COLORADO
Parks and Wildlife
Department of Natural Resources

Water Resources Section
6060 Broadway
Denver, CO 80216

January 14, 2020

Ms. Linda Bassi, Chief
Stream and Lake Protection Section
Colorado Water Conservation Board
1313 Sherman Street, Suite 721
Denver CO 80203

Subject: Instream Flow Recommendations for Kelso Creek in Water Division 4, Mesa County to be presented at the January 2020 CWCB Meeting

Dear Ms. Bassi:

The information contained in and referred to in this letter forms the scientific and biological basis for an instream flow (ISF) recommendation on Kelso Creek in Water Division 4. The field investigations quantifying this ISF recommendation were conducted by Colorado Parks and Wildlife (CPW) personnel in 2019. Instream flow investigations on this stream were initiated in 2013 by US Forest Service personnel because of the rare and valuable cutthroat trout population residing in Kelso Creek. This population is a "core conservation population" of Colorado River cutthroat trout indicating the fish in this population are genetically unaltered. Kelso Creek is a challenging geomorphological setting for data collection, so the recommendation was postponed until 2019 to continue to collect field data and refine the recommendation. This stream reach was presented to interested parties at a number of past ISF Workshops and outreach was conducted to the Mesa County Commissioners during a meeting in November 2019. 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 Kelso Creek and to specifically address the findings required in Rule 5(i) of the Instream Flow Program Rules.

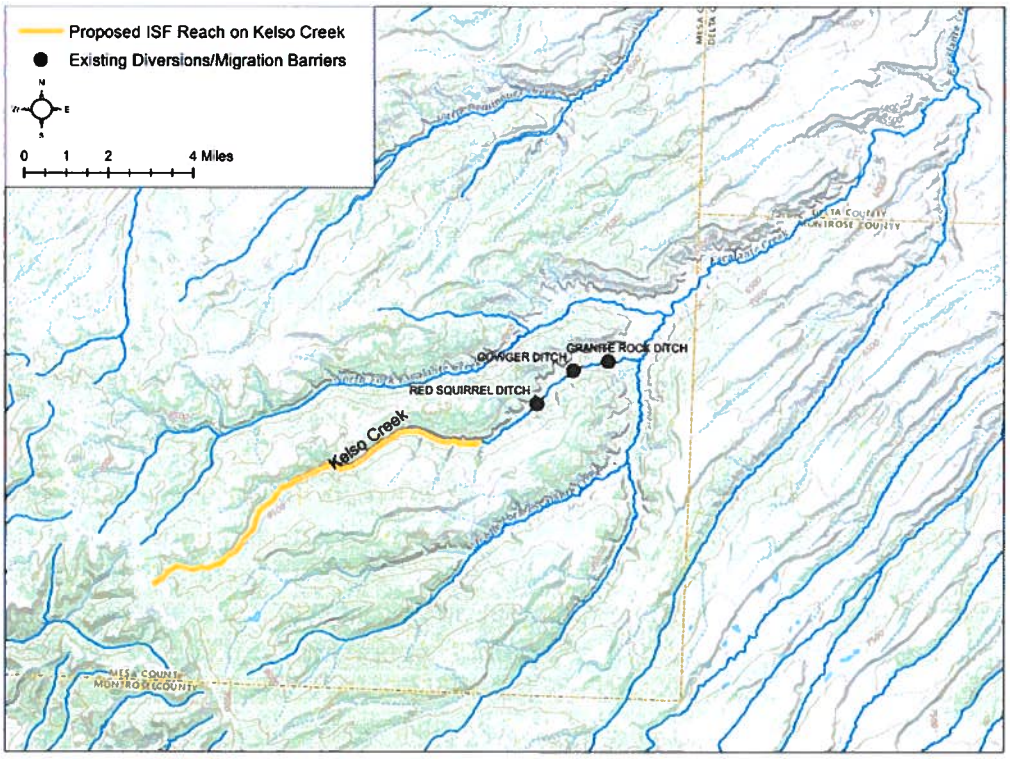
CPW participates in the ISF Program and develops instream flow recommendations for the Board's consideration in an effort to address CPW's legislative declarations "... that the wildlife and their environment are to be protected, preserved, enhanced, and managed for the use, benefit, and enjoyment of 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" (See §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." (See §33-10-101 (1) C.R.S.).

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

Recommended Segments

As shown below, CPW is proposing an ISF recommendation on Kelso Creek from its headwaters (UTM 13S 185287 4271192) to the confluence with Bear Gulch (UTM 13S 197852 4276621). The reach is approximately 10 miles in length. Nearly all of the proposed reach is on public lands managed as part of the Grand Mesa, Uncompahgre, and Gunnison National Forests. Close to the Kelso Creek's headwaters, CPW manages the White Hawk State Wildlife Area, which was acquired by land swap in 2017. There is another small private land inholding accounting for 0.4 miles of the proposed reach.



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 some of these objectives can be addressed with an instream flow water right on Kelso Creek, which is known to support a core conservation population of the Gunnison basin lineage of the CRCT. Information about the species and Conservation Strategy can be found here: https://cpw.state.co.us/learn/Pages/ResearchColoradoRiverCutthroatTrout.aspx.

Natural Environment and Biological Summary

Kelso Creek is a tributary of Escalante Creek located west of the town of Olathe. The stream drains northeasterly off the Uncompahgre Plateau. The stream's hydrology is dominated by snowmelt; the basin receives approximately 22 inches of precipitation a year. The drainage basin contributing to the ISF reach is approximately 17 square miles in size. It is forested, mainly containing stands of aspen interspersed with pinyon-juniper woodland. Kelso Creek supports a healthy riparian area consisting of narrowleaf cottonwood, gray alder, and willow.

Kelso Creek is a first to second order headwaters stream. The stream is a relatively low gradient, mainly single thread channel with substrate size that ranges from sand to cobble. The reach has a mixture of riffles, runs, glides, and pools, containing suitable fish habitat. There is notable vegetative cover adding complexity and temperature buffering during periods of low flow. The creek supports a diverse macroinvertebrate community including mayflies, stoneflies, and caddisflies, which were observed in the field.

The resident trout population in Kelso Creek are a core conservation population of CRCT, meaning genetic analyses indicate greater than 99% purity. CRCT are state species of special concern and considered federally sensitive by the BLM and USFS (State Wildlife Action Plan, 2015). The Kelso Creek population is physically isolated from trout in Escalante Creek due to a number of diversions on lower Kelso Creek that act as migration barriers. The population has such notably pure genetics that they are being replicated as a source population for CPW's cutthroat trout conservation and restoration efforts in the Gunnison River basin. Length-frequency data surveyed by CPW in 2011 shows multiple age classes of fish, indicating the cutthroat trout in Kelso Creek are a self-sustaining population (see attached).

R2Cross Background

Initial biological instream flow recommendations were developed using the R2Cross methodology (Espegren, 1996). R2Cross uses field data that has been collected in a riffle habitat type. Riffles are often the limiting habitat type in streams during low flow events, so maintaining specific conditions across riffle habitat types will also maintain aquatic habitat in pools and runs for most life stages of fish and macroinvertebrates (Nehring, 1979). 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 Manning's equation 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 from riffle to riffle 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). The Manning's equation relies on a roughness coefficient computed with information collected at the time of the survey, so the most accurate application of the model is for flows ranging between 40 to 250 percent of the surveyed flow.

Initial Biological Flow Recommendation Based on 2019 Survey Data

It is important to note that a number of past R2Cross efforts were unable to achieve model results satisfying the hydraulic criteria used to determine winter and summer flow rates. Model results for many of the past cross sections were out of range or did not reach the needed 1 foot per second (ft/s) velocity criteria. Maintaining adequate velocity over the summer period is important for the reproductive success of the Kelso Creek cutthroat trout population. In order to determine the required summer flows, investigations in 2019 sought to survey earlier in the season when the velocity criteria could be met within the model's suggested accuracy range.

In June 2019, CPW collected two cross-section data sets on Kelso Creek at a higher flow range than past efforts. The results of the R2CROSS analysis are summarized below.

	Bankfull Channel Width	**Date Measured**	**Flow Measured**	**Model Accuracy Range**	**Flow Meeting Two Criteria**	**Flow Meeting Three Criteria**
XS-1	14.6 ft	6/25/2019	6.5 cfs	2.6 – 16.4 cfs	Out of Range	2.63 cfs
XS-2	14.0 ft	6/25/2019	4.9 cfs	1.97 – 12.3 cfs	Out of Range[1]	2.07 cfs
				Mean		**2.35 cfs**

[1]The flow meeting 2 of 3 hydraulic criteria is out of range. The lowest in range streamflow for the modeling results is 1.97 cfs.

Based on 2019 field investigations, the initial biological recommendation is 2.4 cfs in the summer, which maintains an average of 1 ft/s velocity, average depth of at least 0.2 feet, and at least 50 percent wetted perimeter in the stream channel. Numerous field trips over a five year period

were unable achieve in range model results that satisfy two of the three hydraulic criteria used to determine winter flow rates. However, the lowest in range modeled flow (1.97 cfs) is the closest to meeting two of the three criteria. Using this value results in protecting an average depth that is slightly higher than the typical depth criteria for a stream this size (0.24 feet compared to 0.2 feet). It is CPW's opinion that recommending 2.0 cfs (based on standard rounding of 1.97 to the nearest whole number) for the initial biological winter recommendation is reasonable given a number of factors: the value of the Kelso Creek cutthroat trout population; the proven difficulty to achieve in-range model results on Kelso Creek; and importantly because water availability constraints limit this flow rate to 0.85 cfs during the baseflow period.

Water Availability

In order to make a preliminary determination whether water is available for the R2CROSS-based flow recommendations and to determine the appropriate seasonal transition dates, CPW examined basic hydrologic data and water rights information for the Escalante River Basin. There is no gage data on Kelso Creek, so CPW relied upon USGS StreamStats regression estimates for monthly flow estimates and seasonality.

CPW is not aware of any water rights within the proposed reach. There are a number of diversions below the lower terminus of the ISF reach – the Red Squirrel, Cowger, and Granite Rock Ditches. It is our understanding that a number of these structures act as full and partial barriers that have isolated the native species in Kelso Creek and helped to prevent non-native trout from moving upstream into Kelso Creek to compete and/or hybridize. It is in the best interest of the Cutthroat Conservation Strategy and the Kelso Creek resident cutthroat population for these structures to continue their historic operations.

Refined Flow Recommendation

CPW's analysis of this data indicates that the following flows are needed to protect the natural environment to a reasonable degree. Based on the hydrology from StreamStats, there appears to be water availability limitations during the baseflow period from September through March. Therefore, our flow recommendation has been refined based on water availability to the following:

- Summer Flow Recommendation: 2.4 cfs (April 1 through August 31)
    - Maintains adequate depth, velocity, and wetted perimeter during the critical time period when the eggs are incubating in the gravel.
- Baseflow Recommendation: 0.85 cfs (September 1 through March 31)
    - The flow recommendation is reduced due to water availability constraints, but should provide adequate flows over the baseflow period to maintain habitat and provide connectivity.

The purpose of this letter is to formally transmit this ISF recommendation to CWCB for the Board's consideration. CPW has determined that there is a flow-dependent natural environment in Kelso Creek. CPW believes this stream 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 present at the January 2020 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

Water **46082** **Kelso Creek** Date **9/21/2011**

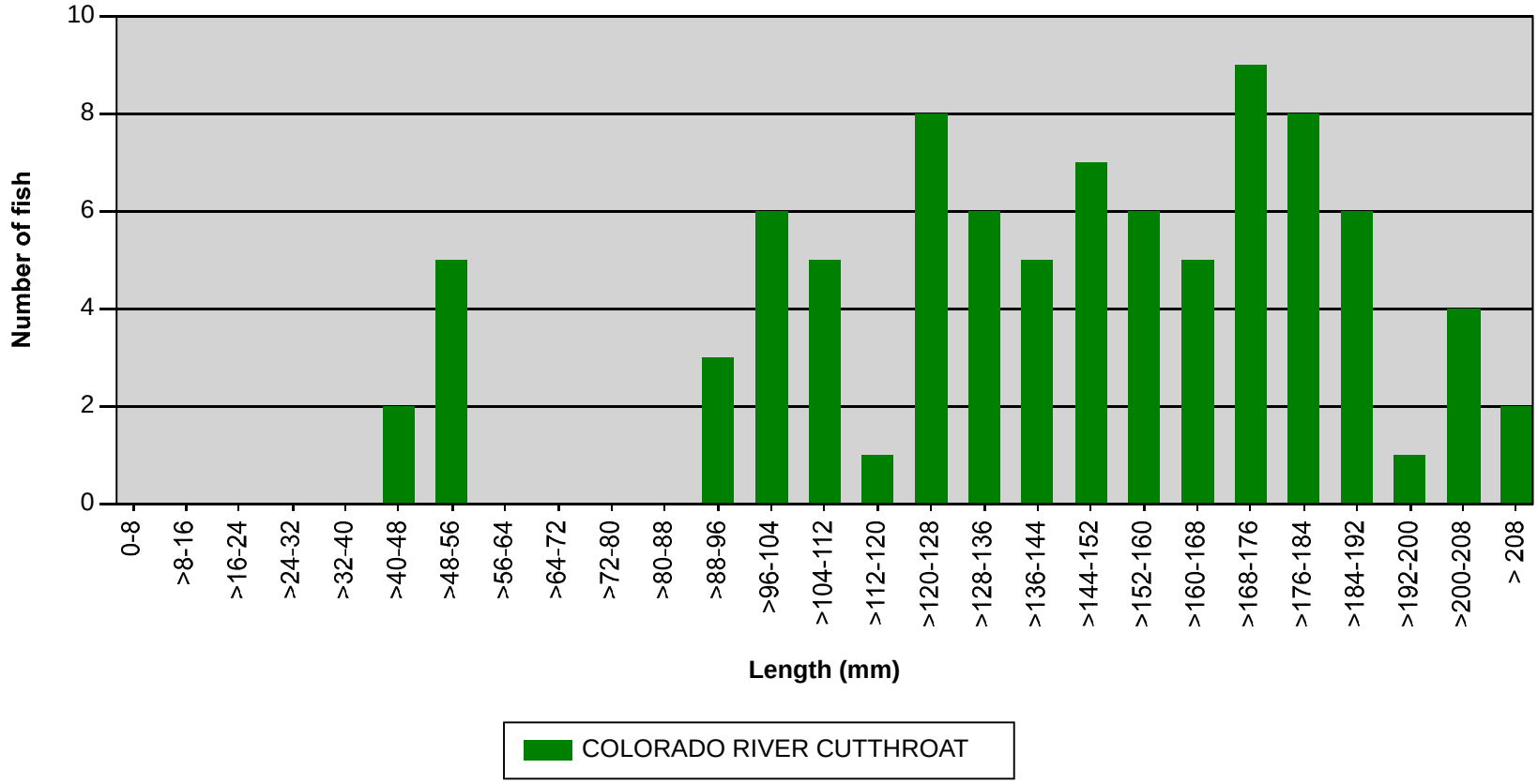
Station **GU2766** **1.4 KM BLW FS RD 421.1A**

Drainage **Gunnison River** UtmX **711720** UtmY **4269803** Elevation **2525 m**

Length **84 m** Width **1.77 m** Area **0.01 Ha**

Surveyors **M Dare, M Carrillo, M Tracy**

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



COLORADO WATER CONSERVATION BOARD

FIELD DATA FOR INSTREAM FLOW DETERMINATIONS

LOCATION INFORMATION

STREAM NAME: Kelso Creek					CROSS-SECTION NO.: 2
CROSS-SECTION LOCATION: Near Trail Xing					
DATE: 6/25/19	OBSERVERS: Birch Gardunio Anderson Kimber				
LEGAL DESCRIPTION	¼ SECTION:	SECTION:	TOWNSHIP: N/S	RANGE: E/W	PM:
COUNTY:	WATERSHED:	WATER DIVISION:	DOW WATER CODE:		
MAP(S): USGS: See UTM loc.	USFS:				

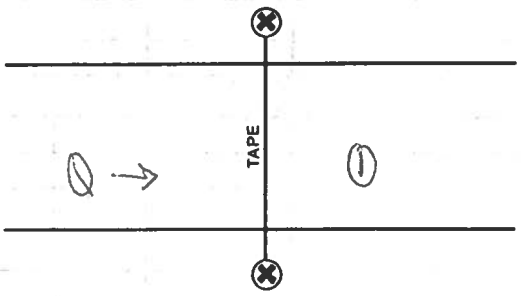
SUPPLEMENTAL DATA

SAG TAPE SECTION SAME AS DISCHARGE SECTION: (YES) NO	METER TYPE: Marsh Mc Birney			
METER NUMBER:	DATE RATED:	CALIB/SPIN: ____ sec	TAPE WEIGHT: ____ lbs/foot	TAPE TENSION: ____ lbs
CHANNEL BED MATERIAL SIZE RANGE: Sand, gravel, cobble	PHOTOGRAPHS TAKEN: (YES) NO	NUMBER OF PHOTOGRAPHS:		

CHANNEL PROFILE DATA

STATION	DISTANCE FROM TAPE (ft)	ROD READING (ft)
⊗ Tape @ Stake LB	0.0	
⊗ Tape @ Stake RB	0.0	
① WS @ Tape LB/RB	0.0	4.42/4.43
② WS Upstream	> 162	4.40
③ WS Downstream		4.81
SLOPE		

SKETCH



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

AQUATIC SAMPLING SUMMARY

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

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

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

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

COMMENTS

FORM #105-ED-1-85

DISCHARGE/CROSS SECTION NOTES

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

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

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		
S	0		1.65								
BF	2.2		3.5								
WS	4.5		4.43	0					0		
	5		4.7	.35					0.98		
	5.5		4.7	.35					1.16		
	6		4.75	.4					1.37		
	6.5		4.8	.45					1.36		
	7		4.75	.45					1.53		
	7.5		4.75	.4					1.6		
	8		4.85	.5					1.43		
	8.5		4.85	.5					1.55		
	9		4.9	.5					1.53		
	9.5		4.9	.5					1.63		
	10		4.9	.5					1.53		
	10.5		4.8	.4					1.2		
	11		4.8	.4					1.22		
	11.5		4.8	.4					1.43		
	12		4.8	.4					1.54		
	12.5		4.75	.35					1.03		
	13		4.75	.35					1.16		
WS	13.1		4.42	0					0		
BF	17.0		3.25								
	17.4		3.45								
	27.1		2.85								
TOTALS:											

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

COLORADO WATER CONSERVATION BOARD

FIELD DATA FOR INSTREAM FLOW DETERMINATIONS

COLORADO DIVISION OF WILDLIFE

LOCATION INFORMATION

STREAM NAME: Kelso Creek					CROSS-SECTION NO.: 1
CROSS-SECTION LOCATION: near Trail Xing					
DATE: 6/25/19	OBSERVERS: Birch, Gardunio, J Anderson, A Kimber, Kelso Pup				
LEGAL DESCRIPTION	¼ SECTION:	SECTION:	TOWNSHIP: N/S	RANGE: E/W	PM:
COUNTY:	WATERSHED:	WATER DIVISION:	DOW WATER CODE:		
MAP(S): USGS: See Lat/Long	USFS:				

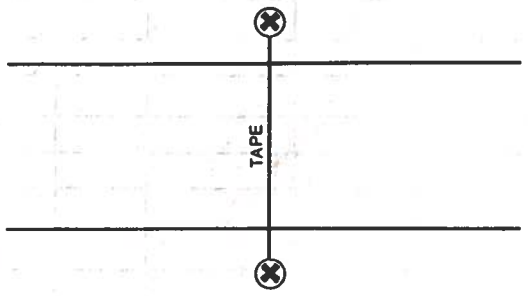
SUPPLEMENTAL DATA

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

CHANNEL PROFILE DATA

STATION	DISTANCE FROM TAPE (ft)	ROD READING (ft)
⊗ Tape @ Stake LB	0.0	~
⊗ Tape @ Stake RB	0.0	~
① WS @ Tape LB/RB	0.0	5.72/5.76
② WS Upstream	9.6 >	5.62
③ WS Downstream	1	5.85
SLOPE		

SKETCH



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

AQUATIC SAMPLING SUMMARY

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

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

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

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

COMMENTS

DISCHARGE/CROSS SECTION NOTES

STREAM NAME: Kelso Creek	CROSS-SECTION NO.: 1	DATE:	SHEET ___ OF ___
BEGINNING OF MEASUREMENT	EDGE OF WATER LOOKING DOWNSTREAM: (0.0 AT STAKE) LEFT / RIGHT	Gage Reading: _____ ft	TIME:

Features: Stake (S) Grassline (G) Waterline (W) Rock (R)	Distance From Initial Point (ft)	Width (ft)	Total Vertical Depth From Tape/Inst (ft)	Water Depth (ft)	Depth of Observation (ft)	Revolutions	Time (sec)	Velocity (ft/sec) At Point	Velocity (ft/sec) Mean in Vertical	Area (ft^2)	Discharge (cfs)
S	0		3.72								
BF	0.7		4.91								
W	1.4		5.67	Ø							
	1.6		6.02	0.3					0.04		
	2.0		6.16	0.5					1.30		
	2.5		6.08	0.4					2.08		
	3.0		6.06	0.4					2.17		
	3.5		6.02	0.4					2.52		
	4.0		6.00	0.4					2.49		
	4.5		5.94	0.3					2.10		
	5.0		5.98	0.3					2.02		
	5.5		5.98	0.3					2.83		
	6.0		5.96	0.3					2.34		
	6.5		5.97	0.3					2.68		
	7.0		6.06	0.4					2.16		
	7.5		5.95	0.3					2.49		
	8.0		6.04	0.4					1.92		
	8.5		6.02	0.4					1.66		
	9.0		5.96	0.3					1.84		
	9.5		5.99	0.3					1.40		
	10.0		6.05	0.4					2.13		
	10.5		5.97	0.3					1.21		
W	10.9		5.71	Ø							
	12.8		5.10								
BF	15.7		4.88								
	23.2		4.70								
	30.7		3.00								
TOTALS:											

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

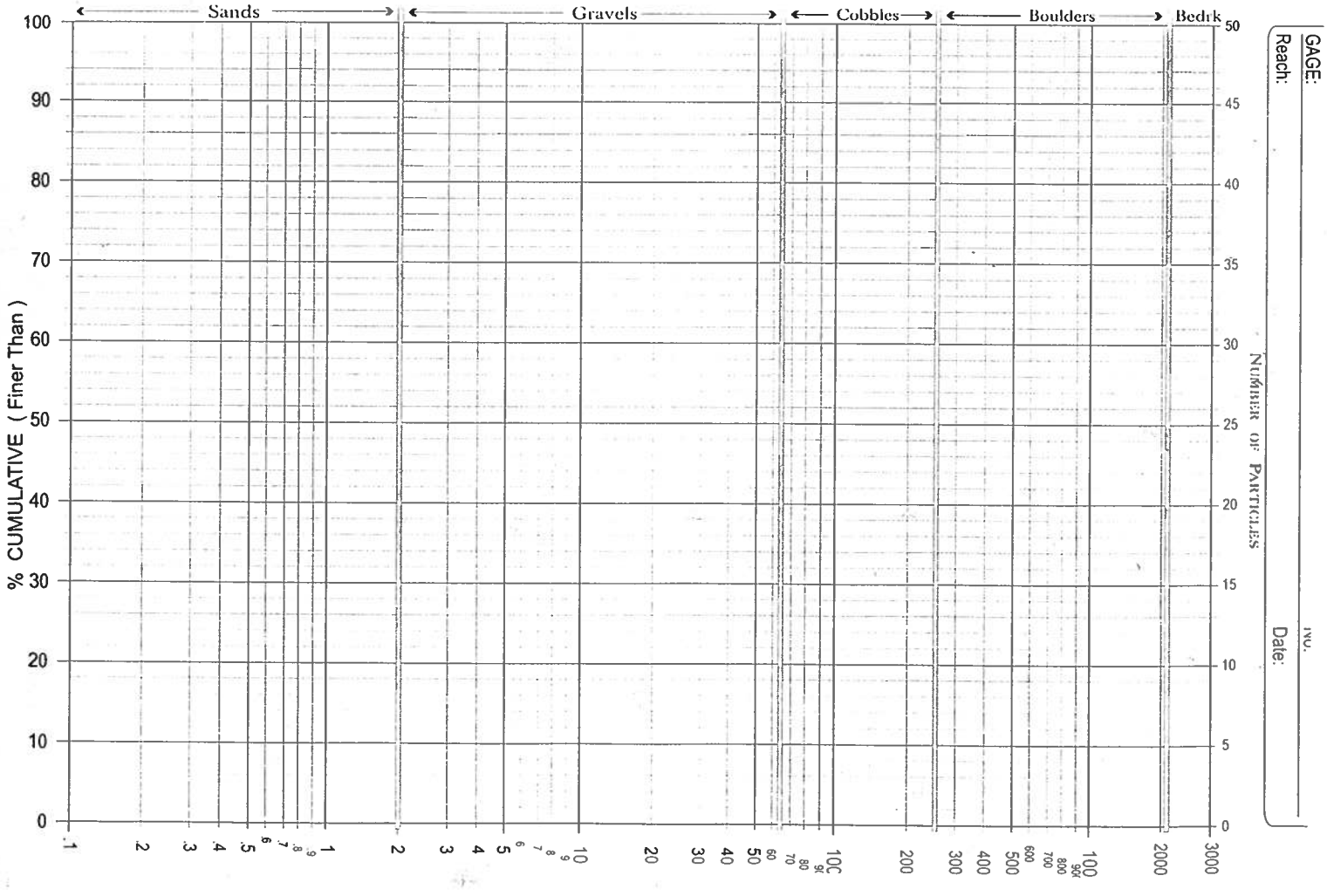
PEBBLE COUNT

Site: Kelso
Reach: 1
Party: Birch, Gordanier, Anderson
Date:

Inches	PARTICLE	Millimeters		PARTICLE COUNT 1 (Site 1)	PARTICLE COUNT 2 (Site 2)	PARTICLE COUNT 3	TOT #	ITEM %	% CUM
	Silt / Clay	< .062	SAND						
	Very Fine	.062 - .125	SAND						
	Fine	.125 - .25	SAND						
	Medium	.25 - .50	SAND						
	Coarse	.50 - 1.0	SAND						
.04 - .08	Very Coarse	1.0 - 2	SAND	2	2				
.08 - .16	Very Fine	2 - 4	GRAVEL						
.16 - .22	Fine	4 - 5.7	GRAVEL	2					
.22 - .31	Fine	5.7 - 8	GRAVEL	7	2				
.31 - .44	Medium	8 - 11.3	GRAVEL	9	4				
.44 - .63	Medium	11.3 - 16	GRAVEL	12	5				
.63 - .89	Coarse	16 - 22.6	GRAVEL	10	20				
.89 - 1.26	Coarse	22.6 - 32	GRAVEL	14	14				
1.26 - 1.77	Very Coarse	32 - 45	GRAVEL	17	10				
1.77 - 2.5	Very Coarse	45 - 64	GRAVEL	14	23				
2.5 - 3.5	Small	64 - 90	COBBLE	9	9				
3.5 - 5.0	Small	90 - 128	COBBLE	4	7				
5.0 - 7.1	Large	128 - 180	COBBLE		2				
7.1 - 10.1	Large	180 - 256	COBBLE		1				
10.1 - 14.3	Small	256 - 362	BOULDER		1				
14.3 - 20	Small	362 - 512	BOULDER						
20 - 40	Medium	512 - 1024	BOULDER						
40 - 80	Large-Vry Large	1024 - 2048	BOULDER						
	Bedrock		BEDROCK						
						TOTALS →			

PEBBLE COUNT — Reach: — Date: — TOT # | ITEM % | % CUM

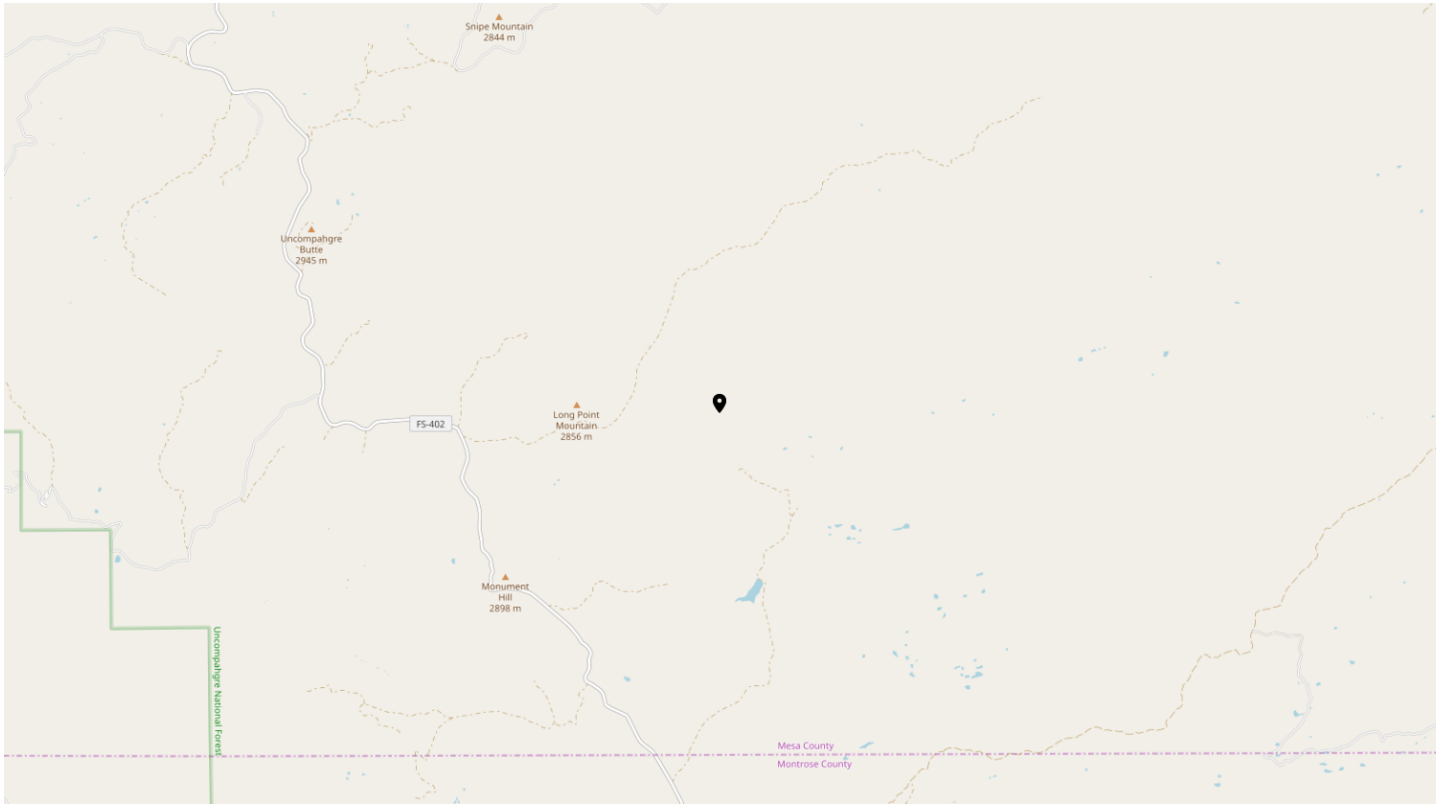
PEBBLE COUNT — Reach: — Date: — TOT # | ITEM % | % CUM



R2Cross RESULTS

Stream Name: Kelso Creek
Stream Locations: Near Trail Crossing
Fieldwork Date: 06/25/2019
Cross-section: 1
Observers: Birch Gardunio Anderson, Kimber
Coordinate System: UTM Zone 12
X (easting): 711645
Y (northing): 4269720
Date Processed: 12/06/2019
Slope: 0.0238
Computation method: Manning's n
R2Cross data filename: R2CrossData_Kelso1-6-25-2019.xlsx
R2Cross version: 1.0.10

LOCATION



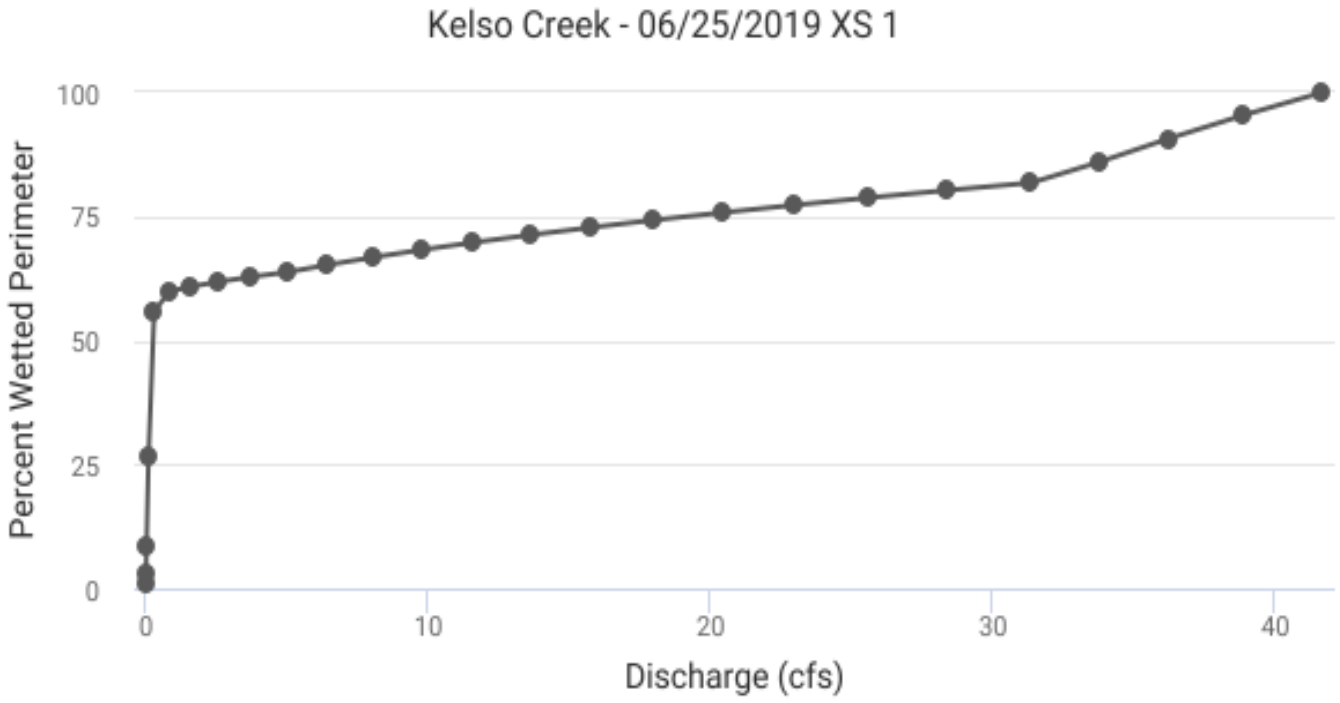
ANALYSIS RESULTS

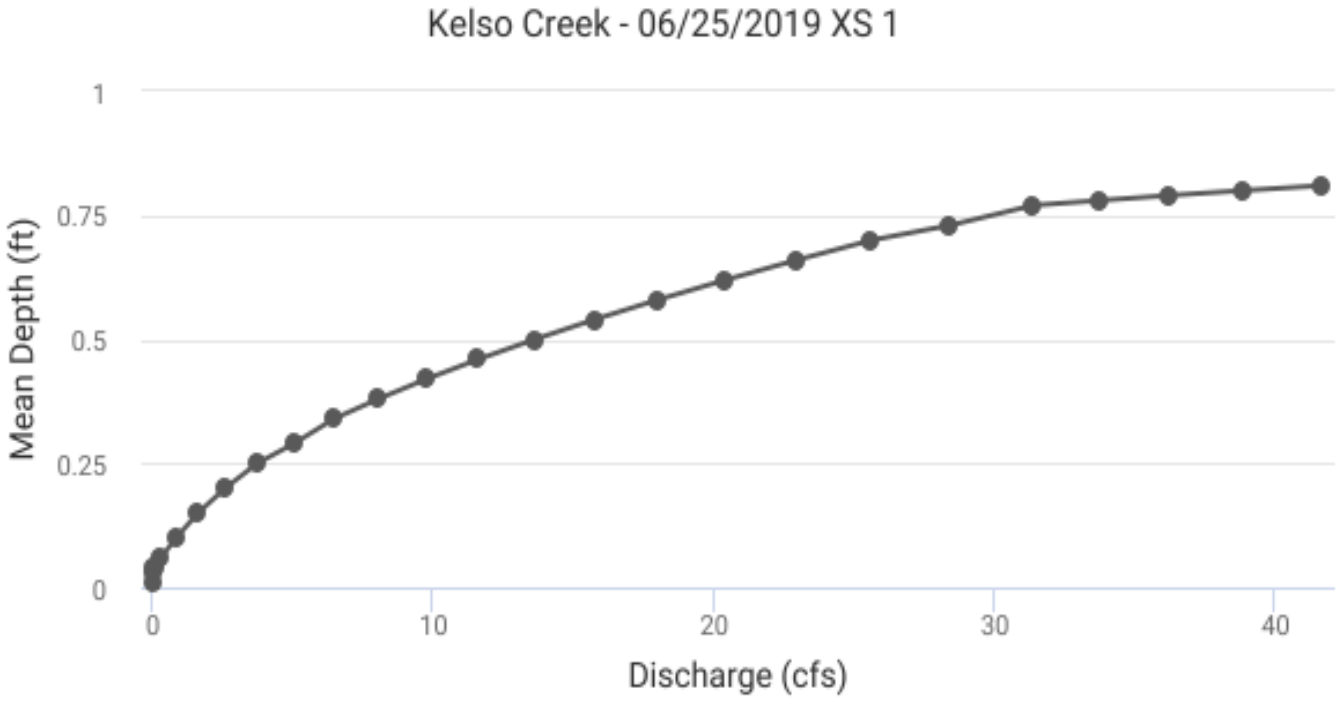
Habitat Criteria Results

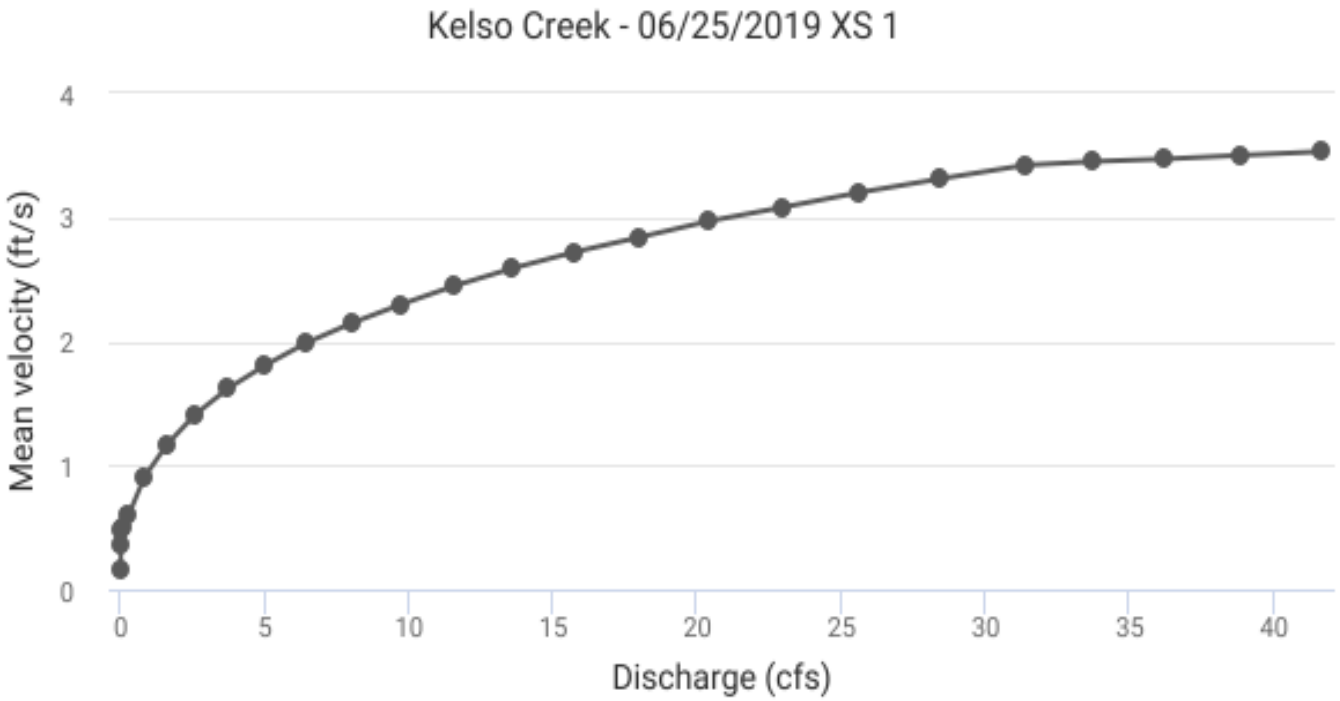
Bankfull top width (ft) = 14.6

	Habitat Criteria	Discharge (cfs) Meeting Criteria
Mean Depth (ft)	0.2	2.63
Percent Wetted Perimeter (%) **	50.0	0.25
Mean Velocity (ft/s) **	1.0	1.11

**Values highlighted in yellow indicate that the discharge is less than 40% of measured Q or greater than 250% of measured Q.




Kelso Creek - 06/25/2019 XS 1
Mean Depth (ft)
1
0.75
0.5
0.25
0
0
10
20
30
40
Discharge (cfs)


Kelso Creek - 06/25/2019 XS 1
Mean velocity (ft/s)
4
3
2
1
0
0
5
10
15
20
25
30
35
40
Discharge (cfs)

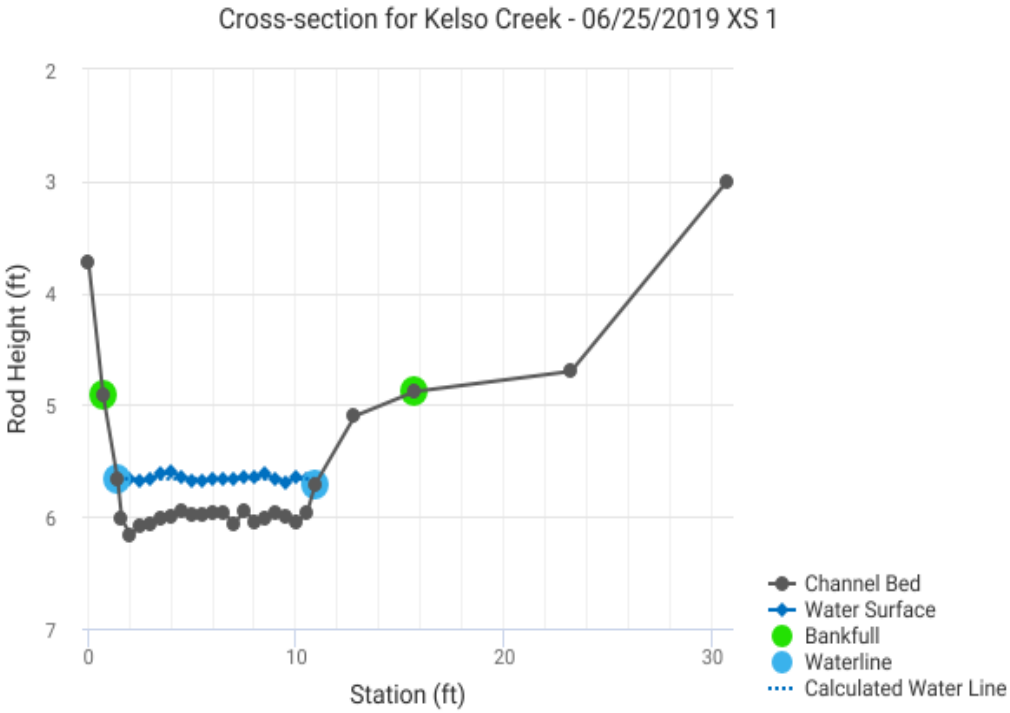
STAGING TABLE

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)	Mean Velocity (ft/s)	Discharge (cfs)
Bankfull	4.91	14.6	0.81	1.25	11.8	15.4	100.00%	0.77	3.53	41.69
	4.96	13.92	0.8	1.2	11.11	14.69	95.39%	0.76	3.5	38.88
	5.01	13.21	0.79	1.15	10.43	13.96	90.65%	0.75	3.47	36.22
	5.06	12.51	0.78	1.1	9.79	13.23	85.92%	0.74	3.45	33.76
	5.11	11.89	0.77	1.05	9.18	12.59	81.75%	0.73	3.42	31.36
	5.16	11.69	0.73	1.0	8.59	12.36	80.25%	0.69	3.31	28.42
	5.21	11.49	0.7	0.95	8.01	12.13	78.75%	0.66	3.2	25.62
	5.26	11.28	0.66	0.9	7.44	11.9	77.24%	0.63	3.08	22.95
	5.31	11.08	0.62	0.85	6.88	11.67	75.74%	0.59	2.97	20.42
	5.36	10.88	0.58	0.8	6.33	11.43	74.24%	0.55	2.84	18.01
	5.41	10.68	0.54	0.75	5.79	11.2	72.73%	0.52	2.72	15.74
	5.46	10.48	0.5	0.7	5.26	10.97	71.23%	0.48	2.59	13.61
	5.51	10.28	0.46	0.65	4.75	10.74	69.73%	0.44	2.45	11.61
	5.56	10.07	0.42	0.6	4.24	10.51	68.22%	0.4	2.3	9.75
	5.61	9.87	0.38	0.55	3.74	10.28	66.72%	0.36	2.15	8.04
Waterline	5.66	9.67	0.34	0.5	3.25	10.04	65.22%	0.32	1.99	6.46
	5.71	9.48	0.29	0.45	2.77	9.82	63.76%	0.28	1.81	5.03
	5.76	9.37	0.25	0.4	2.3	9.67	62.78%	0.24	1.62	3.72
	5.81	9.27	0.2	0.35	1.83	9.52	61.81%	0.19	1.41	2.58
	5.86	9.16	0.15	0.3	1.37	9.37	60.84%	0.15	1.17	1.61
	5.91	9.06	0.1	0.25	0.92	9.22	59.87%	0.1	0.91	0.83
	5.96	8.47	0.06	0.2	0.47	8.59	55.78%	0.05	0.61	0.29
	6.01	4.08	0.04	0.15	0.18	4.13	26.84%	0.04	0.51	0.09
	6.06	1.32	0.04	0.1	0.05	1.34	8.72%	0.04	0.48	0.02
	6.11	0.47	0.03	0.05	0.01	0.48	3.11%	0.02	0.36	0.0

	6.14	0.14	0.01	0.01	0.0	0.14	0.91%	0.01	0.16	0.0

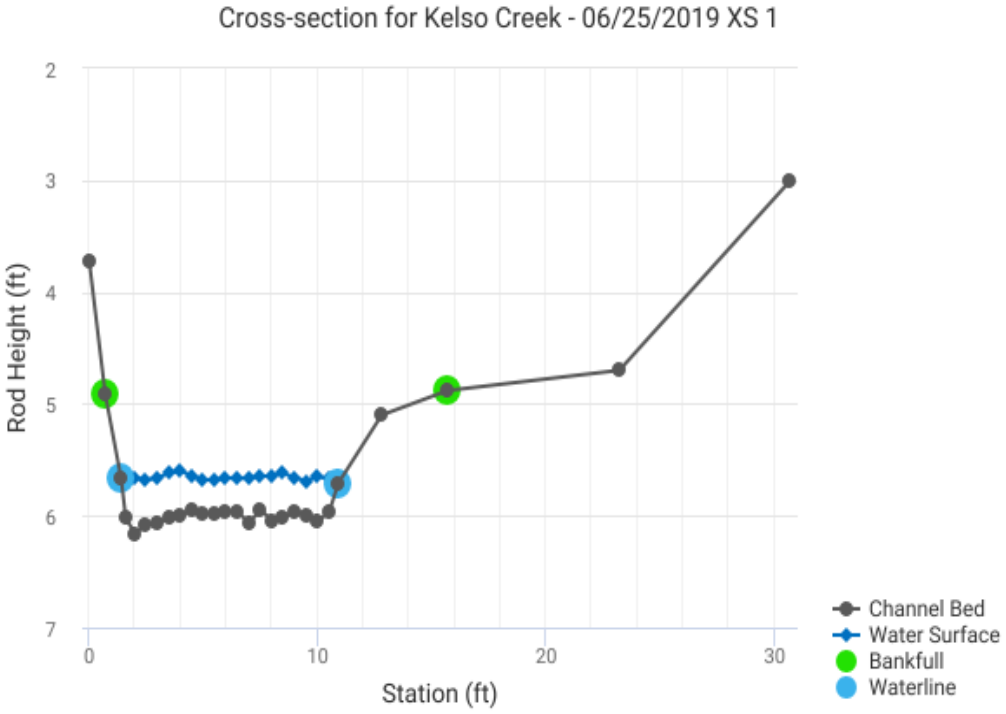
MODEL SUMMARY

Measured Flow (Qm) =	6.54
Calculated Flow (Qc) =	6.46
(Qm-Qc)/Qm * 100 =	1.23%
Measured Waterline (WLm) =	5.69
Calculated Waterline (WLc) =	5.66
(WLm-WLc)/WLm * 100 =	0.55%
Max Measured Depth (Dm) =	0.5
Max Calculated Depth (Dc) =	0.5
(Dm-Dc)/Dm * 100 =	-0.25%
Mean Velocity =	1.99
Manning's n =	0.054
0.4 * Qm =	2.62
2.5 * Qm =	16.35



FIELD DATA

Feature	Station (ft)	Rod Height (ft)	Water depth (ft)	Velocity (ft/s)
	0	3.72		
Bankfull	0.7	4.91		
Waterline	1.4	5.67	0	0
	1.6	6.02	0.3	0.04
	2	6.16	0.5	1.3
	2.5	6.08	0.4	2.08
	3	6.06	0.4	2.17
	3.5	6.02	0.4	2.52
	4	6	0.4	2.49
	4.5	5.94	0.3	2.1
	5	5.98	0.3	2.02
	5.5	5.98	0.3	2.83
	6	5.96	0.3	2.34
	6.5	5.97	0.3	2.68
	7	6.06	0.4	2.16
	7.5	5.95	0.3	2.49
	8	6.04	0.4	1.92
	8.5	6.02	0.4	1.66
	9	5.96	0.3	1.84
	9.5	5.99	0.3	1.4
	10	6.05	0.4	2.13
	10.5	5.97	0.3	1.21
Waterline	10.9	5.71	0	0
	12.8	5.1		
Bankfull	15.7	4.88		
	23.2	4.7		
	30.7	3		


Cross-section for Kelso Creek - 06/25/2019 XS 1
Rod Height (ft)
2
3
4
5
6
7
0
10
20
30
Station (ft)
Channel Bed
Water Surface
Bankfull
Waterline

COMPUTED FROM MEASURED FIELD DATA

Wetted Perimeter (ft)	Water Depth (ft)	Area (SQ ft)	Discharge (cfs)	Percent Discharge
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0.4	0.3	0.09	0	0.06
0.42	0.5	0.23	0.29	4.47
0.51	0.4	0.2	0.42	6.36
0.5	0.4	0.2	0.43	6.64
0.5	0.4	0.2	0.5	7.71
0.5	0.4	0.2	0.5	7.61
0.5	0.3	0.15	0.32	4.82
0.5	0.3	0.15	0.3	4.63
0.5	0.3	0.15	0.42	6.49
0.5	0.3	0.15	0.35	5.37
0.5	0.3	0.15	0.4	6.15
0.51	0.4	0.2	0.43	6.61
0.51	0.3	0.15	0.37	5.71
0.51	0.4	0.2	0.38	5.87
0.5	0.4	0.2	0.33	5.08
0.5	0.3	0.15	0.28	4.22
0.5	0.3	0.15	0.21	3.21
0.5	0.4	0.2	0.43	6.51
0.51	0.3	0.14	0.16	2.5
0.48	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0

DISCLAIMER

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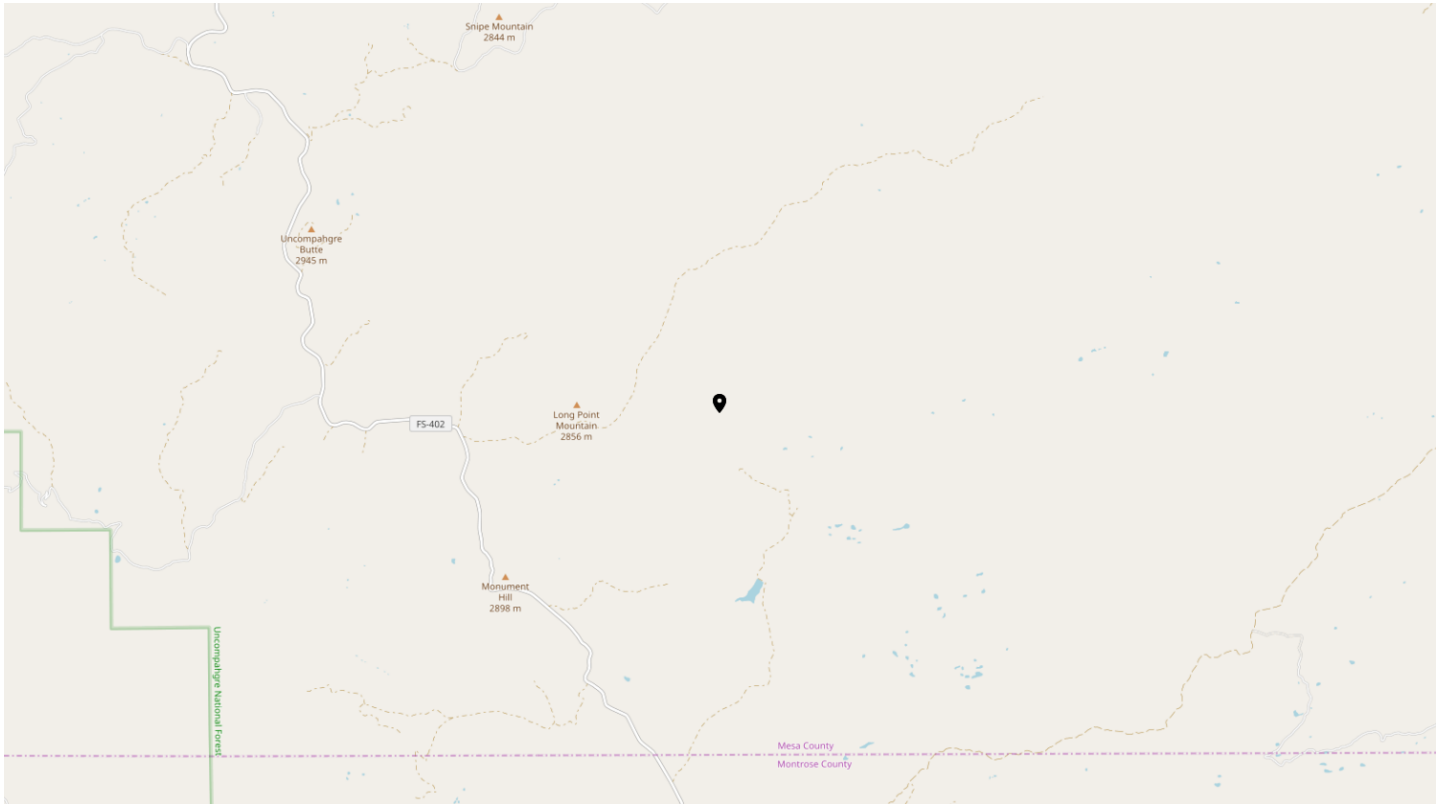
R2Cross RESULTS

Stream Name: Kelso Creek
Stream Locations: Near Trail Crossing
Fieldwork Date: 06/25/2019
Cross-section: 2
Observers: Birch Gardunio Anderson, Kimber
Coordinate System: UTM Zone 12
X (easting): 711682
Y (northing): 4269720
Date Processed: 12/06/2019
Slope: 0.0253
Computation method: Manning's n
R2Cross data filename: R2CrossData_Kelso2-6-25-2019.xlsx
R2Cross version: 1.0.10

LOCATION



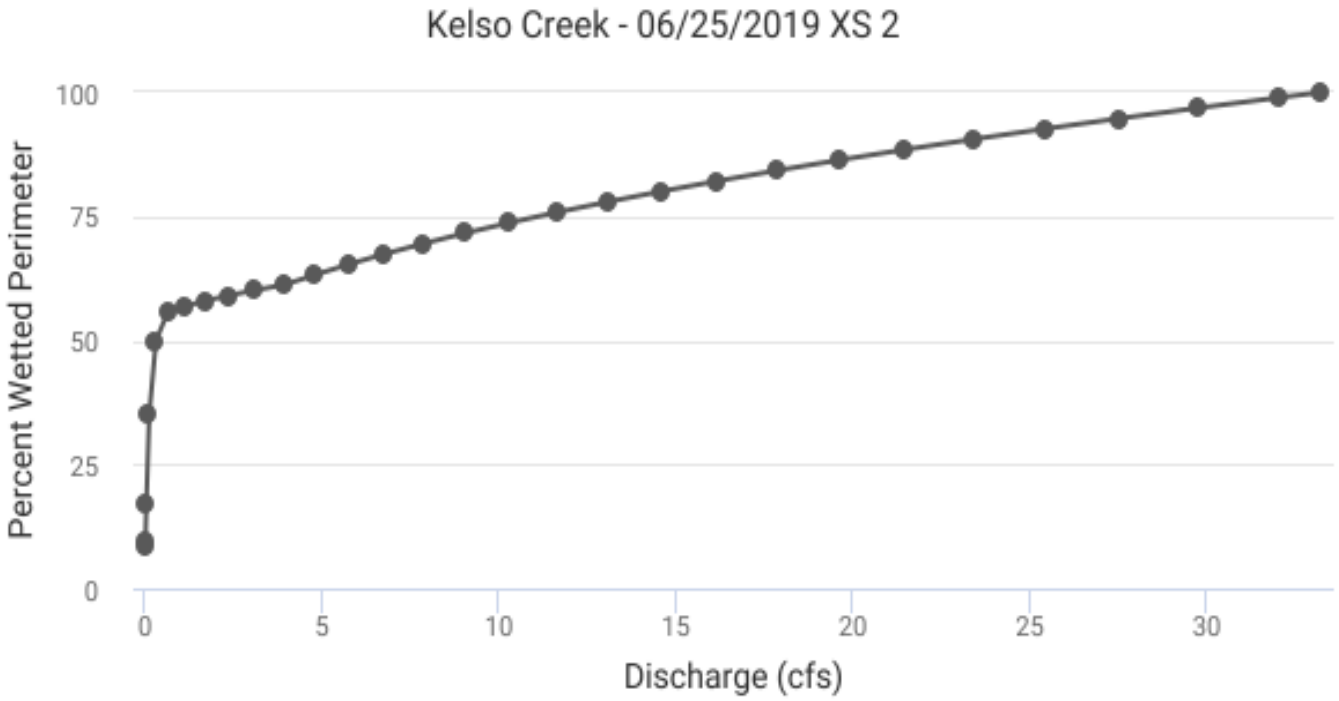
ANALYSIS RESULTS

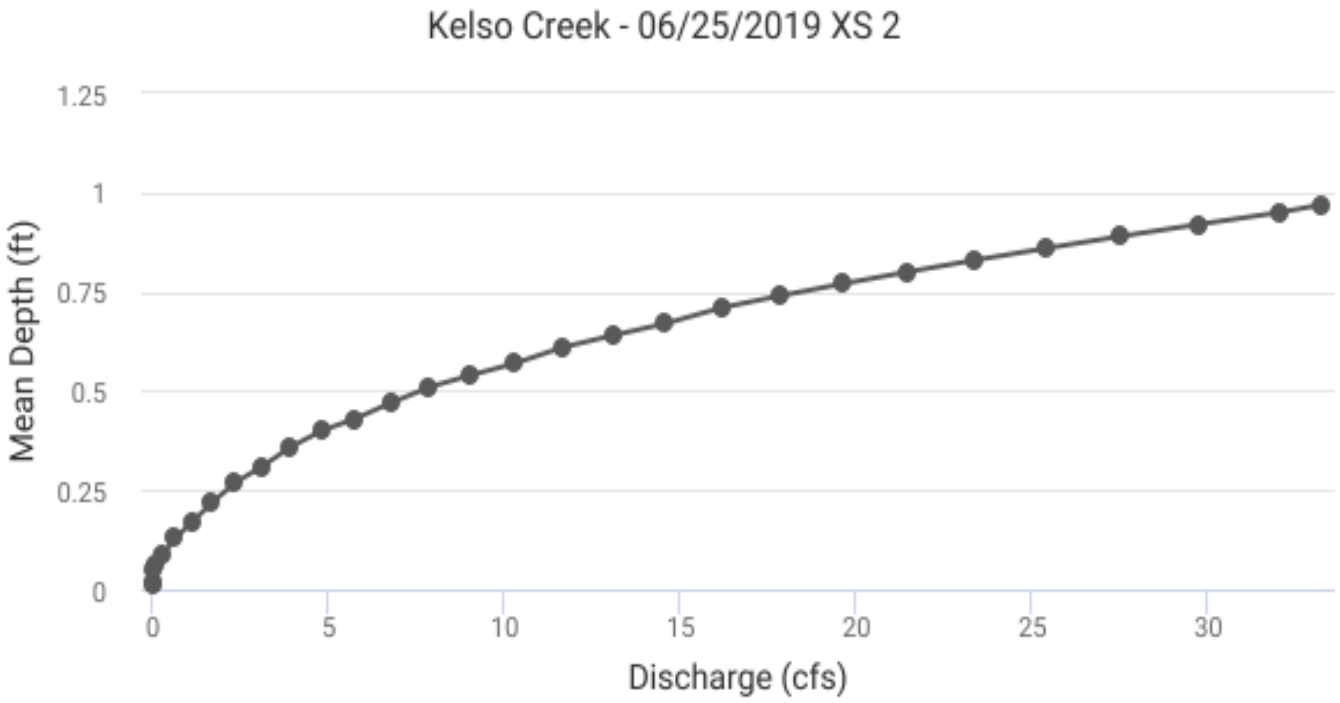
Habitat Criteria Results

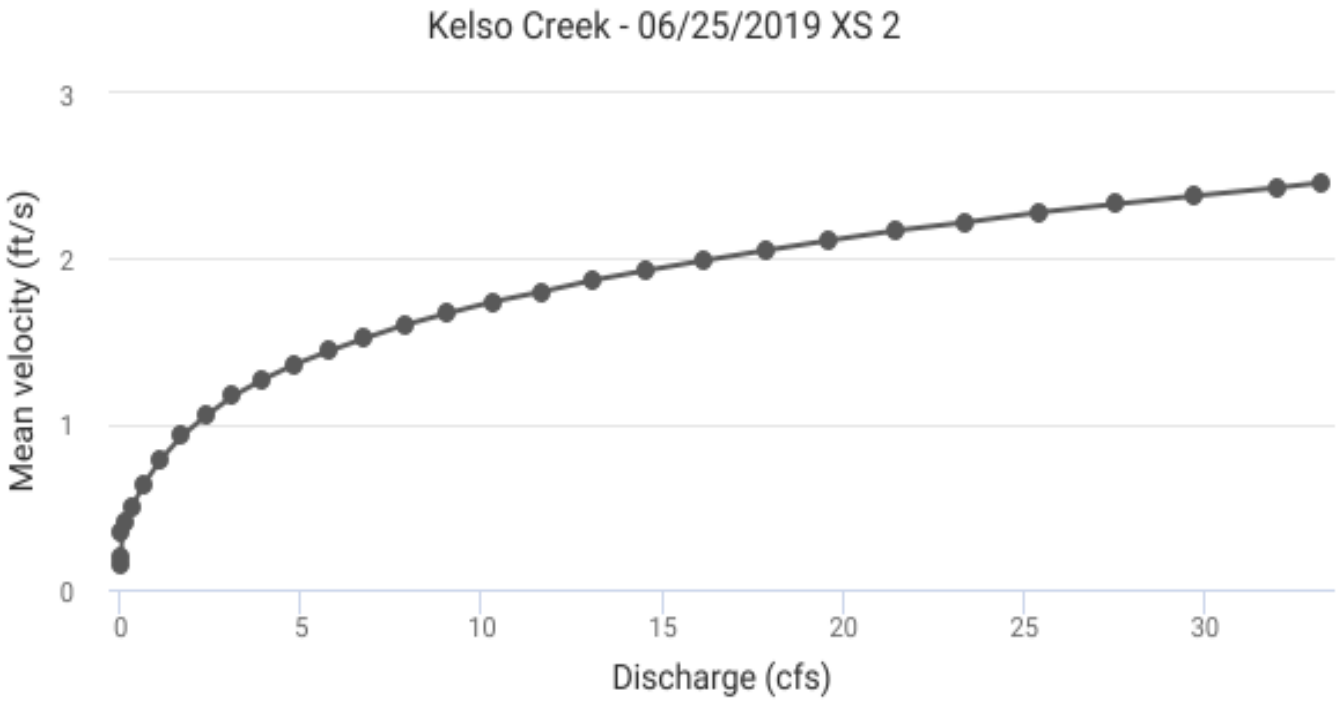
Bankfull top width (ft) = 13.97

	Habitat Criteria	Discharge (cfs) Meeting Criteria
Mean Depth (ft) **	0.2	1.45
Percent Wetted Perimeter (%) **	50.0	0.32
Mean Velocity (ft/s)	1.0	2.07

**Values highlighted in yellow indicate that the discharge is less than 40% of measured Q or greater than 250% of measured Q.




Kelso Creek - 06/25/2019 XS 2
Mean Depth (ft)
1.25
1
0.75
0.5
0.25
0
0
5
10
15
20
25
30
Discharge (cfs)


Kelso Creek - 06/25/2019 XS 2
Mean velocity (ft/s)
3
2
1
0
0
5
10
15
20
25
30
Discharge (cfs)

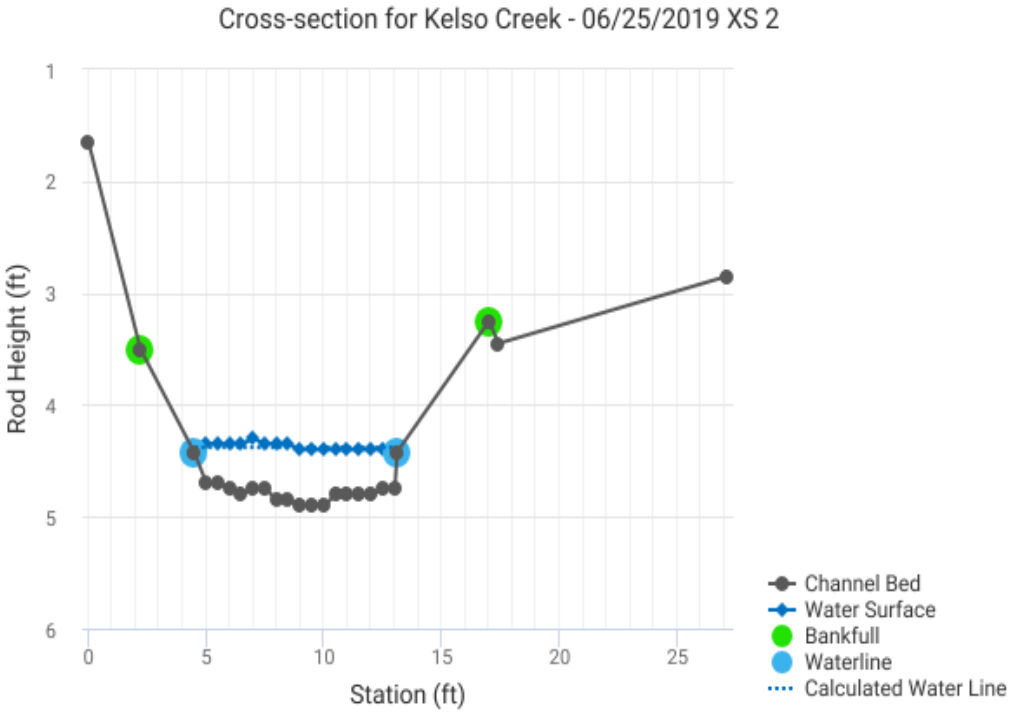
STAGING TABLE

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)	Mean Velocity (ft/s)	Discharge (cfs)
Bankfull	3.5	13.97	0.97	1.4	13.53	14.63	100.00%	0.93	2.46	33.26
	3.53	13.82	0.95	1.37	13.18	14.47	98.92%	0.91	2.43	32.05
	3.58	13.53	0.92	1.32	12.49	14.16	96.82%	0.88	2.38	29.75
	3.63	13.24	0.89	1.27	11.83	13.86	94.72%	0.85	2.33	27.54
	3.68	12.95	0.86	1.22	11.17	13.55	92.62%	0.82	2.28	25.43
	3.73	12.66	0.83	1.17	10.53	13.24	90.52%	0.8	2.22	23.4
	3.78	12.37	0.8	1.12	9.9	12.93	88.42%	0.77	2.17	21.46
	3.83	12.08	0.77	1.07	9.29	12.63	86.32%	0.74	2.11	19.61
	3.88	11.79	0.74	1.02	8.7	12.32	84.21%	0.71	2.05	17.85
	3.93	11.5	0.71	0.97	8.12	12.01	82.11%	0.68	1.99	16.18
	3.98	11.21	0.67	0.92	7.55	11.7	80.01%	0.64	1.93	14.58
	4.03	10.91	0.64	0.87	6.99	11.4	77.91%	0.61	1.87	13.08
	4.08	10.62	0.61	0.82	6.46	11.09	75.81%	0.58	1.8	11.65
	4.13	10.33	0.57	0.77	5.93	10.78	73.71%	0.55	1.74	10.31
	4.18	10.04	0.54	0.72	5.42	10.47	71.61%	0.52	1.67	9.05
	4.23	9.75	0.51	0.67	4.93	10.17	69.50%	0.48	1.6	7.87
	4.28	9.46	0.47	0.62	4.45	9.86	67.40%	0.45	1.52	6.77
	4.33	9.17	0.43	0.57	3.98	9.55	65.30%	0.42	1.44	5.75
Waterline	4.38	8.88	0.4	0.52	3.53	9.24	63.20%	0.38	1.36	4.81
	4.43	8.61	0.36	0.47	3.09	8.95	61.19%	0.35	1.27	3.94
	4.48	8.5	0.31	0.42	2.67	8.79	60.10%	0.3	1.17	3.11
	4.53	8.39	0.27	0.37	2.24	8.63	59.02%	0.26	1.05	2.36
	4.58	8.28	0.22	0.32	1.83	8.48	57.95%	0.22	0.93	1.7
	4.63	8.18	0.17	0.27	1.42	8.32	56.87%	0.17	0.79	1.12
	4.68	8.07	0.13	0.22	1.01	8.16	55.79%	0.12	0.64	0.65

	4.73	7.25	0.09	0.17	0.62	7.3	49.91%	0.09	0.5	0.31
	4.78	5.1	0.06	0.12	0.31	5.13	35.05%	0.06	0.4	0.12
	4.83	2.49	0.05	0.07	0.13	2.51	17.13%	0.05	0.35	0.04
	4.88	1.37	0.02	0.02	0.03	1.37	9.36%	0.02	0.2	0.01
	4.88	1.22	0.01	0.01	0.02	1.23	8.39%	0.01	0.15	0.0

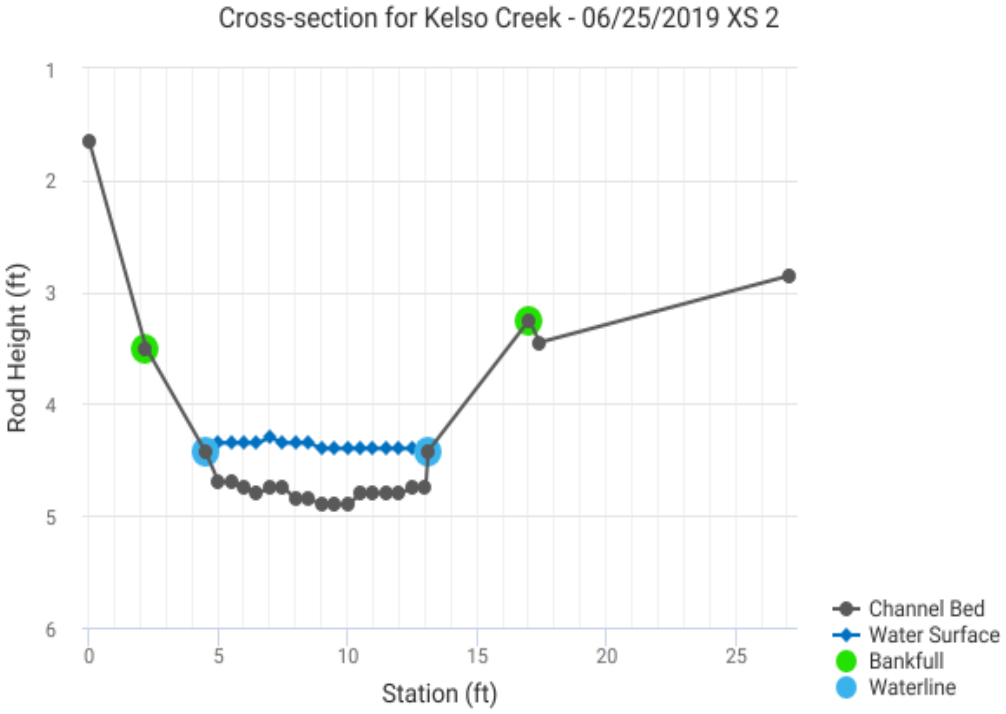
MODEL SUMMARY

Measured Flow (Qm) =	4.92
Calculated Flow (Qc) =	4.81
(Qm-Qc)/Qm * 100 =	2.16%
Measured Waterline (WLm) =	4.42
Calculated Waterline (WLc) =	4.38
(WLm-WLc)/WLm * 100 =	1.12%
Max Measured Depth (Dm) =	0.5
Max Calculated Depth (Dc) =	0.52
(Dm-Dc)/Dm * 100 =	-4.88%
Mean Velocity =	1.36
Manning's n =	0.091
0.4 * Qm =	1.97
2.5 * Qm =	12.29



FIELD DATA

Feature	Station (ft)	Rod Height (ft)	Water depth (ft)	Velocity (ft/s)
	0	1.65		
Bankfull	2.2	3.5		
Waterline	4.5	4.43	0	0
	5	4.7	0.35	0.98
	5.5	4.7	0.35	1.16
	6	4.75	0.4	1.37
	6.5	4.8	0.45	1.36
	7	4.75	0.45	1.53
	7.5	4.75	0.4	1.6
	8	4.85	0.5	1.43
	8.5	4.85	0.5	1.55
	9	4.9	0.5	1.53
	9.5	4.9	0.5	1.63
	10	4.9	0.5	1.53
	10.5	4.8	0.4	1.2
	11	4.8	0.4	1.22
	11.5	4.8	0.4	1.43
	12	4.8	0.4	1.54
	12.5	4.75	0.35	1.03
	13	4.75	0.35	1.16
Waterline	13.1	4.42	0	0
Bankfull	17	3.25		
	17.4	3.45		
	27.1	2.85		


Cross-section for Kelso Creek - 06/25/2019 XS 2
Rod Height (ft)
1
2
3
4
5
6
0
5
10
15
20
25
Station (ft)
Channel Bed
Water Surface
Bankfull
Waterline

COMPUTED FROM MEASURED FIELD DATA

Wetted Perimeter (ft)	Water Depth (ft)	Area (SQ ft)	Discharge (cfs)	Percent Discharge
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0.57	0.35	0.17	0.17	3.49
0.5	0.35	0.17	0.2	4.13
0.5	0.4	0.2	0.27	5.57
0.5	0.45	0.23	0.31	6.22
0.5	0.45	0.23	0.34	7
0.5	0.4	0.2	0.32	6.51
0.51	0.5	0.25	0.36	7.27
0.5	0.5	0.25	0.39	7.88
0.5	0.5	0.25	0.38	7.78
0.5	0.5	0.25	0.41	8.29
0.5	0.5	0.25	0.38	7.78
0.51	0.4	0.2	0.24	4.88
0.5	0.4	0.2	0.24	4.96
0.5	0.4	0.2	0.29	5.82
0.5	0.4	0.2	0.31	6.26
0.5	0.35	0.17	0.18	3.67
0.5	0.35	0.1	0.12	2.48
0.34	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0

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Discharge Measurment Field Visit Data Report *(Filters: Name begins with kelso;)*

Div	Name	CWCB Case Number	Segment ID	Meas. Date	UTM	Location	Flow Amount (cfs)	Meas #	Rating	Station ID
4	Kelso Creek		15/4/A-003	07/30/2014	UTMx: UTMy:	Kelso R2X CWCB	0.46	1		
4	Kelso Creek		15/4/A-003	07/31/2019	UTMx: 710822 UTMy: 4268692	Kelso Creek FS land near middle of segment	0.42	2	P	

Discharge Measurement Summary

Date Generated: Mon Aug 4 2014

File Information

File Name	KELSOR2X.001.WAD
Start Date and Time	2014/07/30 12:59:53

Site Details

Site Name	KELSO R2X CWCB
Operator(s)	BJE

System Information

Sensor Type	FlowTracker
Serial #	P2355
CPU Firmware Version	3.9
Software Ver	2.30
Mounting Correction	0.0%

Units (English Units)

Distance	ft
Velocity	ft/s
Area	ft^2
Discharge	cfs

Discharge Uncertainty

Category	ISO	Stats
Accuracy	1.0%	1.0%
Depth	0.6%	3.7%
Velocity	0.5%	3.4%
Width	0.2%	0.2%
Method	3.0%	-
# Stations	5.8%	-
Overall	**6.6%**	**5.1%**

Summary

Averaging Int.	40	# Stations	9
Start Edge	REW	Total Width	3.800
Mean SNR	23.3 dB	Total Area	1.117
Mean Temp	58.58 °F	Mean Depth	0.294
Disch. Equation	Mid-Section	Mean Velocity	0.4152
		Total Discharge	**0.4637**

Supplemental Data

#	Time	Location	Gauge Height	Rated Flow	Comments
1	Wed Jul 30 13:10:24 MDT 2014	4.800			REV MTR COR NEG 1

Measurement Results

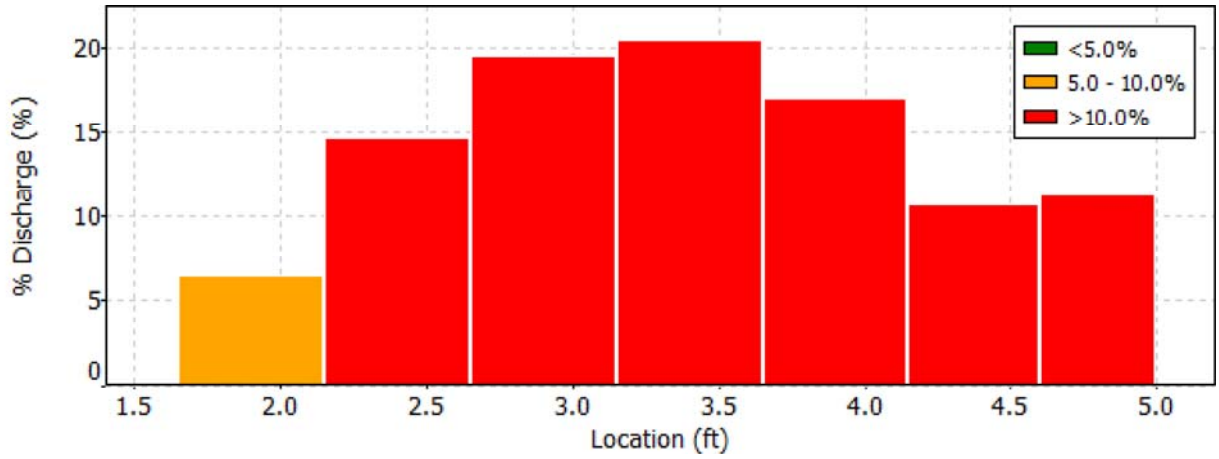
St	Clock	Loc	Method	Depth	%Dep	MeasD	Vel	CorrFact	MeanV	Area	Flow	%Q
0	12:59	1.40	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0
1	12:59	1.90	0.6	0.230	0.6	0.092	0.2602	1.00	0.2602	0.115	0.0299	6.5
2	13:00	2.40	0.6	0.300	0.6	0.120	0.4514	1.00	0.4514	0.150	0.0677	14.6
3	13:01	2.90	0.6	0.400	0.6	0.160	0.4508	1.00	0.4508	0.200	0.0901	19.4
4	13:03	3.40	0.6	0.420	0.6	0.168	0.4521	1.00	0.4521	0.210	0.0949	20.5
5	13:04	3.90	0.6	0.360	0.6	0.144	0.4396	1.00	0.4396	0.180	0.0791	17.1
6	13:05	4.40	0.6	0.280	0.6	0.112	0.3937	1.00	0.3937	0.126	0.0496	10.7
7	*13:06*	*4.80*	*0.6*	*0.340*	*0.6*	*0.136*	*-0.3848*	*-1.00*	*0.3848*	*0.136*	*0.0523*	*11.3*
8	13:06	5.20	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0

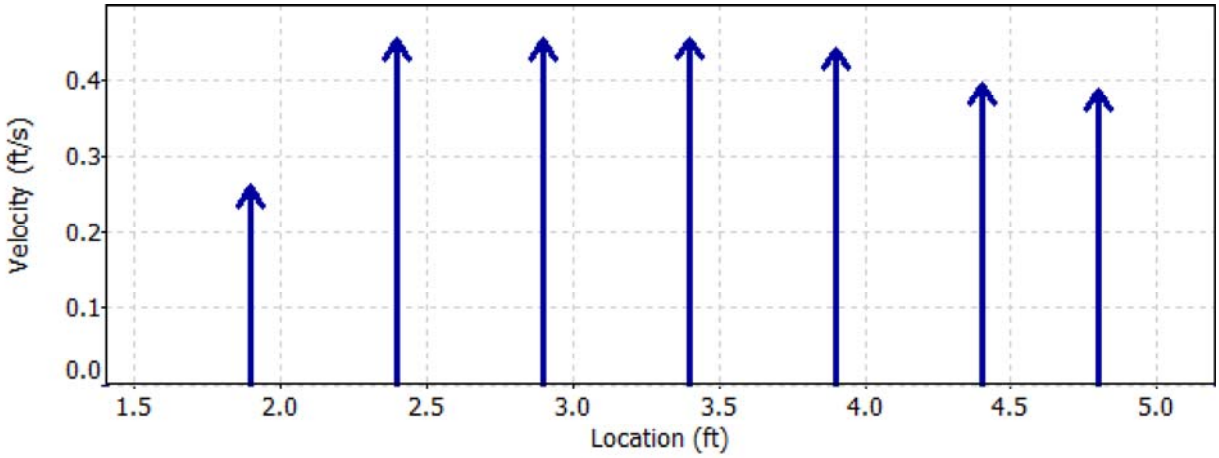
Rows in italics indicate a QC warning. See the Quality Control page of this report for more information.

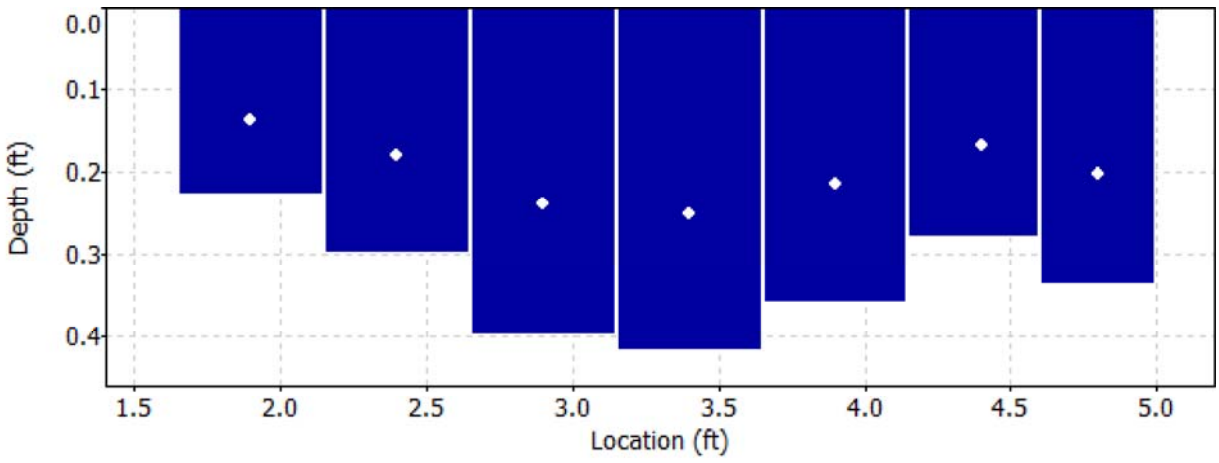
Discharge Measurement Summary

Date Generated: Mon Aug 4 2014

File Information		Site Details	
File Name	KELSOR2X.001.WAD	Site Name	KELSO R2X CWCB
Start Date and Time	2014/07/30 12:59:53	Operator(s)	BJE







Discharge Measurement Summary

Date Generated: Mon Aug 4 2014

File Information		Site Details	
File Name	KELSOR2X.001.WAD	Site Name	KELSO R2X CWCB
Start Date and Time	2014/07/30 12:59:53	Operator(s)	BJE

Quality Control

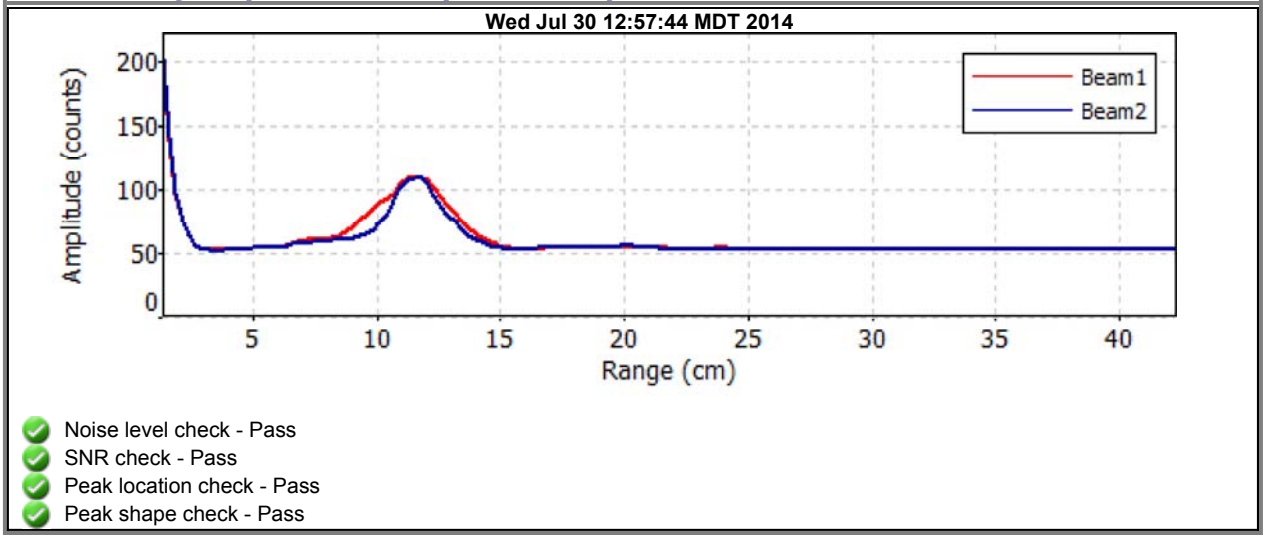
St	Loc	%Dep	Message
7	4.80	0.6	High angle: 179

Discharge Measurement Summary

Date Generated: Mon Aug 4 2014

File Information		Site Details	
File Name	KELSOR2X.001.WAD	Site Name	KELSO R2X CWCB
Start Date and Time	2014/07/30 12:59:53	Operator(s)	BJE

Automatic Quality Control Test (BeamCheck)



- Noise level check - Pass
- SNR check - Pass
- Peak location check - Pass
- Peak shape check - Pass

Discharge Measurement Summary

File Information

File name	Kelso Cr_20190731-171635.ft
Start date and time	7/31/2019 5:04 PM
Calculations engine	FlowTracker2
Data collection mode	Discharge

Discharge Summary

Start time	7/31/2019 5:05:19 PM	End time	7/31/2019 5:15:41 PM
# Stations	11	Avg interval	40
Mean depth	0.446 ft		
Mean velocity	0.2751 ft/s	Total width	3.400 ft
Mean SNR	42 dB	Total area	1.5175 ft²
Mean temp	57.331 °F	Total discharge	0.4174 ft³/s

System Information

Sensor type	Top Setting
Handheld serial number	FT2H1747037
Probe serial number	FT2P1747048
Probe firmware	1.23
Handheld software	1.4

Site Details

Site name	Kelso Cr
Site number	001
Operator(s)	JEL
Comment	Spot meas

Discharge Uncertainty

Category	ISO	IVE
Accuracy	1.0%	1.0%
Depth	0.7%	7.5%
Velocity	0.7%	11.1%
Width	0.2%	0.2%
Method	3.3%	
# Stations	5.1%	
Overall	6.3%	13.4%

Discharge Settings

Discharge equation	Mid Section
Discharge uncertainty	IVE
Discharge reference	Rated

Station Warning Settings

Station discharge caution	5.00	%
Station discharge warning	10.00	%
Maximum depth change	50.00	%
Maximum spacing change	100.00	%

Summary overview

No changes were made to this file
Quality control warnings

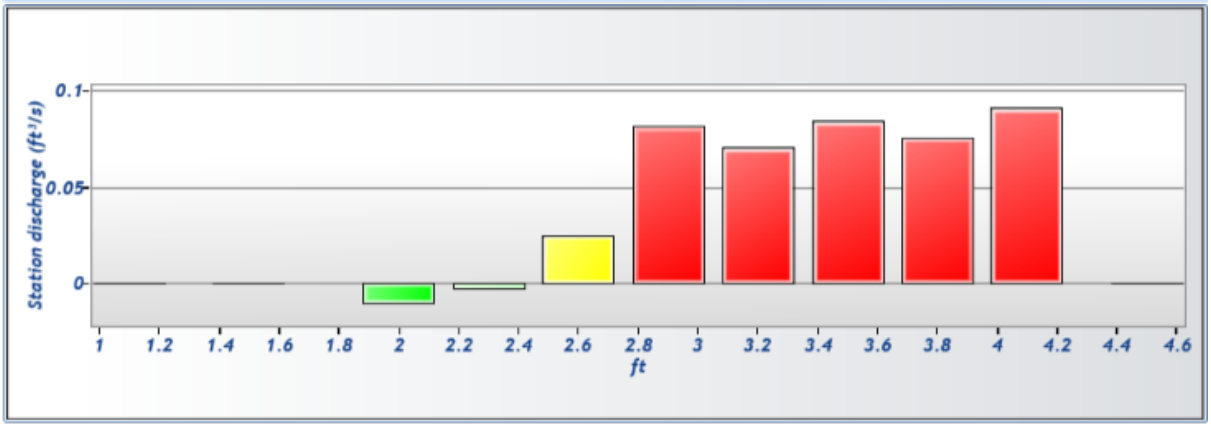
Data Collection Settings

Salinity	0.000	PSS-78
Temperature		°F
Sound speed		ft/s
Mounting correction	0.00	%

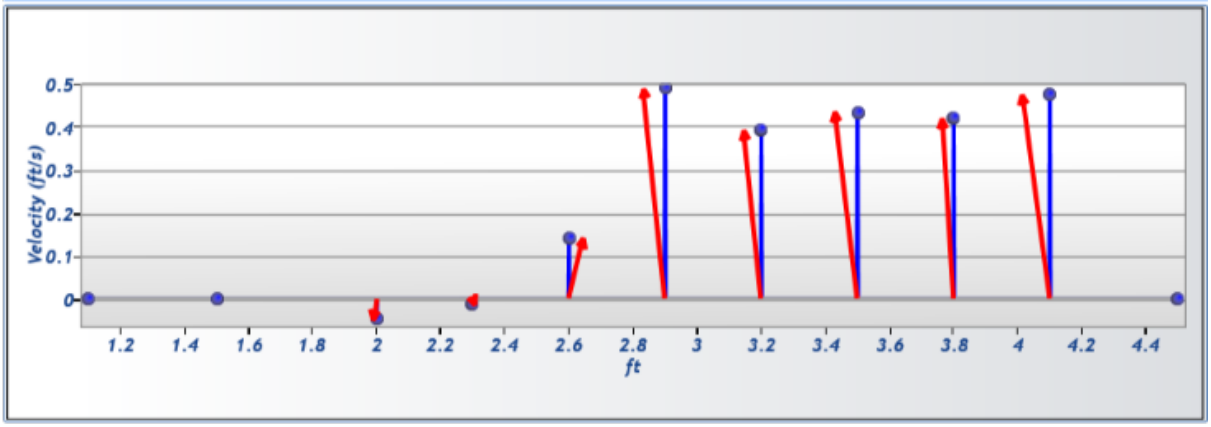
Quality Control Settings

SNR threshold	10	dB
Standard error threshold	0.0328	ft/s
Spike threshold	10.00	%
Maximum velocity angle	20.0	deg
Maximum tilt angle	5.0	deg

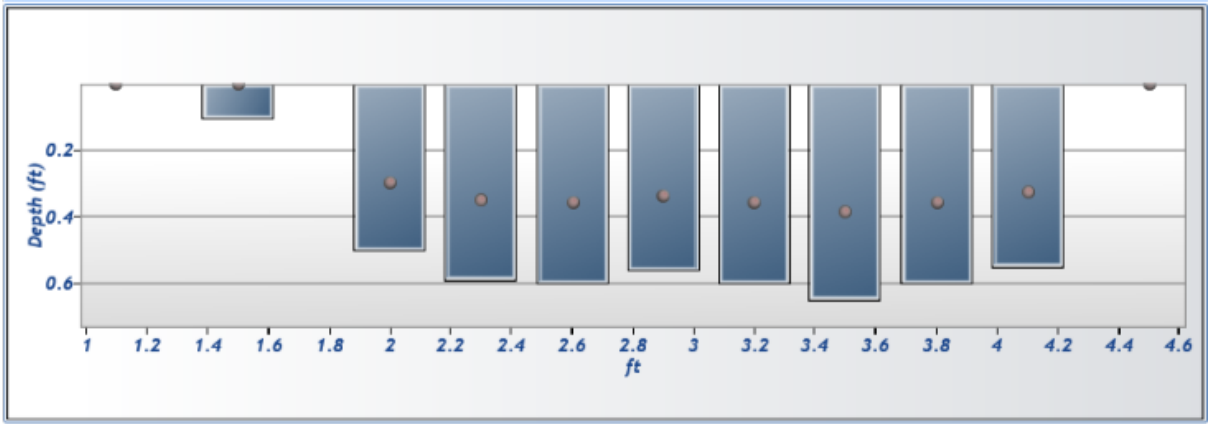
Discharge chart



Velocity chart



Depth chart



Measurement results

St#	Time	Location (ft)	Method	Depth (ft)	%Depth	Measured Depth (ft)	Samples	Velocity (ft/s)	Correction	Mean Velocity (ft/s)	Area (ft^2)	Flow (ft^3/s)	%Q	
0	5:05 PM	1.100	None	0.000	0.0000	0.000	0	0.0000	1.0000	0.0000	0.0000	0.0000	0.00	✓
1	5:05 PM	1.500	Enter Velocity	0.100	0.0000	0.000	0	0.0000	1.0000	0.0000	0.0450	0.0000	0.00	✓
2	5:06 PM	2.000	0.6	0.500	0.6000	0.300	80	-0.0484	1.0000	-0.0484	0.2000	-0.0097	-2.32	✓
3	5:07 PM	2.300	0.6	0.590	0.6000	0.354	80	-0.0147	1.0000	-0.0147	0.1770	-0.0026	-0.62	✓
4	5:08 PM	2.600	0.6	0.600	0.6000	0.360	80	0.1407	1.0000	0.1407	0.1800	0.0253	6.07	✓
5	5:10 PM	2.900	0.6	0.560	0.6000	0.336	80	0.4889	1.0000	0.4889	0.1680	0.0821	19.68	✓
6	5:11 PM	3.200	0.6	0.600	0.6000	0.360	80	0.3922	1.0000	0.3922	0.1800	0.0706	16.91	✓
7	5:12 PM	3.500	0.6	0.650	0.6000	0.390	80	0.4343	1.0000	0.4343	0.1950	0.0847	20.29	✓
8	5:13 PM	3.800	0.6	0.600	0.6000	0.360	80	0.4194	1.0000	0.4194	0.1800	0.0755	18.09	✓
9	5:14 PM	4.100	0.6	0.550	0.6000	0.330	80	0.4750	1.0000	0.4750	0.1925	0.0914	21.91	✓
10	5:15 PM	4.500	None	0.000	0.0000	0.000	0	0.0000	1.0000	0.4750	0.0000	0.0000	0.00	✓

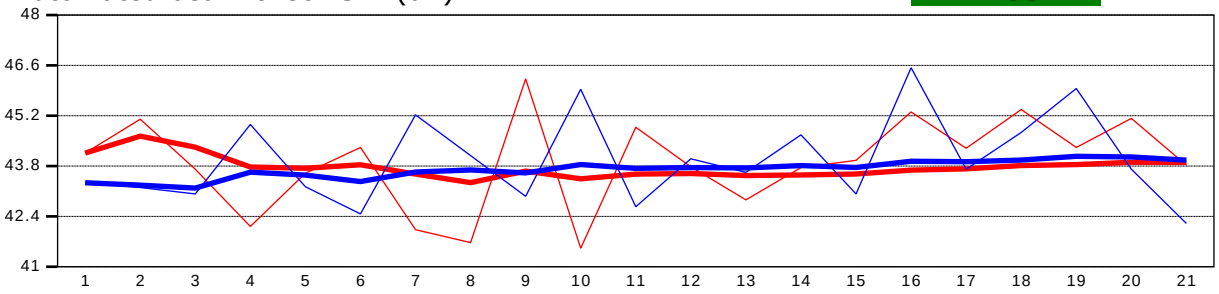
Quality control warnings

St#	Time	Location (ft)	Method	Depth (ft)	%Depth	Measured Depth (ft)	Warnings
2	5:06 PM	2.000	0.6	0.500	0.6000	0.300	Boundary Interference,SNR Threshold Variation
3	5:07 PM	2.300	0.6	0.590	0.6000	0.354	Large SNR Variation,SNR Threshold Variation
5	5:10 PM	2.900	0.6	0.560	0.6000	0.336	High Stn % Discharge
6	5:11 PM	3.200	0.6	0.600	0.6000	0.360	High Stn % Discharge
7	5:12 PM	3.500	0.6	0.650	0.6000	0.390	High Stn % Discharge
8	5:13 PM	3.800	0.6	0.600	0.6000	0.360	High Stn % Discharge
9	5:14 PM	4.100	0.6	0.550	0.6000	0.330	High % Spikes,High Stn % Discharge

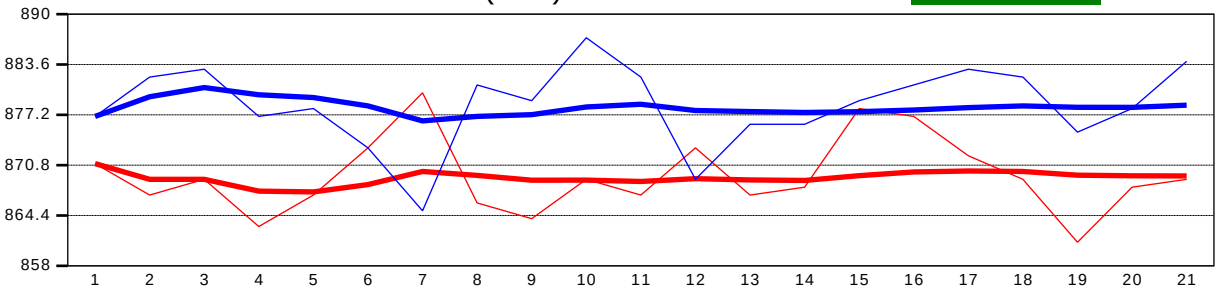
12/12/2019 6:46:05 AM

Automated beam check Start time 7/31/2019 5:04:58 PM

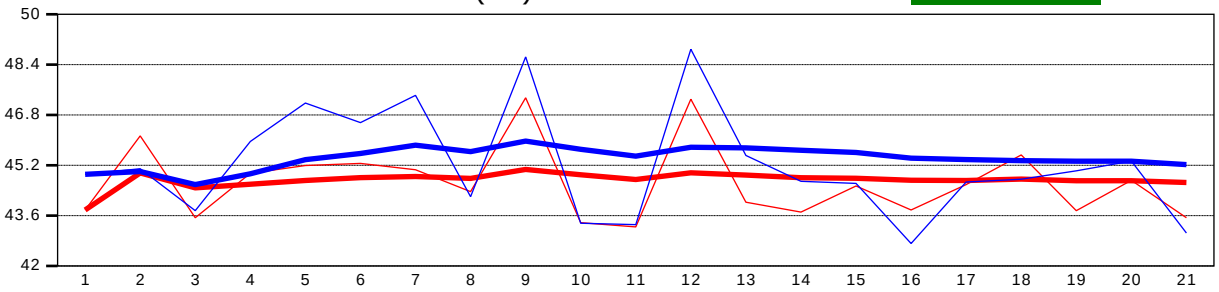
Automated beam check SNR(dB) PASS



Automated beam check Noise level(cnts) PASS



Automated beam check Peak level(dB) PASS



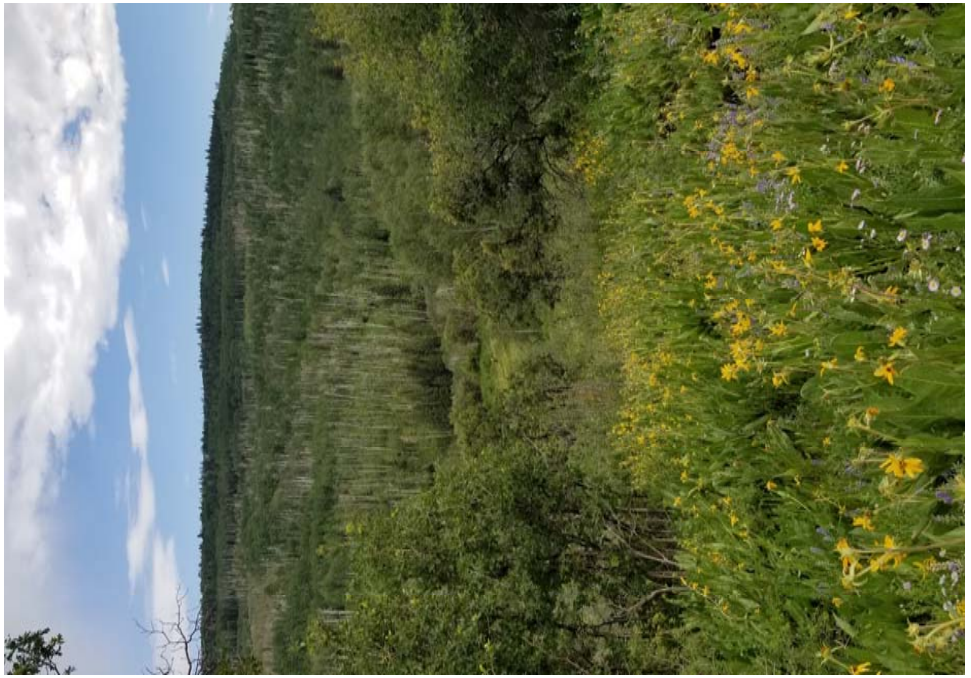
Automated beam check Peak position(ft) PASS

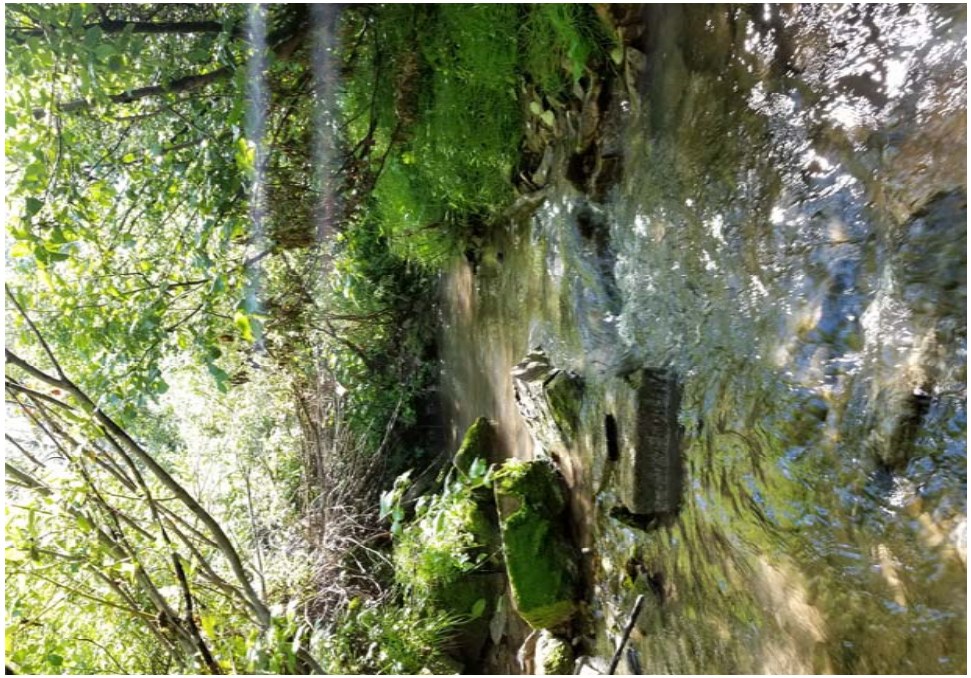
Automated beam check Quality control warnings

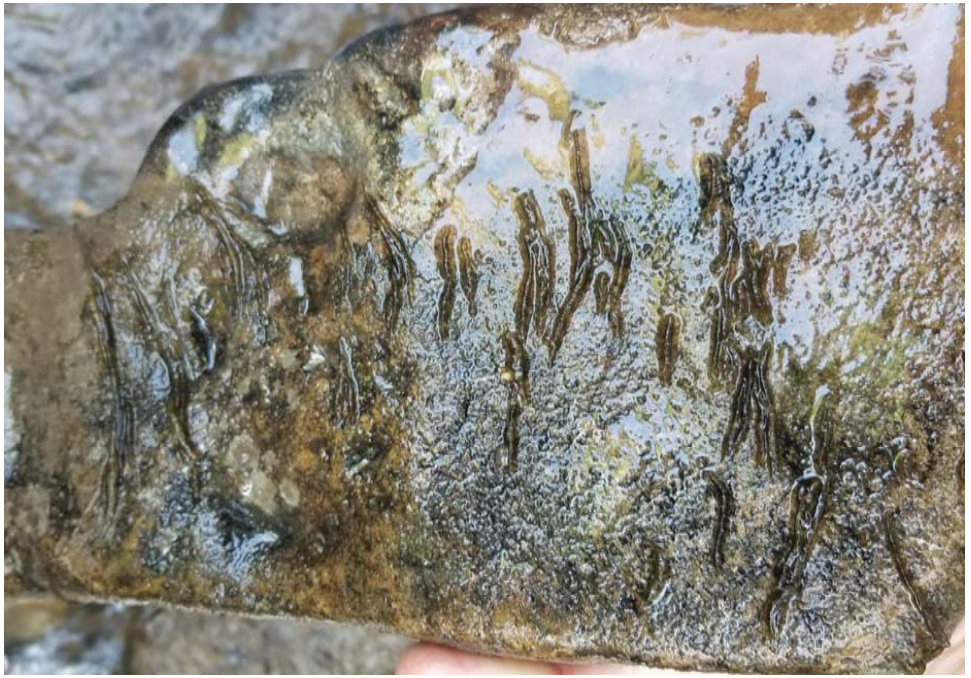
No quality control warnings


Coca-Cola


4-Channel Receiver
ReadyMadeRC
DX5







Kelso Creek Cross Section 1, looking upstream.

Kelso Creek Cross Section 1, looking downstream.

Kelso Creek Cross Section 2, looking across from left bank.

Kelso Creek Cross Section 2, looking upstream.

Kelso Creek, Cutthroat Trout.

Kelso Creek, Pool Habitat.