COLORADO
Parks and Wildlife
Department of Natural Resources

Water Resources Section
6060 Broadway
Denver, CO 80216

November 1, 2024

Mr. Rob Viehl, Section Chief
Colorado Water Conservation Board
Stream and Lake Protection Section
1313 Sherman Street, 7th Floor
Denver, CO 80203

Subject: Instream Flow Recommendation for West Hubbard Creek in Water Division 4, Delta County to be presented at the January 2025 CWCB Meeting

Dear Mr. Viehl:

The information contained within and referred to in this letter forms the scientific and biological basis for an instream flow (ISF) recommendation on West Hubbard Creek in Water Division 4. Field investigations relating to this ISF recommendation were conducted by Colorado Parks and Wildlife (CPW) and Colorado Water Conservation Board (CWCB) staff in 2023. West Hubbard Creek is a first order stream that supports native Colorado River cutthroat trout. This ISF recommendation was first presented to interested parties at the ISF Workshop in January 2020. CPW and CWCB staff conducted outreach to the Delta County Commissioners in 2024, the North Fork Water Users in 2023 and the Ragged Mountain Water User Association in 2024. It is CPW staff's opinion that the information contained in this letter is sufficient for the CWCB's staff to recommend an ISF appropriation to the Board on West Hubbard Creek as it specifically addresses the findings required in Rule 5(i) of the Instream Flow Program Rules.

CPW participates in the ISF Program and develops ISF recommendations for the Board's consideration in an effort to address CPW's legislative directives "… 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 its 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" [§33-1-101 (1) C.R.S.], and "… that the natural, scenic, scientific, and outdoor recreation areas … be protected, preserved, enhanced and managed for the use, benefit, and enjoyment of the people of this state and (its) visitors … and that, to carry out such program and policy, there shall be a continuous operation of acquisition, development, and management of … lands, waters, and facilities." [§33-10-101 (1) C.R.S.].

In addition to these broad statutory guidelines, CPW's strategic planning document (CPW Strategic Plan, 2015) explains the agency's 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 informed by the State Wildlife Action Plan (2002, Revised 2015). The aforementioned 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 Instream Flow and Natural Lake Level Program.

Recommended Segments & Land Status

CPW is proposing an ISF recommendation on West Hubbard Creek from the headwaters (located at UTM 13S 270549.71 4322507.68) to Overland Canal (located at UTM 13S 273785.08 4323616.26). The reach is approximately 2.3 miles in length. The proposed reach is entirely on public lands managed under the Grand Mesa National Forest.

Colorado Cutthroat Trout Conservation Goals

In 2001, CPW entered into a multi-state and multi-agency conservation agreement and strategy concerning Colorado River cutthroat trout (*Oncorhynchus clarkii pleuriticus*). Colorado's partners in this plan and agreement include the natural resource management agencies from Utah and Wyoming, a number of federal agencies including the USFS, USFWS, BLM and NPS, and the Ute Indian Tribe of the Uintah and Ouray Reservation. The purpose of the strategy is to provide a framework for the long-term conservation of the Colorado River cutthroat trout (CRCT), and to reduce or eliminate the threats that warrant its status as a sensitive species or species of concern by federal resource agencies. Essentially, the parties 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 objectives of the strategy are to identify and characterize all CRCT core and conservation populations, secure and enhance conservation populations, restore populations, secure and enhance watershed conditions, public outreach, data sharing, and coordination. CPW believes that flow protection via establishing an ISF water right is a conservation action aligned with "securing and enhancing watershed conditions" and will support the core conservation populations of CRCT which are resident to the Hubbard Creek basin. Information about the species and CPW's conservation strategy can be found here: CPW Cutthroat Trout Research. CPW believes that securing ISF water rights for core conservation populations of CRCT is a critical step in the overall preservation and conservation of these important native trout.

Natural Environment and Biological Summary

West Hubbard Creek is a tributary of Hubbard Creek which flows into the North Fork Gunnison near the town of Somerset. West Hubbard Creek is a first order headwaters stream whose hydrology is snowmelt-dominated with perennial baseflows throughout the year. The basin receives approximately 32 inches of precipitation a year with a 2.8 square mile drainage area that contributes to the ISF reach. The contributing basin is densely forested with stands of pine and aspen. The creek supports a healthy riparian environment with diverse riparian plants and abundant mosses.

West Hubbard Creek has a high gradient channel with substrate that ranges from boulder to small cobbles to gravels. Fish habitat is complex and includes significant undercut banks, pocket pools, and deep pools created by boulders and large woody debris in the channel. There are some riffles in the

reach that might be suitable for spawning, but most of the riffle features are higher gradient. Step-pools are the dominant habitat features utilized by fish. There is ample large woody debris in the channel including both recent and mature wood in the channel. There is plenty of overhead shading and deep pools which provide temperature refuge. Two species of caddisfly, stonefly, and mayfly were observed during site visits.

West Hubbard Creek supports a self-sustaining population of Colorado River cutthroat trout (CRCT) of the Gunnison Basin lineage. CRCT are state species of special concern and considered federally sensitive (State Wildlife Action Plan, 2015). Length-frequency data indicates multiple age classes surveyed by CPW in 2009 (see attached). Multiple age classes indicate that the cutthroat trout population are self-sustaining population which have natural recruitment. While brook trout have recently invaded West Hubbard Creek, CPW is working with the Forest Service to design and build a fish barrier. Once that project fish barrier construction project is complete, CPW plans to remove brook trout which have invaded the upper portions of the creek and recolonize native cutthroat trout to restore the population.

R2Cross Background

Initial biological instream flow recommendations were developed using the R2Cross methodology (Espegren, 1996[1]). R2Cross uses field data that has been collected in a riffle habitat type. Riffles are often the limiting habitat features in streams during low flow events, so maintaining specific hydraulic conditions across riffle habitat types will also maintain aquatic habitat in pools and runs for most life stages of fish and macroinvertebrates (Nehring, 1979[2]). The R2Cross model uses field data, including a survey of cross-sectional channel geometry, a longitudinal slope of the water surface, and a flow measurement, as input to a single transect hydraulic model. R2Cross uses Ferguson's Variable-Power Equation (Ferguson, 2007[3]) to model a stage-discharge relationship and compute corresponding hydraulic parameters of average depth, average velocity, and percent wetted perimeter over modeled stages. Maintaining these three hydraulic parameters at specified levels should ensure conditions that allow movement of fish longitudinally across riffles and adequate depths, velocities, and oxygenation for production of macroinvertebrates and development of trout eggs. Baseflow recommendations are typically developed based on the flows that meet two of three hydraulic criteria and summer flow recommendations are based on hydraulic criteria that meet three of three hydraulic criteria (as described in Nehring 1979 and Espergren 1996).

In 2023, CPW and CWCB staff collected two cross-section data sets on West Hubbard Creek upstream of the Overland Canal diversion structure. The results of the R2Cross analysis are summarized below.

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

[2]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.

[3] Ferguson, R.I., 2007. Flow resistance equations for gravel- and boulder-bed streams. Water Resources Research 43. https://doi.org/10.1029/2006WR005422

	Bankfull Top Width	Date Measured	Flow Measured	Flow Meeting Two Criteria	Flow Meeting Three Criteria
1	11.86 ft	8/21/2023	0.86 cfs	0.28 cfs	8.60 cfs
2	11.85 ft	8/21/2023	0.86 cfs	0.52 cfs	4.45 cfs
Recommended Flow Rates:				**0.40 cfs**	**6.5 cfs**

The biological flow recommendation during the baseflow period is 0.40 cfs. This flow rate will be protective by maintaining over 50 percent wetted perimeter in the channel and average depth of 0.2 feet. The biological flow recommendation in the summer is 6.5 cfs, which will also maintain these two hydraulic parameters as well as average velocity of 1 foot per second (fps).

Water Availability Refined Flow Recommendations

In order to make a preliminary determination where water is available for the R2Cross-based flow recommendations and to determine appropriate seasonal transition dates, CPW examined basic hydrological data and water rights information for West Hubbard Creek. There is a gage on West Hubbard Creek that was maintained by the USGS between 1960 and 1973 (USGS '9132900'). This dataset was analyzed by CWCB staff to help inform physical water availability to meet the biological flow recommendations. CPW's analysis indicates that the following flows are needed to protect the natural environment to a reasonable degree. There are slight water availability limitations during the baseflow period. Therefore, CPW's flow recommendations have been refined to the following:

- Baseflow Recommendation (October 1 through April 30): **0.40 cfs**
    - This flow recommendation will maintain adequate depth and wetted perimeter in riffles and will also provide sufficient holding habitats in pools. This will support fish during overwintering periods when metabolic activity is limited and they are resting in discrete habitat features (not moving longitudinally throughout the stream). It will also support trout as they transition into and out of overwintering habitats by allowing them to move longitudinally throughout the channel over critical riffle features.
- Rising Limb Flow Recommendation (May 1 through May 14): **4.0 cfs**
    - Maintains adequate wetted perimeter and depth, as well as swifter velocities, which will support fish as they transition into more metabolic activity as ice cover decreases and flows start to rise during the beginning of snowmelt runoff.
- Summer Flow Recommendation (May 15 through July 15): **6.5 cfs**
    - Maintains adequate depth, velocity, and wetted perimeter during spring runoff through its recession. This flow rate will support fish when they are active feeding and spawning. This higher flow rate will support ideal conditions for cutthroat trout spawning which occurs in the early months of summer, as well as productivity of the macroinvertebrate community.
- Late July Flow Recommendation (July 16 through July 31): **3.2 cfs**
    - This flow recommendation will maintain adequate depth and wetted perimeter, as well as swift velocities, that support rearing and refuge habitats for fish. Longer days and warmer water temperature facilitate growth. This flow rate will support a productive macroinvertebrate community and refuge and foraging habitats for fish during this critical time period for growth.
- Late Summer Flow Recommendation (August 1 through September 30): **1.3 cfs**

- This flow recommendation will maintain adequate depth and wetted perimeter in riffles to allow fish movement longitudinally. It will also provide good habitat availability in riffles, glides, and pools to facilitate rearing and growth during the later part of summer and fall.

The purpose of this letter is to formally transmit this ISF recommendation to CWCB for their Board's consideration. Based on CPW's opinion that there is a flow-dependent natural environment in West Hubbard Creek that can be preserved to a reasonable degree with an ISF water right in the recommended rates. Please refer to attachments which include; R2Cross field forms, R2Cross output, fish survey information, and photographs at each cross section location.

CPW personnel will be available at the January 2025 CWCB meeting to answer any questions that the Board might have regarding these flow recommendations. We appreciate your consideration.

Sincerely,

Katie Birch
CPW Instream Flow Program Coordinator
Attachments (as stated)

Length Frequency Data

Water **46676** **Hubbard Creek, West** Date **7/23/2009**

Station **GU2511** **ABV Fs 705.1a @ Gauge**

Drainage **Gunnison River** UtmX **273747** UtmY **4323602** Elevation **2935 m**

Length **63 m** Width **2.74 m** Area **0.02 Ha**

Surveyors **Forest Service**

Gear **NOT LISTED** Effort **2.00** Metric **PASS** Protocol **TWO-PASS REMOVAL**

Total catch **18**

Species	Count	Length (mm)	Weight (gm)	Status	Mark	Tag ID	Habitat
BRK	1	154	49	1			A
BRK	1	174	72	1			A
BRK	1	141	37	1			A
BRK	1	153	42	1			A
BRK	1	152	50	1			A
BRK	1	147	38	1			A
BRK	1	66	4	1			A
BRK	1	144	44	1			A
BRK	1	176	67	1			A
BRK	1	159	46	1			A
BRK	1	106	16	1			A
BRK	1	137	36	1			A
BRK	1	150	52	1			A
BRK	1	66	3	2			A
CRN	1	76	5	1			A
CRN	1	148	37	1			A
CRN	1	211	100	1			A

Length Frequency Data

Water **46676** **Hubbard Creek, West** Date **7/23/2009**

Station **GU2511** **ABV Fs 705.1a @ Gauge**

Species	Count	Length (mm)	Weight (gm)	Status	Mark	Tag ID	Habitat
CRN	1	117	20	1			A

Notes: Efforts 1st pass

Length Frequency Data

Water **46676** **Hubbard Creek, West** Date **7/23/2009**

Station **GU2512** **1.4 KM ABV FS 705.1A**

Drainage **Gunnison River** UtmX **272556** UtmY **4323073** Elevation **3035 m**

Length **66 m** Width **2.13 m** Area **0.01 Ha**

Surveyors **Forest Service**

Gear **NOT LISTED** Effort **2.00** Metric **PASS** Protocol **TWO-PASS REMOVAL**

Total catch **13**

Species	Count	Length (mm)	Weight (gm)	Status	Mark	Tag ID	Habitat
BRK	1	183	95	1			A
BRK	1	166	51	1			A
BRK	1	160	59	1			A
BRK	1	175	68	1			A
BRK	1	158	54	2			A
BRK	1	141	39	2			A
BRK	1	120	20	2			A
CRN	1	198	92	1			A
CRN	1	166	56	1			A
CRN	1	110	17	1			A
CRN	1	183	76	1			A
CRN	1	240	154	1			A
CRN	1	236	159	1			A

Notes: Efforts 1st pass

West Hubbard 8/21/23
K. Brian M Sidell
XS 1
UTM 13S 273648 4323616

U/S Slope: 6.72'
d/s Slope: 7.42'
Length: 12.8'

WSR: 6.91' WSL: 6.91

Horizontal	Vert.	water depth	Feature
0	5.49		S
1.4	6.08		BF
2.0	6.38		
2.1	6.9		WSR
2.15	7.0	0.1	VB
2.5	7.21	0.31	
3.0	7.2	0.31	
3.5	7.14	0.24	
4.0	7.14	0.23	
4.5	7.11	0.21	
5.0	7.17	0.25	
6.5	7.25	0.34	
6.0	7.08	0.14	Rock
6.5	7.06	0.25	Rock

Horizontal	Vert	WDepth	Feature
7.0	7.00	0.12	
7.5	7.02	0.15	
8.0	7.09	0.18	
8.5	7.16	0.24	
9.0	7.23	0.31	
9.5	7.30	0.39	
10.0	7.47	0.56	
10.5	7.40	0.53	
11.0	7.37	0.47	
11.5	7.39	0.47	
12.0	7.40	0.49	
12.5	7.41	0.49	
12.55	6.91		WSL
12.6	6.32		VB
13.4	6.63		BF
14.4	5.85		S

Notes: Riffle 1 more representative of spawning riffle. Riffle 2 representative of HGR, shnt. Flow measurement taken d/s XS 2, above Overlook canal. Great riffle in lower-gradient section. Significant undercut banks, pocket pools from abundant LWD in channel - old & new. Large plunge pools, smaller pocket pools. Alder, pine, abundant riparian plants & mosses. Boulder & small gravel a great spawning habitat

Flow measured by M Sidell = 0.8587 cfs

Hubbard XS 2 8/21/23

D/S near Overland Ditch

M. Sidell K. Birch UTM: 13S 273744
4323600

slope WS U/S: 6.98

WS D/S: 7.25 Length: 9.6

RWS: 7.18 LWS: 7.20

Horizontal	Vertical	Depth	Feature
0.5	6.14		S
2.0	6.52		BF
2.5	6.41		
3.5	6.57		
4.5	7.18	Ø	RWS
5.0	7.59	0.22	
5.5	7.53	0.32	
6.0	7.35	0.15	R
6.5	7.44	0.25	
7.0	7.38	0.26	
7.5	7.31	0.15	
8.0	7.1	0.08	R
8.5	7.07	0.1	R
9.0	7.31	0.32	
9.5	7.42	0.29	
10.	7.40	0.25	
10.5	7.32	0.15	

11.0	7.45	0.24	
11.5	7.50	0.35	
12.0	7.50	0.38	
12.5	7.55	0.31	
13.0	7.60	0.4	
13.5	7.20	∅	LWS
15.1	6.53		BF
15.7	5.89		
18.4	5.54		

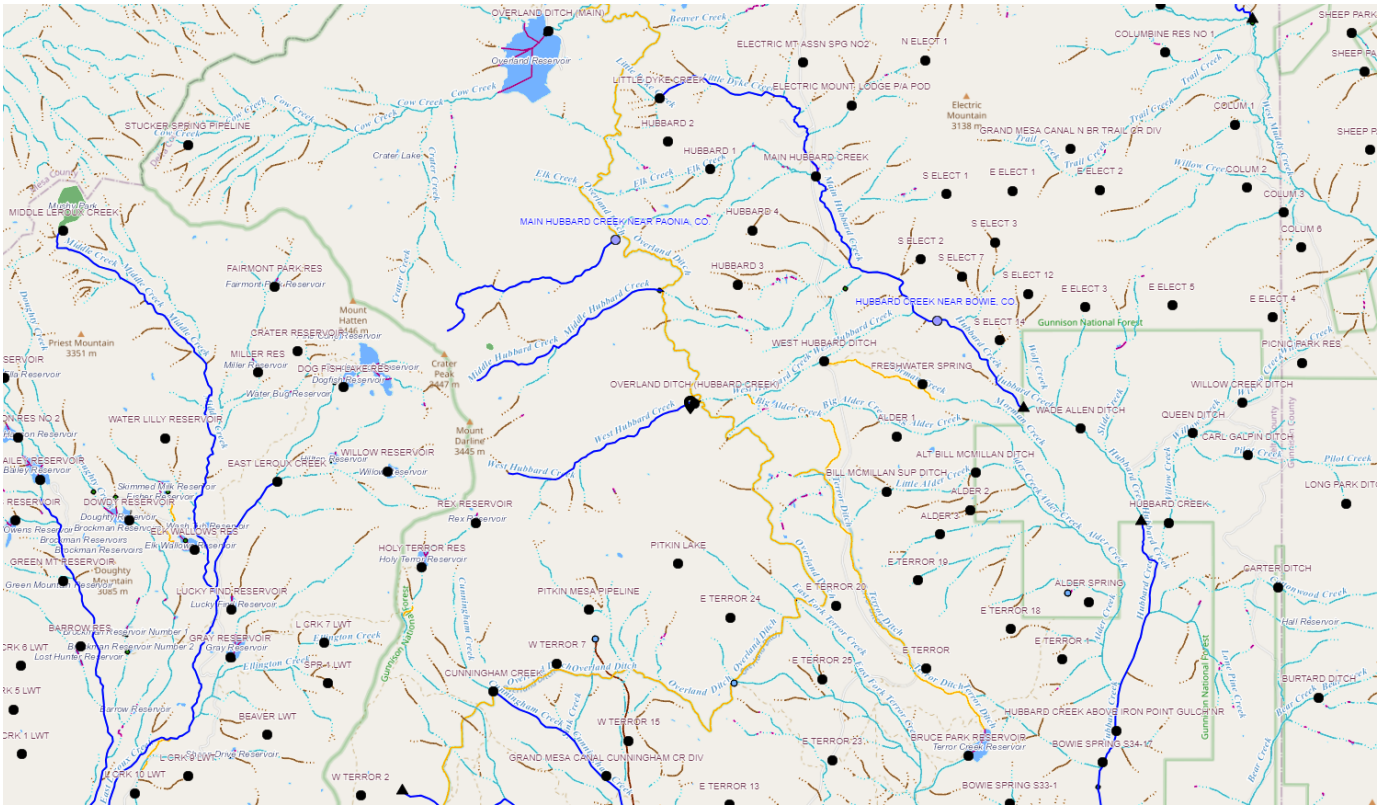
Notes:

Macros: caddis(2), stone larvae, mayfly hatch.

R2Cross RESULTS

Stream Name: West Hubbard Creek
Stream Locations: Upstream of Overland Canal
Fieldwork Date: 08/21/2023
Cross-section: 1
Observers: KB MS
Coordinate System: UTM Zone 13
X (easting): 273648
Y (northing): 4323616
Date Processed: 09/21/2023
Slope: 0.0547
Discharge: Entered Value: 0.86 (cfs)
Computation method: Ferguson VPE
R2Cross data filename: WestHubbard_XS1_8-21-23-Q=0.859.xlsx
R2Cross version: 2.0.2

LOCATION



ANALYSIS RESULTS

Habitat Criteria Results

Bankfull top width (ft) = 11.86

	Habitat Criteria	Discharge (cfs) Meeting Criteria
Mean Depth (ft)	0.2	0.28
Percent Wetted Perimeter (%)	50.0	0.09
Mean Velocity (ft/s)	1.0	8.6

STAGING TABLE

Feature	Distance to Water (ft)	Top Width (ft)	Mean Depth (ft)	Maximum Depth (ft)	Area (sq ft)	Wetted Perimeter (ft)	Percent Wetted Perimeter	Hydraulic Radius (ft)	Manning's n	Mean Velocity (ft/s)	Discharge (cfs)
Bankfull	6.08	11.86	1.02	1.39	12.05	13.62	100.0	0.88	0.23	1.4	16.82
	6.1	11.76	1.0	1.37	11.81	13.51	99.22	0.87	0.23	1.37	16.18
	6.15	11.53	0.97	1.32	11.23	13.26	97.32	0.85	0.24	1.31	14.69
	6.2	11.29	0.94	1.27	10.66	13.0	95.42	0.82	0.24	1.25	13.3
	6.25	11.05	0.91	1.22	10.1	12.74	93.53	0.79	0.25	1.19	11.99
	6.3	10.81	0.88	1.17	9.55	12.48	91.63	0.77	0.26	1.13	10.77
	6.35	10.66	0.85	1.12	9.02	12.28	90.16	0.73	0.27	1.06	9.56
	6.4	10.59	0.8	1.07	8.49	12.14	89.16	0.7	0.28	0.99	8.36
	6.45	10.58	0.75	1.02	7.96	12.04	88.41	0.66	0.29	0.91	7.22
	6.5	10.56	0.7	0.97	7.43	11.94	87.67	0.62	0.31	0.83	6.16
	6.55	10.55	0.65	0.92	6.9	11.84	86.93	0.58	0.32	0.75	5.2
	6.6	10.53	0.61	0.87	6.37	11.74	86.19	0.54	0.34	0.68	4.32
	6.65	10.52	0.56	0.82	5.85	11.64	85.45	0.5	0.36	0.6	3.53
	6.7	10.51	0.51	0.77	5.32	11.54	84.7	0.46	0.39	0.53	2.83
	6.75	10.49	0.46	0.72	4.8	11.44	83.96	0.42	0.42	0.46	2.22
	6.8	10.48	0.41	0.67	4.27	11.33	83.22	0.38	0.46	0.39	1.68
	6.85	10.46	0.36	0.62	3.75	11.23	82.48	0.33	0.51	0.33	1.23
Waterline	6.9	10.45	0.31	0.57	3.23	11.13	81.73	0.29	0.57	0.27	0.86
	6.95	10.42	0.26	0.52	2.7	11.03	80.95	0.25	0.66	0.21	0.56
	7.0	10.37	0.21	0.47	2.18	10.9	80.04	0.2	0.78	0.15	0.33
	7.05	9.16	0.19	0.42	1.7	9.63	70.68	0.18	0.86	0.13	0.22
	7.1	8.08	0.16	0.37	1.27	8.48	62.23	0.15	0.99	0.1	0.13
	7.15	6.06	0.15	0.32	0.91	6.38	46.86	0.14	1.03	0.09	0.08
	7.2	4.67	0.14	0.27	0.64	4.92	36.12	0.13	1.11	0.08	0.05
	7.25	3.37	0.13	0.22	0.45	3.55	26.07	0.13	1.14	0.08	0.03

	7.3	3.01	0.1	0.17	0.29	3.14	23.07	0.09	1.48	0.05	0.01
	7.35	2.86	0.05	0.12	0.14	2.94	21.56	0.05	2.5	0.02	0.0
	7.4	1.17	0.02	0.07	0.03	1.2	8.8	0.02	4.86	0.01	0.0
	7.45	0.2	0.01	0.02	0.0	0.2	1.47	0.01	9.85	0.0	0.0
	7.46	0.15	0.01	0.01	0.0	0.15	1.14	0.01	12.22	0.0	0.0

This Manning's roughness coefficient was calculated based on velocity estimates from the Ferguson VPE method

MODEL SUMMARY

Measured Flow (Qm) =	0.86	(cfs)
Calculated Flow (Qc) =	0.86	(cfs)
(Qm-Qc)/Qm * 100 =	0.06%	
Measured Waterline (WLm) =	6.91	(ft)
Calculated Waterline (WLc) =	6.9	(ft)
(WLm-WLc)/WLm * 100 =	0.06%	
Max Measured Depth (Dm) =	0.56	(ft)
Max Calculated Depth (Dc) =	0.57	(ft)
(Dm-Dc)/Dm * 100 =	-1.69%	
Mean Velocity =	0.27	(ft/s)
Manning's n =	0.572	
0.4 * Qm =	0.34	(cfs)
2.5 * Qm =	2.15	(cfs)

FIELD DATA

Feature	Station (ft)	Rod Height (ft)	Water depth (ft)	Velocity (ft/s)
	0	5.49		
Bankfull	1.4	6.08		
	2	6.38		
Waterline	2.1	6.9	0	
	2.15	7	0.1	
	2.5	7.21	0.31	
	3	7.2	0.31	
	3.5	7.14	0.24	
	4	7.14	0.23	
	4.5	7.11	0.21	
	5	7.17	0.25	
	5.5	7.25	0.34	
	6	7.08	0.14	
	6.5	7.06	0.25	
	7	7	0.12	
	7.5	7.02	0.15	
	8	7.09	0.18	
	8.5	7.16	0.24	
	9	7.23	0.31	
	9.5	7.3	0.39	
	10	7.47	0.56	
	10.5	7.4	0.53	
	11	7.37	0.47	
	11.5	7.39	0.47	
	12	7.4	0.49	
	12.5	7.41	0.49	
Waterline	12.55	6.91	0	
	12.6	6.32		
Bankfull	13.4	6.03		
	14.4	5.85		

COMPUTED FROM MEASURED FIELD DATA

Wetted Perimeter (ft)	Water Depth (ft)	Area (ft^2)	Discharge (cfs)	Percent Discharge
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0.11	0.1	0.02	0.01	0.62
0.41	0.31	0.13	0.04	4.08
0.5	0.31	0.15	0.04	4.8
0.5	0.24	0.12	0.03	3.72
0.5	0.23	0.12	0.03	3.56
0.5	0.21	0.1	0.03	3.25
0.5	0.25	0.12	0.03	3.87
0.51	0.34	0.17	0.05	5.27
0.53	0.14	0.07	0.02	2.17
0.5	0.25	0.12	0.03	3.87
0.5	0.12	0.06	0.02	1.86
0.5	0.15	0.07	0.02	2.33
0.5	0.18	0.09	0.02	2.79
0.5	0.24	0.12	0.03	3.72
0.5	0.31	0.15	0.04	4.8
0.5	0.39	0.2	0.05	6.04
0.53	0.56	0.28	0.07	8.68
0.5	0.53	0.27	0.07	8.21
0.5	0.47	0.23	0.06	7.28
0.5	0.47	0.23	0.06	7.28
0.5	0.49	0.24	0.07	7.59
0.5	0.49	0.13	0.04	4.18
0.5	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0

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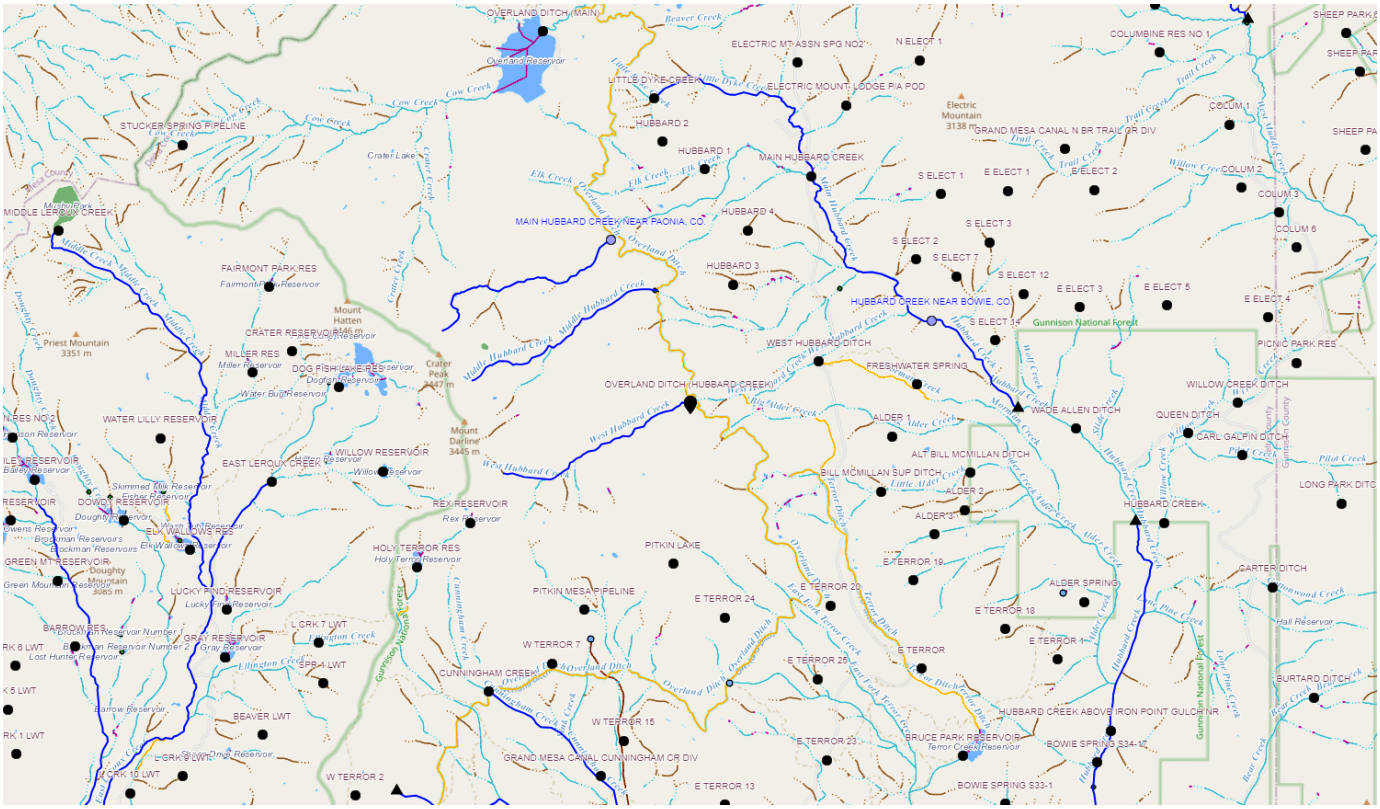
R2Cross RESULTS

Stream Name: West Hubbard Creek
Stream Locations: Upstream of Overland Canal
Fieldwork Date: 08/21/2023
Cross-section: 2
Observers: KB MS
Coordinate System: UTM Zone 13
X (easting): 273744
Y (northing): 4323606
Date Processed: 09/21/2023
Slope: 0.0281
Discharge: Entered Value: 0.86 (cfs)
Computation method: Ferguson VPE
R2Cross data filename: WestHubbard_XS2_8-21-23-Q=0.859.xlsx
R2Cross version: 2.0.2

LOCATION



ANALYSIS RESULTS

Habitat Criteria Results

Bankfull top width (ft) = 11.85

	Habitat Criteria	Discharge (cfs) Meeting Criteria
Mean Depth (ft)	0.2	0.52
Percent Wetted Perimeter (%)	50.0	0.07
Mean Velocity (ft/s)	1.0	4.45

STAGING TABLE

Feature	Distance to Water (ft)	Top Width (ft)	Mean Depth (ft)	Maximum Depth (ft)	Area (sq ft)	Wetted Perimeter (ft)	Percent Wetted Perimeter	Hydraulic Radius (ft)	Manning's n	Mean Velocity (ft/s)	Discharge (cfs)
Bankfull	6.53	11.85	0.72	1.07	8.52	12.55	100.0	0.68	0.1	2.0	17.04
	6.55	11.69	0.71	1.05	8.3	12.38	98.66	0.67	0.1	1.96	16.3
	6.6	11.39	0.68	1.0	7.72	12.06	96.12	0.64	0.1	1.84	14.24
	6.65	11.19	0.64	0.95	7.16	11.84	94.32	0.6	0.1	1.7	12.2
	6.7	10.99	0.6	0.9	6.6	11.61	92.53	0.57	0.11	1.56	10.33
	6.75	10.78	0.56	0.85	6.06	11.39	90.73	0.53	0.11	1.42	8.63
	6.8	10.58	0.52	0.8	5.53	11.16	88.93	0.5	0.12	1.29	7.1
	6.85	10.38	0.48	0.75	5.0	10.94	87.14	0.46	0.13	1.15	5.74
	6.9	10.18	0.44	0.7	4.49	10.71	85.34	0.42	0.14	1.01	4.54
	6.95	9.98	0.4	0.65	3.98	10.48	83.54	0.38	0.15	0.88	3.5
	7.0	9.78	0.36	0.6	3.49	10.26	81.75	0.34	0.16	0.75	2.61
	7.05	9.58	0.31	0.55	3.01	10.03	79.95	0.3	0.18	0.62	1.87
	7.1	8.83	0.29	0.5	2.54	9.26	73.78	0.27	0.19	0.55	1.39
Waterline	7.15	8.39	0.25	0.45	2.11	8.77	69.91	0.24	0.21	0.45	0.95
	7.2	7.95	0.21	0.4	1.7	8.29	66.06	0.21	0.24	0.36	0.61
	7.25	7.55	0.17	0.35	1.31	7.84	62.44	0.17	0.29	0.26	0.35
	7.3	7.14	0.13	0.3	0.95	7.38	58.82	0.13	0.36	0.18	0.17
	7.35	6.17	0.1	0.25	0.61	6.36	50.67	0.1	0.46	0.11	0.07
	7.4	4.45	0.08	0.2	0.34	4.59	36.56	0.07	0.56	0.08	0.03
	7.45	2.71	0.06	0.15	0.17	2.79	22.26	0.06	0.65	0.06	0.01
	7.5	1.83	0.03	0.1	0.06	1.89	15.02	0.03	1.12	0.02	0.0
	7.55	0.57	0.03	0.05	0.01	0.6	4.74	0.02	1.41	0.02	0.0
	7.58	0.17	0.01	0.01	0.0	0.17	1.39	0.01	3.91	0.0	0.0

This Manning's roughness coefficient was calculated based on velocity estimates from the Ferguson VPE method

MODEL SUMMARY

Measured Flow (Qm) =	0.86	(cfs)
Calculated Flow (Qc) =	0.9	(cfs)
(Qm-Qc)/Qm * 100 =	-4.65%	
Measured Waterline (WLm) =	7.19	(ft)
Calculated Waterline (WLc) =	7.15	(ft)
(WLm-WLc)/WLm * 100 =	0.57%	
Max Measured Depth (Dm) =	0.4	(ft)
Max Calculated Depth (Dc) =	0.45	(ft)
(Dm-Dc)/Dm * 100 =	-12.78%	
Mean Velocity =	0.43	(ft/s)
Manning's n =	0.226	
0.4 * Qm =	0.34	(cfs)
2.5 * Qm =	2.15	(cfs)

FIELD DATA

Feature	Station (ft)	Rod Height (ft)	Water depth (ft)	Velocity (ft/s)
	0.5	6.14		
Bankfull	2	6.52		
	2.5	6.41		
	3.5	6.57		
Waterline	4.5	7.18	0	
	5	7.39	0.22	
	5.5	7.53	0.32	
	6	7.35	0.15	
	6.5	7.44	0.25	
	7	7.38	0.26	
	7.5	7.31	0.15	
	8	7.1	0.08	
	8.5	7.07	0.1	
	9	7.31	0.32	
	9.5	7.42	0.29	
	10	7.4	0.25	
	10.5	7.32	0.15	
	11	7.45	0.24	
	11.5	7.5	0.35	
	12	7.5	0.38	
	12.5	7.55	0.31	
	13	7.6	0.4	
Waterline	13.5	7.2	0	
Bankfull	15.1	6.53		
	15.7	5.89		
	18.4	5.54		

COMPUTED FROM MEASURED FIELD DATA

Wetted Perimeter (ft)	Water Depth (ft)	Area (ft^2)	Discharge (cfs)	Percent Discharge
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0.54	0.22	0.11	0.04	5.21
0.52	0.32	0.16	0.07	7.58
0.53	0.15	0.07	0.03	3.56
0.51	0.25	0.12	0.05	5.92
0.5	0.26	0.13	0.05	6.16
0.5	0.15	0.07	0.03	3.56
0.54	0.08	0.04	0.02	1.9
0.5	0.1	0.05	0.02	2.37
0.55	0.32	0.16	0.07	7.58
0.51	0.29	0.14	0.06	6.87
0.5	0.25	0.12	0.05	5.92
0.51	0.15	0.07	0.03	3.56
0.52	0.24	0.12	0.05	5.69
0.5	0.35	0.17	0.07	8.29
0.5	0.38	0.19	0.08	9.01
0.5	0.31	0.15	0.06	7.35
0.5	0.4	0.2	0.08	9.48
0.64	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0

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General Site Field Visit Data Report *(Filters: Name begins with West Hubbard Creek; Division = 4;)*

Type		Div	Name	CWCB Case Number	Segment ID	Visit Date	Location Description	Watershed Name
Stream		4	West Hubbard Creek		21/4/A-012	8/15/2024	West Hubbard Creek above the Overland Ditch	North Fork Gunnison
	Remarks	Date	Remark					
		15/08/24 09:00	Assisted CPW in collecting R2Cross measurements and assesed the natural environment.					
	GPS Log	No GPS Log records for this visit.						
	Photo Log	No Photo Log records for this visit.						

Discharge Measurement Summary

Site name	Whubbard
Site number	082123
Operator(s)	MS
File name	Whubbard_20230821-203151.ft
Comment	

Start time	8/21/2023 7:41 PM
End time	8/21/2023 8:29 PM
Start location latitude	39.032
Start location longitude	-107.614
Calculations engine	FlowTracker2

Sensor type	Top Setting
Handheld serial number	FT2H2113010
Probe serial number	FT2P2114008
Probe firmware	1.30
Handheld software	1.6.4

# Stations	Avg interval (s)	Total discharge (ft³/s)
24	40	0.859

Total width (ft)	Total area (ft²)	Wetted Perimeter (ft)
7.450	2.178	8.148

Mean SNR (dB)	Mean depth (ft)	Mean velocity (ft/s)
49.120	0.292	0.394

Mean temp (°F)	Max depth (ft)	Max velocity (ft/s)
48.375	0.600	1.508

Discharge Uncertainty		
Category	**ISO**	**IVE**
Accuracy	1.0%	1.0%
Depth	0.5%	11.0%
Velocity	1.2%	29.5%
Width	0.2%	0.2%
Method	2.3%	
# Stations	2.1%	
Overall	**3.5%**	**31.5%**

Discharge equation	Mid Section
Discharge uncertainty	IVE
Discharge reference	Rated

Data Collection Settings	
Salinity	0.000 PSS-78
Temperature	-
Sound speed	-
Mounting correction	0.000 %

Summary overview

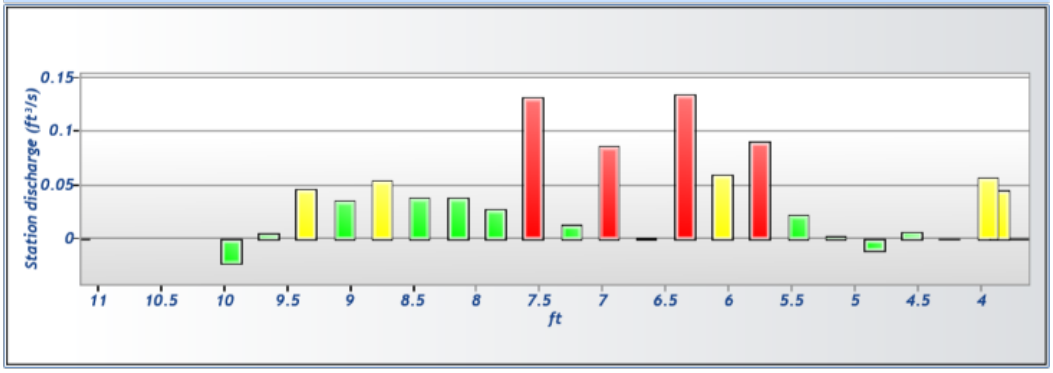
No changes were made to this file
Quality control warnings

Discharge Measurement Summary

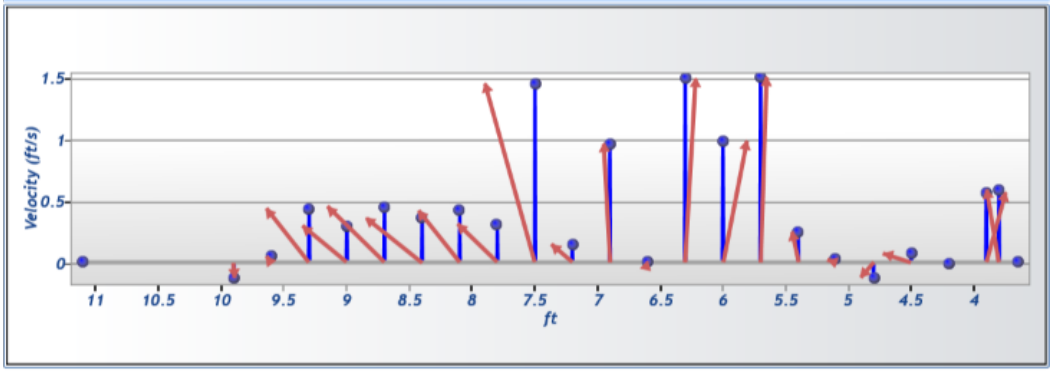
Site name	Whubbard
Site number	082123
Operator(s)	MS
File name	Whubbard_20230821-203151.ft
Comment	

Station Warning Settings		
Station discharge OK	Station discharge < 5.000%	
Station discharge caution	5.000% >= Station discharge < 10.000%	
Station discharge warning	Station discharge >= 10.000%	

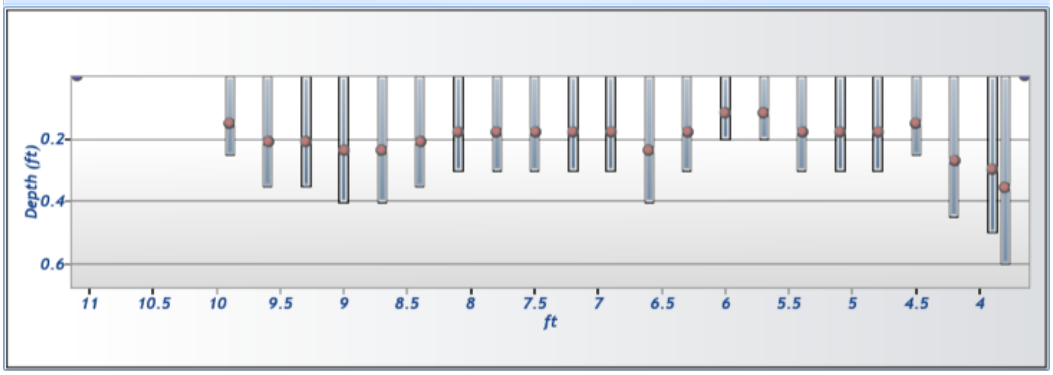
Discharge chart



Velocity chart



Depth chart



Discharge Measurement Summary

Site name	Whubbard
Site number	082123
Operator(s)	MS
File name	Whubbard_20230821-203151.ft
Comment	

Measurement results

St#	Time	Location (ft)	Method	Depth (ft)	%Depth	Measured Depth (ft)	Samples	Velocity (ft/s)	Correction	Mean Velocity (ft/s)	Area (ft²)	Flow (ft³/s)	%Q	
0	7:41 PM	3.650	None	0.000	0.000	0.000	0	0.000		0.592	0.000	0.000	0.000	✓
1	7:42 PM	3.800	0.6	0.600	0.600	0.360	80	0.592	1.000	0.592	0.075	0.044	5.168	✓
2	7:48 PM	3.900	0.6	0.500	0.600	0.300	80	0.568	1.000	0.568	0.100	0.057	6.613	✓
3	7:51 PM	4.200	0.6	0.450	0.600	0.270	80	0.000	1.000	0.000	0.135	0.000	-0.007	✓
4	7:53 PM	4.500	0.6	0.250	0.600	0.150	80	0.074	1.000	0.074	0.075	0.006	0.649	✓
5	7:55 PM	4.800	0.6	0.300	0.600	0.180	80	-0.125	1.000	-0.125	0.090	-0.011	-1.310	✓
6	7:57 PM	5.100	0.6	0.300	0.600	0.180	80	0.024	1.000	0.024	0.090	0.002	0.252	✓
7	7:59 PM	5.400	0.6	0.300	0.600	0.180	80	0.248	1.000	0.248	0.090	0.022	2.602	✓
8	8:01 PM	5.700	0.6	0.200	0.600	0.120	80	1.508	1.000	1.508	0.060	0.090	10.536	✓
9	8:03 PM	6.000	0.6	0.200	0.600	0.120	80	0.988	1.000	0.988	0.060	0.059	6.903	✓
10	8:05 PM	6.300	0.6	0.300	0.600	0.180	80	1.495	1.000	1.495	0.090	0.135	15.667	✓
11	8:07 PM	6.600	0.6	0.400	0.600	0.240	80	0.006	1.000	0.006	0.120	0.001	0.084	✓
12	8:12 PM	6.900	0.6	0.300	0.600	0.180	80	0.965	1.000	0.965	0.090	0.087	10.114	✓
13	8:13 PM	7.200	0.6	0.300	0.600	0.180	80	0.145	1.000	0.145	0.090	0.013	1.521	✓
14	8:15 PM	7.500	0.6	0.300	0.600	0.180	80	1.455	1.000	1.455	0.090	0.131	15.247	✓
15	8:16 PM	7.800	0.6	0.300	0.600	0.180	80	0.312	1.000	0.312	0.090	0.028	3.274	✓
16	8:18 PM	8.100	0.6	0.300	0.600	0.180	80	0.421	1.000	0.421	0.090	0.038	4.417	✓
17	8:19 PM	8.400	0.6	0.350	0.600	0.210	80	0.362	1.000	0.362	0.105	0.038	4.432	✓
18	8:21 PM	8.700	0.6	0.400	0.600	0.240	80	0.455	1.000	0.455	0.120	0.055	6.359	✓
19	8:22 PM	9.000	0.6	0.400	0.600	0.240	80	0.296	1.000	0.296	0.120	0.036	4.138	✓
20	8:23 PM	9.300	0.6	0.350	0.600	0.210	80	0.440	1.000	0.440	0.105	0.046	5.375	✓
21	8:24 PM	9.600	0.6	0.350	0.600	0.210	80	0.051	1.000	0.051	0.105	0.005	0.618	✓
22	8:26 PM	9.900	0.6	0.250	0.600	0.150	80	-0.121	1.000	-0.121	0.188	-0.023	-2.652	✓
23	8:29 PM	11.100	None	0.000	0.000	0.000	0	0.000		-0.121	0.000	0.000	0.000	✓

Discharge Measurement Summary

Site name	Whubbard
Site number	082123
Operator(s)	MS
File name	Whubbard_20230821-203151.ft
Comment	

Quality Control Settings	
Maximum depth change	50.000%
Maximum spacing change	100.000%
SNR threshold	10.000 dB
Standard error threshold	0.033 ft/s
Spike threshold	10.000%
Maximum velocity angle	20.000 deg
Maximum tilt angle	5.000 deg

Quality control warnings

St#	Time	Location (ft)	Method	Depth (ft)	%Depth	Measured Depth (ft)	Warnings
1	7:42 PM	3.800	0.6	0.600	0.600	0.360	Standard Error > QC
3	7:51 PM	4.200	0.6	0.450	0.600	0.270	Boundary Interference,High % Spikes
4	7:53 PM	4.500	0.6	0.250	0.600	0.150	Velocity Angle > QC
5	7:55 PM	4.800	0.6	0.300	0.600	0.180	Velocity Angle > QC
8	8:01 PM	5.700	0.6	0.200	0.600	0.120	Standard Error > QC,High Stn % Discharge
9	8:03 PM	6.000	0.6	0.200	0.600	0.120	Standard Error > QC
10	8:05 PM	6.300	0.6	0.300	0.600	0.180	High Stn % Discharge
11	8:07 PM	6.600	0.6	0.400	0.600	0.240	Beam SNRs Not Similar,High % Spikes
12	8:12 PM	6.900	0.6	0.300	0.600	0.180	High Stn % Discharge
13	8:13 PM	7.200	0.6	0.300	0.600	0.180	Velocity Angle > QC
14	8:15 PM	7.500	0.6	0.300	0.600	0.180	Standard Error > QC,High Stn % Discharge
15	8:16 PM	7.800	0.6	0.300	0.600	0.180	Velocity Angle > QC
16	8:18 PM	8.100	0.6	0.300	0.600	0.180	Velocity Angle > QC
17	8:19 PM	8.400	0.6	0.350	0.600	0.210	Velocity Angle > QC
18	8:21 PM	8.700	0.6	0.400	0.600	0.240	Velocity Angle > QC
19	8:22 PM	9.000	0.6	0.400	0.600	0.240	Velocity Angle > QC
20	8:23 PM	9.300	0.6	0.350	0.600	0.210	Velocity Angle > QC
22	8:26 PM	9.900	0.6	0.250	0.600	0.150	Velocity Angle > QC
23	8:29 PM	11.100	None	0.000	0.000	0.000	Stn Spacing > QC

West Hubbard Creek, Cross Section 1, looking downstream.

West Hubbard Creek, Cross Section 1, looking upstream.

West Hubbard Creek, Cross Section 1, looking across from right bank.

West Hubbard Creek, Cross Section 2, looking upstream

West Hubbard Creek, Cross Section 2, looking downstream

West Hubbard Creek, Flow measurement

West Hubbard Creek, Fish habitat overview

West Hubbard Creek, Overview

West Hubbard Creek, Riparian habitat

West Hubbard Creek, Large woody debris in channel

West Hubbard Creek, Macroinvertebrates

West Hubbard Creek, Caddisfly cases

West Hubbard Creek, Step-pool habitat