Instream Flow Recommendation:

North Fork of Elkhead Creek (Headwaters to the Confluence with 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 the North Fork of Elkhead Creek in Routt County, Colorado. This recommendation, along with two other 2017 ISF recommendations in the Elkhead Creek basin, represent 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 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 the North Fork 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 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: The North Fork of Elkhead Creek from the headwaters to the confluence with Elkhead Creek (Figure 1)

Upper Terminus: Headwaters
UTM North: 4515748.47817; UTM East: 310855.196413
Elevation: 9,070 feet

Lower Terminus: Confluence with Elkhead Creek
UTM North: 4504451.44952; UTM East: 306665.084031
Elevation: 6, 833 feet

Water Division: 6
Water District: 44
CPW Water Code: 20153
Approximate segment length: 9.4 miles
County: Routt County

Major Drainage Basin: Yampa River
Name of USGS quad maps: Bears Ears Peak and Slide Mountain

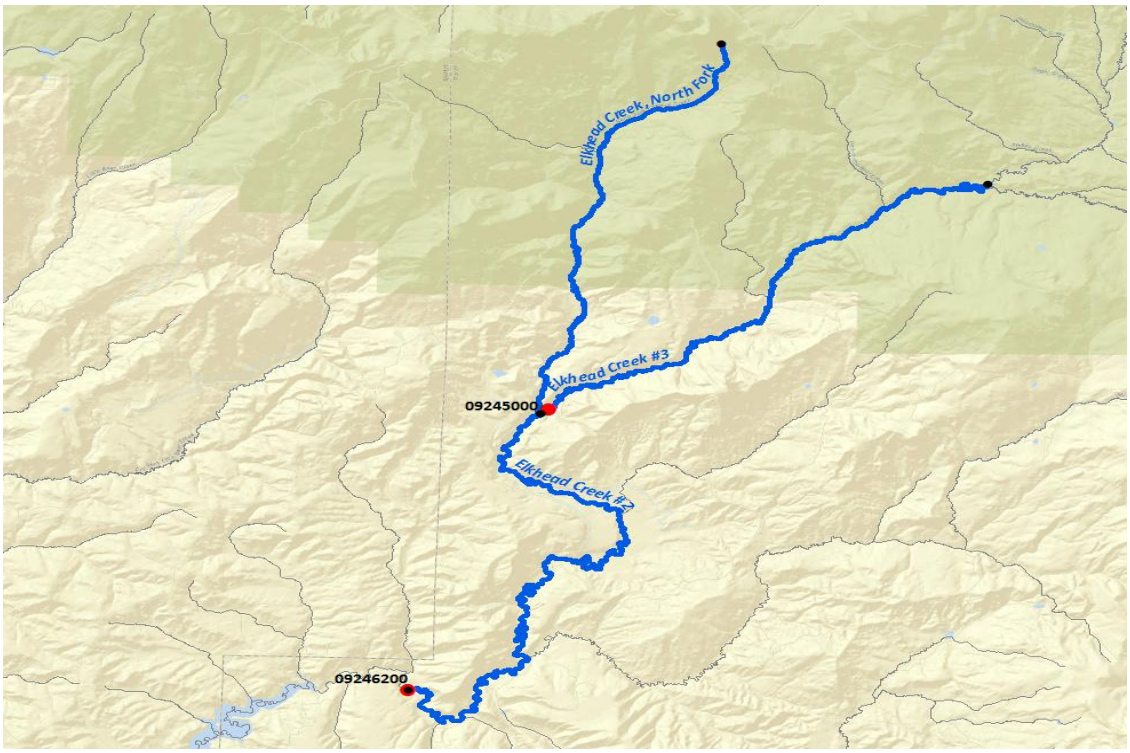


Figure 1. Map showing the location of the 2017 Elkhead Creek recommended reaches. Black dots represent the reach termini. The red dots are gaging stations within or near the recommended reaches.

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. One major tributary of Elkhead Creek is the North Fork of Elkhead Creek; the North Fork has its confluence with the mainstem of Elkhead Creek at an elevation of approximately 6,833 feet. The North Fork is approximately 9.4 miles long; the basin area is approximately 22.5 square miles and has a mean basin elevation of 8,400 feet.

Recommended Segment:

This ISF recommendation is for the North Fork of Elkhead Creek. The recommended segment begins at the headwaters and extends about 9.4 miles downstream to the confluence with Elkhead Creek. The North Fork starts as a first order stream and then is a second order stream for the lower 6 miles. This recommended reach drops about 2,250 feet over 9.4 miles that so much of the creek is fairly high gradient. The North Fork valley is mostly confined so the stream is relatively straight for much of its 9.4 miles and from aerial photography of the basin, most of the channel is a single thread. Any hydrologic connection to the floodplain likely occurs only during spring runoff or high precipitation events. The stream's banks are mostly intact and stable; some areas have been impacted by beaver activity. A prominent and healthy riparian corridor exists throughout this segment and has a crucial role in the energy and food web dynamics of and for the aquatic environment, providing food for both the aquatic macro-invertebrates and fish. The riparian community is mostly willows, alders, and cottonwoods. Stream cover is variable but is mostly forested with a few openings in the riparian canopy. The health of the riparian canopy is a major factor in protecting this small stream from solar radiation and heating during times of low flow during the late summer months. Due to the

stream's relative steepness, a majority of the habitat is small pools and short riffle sections. The stream's substrate was predominantly boulders and large cobble.

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

Upper Terminus	Lower Terminus	Total Length (miles)	Approximate Land Ownership	
			% Private	%Public
Headwaters	Confluence with Elkhead Creek	9.39	30	70+

+ = Public lands are USFS lands

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) (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; boreal toads are not currently present in the North Fork. 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) (CRCT Conservation Team 2006). The entire Elkhead Creek basin starting at 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. Unique aquatic habitat characteristics can be found for all native fish species in the North Fork of Elkhead Creek, and this is illustrated in the fish numbers observed in the fish samples from the North Fork. We believe that both headwater and mainstem aquatic habitat

characteristics are present in this recommended reach. CPW believes that all of the aquatic species discussed above and listed in the table below will benefit from the conservation actions described in the above narrative and the ISFs recommended herein.

Table 2. Natural environment information for the North Fork of 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 2015, CPW and CWCB staff collected stream cross-section data at two sites on the North Fork 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 type; riffles are the limiting habitat type in a stream 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, both a winter and summer flow recommendation was developed utilizing the 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 two sites within the recommended segment of the North Fork of Elkhead Creek.

Table 3. Summary of R2CROSS transect measurements and the resulting flow recommendations for the North Fork of 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 recommendation.

Entity	Date Measured	Q measured	40%-250%	Flow Meeting Two Criteria	Flow Meeting Three Criteria
CPW/CWCB	10/28/2015	2.12 cfs	0.8-5.3 cfs	0.89 cfs	5.3* cfs
CPW/CWCB	10/28/2015	2.21 cfs	0.9-5.5 cfs	4.0 cfs	5.5* cfs
			Mean	**2.5 cfs**	**5.4 cfs**

*These flows are the upper limit of the accuracy range for these R2CROSS runs. While they do not meet all three hydraulic criteria (they fall short of the average velocity or wetted perimeter criteria), they are the highest flows

that can be accurately predicted with these data sets and were therefore used to compute a summer flow recommendation.

ISF Recommendation:

From the above table, the R2CROSS-based winter flow recommendation is 2.5 cfs - 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 5.4 cfs – this flow is derived from the average of the upper limit of R2CROSS modeling accuracy for the two sites that we have data (see above footnote). These summer flow recommendations, while short of the flow needed to meet all three hydraulic criteria, are still within the R2CROSS modeling accuracy and should provide adequate protection for the natural environment. We feel that it is important to secure ISF protection for North Elkhead Creek now with the data available; if additional data sets are collected in the future that substantiate higher summer flows that meet the third criterion, CPW reserves the right to initiate an enlargement recommendation at that point in time.

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. Division of Water Resources data indicates that the North Fork of Elkhead Creek has four existing water rights. According to DWR Hydrobase, the names, structure ID numbers, and diversion information associated with these water rights are as follows:

- The Old Ellis &Kitchens Ditch (structure ID: 2211), structure is thought to be nonexistent with no contemporary or historical record of use. The water right for this structure may have been transferred to an alternate point of diversion.
- The North Elkhead Feeder Canal (structure ID: 2022), shows no decree information and no historical diversion records.
- The Ellis Kitchens Ditch (structure ID: 614), decreed absolute for 7.66 cfs, and conditionally for 6 cfs, contemporary diversion records exist for this structure.
- The Anderson Ditch (structure ID: 533), decreed absolute for 5 cfs, contemporary diversion records exist for this structure.

No stream gage exists for the North Fork of Elkhead Creek. Figure 2 (below) shows the mean monthly flows generated by the USGS StreamStats on-line tool and the areal apportionment of the Elkhead Creek USGS gage located near the confluence with the North Fork. The R2CROSS generated ISF recommendations are also depicted on this hydrograph. The purpose of this figure is to illustrate preliminary water availability and seasonality of the ISF recommendations generated by R2CROSS.

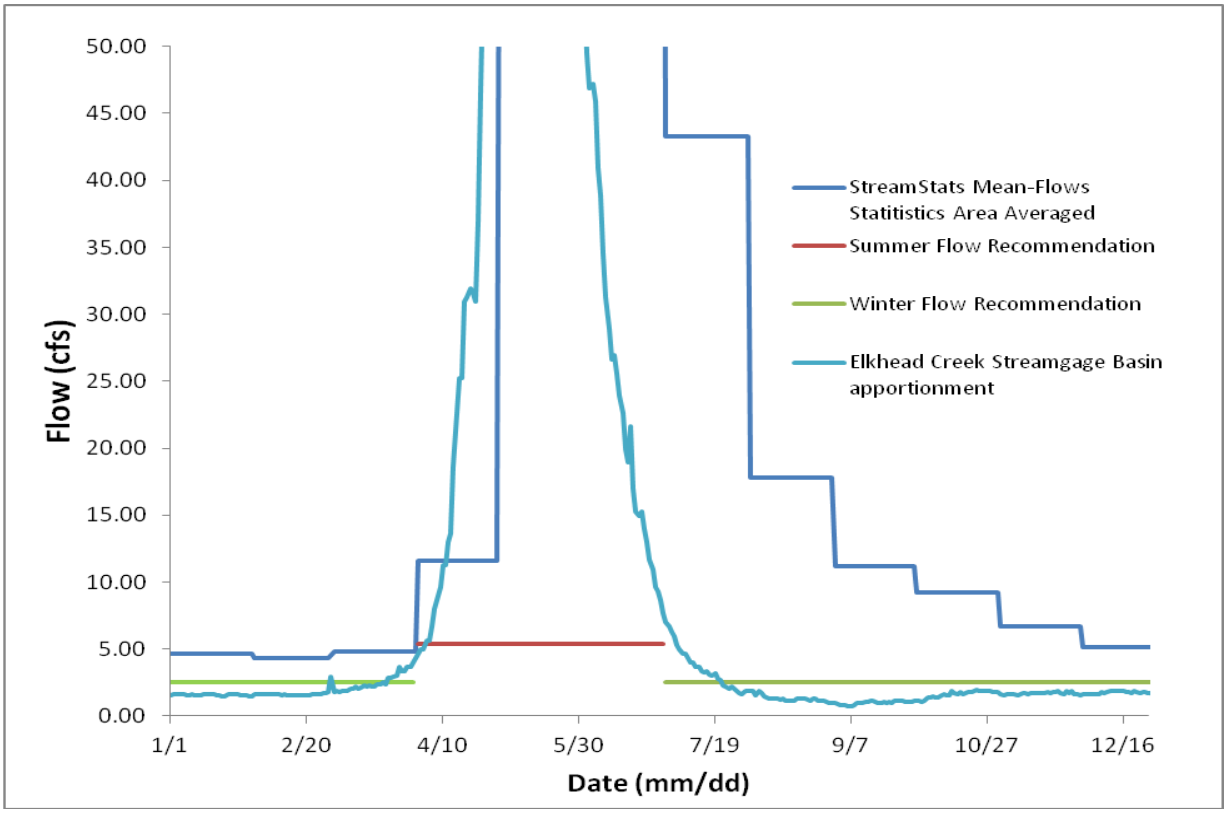


Figure 2. Hydrograph showing the available streamflow information and the R2CROSS ISF recommendations for the North Fork of Elkhead Creek. Streamflow data from a basin area apportionment of the nearby Elkhead Creek Near Elkhead, CO streamgage and monthly estimates from USGS StreamStats.

Seasonal ISF Recommendation

After reviewing the above preliminary water availability information, it is CPW's opinion that the following flows are necessary to protect and preserve the fishery and natural environment in the North Fork of Elkhead Creek (see Figure 2, above). 5.4 cubic feet per second is recommended for the snowmelt runoff period from April 1st through June 30th. This recommendation is driven by highest flow that can be accurately predicted with the data that we have at this point in time (it falls short of the flow needed to meet the third hydraulic criterion, but is based on the best available information). 2.5 cubic feet per second is being recommended for the base flow period from July 1st to March 30th (Figure 2). This flow is mainly driven by depth and wetted perimeter criteria and is necessary to provide overwintering habitat for the native species present in the drainage. The overall goal of this flow recommendation is to provide a minimum amount of protection for spawning and overwintering habitat for the native species present in North Elkhead Creek.

As stated above, CPW is of the opinion that ISF protection for this stream is critical at this point in time. The Elkhead Creek basin represents a unique opportunity for CRCT conservation activities in that we have a small watershed that we are managing for CRCT and other native species (in contrast to the more typical case where an isolated tributary is being managed for

species conservation activities). If additional data is collected in the future that substantiates a flow recommendation that meets all three hydraulic criteria for the summer months, CPW reserves the right to initiate an enlargement recommendation for the summer high-flow season for this important stream segment.

Citations

Capesius, J.P. and V.C. Stephens, 2009, Regional regression equations for estimation of natural streamflow statistics in Colorado, Scientific Investigations Report 2009-5136. (USGS StreamStats)

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.

NRCS. 2007. Cutthroat trout (*Oncorhynchus clarki*). Fish and Wildlife Habitat management Leaflet 47, 1-12.

Appendices

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

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

Photos:

Figure 3: Hills above the North Fork Elkhead Creek.

Figure 4: North Fork Elkhead Creek (2015) cross-section number one looking across tape.

Figure 5: North Fork Elkhead Creek (2015) cross-section number one looking upstream.

Figure 6: North Fork Elkhead Creek cross-section number one (2015) looking upstream.

Figure 7: North Fork Elkhead Creek cross-section number one (2015) looking upstream.

Figure 8: North Fork Elkhead Creek cross-section number two (2015) looking across tape.

Figure 9: North Fork Elkhead Creek cross-section number two (2015) looking downstream.

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

Figure 11: North Fork Elkhead Creek cross-section number two (2015) looking upstream.

Figure 12. Natural Environment of Elkhead Creek Basin

Figure 13. Natural Environment of Elkhead Creek Basin

Figure 14. Natural Environment of Elkhead Creek Basin.

Figure 15. Natural Environment of Elkhead Creek Basin.

Data Input & Proofing

STREAM NAME:	N Fk Elkhead Creek
XS LOCATION:	Stuckey Property
XS NUMBER:	1
DATE:	10/28/2015
OBSERVERS:	js rv sm
1/4 SEC:	
SECTION:	
TWP:	40 41 07.59
RANGE:	107 16 50.27
PM:	
COUNTY:	Routt
WATERSHED:	
DIVISION:	
DOW CODE:	
USGS MAP:	
USFS MAP:	
	Level and Rod Survey
TAPE WT:	0.0106 lbs / ft
TENSION:	99999 lbs
SLOPE:	0.021 ft / ft

CHECKED BY:.....DATE.....

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

GL=1	FEATURE	DIST	VERT DEPTH	WATER DEPTH	VEL	A	Q	Tape to Water
		Total Data Points = 29						
1	s gl	0.00	8.79			0.00	0.00	0.00
		4.00	9.50			0.00	0.00	0.00
	wl	6.00	9.65	0.00	0.00	0.00	0.00	0.00
		6.50	9.73	0.05	0.00	0.03	0.00	9.68
		7.00	9.85	0.20	0.13	0.10	0.01	9.65
		7.50	9.89	0.30	0.20	0.15	0.03	9.59
		8.00	9.85	0.20	1.60	0.10	0.16	9.65
		8.50	10.01	0.35	0.56	0.18	0.10	9.66
		9.00	9.89	0.20	0.94	0.10	0.09	9.69
		9.50	10.11	0.50	1.49	0.25	0.37	9.61
		10.00	9.98	0.30	0.74	0.15	0.11	9.68
		10.50	10.03	0.40	0.87	0.20	0.17	9.63
		11.00	10.00	0.45	1.14	0.23	0.26	9.55
		11.50	10.13	0.45	0.63	0.23	0.14	9.68
		12.00	9.88	0.20	0.67	0.10	0.07	9.68
		12.50	9.96	0.25	0.96	0.13	0.12	9.71
		13.00	9.73	0.35	0.90	0.18	0.16	9.38
		13.50	9.78	0.20	1.52	0.10	0.15	9.58
		14.00	9.99	0.30	1.35	0.15	0.20	9.69
		14.50	9.92	0.25	0.50	0.13	0.06	9.67
		15.00	9.88	0.15	0.00	0.08	0.00	9.73
		15.50	9.82	0.15	0.00	0.08	0.00	9.67
	wl	16.00	9.64	0.00	0.00	0.00	0.00	0.00
		16.50	9.43			0.00	0.00	0.00
		21.50	9.28			0.00	0.00	0.00
		28.30	9.39			0.00	0.00	0.00
		29.00	8.85			0.00	0.00	0.00
1	gl	31.00	8.50			0.00	0.00	0.00
	s gl	32.80	8.33			0.00	0.00	0.00
					Totals	2.63	2.21	

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

LOCATION INFORMATION

STREAM NAME:	N Fk Elkhead Creek
XS LOCATION:	Stuckey Property
XS NUMBER:	1
DATE:	28-Oct-15
OBSERVERS:	js rv sm
1/4 SEC:	0
SECTION:	0
TWP:	40 41 07.59
RANGE:	107 16 50.27
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:	0.021

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

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

STREAM NAME: N Fk Elkhead Creek
XS LOCATION: Stuckey Property
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	8.79			0.00		0.00	0.00	0.0%
		4.00	9.50			0.00		0.00	0.00	0.0%
	wl	6.00	9.65	0.00	0.00	0.00		0.00	0.00	0.0%
		6.50	9.73	0.05	0.00	0.51	0.05	0.03	0.00	0.0%
		7.00	9.85	0.20	0.13	0.51	0.20	0.10	0.01	0.6%
		7.50	9.89	0.30	0.20	0.50	0.30	0.15	0.03	1.4%
		8.00	9.85	0.20	1.60	0.50	0.20	0.10	0.16	7.2%
		8.50	10.01	0.35	0.56	0.52	0.35	0.18	0.10	4.4%
		9.00	9.89	0.20	0.94	0.51	0.20	0.10	0.09	4.2%
		9.50	10.11	0.50	1.49	0.55	0.50	0.25	0.37	16.8%
		10.00	9.98	0.30	0.74	0.52	0.30	0.15	0.11	5.0%
		10.50	10.03	0.40	0.87	0.50	0.40	0.20	0.17	7.9%
		11.00	10.00	0.45	1.14	0.50	0.45	0.23	0.26	11.6%
		11.50	10.13	0.45	0.63	0.52	0.45	0.23	0.14	6.4%
		12.00	9.88	0.20	0.67	0.56	0.20	0.10	0.07	3.0%
		12.50	9.96	0.25	0.96	0.51	0.25	0.13	0.12	5.4%
		13.00	9.73	0.35	0.90	0.55	0.35	0.18	0.16	7.1%
		13.50	9.78	0.20	1.52	0.50	0.20	0.10	0.15	6.9%
		14.00	9.99	0.30	1.35	0.54	0.30	0.15	0.20	9.2%
		14.50	9.92	0.25	0.50	0.50	0.25	0.13	0.06	2.8%
		15.00	9.88	0.15	0.00	0.50	0.15	0.08	0.00	0.0%
		15.50	9.82	0.15	0.00	0.50	0.15	0.08	0.00	0.0%
	wl	16.00	9.64	0.00	0.00	0.53		0.00	0.00	0.0%
		16.50	9.43			0.00		0.00	0.00	0.0%
		21.50	9.28			0.00		0.00	0.00	0.0%
		28.30	9.39			0.00		0.00	0.00	0.0%
		29.00	8.85			0.00		0.00	0.00	0.0%
1	gl	31.00	8.50			0.00		0.00	0.00	0.0%
	s gl	32.80	8.33			0.00		0.00	0.00	0.0%
	TOTALS ----------					10.35	0.5 (Max.)	2.63	2.21	100.0%

Manning's n = 0.1024
Hydraulic Radius= 0.253676

STREAM NAME: N Fk Elkhead Creek
XS LOCATION: Stuckey Property
XS NUMBER: 1

WATER LINE COMPARISON TABLE

WATER LINE	MEAS AREA	COMP AREA	AREA ERROR
	2.63	2.59	-1.4%
9.40	2.63	5.57	112.2%
9.42	2.63	5.29	101.6%
9.44	2.63	5.03	91.6%
9.46	2.63	4.77	81.9%
9.48	2.63	4.52	72.3%
9.50	2.63	4.27	62.8%
9.52	2.63	4.03	53.4%
9.54	2.63	3.79	44.3%
9.56	2.63	3.56	35.5%
9.58	2.63	3.33	26.9%
9.60	2.63	3.11	18.5%
9.61	2.63	3.00	14.4%
9.62	2.63	2.90	10.3%
9.63	2.63	2.79	6.4%
9.64	2.63	2.69	2.4%
9.65	2.63	2.59	-1.4%
9.66	2.63	2.49	-5.2%
9.67	2.63	2.39	-9.0%
9.68	2.63	2.29	-12.7%
9.69	2.63	2.19	-16.4%
9.70	2.63	2.10	-20.1%
9.72	2.63	1.91	-27.3%
9.74	2.63	1.72	-34.4%
9.76	2.63	1.54	-41.2%
9.78	2.63	1.37	-47.7%
9.80	2.63	1.21	-54.0%
9.82	2.63	1.05	-60.1%
9.84	2.63	0.89	-66.0%
9.86	2.63	0.74	-71.7%
9.88	2.63	0.61	-76.8%
9.90	2.63	0.49	-81.2%

WATERLINE AT ZERO
AREA ERROR = 9.641

STREAM NAME: N Fk Elkhead Creek
XS LOCATION: Stuckey Property
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	8.79	29.34	0.72	1.34	21.27	29.99	100.0%	0.71	35.58	1.67
	8.79	29.33	0.72	1.34	21.23	29.98	99.9%	0.71	35.48	1.67
	8.84	28.76	0.69	1.29	19.78	29.40	98.0%	0.67	31.94	1.61
	8.89	28.38	0.65	1.24	18.35	29.00	96.7%	0.63	28.46	1.55
	8.94	28.03	0.60	1.19	16.94	28.63	95.5%	0.59	25.12	1.48
	8.99	27.68	0.56	1.14	15.55	28.26	94.2%	0.55	21.96	1.41
	9.04	27.34	0.52	1.09	14.18	27.89	93.0%	0.51	18.98	1.34
	9.09	26.99	0.47	1.04	12.82	27.53	91.8%	0.47	16.19	1.26
	9.14	26.64	0.43	0.99	11.48	27.16	90.5%	0.42	13.59	1.18
	9.19	26.30	0.39	0.94	10.15	26.79	89.3%	0.38	11.18	1.10
	9.24	25.95	0.34	0.89	8.85	26.42	88.1%	0.33	8.97	1.01
	9.29	24.53	0.31	0.84	7.56	24.98	83.3%	0.30	7.17	0.95
	9.34	19.42	0.33	0.79	6.47	19.85	66.2%	0.33	6.44	1.00
	9.39	14.40	0.39	0.74	5.62	14.81	49.4%	0.38	6.20	1.10
	9.44	12.80	0.39	0.69	4.95	13.20	44.0%	0.37	5.41	1.09
	9.49	12.40	0.35	0.64	4.32	12.79	42.6%	0.34	4.40	1.02
	9.54	11.68	0.32	0.59	3.71	12.06	40.2%	0.31	3.56	0.96
	9.59	10.90	0.29	0.54	3.15	11.26	37.5%	0.28	2.83	0.90
WL	9.64	10.11	0.26	0.49	2.62	10.46	34.9%	0.25	2.20	0.84
	9.69	9.60	0.22	0.44	2.13	9.93	33.1%	0.21	1.61	0.75
	9.74	9.03	0.18	0.39	1.67	9.35	31.2%	0.18	1.11	0.67
	9.79	8.16	0.15	0.34	1.24	8.45	28.2%	0.15	0.72	0.58
	9.84	7.47	0.11	0.29	0.84	7.73	25.8%	0.11	0.41	0.48
	9.89	5.51	0.09	0.24	0.51	5.73	19.1%	0.09	0.22	0.42
	9.94	3.88	0.07	0.19	0.28	4.04	13.5%	0.07	0.10	0.36
	9.99	2.53	0.05	0.14	0.12	2.62	8.7%	0.05	0.03	0.27
	10.04	0.94	0.04	0.09	0.04	0.99	3.3%	0.04	0.01	0.24
	10.09	0.34	0.02	0.04	0.01	0.36	1.2%	0.02	0.00	0.13

STREAM NAME: N Fk Elkhead Creek
XS LOCATION: Stuckey Property
XS NUMBER: 1

SUMMARY SHEET

MEASURED FLOW (Qm)=	2.21	cfs
CALCULATED FLOW (Qc)=	2.20	cfs
(Qm-Qc)/Qm * 100 =	0.7	%
MEASURED WATERLINE (WLm)=	9.65	ft
CALCULATED WATERLINE (WLc)=	9.64	ft
(WLm-WLc)/WLm * 100 =	0.0	%
MAX MEASURED DEPTH (Dm)=	0.50	ft
MAX CALCULATED DEPTH (Dc)=	0.49	ft
(Dm-Dc)/Dm * 100	2.3	%
MEAN VELOCITY=	0.84	ft/sec
MANNING'S N=	0.102	
SLOPE=	0.021	ft/ft
.4 * Qm =	0.9	cfs
2.5 * Qm=	5.5	cfs

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

FLOW (CFS)	PERIOD
==========	========
_____	_____
_____	_____
_____	_____
_____	_____

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

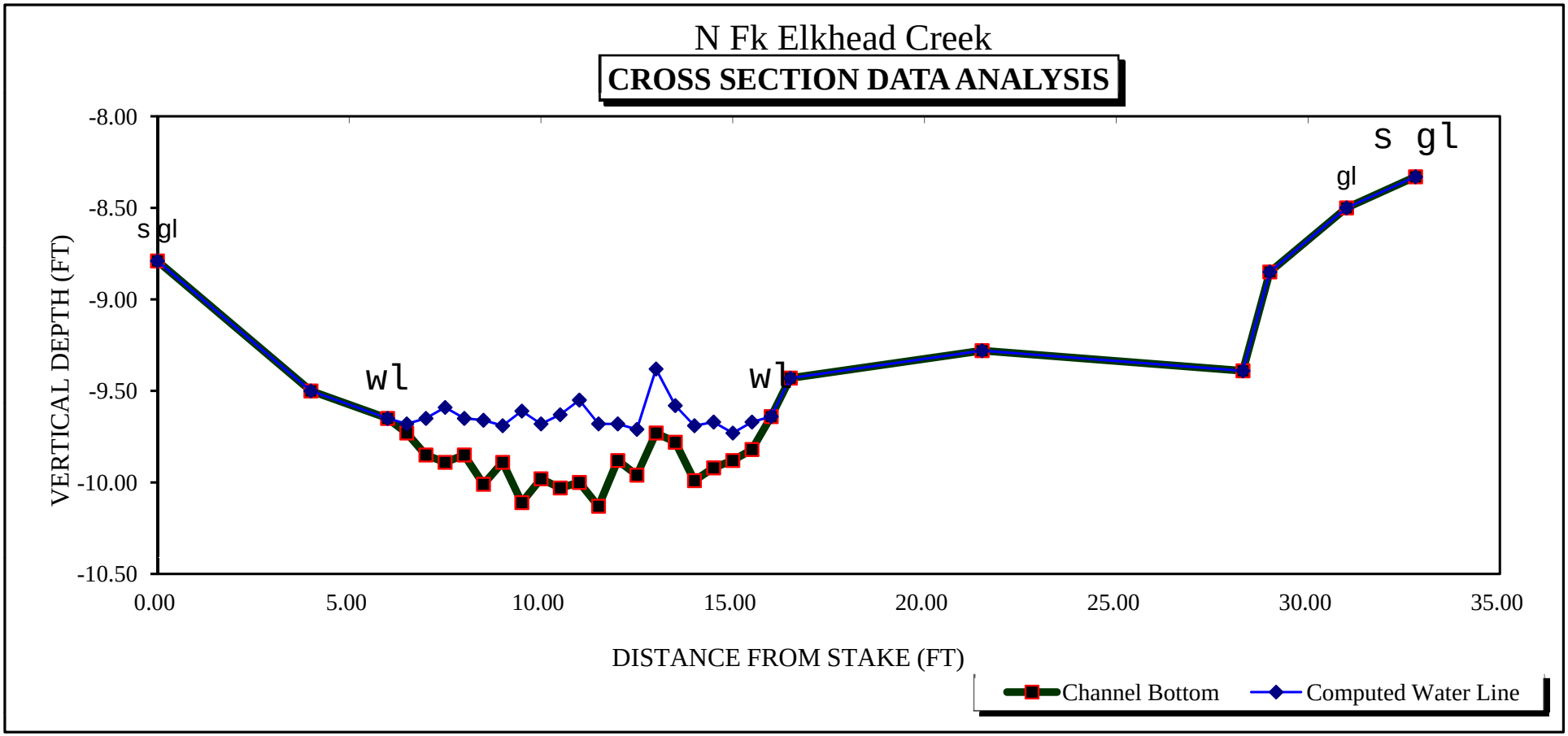
RECOMMENDATION BY: …… AGENCY…… DATE:……

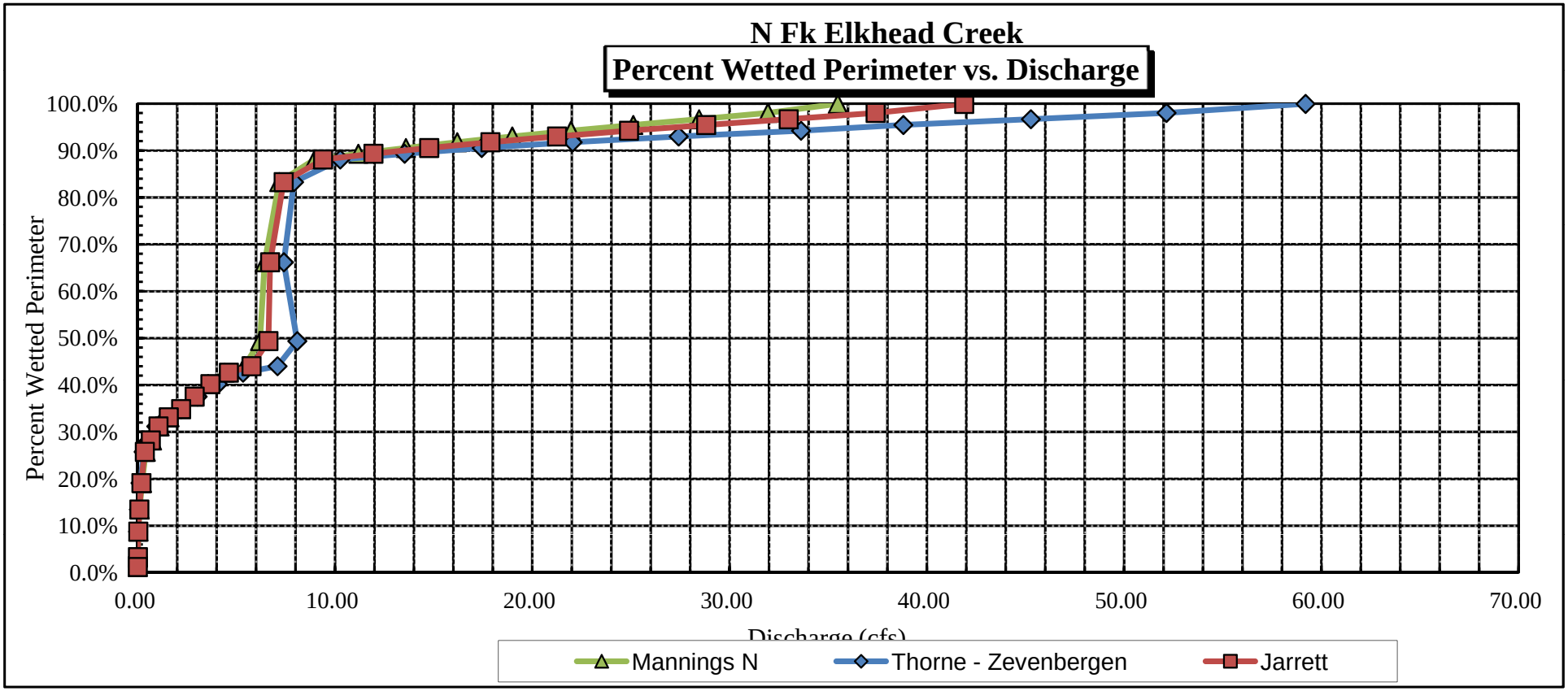
CWCB REVIEW BY: …… DATE:……

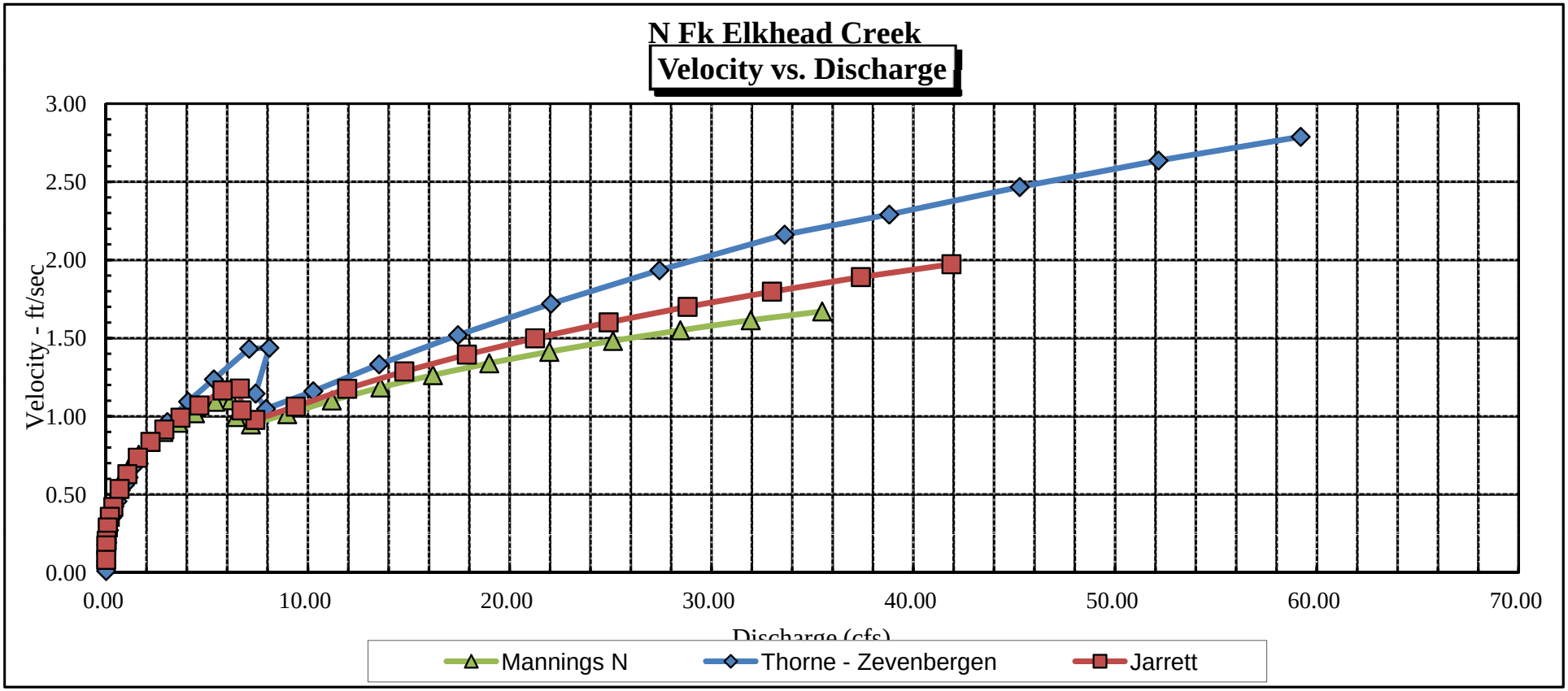
STREAM NAME: N Fk Elkhead Creek
XS LOCATION: Stuckey Property
XS NUMBER: 1 Jarrett Variable Manning's n Correction Applied

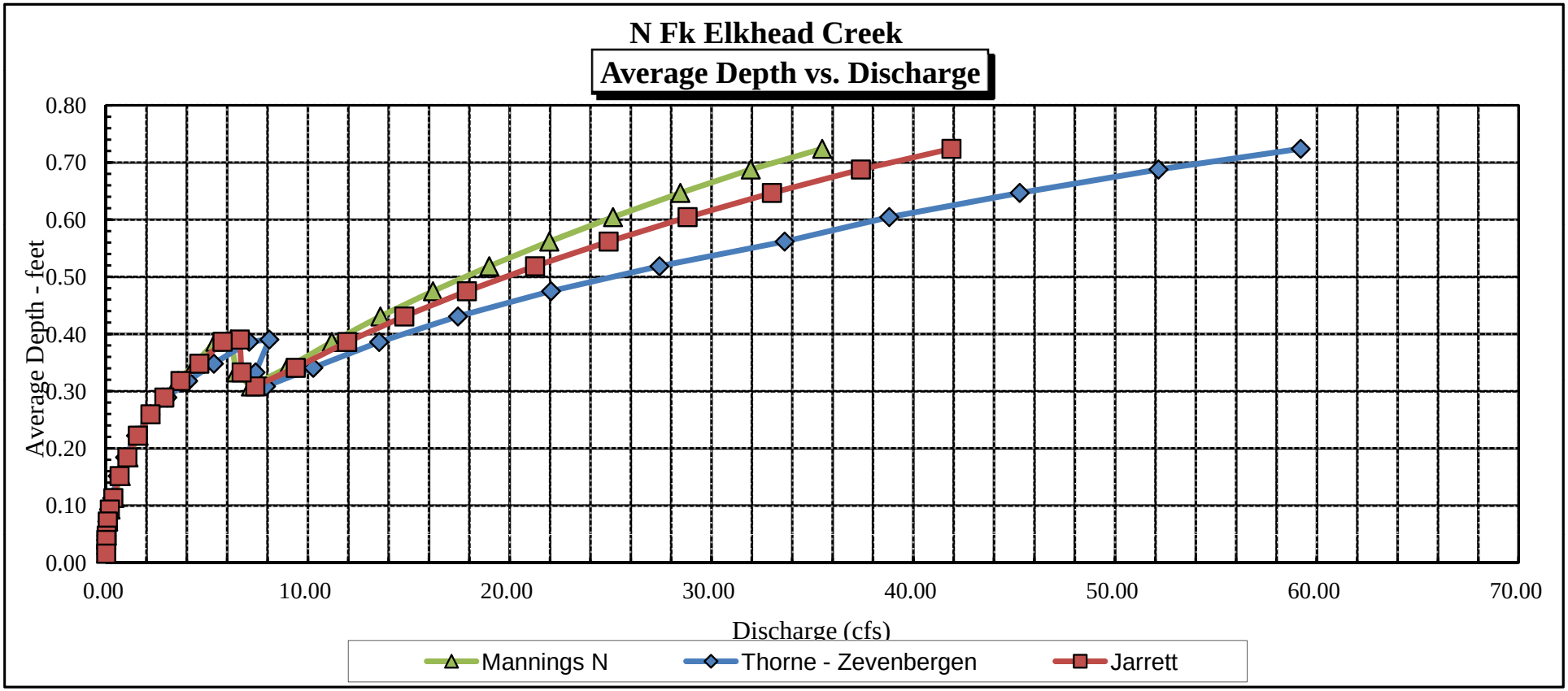
GL = lowest Grassline elevation corrected for sag
STAGING TABLE *WL* = Waterline corrected for variations in field measured water surface elevations and sag

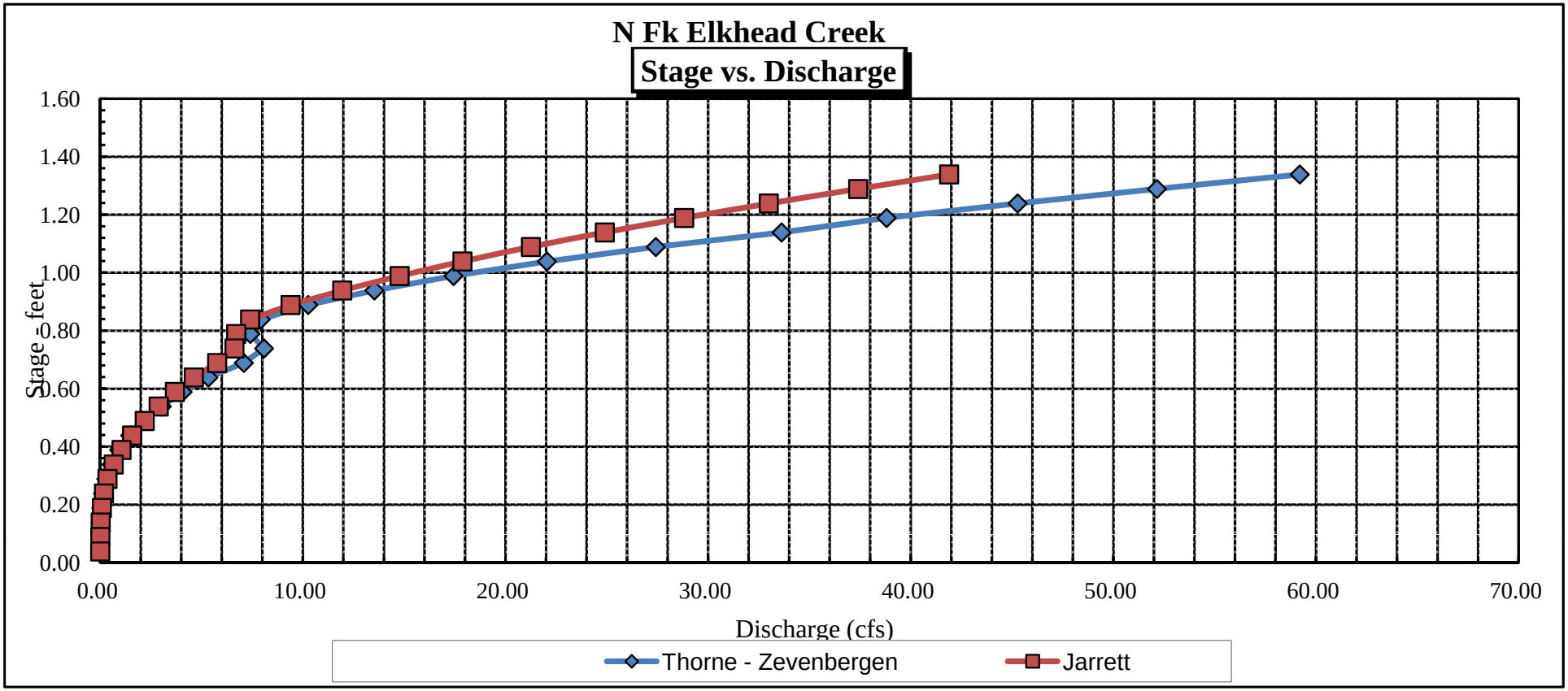
	DIST TO WATER (FT)	TOP WIDTH (FT)	AVG. DEPTH (FT)	MAX. DEPTH (FT)	AREA (SQ FT)	WETTED PERIM. (FT)	PERCENT WET PERIM (%)	HYDR RADIUS (FT)	FLOW (CFS)	AVG. VELOCITY (FT/SEC)
GL	8.79	29.34	0.72	1.34	21.27	29.99	100.0%	0.71	42.02	1.98
	8.79	29.33	0.72	1.34	21.23	29.98	99.9%	0.71	41.89	1.97
	8.84	28.76	0.69	1.29	19.78	29.40	98.0%	0.67	37.40	1.89
	8.89	28.38	0.65	1.24	18.35	29.00	96.7%	0.63	32.99	1.80
	8.94	28.03	0.60	1.19	16.94	28.63	95.5%	0.59	28.81	1.70
	8.99	27.68	0.56	1.14	15.55	28.26	94.2%	0.55	24.90	1.60
	9.04	27.34	0.52	1.09	14.18	27.89	93.0%	0.51	21.25	1.50
	9.09	26.99	0.47	1.04	12.82	27.53	91.8%	0.47	17.88	1.39
	9.14	26.64	0.43	0.99	11.48	27.16	90.5%	0.42	14.77	1.29
	9.19	26.30	0.39	0.94	10.15	26.79	89.3%	0.38	11.94	1.18
	9.24	25.95	0.34	0.89	8.85	26.42	88.1%	0.33	9.39	1.06
	9.29	24.53	0.31	0.84	7.56	24.98	83.3%	0.30	7.39	0.98
	9.34	19.42	0.33	0.79	6.47	19.85	66.2%	0.33	6.71	1.04
	9.39	14.40	0.39	0.74	5.62	14.81	49.4%	0.38	6.62	1.18
	9.44	12.80	0.39	0.69	4.95	13.20	44.0%	0.37	5.77	1.17
	9.49	12.40	0.35	0.64	4.32	12.79	42.6%	0.34	4.62	1.07
	9.54	11.68	0.32	0.59	3.71	12.06	40.2%	0.31	3.68	0.99
	9.59	10.90	0.29	0.54	3.15	11.26	37.5%	0.28	2.88	0.92
WL	9.64	10.11	0.26	0.49	2.62	10.46	34.9%	0.25	2.20	0.84
	9.69	9.60	0.22	0.44	2.13	9.93	33.1%	0.21	1.57	0.74
	9.74	9.03	0.18	0.39	1.67	9.35	31.2%	0.18	1.05	0.63
	9.79	8.16	0.15	0.34	1.24	8.45	28.2%	0.15	0.66	0.54
	9.84	7.47	0.11	0.29	0.84	7.73	25.8%	0.11	0.36	0.42
	9.89	5.51	0.09	0.24	0.51	5.73	19.1%	0.09	0.18	0.36
	9.94	3.88	0.07	0.19	0.28	4.04	13.5%	0.07	0.08	0.29
	9.99	2.53	0.05	0.14	0.12	2.62	8.7%	0.05	0.02	0.20
	10.04	0.94	0.04	0.09	0.04	0.99	3.3%	0.04	0.01	0.17
	10.09	0.34	0.02	0.04	0.01	0.36	1.2%	0.02	0.00	0.08


N Fk Elkhead Creek
CROSS SECTION DATA ANALYSIS
-8.00
-8.50
-9.00
-9.50
-10.00
-10.50
VERTICAL DEPTH (FT)
s gl
wl
wl
gl
s gl
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


N Fk Elkhead Creek
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


N Fk Elkhead Creek
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


N Fk Elkhead Creek
Average Depth vs. Discharge
Average Depth - feet
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


N Fk Elkhead Creek
Stage vs. Discharge
Stage - feet
1.60
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
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:	N Fk Elkhead Creek
XS LOCATION:	Stuckey Property
XS NUMBER:	2
DATE:	28-Oct-15
OBSERVERS:	js rv sm
1/4 SEC:	0
SECTION:	0
TWP:	40 41 16.53
RANGE:	107 16 49.74
PM:	0
COUNTY:	Routt
WATERSHED:	0
DIVISION:	0
DOW CODE:	0
USGS MAP:	0
USFS MAP:	0

SUPPLEMENTAL DATA

		*** NOTE ***
		Leave TAPE WT and TENSION
		at defaults for data collected
TAPE WT:	0.0106	with a survey level and rod
TENSION:	99999	

CHANNEL PROFILE DATA

SLOPE:	0.004

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

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

STREAM NAME: N Fk Elkhead Creek
XS LOCATION: Stuckey Property
XS NUMBER: 2

DATA POINTS= 32

VALUES COMPUTED FROM RAW FIELD DATA

	FEATURE	DIST	VERT DEPTH	WATER DEPTH	VEL	WETTED PERIM.	WATER DEPTH	AREA (Am)	Q (Qm)	% Q CELL
	s	0.00	8.17			0.00		0.00	0.00	0.0%
1	gl	1.00	8.90			0.00		0.00	0.00	0.0%
		2.00	9.49			0.00		0.00	0.00	0.0%
	wl	2.50	9.69	0.00	0.00	0.00		0.00	0.00	0.0%
		3.00	9.77	0.10	0.00	0.51	0.10	0.05	0.00	0.0%
		3.50	9.91	0.15	0.13	0.52	0.15	0.08	0.01	0.5%
		4.00	10.11	0.40	0.84	0.54	0.40	0.20	0.17	7.9%
		4.50	10.20	0.50	0.66	0.51	0.50	0.25	0.17	7.8%
		5.00	10.40	0.70	0.25	0.54	0.70	0.35	0.09	4.1%
		5.50	10.42	0.70	0.46	0.50	0.70	0.35	0.16	7.6%
		6.00	10.30	0.60	1.00	0.51	0.60	0.30	0.30	14.1%
		6.50	10.23	0.55	0.74	0.50	0.55	0.28	0.20	9.6%
		7.00	10.39	0.70	0.26	0.52	0.70	0.35	0.09	4.3%
		7.50	10.50	0.75	0.39	0.51	0.75	0.38	0.15	6.9%
		8.00	10.48	0.80	0.26	0.50	0.80	0.40	0.10	4.9%
		8.50	10.40	0.70	0.42	0.51	0.70	0.35	0.15	6.9%
		9.00	10.36	0.60	0.53	0.50	0.60	0.30	0.16	7.5%
		9.50	10.25	0.55	0.75	0.51	0.55	0.28	0.21	9.7%
		10.00	10.23	0.50	0.46	0.50	0.50	0.25	0.12	5.4%
		10.50	9.82	0.05	0.00	0.65	0.05	0.03	0.00	0.0%
		11.00	9.83	0.10	0.00	0.50	0.10	0.05	0.00	0.0%
		11.50	9.95	0.25	0.04	0.51	0.25	0.13	0.01	0.2%
		12.00	10.03	0.20	0.01	0.51	0.20	0.10	0.00	0.0%
		12.50	9.98	0.30	0.04	0.50	0.30	0.15	0.01	0.3%
		13.00	10.03	0.25	0.21	0.50	0.25	0.13	0.03	1.2%
		13.50	10.08	0.25	0.06	0.50	0.25	0.13	0.01	0.4%
		14.00	9.81	0.20	0.00	0.57	0.20	0.10	0.00	0.0%
		14.50	10.00	0.25	0.12	0.53	0.25	0.11	0.01	0.6%
	wl	14.90	9.71	0.00	0.00	0.49		0.00	0.00	0.0%
		17.00	9.43			0.00		0.00	0.00	0.0%
1	gl	20.00	8.86			0.00		0.00	0.00	0.0%
	s	25.00	8.33			0.00		0.00	0.00	0.0%
	TOTALS ----------					12.96	0.8 (Max.)	5.06	2.12	100.0%

Manning's n = 0.1198
Hydraulic Radius= 0.39063355

STREAM NAME: N Fk Elkhead Creek
XS LOCATION: Stuckey Property
XS NUMBER: 2

WATER LINE COMPARISON TABLE

WATER LINE	MEAS AREA	COMP AREA	AREA ERROR
	5.06	5.33	5.2%
9.45	5.06	8.75	72.8%
9.47	5.06	8.45	67.0%
9.49	5.06	8.16	61.2%
9.51	5.06	7.87	55.5%
9.53	5.06	7.59	49.8%
9.55	5.06	7.31	44.3%
9.57	5.06	7.03	38.8%
9.59	5.06	6.76	33.4%
9.61	5.06	6.49	28.1%
9.63	5.06	6.22	22.9%
9.65	5.06	5.96	17.7%
9.66	5.06	5.83	15.2%
9.67	5.06	5.70	12.7%
9.68	5.06	5.58	10.1%
9.69	5.06	5.45	7.7%
9.70	5.06	5.33	5.2%
9.71	5.06	5.20	2.8%
9.72	5.06	5.08	0.3%
9.73	5.06	4.96	-2.1%
9.74	5.06	4.84	-4.5%
9.75	5.06	4.72	-6.8%
9.77	5.06	4.48	-11.5%
9.79	5.06	4.24	-16.2%
9.81	5.06	4.01	-20.8%
9.83	5.06	3.78	-25.3%
9.85	5.06	3.57	-29.5%
9.87	5.06	3.36	-33.7%
9.89	5.06	3.15	-37.7%
9.91	5.06	2.96	-41.6%
9.93	5.06	2.76	-45.4%
9.95	5.06	2.58	-49.1%

WATERLINE AT ZERO
AREA ERROR = 9.721

STREAM NAME: N Fk Elkhead Creek
XS LOCATION: Stuckey Property
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	8.90	18.79	0.96	1.60	18.03	19.62	100.0%	0.92	13.37	0.74
	8.92	18.64	0.95	1.58	17.63	19.46	99.2%	0.91	12.95	0.73
	8.97	18.29	0.91	1.53	16.71	19.09	97.3%	0.87	11.99	0.72
	9.02	17.94	0.88	1.48	15.80	18.73	95.5%	0.84	11.07	0.70
	9.07	17.60	0.85	1.43	14.91	18.36	93.6%	0.81	10.18	0.68
	9.12	17.25	0.81	1.38	14.04	18.00	91.7%	0.78	9.34	0.66
	9.17	16.90	0.78	1.33	13.19	17.63	89.9%	0.75	8.53	0.65
	9.22	16.55	0.75	1.28	12.35	17.26	88.0%	0.72	7.75	0.63
	9.27	16.21	0.71	1.23	11.53	16.90	86.1%	0.68	7.01	0.61
	9.32	15.86	0.68	1.18	10.73	16.53	84.3%	0.65	6.31	0.59
	9.37	15.51	0.64	1.13	9.95	16.16	82.4%	0.62	5.65	0.57
	9.42	15.16	0.61	1.08	9.18	15.80	80.5%	0.58	5.02	0.55
	9.47	14.72	0.57	1.03	8.43	15.34	78.2%	0.55	4.44	0.53
	9.52	14.24	0.54	0.98	7.71	14.84	75.7%	0.52	3.91	0.51
	9.57	13.74	0.51	0.93	7.01	14.33	73.0%	0.49	3.41	0.49
	9.62	13.24	0.48	0.88	6.33	13.81	70.4%	0.46	2.96	0.47
	9.67	12.74	0.45	0.83	5.69	13.30	67.8%	0.43	2.53	0.45
WL	9.72	12.19	0.42	0.78	5.06	12.74	65.0%	0.40	2.15	0.42
	9.77	11.81	0.38	0.73	4.46	12.34	62.9%	0.36	1.78	0.40
	9.82	11.44	0.34	0.68	3.88	11.95	60.9%	0.32	1.44	0.37
	9.87	10.30	0.32	0.63	3.34	10.74	54.8%	0.31	1.20	0.36
	9.92	9.58	0.30	0.58	2.85	9.94	50.7%	0.29	0.97	0.34
	9.97	8.84	0.27	0.53	2.39	9.14	46.6%	0.26	0.76	0.32
	10.02	7.31	0.27	0.48	1.98	7.54	38.5%	0.26	0.64	0.32
	10.07	6.39	0.26	0.43	1.64	6.58	33.6%	0.25	0.51	0.31
	10.12	6.07	0.22	0.38	1.33	6.23	31.8%	0.21	0.37	0.28
	10.17	5.73	0.18	0.33	1.03	5.87	29.9%	0.18	0.26	0.25
	10.22	5.46	0.14	0.28	0.76	5.57	28.4%	0.14	0.16	0.21
	10.27	4.30	0.12	0.23	0.51	4.39	22.4%	0.12	0.10	0.19
	10.32	3.50	0.09	0.18	0.32	3.56	18.1%	0.09	0.05	0.16
	10.37	2.69	0.06	0.13	0.16	2.72	13.9%	0.06	0.02	0.12
	10.42	1.22	0.05	0.08	0.06	1.24	6.3%	0.05	0.01	0.10
	10.47	0.68	0.02	0.03	0.01	0.69	3.5%	0.02	0.00	0.05

STREAM NAME: N Fk Elkhead Creek
XS LOCATION: Stuckey Property
XS NUMBER: 2

SUMMARY SHEET

MEASURED FLOW (Qm)=	2.12	cfs
CALCULATED FLOW (Qc)=	2.15	cfs
(Qm-Qc)/Qm * 100 =	-1.1	%
MEASURED WATERLINE (WLm)=	9.70	ft
CALCULATED WATERLINE (WLc)=	9.72	ft
(WLm-WLc)/WLm * 100 =	-0.2	%
MAX MEASURED DEPTH (Dm)=	0.80	ft
MAX CALCULATED DEPTH (Dc)=	0.78	ft
(Dm-Dc)/Dm * 100	2.7	%
MEAN VELOCITY=	0.42	ft/sec
MANNING'S N=	0.120	
SLOPE=	0.004	ft/ft
.4 * Qm =	0.8	cfs
2.5 * Qm=	5.3	cfs

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

FLOW (CFS)	PERIOD
___________	________

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

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

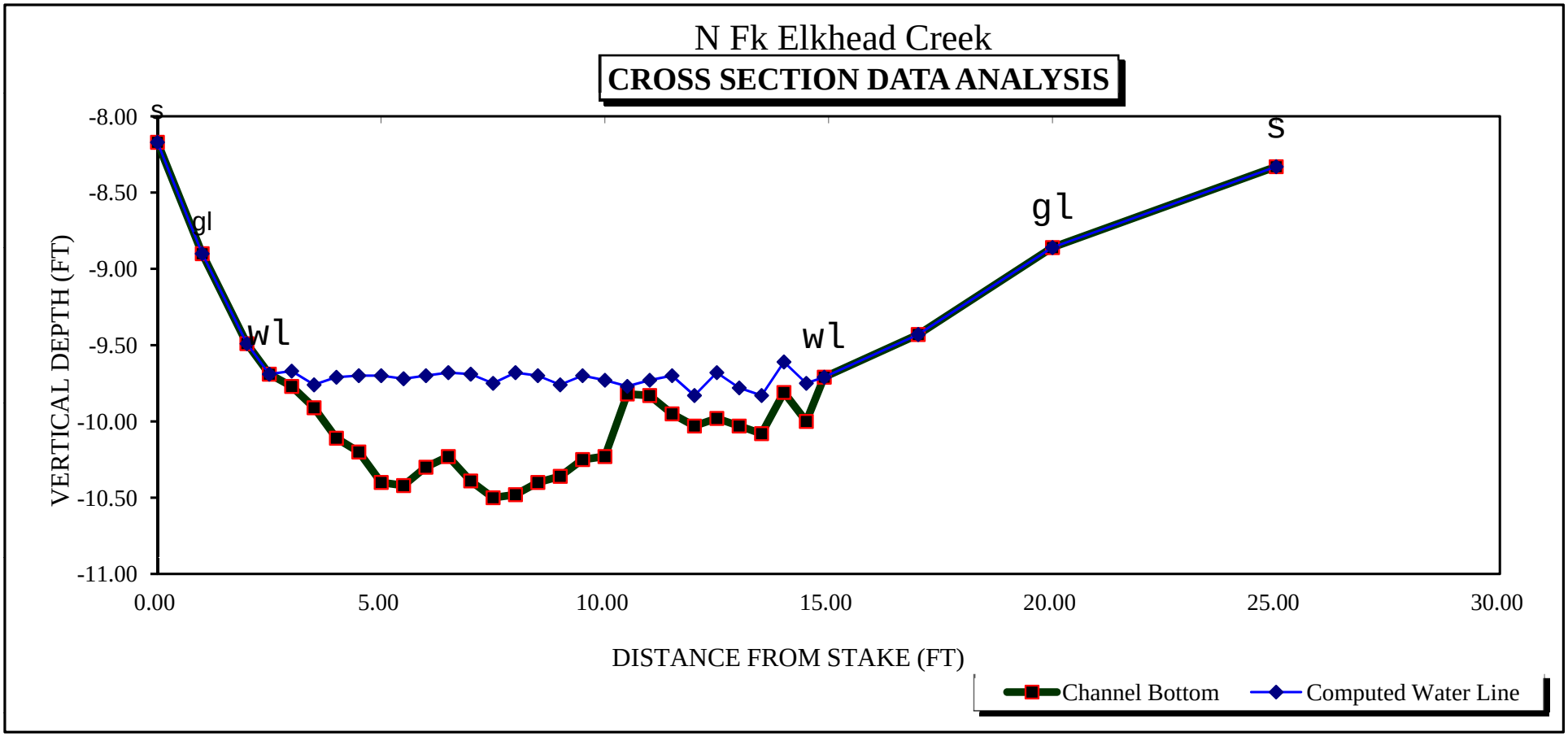
CWCB REVIEW BY: ..……………………………..........………………………………………………………...…............. DATE:..................…………….....

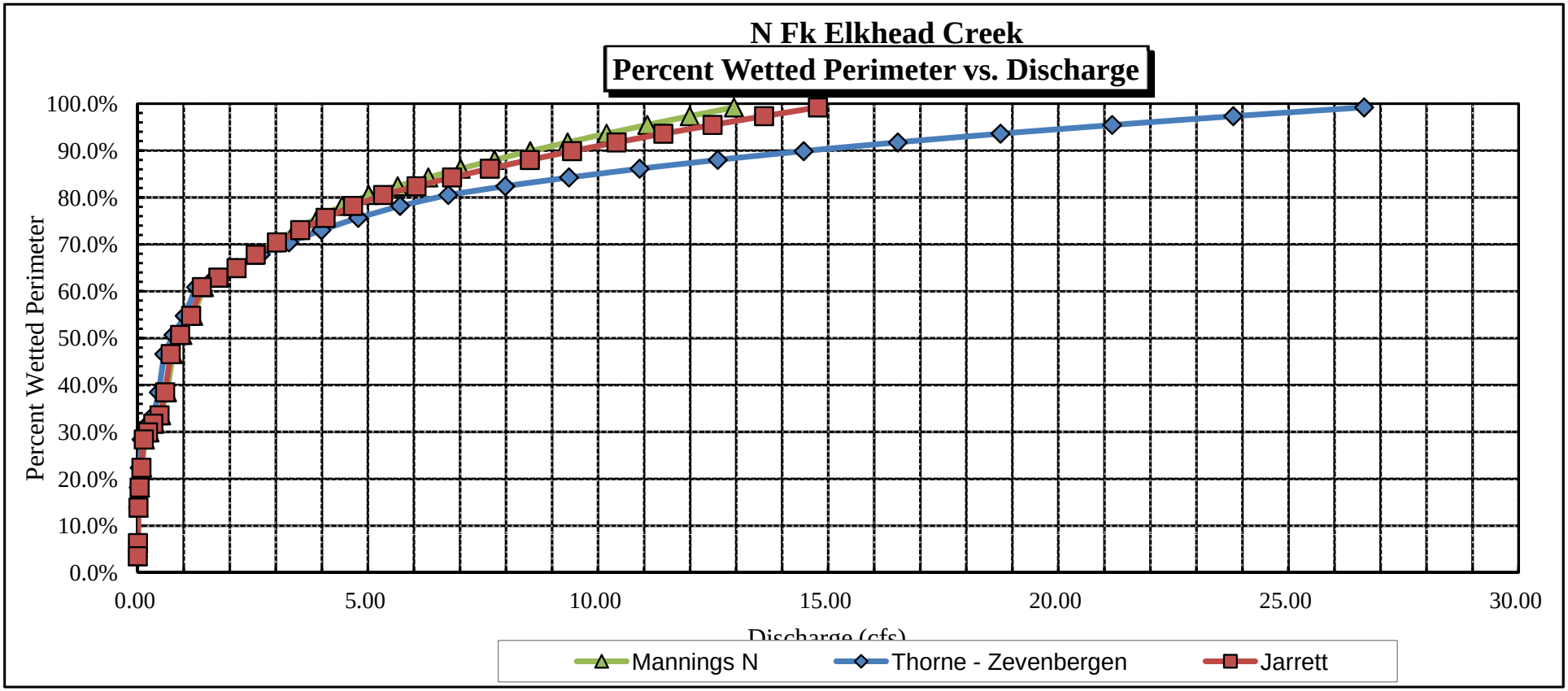
STREAM NAME: N Fk Elkhead Creek
XS LOCATION: Stuckey Property
XS NUMBER: 2

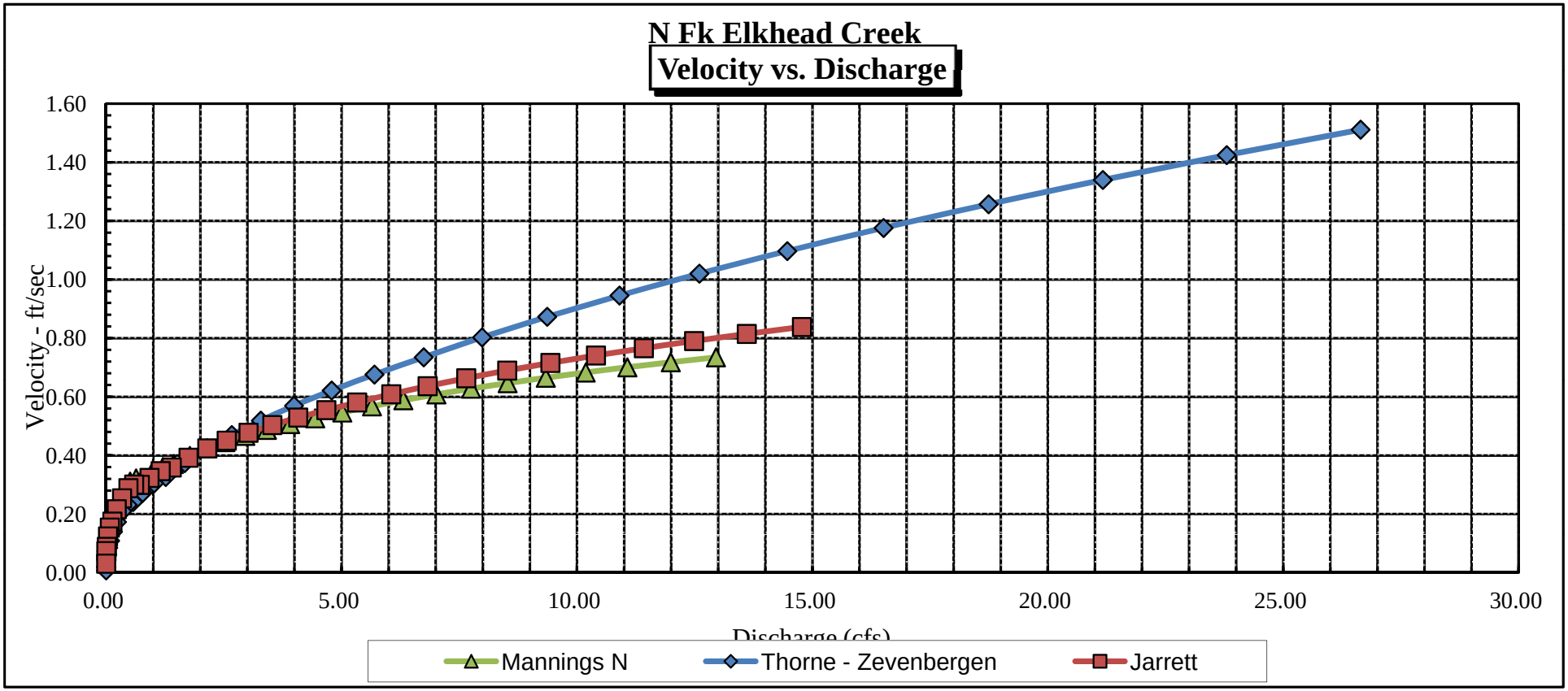
Jarrett Variable Manning's n Correction Applied

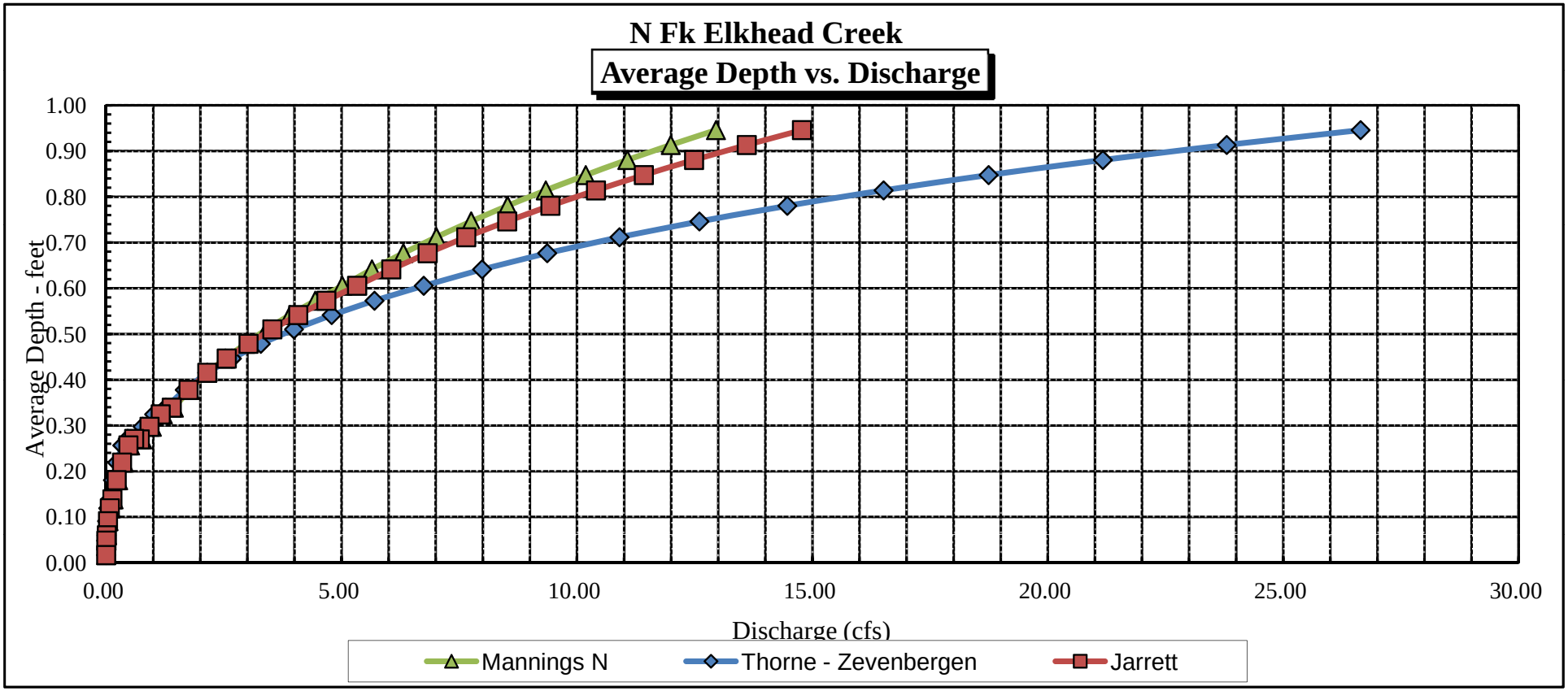
GL = lowest Grassline elevation corrected for sag
STAGING TABLE *WL* = Waterline corrected for variations in field measured water surface elevations and sag

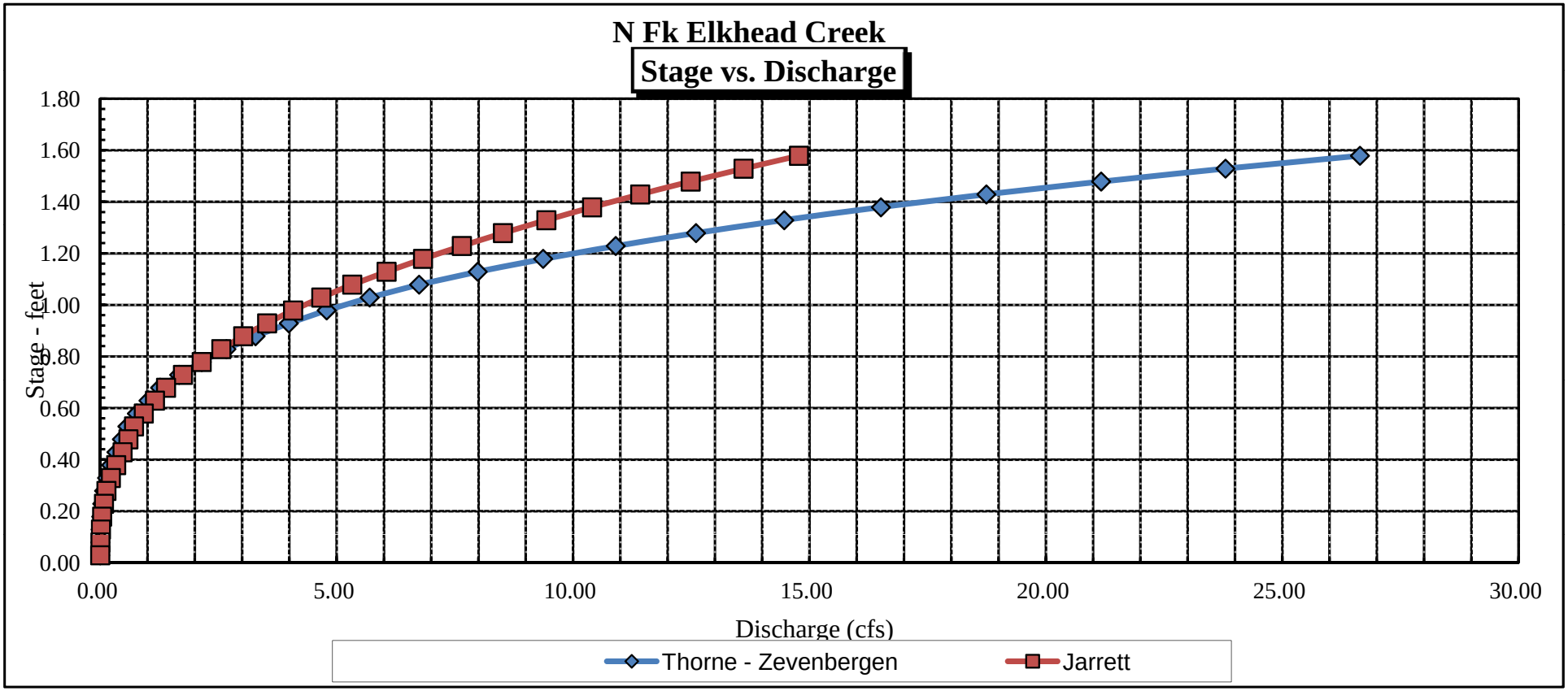
	DIST TO WATER (FT)	TOP WIDTH (FT)	AVG. DEPTH (FT)	MAX. DEPTH (FT)	AREA (SQ FT)	WETTED PERIM. (FT)	PERCENT WET PERIM (%)	HYDR RADIUS (FT)	FLOW (CFS)	AVG. VELOCITY (FT/SEC)
GL	8.90	18.79	0.96	1.60	18.03	19.62	100.0%	0.92	15.29	0.85
	8.92	18.64	0.95	1.58	17.63	19.46	99.2%	0.91	14.78	0.84
	8.97	18.29	0.91	1.53	16.71	19.09	97.3%	0.87	13.61	0.81
	9.02	17.94	0.88	1.48	15.80	18.73	95.5%	0.84	12.49	0.79
	9.07	17.60	0.85	1.43	14.91	18.36	93.6%	0.81	11.42	0.77
	9.12	17.25	0.81	1.38	14.04	18.00	91.7%	0.78	10.40	0.74
	9.17	16.90	0.78	1.33	13.19	17.63	89.9%	0.75	9.43	0.72
	9.22	16.55	0.75	1.28	12.35	17.26	88.0%	0.72	8.52	0.69
	9.27	16.21	0.71	1.23	11.53	16.90	86.1%	0.68	7.65	0.66
	9.32	15.86	0.68	1.18	10.73	16.53	84.3%	0.65	6.83	0.64
	9.37	15.51	0.64	1.13	9.95	16.16	82.4%	0.62	6.06	0.61
	9.42	15.16	0.61	1.08	9.18	15.80	80.5%	0.58	5.33	0.58
	9.47	14.72	0.57	1.03	8.43	15.34	78.2%	0.55	4.68	0.55
	9.52	14.24	0.54	0.98	7.71	14.84	75.7%	0.52	4.08	0.53
	9.57	13.74	0.51	0.93	7.01	14.33	73.0%	0.49	3.53	0.50
	9.62	13.24	0.48	0.88	6.33	13.81	70.4%	0.46	3.02	0.48
	9.67	12.74	0.45	0.83	5.69	13.30	67.8%	0.43	2.56	0.45
WL	9.72	12.19	0.42	0.78	5.06	12.74	65.0%	0.40	2.15	0.42
	9.77	11.81	0.38	0.73	4.46	12.34	62.9%	0.36	1.75	0.39
	9.82	11.44	0.34	0.68	3.88	11.95	60.9%	0.32	1.39	0.36
	9.87	10.30	0.32	0.63	3.34	10.74	54.8%	0.31	1.16	0.35
	9.92	9.58	0.30	0.58	2.85	9.94	50.7%	0.29	0.92	0.32
	9.97	8.84	0.27	0.53	2.39	9.14	46.6%	0.26	0.71	0.30
	10.02	7.31	0.27	0.48	1.98	7.54	38.5%	0.26	0.60	0.30
	10.07	6.39	0.26	0.43	1.64	6.58	33.6%	0.25	0.47	0.29
	10.12	6.07	0.22	0.38	1.33	6.23	31.8%	0.21	0.34	0.25
	10.17	5.73	0.18	0.33	1.03	5.87	29.9%	0.18	0.22	0.22
	10.22	5.46	0.14	0.28	0.76	5.57	28.4%	0.14	0.13	0.17
	10.27	4.30	0.12	0.23	0.51	4.39	22.4%	0.12	0.08	0.15
	10.32	3.50	0.09	0.18	0.32	3.56	18.1%	0.09	0.04	0.12
	10.37	2.69	0.06	0.13	0.16	2.72	13.9%	0.06	0.01	0.09
	10.42	1.22	0.05	0.08	0.06	1.24	6.3%	0.05	0.00	0.07
	10.47	0.68	0.02	0.03	0.01	0.69	3.5%	0.02	0.00	0.03


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


N Fk Elkhead Creek
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
5.00
10.00
15.00
20.00
25.00
30.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


N Fk Elkhead Creek
Velocity vs. Discharge
Velocity - ft/sec
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


N Fk Elkhead Creek
Average Depth vs. Discharge
Average Depth - feet
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


N Fk Elkhead Creek
Stage vs. Discharge
Stage - feet
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
Discharge (cfs)
Thorne - Zevenbergen
Jarrett

COLORADO WATER CONSERVATION BOARD

FIELD DATA FOR INSTREAM FLOW DETERMINATIONS

COLORADO DIVISION OF WILDLIFE

LOCATION INFORMATION

STREAM NAME: NF Elkhead Creek					CROSS-SECTION NO.: 1
CROSS-SECTION LOCATION:					
DATE: 10-28-15	OBSERVERS: J. Skinner ; S. May , R Viehl				
LEGAL DESCRIPTION	¼ SECTION:	SECTION:	TOWNSHIP: N/S	RANGE: E/W	PM:
COUNTY: Routt	WATERSHED:	WATER DIVISION: 6	DOW WATER CODE:		
MAP(S): USGS:	40 41 07.59				
USFS:	107 11 50.27				

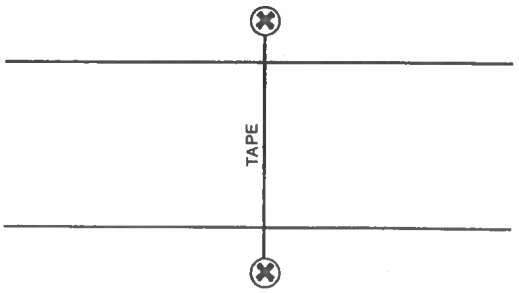
SUPPLEMENTAL DATA

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:		PHOTOGRAPHS TAKEN: YES/NO	NUMBER OF PHOTOGRAPHS:	

CHANNEL PROFILE DATA

STATION	DISTANCE FROM TAPE (ft)	ROD READING (ft)
⊗ Tape @ Stake LB	0.0	9.65
⊗ Tape @ Stake RB	0.0	9.64
① WS @ Tape LB/RB	0.0	
② WS Upstream	8.0	9.45
③ WS Downstream	11.0	9.84
SLOPE	0.39 / 19 = 0.021	

SKETCH



LEGEND:
Stake ⊗
Stat ①
Pho 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.:	DATE:	SHEET ___ OF ___

BEGINNING OF MEASUREMENT	EDGE OF WATER LOOKING DOWNSTREAM: (0.0 AT STAKE) LEFT / RIGHT	Gage Reading: _____ ft	TIME: 10:34

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		9.79								
	4		9.50								
LB W	6		9.65		0						
	6.5		9.73		.05			0			
	7.0		9.85		.20			0.13			
	7.5		9.89		.30			0.20			
	8.0		9.85		.20			1.60			
	8.5		10.01		.35			0.56			
	9.0		9.89		.20			.94			
	9.5		10.11		.50			1.49			
	10.0		9.98		.30			0.74			
	10.5		10.03		.40			0.87			
	11.0		10.00		.45			1.14			
	11.5		10.13		.45			0.63			
	12.0		9.88		.20			0.67			
	12.5		9.96		.25			0.96			
	13.0		9.73		.35			0.90			
	13.5		9.78		.20			1.52			
	14.0		9.99		.30			1.35			
	14.5		9.92		.25			0.50			
	15.0		9.88		.15			0			
	15.5		9.82		.15			0			
RB WL	16.0		9.64		0						
	16.5		9.43								
	21.5		9.28								
	28.3		9.39								
	29.0		8.85								
GL	31.0		8.50								
S	32.75		8.33								
TOTALS:											

End of Measurement	Time: 1049	Gage Reading: _____ ft	CALCULATIONS PERFORMED BY:	CALCULATIONS CHECKED BY

COLORADO WATER CONSERVATION BOARD

FIELD DATA FOR INSTREAM FLOW DETERMINATIONS

COLORADO DIVISION OF WILDLIFE

LOCATION INFORMATION

STREAM NAME: N FK Elkhead Creek					CROSS-SECTION NO.: 2
CROSS-SECTION LOCATION:					
DATE: 10-25-15	OBSERVERS: J. Skinner, R. Viehl				
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 16.53				
USFS:	107 16 49.74				

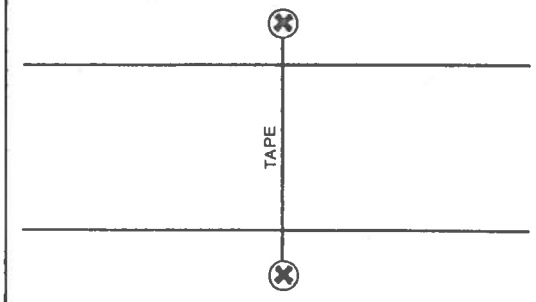
SUPPLEMENTAL DATA

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:	PHOTOGRAPHS TAKEN: YES/NO	NUMBER OF PHOTOGRAPHS:		

CHANNEL PROFILE DATA

STATION	DISTANCE FROM TAPE (ft)	ROD READING (ft)
⊗ Tape @ Stake LB	0.0	9.71
⊗ Tape @ Stake RB	0.0	9.69
① WS @ Tape LB/RB	0.0	
② WS Upstream	20.00	9.60
③ WS Downstream	30.5	9.79
SLOPE	0.19 / 30.5 = 0.004	

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.:	DATE:	SHEET ___ OF ___

BEGINNING OF MEASUREMENT	EDGE OF WATER LOOKING DOWNSTREAM: (0.0 AT STAKE) LEFT / RIGHT	Gage Reading: _____ ft	TIME: 10:59

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)
S	0		8.17								
G	1		8.90								
	2		9.49								
RBWL	2.5		9.69		0						
	3.0		9.77		0.10			0			
	3.5		9.91		0.15			0.13			
	4.0		10.11		0.40			0.84			
	4.5		10.20		0.50			0.66			
	5.0		10.40		0.70			0.25			
	5.5		10.42		0.70			0.46			
	6.0		10.30		0.60			1.00			
	6.5		10.23		0.55			0.74			
	7.0		10.39		0.70			0.26			
	7.5		10.50		0.75			0.39			
	8.0		10.48		0.80			0.26			
	8.5		10.40		0.70			0.42			
	9.0		10.36		0.60			0.55			
	9.5		10.25		0.55			0.75			
	10.0		10.23		0.50			0.46			
	10.5		9.82		0.05			0			
	11.0		9.83		0.10			0			
	11.5		9.95		0.25			0.04			
	12.0		10.03		0.20			0.01			
	12.5		9.98		0.30			0.04			
	13.0		10.03		0.25			0.21			
	13.5		10.08		0.25			0.06			
	14.0		9.81		0.20			0			
	14.5		10.00		0.25			.12			
LBWL	14.9		9.71		0						
	17.0		9.43								
GL	20.0		8.86								
S	25		8.33								
TOTALS:											

End of Measurement	Time: 1120	Gage Reading: _____ ft	CALCULATIONS PERFORMED BY:	CALCULATIONS CHECKED BY: