COLORADO
Parks and Wildlife
Department of Natural Resources

Water Resources Section – Aquatic, Terrestrial, and Natural Resources Branch

January 5, 2021

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 Dry Gulch in Water Division 1, Clear Creek County to be presented at the January 2021 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 Dry Gulch in Water Division 1. The field investigations relating to this ISF recommendations were conducted by Colorado Parks and Wildlife (CPW) staff in 2020. Dry Gulch is a high elevation montane stream that CPW reclaimed as a greenback cutthroat trout conservation stream in 2017. This stream reach was presented to interested parties at the ISF Workshop in January 2020. Outreach was also conducted to the Clear Creek County Commissioners in November 2020. It is the 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 Dry Gulch 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) explains current agency goals to, "[c]onserve wildlife and habitat to ensure healthy sustainable populations and ecosystems." In order to, "protect and enhance water resources for fish and wildlife populations," by pursuing, "partnerships and agreements to enhance instream flows, protect reservoir levels, and influence water management activities," and to, "[a]dvocate for water quality and quantities to conserve aquatic resources." In addition to the CPW strategic plan, the agency's fish and wildlife conservation activities are also directed by the State Wildlife Action Plan (2002, Revised 2015). The goals and priorities from these documents direct CPW to advocate for the preservation of the state's fish and wildlife resources and natural environment, and therefore link CPW's mission to the goals and priorities of CWCB's ISF/NLL Program.

Recommended Segments

CPW is proposing an ISF recommendation on Dry Gulch from its headwaters (located at UTM 13S 421166 4395039) to the confluence with Clear Creek (UTM 13S 425249 4394414). The reach is approximately 2.8 miles in length. All of the proposed reach is on public lands managed by the USFS Arapahoe and Roosevelt National Forests.

Greenback Cutthroat Trout Conservation Goals

The greenback cutthroat trout was designated Colorado's state fish in 1994. This subspecies of cutthroat trout has been listed as a threatened species by both the state and federal government. Following the listing of the greenback cutthroat trout under the authorities on the Endangered Species Act of 1973, state and federal fish and wildlife managers have engaged in efforts to establish new populations of this subspecies around the state of Colorado. The greenback cutthroat trout recovery plan's overall goal is as follows:

"The objective of the greenback cutthroat trout recovery plan is the removal of this subspecies from the list of Threatened and Endangered Species. This subspecies will be considered recovered when 20 stable greenback cutthroat trout populations are documented representing a minimum of 50 hectares of lakes and ponds and 50 kilometers of stream habitat within its native range. A minimum of five of these will exist in the Arkansas River drainage. Once recovery objectives have been met, a long range management strategy will be implemented for the continued restoration of the species." (Greenback Cutthroat Trout Recovery Team, 1977)

Establishing new conservation populations of greenback cutthroat trout and protecting the habitat where these populations reside will be critical to the success of the identified conservation efforts, actions and activities. CPW believes that if Dry Gulch is protected by an ISF water right, this action can be a critical step in the overall preservation and conservation of greenback cutthroat trout.

Natural Environment and Biological Summary

Dry Gulch is a tributary of Clear Creek located just northeast of Loveland Basin Ski Area at the base of Mount Trelease and Mount Bethel. The stream's hydrology is snowmelt-driven with high-elevation snowpack contributions. The basin's mean elevation is almost 12,000 feet. This zone

receives approximately 34 inches of precipitation a year. The contributing basin is approximately 3.2 square miles and is high-alpine and forested.

The Dry Gulch is a first order stream. The channel is high-gradient, mainly single thread with some side channel formation. Substrate size ranges from medium-sized cobble to boulder. The reach has a mixture of coarser substrate riffles and runs, and pools formed by large boulders and woody debris. A significant avalanche cycle of 2019 added notable large woody debris to the creek, creating numerous log jam scour pools. Suitable trout habitat is plentiful including large pools, smaller pocket pools, undercut banks, and abundant riparian cover in the forested, high-gradient reach of the creek. Riparian willows are dense in the lower-gradient transition zone from the alpine to the high-gradient forested cascading reach.

A reclamation project was conducted on Dry Gulch in 2016 to remove all non-native cutthroat trout from the stream. Prior to the 2016 reclamation of Dry Gulch, the stream supported a population of Colorado River cutthroat trout native to the Western Slope. These fish were removed from Dry Gulch and transplanted to a stream in the headwaters of the Yampa River Basin. Following the reclamation, CPW stocked native Bear Creek greenback cutthroat trout in the stream in 2017, 2018, and 2019.

A 2019 CPW fishery survey indicates the reclamation was successful and the fishery is exclusively greenback cutthroat trout at this point. CPW biologists expect to find evidence of natural recruitment of the Dry Gulch greenback population in the coming years. Fish were observed during CPW's site visit in 2020 residing in pocket pools. Macroinvertebrates noted in the field include two types of caddisfly, mayfly, stonefly, diptera, and flatworm.

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).

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.

In 2020, CPW collected two cross-section data sets on Dry Gulch. The results of the R2Cross analysis are summarized below.

	Bankfull Top Width	**Date Measured**	**Flow Measured**	**Accuracy Range**	**Flow Meeting Two Criteria**	**Flow Meeting Three Criteria**
1	12.4 ft	8/17/2020	3.05 cfs	1.2 – 8 cfs	1.56 cfs	4.33 cfs
2	16.5 ft	8/28/2020	2.98 cfs	1.2 – 7 cfs	1.45 cfs	6.45 cfs
Averaged Results					**1.5 cfs**	**5.4 cfs**

The initial biological winter flow recommendation is 1.5 cfs. This rate during the baseflow period should be protective during the overwintering period by maintaining an average depth of 0.2 feet and at least 50 percent wetted perimeter of the stream channel on average. The initial biological summer flow recommendation is 5.4 cfs, which will maintain these hydraulic parameters in critical riffle transects, as well as average velocity of 1 fps.

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 Dry Gulch. Dry Gulch does not have any gage data, and because it is high-elevation and undeveloped, CPW relied upon USGS StreamStats regression estimates for monthly flow estimates to determine the seasonality of the flow recommendations. CPW is not aware of any water rights within the reach.

<u>Refined Flow Recommendation</u>

CPW's analysis 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 October through March. Therefore, our flow recommendation has been refined based on water availability to the following:

- Summer Flow Recommendation (May 1 through July 31): 5.4 cfs
    - Maintains adequate depth, velocity, and wetted perimeter during the summer period when fish are most active.
- Fall Flow Recommendation (August 1 through September 31): 2.0 cfs
    - Maintains available habitat and allows fish movement as they are headed into the overwintering period.
- Baseflow Recommendation (October 1 through December 31): 0.85 cfs
    - The flow recommendation is reduced due to water availability constraints, but will provide sufficient habitat availability in pools and deep glides.
- Baseflow Recommendation (January 1 through April 30): 0.67 cfs
    - The flow recommendation is reduced due to water availability constraints, but will provide sufficient habitat availability in pools and deep glides.

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 Dry Gulch 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.

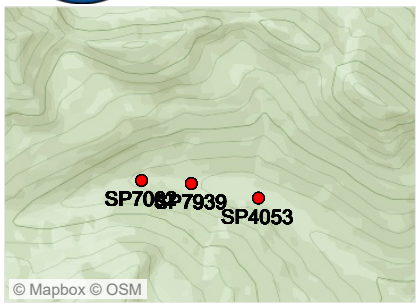
CPW personnel will be available at the January 2021 CWCB meeting to answer any questions that the Board might have regarding these flow recommendations. We appreciate your consideration.

Sincerely,

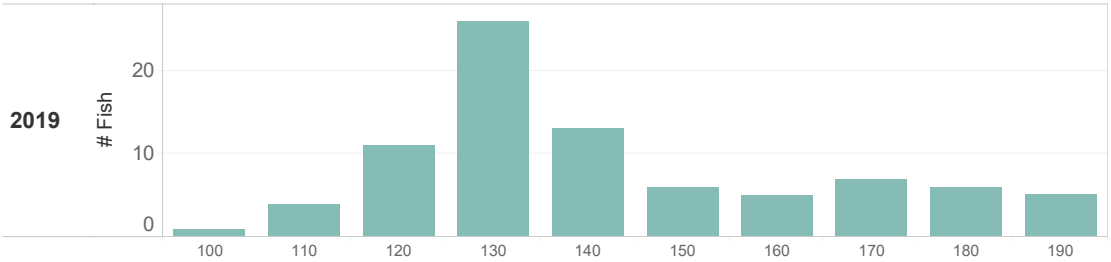
Katie Birch

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

	10877 Dry Gulch	
SP4053 11-Sep-19 SurveyID: 60204	SP7062 11-Sep-19 SurveyID: 59889	SP7939 11-Sep-19 SurveyID: 59888
Abc	Abc	Abc

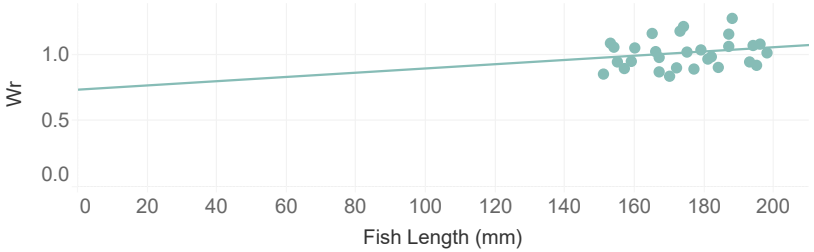


Length-Frequency (mm) for GREENBACK CUTTHROAT, BEAR CREEK, 10877 - Dry Gulch @ All



Relative Abundance by Net/Pass on 10877 - Dry Gulch @ All

Relative Weight of GREENBACK CUTTHROAT, BEAR CREEK on 10877 - Dry Gulch @ All



COLORADO WATER CONSERVATION BOARD

FIELD DATA FOR INSTREAM FLOW DETERMINATIONS

COLORADO DIVISION OF WILDLIFE

LOCATION INFORMATION

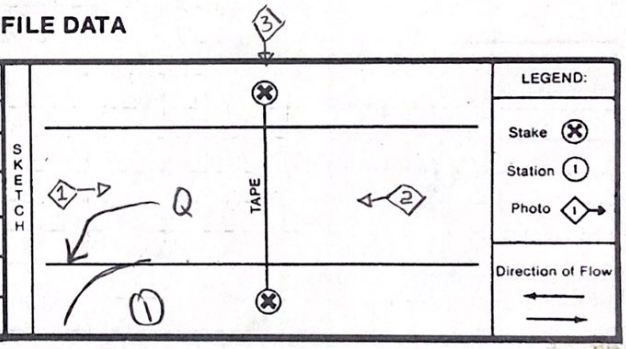
STREAM NAME: Dry Gulch						CROSS-SECTION NO.: 1
CROSS-SECTION LOCATION: Near Loveland Ski Area						
DATE: 8/17/20	OBSERVERS: Birch McConville					
LEGAL DESCRIPTION	¼ SECTION:	SECTION:	TOWNSHIP: N/S	RANGE: E/W	PM:	
COUNTY:	WATERSHED: Clear Creek		WATER DIVISION: 1		DOW WATER CODE:	
MAP(S): USGS: UTM 13S 424368						
USFS: 4394861						

SUPPLEMENTAL DATA

SAG TAPE SECTION SAME AS DISCHARGE SECTION: (YES) NO	METER TYPE: Flow Tracker "DRY-GULCH01" by M. McConville			
METER NUMBER:	DATE RATED:	CALIB/SPIN: ____ sec	TAPE WEIGHT: ____ lbs/foot	TAPE TENSION: ____ lbs
CHANNEL BED MATERIAL SIZE RANGE: gravel, cobble, small-large boulder	PHOTOGRAPHS TAKEN: YES/NO	NUMBER OF PHOTOGRAPHS:		

CHANNEL PROFILE DATA

STATION	DISTANCE FROM TAPE (ft)	ROD READING (ft)
⊗ Tape @ Stake LB	0.0	X
⊗ Tape @ Stake RB	0.0	X
① WS @ Tape LB/RB	0.0	4.38 / 4.31
② WS Upstream	0	4.22
③ WS Downstream	23.80	5.02
SLOPE	3.4%	



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
Fish observed- greenback ~4"																	

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

caddis, mayfly, stonefly

COMMENTS

Flow measured in upstream glide Q = 3.05 cfs T = 52.9°F
Fish habitat clean pocket pool, large pools from high gradient, large boulders, some wood. plenty of glide habitat w/ undercut banks. Good cover. Forested conifer & abundant willows

FORM #ISF FD 1-85 (1.9F)

LB 4.41 4.37
RB 4.30

DISCHARGE/CROSS SECTION NOTES

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

BEGINNING OF MEASUREMENT | EDGE OF WATER LOOKING DOWNSTREAM: (0.0 AT STAKE) LEFT / RIGHT | Gage Reading: _____ ft | TIME: 2:30 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) At Point	Velocity (ft/sec) Mean in Vertical	Area (ft^2)	Discharge (cfs)
S	0	–	3.18								
	1.3		3.35								
	2.3		3.35								
BF	3.0		3.65								
WS-RB	3.2		4.30	0							
	3.5		4.98	0.2							
	4.0		4.93	0.15							
	4.5		4.5	0.25							
	5.0		4.5	0.25							
	5.5		4.65	0.4							
	6.0		4.65	0.4							
	6.5		4.7	0.45							
	7.0		4.7	0.43							
	7.5		4.7	0.45							
	8.0		4.7	0.45							
	8.5		4.7	0.42							
on rock	9		4.6	0.35							
on rock	9.5		4.6	0.2							
same rock	10		4.75	0.4							
	10.5		4.8	0.4							
	11		4.75	0.35							
	11.5		4.65	0.3							
	12		4.65	0.3							
	12.5		4.6	0.25							
	13		4.55	0.15							
	13.5		4.55	0.15							
	14		4.5	0.1							
	14.5		4.55	0.2							
WS-LB	15		4.38	0							
	15.1		3.95								
BF	15.4		3.65								
S	16.2		3.26								
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: Dry Gulch					CROSS-SECTION NO.: 2
CROSS-SECTION LOCATION: Near Loveland Ski Area					
DATE: 8/28/20	OBSERVERS: Birch Le Boileau				
LEGAL DESCRIPTION	¼ SECTION:	SECTION:	TOWNSHIP: N/S	RANGE: E/W	PM:
COUNTY:	WATERSHED:	WATER DIVISION:	DOW WATER CODE:		
MAP(S): USGS: 135	424510				
USFS:	4394799				

SUPPLEMENTAL DATA

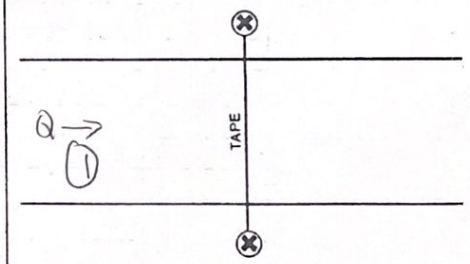
SAG TAPE SECTION SAME AS DISCHARGE SECTION: (YES) NO	METER TYPE: FlowTracker "Dry Gulch-02"			
METER NUMBER:	DATE RATED:	CALIB/SPIN: ____ sec	TAPE WEIGHT: ____ lbs/foot	TAPE TENSION: ____ lbs
CHANNEL BED MATERIAL SIZE RANGE:	PHOTOGRAPHS TAKEN: YES/NO	NUMBER OF PHOTOGRAPHS:		

5.30

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	5.30 / 5.35
② WS Upstream	21.1	5.22
③ WS Downstream		6.45
SLOPE = 0.058		

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
Black fly Larvae / crane fly larvae																	
unknown beatle casing																	

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

macros collected by AL: mayfly, stnefly, caddis (2), diptera, flatworm (planarian)

COMMENTS

Flow taken in u/s glide by B.B. Q = 2.977 cfs
T = 47.5°F

Clear, cold water. No major precip.

Riparian willows, some conifer, abundant cover (large boulders + shading from conifer)

FORM #ISF FD 1-85

DISCHARGE/CROSS SECTION NOTES

STREAM NAME: Dry Gulch | CROSS-SECTION NO.: 2 | DATE: 8/28/20 | SHEET ___ OF ___

BEGINNING OF MEASUREMENT | EDGE OF WATER LOOKING DOWNSTREAM: (0.0 AT STAKE) LEFT / RIGHT | Gage Reading: _____ ft | TIME: 10:30 AM

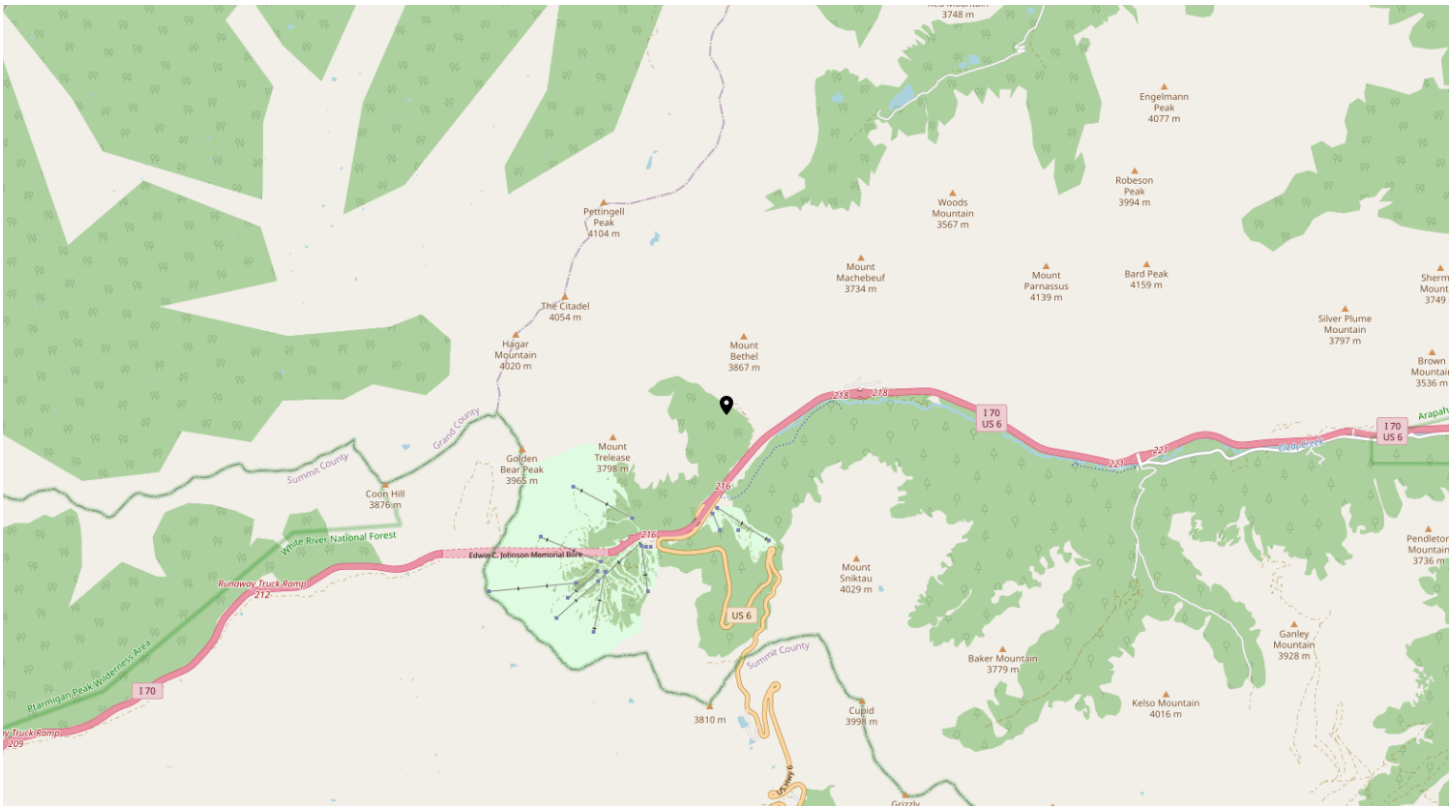
Features: Stake (S) Grassline (G) Waterline (W) Rock (R)	Distance From Initial Point (ft)	Width (ft)	Total Vertical Depth From Tape/Inst (ft)	Water Depth (ft)	Depth of Observation (ft)	Revolutions	Time (sec)	Velocity (ft/sec) At Point	Velocity (ft/sec) Mean in Vertical	Area (ft^2)	Discharge (cfs)
S	0		3.45								
	0.5		3.90								
BF	0.8		4.3								
	1.0		5.2								
LWS	1.3		5.3	0							
	2.0		5.5	0.15							
	2.7		5.35	0.05							
	3.4		5.6	0.25							
	4.1		6.0	0.70							
	4.8		5.8	0.50							
	5.5		5.80	0.6							
	6.2		5.75	0.45							
	6.9		5.45	0.15							
	7.6		5.8	0.7							
	8.3		5.95	0.6							
	9.0		5.90	0.5							
	9.7		5.5	0.15							
	10.4		5.6	0.2							
	11.1		5.55	0.2							
	11.8		5.55	0.15							
	12.5		5.7	0.30							
	13.2		5.6	0.20							
Rock	13.9		5.45	0.05							
	14.6		5.55	0.1							
	15.3		5.50	0.1							
RWS	15.5		5.35	0							
	16.4		5.05								
	16.6		4.8								
	16.7		4.6								
	16.9		4.55								
BF	17.3		4.4								
	18.7		4.25								
TOTALS:											

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

R2Cross RESULTS

Stream Name: Dry Gulch
Stream Locations: Near Loveland Ski Area
Fieldwork Date: 09/17/2020
Cross-section: 1
Observers: Birch McConville
Coordinate System: UTM Zone 13
X (easting): 424368
Y (northing): 4394861
Date Processed: 11/09/2020
Slope: 0.0336
Computation method: Manning's n
R2Cross data filename: R2Cross_Dry-Gulch-1_8-17-2020-Q=3.05.xlsx
R2Cross version: 1.0.30

LOCATION



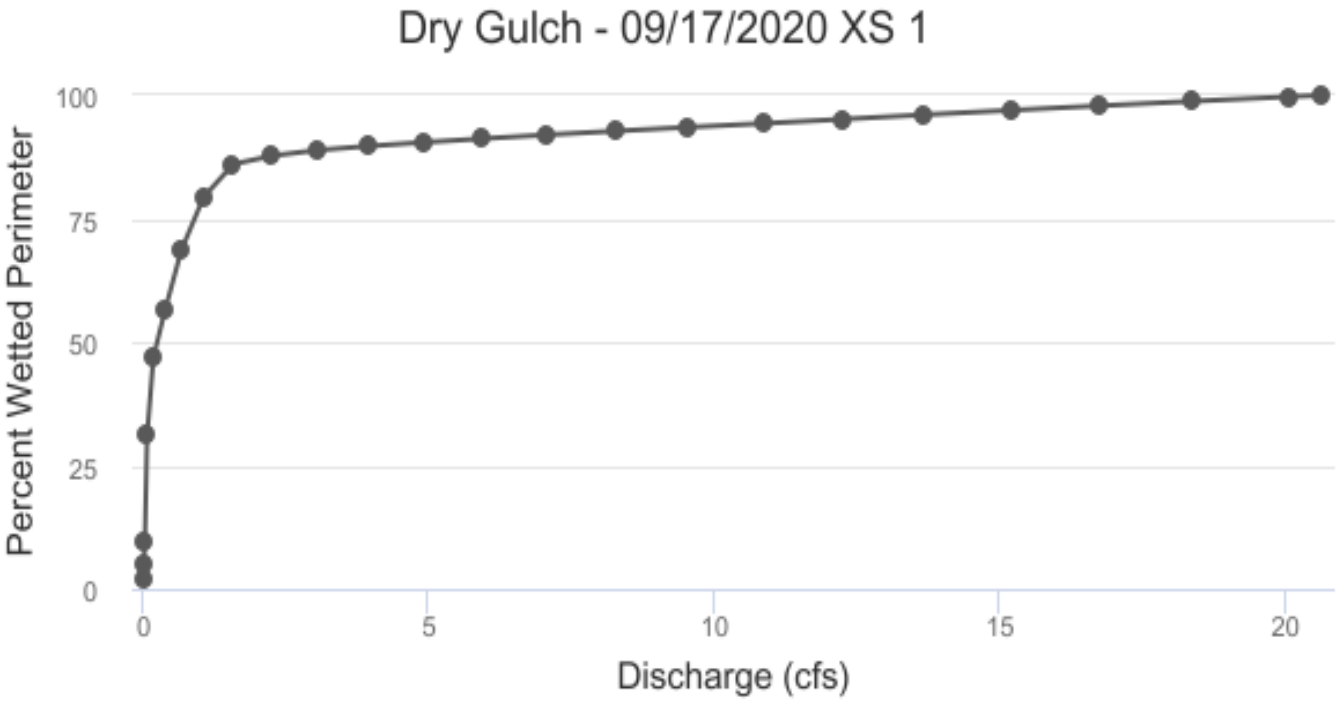
ANALYSIS RESULTS

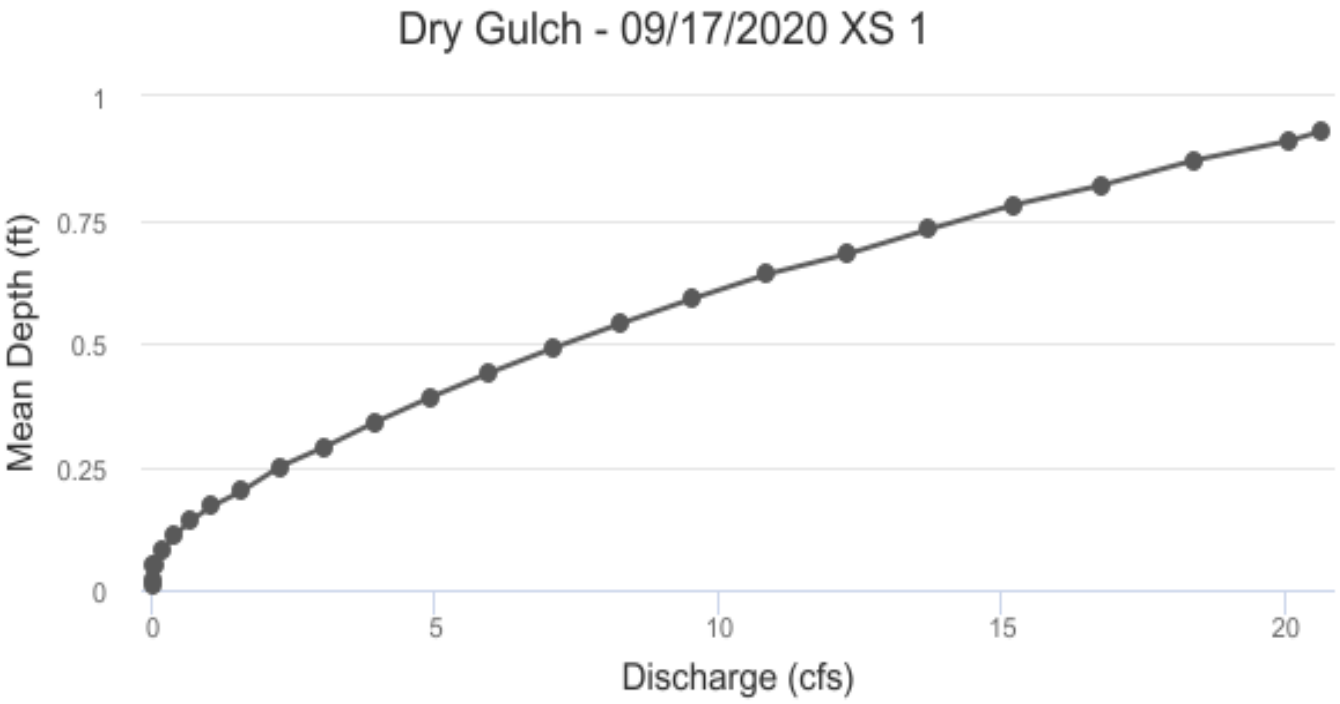
Habitat Criteria Results

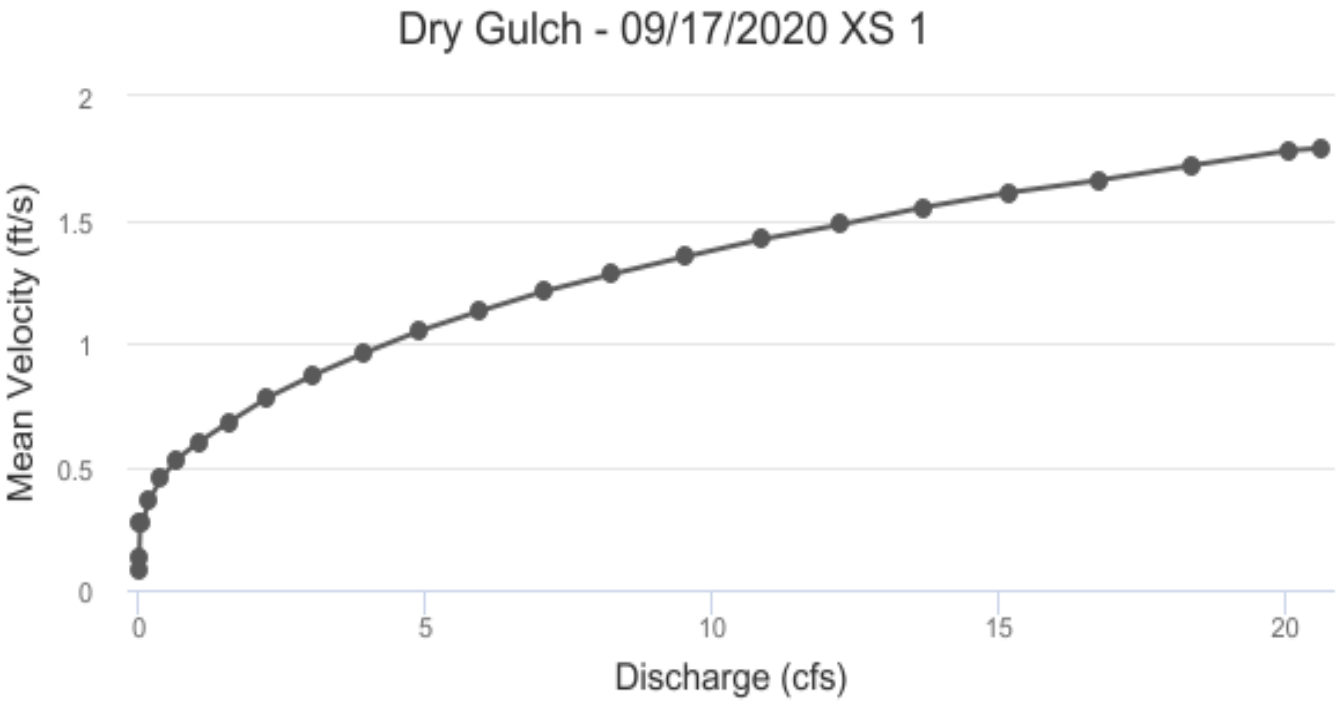
Bankfull top width (ft) = 12.4

	Habitat Criteria	Discharge (cfs) Meeting Criteria
Mean Depth (ft)	0.2	1.56
Percent Wetted Perimeter (%) **	50.0	0.24
Mean Velocity (ft/s)	1.0	4.33

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




Dry Gulch - 09/17/2020 XS 1
Mean Depth (ft)
1
0.75
0.5
0.25
0
0
5
10
15
20
Discharge (cfs)

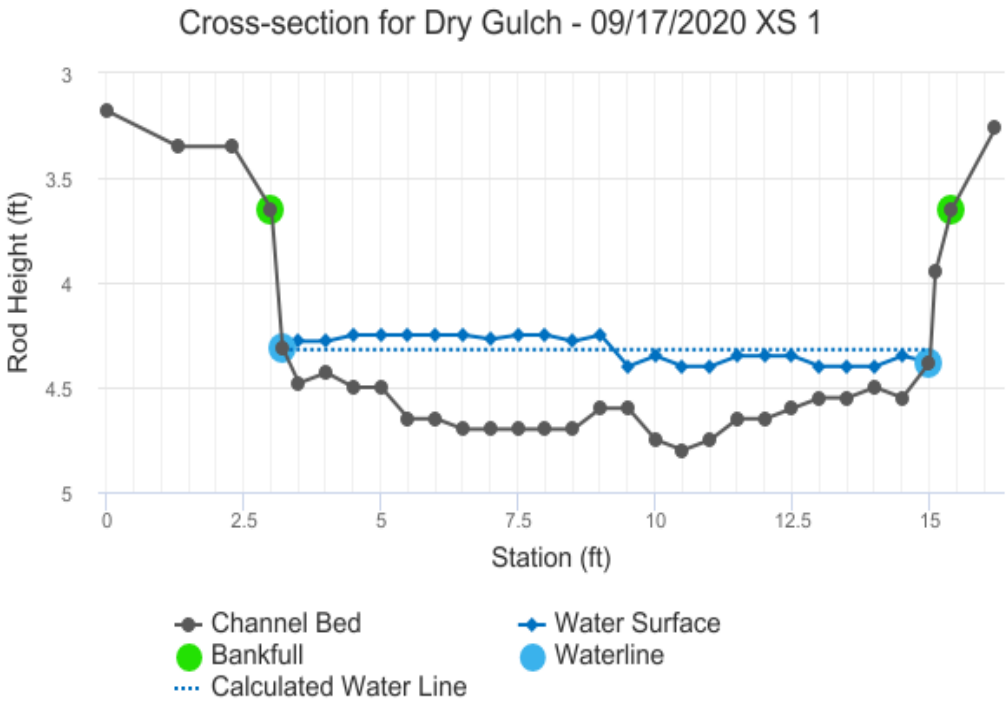

Dry Gulch - 09/17/2020 XS 1
Mean Velocity (ft/s)
2
1.5
1
0.5
0
0
5
10
15
20
Discharge (cfs)

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	3.65	12.4	0.93	1.15	11.52	13.52	100.00%	0.85	1.79	20.66
	3.67	12.38	0.91	1.13	11.3	13.47	99.69%	0.84	1.78	20.07
	3.72	12.31	0.87	1.08	10.68	13.35	98.78%	0.8	1.72	18.38
	3.77	12.25	0.82	1.03	10.07	13.23	97.87%	0.76	1.66	16.76
	3.82	12.18	0.78	0.98	9.46	13.11	96.96%	0.72	1.61	15.2
	3.87	12.12	0.73	0.93	8.85	12.98	96.05%	0.68	1.55	13.69
	3.92	12.05	0.68	0.88	8.25	12.86	95.14%	0.64	1.48	12.25
	3.97	12.0	0.64	0.83	7.65	12.74	94.28%	0.6	1.42	10.86
	4.02	11.97	0.59	0.78	7.05	12.64	93.51%	0.56	1.35	9.53
	4.07	11.95	0.54	0.73	6.45	12.54	92.74%	0.51	1.28	8.27
	4.12	11.92	0.49	0.68	5.85	12.43	91.98%	0.47	1.21	7.07
	4.17	11.89	0.44	0.63	5.26	12.33	91.21%	0.43	1.13	5.95
	4.22	11.87	0.39	0.58	4.66	12.23	90.45%	0.38	1.05	4.9
	4.27	11.84	0.34	0.53	4.07	12.12	89.68%	0.34	0.96	3.93
Waterline	4.32	11.8	0.29	0.48	3.48	12.01	88.86%	0.29	0.87	3.04
	4.37	11.7	0.25	0.43	2.89	11.86	87.73%	0.24	0.78	2.25
	4.42	11.5	0.2	0.38	2.31	11.63	86.03%	0.2	0.68	1.57
	4.47	10.63	0.17	0.33	1.75	10.73	79.37%	0.16	0.6	1.05
	4.52	9.19	0.14	0.28	1.25	9.28	68.62%	0.14	0.53	0.66
	4.57	7.6	0.11	0.23	0.83	7.67	56.73%	0.11	0.45	0.38
	4.62	6.29	0.08	0.18	0.48	6.34	46.93%	0.08	0.36	0.17
	4.67	4.18	0.05	0.13	0.21	4.21	31.15%	0.05	0.27	0.06
	4.72	1.27	0.05	0.08	0.06	1.29	9.51%	0.05	0.27	0.02
	4.77	0.65	0.02	0.03	0.01	0.66	4.87%	0.02	0.13	0.0
	4.79	0.3	0.01	0.01	0.0	0.3	2.23%	0.01	0.08	0.0

MODEL SUMMARY

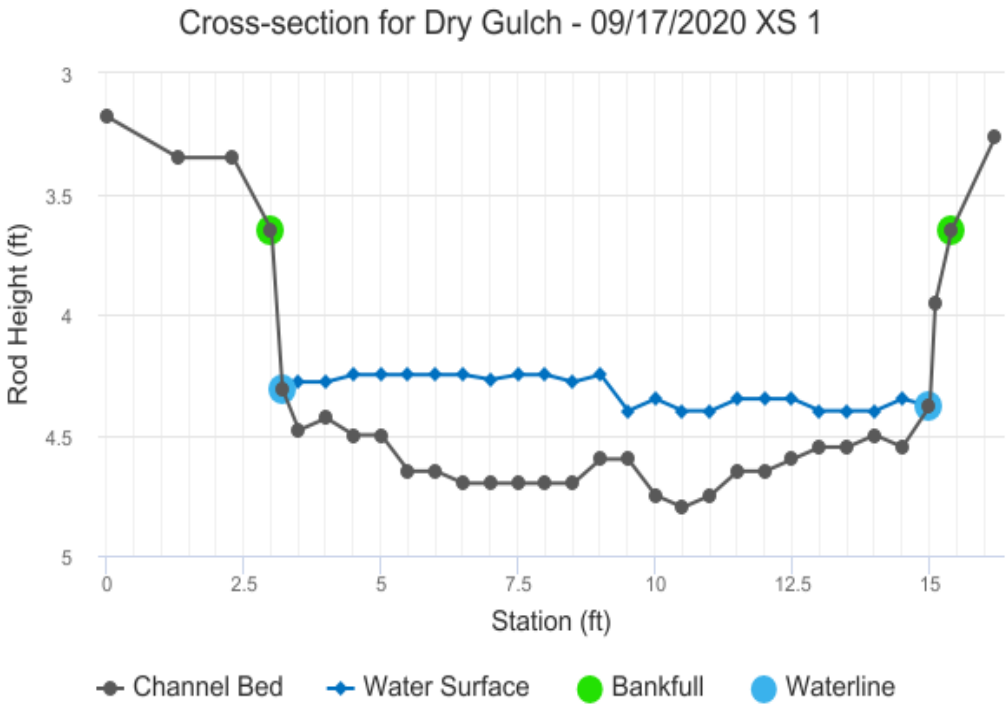
Measured Flow (Qm) =	3.05
Calculated Flow (Qc) =	3.04
(Qm-Qc)/Qm * 100 =	0.26%
Measured Waterline (WLm) =	4.34
Calculated Waterline (WLc) =	4.32
(WLm-WLc)/WLm * 100 =	0.64%
Max Measured Depth (Dm) =	0.45
Max Calculated Depth (Dc) =	0.48
(Dm-Dc)/Dm * 100 =	-7.27%
Mean Velocity =	0.87
Manning's n =	0.136
0.4 * Qm =	1.22
2.5 * Qm =	7.62



FIELD DATA

Feature	Station (ft)	Rod Height (ft)	Water depth (ft)	Velocity (ft/s)
	0	3.18		
	1.3	3.35		
	2.3	3.35		
Bankfull	3	3.65		
Waterline	3.2	4.31	0	
	3.5	4.48	0.2	
	4	4.43	0.15	
	4.5	4.5	0.25	
	5	4.5	0.25	
	5.5	4.65	0.4	
	6	4.65	0.4	
	6.5	4.7	0.45	
	7	4.7	0.43	
	7.5	4.7	0.45	
	8	4.7	0.45	
	8.5	4.7	0.42	
	9	4.6	0.35	
	9.5	4.6	0.2	
	10	4.75	0.4	
	10.5	4.8	0.4	
	11	4.75	0.35	
	11.5	4.65	0.3	
	12	4.65	0.3	
	12.5	4.6	0.25	
	13	4.55	0.15	
	13.5	4.55	0.15	
	14	4.5	0.1	
	14.5	4.55	0.2	
Waterline	15	4.38	0	
	15.1	3.95		

Bankfull	15.4	3.65
	16.2	3.26



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	0	0	0	0
0	0	0	0	0
0.34	0.2	0.08	0.07	2.3
0.5	0.15	0.07	0.07	2.15
0.5	0.25	0.12	0.11	3.59
0.5	0.25	0.12	0.11	3.59
0.52	0.4	0.2	0.18	5.75
0.5	0.4	0.2	0.18	5.75
0.5	0.45	0.23	0.2	6.47
0.5	0.43	0.21	0.19	6.18
0.5	0.45	0.23	0.2	6.47
0.5	0.45	0.23	0.2	6.47
0.5	0.42	0.21	0.18	6.03
0.51	0.35	0.17	0.15	5.03
0.5	0.2	0.1	0.09	2.87
0.52	0.4	0.2	0.18	5.75
0.5	0.4	0.2	0.18	5.75
0.5	0.35	0.17	0.15	5.03
0.51	0.3	0.15	0.13	4.31
0.5	0.3	0.15	0.13	4.31
0.5	0.25	0.12	0.11	3.59
0.5	0.15	0.07	0.07	2.15
0.5	0.15	0.07	0.07	2.15
0.5	0.1	0.05	0.04	1.44
0.5	0.2	0.1	0.09	2.87
0.53	0	0	0	0
0	0	0	0	0

0	0	0	0	0
0	0	0	0	0

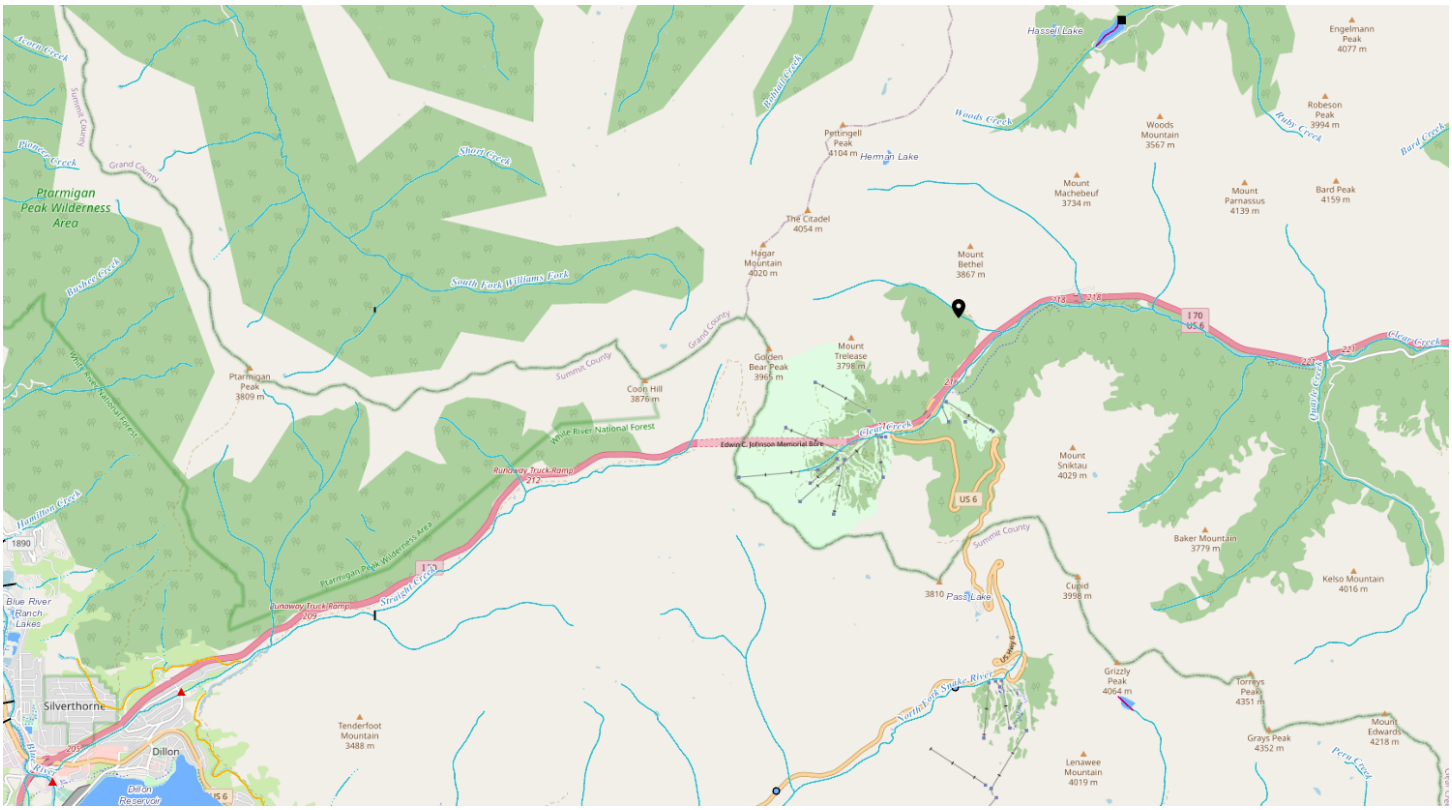
DISCLAIMER

"The Colorado Water Conservation Board makes no representations about the use of the software contained in the R2Cross platform for any purpose besides that for which it was designed. To the maximum extent permitted by applicable law, all information, modeling results, and software are provided “as is” without warranty or condition of any kind, including all implied warranties or conditions of merchantability, or fitness for a particular purpose. The user assumes all responsibility for the accuracy and suitability of this program for a specific application. In no event shall the Colorado Water Conservation Board or any state agency, official or employee be liable for any direct, indirect, punitive, incidental, special, consequential damages or any damages whatsoever including, without limitation, damages for loss of use, data, profits, or savings arising from the implementation, reliance on, or use of or inability to use the R2Cross platform.

R2Cross RESULTS

Stream Name: Dry Gulch
Stream Locations: Near Loveland Ski Area
Fieldwork Date: 08/28/2020
Cross-section: 2
Observers: Birch Le Boileau
Coordinate System: UTM Zone 13
X (easting): 424510
Y (northing): 4394799
Date Processed: 11/09/2020
Slope: 0.0583
Computation method: Manning's n
R2Cross data filename: R2Cross_Dry-Gulch-2_8-28-2020-Q=2.977.xlsx
R2Cross version: 1.0.30

LOCATION



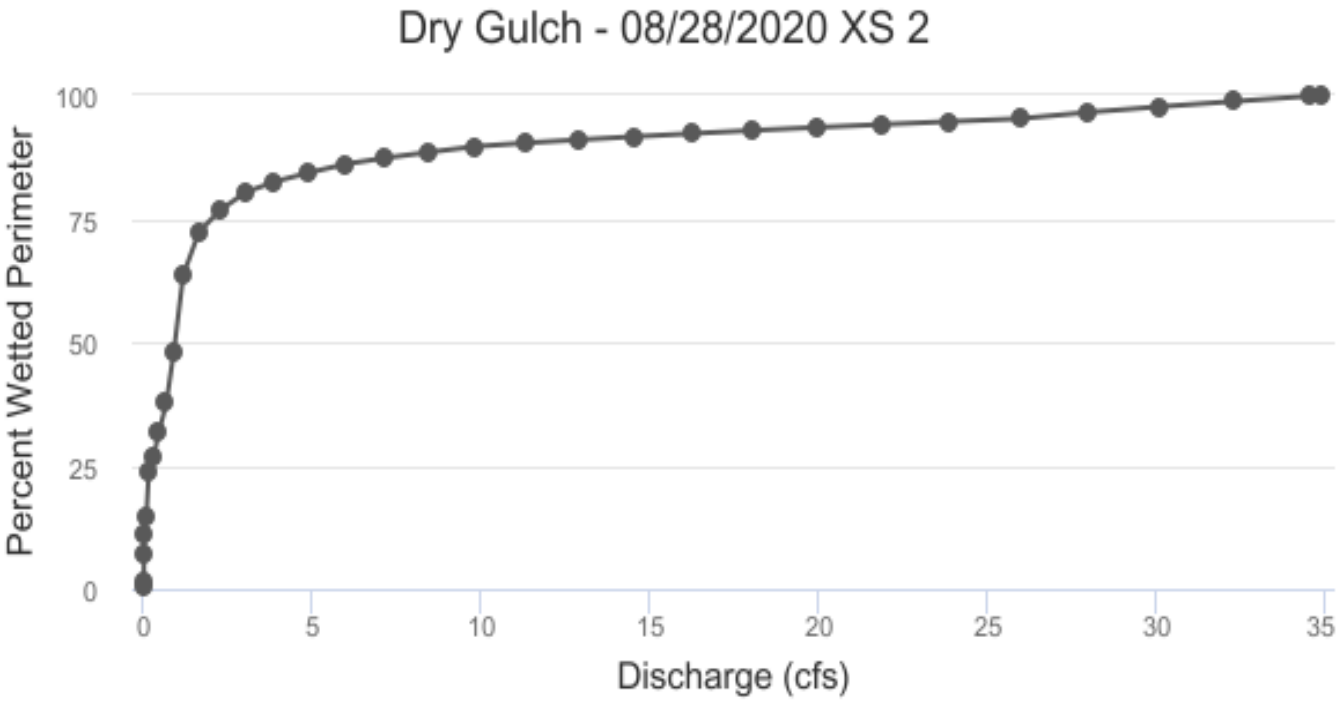
ANALYSIS RESULTS

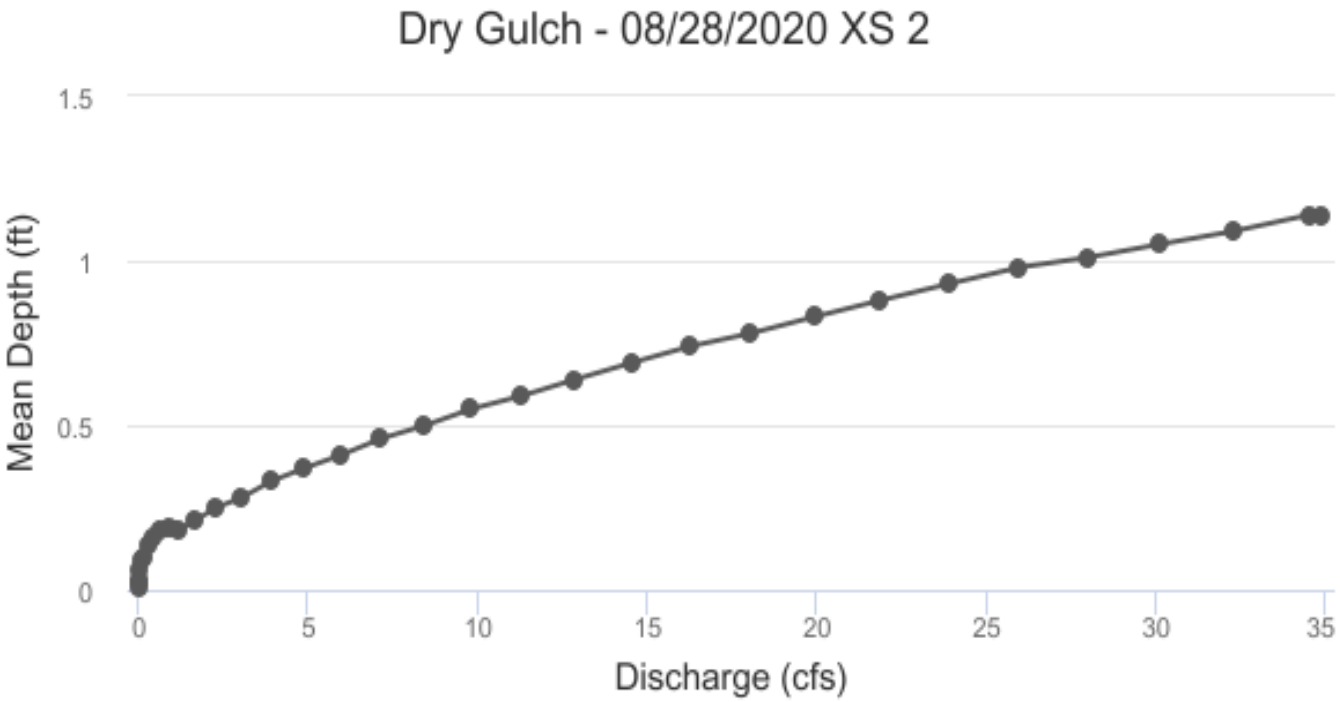
Habitat Criteria Results

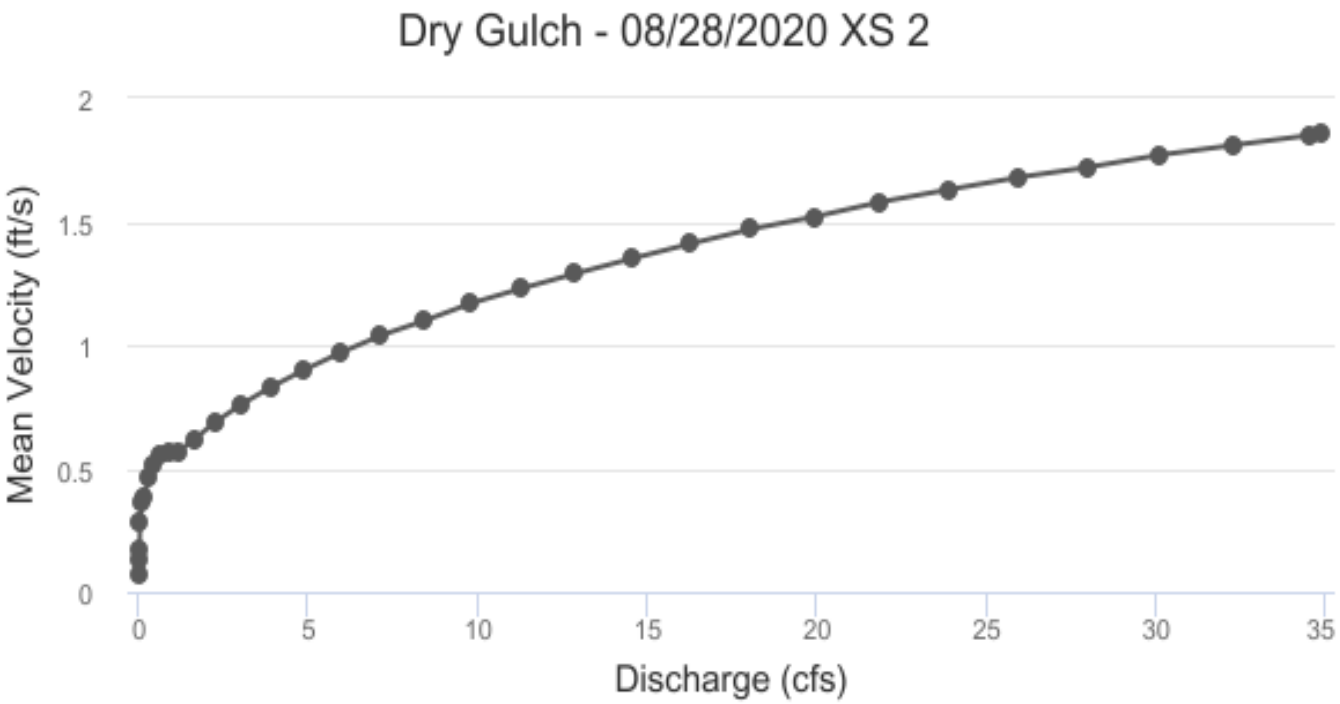
Bankfull top width (ft) = 16.48

	Habitat Criteria	Discharge (cfs) Meeting Criteria
Mean Depth (ft)	0.2	1.45
Percent Wetted Perimeter (%) **	50.0	0.92
Mean Velocity (ft/s)	1.0	6.45

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




Dry Gulch - 08/28/2020 XS 2
Mean Depth (ft)
1.5
1
0.5
0
0
5
10
15
20
25
30
35
Discharge (cfs)


Dry Gulch - 08/28/2020 XS 2
Mean Velocity (ft/s)
2
1.5
1
0.5
0
0
5
10
15
20
25
30
35
Discharge (cfs)

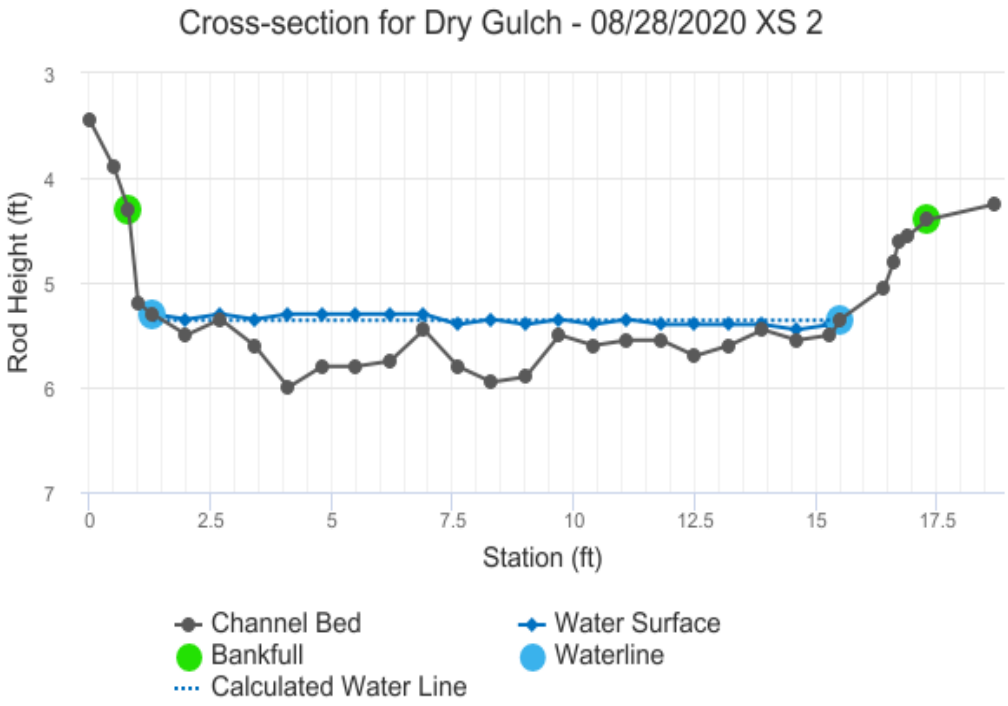
STAGING TABLE

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	4.4	16.48	1.14	1.6	18.81	18.06	100.00%	1.04	1.86	34.92
	4.41	16.45	1.14	1.59	18.68	18.03	99.82%	1.04	1.85	34.54
	4.46	16.31	1.09	1.54	17.86	17.83	98.75%	1.0	1.81	32.29
	4.51	16.17	1.05	1.49	17.05	17.64	97.68%	0.97	1.77	30.1
	4.56	16.01	1.01	1.44	16.24	17.44	96.55%	0.93	1.72	27.98
	4.61	15.83	0.98	1.39	15.45	17.2	95.26%	0.9	1.68	25.97
	4.66	15.79	0.93	1.34	14.66	17.1	94.67%	0.86	1.63	23.89
	4.71	15.76	0.88	1.29	13.87	16.99	94.08%	0.82	1.58	21.88
	4.76	15.72	0.83	1.24	13.08	16.88	93.48%	0.77	1.52	19.93
	4.81	15.68	0.78	1.19	12.29	16.77	92.88%	0.73	1.47	18.06
	4.86	15.63	0.74	1.14	11.51	16.66	92.24%	0.69	1.41	16.25
	4.91	15.58	0.69	1.09	10.73	16.54	91.61%	0.65	1.35	14.53
	4.96	15.53	0.64	1.04	9.95	16.43	90.97%	0.61	1.29	12.88
	5.01	15.48	0.59	0.99	9.18	16.31	90.33%	0.56	1.23	11.3
	5.06	15.41	0.55	0.94	8.41	16.18	89.61%	0.52	1.17	9.81
	5.11	15.25	0.5	0.89	7.64	15.97	88.45%	0.48	1.1	8.44
	5.16	15.08	0.46	0.84	6.88	15.76	87.29%	0.44	1.04	7.15
	5.21	14.9	0.41	0.79	6.13	15.54	86.03%	0.39	0.97	5.96
	5.26	14.6	0.37	0.74	5.39	15.22	84.28%	0.35	0.9	4.88
	5.31	14.3	0.33	0.69	4.67	14.9	82.51%	0.31	0.83	3.89
Waterline	5.36	13.92	0.28	0.64	3.97	14.51	80.34%	0.27	0.76	3.02
	5.41	13.31	0.25	0.59	3.28	13.86	76.73%	0.24	0.69	2.27
	5.46	12.56	0.21	0.54	2.63	13.07	72.36%	0.2	0.62	1.64
	5.51	11.04	0.18	0.49	2.04	11.48	63.56%	0.18	0.57	1.17
	5.56	8.28	0.19	0.44	1.55	8.66	47.96%	0.18	0.57	0.89

	5.61	6.48	0.18	0.39	1.18	6.8	37.66%	0.17	0.56	0.67
	5.66	5.51	0.16	0.34	0.88	5.77	31.95%	0.15	0.52	0.46
	5.71	4.63	0.14	0.29	0.63	4.83	26.77%	0.13	0.46	0.29
	5.76	4.14	0.1	0.24	0.41	4.3	23.81%	0.1	0.38	0.15
	5.81	2.53	0.09	0.19	0.23	2.65	14.67%	0.09	0.36	0.08
	5.86	1.95	0.06	0.14	0.12	2.03	11.22%	0.06	0.28	0.03
	5.91	1.26	0.03	0.09	0.04	1.31	7.23%	0.03	0.17	0.01
	5.96	0.22	0.02	0.04	0.0	0.24	1.31%	0.02	0.13	0.0
	5.99	0.08	0.01	0.01	0.0	0.08	0.47%	0.01	0.07	0.0

MODEL SUMMARY

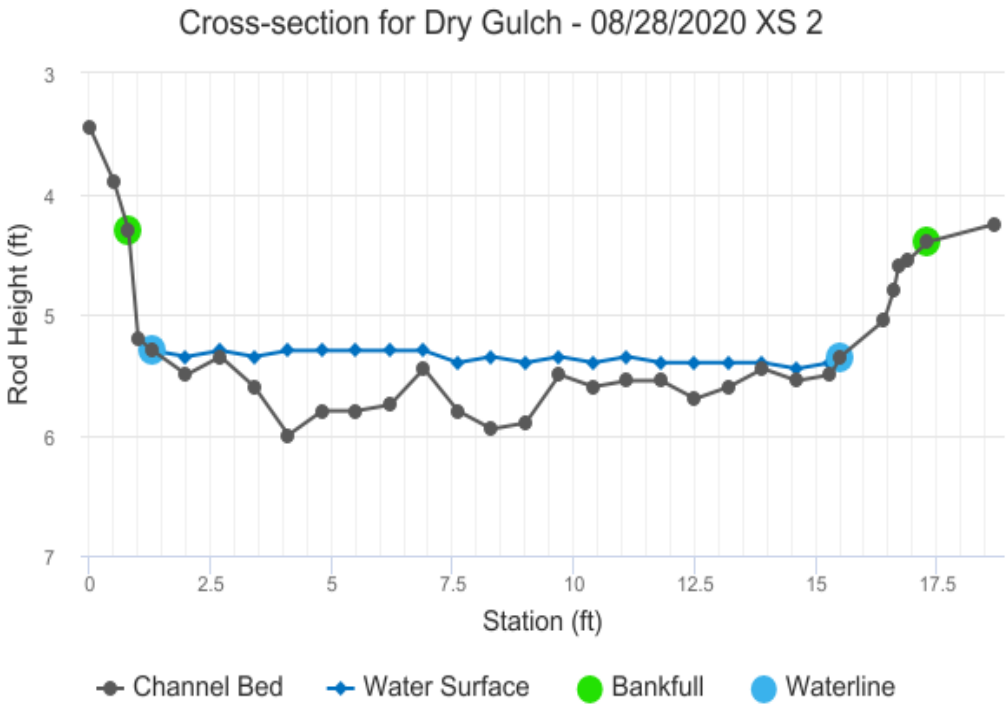
Measured Flow (Qm) =	2.98
Calculated Flow (Qc) =	3.02
(Qm-Qc)/Qm * 100 =	-1.33%
Measured Waterline (WLm) =	5.33
Calculated Waterline (WLc) =	5.36
(WLm-WLc)/WLm * 100 =	-0.62%
Max Measured Depth (Dm) =	0.7
Max Calculated Depth (Dc) =	0.64
(Dm-Dc)/Dm * 100 =	8.31%
Mean Velocity =	0.76
Manning's n =	0.199
0.4 * Qm =	1.19
2.5 * Qm =	7.44



FIELD DATA

Feature	Station (ft)	Rod Height (ft)	Water depth (ft)	Velocity (ft/s)
	0	3.45		
	0.5	3.9		
Bankfull	0.8	4.3		
	1	5.2		
Waterline	1.3	5.3	0	
	2	5.5	0.15	
	2.7	5.35	0.05	
	3.4	5.6	0.25	
	4.1	6.0	0.7	
	4.8	5.8	0.5	
	5.5	5.8	0.5	
	6.2	5.75	0.45	
	6.9	5.45	0.15	
	7.6	5.8	0.4	
	8.3	5.95	0.6	
	9	5.9	0.5	
	9.7	5.5	0.15	
	10.4	5.6	0.2	
	11.1	5.55	0.2	
	11.8	5.55	0.15	
	12.5	5.7	0.3	
	13.2	5.6	0.2	
	13.9	5.45	0.05	
	14.6	5.55	0.1	
	15.3	5.5	0.1	
Waterline	15.5	5.35	0	
	16.4	5.05		
	16.6	4.8		
	16.7	4.6		
	16.9	4.55		

Bankfull	17.3	4.4
	18.7	4.25



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	0	0	0	0
0	0	0	0	0
0.73	0.15	0.1	0.08	2.65
0.72	0.05	0.04	0.03	0.88
0.74	0.25	0.17	0.13	4.41
0.81	0.7	0.49	0.37	12.36
0.73	0.5	0.35	0.26	8.83
0.7	0.5	0.35	0.26	8.83
0.7	0.45	0.32	0.24	7.95
0.76	0.15	0.1	0.08	2.65
0.78	0.4	0.28	0.21	7.06
0.72	0.6	0.42	0.32	10.59
0.7	0.5	0.35	0.26	8.83
0.81	0.15	0.1	0.08	2.65
0.71	0.2	0.14	0.11	3.53
0.7	0.2	0.14	0.11	3.53
0.7	0.15	0.1	0.08	2.65
0.72	0.3	0.21	0.16	5.3
0.71	0.2	0.14	0.11	3.53
0.72	0.05	0.04	0.03	0.88
0.71	0.1	0.07	0.05	1.76
0.7	0.1	0.04	0.03	1.14
0.25	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	0	0	0
0	0	0	0	0

DISCLAIMER

"The Colorado Water Conservation Board makes no representations about the use of the software contained in the R2Cross platform for any purpose besides that for which it was designed. To the maximum extent permitted by applicable law, all information, modeling results, and software are provided “as is” without warranty or condition of any kind, including all implied warranties or conditions of merchantability, or fitness for a particular purpose. The user assumes all responsibility for the accuracy and suitability of this program for a specific application. In no event shall the Colorado Water Conservation Board or any state agency, official or employee be liable for any direct, indirect, punitive, incidental, special, consequential damages or any damages whatsoever including, without limitation, damages for loss of use, data, profits, or savings arising from the implementation, reliance on, or use of or inability to use the R2Cross platform.

Discharge Measurment Field Visit Data Report *(Filters: Name begins with Clear Creek; Division = 1;)*

Div	Name	CWCB Case Number	Segment ID	Meas. Date	UTM	Location	Flow Amount (cfs)	Meas #	Rating	Station ID
1	Clear Creek		21/1/A-001	10/13/2020	UTMx: 424895 UTMy: 4394495	Near loveland pass, north/upstream of I-70 and downstream of culvert.	1.63	1	Good	

Discharge Measurement Summary

Site name	Dryg
Site number	101213
Operator(s)	Lfs
File name	Dryg_20201013-133215.ft
Comment	

Start time	10/13/2020 1:01 PM
End time	10/13/2020 1:26 PM
Start location latitude	39.697
Start location longitude	-105.876
Calculations engine	FlowTracker2

Sensor type	Top Setting
Handheld serial number	FT2H1747037
Probe serial number	FT2P1747048
Probe firmware	1.30
Handheld software	1.7

# Stations	Avg interval (s)	Total discharge (ft³/s)
20	40	1.629

Total width (ft)	Total area (m²)	Wetted Perimeter (ft)
5.600	0.301	6.088

Mean SNR (dB)	Mean depth (ft)	Mean velocity (m/s)
45.670	0.578	0.154

Mean temp (°C)	Max depth (ft)	Max velocity (m/s)
1.703	0.870	0.638

Discharge Uncertainty		
Category	**ISO**	**IVE**
Accuracy	1.0%	1.0%
Depth	0.5%	5.6%
Velocity	2.0%	14.0%
Width	0.2%	0.2%
Method	2.4%	
# Stations	2.5%	
Overall	**4.2%**	**15.2%**

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

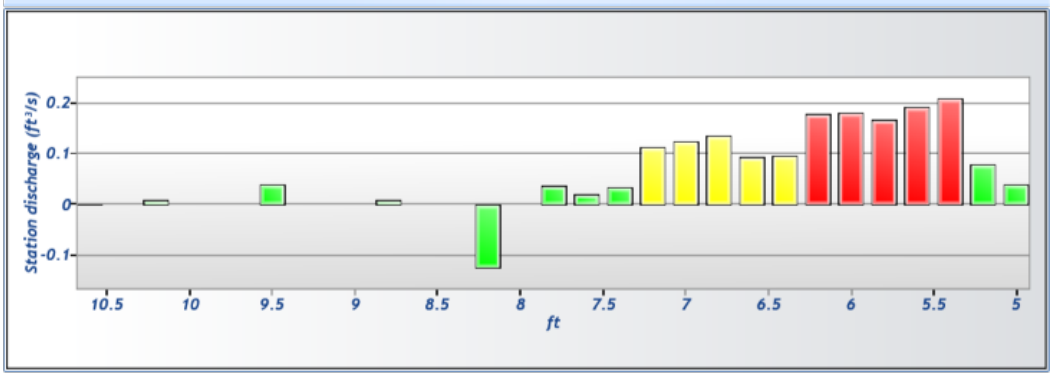
No changes were made to this file
Quality control warnings

Discharge Measurement Summary

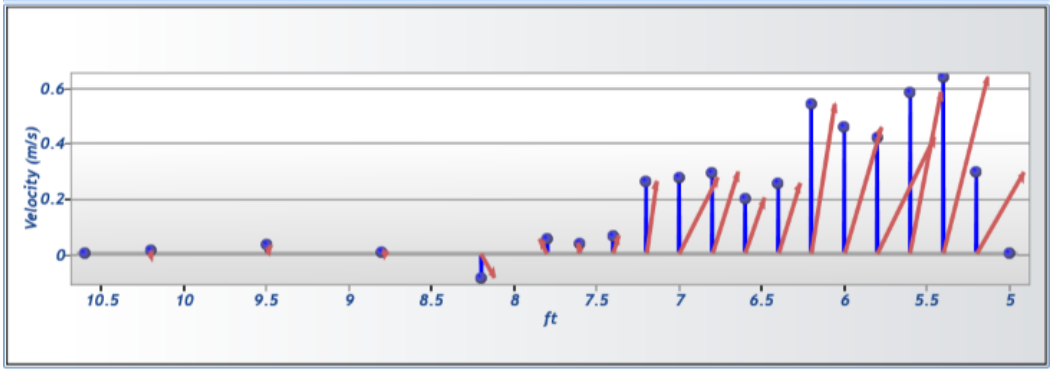
Site name	Dryg
Site number	101213
Operator(s)	Lfs
File name	Dryg_20201013-133215.ft
Comment	

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%

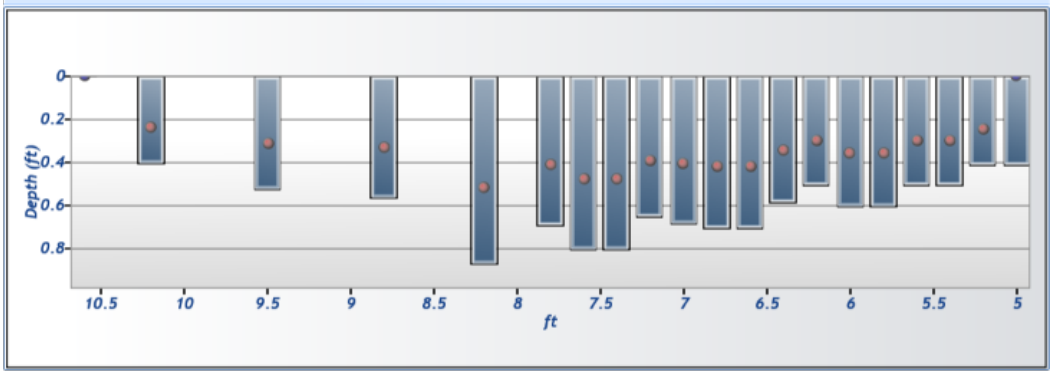
Discharge chart



Velocity chart



Depth chart



Discharge Measurement Summary

Site name	Dryg
Site number	101213
Operator(s)	Lfs
File name	Dryg_20201013-133215.ft
Comment	

Measurement results

St#	Time	Location (ft)	Method	Depth (ft)	%Depth	Measured Depth (ft)	Samples	Velocity (m/s)	Correction	Mean Velocity (m/s)	Area (m²)	Flow (ft³/s)	%Q	
0	1:01 PM	5.000	None	0.410	0.000	0.000	0	0.000	1.000	0.295	0.004	0.040	2.438	✓
1	1:01 PM	5.200	0.6	0.410	0.600	0.246	80	0.295	1.000	0.295	0.008	0.079	4.876	✓
2	1:03 PM	5.400	0.6	0.500	0.600	0.300	80	0.638	1.000	0.638	0.009	0.209	12.847	✓
3	1:04 PM	5.600	0.6	0.500	0.600	0.300	80	0.585	1.000	0.585	0.009	0.192	11.782	✓
4	1:05 PM	5.800	0.6	0.600	0.600	0.360	80	0.422	1.000	0.422	0.011	0.166	10.189	✓
5	1:08 PM	6.000	0.6	0.600	0.600	0.360	80	0.457	1.000	0.457	0.011	0.180	11.053	✓
6	1:09 PM	6.200	0.6	0.500	0.600	0.300	80	0.541	1.000	0.541	0.009	0.178	10.899	✓
7	1:11 PM	6.400	0.6	0.580	0.600	0.348	80	0.254	1.000	0.254	0.011	0.097	5.944	✓
8	1:12 PM	6.600	0.6	0.700	0.600	0.420	80	0.202	1.000	0.202	0.013	0.093	5.689	✓
9	1:13 PM	6.800	0.6	0.700	0.600	0.420	80	0.295	1.000	0.295	0.013	0.135	8.317	✓
10	1:14 PM	7.000	0.6	0.680	0.600	0.408	80	0.277	1.000	0.277	0.013	0.124	7.586	✓
11	1:16 PM	7.200	0.6	0.650	0.600	0.390	80	0.262	1.000	0.262	0.012	0.112	6.869	✓
12	1:17 PM	7.400	0.6	0.800	0.600	0.480	80	0.065	1.000	0.065	0.015	0.034	2.107	✓
13	1:18 PM	7.600	0.6	0.800	0.600	0.480	80	0.038	1.000	0.038	0.015	0.020	1.212	✓
14	1:19 PM	7.800	0.6	0.690	0.600	0.414	80	0.056	1.000	0.056	0.019	0.038	2.322	✓
15	1:20 PM	8.200	0.6	0.870	0.600	0.522	80	-0.087	1.000	-0.087	0.040	-0.124	-7.582	✓
16	1:22 PM	8.800	0.6	0.560	0.600	0.336	80	0.007	1.000	0.007	0.034	0.008	0.511	✓
17	1:23 PM	9.500	0.6	0.520	0.600	0.312	80	0.033	1.000	0.033	0.034	0.039	2.417	✓
18	1:24 PM	10.200	0.6	0.400	0.600	0.240	80	0.012	1.000	0.012	0.020	0.009	0.526	✓
19	1:26 PM	10.600	None	0.000	0.000	0.000	0	0.000	1.000	0.012	0.000	0.000	0.000	✓

Discharge Measurement Summary

Site name	Dryg
Site number	101213
Operator(s)	Lfs
File name	Dryg_20201013-133215.ft
Comment	

Quality Control Settings	
Maximum depth change	50.000%
Maximum spacing change	100.000%
SNR threshold	10.000 dB
Standard error threshold	0.010 m/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	1:01 PM	5.200	0.6	0.410	0.600	0.246	Standard Error > QC,Velocity Angle > QC
2	1:03 PM	5.400	0.6	0.500	0.600	0.300	Velocity Angle > QC,High Stn % Discharge
3	1:04 PM	5.600	0.6	0.500	0.600	0.300	Standard Error > QC,High Stn % Discharge
4	1:05 PM	5.800	0.6	0.600	0.600	0.360	Standard Error > QC,Velocity Angle > QC,High Stn % Discharge
5	1:08 PM	6.000	0.6	0.600	0.600	0.360	Standard Error > QC,Velocity Angle > QC,High Stn % Discharge
6	1:09 PM	6.200	0.6	0.500	0.600	0.300	Standard Error > QC,High Stn % Discharge
7	1:11 PM	6.400	0.6	0.580	0.600	0.348	Standard Error > QC,Velocity Angle > QC
8	1:12 PM	6.600	0.6	0.700	0.600	0.420	Standard Error > QC,Velocity Angle > QC
9	1:13 PM	6.800	0.6	0.700	0.600	0.420	Standard Error > QC,Velocity Angle > QC
10	1:14 PM	7.000	0.6	0.680	0.600	0.408	Velocity Angle > QC
11	1:16 PM	7.200	0.6	0.650	0.600	0.390	Standard Error > QC
12	1:17 PM	7.400	0.6	0.800	0.600	0.480	Velocity Angle > QC
13	1:18 PM	7.600	0.6	0.800	0.600	0.480	Velocity Angle > QC
14	1:19 PM	7.800	0.6	0.690	0.600	0.414	Velocity Angle > QC
15	1:20 PM	8.200	0.6	0.870	0.600	0.522	Standard Error > QC,Velocity Angle > QC
17	1:23 PM	9.500	0.6	0.520	0.600	0.312	Velocity Angle > QC

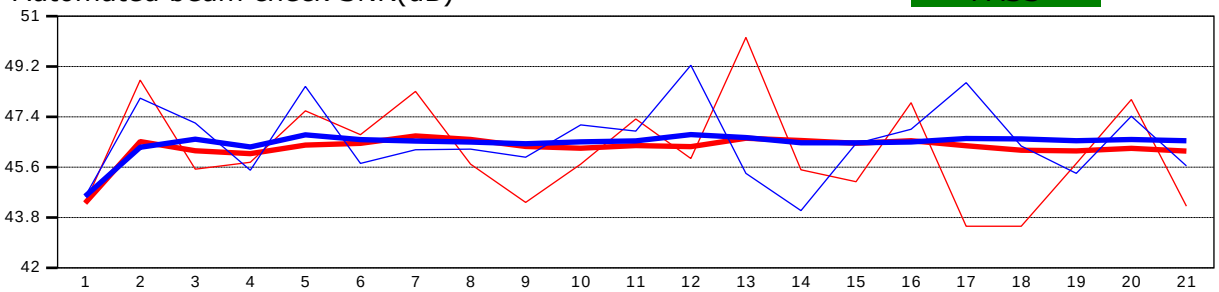
Discharge Measurement Summary

Site name	Dryg
Site number	101213
Operator(s)	Lfs
File name	Dryg_20201013-133215.ft
Comment	

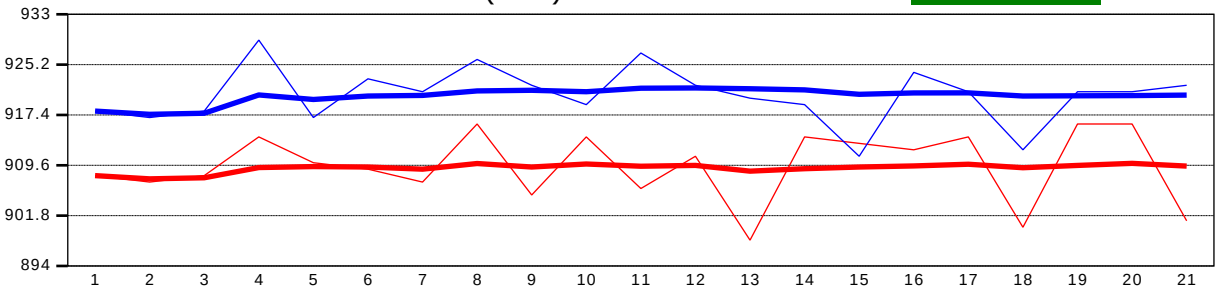
Beam 1	
Beam 2	

Automated beam check Start time 10/13/2020 1:00:31 PM

Automated beam check SNR(dB) PASS



Automated beam check Noise level(cnts) PASS



Automated beam check Quality control warnings

No quality control warnings

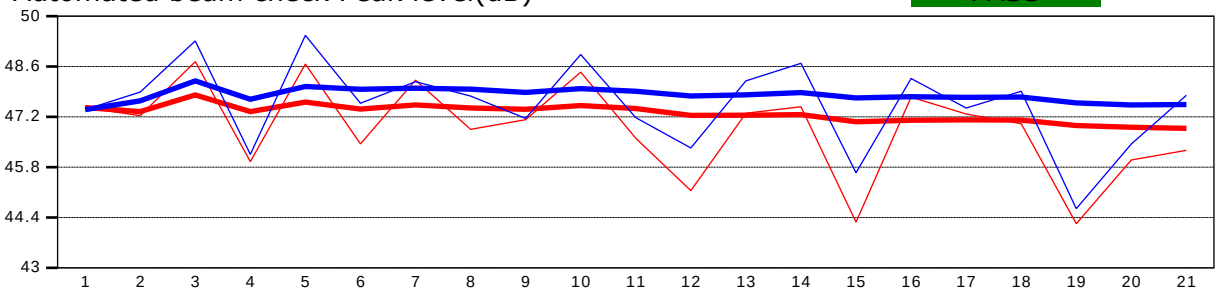
Discharge Measurement Summary

Site name	Dryg
Site number	101213
Operator(s)	Lfs
File name	Dryg_20201013-133215.ft
Comment	

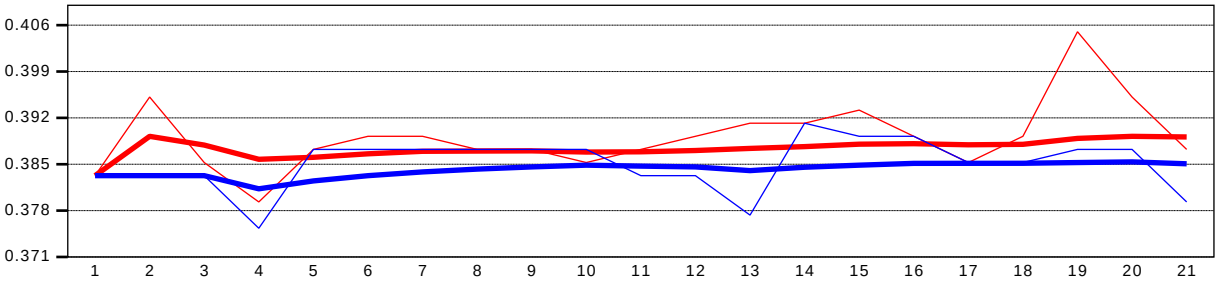
Beam 1	
Beam 2	

Automated beam check Start time 10/13/2020 1:00:31 PM

Automated beam check Peak level(dB) PASS



Automated beam check Peak position(ft) PASS



Automated beam check Quality control warnings

No quality control warnings