

DRAFT INSTREAM FLOW RECOMMENDATION

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

Dear Ms. Bassi:

The Bureau of Land Management (BLM) is writing this letter to formally communicate its recommendation for an enlargement of two existing instream flow water rights on Willow Creek. Willow Creek is located in Water Division 6 near Steamboat Lake State Park. The CWCB appropriated instream flow water rights on Willow Creek in 1977 in the following amounts:

- Outlet of Steamboat Lake to confluence with Beaver Creek – 5 cfs, year round
- Confluence with Beaver Creek to confluence with Elk River – 7 cfs, year round

Location and Land Status. Willow Creek originates west of Hahns Peak and northwest of Steamboat Lake State Park. It flows into the Elk River approximately five miles southeast of Steamboat Lake State Park. This recommendation covers two stream reaches:

- Outlet of Steamboat Lake to confluence with Beaver Creek, a distance of approximately 4.8 miles. Of this mileage, BLM manages 1.9 miles, Colorado Parks and Wildlife manages 1.1 miles, and private owners manage 1.8 miles.
- Confluence with Beaver Creek to confluence with Lester Creek, a distance of approximately 1.5 miles. Note that this enlargement recommendation does not apply to the portion of Willow Creek between the confluence with Lester Creek and the confluence with the Elk River. Of this mileage, BLM manages 0.9 miles and private owners manage 0.6 miles.

Biological Summary. This portion of Willow Creek is a cold-water, low gradient stream that flows through wide stream valleys before entering the Routt National Forest. The stream has a good mix of riffle, run, and deep pool habitats. Substrate ranges from gravels to eight-inch cobbles. Presence of some filamentous algae indicates that the creek may have nutrient loading and/or excessively high water temperatures.

Fishery surveys revealed a self-sustaining native fishery which included mountain suckers, mottled sculpin, and speckled dace. White suckers, which are native to the Front Range, were also documented in the creek. Intensive macro-invertebrate surveys have not been conducted (Emily - is this correct?), but spot samples have revealed various species of mayfly and caddisfly,

The riparian community along Willow Creek is in good condition, and streambanks stability appears to be improving. The riparian community is comprised mainly of willows and sedges, and it occupies the entire valley bottom.

R2Cross Analysis. BLM collected the following R2Cross data from Willow Creek:

Reach #1 – Outlet of Steamboat Lake to confluence with Beaver Creek:

Cross Section Date	Discharge Rate	Top Width	Winter Flow Recommendation (meets 2 of 3 hydraulic criteria)	Summer Flow Recommendation (meets 3 of 3 hydraulic criteria)
08/16/2011 #3	10.75 cfs	34.97 feet	7.22 cfs	11.94 cfs
08/16/2011 #4	10.27 cfs	34.81 feet	8.22 cfs	11.83 cfs
Averages: 7.72 cfs 11.89 cfs				

Reach #2 – Confluence with Beaver Creek to confluence with Lester Creek:

Cross Section Date	Discharge Rate	Top Width	Winter Flow Recommendation (meets 2 of 3 hydraulic criteria)	Summer Flow Recommendation (meets 3 of 3 hydraulic criteria)
09/26/2011 #1	13.78 cfs	36.79 feet	6.09 cfs	16.44 cfs
09/26/2011 #2	12.69 cfs	39.21 feet	Out of confidence interval	20.89 cfs
08/16/2011 #1	16.89 cfs	41.91 feet	Out of confidence interval	27.98 cfs
08/16/2011 #2	16.56 cfs	42.60 feet	8.56 cfs	15.97 cfs
Averages: 7.33 cfs 20.32 cfs				

BLM's analysis of this data, coordinated with Colorado Parks and Wildlife, indicates that the following flows are needed to protect the fishery and natural environment to a reasonable degree:

Reach #1 – Outlet of Steamboat Lake to confluence with Beaver Creek

An enlargement of 6.9 cubic feet per second to the existing 5.0 cfs instream flow water right is recommended during the snowmelt runoff period, from April 1 through July 31. This recommendation is driven by the average velocity criteria. This flow rate will assist in maintaining the native fish assemblage, by maintaining a sufficient amount of physical habitat during their spawning period. Appropriation of an additional 6.9 cfs would bring the total instream flow water right up to 11.90 cubic feet per second during April 1 to July 31 period.

An enlargement of 2.7 cubic feet per second is recommended for the remainder of the year, from August 1 to March 31. This flow rate will help prevent excessively high stream temperatures during late summer and it should also be sufficient to prevent icing of pools, which will protect overwintering fish.

Appropriation of an additional 2.7 cfs would bring the total instream flow water right up to 7.70 cfs during the August 1 to March 31 period.

Reach #2 – Confluence with Beaver Creek to confluence with Lester Creek

An enlargement of 13.30 cubic feet per second to the existing 7.0 cfs instream flow water right is recommended during the snowmelt runoff period, from April 1 through July 31. This recommendation is driven by the average depth criteria. This flow rate will assist in maintaining the native fish assemblage, by maintaining a sufficient amount of physical habitat during their spawning period. Appropriation of an additional 13.30 cfs would bring the total instream flow water right up to 20.30 cfs during the August 1 to March 31 period.

BLM recommends that the existing 7.0 cubic feet per second water right remain unchanged for the remainder of year, unless additional data collection demonstrates that this flow is not sufficient to meet instream flow criteria.

Water Availability. While there is no gage located on this creek, there is an abundance of gaging data in the larger Elk River watershed. Gage data that the CWCB could use for an analysis of comparable watersheds or for a basin apportionment analysis include the following USGS gages:

09241000 Elk River at Clark, CO

09244500 Elkhead Creek near Clark, CO

09240800 South Fork Elk River near Clark, CO

BLM recommends using the StreamStats package developed jointly between the U.S. Geological Survey and the CWCB to develop a raw estimate of water availability. Historic diversions and storage volumes could be subtracted from streamflow estimates produced by the StreamStats package.

BLM is not aware of any existing diversions in the proposed instream flow reaches. However, BLM is aware of the following conditional water rights:

- Steamboat Lake Water District Well No. 1 is decreed for 13 cfs, 1976 priority, for municipal, domestic, and other uses. While the well would not divert directly from the creek, it would be located very close to the alluvium associated with Willow Creek. As such, it could reduce flow in the creek.
- Grouse Mountain Reservoir is decreed for 79,262 acre feet for municipal, domestic, industrial, commercial, and other uses to Tri-State Generation and Transmission Association. The water right was adjudicated 40 years ago in 1972. If constructed, the reservoir would inundate the proposed instream flow reaches.

BLM is aware of other water rights in upstream locations that could be affected by the proposed

instream flow appropriation:

- Colorado Division of Parks and Wildlife holds an 18,064 acre foot storage decree for Steamboat Lake State Park. Tri-State Generation and Transmission Association also holds a right to store up to 5,000 acre feet of water in Steamboat Lake.
- There are two significant ditches upstream from Steamboat Lake. Folden Ditch holds a decree for 3.0 cfs for irrigation purposes. Willow Spring Ditch holds a water right for 0.5 cfs for irrigation purposes.

In addition to the water rights described above, there are also numerous small water rights upstream from Steamboat Lake on springs, wells, and reservoirs less than 10 acre feet.

Relationship to Land Management Plans. Even though the BLM's ownership along the creek is limited, BLM has elected to retain that land in public ownership because of its high riparian and recreation values. Lands owned by BLM are easily accessed by major roads and provide additional recreation opportunities adjacent to Steamboat Lake State Park. In addition, the creek provides important lower elevation habitat for native fish species in an area where most of the land is privately owned. BLM intends to continue management for riparian and fishery values, with emphasis on improving livestock use patterns to maintain and improve riparian conditions. Appropriation of an instream flow water right would assist BLM in long-term management of riparian values and important fishery values.

Data sheets, R2Cross output, fishery survey information, and photographs of the cross section were included with BLM's draft recommendation in February 2012. We thank both Colorado Parks and Wildlife and the Colorado Water Conservation Board for their cooperation in this effort.

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

Sincerely,

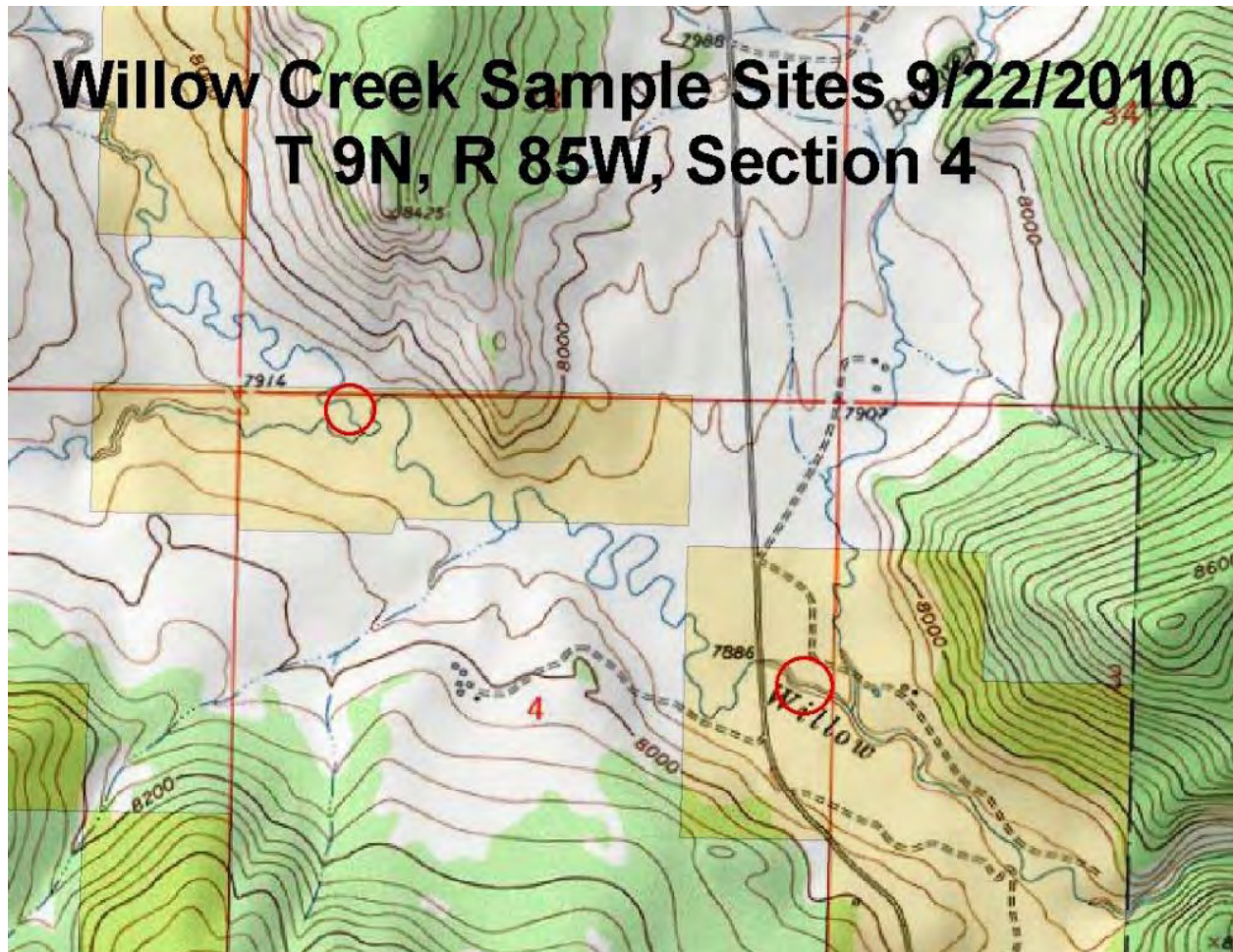
Leigh Espy
Deputy State Director
Resources and Fire

Cc: Emily Spencer, Little Snake FO
Wendy Reynolds, Little Snake FO

Little Snake Field Office Stream Surveys September 2010

Willow Creek - Water Code #22842

Willow Creek, located northwest and southeast of Steamboat Lake State Park on BLM lands managed by the Little Snake Field Office was sampled on September 22 and 23, 2010. Willow Creek is tributary to the Elk River and then the Yampa River. Sampling was done in support of the instream flow program. Presence/Absence sampling was completed to determine fishery status and composition. A two-pass removal population estimate was not completed due to the size of the stream and lack of personnel. Sampling was conducted at two sites, via one backpack electro-shocker. A 336 foot stream reach was sampled at the first site and a 300 foot stream reach was sampled at the second. Personnel present were Gregory Delevan and Clay Ramey, BLM.





Willow Creek



Mottled Scalping

STREAM SURVEY FISH SAMPLING FORM								
Water	Willow Creek		H₂O Code	22842	Date	9/23/2010		
Gear	BPE	Effort		Station #	2	Pass #	SPOT	
Crew	Dekleva, Ramey			Drainage	Yampa	Location	GPS	
PASS	SPECIES	LENGTH	WEIGHT		PASS	SPECIES	LENGTH	WEIGHT
1	MOS	155			1	MOS	95	
1	MOS	141			1	MTS	80	
1	MTS	88						
1	MOS	93						
1	MOS	137						
1	MOS	100						
1	MOS	103						
1	MTS	72						
1	MOS	88						
1	MOS	97						
1	MOS	114						
1	MTS	75						
1	MTS	85						
1	MOS	111						
1	MTS	81						
1	MTS	94						
1	MTS	92						
1	MOS	103						
1	MOS	90						
1	MTS	80						
1	MTS	86						
1	MOS	94						
1	MTS	76						
1	MTS	91						
1	MTS	74						
GPS LOCATION:		13T	338189, 4514909					
STREAM WIDTH:		~30 ft.		SAMPLE REACH:		336 ft.		
CONDUCTIVITY:			ELECTROSHOCKER SETTINGS :					
NOTES: Willows, Sedges, Embedded Cobbles, Wide Flat Bottom, Slow moving water								

[illegible]

Discussion. Willow Creek is a source of water for Steamboat Lake and is the tailwater stream below the dam. Willow Creek contained a good mix of riffles, runs, and pools. At the sample sites the stream was wide with slow moving water and a cobble based bottom, the water was also slightly stained. The stream appeared to be a Rosgen C channel type. Riparian vegetation consisted of willows and sedges mainly, as well as a small grass component.

For the size of the stream less fish were captured at both sites versus the smaller tributaries, Red and Beaver Creeks. This may be due to the size of the stream and the ability of the fish to swim away from the electricity. A variety of fish were captured including Mountain suckers, Mottled sculpin, Speckled dace, Fathead minnow and White suckers. Macro-invertebrates present were caddis, mayflies, and damselflies.

Recommendations:

- This stream would benefit from an instream flow recommendation. Periodically monitor to ensure that stream habitats remain in good condition.
- Follow up with a two-pass removal population estimate with three backpack electro-fishers or possibly a bank shocking rig.



FIELD DATA FOR INSTREAM FLOW DETERMINATIONS



COLORADO WATER
CONSERVATION BOARD

LOCATION INFORMATION

STREAM NAME: <u>Willow Creek</u>		CROSS-SECTION NO.: <u>1</u>
CROSS-SECTION LOCATION: <u>800 ft. downstream from confluence with Beaver Cr.</u>		
DATE: <u>8-16-11</u>	OBSERVERS: <u>R. Smith, E. Spencer</u>	
LEGAL DESCRIPTION:	1/4 SECTION: <u>SW</u>	SECTION: <u>3</u>
	TOWNSHIP: <u>9N/S</u>	RANGE: <u>85 E/W</u>
COUNTY: <u>Powll</u>	WATERSHED: <u>Yampa</u>	WATER DIVISION: <u>6</u>
		DOW WATER CODE: <u>02842</u>
MAP(S):	USGS: <u>GPS Zone 13</u>	<u>338449</u>
	USFS: <u>4514639</u>	

SUPPLEMENTAL DATA

SAG TAPE SECTION SAME AS DISCHARGE SECTION: ☒ YES ☐ NO	METER TYPE: <u>M.M</u>		
METER NUMBER:	DATE RATED:	CALIB/SPIN: <u>sec</u>	TAPE WEIGHT: <u>surveyed</u> lbs/1001
			TAPE TENSION: <u>surveyed</u> lbs
CHANNEL BED MATERIAL SIZE RANGE: <u>4 to 8 cobbles</u>	PHOTOGRAPHS TAKEN: ☒ YES ☐ NO	NUMBER OF PHOTOGRAPHS: <u>3</u>	

CHANNEL PROFILE DATA

STATION	DISTANCE FROM TAPE (ft)	ROD READING (ft)
⊗ Tape @ Stake LB	0.0	<u>surveyed</u>
⊗ Tape @ Stake RB	0.0	<u>surveyed</u>
① WS @ Tape LB/RB	0.0	<u>7.22 / 7.23</u>
② WS Upstream	<u>17.6</u>	<u>7.18</u>
③ WS Downstream	<u>33.0</u>	<u>7.35</u>
SLOPE	<u>0.17 / 50.6 = .0034</u>	

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																	
<u>mayfly, caddisfly, stonefly</u>																	

COMMENTS

<u>Temp = 17.6°C</u>
<u>Cond = 54</u>
<u>Salinity = 0</u>
<u>pH = 8.38</u>

DISCHARGE/CROSS SECTION NOTES

[illegible]

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

LOCATION INFORMATION

STREAM NAME: Willow Creek
XS LOCATION: 800 ft downst fr conf w Beaver Creek
XS NUMBER: 1

DATE: 16-Aug-11
OBSERVERS: R. Smith, E. Spencer

1/4 SEC: SW
SECTION: 3
TWP: 9N
RANGE: 85W
PM: 6th

COUNTY: Routt
WATERSHED: Elk River
DIVISION: 6
DOW CODE: 22842

USGS MAP: 0
USFS MAP: 0

SUPPLEMENTAL DATA

*** NOTE ***

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

TAPE WT: 0.0106
TENSION: 99999

CHANNEL PROFILE DATA

SLOPE: 0.0034

INPUT DATA CHECKED BY:DATE.....

ASSIGNED TO:DATE.....

STREAM NAME: Willow Creek
 XS LOCATION: 800 ft downst fr conf w Beaver Creek
 XS NUMBER: 1

DATA POINTS= 29

VALUES COMPUTED FROM RAW FIELD DATA

FEATURE	DIST	VERT DEPTH	WATER DEPTH	VEL
RS	0.00	5.49		
1 G	6.00	5.92		
	8.00	6.83		
	10.00	7.15		
W	12.00	7.20	0.00	0.00
	13.00	7.20	0.00	0.00
	14.50	7.30	0.10	0.92
	16.00	7.50	0.30	0.92
	17.50	7.50	0.30	1.56
	19.00	7.65	0.45	2.32
	20.50	7.60	0.40	2.34
	22.00	7.70	0.50	2.40
	23.50	7.80	0.60	2.06
	25.00	7.70	0.50	1.94
	26.50	7.50	0.40	2.08
	28.00	7.50	0.30	0.70
	29.50	7.70	0.50	2.08
	31.00	7.55	0.35	1.85
	32.50	7.70	0.50	1.97
	34.00	7.60	0.40	1.01
	35.50	7.50	0.30	1.58
	37.00	7.40	0.20	0.29
	38.50	7.35	0.15	0.92
	40.00	7.30	0.10	0.18
	41.50	7.30	0.10	0.48
	43.00	7.60	0.40	0.65
W	43.60	7.20	0.00	0.00
	43.70	6.43		
1 LS & G	48.00	5.96		

WETTED PERIM.	WATER DEPTH	AREA (Am)	Q (Qm)	% Q CELL
0.00		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
1.50	0.10	0.15	0.14	0.8%
1.51	0.30	0.45	0.41	2.5%
1.50	0.30	0.45	0.70	4.2%
1.51	0.45	0.68	1.57	9.3%
1.50	0.40	0.60	1.40	8.3%
1.50	0.50	0.75	1.80	10.7%
1.50	0.60	0.90	1.85	11.0%
1.50	0.50	0.75	1.46	8.6%
1.51	0.40	0.60	1.25	7.4%
1.50	0.30	0.45	0.32	1.9%
1.51	0.50	0.75	1.56	9.2%
1.51	0.35	0.53	0.97	5.8%
1.51	0.50	0.75	1.48	8.7%
1.50	0.40	0.60	0.61	3.6%
1.50	0.30	0.45	0.71	4.2%
1.50	0.20	0.30	0.09	0.5%
1.50	0.15	0.23	0.21	1.2%
1.50	0.10	0.15	0.03	0.2%
1.50	0.10	0.15	0.07	0.4%
1.53	0.40	0.42	0.27	1.6%
0.72		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%

TOTALS -----

30.84 0.6 10.10 16.89 100.0%
 (Max.)

Manning's n = 0.0246
 Hydraulic Radius= 0.3273464

STREAM NAME: Willow Creek
 XS LOCATION: 800 ft downst fr conf w Beaver Creek
 XS NUMBER: 1

WATER LINE COMPARISON TABLE

WATER LINE	MEAS AREA	COMP AREA	AREA ERROR
	10.10	9.95	-1.5%
6.95	10.10	18.42	82.5%
6.97	10.10	17.73	75.6%
6.99	10.10	17.03	68.7%
7.01	10.10	16.34	61.9%
7.03	10.10	15.65	55.1%
7.05	10.10	14.97	48.3%
7.07	10.10	14.28	41.5%
7.09	10.10	13.60	34.8%
7.11	10.10	12.92	28.0%
7.13	10.10	12.25	21.3%
7.15	10.10	11.58	14.7%
7.16	10.10	11.24	11.4%
7.17	10.10	10.91	8.1%
7.18	10.10	10.59	4.9%
7.19	10.10	10.26	1.7%
7.20	10.10	9.95	-1.5%
7.21	10.10	9.64	-4.5%
7.22	10.10	9.34	-7.5%
7.23	10.10	9.03	-10.5%
7.24	10.10	8.73	-13.5%
7.25	10.10	8.44	-16.4%
7.27	10.10	7.84	-22.3%
7.29	10.10	7.26	-28.1%
7.31	10.10	6.70	-33.7%
7.33	10.10	6.16	-38.9%
7.35	10.10	5.65	-44.0%
7.37	10.10	5.15	-48.9%
7.39	10.10	4.68	-53.7%
7.41	10.10	4.21	-58.3%
7.43	10.10	3.76	-62.7%
7.45	10.10	3.33	-67.0%

WATERLINE AT ZERO

AREA ERROR = 7.195

STREAM NAME: Willow Creek
 XS LOCATION: 800 ft downst fr conf w Beaver Creek
 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	5.96	41.91	1.33	1.84	55.55	43.07	100.0%	1.29	231.82	4.17
	6.20	39.24	1.17	1.60	46.00	40.33	93.7%	1.14	176.86	3.84
	6.25	38.67	1.14	1.55	44.05	39.75	92.3%	1.11	166.15	3.77
	6.30	38.11	1.11	1.50	42.13	39.17	91.0%	1.08	155.78	3.70
	6.35	37.54	1.07	1.45	40.24	38.59	89.6%	1.04	145.75	3.62
	6.40	36.97	1.04	1.40	38.38	38.01	88.3%	1.01	136.04	3.54
	6.45	36.54	1.00	1.35	36.54	37.55	87.2%	0.97	126.39	3.46
	6.50	36.43	0.95	1.30	34.72	37.38	86.8%	0.93	116.40	3.35
	6.55	36.31	0.91	1.25	32.90	37.21	86.4%	0.88	106.74	3.24
	6.60	36.19	0.86	1.20	31.09	37.04	86.0%	0.84	97.42	3.13
	6.65	36.08	0.81	1.15	29.28	36.87	85.6%	0.79	88.44	3.02
	6.70	35.96	0.76	1.10	27.48	36.70	85.2%	0.75	79.81	2.90
	6.75	35.85	0.72	1.05	25.68	36.53	84.8%	0.70	71.53	2.79
	6.80	35.73	0.67	1.00	23.89	36.36	84.4%	0.66	63.62	2.66
	6.85	35.55	0.62	0.95	22.11	36.13	83.9%	0.61	56.14	2.54
	6.90	35.23	0.58	0.90	20.34	35.76	83.0%	0.57	49.19	2.42
	6.95	34.91	0.53	0.85	18.59	35.39	82.2%	0.53	42.62	2.29
	7.00	34.59	0.49	0.80	16.85	35.03	81.3%	0.48	36.44	2.16
	7.05	34.27	0.44	0.75	15.13	34.66	80.5%	0.44	30.66	2.03
	7.10	33.96	0.40	0.70	13.42	34.29	79.6%	0.39	25.30	1.88
	7.15	33.64	0.35	0.65	11.73	33.92	78.8%	0.35	20.36	1.74
WL	7.20	31.79	0.32	0.60	10.09	32.03	74.4%	0.32	16.46	1.63
	7.25	29.85	0.29	0.55	8.58	30.08	69.8%	0.29	13.09	1.53
	7.30	29.03	0.24	0.50	7.10	29.23	67.9%	0.24	9.74	1.37
	7.35	25.46	0.23	0.45	5.77	25.64	59.5%	0.23	7.52	1.30
	7.40	23.26	0.20	0.40	4.55	23.42	54.4%	0.19	5.38	1.18
	7.45	21.74	0.16	0.35	3.43	21.87	50.8%	0.16	3.51	1.02
	7.50	20.29	0.12	0.30	2.38	20.40	47.4%	0.12	2.00	0.84
	7.55	15.04	0.10	0.25	1.55	15.12	35.1%	0.10	1.20	0.77
	7.60	11.81	0.07	0.20	0.88	11.86	27.5%	0.07	0.55	0.62
	7.65	6.75	0.06	0.15	0.41	6.77	15.7%	0.06	0.22	0.54
	7.70	3.31	0.05	0.10	0.16	3.31	7.7%	0.05	0.08	0.48
	7.75	1.64	0.03	0.05	0.04	1.65	3.8%	0.03	0.01	0.32
	7.80	0.14	0.00	0.00	0.00	0.14	0.3%	0.00	0.00	0.06

STREAM NAME: Willow Creek
XS LOCATION: 800 ft downst fr conf w Beaver Creek
XS NUMBER: 1

SUMMARY SHEET

MEASURED FLOW (Qm)= 16.89 cfs
CALCULATED FLOW (Qc)= 16.46 cfs
(Qm-Qc)/Qm * 100 = 2.5 %

MEASURED WATERLINE (WLm)= 7.20 ft
CALCULATED WATERLINE (WLc)= 7.20 ft
(WLm-WLc)/WLm * 100 = 0.1 %

MAX MEASURED DEPTH (Dm)= 0.60 ft
MAX CALCULATED DEPTH (Dc)= 0.60 ft
(Dm-Dc)/Dm * 100 = -0.8 %

MEAN VELOCITY= 1.63 ft/sec
MANNING'S N= 0.025
SLOPE= 0.0034 ft/ft

.4 * Qm = 6.8 cfs
2.5 * Qm= 42.2 cfs

RECOMMENDED INSTREAM FLOW:
=====

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

RATIONALE FOR RECOMMENDATION:
=====

RECOMMENDATION BY: AGENCY..... DATE:.....
CWCB REVIEW BY: DATE:.....

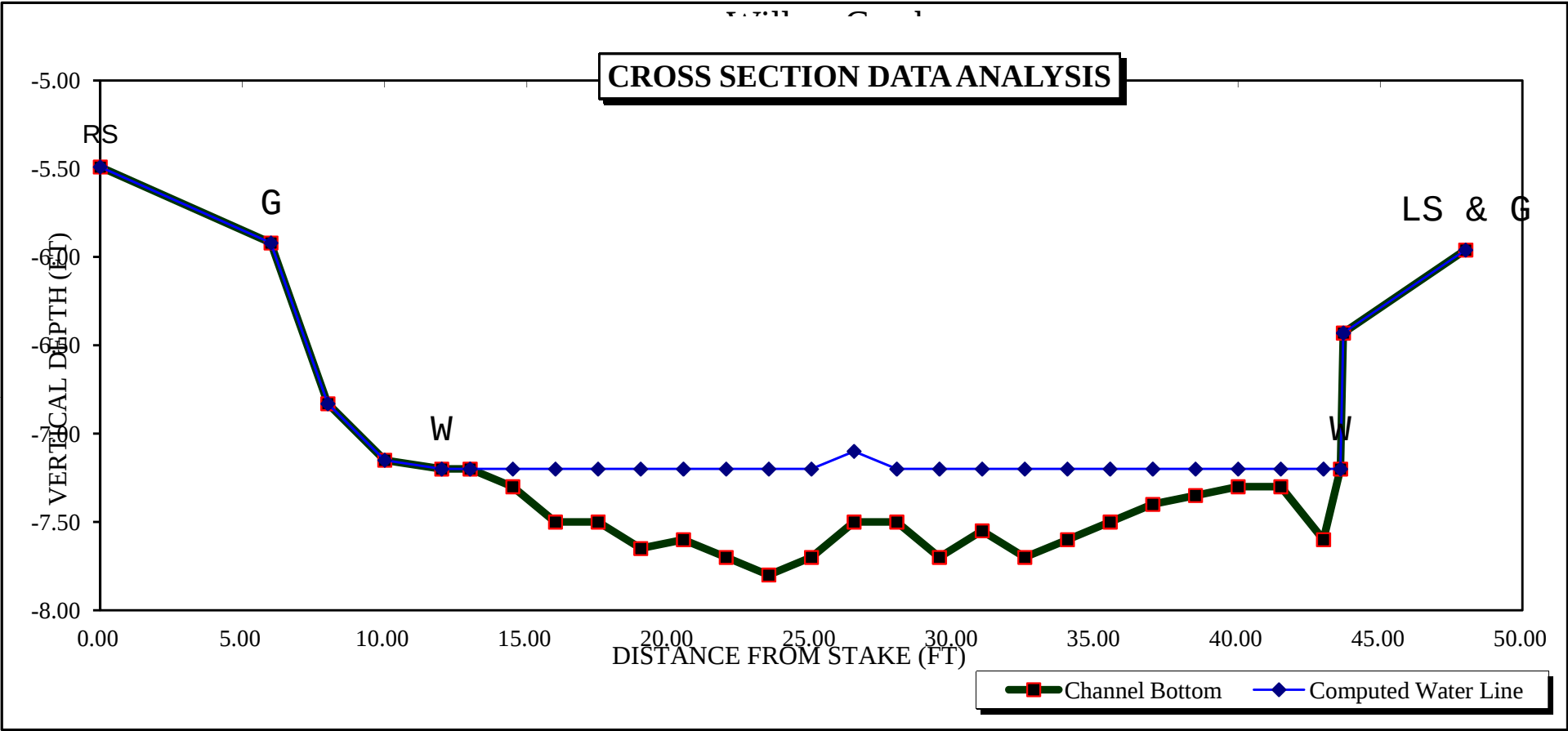
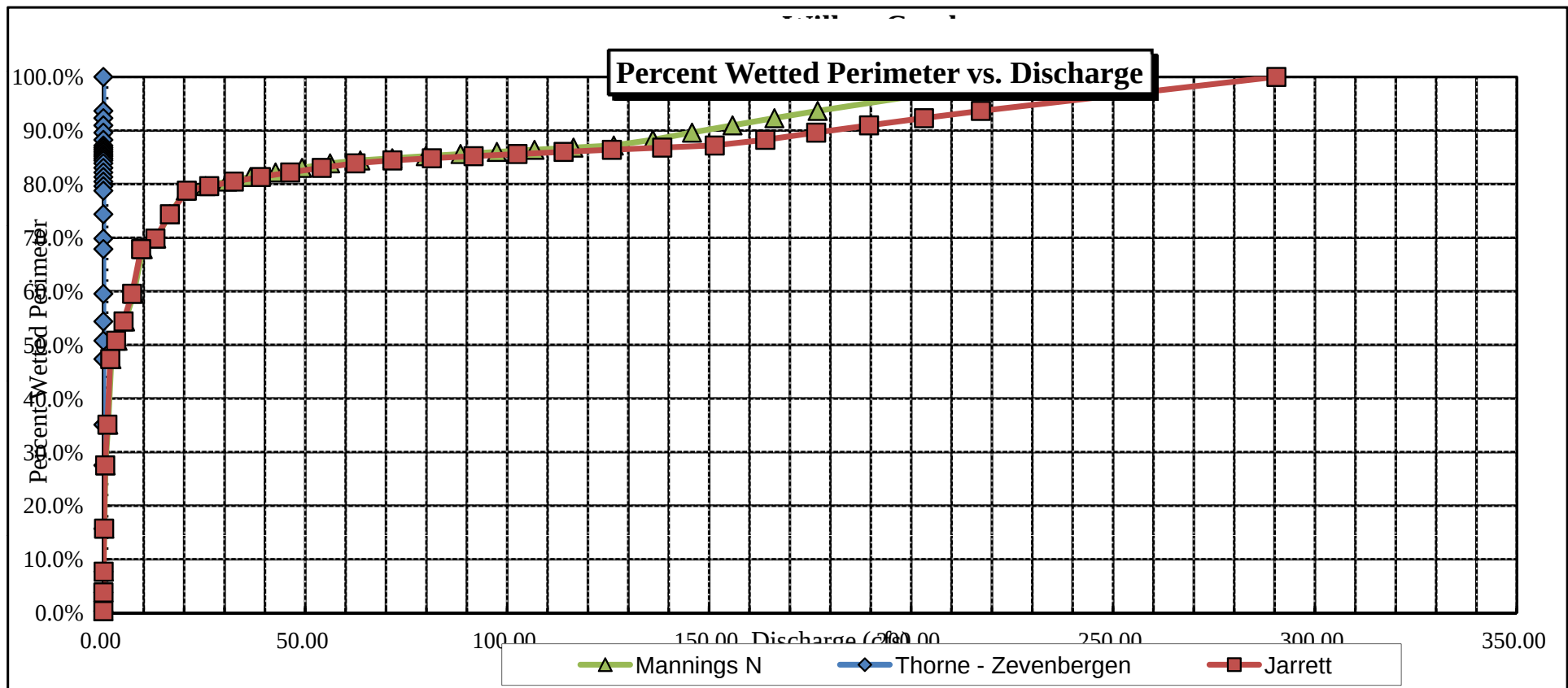
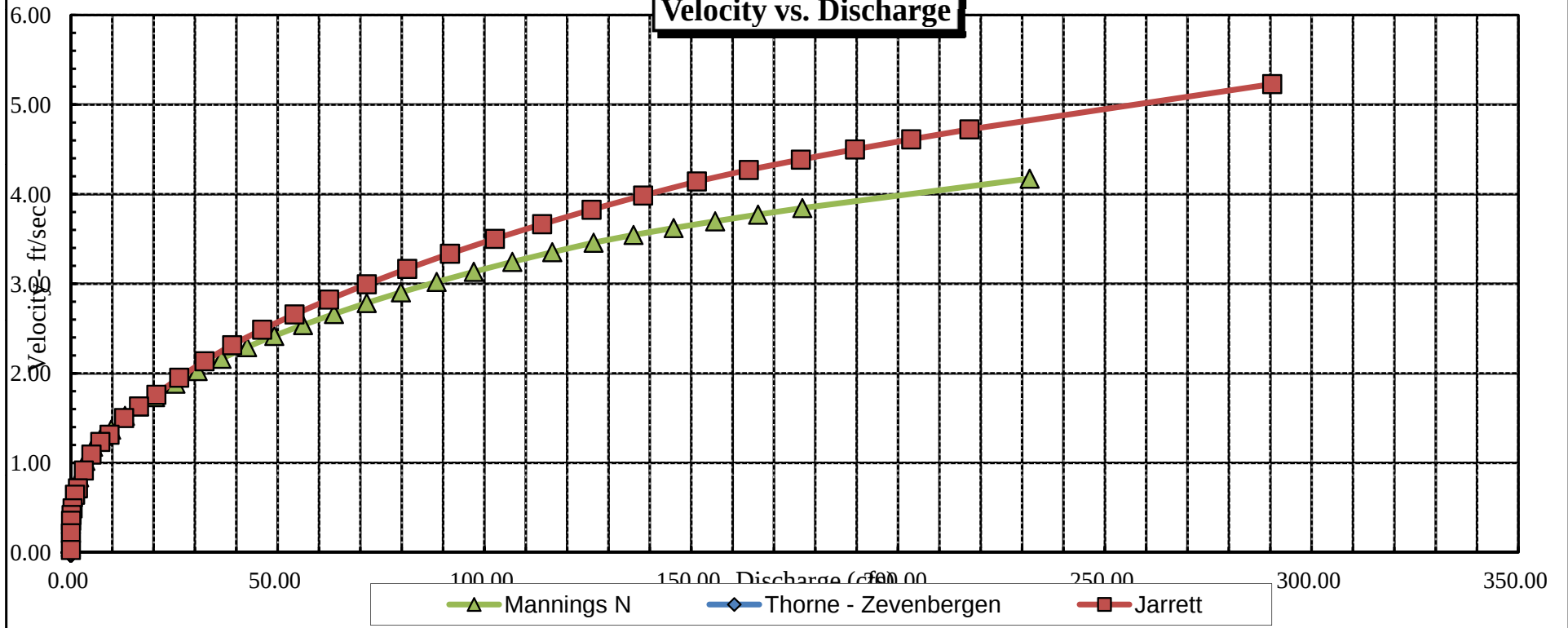
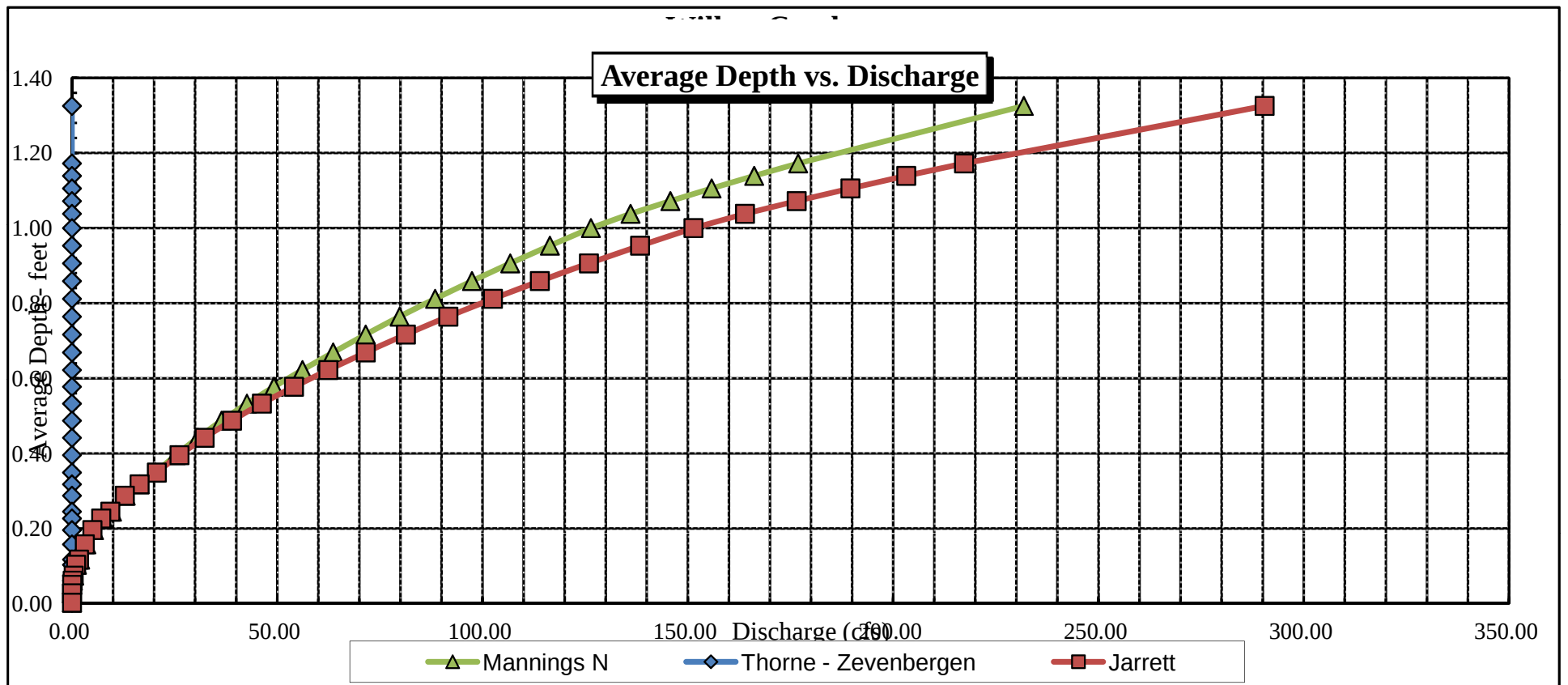


Chart 6.1

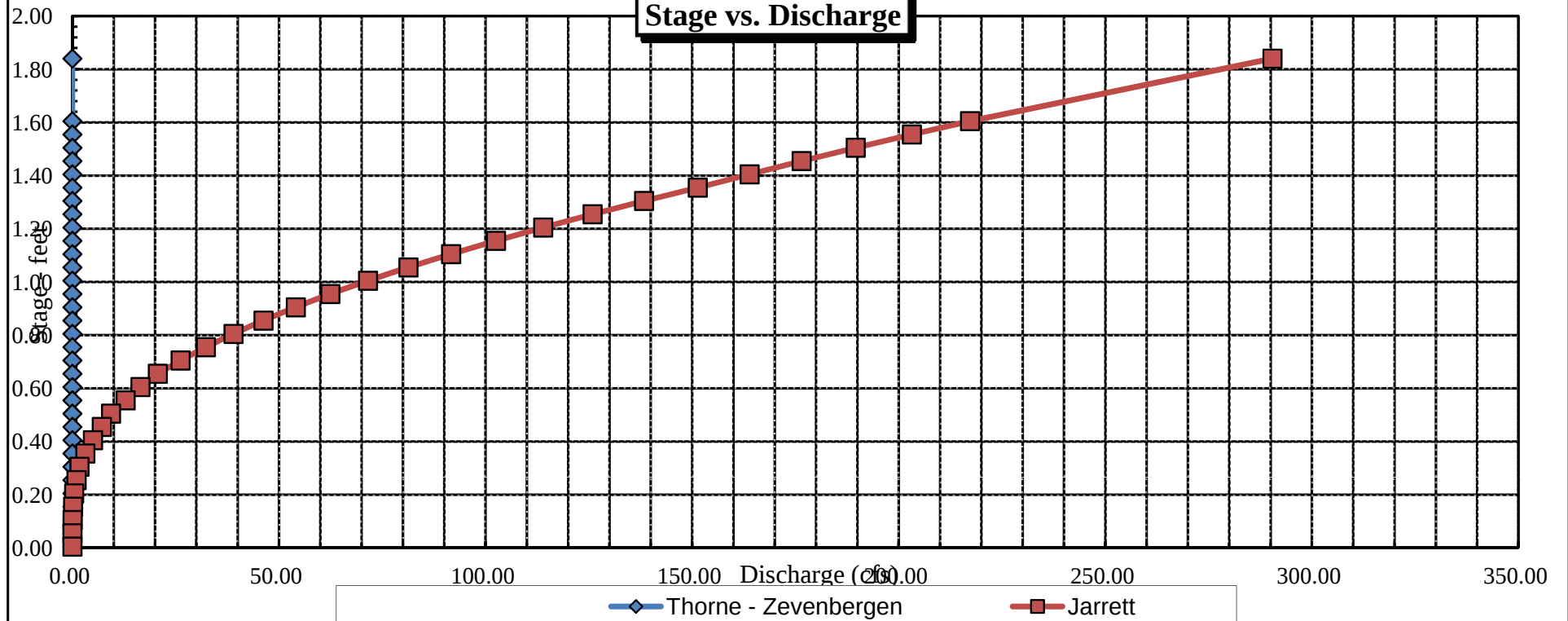


Velocity vs. Discharge





Stage vs. Discharge





FIELD DATA FOR INSTREAM FLOW DETERMINATIONS



COLORADO WATER
CONSERVATION BOARD

LOCATION INFORMATION

STREAM NAME: <u>Willow Creek</u>		CROSS-SECTION NO.: <u>2</u>
CROSS-SECTION LOCATION: <u>400 ft. downstream from conf. w/ Beaver Creek</u>		
DATE: <u>8-16-11</u>	OBSERVERS: <u>R. Smith, E. Spencer</u>	
LEGAL DESCRIPTION	1/4 SECTION: <u>SW</u>	SECTION: <u>3</u>
	TOWNSHIP: <u>9 N/S</u>	RANGE: <u>85 E/W</u>
	PM: <u>6th</u>	
COUNTY: <u>Route</u>	WATERSHED: <u>Yampa</u>	WATER DIVISION: <u>6</u>
	DOW WATER CODE: <u>22842</u>	
MAP(S):	USGS:	<u>CPS Zone 13 338423</u>
	USFS:	<u>4514773</u>

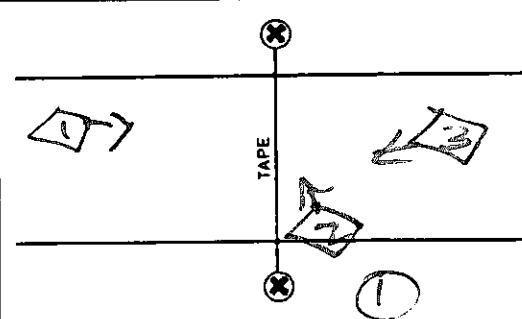
SUPPLEMENTAL DATA

SAG TAPE SECTION SAME AS DISCHARGE SECTION: <u>YES</u> NO	METER TYPE: <u>M-M</u>
METER NUMBER:	DATE RATED:
CALIB/SPIN:	sec
TAPE WEIGHT: <u>surveyed</u>	lbs/foot
TAPE TENSION: <u>surveyed</u>	lbs
CHANNEL BED MATERIAL SIZE RANGE: <u>2 to 8" cobbles</u>	PHOTOGRAPHS TAKEN <u>YES</u> NO
	NUMBER OF PHOTOGRAPHS: <u>3</u>

CHANNEL PROFILE DATA

STATION	DISTANCE FROM TAPE (ft)	ROD READING (ft)
(X) Tape @ Stake LB	0.0	<u>surveyed</u>
(X) Tape @ Stake RB	0.0	<u>surveyed</u>
(1) WS @ Tape LB/RB	0.0	<u>5.15 / 5.10</u>
(2) WS Upstream	<u>27.5'</u>	<u>5.03</u>
(3) WS Downstream	<u>35.0'</u>	<u>5.26</u>
SLOPE	<u>0.23 / 62.5 = .0036</u>	

SKETCH



LEGEND:

Stake (X)

Station (1)

Photo (1)

Direction of Flow

AQUATIC SAMPLING SUMMARY

STREAM ELECTROFISHED: <u>YES</u> NO	DISTANCE ELECTROFISHED: _____ ft	FISH CAUGHT YES/NO	WATER CHEMISTRY SAMPLED: <u>YES</u> 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																	
<u>mayfly, caddisfly, stonefly</u>																	

COMMENTS

PH: <u>8.38</u>
Cond: <u>54</u>
Temp: <u>17.6°C</u>
Salinity: <u>0</u>

DISCHARGE/CROSS SECTION NOTES

[illegible]

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

LOCATION INFORMATION

STREAM NAME: Willow Creek
XS LOCATION: 400 ft ds fr conf w Beaver Creek
XS NUMBER: 2

DATE: 16-Aug-11
OBSERVERS: R. Smith, E. Spencer

1/4 SEC: SW
SECTION: 3
TWP: 9N
RANGE: 85W
PM: 6th

COUNTY: Routt
WATERSHED: Elk River
DIVISION: 6
DOW CODE: 22842

USGS MAP: 0
USFS MAP: 0

SUPPLEMENTAL DATA

*** NOTE ***

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

TAPE WT: 0.0106
TENSION: 99999

CHANNEL PROFILE DATA

SLOPE: 0.0036

INPUT DATA CHECKED BY:DATE.....

ASSIGNED TO:DATE.....

STREAM NAME: Willow Creek
 XS LOCATION: 400 ft ds fr conf w Beaver Creek
 XS NUMBER: 2

DATA POINTS= 28

VALUES COMPUTED FROM RAW FIELD DATA

FEATURE	DIST	VERT DEPTH	WATER DEPTH	VEL
LS	0.00	2.16		
1 G	1.40	3.56		
	3.10	4.48		
	9.00	4.70		
W	11.20	5.15	0.00	0.00
	12.00	5.40	0.25	0.31
	13.50	5.65	0.50	1.73
	15.00	5.65	0.50	0.58
	16.50	5.75	0.60	1.62
	18.00	5.90	0.75	1.70
	19.50	5.95	0.80	2.06
	20.25	5.95	0.80	1.84
	21.00	5.85	0.70	2.23
	22.50	5.75	0.65	1.77
	24.00	5.75	0.65	1.55
	25.50	5.80	0.70	1.56
	27.00	5.50	0.40	1.48
	28.50	5.30	0.20	1.28
	30.00	5.35	0.25	0.30
	31.50	5.30	0.20	0.42
	33.00	5.35	0.25	0.40
	34.50	5.30	0.20	0.28
	36.00	5.20	0.10	0.22
	37.50	5.10	0.00	0.00
W	38.40	5.10	0.00	0.00
	40.00	4.66		
1 G	44.00	3.56		
RS	57.00	2.68		

WETTED PERIM.	WATER DEPTH	AREA (Am)	Q (Qm)	% Q CELL
0.00		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
0.84	0.25	0.29	0.09	0.5%
1.52	0.50	0.75	1.30	7.8%
1.50	0.50	0.75	0.44	2.6%
1.50	0.60	0.90	1.46	8.8%
1.51	0.75	1.13	1.91	11.5%
1.50	0.80	0.90	1.85	11.2%
0.75	0.80	0.60	1.10	6.7%
0.76	0.70	0.79	1.76	10.6%
1.50	0.65	0.98	1.73	10.4%
1.50	0.65	0.98	1.51	9.1%
1.50	0.70	1.05	1.64	9.9%
1.53	0.40	0.60	0.89	5.4%
1.51	0.20	0.30	0.38	2.3%
1.50	0.25	0.38	0.11	0.7%
1.50	0.20	0.30	0.13	0.8%
1.50	0.25	0.38	0.15	0.9%
1.50	0.20	0.30	0.08	0.5%
1.50	0.10	0.15	0.03	0.2%
1.50		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%

TOTALS -----

26.43 0.8 11.50 16.56 100.0%
 (Max.)

Manning's n = 0.0356
 Hydraulic Radius= 0.4350415

STREAM NAME: Willow Creek
 XS LOCATION: 400 ft ds fr conf w Beaver Creek
 XS NUMBER: 2

WATER LINE COMPARISON TABLE

WATER LINE	MEAS AREA	COMP AREA	AREA ERROR
	11.50	11.38	-1.1%
4.88	11.50	18.42	60.2%
4.90	11.50	17.84	55.1%
4.92	11.50	17.26	50.1%
4.94	11.50	16.68	45.0%
4.96	11.50	16.10	40.0%
4.98	11.50	15.53	35.1%
5.00	11.50	14.96	30.1%
5.02	11.50	14.40	25.2%
5.04	11.50	13.84	20.3%
5.06	11.50	13.28	15.5%
5.08	11.50	12.72	10.6%
5.09	11.50	12.45	8.2%
5.10	11.50	12.17	5.8%
5.11	11.50	11.90	3.5%
5.12	11.50	11.64	1.2%
5.13	11.50	11.38	-1.1%
5.14	11.50	11.12	-3.3%
5.15	11.50	10.86	-5.6%
5.16	11.50	10.60	-7.8%
5.17	11.50	10.35	-10.0%
5.18	11.50	10.10	-12.2%
5.20	11.50	9.60	-16.5%
5.22	11.50	9.11	-20.8%
5.24	11.50	8.63	-25.0%
5.26	11.50	8.15	-29.1%
5.28	11.50	7.68	-33.2%
5.30	11.50	7.22	-37.2%
5.32	11.50	6.78	-41.1%
5.34	11.50	6.38	-44.5%
5.36	11.50	6.04	-47.4%
5.38	11.50	5.72	-50.2%

WATERLINE AT ZERO

AREA ERROR = 5.120

STREAM NAME: Willow Creek
 XS LOCATION: 400 ft ds fr conf w Beaver Creek
 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	3.56	42.60	1.60	2.39	68.09	43.22	100.0%	1.58	231.19	3.40
	4.12	39.53	1.14	1.83	45.08	39.93	92.4%	1.13	122.59	2.72
	4.17	39.25	1.10	1.78	43.11	39.64	91.7%	1.09	114.35	2.65
	4.22	38.98	1.06	1.73	41.16	39.35	91.0%	1.05	106.36	2.58
	4.27	38.70	1.01	1.68	39.22	39.05	90.4%	1.00	98.62	2.51
	4.32	38.43	0.97	1.63	37.29	38.76	89.7%	0.96	91.13	2.44
	4.37	38.16	0.93	1.58	35.37	38.47	89.0%	0.92	83.89	2.37
	4.42	37.88	0.88	1.53	33.47	38.17	88.3%	0.88	76.90	2.30
	4.47	37.61	0.84	1.48	31.58	37.88	87.6%	0.83	70.17	2.22
	4.52	36.33	0.82	1.43	29.73	36.59	84.6%	0.81	64.93	2.18
	4.57	34.80	0.80	1.38	27.95	35.06	81.1%	0.80	60.28	2.16
	4.62	33.28	0.79	1.33	26.25	33.53	77.6%	0.78	55.92	2.13
	4.67	31.76	0.78	1.28	24.62	32.00	74.0%	0.77	51.86	2.11
	4.72	30.68	0.75	1.23	23.07	30.91	71.5%	0.75	47.60	2.06
	4.77	30.26	0.71	1.18	21.55	30.47	70.5%	0.71	42.89	1.99
	4.82	29.83	0.67	1.13	20.04	30.03	69.5%	0.67	38.39	1.92
	4.87	29.40	0.63	1.08	18.56	29.60	68.5%	0.63	34.11	1.84
	4.92	28.98	0.59	1.03	17.10	29.16	67.5%	0.59	30.06	1.76
	4.97	28.55	0.55	0.98	15.67	28.72	66.4%	0.55	26.23	1.67
	5.02	28.12	0.51	0.93	14.25	28.28	65.4%	0.50	22.63	1.59
	5.07	27.70	0.46	0.88	12.85	27.84	64.4%	0.46	19.25	1.50
WL	5.12	26.14	0.44	0.83	11.50	26.28	60.8%	0.44	16.62	1.45
	5.17	25.18	0.41	0.78	10.22	25.31	58.6%	0.40	14.00	1.37
	5.22	24.27	0.37	0.73	8.98	24.39	56.4%	0.37	11.57	1.29
	5.27	23.36	0.33	0.68	7.79	23.47	54.3%	0.33	9.37	1.20
	5.32	20.17	0.33	0.63	6.67	20.27	46.9%	0.33	7.97	1.20
	5.37	16.07	0.36	0.58	5.80	16.15	37.4%	0.36	7.34	1.27
	5.42	15.48	0.32	0.53	5.01	15.55	36.0%	0.32	5.90	1.18
	5.47	14.80	0.29	0.48	4.25	14.87	34.4%	0.29	4.63	1.09
	5.52	14.18	0.25	0.43	3.53	14.24	32.9%	0.25	3.49	0.99
	5.57	13.63	0.21	0.38	2.83	13.68	31.6%	0.21	2.49	0.88
	5.62	13.08	0.17	0.33	2.17	13.12	30.4%	0.17	1.63	0.75
	5.67	10.84	0.14	0.28	1.56	10.88	25.2%	0.14	1.07	0.69
	5.72	9.84	0.11	0.23	1.04	9.87	22.8%	0.11	0.58	0.56
	5.77	6.53	0.09	0.18	0.61	6.55	15.2%	0.09	0.32	0.52
	5.82	4.24	0.08	0.13	0.35	4.26	9.8%	0.08	0.17	0.48
	5.87	3.15	0.05	0.08	0.17	3.15	7.3%	0.05	0.06	0.36
	5.92	1.87	0.02	0.03	0.04	1.87	4.3%	0.02	0.01	0.19

STREAM NAME: Willow Creek
XS LOCATION: 400 ft ds fr conf w Beaver Creek
XS NUMBER: 2

SUMMARY SHEET

MEASURED FLOW (Qm)= 16.56 cfs
CALCULATED FLOW (Qc)= 16.62 cfs
(Qm-Qc)/Qm * 100 = -0.4 %

MEASURED WATERLINE (WLm)= 5.13 ft
CALCULATED WATERLINE (WLc)= 5.12 ft
(WLm-WLc)/WLm * 100 = 0.1 %

MAX MEASURED DEPTH (Dm)= 0.80 ft
MAX CALCULATED DEPTH (Dc)= 0.83 ft
(Dm-Dc)/Dm * 100 = -3.7 %

MEAN VELOCITY= 1.45 ft/sec
MANNING'S N= 0.036
SLOPE= 0.0036 ft/ft

.4 * Qm = 6.6 cfs
2.5 * Qm= 41.4 cfs

RECOMMENDED INSTREAM FLOW:
=====

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

RATIONALE FOR RECOMMENDATION:
=====

RECOMMENDATION BY: AGENCY..... DATE:.....
CWCB REVIEW BY: DATE:.....

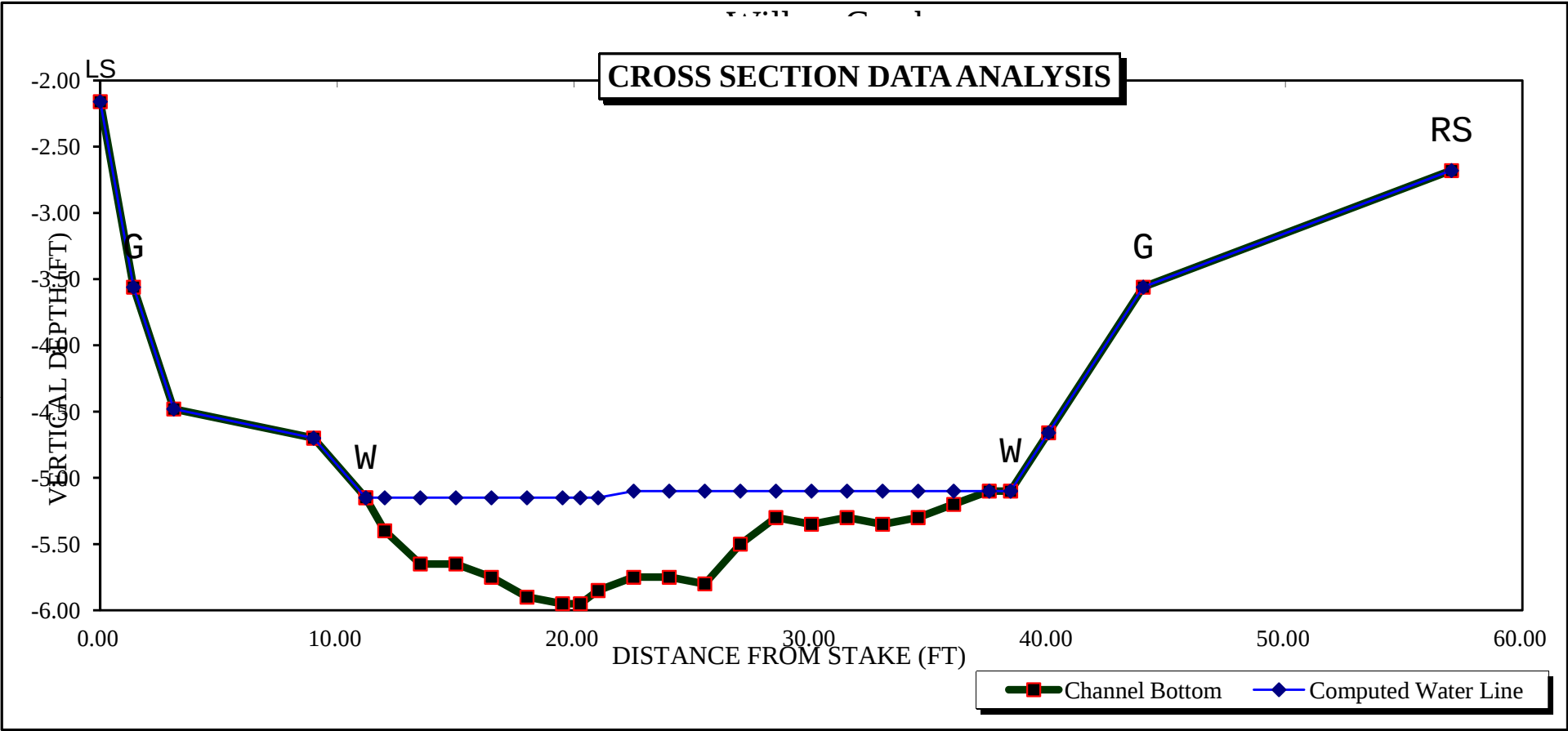
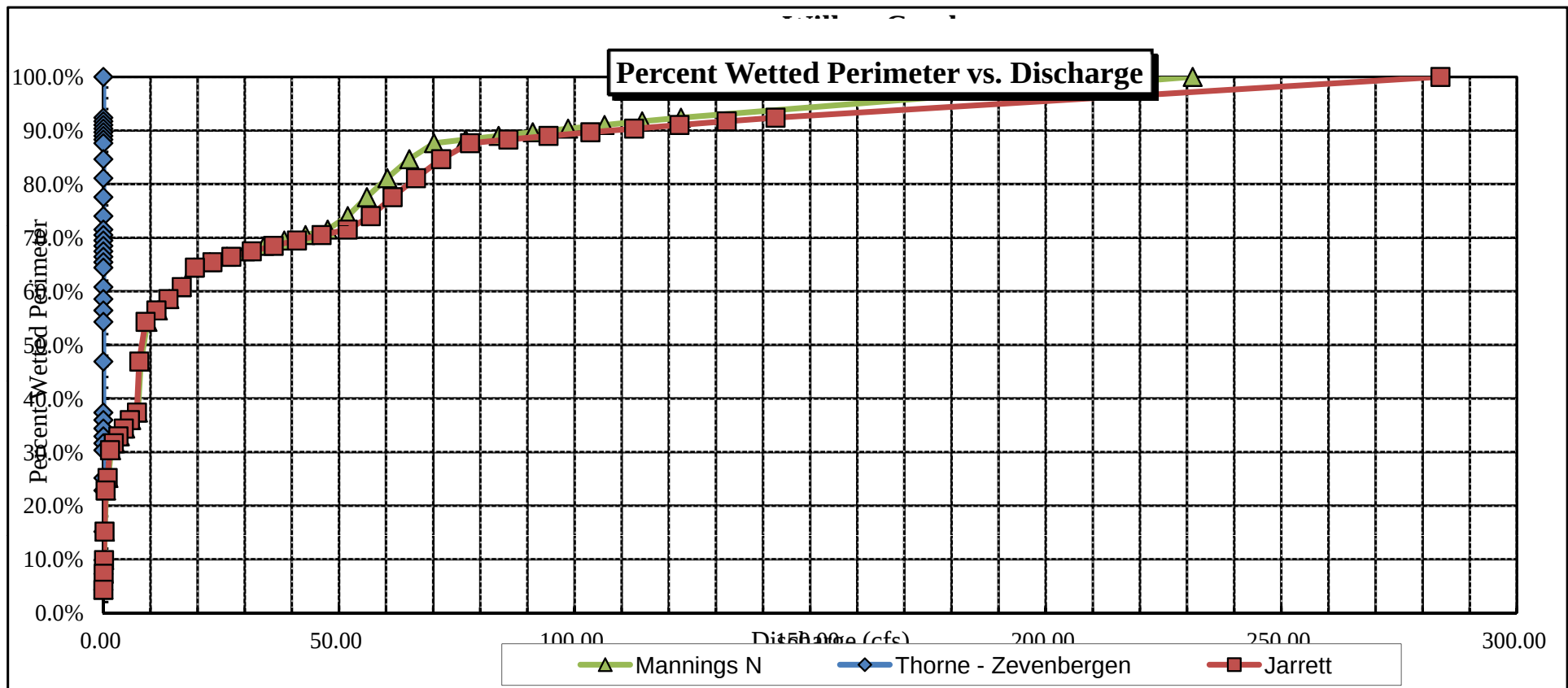
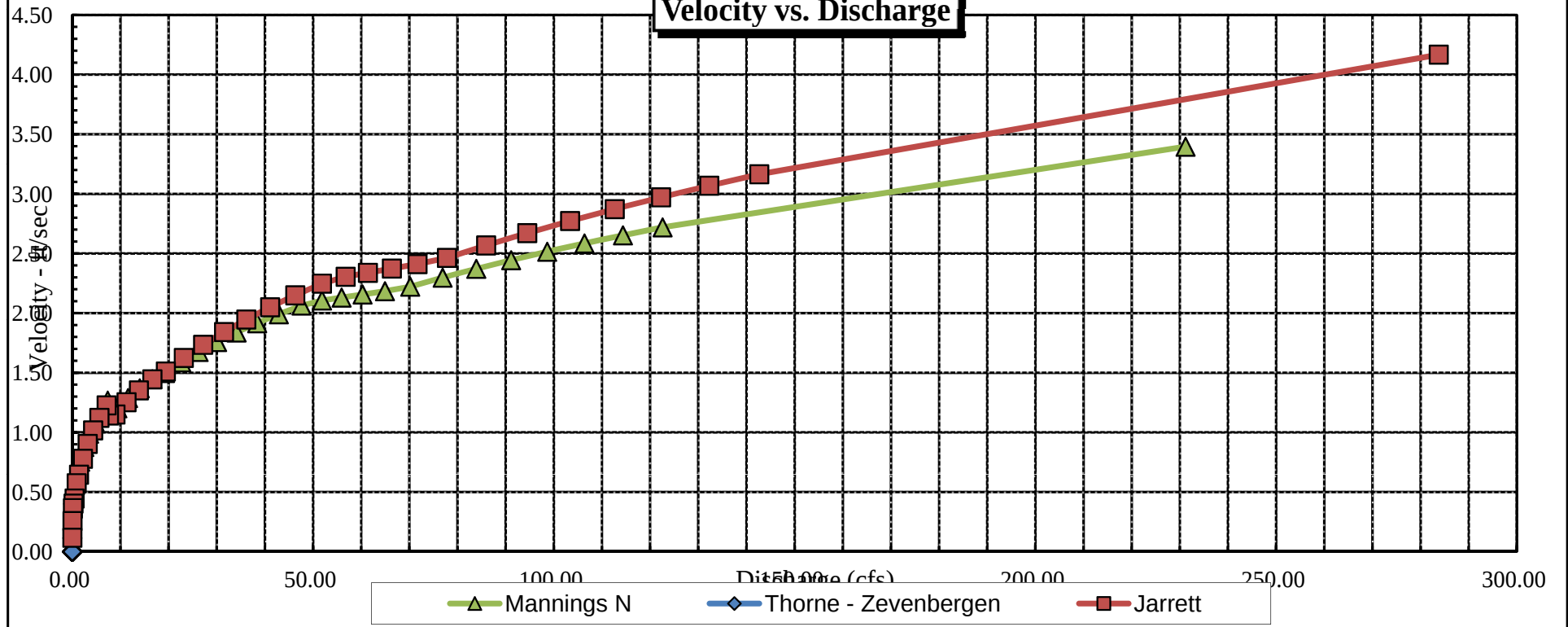
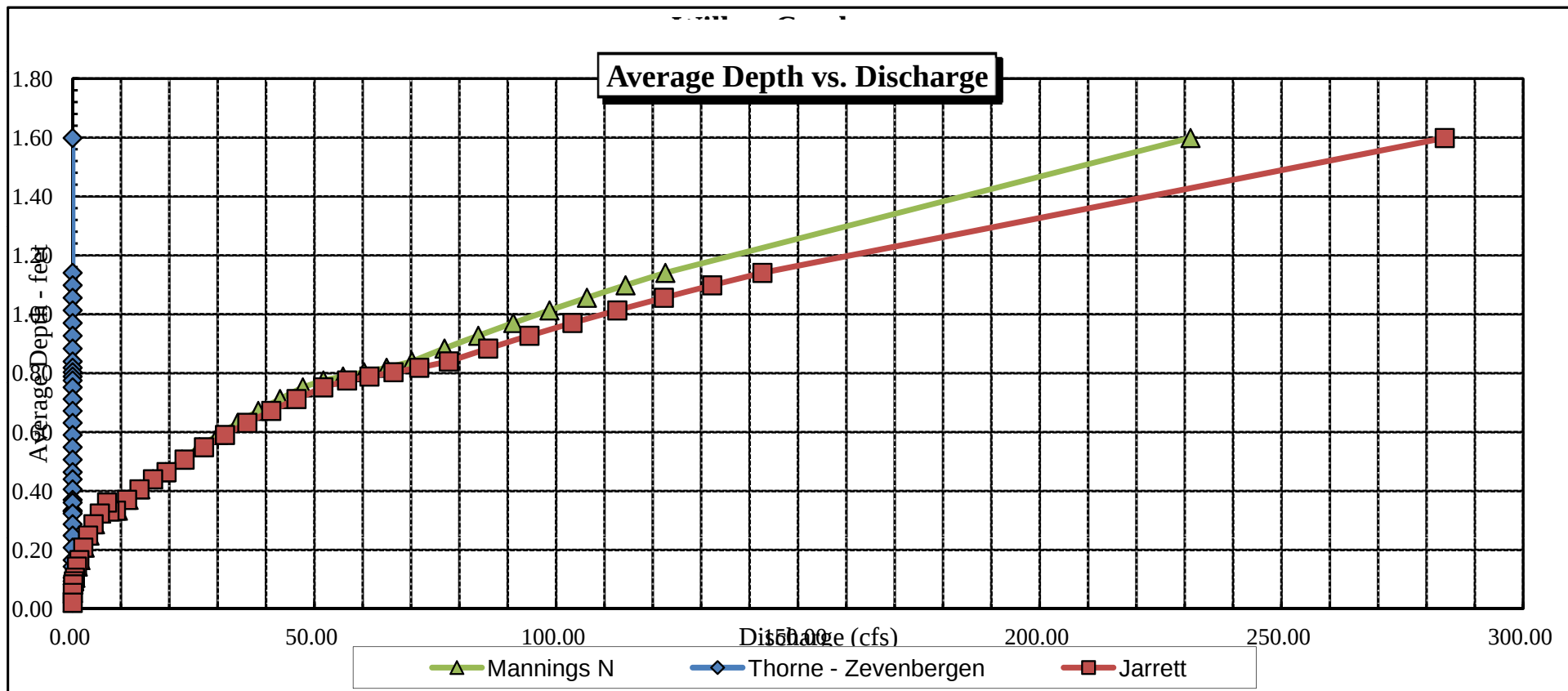


Figure 6.1

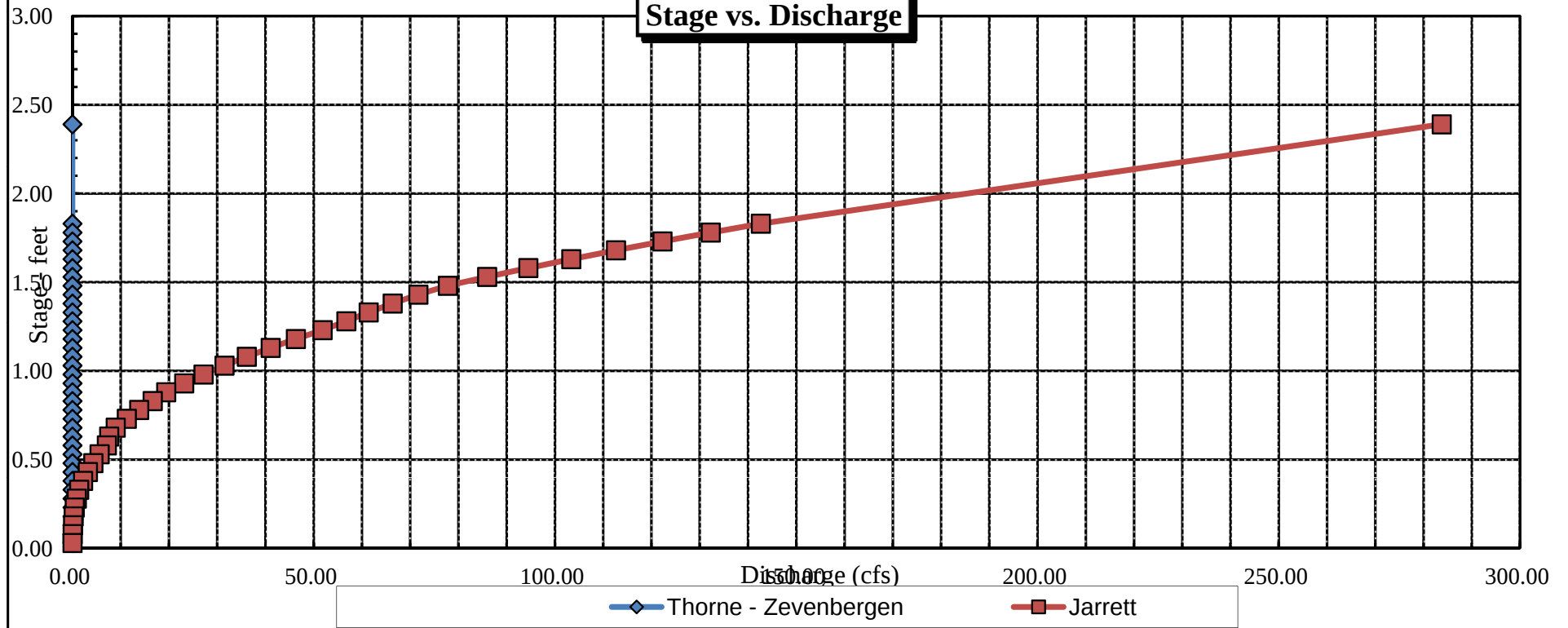


Velocity vs. Discharge





Stage vs. Discharge





COLORADO WATER
CONSERVATION BOARD

FIELD DATA FOR INSTREAM FLOW DETERMINATIONS



LOCATION INFORMATION

STREAM NAME: <u>Willow Creek</u>		CROSS-SECTION NO.: <u>3</u>
CROSS-SECTION LOCATION: <u>200 ft. upstream from confluence w/ Beaver Creek</u>		
DATE: <u>8-16-11</u>	OBSERVERS: <u>R. Smith, E. Spencer</u>	
LEGAL DESCRIPTION	1/4 SECTION: <u>NE</u>	SECTION: <u>4</u>
	TOWNSHIP: <u>9 N</u>	RANGE: <u>85 E</u>
COUNTY: <u>Routt</u>	WATERSHED: <u>Yampa</u>	WATER DIVISION: <u>6</u>
		DOW WATER CODE: <u>22842</u>
MAP(S):	USGS:	GPS <u>338258 Zone 13</u>
	USFS:	<u>4514834</u>

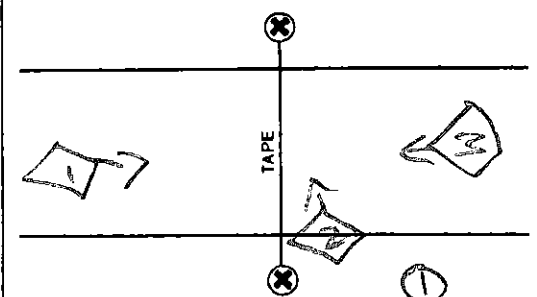
SUPPLEMENTAL DATA

SAG TAPE SECTION SAME AS DISCHARGE SECTION: ☒ YES ☐ NO	METER TYPE: <u>M-M</u>
METER NUMBER:	DATE RATED:
CALIB/SPIN: _____ sec	TAPE WEIGHT: <u>sunweyed</u> lbs/100'
	TAPE TENSION: <u>sunweyed</u> lbs
CHANNEL BED MATERIAL SIZE RANGE: <u>2" to 8" cobbles</u>	PHOTOGRAPHS TAKEN: ☒ YES ☐ NO
	NUMBER OF PHOTOGRAPHS: <u>3</u>

CHANNEL PROFILE DATA

STATION	DISTANCE FROM TAPE (ft)	ROD READING (ft)
⊗ Tape @ Stake LB	0.0	<u>sunweyed</u>
⊗ Tape @ Stake RB	0.0	<u>sunweyed</u>
① WS @ Tape LB/RB	0.0	<u>4.97/4.98</u>
② WS Upstream	<u>33.5</u>	<u>4.80</u>
③ WS Downstream	<u>44.0</u>	<u>5.40</u>
SLOPE	<u>0.6/73.5 = .008</u>	

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:																	
<u>mayfly, caddisfly</u>																	

COMMENTS

<u>Ph = 8.72</u>
<u>Temp = 21.0°C</u>
<u>Cond = 86</u>
<u>Solubility = 0.0</u>

DISCHARGE/CROSS SECTION NOTES

[illegible]

PH = 8.72
Cond = 86
Temp = 21°C
Salinity = 0.0

DISCHARGE/CROSS SECTION NOTES

[illegible]

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

LOCATION INFORMATION

STREAM NAME: Willow Creek
XS LOCATION: 800 ft upst fr conf w Beaver Creek
XS NUMBER: 4

DATE: 16-Aug-11
OBSERVERS: R. Smith, E. Spencer

1/4 SEC: NE
SECTION: 4
TWP: 9N
RANGE: 85W
PM: 6th

COUNTY: Routt
WATERSHED: Elk River
DIVISION: 6
DOW CODE: 22842

USGS MAP: 0
USFS MAP: 0

SUPPLEMENTAL DATA

*** NOTE ***

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

TAPE WT: 0.0106
TENSION: 99999

CHANNEL PROFILE DATA

SLOPE: 0.004

INPUT DATA CHECKED BY:DATE.....

ASSIGNED TO:DATE.....

STREAM NAME: Willow Creek
 XS LOCATION: 800 ft upst fr conf w Beaver Creek
 XS NUMBER: 4

DATA POINTS= 29

VALUES COMPUTED FROM RAW FIELD DATA

FEATURE	DIST	VERT DEPTH	WATER DEPTH	VEL
RS	0.00	3.60		
1 G	2.60	5.77		
W	5.70	6.80	0.00	0.00
	7.00	6.80	0.00	0.00
	9.00	7.10	0.30	0.00
	10.00	7.30	0.50	0.33
	11.00	7.40	0.60	1.46
	12.00	7.50	0.70	1.02
	13.00	7.45	0.65	0.86
	14.00	7.40	0.60	0.73
	15.00	7.35	0.55	1.04
	16.00	7.25	0.45	1.72
	17.00	7.30	0.50	1.29
	18.00	7.10	0.30	1.66
	19.50	7.15	0.40	0.72
	21.00	6.95	0.20	0.94
	22.50	7.05	0.30	0.00
	24.00	6.90	0.15	0.00
	25.50	6.95	0.20	0.99
	27.00	7.25	0.50	0.90
	28.00	7.25	0.50	1.31
	29.00	7.15	0.40	1.61
	30.00	7.15	0.40	1.14
	31.00	7.25	0.50	1.22
	32.00	7.25	0.50	1.07
	33.00	7.25	0.50	1.07
W	33.60	6.75	0.00	0.00
1 G	37.50	5.80		
LS	41.90	4.82		

WETTED PERIM.	WATER DEPTH	AREA (Am)	Q (Qm)	% Q CELL
0.00		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
2.02	0.30	0.45	0.00	0.0%
1.02	0.50	0.50	0.17	1.6%
1.00	0.60	0.60	0.88	8.5%
1.00	0.70	0.70	0.71	7.0%
1.00	0.65	0.65	0.56	5.4%
1.00	0.60	0.60	0.44	4.3%
1.00	0.55	0.55	0.57	5.6%
1.00	0.45	0.45	0.77	7.5%
1.00	0.50	0.50	0.65	6.3%
1.02	0.30	0.38	0.62	6.1%
1.50	0.40	0.60	0.43	4.2%
1.51	0.20	0.30	0.28	2.7%
1.50	0.30	0.45	0.00	0.0%
1.51	0.15	0.23	0.00	0.0%
1.50	0.20	0.30	0.30	2.9%
1.53	0.50	0.63	0.56	5.5%
1.00	0.50	0.50	0.66	6.4%
1.00	0.40	0.40	0.64	6.3%
1.00	0.40	0.40	0.46	4.4%
1.00	0.50	0.50	0.61	5.9%
1.00	0.50	0.50	0.54	5.2%
1.00	0.50	0.40	0.43	4.2%
0.78		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%

TOTALS -----

26.93 0.7 10.58 10.27 100.0%
 (Max.)

Manning's n = 0.0519
 Hydraulic Radius= 0.39270807

STREAM NAME: Willow Creek
 XS LOCATION: 800 ft upst fr conf w Beaver Creek
 XS NUMBER: 4

WATER LINE COMPARISON TABLE

WATER LINE	MEAS AREA	COMP AREA	AREA ERROR
	10.58	10.53	-0.4%
6.53	10.58	17.72	67.6%
6.55	10.58	17.13	62.0%
6.57	10.58	16.54	56.4%
6.59	10.58	15.96	50.9%
6.61	10.58	15.37	45.4%
6.63	10.58	14.79	39.9%
6.65	10.58	14.22	34.4%
6.67	10.58	13.64	29.0%
6.69	10.58	13.07	23.6%
6.71	10.58	12.50	18.2%
6.73	10.58	11.93	12.9%
6.74	10.58	11.65	10.2%
6.75	10.58	11.37	7.5%
6.76	10.58	11.09	4.9%
6.77	10.58	10.81	2.2%
6.78	10.58	10.53	-0.4%
6.79	10.58	10.25	-3.1%
6.80	10.58	9.97	-5.7%
6.81	10.58	9.70	-8.3%
6.82	10.58	9.44	-10.8%
6.83	10.58	9.17	-13.3%
6.85	10.58	8.65	-18.2%
6.87	10.58	8.13	-23.2%
6.89	10.58	7.61	-28.1%
6.91	10.58	7.09	-32.9%
6.93	10.58	6.59	-37.7%
6.95	10.58	6.11	-42.2%
6.97	10.58	5.65	-46.6%
6.99	10.58	5.20	-50.8%
7.01	10.58	4.78	-54.8%
7.03	10.58	4.37	-58.7%

WATERLINE AT ZERO

AREA ERROR = 6.773

STREAM NAME: Willow Creek
 XS LOCATION: 800 ft upst fr conf w Beaver Creek
 XS NUMBER: 4

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	5.80	34.81	1.18	1.70	41.09	35.41	100.0%	1.16	82.14	2.00
	5.82	34.64	1.16	1.68	40.28	35.24	99.5%	1.14	79.71	1.98
	5.87	34.29	1.12	1.63	38.55	34.87	98.5%	1.11	74.63	1.94
	5.92	33.93	1.09	1.58	36.85	34.50	97.4%	1.07	69.70	1.89
	5.97	33.58	1.05	1.53	35.16	34.13	96.4%	1.03	64.93	1.85
	6.02	33.22	1.01	1.48	33.49	33.76	95.3%	0.99	60.31	1.80
	6.07	32.86	0.97	1.43	31.84	33.39	94.3%	0.95	55.84	1.75
	6.12	32.51	0.93	1.38	30.20	33.02	93.2%	0.91	51.53	1.71
	6.17	32.15	0.89	1.33	28.59	32.65	92.2%	0.88	47.37	1.66
	6.22	31.80	0.85	1.28	26.99	32.28	91.2%	0.84	43.36	1.61
	6.27	31.44	0.81	1.23	25.41	31.91	90.1%	0.80	39.51	1.56
	6.32	31.09	0.77	1.18	23.84	31.54	89.1%	0.76	35.82	1.50
	6.37	30.73	0.73	1.13	22.30	31.17	88.0%	0.72	32.29	1.45
	6.42	30.37	0.68	1.08	20.77	30.80	87.0%	0.67	28.92	1.39
	6.47	30.02	0.64	1.03	19.26	30.43	85.9%	0.63	25.71	1.33
	6.52	29.66	0.60	0.98	17.77	30.06	84.9%	0.59	22.66	1.28
	6.57	29.31	0.56	0.93	16.29	29.69	83.8%	0.55	19.77	1.21
	6.62	28.95	0.51	0.88	14.84	29.32	82.8%	0.51	17.06	1.15
	6.67	28.60	0.47	0.83	13.40	28.95	81.8%	0.46	14.51	1.08
	6.72	28.24	0.42	0.78	11.98	28.58	80.7%	0.42	12.15	1.01
WL	6.77	27.95	0.38	0.73	10.57	28.28	79.8%	0.37	9.94	0.94
	6.82	26.36	0.35	0.68	9.21	26.66	75.3%	0.35	8.22	0.89
	6.87	25.96	0.30	0.63	7.91	26.24	74.1%	0.30	6.43	0.81
	6.92	24.63	0.27	0.58	6.63	24.89	70.3%	0.27	4.97	0.75
	6.97	22.30	0.24	0.53	5.46	22.52	63.6%	0.24	3.84	0.70
	7.02	20.03	0.22	0.48	4.40	20.22	57.1%	0.22	2.88	0.65
	7.07	18.35	0.19	0.43	3.45	18.50	52.3%	0.19	2.04	0.59
	7.12	16.55	0.15	0.38	2.56	16.67	47.1%	0.15	1.33	0.52
	7.17	13.27	0.14	0.33	1.82	13.36	37.7%	0.14	0.87	0.48
	7.22	11.46	0.11	0.28	1.20	11.51	32.5%	0.10	0.48	0.40
	7.27	6.56	0.11	0.23	0.75	6.59	18.6%	0.11	0.32	0.42
	7.32	5.03	0.09	0.18	0.46	5.05	14.2%	0.09	0.17	0.37
	7.37	3.80	0.06	0.13	0.24	3.81	10.7%	0.06	0.07	0.29
	7.42	2.30	0.04	0.08	0.09	2.30	6.5%	0.04	0.02	0.21
	7.47	0.80	0.01	0.03	0.01	0.80	2.3%	0.01	0.00	0.10

STREAM NAME: Willow Creek
XS LOCATION: 800 ft upst fr conf w Beaver Creek
XS NUMBER: 4

SUMMARY SHEET

MEASURED FLOW (Qm)= 10.27 cfs
CALCULATED FLOW (Qc)= 9.94 cfs
(Qm-Qc)/Qm * 100 = 3.2 %

MEASURED WATERLINE (WLm)= 6.78 ft
CALCULATED WATERLINE (WLc)= 6.77 ft
(WLm-WLc)/WLm * 100 = 0.0 %

MAX MEASURED DEPTH (Dm)= 0.70 ft
MAX CALCULATED DEPTH (Dc)= 0.73 ft
(Dm-Dc)/Dm * 100 = -3.8 %

MEAN VELOCITY= 0.94 ft/sec
MANNING'S N= 0.052
SLOPE= 0.004 ft/ft

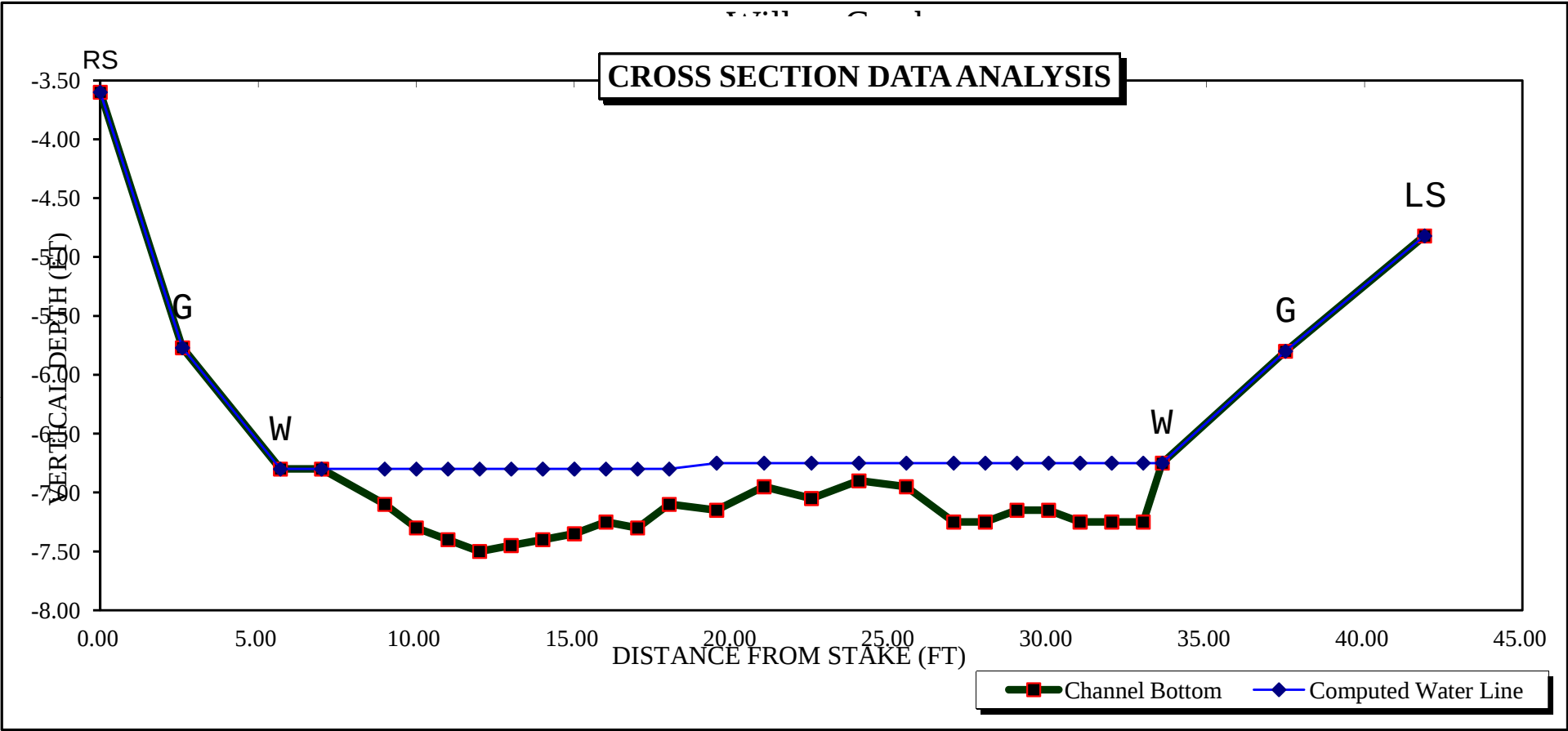
.4 * Qm = 4.1 cfs
2.5 * Qm= 25.7 cfs

RECOMMENDED INSTREAM FLOW:
=====

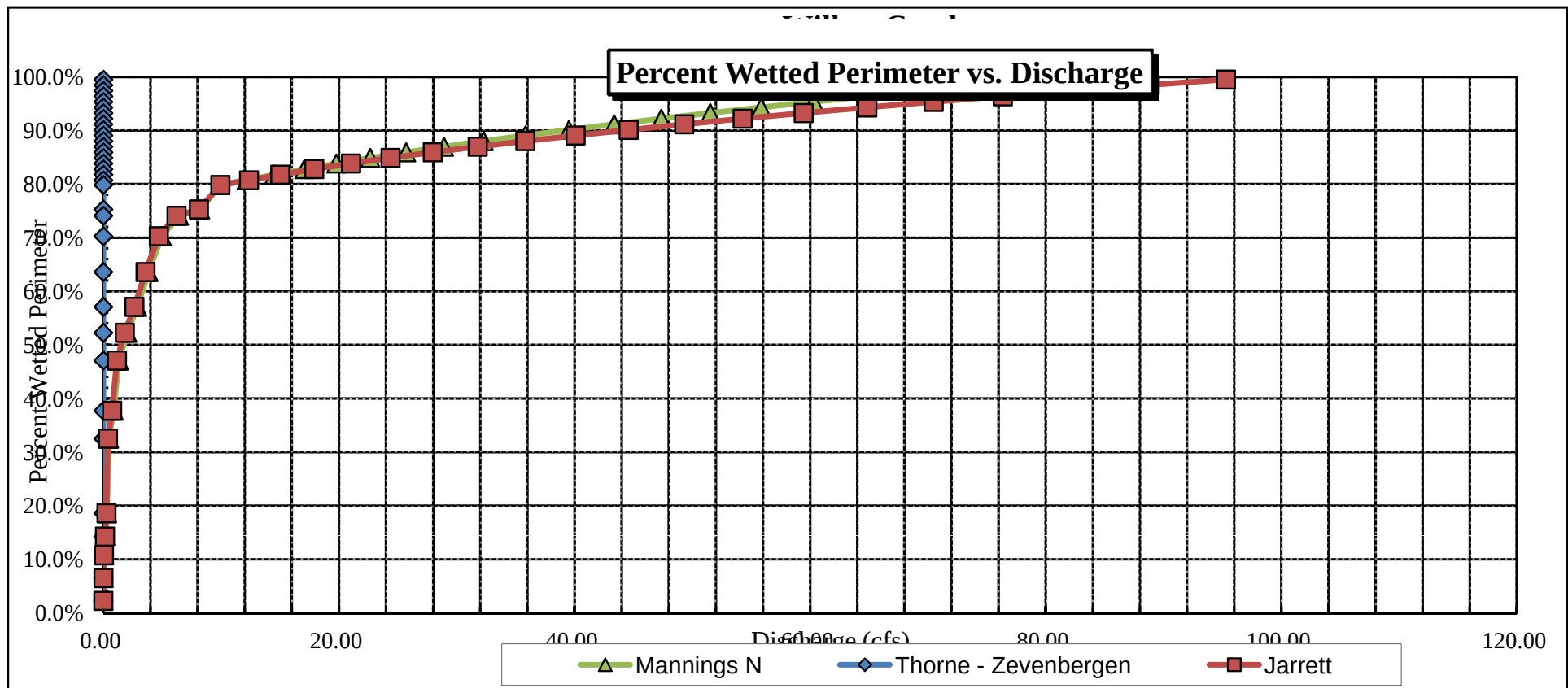
FLOW (CFS)	PERIOD
=====	=====
_____	_____
_____	_____
_____	_____
_____	_____

RATIONALE FOR RECOMMENDATION:
=====

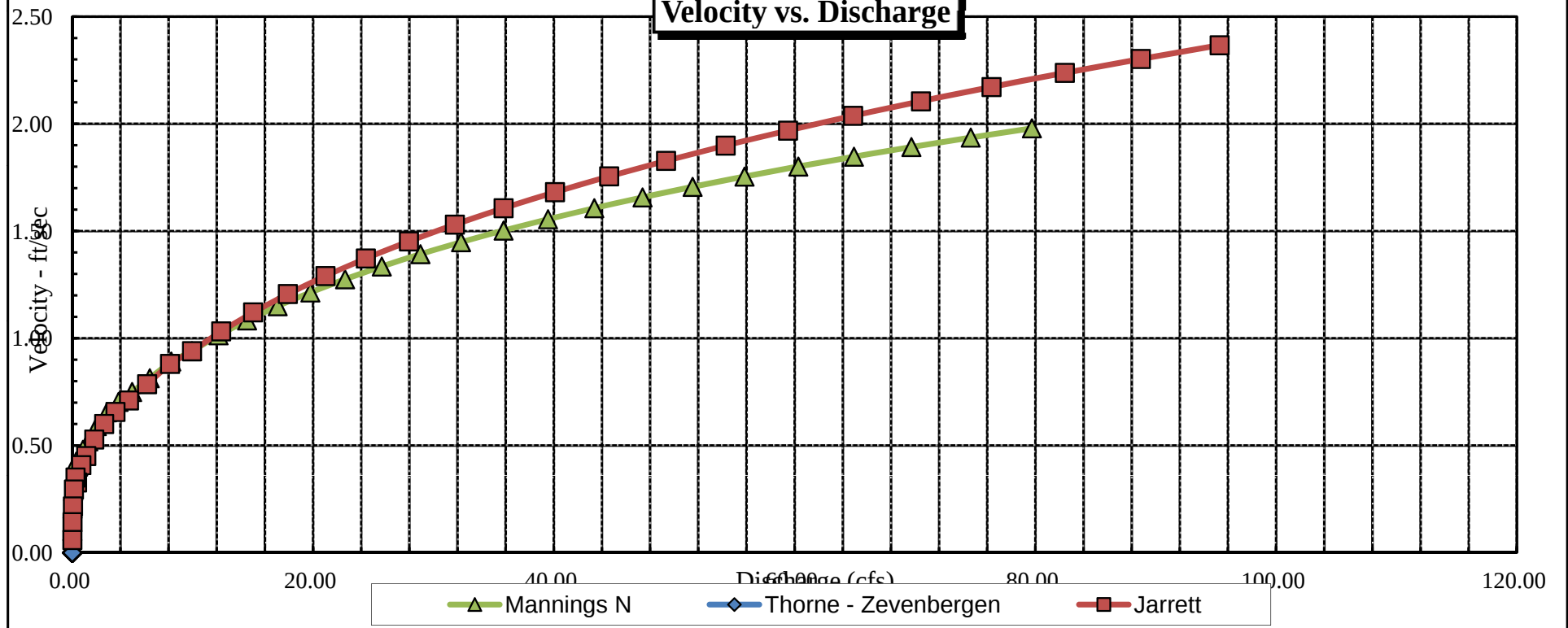
RECOMMENDATION BY: AGENCY..... DATE:.....
CWCB REVIEW BY: DATE:.....

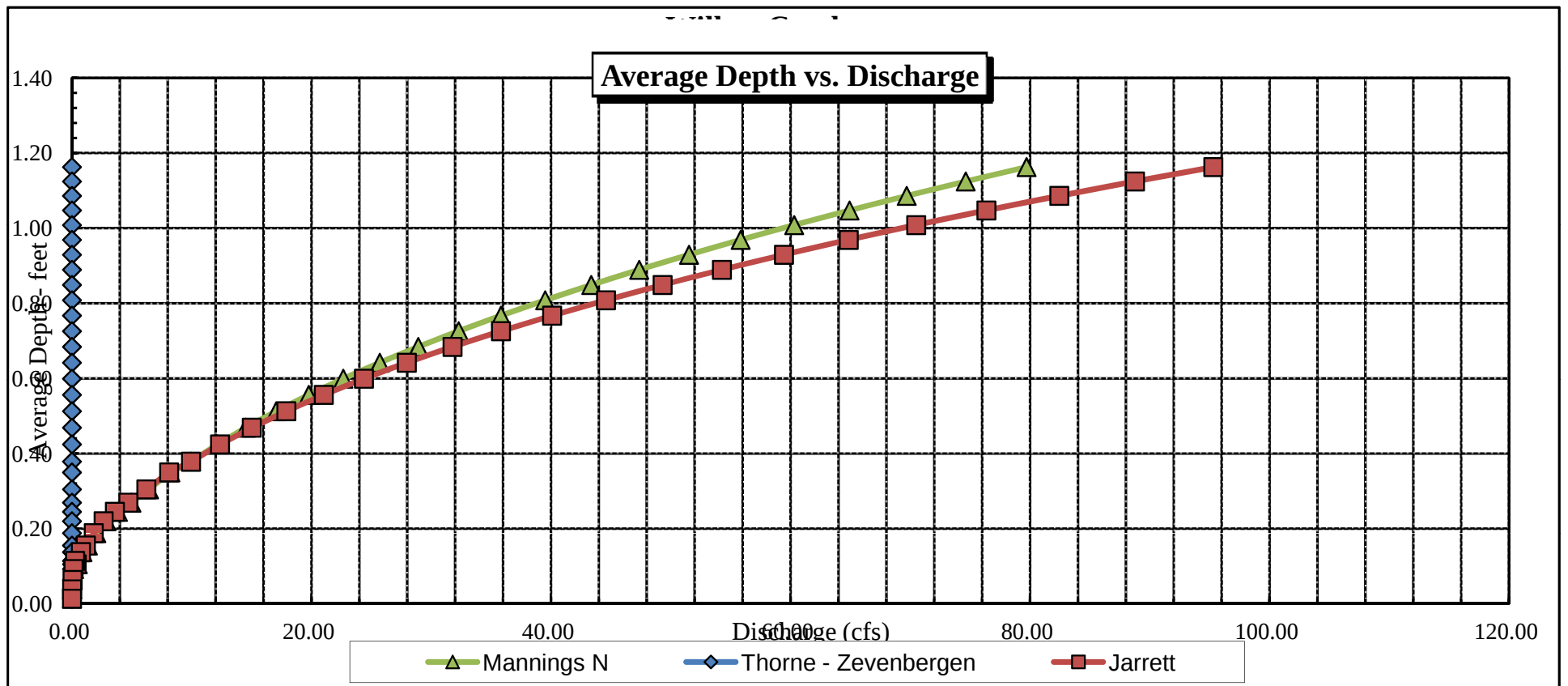


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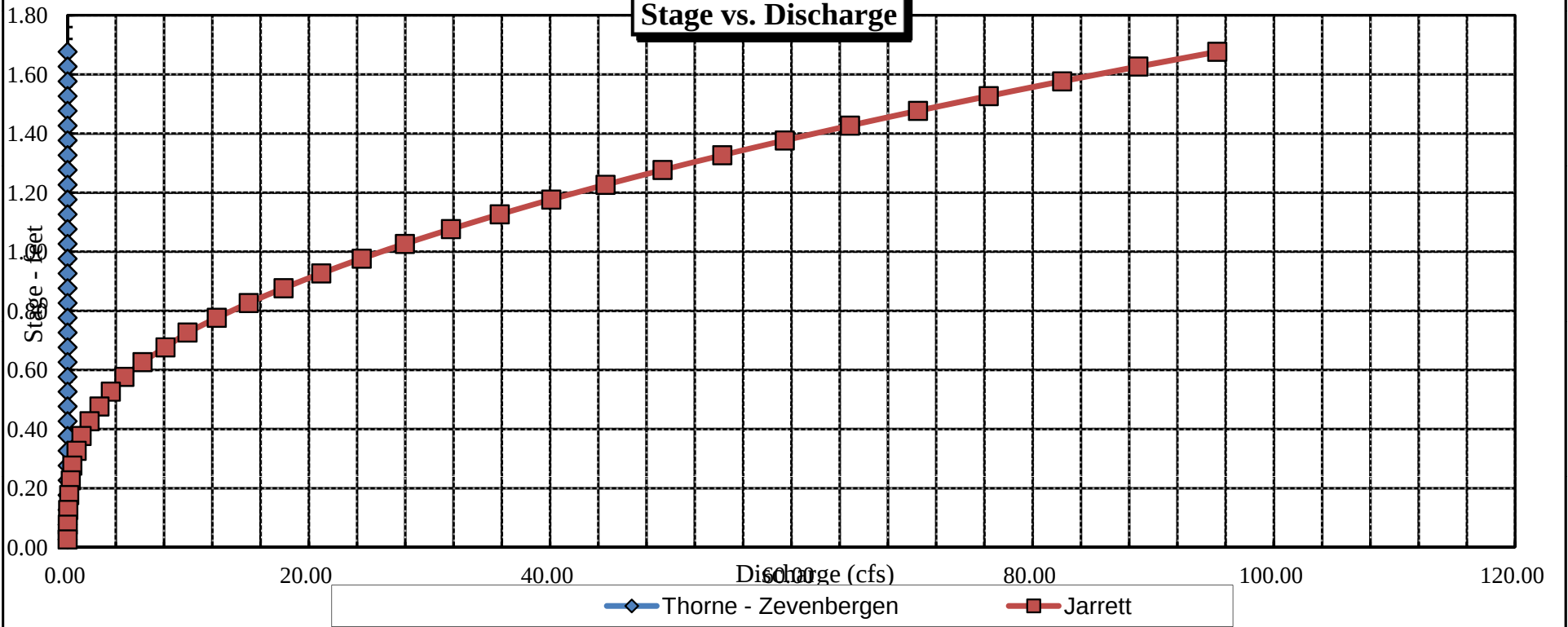


Velocity vs. Discharge





Stage vs. Discharge





FIELD DATA FOR INSTREAM FLOW DETERMINATIONS



COLORADO WATER
CONSERVATION BOARD

LOCATION INFORMATION

STREAM NAME: <u>Willow Creek</u>		CROSS-SECTION NO.: <u>1</u>
CROSS-SECTION LOCATION: <u>at mouth of canyon</u>		
DATE: <u>9-26-11</u>	OBSERVERS: <u>R Smith, J Neely</u>	
LEGAL DESCRIPTION:	1/4 SECTION: <u>SW</u>	SECTION: <u>3</u>
	TOWNSHIP: <u>9(N)S</u>	RANGE: <u>95 E/W</u>
COUNTY: <u>Route</u>	WATERSHED: <u>Elk River</u>	DOW WATER CODE: <u>22842</u>
MAP(S):	USGS: <u>GPS 339034</u>	USFS: <u>4514300</u>

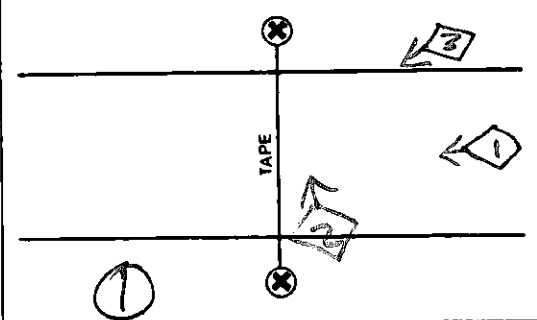
SUPPLEMENTAL DATA

SAG TAPE SECTION SAME AS DISCHARGE SECTION: ☒ YES ☐ NO	METER TYPE: <u>M-M</u>		
METER NUMBER:	DATE RATED:	CALIB/SPIN: <u>sec</u>	TAPE WEIGHT: <u>surveyed</u> lbs/foot
CHANNEL BED MATERIAL SIZE RANGE: <u>4" cobbles to 2' boulders</u>		TAPE TENSION: <u>surveyed</u> lbs	NUMBER OF PHOTOGRAPHS: <u>3</u>
PHOTOGRAPHS TAKEN: ☒ YES ☐ NO			

CHANNEL PROFILE DATA

STATION	DISTANCE FROM TAPE (ft)	ROD READING (ft)
⊗ Tape @ Stake LB	0.0	<u>surveyed</u>
⊗ Tape @ Stake RB	0.0	<u>surveyed</u>
① WS @ Tape LB/RB	0.0	<u>4.28 / 4.28</u>
② WS Upstream	<u>38.5</u>	<u>3.86</u>
③ WS Downstream	<u>27.8</u>	<u>4.80</u>
SLOPE	<u>0.94 / 66.3 =</u>	

SKETCH



LEGEND:

Stake ⊗

Station ①

Photo ◇

Direction of Flow ↻

AQUATIC SAMPLING SUMMARY

STREAM ELECTROFISHED: ☒ YES ☐ NO	DISTANCE ELECTROFISHED: <u>ft</u>	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																	
<u>mayfly, caddisfly, stonefly</u>																	

COMMENTS

<u>PH = 8.84</u>
<u>Cond = 80.9</u>
<u>Salinity = 0</u>
<u>Temp = 15.1° C</u>

DISCHARGE/CROSS SECTION NOTES

[illegible]

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

LOCATION INFORMATION

STREAM NAME: Willow Creek
XS LOCATION: At mouth of canyon
XS NUMBER: 1

DATE: 26-Sep-11
OBSERVERS: R. Smith, J. Neely

1/4 SEC: SW
SECTION: 3
TWP: 9N
RANGE: 95W
PM: Sixth

COUNTY: Routt
WATERSHED: Elk River
DIVISION: 6
DOW CODE: 22842

USGS MAP: 0
USFS MAP: 0

SUPPLEMENTAL DATA

*** NOTE ***

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

TAPE WT: 0.0106
TENSION: 99999

CHANNEL PROFILE DATA

SLOPE: 0.014

INPUT DATA CHECKED BY:DATE.....

ASSIGNED TO:DATE.....

STREAM NAME: Willow Creek
 XS LOCATION: At mouth of canyon
 XS NUMBER: 1

DATA POINTS= 33

VALUES COMPUTED FROM RAW FIELD DATA

FEATURE	DIST	VERT DEPTH	WATER DEPTH	VEL
LS	0.00	2.82		
1 G	3.00	3.40		
	5.00	3.40		
	7.00	3.72		
W	9.50	4.28	0.00	0.00
	10.00	4.40	0.10	0.00
	11.00	4.40	0.10	0.10
	12.00	4.40	0.10	0.72
	13.00	4.40	0.10	0.44
	14.00	4.40	0.10	0.88
	15.00	4.40	0.10	0.11
	16.00	4.35	0.05	0.00
	17.00	4.50	0.20	0.65
	18.00	4.80	0.50	2.17
	19.00	4.70	0.40	1.83
	20.00	5.00	0.70	2.13
	21.00	5.05	0.75	1.58
	22.00	5.00	0.70	1.28
	23.00	4.90	0.60	1.35
	24.00	4.80	0.50	1.44
	25.00	4.80	0.50	1.57
	26.00	4.90	0.60	1.78
	27.00	4.60	0.30	1.92
	28.00	4.50	0.20	1.60
	30.00	4.55	0.25	0.78
	32.00	4.95	0.65	1.53
	34.00	4.90	0.60	0.96
	36.00	4.50	0.20	0.16
	38.00	4.45	0.15	0.00
W	40.50	4.28	0.00	0.00
1 G	42.00	3.26		
	43.70	2.62		
RS	49.50	2.30		

WETTED PERIM.	WATER DEPTH	AREA (Am)	Q (Qm)	% Q CELL
0.00		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
0.51	0.10	0.08	0.00	0.0%
1.00	0.10	0.10	0.01	0.1%
1.00	0.10	0.10	0.07	0.5%
1.00	0.10	0.10	0.04	0.3%
1.00	0.10	0.10	0.09	0.6%
1.00	0.10	0.10	0.01	0.1%
1.00	0.05	0.05	0.00	0.0%
1.01	0.20	0.20	0.13	0.9%
1.04	0.50	0.50	1.09	7.9%
1.00	0.40	0.40	0.73	5.3%
1.04	0.70	0.70	1.49	10.8%
1.00	0.75	0.75	1.19	8.6%
1.00	0.70	0.70	0.90	6.5%
1.00	0.60	0.60	0.81	5.9%
1.00	0.50	0.50	0.72	5.2%
1.00	0.50	0.50	0.79	5.7%
1.00	0.60	0.60	1.07	7.8%
1.04	0.30	0.30	0.58	4.2%
1.00	0.20	0.30	0.48	3.5%
2.00	0.25	0.50	0.39	2.8%
2.04	0.65	1.30	1.99	14.4%
2.00	0.60	1.20	1.15	8.4%
2.04	0.20	0.40	0.06	0.5%
2.00	0.15	0.34	0.00	0.0%
2.51		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%

TOTALS -----

31.27 0.75 10.41 13.78 100.0%
 (Max.)

Manning's n = 0.0638
 Hydraulic Radius= 0.33295466

STREAM NAME: Willow Creek
 XS LOCATION: At mouth of canyon
 XS NUMBER: 1

WATER LINE COMPARISON TABLE

WATER LINE	MEAS AREA	COMP AREA	AREA ERROR
	10.41	11.00	5.7%
4.03	10.41	18.94	81.9%
4.05	10.41	18.29	75.7%
4.07	10.41	17.64	69.4%
4.09	10.41	17.00	63.3%
4.11	10.41	16.36	57.1%
4.13	10.41	15.72	51.0%
4.15	10.41	15.08	44.9%
4.17	10.41	14.45	38.8%
4.19	10.41	13.82	32.7%
4.21	10.41	13.19	26.6%
4.23	10.41	12.56	20.6%
4.24	10.41	12.25	17.6%
4.25	10.41	11.94	14.6%
4.26	10.41	11.62	11.6%
4.27	10.41	11.31	8.6%
4.28	10.41	11.00	5.7%
4.29	10.41	10.69	2.7%
4.30	10.41	10.39	-0.2%
4.31	10.41	10.08	-3.2%
4.32	10.41	9.78	-6.1%
4.33	10.41	9.48	-9.0%
4.35	10.41	8.88	-14.7%
4.37	10.41	8.29	-20.3%
4.39	10.41	7.73	-25.8%
4.41	10.41	7.23	-30.6%
4.43	10.41	6.79	-34.8%
4.45	10.41	6.36	-38.9%
4.47	10.41	5.94	-42.9%
4.49	10.41	5.54	-46.8%
4.51	10.41	5.16	-50.4%
4.53	10.41	4.81	-53.8%

WATERLINE AT ZERO
 AREA ERROR = 4.299

STREAM NAME: Willow Creek
 XS LOCATION: At mouth of canyon
 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	3.40	36.79	1.11	1.65	40.67	37.43	100.0%	1.09	118.43	2.91
	3.45	36.41	1.07	1.60	38.87	37.03	98.9%	1.05	110.61	2.85
	3.50	36.03	1.03	1.55	37.06	36.62	97.9%	1.01	102.91	2.78
	3.55	35.64	0.99	1.50	35.27	36.22	96.8%	0.97	95.46	2.71
	3.60	35.26	0.95	1.45	33.50	35.81	95.7%	0.94	88.25	2.63
	3.65	34.87	0.91	1.40	31.74	35.41	94.6%	0.90	81.31	2.56
	3.70	34.48	0.87	1.35	30.01	35.00	93.5%	0.86	74.61	2.49
	3.75	34.15	0.83	1.30	28.30	34.65	92.6%	0.82	68.10	2.41
	3.80	33.85	0.79	1.25	26.60	34.33	91.7%	0.77	61.80	2.32
	3.85	33.56	0.74	1.20	24.91	34.01	90.9%	0.73	55.75	2.24
	3.90	33.26	0.70	1.15	23.24	33.69	90.0%	0.69	49.97	2.15
	3.95	32.96	0.65	1.10	21.58	33.37	89.2%	0.65	44.46	2.06
	4.00	32.67	0.61	1.05	19.94	33.06	88.3%	0.60	39.22	1.97
	4.05	32.37	0.57	1.00	18.32	32.74	87.5%	0.56	34.26	1.87
	4.10	32.07	0.52	0.95	16.71	32.42	86.6%	0.52	29.58	1.77
	4.15	31.78	0.48	0.90	15.11	32.10	85.8%	0.47	25.18	1.67
	4.20	31.48	0.43	0.85	13.53	31.79	84.9%	0.43	21.08	1.56
	4.25	31.18	0.38	0.80	11.96	31.47	84.1%	0.38	17.29	1.45
WL	4.30	30.64	0.34	0.75	10.41	30.91	82.6%	0.34	13.89	1.33
	4.35	29.72	0.30	0.70	8.90	29.98	80.1%	0.30	10.92	1.23
	4.40	22.42	0.33	0.65	7.48	22.67	60.6%	0.33	9.83	1.31
	4.45	21.37	0.30	0.60	6.38	21.62	57.8%	0.29	7.78	1.22
	4.50	19.05	0.28	0.55	5.37	19.29	51.5%	0.28	6.30	1.17
	4.55	16.10	0.28	0.50	4.49	16.33	43.6%	0.27	5.22	1.16
	4.60	14.93	0.25	0.45	3.71	15.14	40.4%	0.25	4.00	1.08
	4.65	14.10	0.21	0.40	2.98	14.28	38.2%	0.21	2.90	0.97
	4.70	13.28	0.17	0.35	2.30	13.43	35.9%	0.17	1.95	0.85
	4.75	11.78	0.14	0.30	1.67	11.90	31.8%	0.14	1.25	0.75
	4.80	9.28	0.12	0.25	1.12	9.37	25.0%	0.12	0.75	0.67
	4.85	7.45	0.09	0.20	0.70	7.51	20.1%	0.09	0.40	0.57
	4.90	5.63	0.07	0.15	0.38	5.66	15.1%	0.07	0.17	0.45
	4.95	2.68	0.06	0.10	0.17	2.69	7.2%	0.06	0.07	0.44
	5.00	2.03	0.03	0.05	0.05	2.04	5.4%	0.03	0.01	0.24
	5.05	0.00	#DIV/0!	0.00	0.00	0.00	0.0%	#DIV/0!	#DIV/0!	#DIV/0!

STREAM NAME: Willow Creek
XS LOCATION: At mouth of canyon
XS NUMBER: 1

SUMMARY SHEET

MEASURED FLOW (Qm)=	13.78 cfs
CALCULATED FLOW (Qc)=	13.89 cfs
(Qm-Qc)/Qm * 100 =	-0.8 %
MEASURED WATERLINE (WLm)=	4.28 ft
CALCULATED WATERLINE (WLc)=	4.30 ft
(WLm-WLc)/WLm * 100 =	-0.4 %
MAX MEASURED DEPTH (Dm)=	0.75 ft
MAX CALCULATED DEPTH (Dc)=	0.75 ft
(Dm-Dc)/Dm * 100	-0.1 %
MEAN VELOCITY=	1.33 ft/sec
MANNING'S N=	0.064
SLOPE=	0.014 ft/ft
.4 * Qm =	5.5 cfs
2.5 * Qm=	34.4 cfs

RECOMMENDED INSTREAM FLOW:
=====

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

RATIONALE FOR RECOMMENDATION:
=====

[illegible]

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

CWCB REVIEW BY: DATE:.....

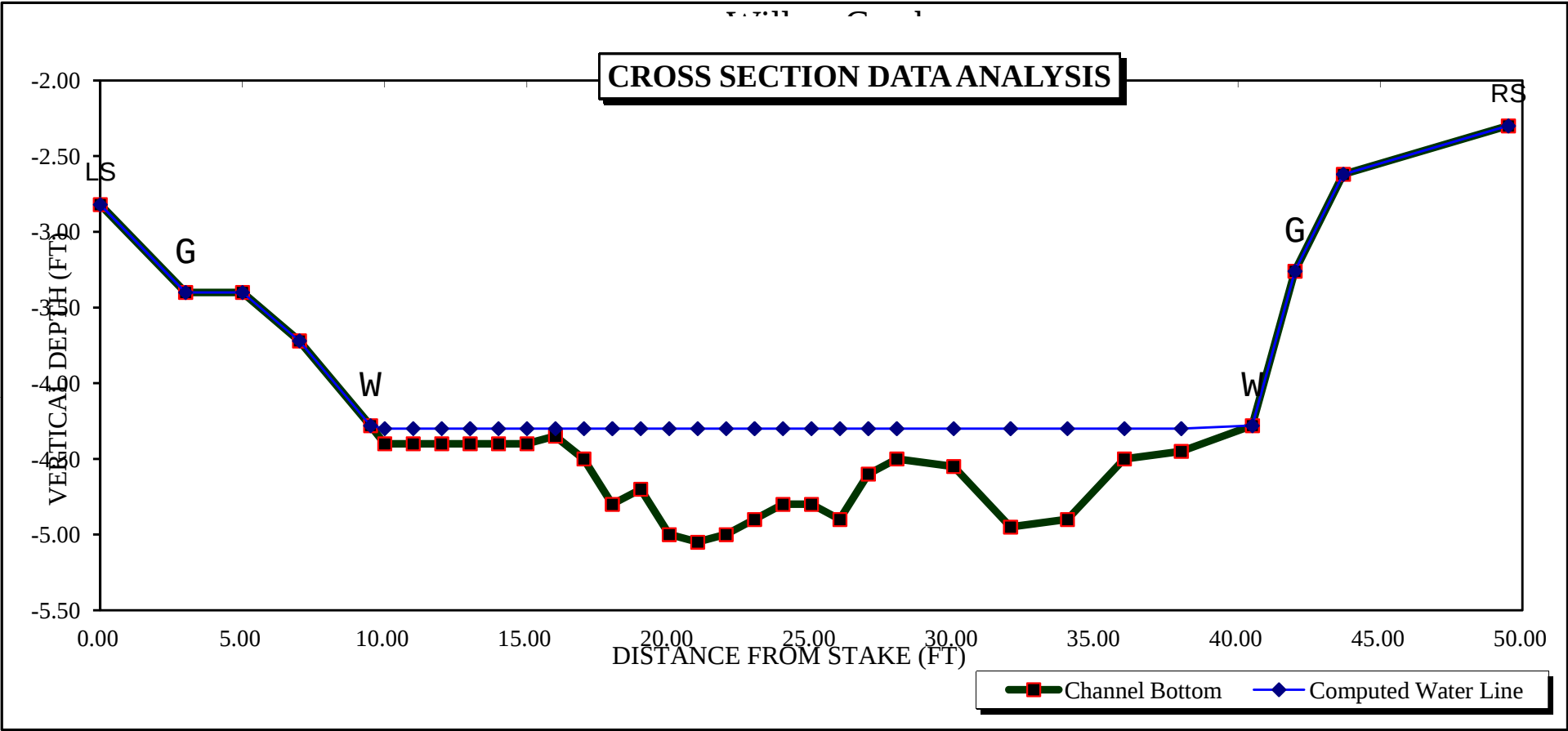
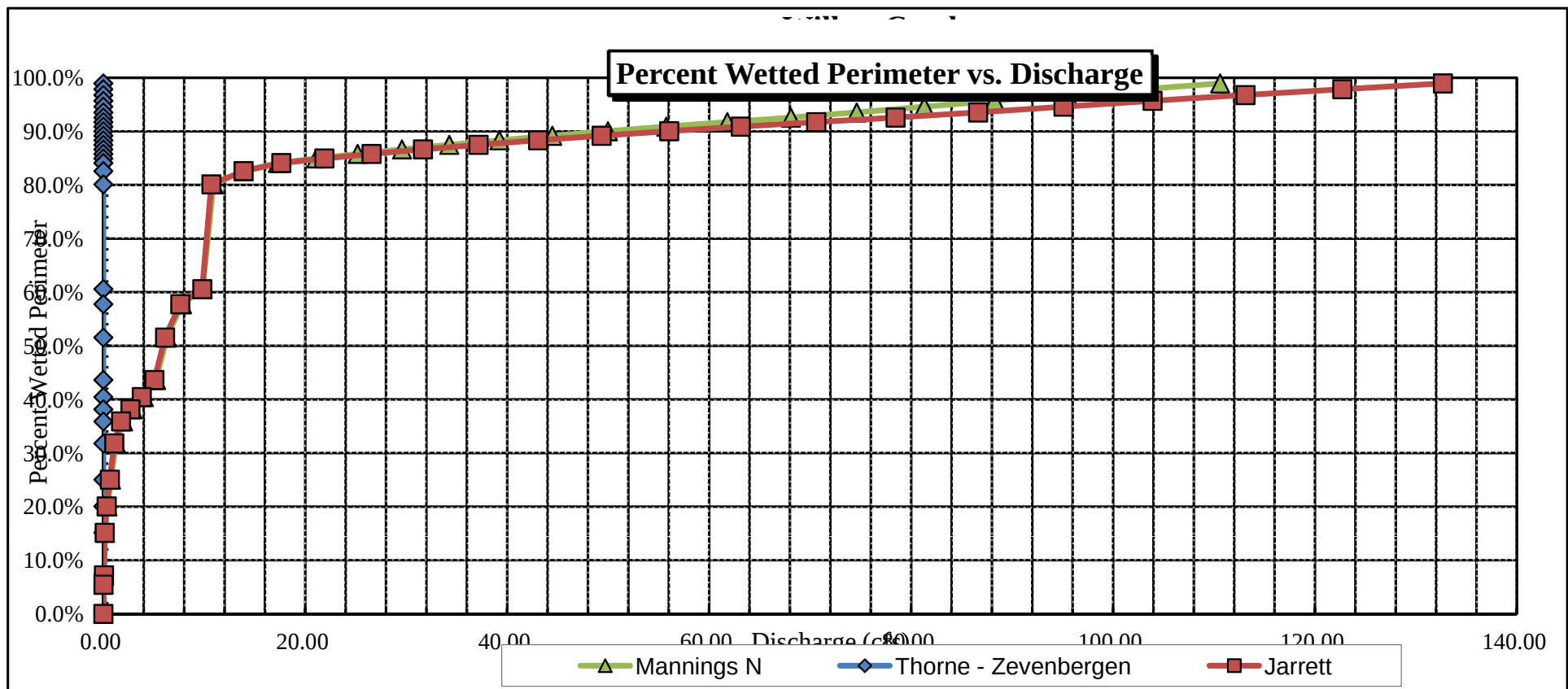
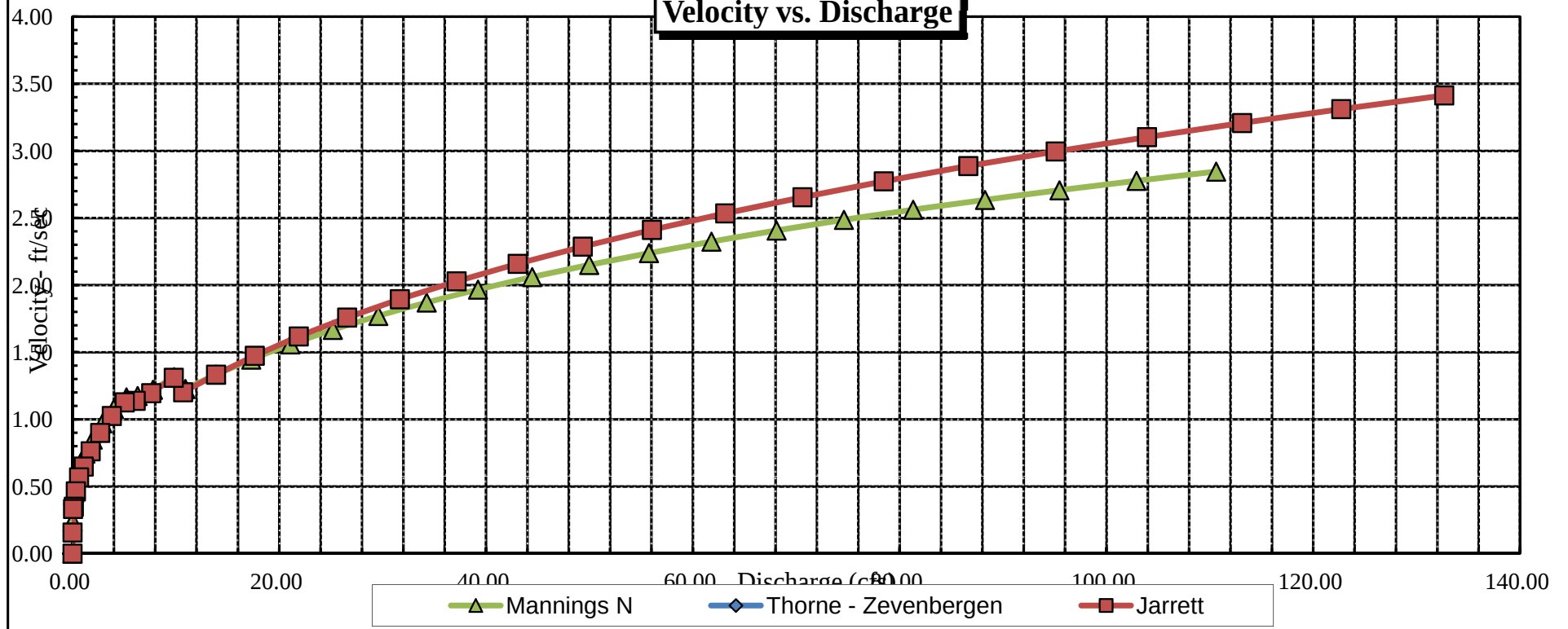
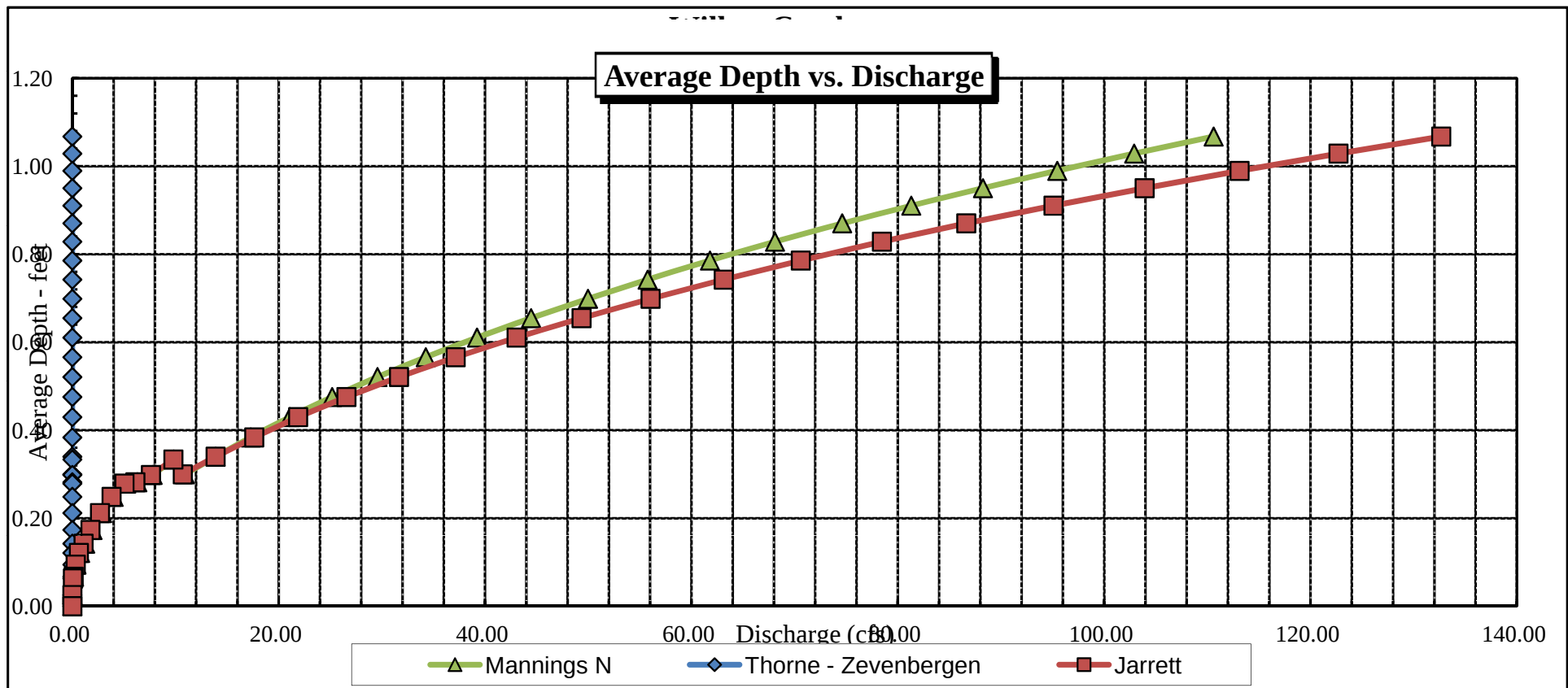


Figure 6.1

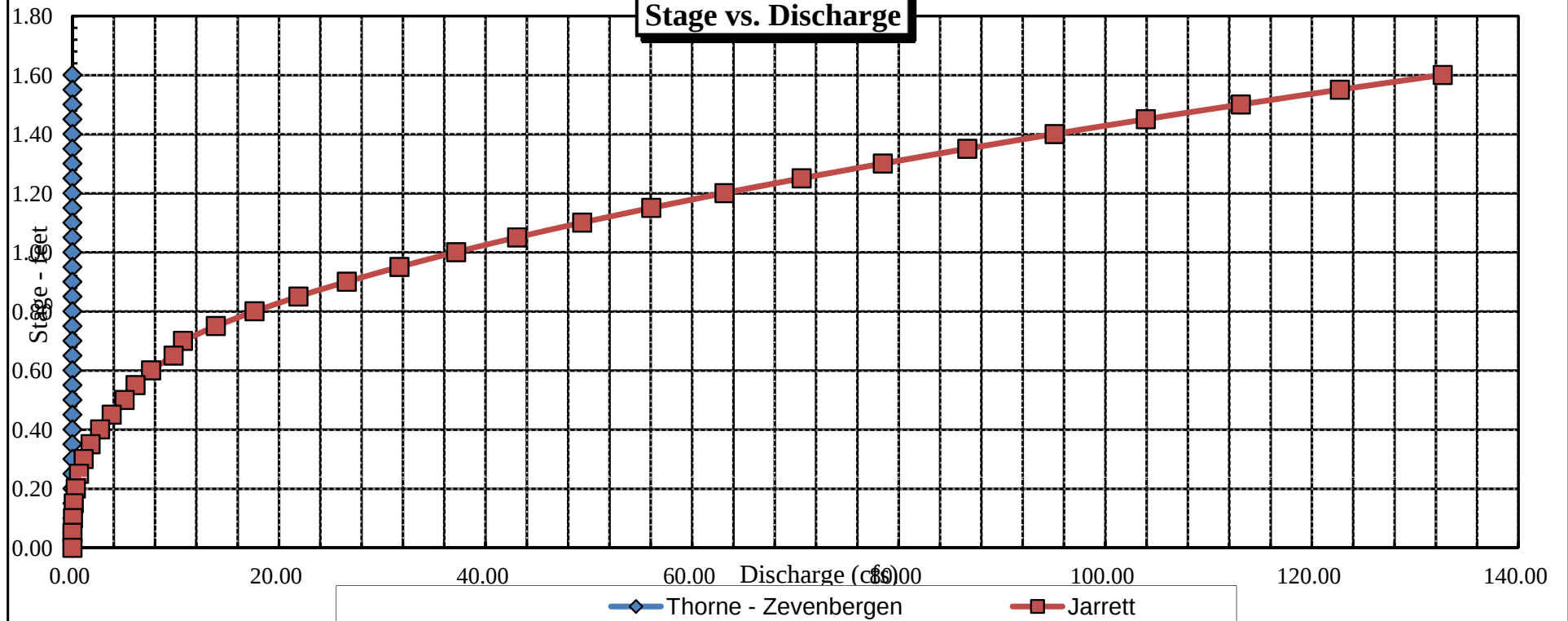


Velocity vs. Discharge





Stage vs. Discharge





FIELD DATA FOR INSTREAM FLOW DETERMINATIONS



COLORADO WATER
CONSERVATION BOARD

LOCATION INFORMATION

STREAM NAME: <u>Willow Creek</u>		CROSS-SECTION NO.: <u>2</u>
CROSS-SECTION LOCATION: <u>800 ft. downstream from confluence with Beaver Creek</u>		
DATE: <u>9-26-11</u>	OBSERVERS: <u>R. Smith, J. Neely</u>	
LEGAL DESCRIPTION	1/4 SECTION: <u>SW</u>	SECTION: <u>3</u>
	TOWNSHIP: <u>9N</u>	RANGE: <u>85 E/W</u>
COUNTY: <u>Routt</u>	WATERSHED: <u>Elk River</u>	WATER DIVISION: <u>6</u>
		DOW WATER CODE: <u>22842</u>
MAP(S):	USGS: <u>CPS = 338444</u>	USFS: <u>4514648</u>

SUPPLEMENTAL DATA

SAG TAPE SECTION SAME AS DISCHARGE SECTION: <u>YES</u>	METER TYPE: <u>M-M</u>
METER NUMBER:	DATE RATED:
CALIB/SPIN: <u>_____</u> sec	TAPE WEIGHT: <u>surveyed</u> lbs/100'
CHANNEL BED MATERIAL SIZE RANGE: <u>gravel to 8" cobbles</u>	TAPE TENSION: <u>surveyed</u> lbs
PHOTOGRAPHS TAKEN: <u>YES</u>	NUMBER OF PHOTOGRAPHS: <u>3</u>

CHANNEL PROFILE DATA

STATION	DISTANCE FROM TAPE (ft)	ROD READING (ft)
⊗ Tape @ Stake LB	0.0	<u>surveyed</u>
⊗ Tape @ Stake RB	0.0	<u>surveyed</u>
① WS @ Tape LB/RB	0.0	<u>4.97/5.01</u>
② WS Upstream	<u>18.0</u>	<u>4.84</u>
③ WS Downstream	<u>35.5</u>	<u>5.05</u>
SLOPE	<u>0.21/53.5</u>	

SKETCH

LEGEND:

Stake ⊗

Station ①

Photo ◇

Direction of Flow →

AQUATIC SAMPLING SUMMARY

STREAM ELECTROFISHED: YES <u>NO</u>	DISTANCE ELECTROFISHED: <u>_____</u> ft	FISH CAUGHT: YES/NO	WATER CHEMISTRY SAMPLED: YES <u>NO</u>														
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:																	
<u>mayfly, caddisfly, stonefly</u>																	

COMMENTS

<u>Ph = 8.84</u>
<u>Cond = 80.9</u>
<u>Salinity = 0</u>
<u>Temp = 15.1°C</u>

DISCHARGE/CROSS SECTION NOTES

STREAM NAME: Willow Creek				CROSS-SECTION NO: 2		DATE: 9-26-11		SHEET ___ OF ___				
BEGINNING OF MEASUREMENT		EDGE OF WATER LOOKING DOWNSTREAM: (0.0 AT STAKE)		LEFT / RIGHT		Gage Reading: ___ ft		TIME: 3.15 pm				
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)		Area (ft ²)	Discharge (cfs)
									At Point	Mean in Vertical		
RS		0.0	3.0	2.98	3.08							
G		4.0		3.21								
		7.0		4.66								
W		12.6		5.01								
		13		5.1	.1					1.03		
		14		5.1	.1					1.26		
		15		5.25	.25					1.73		
		16		5.4	.40					1.11		
		17		5.25	.25					1.97		
		18		5.2	.20					2.04		
		19		5.3	.30					2.17		
		20		5.3	.30					2.11		
		21		5.4	.40					1.40		
		22		5.55	.55					1.89		
		23		5.5	.50					1.88		
		24		5.4	.40					1.93		
		25		5.3	.30					1.77		
		26		5.25	.25					1.61		
		27		5.35	.35					1.46		
		28		5.50	.50					1.64		
		29		5.55	.55					1.35		
		30		5.60	.60					1.57		
		31		5.50	.50					1.35		
		32		5.40	.40					1.16		
		33		5.45	.45					0.91		
		34		5.45	.40					0.42		
		35		5.10	.10					0.56		
		36		5.0	0					0.28		
		37		5.10	.10					0		
		38		5.10	.10					0.35		
		39		5.0	0					0.32		
		40		5.30	.30							
		41		5.20	.20							
W		41.5		4.97								
G		42.9		3.17								
LS		44.5		3.10								
TOTALS:												
End of Measurement		Time		Gage Reading		CALCULATIONS PERFORMED BY		CALCULATIONS CHECKED BY				

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

LOCATION INFORMATION

STREAM NAME: Willow Creek
XS LOCATION: 800 ft. downst fr conf w/ Beaver Creek
XS NUMBER: 2

DATE: 26-Sep-11
OBSERVERS: R. Smith, J. Neely

1/4 SEC: SW
SECTION: 3
TWP: 9N
RANGE: 85W
PM: Sixth

COUNTY: Routt
WATERSHED: Elk River
DIVISION: 6
DOW CODE: 22842

USGS MAP: 0
USFS MAP: 0

SUPPLEMENTAL DATA

*** NOTE ***

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

TAPE WT: 0.0106
TENSION: 99999

CHANNEL PROFILE DATA

SLOPE: 0.004

INPUT DATA CHECKED BY:DATE.....

ASSIGNED TO:DATE.....

STREAM NAME: Willow Creek
 XS LOCATION: 800 ft. downst fr conf w/ Beaver Creek
 XS NUMBER: 2

DATA POINTS= 37

VALUES COMPUTED FROM RAW FIELD DATA

FEATURE	DIST	VERT DEPTH	WATER DEPTH	VEL	WETTED	WATER	AREA	Q	% Q
					PERIM.	DEPTH	(Am)	(Qm)	CELL
RS	0.00	2.98			0.00		0.00	0.00	0.0%
1 G	3.00	3.08			0.00		0.00	0.00	0.0%
	4.00	3.21			0.00		0.00	0.00	0.0%
	7.00	4.66			0.00		0.00	0.00	0.0%
W	12.60	5.01	0.00	0.00	0.00		0.00	0.00	0.0%
	13.00	5.10	0.10	1.03	0.41	0.10	0.07	0.07	0.6%
	14.00	5.10	0.10	0.00	1.00	0.10	0.10	0.00	0.0%
	15.00	5.25	0.25	1.26	1.01	0.25	0.25	0.32	2.5%
	16.00	5.40	0.40	1.73	1.01	0.40	0.40	0.69	5.5%
	17.00	5.25	0.25	1.11	1.01	0.25	0.25	0.28	2.2%
	18.00	5.20	0.20	1.97	1.00	0.20	0.20	0.39	3.1%
	19.00	5.30	0.30	2.04	1.00	0.30	0.30	0.61	4.8%
	20.00	5.30	0.30	2.17	1.00	0.30	0.30	0.65	5.1%
	21.00	5.40	0.40	2.11	1.00	0.40	0.40	0.84	6.6%
	22.00	5.55	0.55	1.40	1.01	0.55	0.55	0.77	6.1%
	23.00	5.50	0.50	1.89	1.00	0.50	0.50	0.95	7.4%
	24.00	5.40	0.40	1.88	1.00	0.40	0.40	0.75	5.9%
	25.00	5.30	0.30	1.93	1.00	0.30	0.30	0.58	4.6%
	26.00	5.25	0.25	1.77	1.00	0.25	0.25	0.44	3.5%
	27.00	5.35	0.35	1.61	1.00	0.35	0.35	0.56	4.4%
	28.00	5.50	0.50	1.46	1.01	0.50	0.50	0.73	5.8%
	29.00	5.55	0.55	1.64	1.00	0.55	0.55	0.90	7.1%
	30.00	5.60	0.60	1.35	1.00	0.60	0.60	0.81	6.4%
	31.00	5.50	0.50	1.57	1.00	0.50	0.50	0.79	6.2%
	32.00	5.40	0.40	1.35	1.00	0.40	0.40	0.54	4.3%
	33.00	5.45	0.45	1.16	1.00	0.45	0.45	0.52	4.1%
	34.00	5.45	0.40	0.54	1.00	0.40	0.40	0.22	1.7%
	35.00	5.10	0.10	0.42	1.06	0.10	0.10	0.04	0.3%
	36.00	5.00	0.00	0.00	1.00		0.00	0.00	0.0%
	37.00	5.10	0.10	0.56	1.00	0.10	0.10	0.06	0.4%
	38.00	5.10	0.10	0.28	1.00	0.10	0.10	0.03	0.2%
	39.00	5.00	0.00	0.00	1.00		0.00	0.00	0.0%
	40.00	5.30	0.30	0.35	1.04	0.30	0.30	0.11	0.8%
	41.00	5.20	0.20	0.32	1.00	0.20	0.15	0.05	0.4%
W	41.50	4.97	0.00	0.00	0.55		0.00	0.00	0.0%
1 G	42.90	3.17			0.00		0.00	0.00	0.0%
LS	44.50	3.10			0.00		0.00	0.00	0.0%
TOTALS -----					29.18	0.6	8.77	12.69	100.0%
					(Max.)				
					Manning's n =		0.0291		
					Hydraulic Radius=		0.30052596		

STREAM NAME: Willow Creek
 XS LOCATION: 800 ft. downst fr conf w/ Beaver Creek
 XS NUMBER: 2

WATER LINE COMPARISON TABLE

WATER LINE	MEAS AREA	COMP AREA	AREA ERROR
	8.77	8.67	-1.1%
4.76	8.77	16.43	87.4%
4.78	8.77	15.77	79.9%
4.80	8.77	15.12	72.4%
4.82	8.77	14.47	65.0%
4.84	8.77	13.84	57.8%
4.86	8.77	13.20	50.5%
4.88	8.77	12.58	43.4%
4.90	8.77	11.96	36.3%
4.92	8.77	11.34	29.4%
4.94	8.77	10.74	22.4%
4.96	8.77	10.14	15.6%
4.97	8.77	9.84	12.2%
4.98	8.77	9.55	8.9%
4.99	8.77	9.25	5.5%
5.00	8.77	8.96	2.2%
5.01	8.77	8.67	-1.1%
5.02	8.77	8.39	-4.4%
5.03	8.77	8.11	-7.6%
5.04	8.77	7.83	-10.7%
5.05	8.77	7.56	-13.8%
5.06	8.77	7.29	-16.9%
5.08	8.77	6.76	-22.9%
5.10	8.77	6.25	-28.7%
5.12	8.77	5.79	-34.0%
5.14	8.77	5.34	-39.2%
5.16	8.77	4.89	-44.2%
5.18	8.77	4.45	-49.2%
5.20	8.77	4.02	-54.1%
5.22	8.77	3.60	-59.0%
5.24	8.77	3.20	-63.5%
5.26	8.77	2.82	-67.9%

WATERLINE AT ZERO

AREA ERROR = 5.002

STREAM NAME: Willow Creek
 XS LOCATION: 800 ft. downst fr conf w/ Beaver Creek
 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	3.17	39.21	1.90	2.43	74.59	40.72	100.0%	1.83	360.27	4.83
	4.00	36.62	1.18	1.60	43.15	37.53	92.2%	1.15	152.76	3.54
	4.05	36.47	1.13	1.55	41.32	37.35	91.7%	1.11	142.58	3.45
	4.10	36.33	1.09	1.50	39.50	37.18	91.3%	1.06	132.69	3.36
	4.15	36.19	1.04	1.45	37.69	37.00	90.9%	1.02	123.09	3.27
	4.20	36.05	1.00	1.40	35.88	36.82	90.4%	0.97	113.78	3.17
	4.25	35.90	0.95	1.35	34.08	36.64	90.0%	0.93	104.78	3.07
	4.30	35.76	0.90	1.30	32.29	36.46	89.6%	0.89	96.07	2.98
	4.35	35.62	0.86	1.25	30.51	36.29	89.1%	0.84	87.67	2.87
	4.40	35.48	0.81	1.20	28.73	36.11	88.7%	0.80	79.59	2.77
	4.45	35.33	0.76	1.15	26.96	35.93	88.2%	0.75	71.82	2.66
	4.50	35.19	0.72	1.10	25.20	35.75	87.8%	0.70	64.37	2.55
	4.55	35.05	0.67	1.05	23.44	35.57	87.4%	0.66	57.26	2.44
	4.60	34.91	0.62	1.00	21.69	35.39	86.9%	0.61	50.49	2.33
	4.65	34.76	0.57	0.95	19.95	35.22	86.5%	0.57	44.06	2.21
	4.70	34.04	0.54	0.90	18.23	34.47	84.6%	0.53	38.45	2.11
	4.75	33.20	0.50	0.85	16.55	33.60	82.5%	0.49	33.28	2.01
	4.80	32.37	0.46	0.80	14.91	32.74	80.4%	0.46	28.46	1.91
	4.85	31.53	0.42	0.75	13.31	31.87	78.3%	0.42	23.99	1.80
	4.90	30.69	0.38	0.70	11.75	31.01	76.2%	0.38	19.86	1.69
	4.95	29.85	0.34	0.65	10.24	30.14	74.0%	0.34	16.08	1.57
WL	5.00	28.91	0.30	0.60	8.77	29.19	71.7%	0.30	12.69	1.45
	5.05	26.82	0.28	0.55	7.38	27.06	66.5%	0.27	10.01	1.36
	5.10	22.86	0.27	0.50	6.09	23.07	56.7%	0.26	8.09	1.33
	5.15	22.11	0.22	0.45	4.97	22.29	54.7%	0.22	5.89	1.19
	5.20	21.30	0.18	0.40	3.88	21.45	52.7%	0.18	4.00	1.03
	5.25	18.63	0.15	0.35	2.88	18.75	46.1%	0.15	2.67	0.93
	5.30	14.19	0.14	0.30	2.04	14.28	35.1%	0.14	1.80	0.88
	5.35	11.88	0.12	0.25	1.39	11.95	29.4%	0.12	1.06	0.77
	5.40	9.72	0.09	0.20	0.85	9.77	24.0%	0.09	0.53	0.63
	5.45	5.95	0.07	0.15	0.43	5.97	14.7%	0.07	0.24	0.56
	5.50	4.24	0.04	0.10	0.18	4.25	10.4%	0.04	0.07	0.39
	5.55	1.45	0.02	0.05	0.04	1.46	3.6%	0.02	0.01	0.27

STREAM NAME: Willow Creek
XS LOCATION: 800 ft. downst fr conf w/ Beaver Creek
XS NUMBER: 2

SUMMARY SHEET

MEASURED FLOW (Qm)= 12.69 cfs
CALCULATED FLOW (Qc)= 12.69 cfs
(Qm-Qc)/Qm * 100 = 0.0 %

MEASURED WATERLINE (WLm)= 5.01 ft
CALCULATED WATERLINE (WLc)= 5.00 ft
(WLm-WLc)/WLm * 100 = 0.1 %

MAX MEASURED DEPTH (Dm)= 0.60 ft
MAX CALCULATED DEPTH (Dc)= 0.60 ft
(Dm-Dc)/Dm * 100 = 0.3 %

MEAN VELOCITY= 1.45 ft/sec
MANNING'S N= 0.029
SLOPE= 0.004 ft/ft

.4 * Qm = 5.1 cfs
2.5 * Qm= 31.7 cfs

RECOMMENDED INSTREAM FLOW:
=====

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

RATIONALE FOR RECOMMENDATION:
=====

RECOMMENDATION BY: AGENCY..... DATE:.....
CWCB REVIEW BY: DATE:.....

CROSS SECTION DATA ANALYSIS

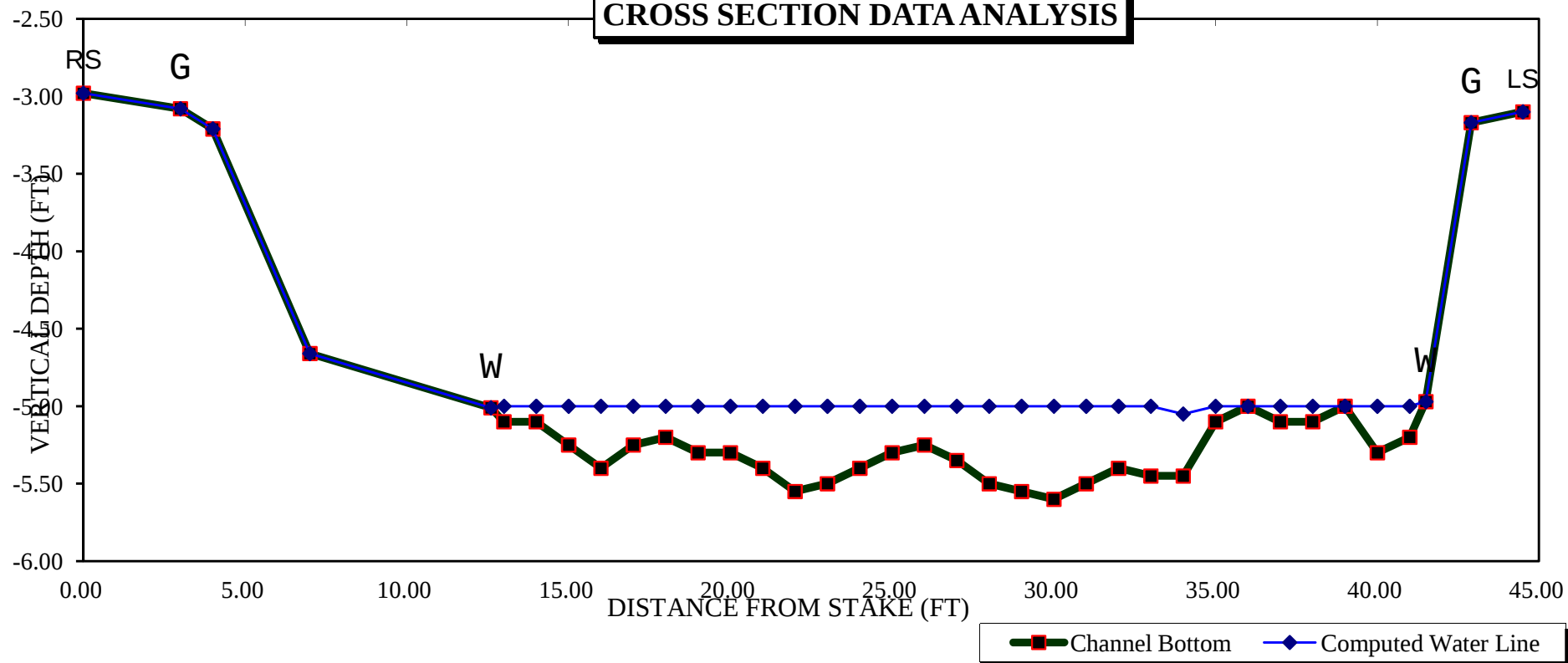
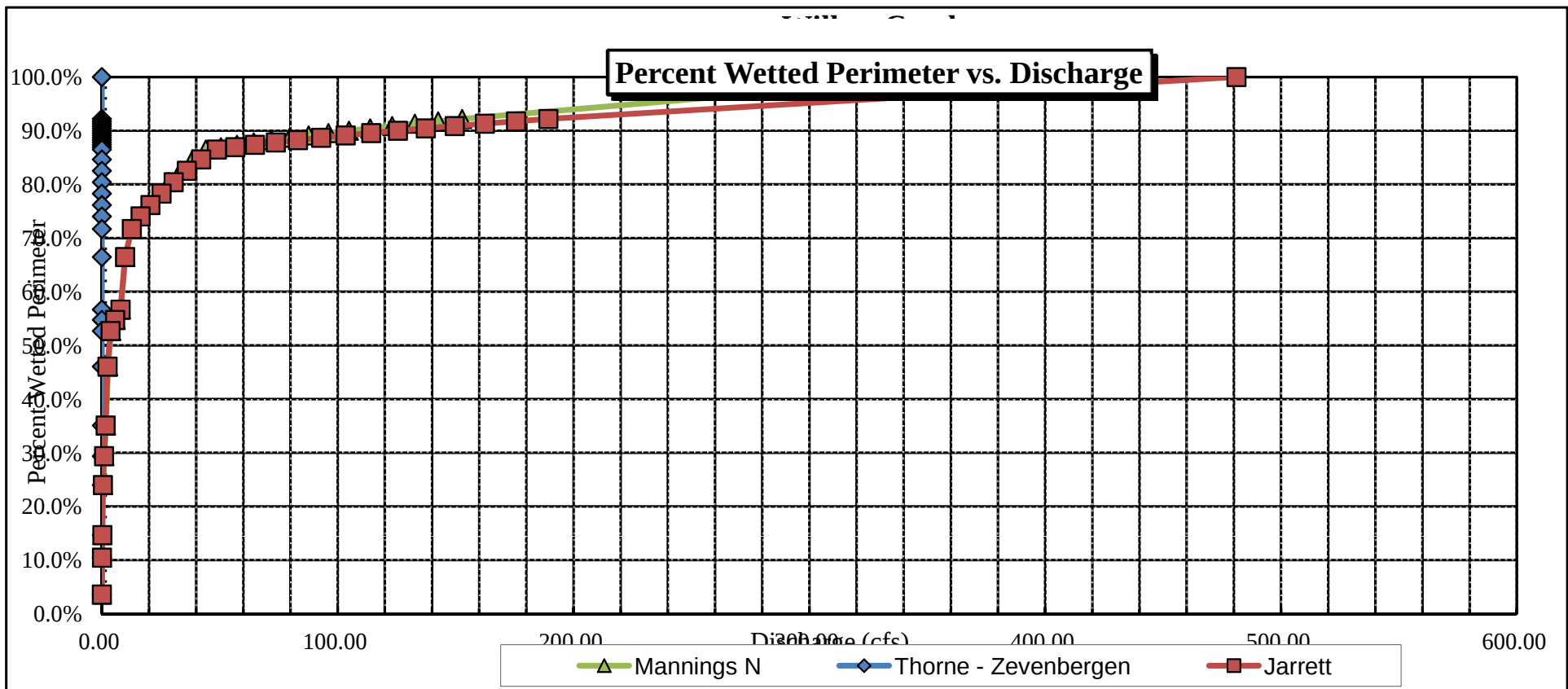
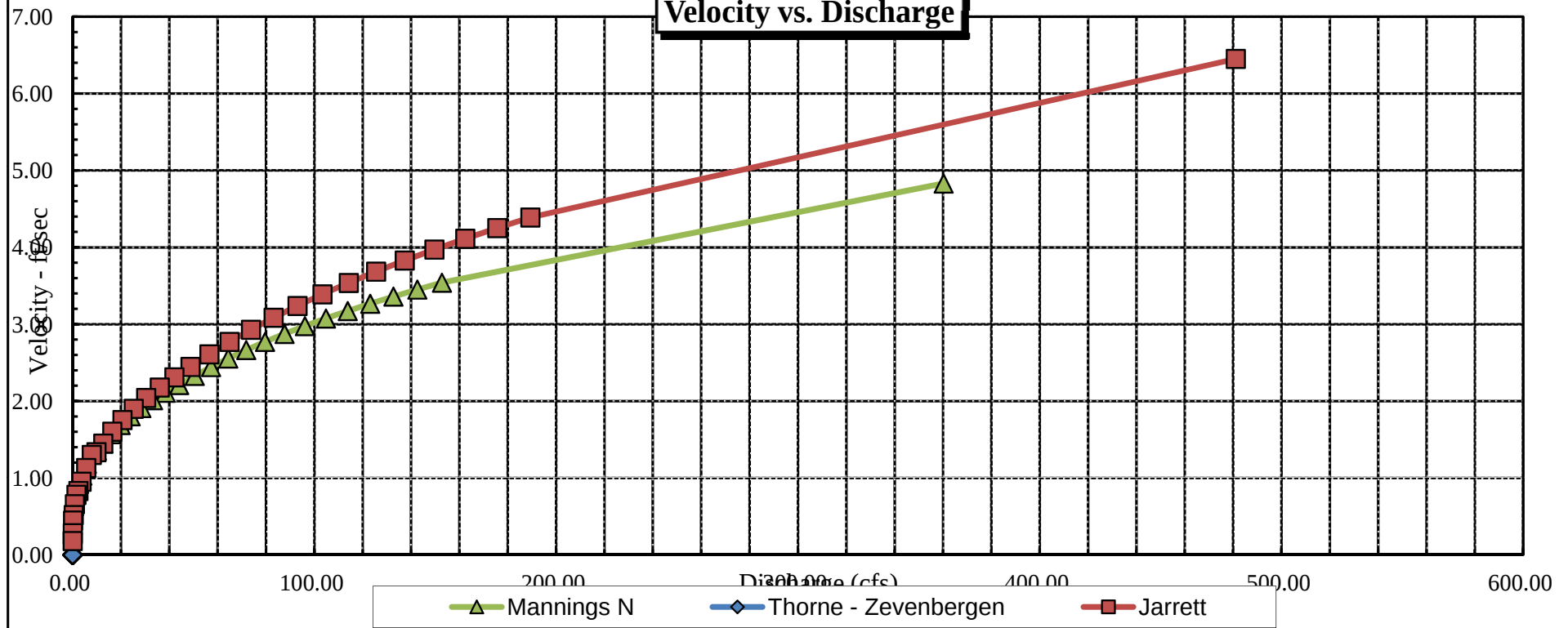
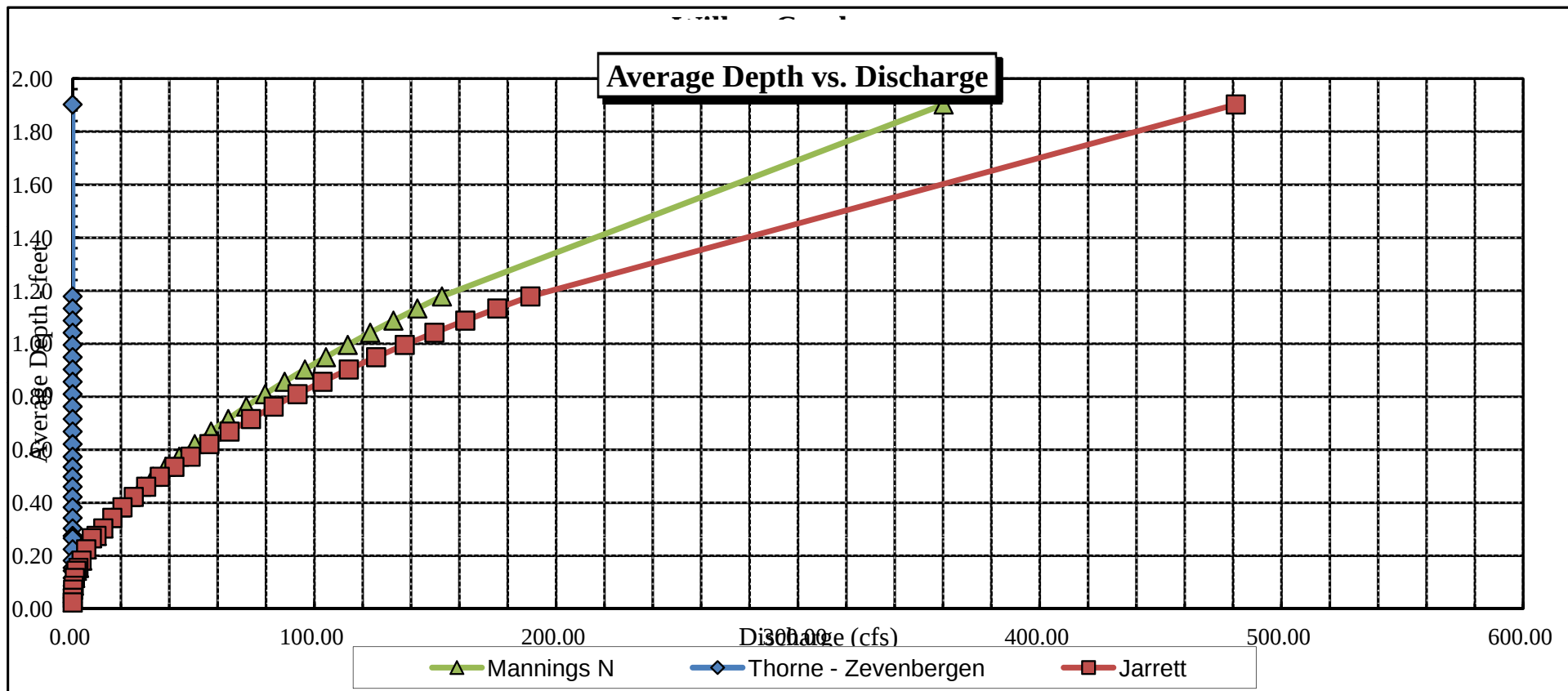


Chart 6.1



Velocity vs. Discharge





Stage vs. Discharge

