.70	0.35	0.25	0.02	0.2%
	3.80	10.10	0.45	0.44	0.73	0.45	0.32	0.14	1.9%
	4.50	9.70	0.20	1.44	0.81	0.20	0.14	0.20	2.8%
	5.20	9.69	0.20	1.70	0.70	0.20	0.14	0.24	3.3%
	5.90	9.71	0.20	1.53	0.70	0.20	0.14	0.21	3.0%
	6.60	9.69	0.20	1.59	0.70	0.20	0.14	0.22	3.1%
	7.30	10.62	0.80	2.13	1.16	0.80	0.56	1.19	16.4%
	8.00	10.69	1.10	1.76	0.70	1.10	0.77	1.36	18.7%
	8.70	10.55	1.10	1.09	0.71	1.10	0.77	0.84	11.6%
	9.40	10.26	0.70	1.64	0.76	0.70	0.49	0.80	11.1%
	10.10	10.30	0.65	1.96	0.70	0.65	0.46	0.89	12.3%
	10.80	10.52	0.85	1.23	0.73	0.85	0.60	0.73	10.1%
	11.50	10.44	0.90	0.40	0.70	0.90	0.63	0.25	3.5%
	12.20	9.89	0.90	0.17	0.89	0.90	0.63	0.11	1.5%
	12.90	10.03	0.25	0.00	0.71	0.25	0.18	0.00	0.0%
	13.60	9.80	0.35	0.04	0.74	0.35	0.25	0.01	0.1%
	14.30	9.95	0.20	0.20	0.72	0.20	0.14	0.03	0.4%
	15.00	9.70	0.20	0.00	0.74	0.20	0.14	0.00	0.0%
	15.70	9.91	0.25	0.00	0.73	0.25	0.18	0.00	0.0%
	16.40	9.63	0.10	0.00	0.75	0.10	0.07	0.00	0.0%
	17.10	9.76	0.20	0.01	0.71	0.20	0.13	0.00	0.0%
wl	17.70	9.55	0.00	0.00	0.64		0.00	0.00	0.0%
	20.50	9.26			0.00		0.00	0.00	0.0%
1 gl	24.00	8.70			0.00		0.00	0.00	0.0%
	28.00	8.15			0.00		0.00	0.00	0.0%
s	30.40	7.76			0.00		0.00	0.00	0.0%
TOTALS ----------					17.21	1.1 (Max.)	7.31	7.25	100.0%

Manning's n = 0.0964
Hydraulic Radius= 0.42438037

STREAM NAME: Elkhead Creek Upper
XS LOCATION: Ab confl with N Fk
XS NUMBER: 2

WATER LINE COMPARISON TABLE

WATER LINE	MEAS AREA	COMP AREA	AREA ERROR
	7.31	7.63	4.4%
9.29	7.31	12.04	64.8%
9.31	7.31	11.65	59.5%
9.33	7.31	11.28	54.4%
9.35	7.31	10.91	49.3%
9.37	7.31	10.54	44.3%
9.39	7.31	10.18	39.4%
9.41	7.31	9.82	34.5%
9.43	7.31	9.47	29.7%
9.45	7.31	9.13	24.9%
9.47	7.31	8.78	20.2%
9.49	7.31	8.45	15.6%
9.50	7.31	8.28	13.4%
9.51	7.31	8.12	11.1%
9.52	7.31	7.95	8.8%
9.53	7.31	7.79	6.6%
9.54	7.31	7.63	4.4%
9.55	7.31	7.47	2.2%
9.56	7.31	7.31	0.0%
9.57	7.31	7.15	-2.2%
9.58	7.31	6.99	-4.3%
9.59	7.31	6.83	-6.5%
9.61	7.31	6.52	-10.8%
9.63	7.31	6.21	-15.1%
9.65	7.31	5.90	-19.3%
9.67	7.31	5.59	-23.4%
9.69	7.31	5.29	-27.5%
9.71	7.31	5.02	-31.3%
9.73	7.31	4.77	-34.7%
9.75	7.31	4.54	-37.9%
9.77	7.31	4.31	-41.0%
9.79	7.31	4.09	-44.0%

WATERLINE AT ZERO
AREA ERROR = 9.555

STREAM NAME: Elkhead Creek Upper
XS LOCATION: Ab confl with N Fk
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	8.70	23.31	1.05	1.99	24.52	24.98	100.0%	0.98	42.58	1.74
	8.71	23.27	1.05	1.98	24.41	24.94	99.8%	0.98	42.28	1.73
	8.76	22.94	1.01	1.93	23.25	24.57	98.4%	0.95	39.39	1.69
	8.81	22.61	0.98	1.88	22.11	24.20	96.9%	0.91	36.59	1.66
	8.86	22.27	0.94	1.83	20.99	23.83	95.4%	0.88	33.90	1.62
	8.91	21.94	0.91	1.78	19.88	23.46	93.9%	0.85	31.30	1.57
	8.96	21.61	0.87	1.73	18.79	23.09	92.4%	0.81	28.80	1.53
	9.01	21.28	0.83	1.68	17.72	22.72	91.0%	0.78	26.40	1.49
	9.06	20.94	0.80	1.63	16.67	22.35	89.5%	0.75	24.09	1.45
	9.11	20.61	0.76	1.58	15.63	21.98	88.0%	0.71	21.88	1.40
	9.16	20.28	0.72	1.53	14.61	21.61	86.5%	0.68	19.77	1.35
	9.21	19.95	0.68	1.48	13.60	21.24	85.0%	0.64	17.76	1.31
	9.26	19.51	0.65	1.43	12.61	20.79	83.2%	0.61	15.89	1.26
	9.31	18.92	0.62	1.38	11.65	20.19	80.8%	0.58	14.20	1.22
	9.36	18.31	0.59	1.33	10.72	19.56	78.3%	0.55	12.62	1.18
	9.41	17.70	0.56	1.28	9.82	18.94	75.8%	0.52	11.14	1.13
	9.46	17.08	0.52	1.23	8.95	18.31	73.3%	0.49	9.76	1.09
	9.51	16.47	0.49	1.18	8.11	17.69	70.8%	0.46	8.48	1.05
WL	9.56	15.91	0.46	1.13	7.30	17.11	68.5%	0.43	7.28	1.00
	9.61	15.65	0.42	1.08	6.52	16.84	67.4%	0.39	6.08	0.93
	9.66	15.20	0.38	1.03	5.74	16.36	65.5%	0.35	5.02	0.87
	9.71	12.74	0.39	0.98	5.01	13.85	55.5%	0.36	4.48	0.89
	9.76	11.31	0.39	0.93	4.42	12.34	49.4%	0.36	3.92	0.89
	9.81	10.56	0.37	0.88	3.87	11.51	46.1%	0.34	3.29	0.85
	9.86	9.35	0.36	0.83	3.37	10.21	40.9%	0.33	2.83	0.84
	9.91	7.87	0.37	0.78	2.94	8.65	34.6%	0.34	2.52	0.86
	9.96	6.71	0.38	0.73	2.58	7.40	29.6%	0.35	2.25	0.87
	10.01	5.93	0.38	0.68	2.26	6.55	26.2%	0.35	1.96	0.87
	10.06	5.36	0.37	0.63	1.98	5.91	23.6%	0.34	1.68	0.85
	10.11	5.01	0.34	0.58	1.72	5.50	22.0%	0.31	1.40	0.81
	10.16	4.91	0.30	0.53	1.48	5.36	21.4%	0.28	1.10	0.74
	10.21	4.81	0.26	0.48	1.23	5.21	20.9%	0.24	0.83	0.67
	10.26	4.71	0.21	0.43	1.00	5.07	20.3%	0.20	0.59	0.59
	10.31	3.78	0.21	0.38	0.78	4.09	16.4%	0.19	0.46	0.58
	10.36	3.40	0.18	0.33	0.60	3.65	14.6%	0.17	0.32	0.53
	10.41	3.02	0.15	0.28	0.44	3.21	12.8%	0.14	0.21	0.47
	10.46	2.53	0.12	0.23	0.30	2.66	10.6%	0.11	0.12	0.41
	10.51	1.77	0.11	0.18	0.19	1.86	7.4%	0.10	0.08	0.39
	10.56	1.42	0.08	0.13	0.12	1.47	5.9%	0.08	0.04	0.32
	10.61	1.14	0.05	0.08	0.05	1.16	4.6%	0.05	0.01	0.23
	10.66	0.52	0.02	0.03	0.01	0.53	2.1%	0.02	0.00	0.12

STREAM NAME: Elkhead Creek Upper
XS LOCATION: Ab confl with N Fk
XS NUMBER: 2

SUMMARY SHEET

MEASURED FLOW (Qm)=	7.25	cfs
CALCULATED FLOW (Qc)=	7.28	cfs
(Qm-Qc)/Qm * 100 =	-0.4	%
MEASURED WATERLINE (WLm)=	9.54	ft
CALCULATED WATERLINE (WLc)=	9.56	ft
(WLm-WLc)/WLm * 100 =	-0.2	%
MAX MEASURED DEPTH (Dm)=	1.10	ft
MAX CALCULATED DEPTH (Dc)=	1.13	ft
(Dm-Dc)/Dm * 100	-3.2	%
MEAN VELOCITY=	1.00	ft/sec
MANNING'S N=	0.096	
SLOPE=	0.013	ft/ft
.4 * Qm =	2.9	cfs
2.5 * Qm=	18.1	cfs

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

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

RATIONALE FOR RECOMMENDATION:
=============================

RECOMMENDATION BY: …………………...………..……............................... AGENCY..……………………......…....…...…....... DATE:.......…...…......……………

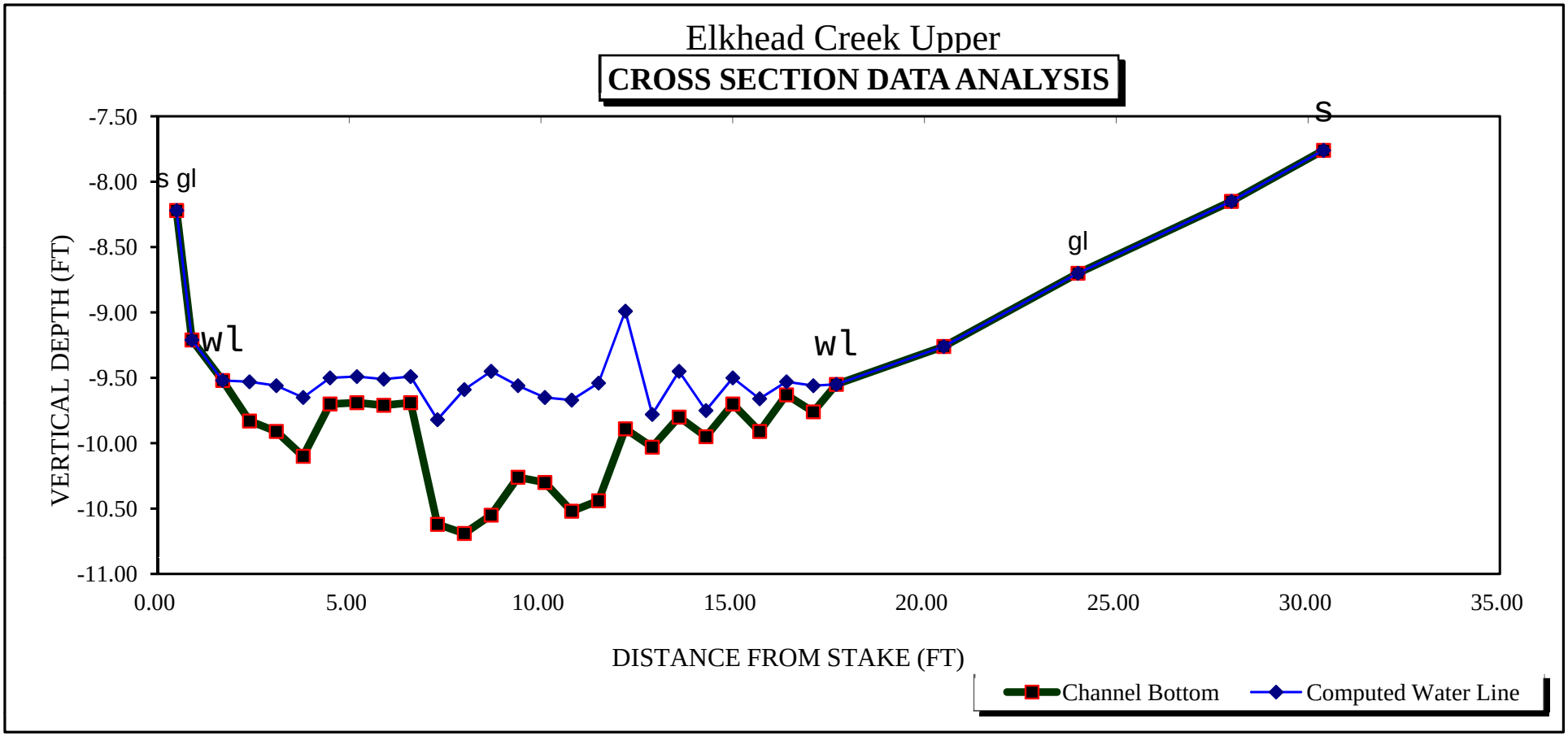
CWCB REVIEW BY: ..…………………………....……………………………………………..…............. DATE:..................…………….....

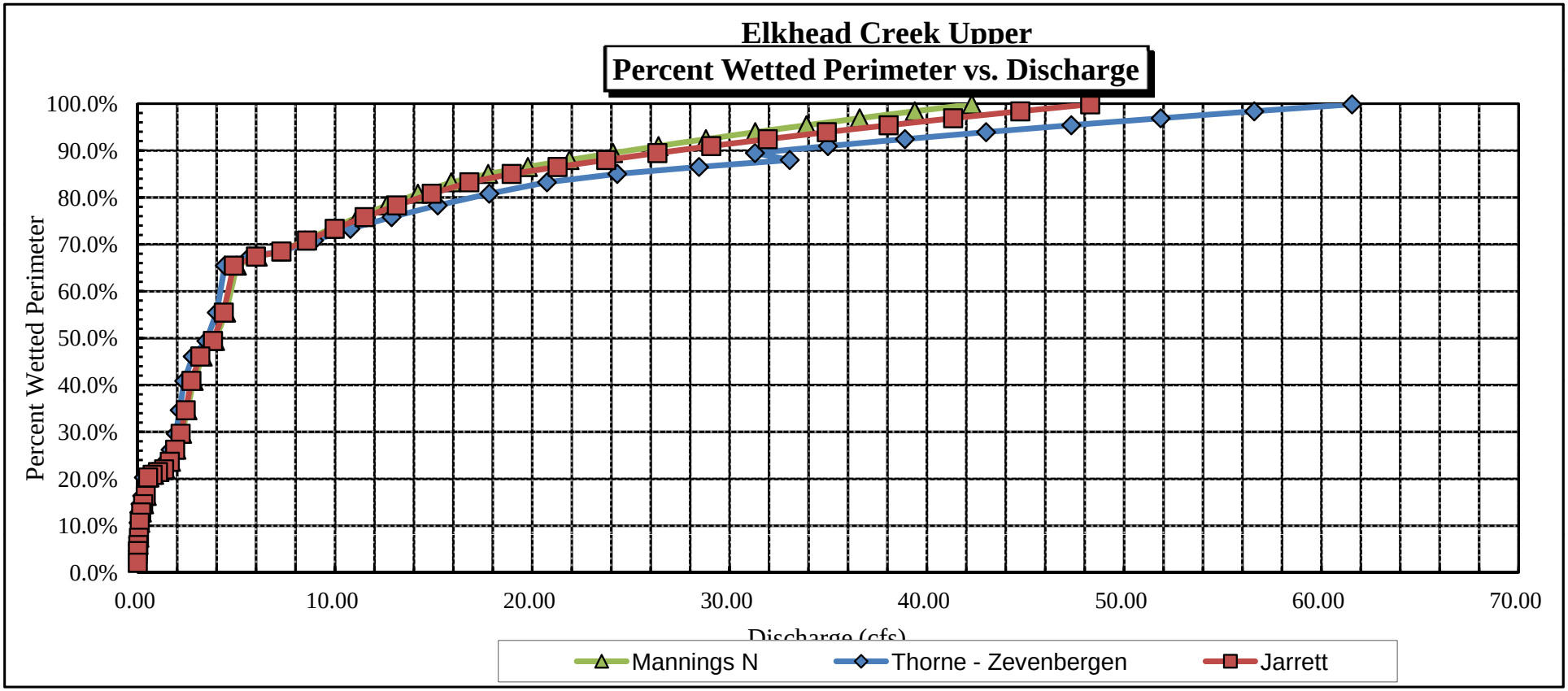
STREAM NAME: Elkhead Creek Upper
XS LOCATION: Ab confl with N Fk
XS NUMBER: 2

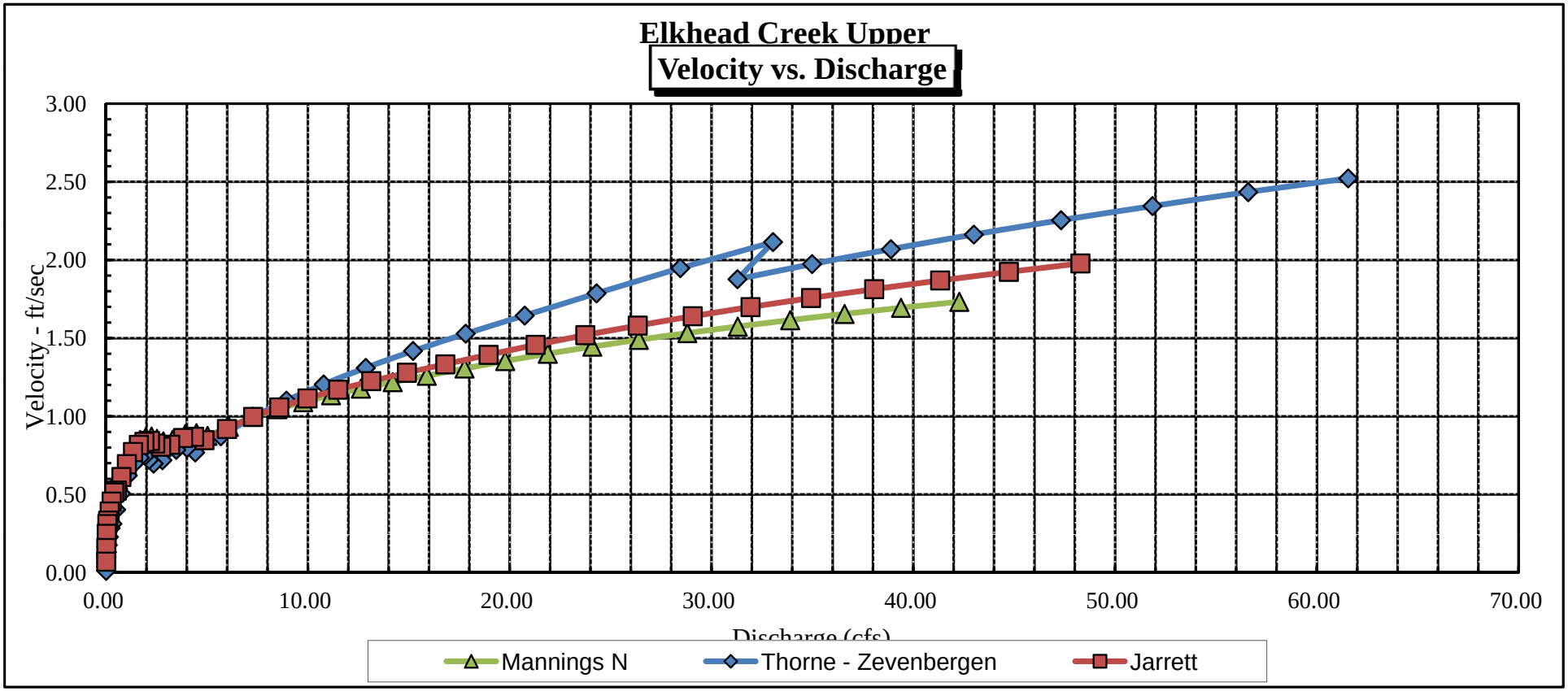
Jarrett Variable Manning's n Correction Applied

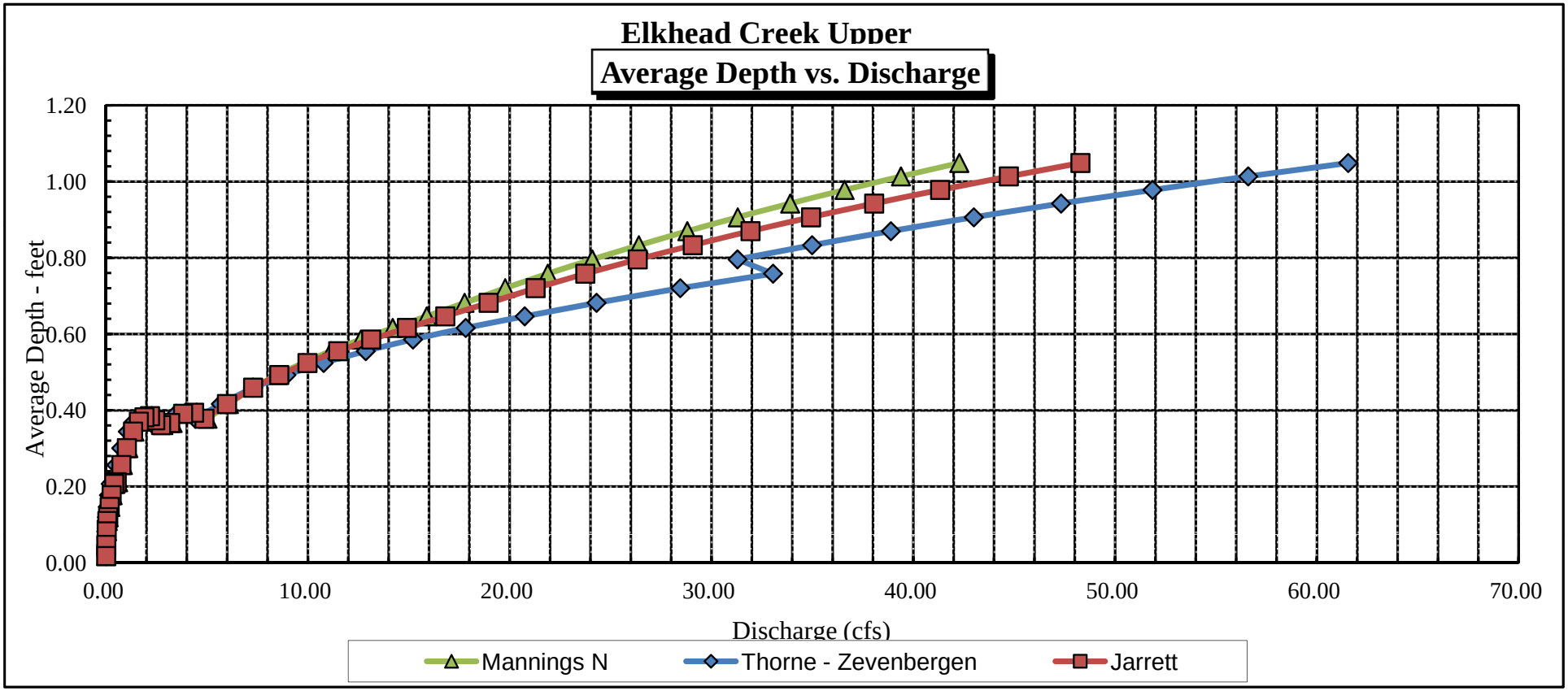
GL = lowest Grassline elevation corrected for sag
STAGING TABLE *WL* = Waterline corrected for variations in field measured water surface elevations and sag

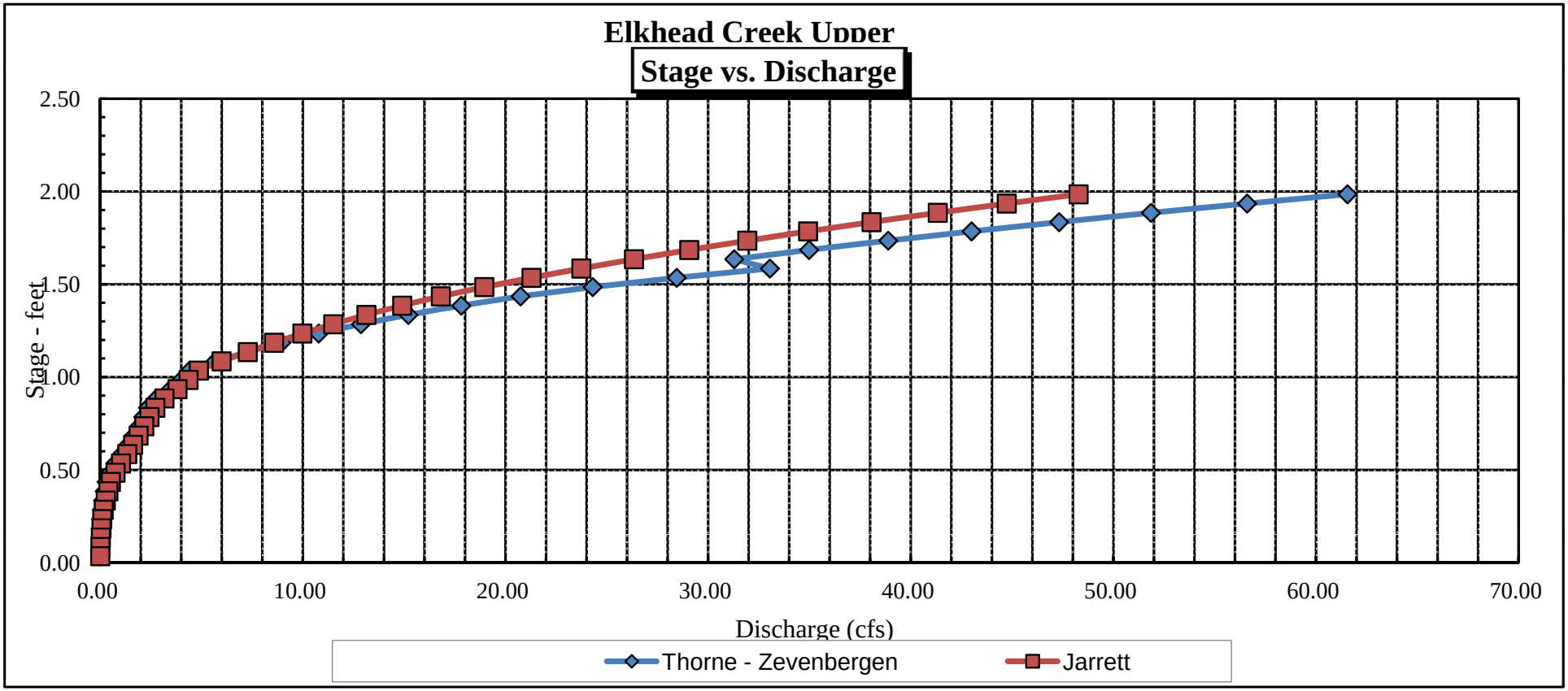
	DIST TO WATER (FT)	TOP WIDTH (FT)	AVG. DEPTH (FT)	MAX. DEPTH (FT)	AREA (SQ FT)	WETTED PERIM. (FT)	PERCENT WET PERIM (%)	HYDR RADIUS (FT)	FLOW (CFS)	AVG. VELOCITY (FT/SEC)
GL	8.70	23.31	1.05	1.99	24.52	24.98	100.0%	0.98	48.65	1.98
	8.71	23.27	1.05	1.98	24.41	24.94	99.8%	0.98	48.28	1.98
	8.76	22.94	1.01	1.93	23.25	24.57	98.4%	0.95	44.74	1.92
	8.81	22.61	0.98	1.88	22.11	24.20	96.9%	0.91	41.33	1.87
	8.86	22.27	0.94	1.83	20.99	23.83	95.4%	0.88	38.06	1.81
	8.91	21.94	0.91	1.78	19.88	23.46	93.9%	0.85	34.93	1.76
	8.96	21.61	0.87	1.73	18.79	23.09	92.4%	0.81	31.93	1.70
	9.01	21.28	0.83	1.68	17.72	22.72	91.0%	0.78	29.07	1.64
	9.06	20.94	0.80	1.63	16.67	22.35	89.5%	0.75	26.34	1.58
	9.11	20.61	0.76	1.58	15.63	21.98	88.0%	0.71	23.75	1.52
	9.16	20.28	0.72	1.53	14.61	21.61	86.5%	0.68	21.28	1.46
	9.21	19.95	0.68	1.48	13.60	21.24	85.0%	0.64	18.95	1.39
	9.26	19.51	0.65	1.43	12.61	20.79	83.2%	0.61	16.81	1.33
	9.31	18.92	0.62	1.38	11.65	20.19	80.8%	0.58	14.90	1.28
	9.36	18.31	0.59	1.33	10.72	19.56	78.3%	0.55	13.14	1.23
	9.41	17.70	0.56	1.28	9.82	18.94	75.8%	0.52	11.50	1.17
	9.46	17.08	0.52	1.23	8.95	18.31	73.3%	0.49	9.98	1.11
	9.51	16.47	0.49	1.18	8.11	17.69	70.8%	0.46	8.58	1.06
WL	9.56	15.91	0.46	1.13	7.30	17.11	68.5%	0.43	7.28	1.00
	9.61	15.65	0.42	1.08	6.52	16.84	67.4%	0.39	5.99	0.92
	9.66	15.20	0.38	1.03	5.74	16.36	65.5%	0.35	4.87	0.85
	9.71	12.74	0.39	0.98	5.01	13.85	55.5%	0.36	4.36	0.87
	9.76	11.31	0.39	0.93	4.42	12.34	49.4%	0.36	3.81	0.86
	9.81	10.56	0.37	0.88	3.87	11.51	46.1%	0.34	3.17	0.82
	9.86	9.35	0.36	0.83	3.37	10.21	40.9%	0.33	2.72	0.81
	9.91	7.87	0.37	0.78	2.94	8.65	34.6%	0.34	2.43	0.83
	9.96	6.71	0.38	0.73	2.58	7.40	29.6%	0.35	2.17	0.84
	10.01	5.93	0.38	0.68	2.26	6.55	26.2%	0.35	1.89	0.84
	10.06	5.36	0.37	0.63	1.98	5.91	23.6%	0.34	1.62	0.82
	10.11	5.01	0.34	0.58	1.72	5.50	22.0%	0.31	1.33	0.77
	10.16	4.91	0.30	0.53	1.48	5.36	21.4%	0.28	1.02	0.69
	10.21	4.81	0.26	0.48	1.23	5.21	20.9%	0.24	0.75	0.61
	10.26	4.71	0.21	0.43	1.00	5.07	20.3%	0.20	0.52	0.52
	10.31	3.78	0.21	0.38	0.78	4.09	16.4%	0.19	0.40	0.51
	10.36	3.40	0.18	0.33	0.60	3.65	14.6%	0.17	0.27	0.45
	10.41	3.02	0.15	0.28	0.44	3.21	12.8%	0.14	0.17	0.39
	10.46	2.53	0.12	0.23	0.30	2.66	10.6%	0.11	0.10	0.33
	10.51	1.77	0.11	0.18	0.19	1.86	7.4%	0.10	0.06	0.31
	10.56	1.42	0.08	0.13	0.12	1.47	5.9%	0.08	0.03	0.25
	10.61	1.14	0.05	0.08	0.05	1.16	4.6%	0.05	0.01	0.16
	10.66	0.52	0.02	0.03	0.01	0.53	2.1%	0.02	0.00	0.07


Elkhead Creek Upper
CROSS SECTION DATA ANALYSIS
-7.50
-8.00
-8.50
-9.00
-9.50
-10.00
-10.50
-11.00
VERTICAL DEPTH (FT)
s gl
wl
wl
gl
s
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
DISTANCE FROM STAKE (FT)
Channel Bottom
Computed Water Line


Elkhead Creek Upper
Percent Wetted Perimeter vs. Discharge
Percent Wetted Perimeter
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


Elkhead Creek Upper
Velocity vs. Discharge
Velocity - ft/sec
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


Elkhead Creek Upper
Average Depth vs. Discharge
Average Depth - feet
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


Elkhead Creek Upper
Stage vs. Discharge
Stage - feet
2.50
2.00
1.50
1.00
0.50
0.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
Discharge (cfs)
Thorne - Zevenbergen
Jarrett

COLORADO WATER CONSERVATION BOARD

FIELD DATA FOR INSTREAM FLOW DETERMINATIONS

COLORADO DIVISION OF WILDLIFE

LOCATION INFORMATION

STREAM NAME: ELKHEAD CK					CROSS-SECTION NO.: 1
CROSS-SECTION LOCATION: D/S OF FIRST CK					
DATE: 9/30/14	OBSERVERS: JWS, TB, BC				
LEGAL DESCRIPTION	¼ SECTION:	SECTION:	TOWNSHIP: N/S	RANGE: E/W	PM:
COUNTY: Routt	WATERSHED: Yampa	WATER DIVISION: 6	DOW WATER CODE:		
MAP(S): USGS:					
USFS: Routt NF					

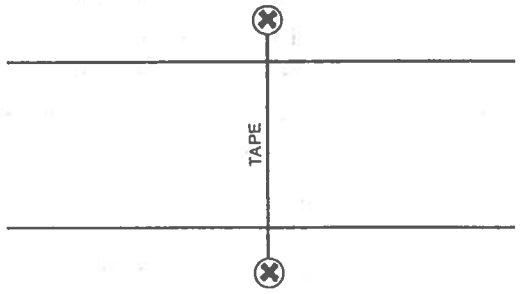
SUPPLEMENTAL DATA

SAG TAPE SECTION SAME AS DISCHARGE SECTION: YES / NO	METER TYPE:			
METER NUMBER:	DATE RATED:	CALIB/SPIN: _____ sec	TAPE WEIGHT: _____ lbs/foot	TAPE TENSION: _____ lbs
CHANNEL BED MATERIAL SIZE RANGE:	PHOTOGRAPHS TAKEN: YES/NO	NUMBER OF PHOTOGRAPHS:		

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	
② WS Upstream	7.18	61
③ WS Downstream	6.80	
SLOPE	.38/61 =	

SKETCH



LEGEND:
- Stake ⊗
- Station ①
- Photo ◇
- 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:

COMMENTS

Cold, Intermitt Run

DISCHARGE/CROSS SECTION NOTES

STREAM NAME:	CROSS-SECTION NO.:	DATE:	SHEET ___ OF ___

BEGINNING OF MEASUREMENT	EDGE OF WATER LOOKING DOWNSTREAM: (0.0 AT STAKE) LEFT / RIGHT	Gage Reading: _____ft	TIME:

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)
SGL	0		4.5								
	4		5.45								
	7		6.15								
WL	9	.5	6.95	0						0	
	10	1.0	7.5	.5						.5	
	11	1.5	7.6	.6						.9	
	13	2	7.7	.7						1.4	
	15	↓	7.75	.75						1.5	
	17	↓	7.6	.6						1.2	
	19	↓	7.7	.7						1.4	
	21		7.7	.7						1.4	
	23		7.6	.6						1.2	
	25		7.6	.6						1.2	
	27	2.	7.55	.55						1.1	
	29	1.5	7.5	.5						.75	
WL	30	.5	7.00	0						0	
	30.6		6.8								
	33		5.25								
GL	35		5.0								
S	37.5		2.95								
										12.45	
TOTALS:											

Q notes from BE

Q = 9 cfs

A = 12.5

$\bar{V}$ = 0.72

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

COLORADO WATER CONSERVATION BOARD

FIELD DATA FOR INSTREAM FLOW DETERMINATIONS

LOCATION INFORMATION

STREAM NAME: Elkhead Creek						CROSS-SECTION NO.: 1
CROSS-SECTION LOCATION: Just U/S of confl. w/ NF Elkhead creek						
DATE: 10-28-15	OBSERVERS:					
LEGAL DESCRIPTION	¼ SECTION:	SECTION:	TOWNSHIP: N/S	RANGE: E/W	PM:	
COUNTY:	WATERSHED:	WATER DIVISION: 6	DOW WATER CODE:			
MAP(S): USGS: 40 41 17.85						
USFS: 107 16 49.55						

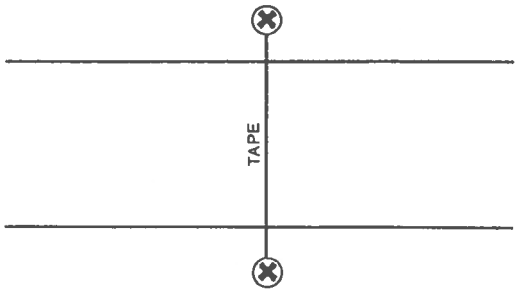
SUPPLEMENTAL DATA

SAG TAPE SECTION SAME AS DISCHARGE SECTION: (YES) NO	METER TYPE:			
METER NUMBER:	DATE RATED:	CALIB/SPIN: _____ sec	TAPE WEIGHT: _____ lbs/foot	TAPE TENSION: _____ lbs
CHANNEL BED MATERIAL SIZE RANGE:	PHOTOGRAPHS TAKEN: YES/NO	NUMBER OF PHOTOGRAPHS:		

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	
② WS Upstream	24	9.65
③ WS Downstream	29	9.79
SLOPE	0.14 / 53 = 0.003	

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:

COMMENTS

FORM #ISF FD 1-85

DISCHARGE/CROSS SECTION NOTES

STREAM NAME:	CROSS-SECTION NO.: 10-28-15	DATE:	SHEET ___ OF ___

BEGINNING OF MEASUREMENT	EDGE OF WATER LOOKING DOWNSTREAM: (0.0 AT STAKE) LEFT / RIGHT	Gage Reading: _____ ft	TIME: 2:28

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)
SG	0		7.45								
	7		8.73								
	11		9.41								
WL	13.8		9.65		0						
	14.0		9.69		.15			0			
	15		9.71		.30			.17			
	16		9.71		.20			.13			
	17		9.98		.40			.18			
	18		10.08		.50			0.98			
	19		10.06		.75			1.06			
	20		10.05		.50			1.11			
	21		10.18		.80			1.15			
	22		10.36		.70			0.75			
	23		10.27		.55			0.53			
	24		10.19		.60			0.72			
	25		10.01		.55			1.37			
	26		10.22		.50			1.24			
	27		10.05		.50			1.31			
	28		10.25		.50			1.28			
	29		10.21		.65			1.37			
	30		10.13		.60			1.16			
	31		9.94		0.35			1.15			
	32		9.94		0.35			0.84			
	33		9.76		0.30			0.07			
WL	34		9.64		0						
	36		9.18								
	38		8.73								
	41		8.37								
GS	46.2		8.65								
TOTALS:											

End of Measurement	Time: 2:44	Gage Reading: _____ ft	CALCULATIONS PERFORMED BY:	CALCULATIONS CHECKED BY: