### **Instream Flow Recommendation:**

Rock Creek (Headwaters to the natural falls near the USFS Boundary)

### **Contact Information:**

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### Introduction:

This document contains the necessary information to form the scientific and biological basis for an instream flow (ISF) recommendation for Rock Creek in Park County, Colorado. The Rock Creek basin supports a high value fishery that is being managed as a designated conservation population of greenback cutthroat trout (Oncorhynchus clarki stomias). In 2014, CPW and CWCB were contacted by members of the Park County Advisory Board on the Environment (ABE); ABE is a citizen advisory sub-committee that was established by the Park County Board of County Commissioners (BOCC) to assist them with community outreach on environmental issues in the county. ABE's initial interest in ISF protection in the county was triggered by some of the Colorado Water Plan public meetings that were going on at that time in various locations around the state. CPW and CWCB met with ABE and the Park County BOCC to discuss existing ISF water rights in the county and places where significant resource values exist in the county without ISF protection. After several meetings that included ABE, the BOCC and local representatives of the Colorado Cattlemen Association, a list of priority streams and lakes in Park County was generated by CPW, CWCB and ABE; this segment of Rock Creek was one of the priority streams that emerged from this collaborative process. CPW believes that the information compiled in this document provides the basis for the findings necessary for an ISF appropriation stated in the ISF statutes and in ISF Program Rule 5(i).

The State of Colorado's Instream Flow and Natural Lake Level Program (ISF/NLL Program) was created in 1973 when the Colorado General Assembly passed Senate Bill 97. This bill recognized, "the need to correlate the activities of mankind with some reasonable preservation of the natural environment (C.R.S. §37-92-102 (3))." Creation of this state program identified the CWCB as the only state agency with the ability to appropriate and acquire instream flow and natural lake level water rights. In an effort to promote participation in the ISF/NLL Program by other entities, the state statute requires the Board to consider instream flow recommendations by local, state, or federal agencies. CPW is recommending this reach of Rock Creek for inclusion in the ISF/NLL Program because there is a natural environment that can be preserved to a reasonable degree with an instream flow water right.

CPW is sending this instream flow recommendation to the Board in order to meet CPW's legislative declaration, "... that the wildlife and their environment are to be protected, preserved, enhanced, and managed for the use, benefit, and enjoyment of the people of this state and it's visitors... and that, to carry out such program and policy, there shall be a continuous operation of planning, acquisition, and development of wildlife habitats and facilities for wildlife-related opportunities (C.R.S. § 33-1-101 (1))," and, "... that the natural, scenic, scientific, and outdoor recreation areas of this state are to be protected, preserved, enhanced and managed for the use, benefit, and enjoyment of the people of this state and visitors of this state... and that to carry such program and policy there shall be a continuous operation of acquisition, development, and management of outdoor recreation lands, waters, and facilities (C.R.S. §33-10-101 (1))."

In addition to these broad statutory guidelines, CPW's current strategic planning document (CPW Strategic Plan, 2015) explains current 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.

### **Stream Reach and Location Information**

**Recommended Reach:** Rock Creek from the headwaters to natural falls (Figure 1)

**Upper Terminus:** Headwaters of Rock Creek

UTM North: 4363476.90749; UTM East: 442888.089974

Elevation: 11,603 feet

Lower terminus: Natural falls

UTM North: 4357205.49814; UTM East: 441529.522061

Elevation: 9,499 feet

Water Division: 1
Water District: 23

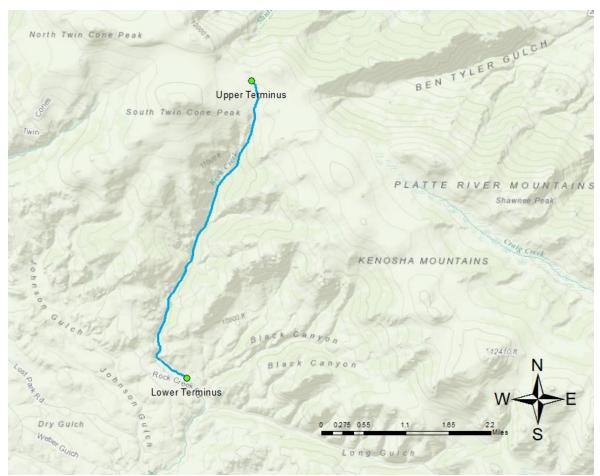
CPW Water Code: 30661

Approximate segment length in miles: 4.7 miles

**County:** Park County

Major Drainage Basin: South Platte River

### USGS quad maps: Mount Logan



**Figure 1.** Map of the recommended reach of Rock Creek (blue), the green dots are the upper and lower termini of the ISF recommendation.

### **Natural Environment**

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 Rock Creek is protected by an ISF water right, this action can be a critical step in the overall preservation and conservation of greenback cutthroat trout.

### **Rock Creek Watershed:**

The Rock Creek watershed is located east of Como, CO, and southeast of Jefferson, CO. The headwaters of Rock Creek is located at an elevation of around 11,600 feet; Rock Creek flows into Tarryall Creek at an elevation of about 9,020 feet approximately 11 miles downstream from the headwaters. The Rock Creek watershed extends from a forested area into South Park. The drainage area of the entire Rock Creek watershed is approximately 45.6 square miles having a mean basin elevation of approximately 10,200 feet; the basin receives about 23 inches of precipitation in an average year. Hydrology of the creek is primarily snow melt driven with perennial flow.

### **Recommended Segment:**

The upper terminus of this recommended reach is at the headwaters and the lower terminus is approximately 4.7 miles downstream at the USFS boundary. At the lower terminus, Rock Creek is a second order stream; aerial photos suggest that Rock Creek is a single thread channel throughout the recommended reach. The creek flows through a confined valley in the upper half of the reach, near the lower terminus the valley is more unconfined. Throughout the reach, a prominent riparian corridor exists, and a significant portion of the reach is surrounded by a forest canopy. Temperature regulation in these smaller tributary streams is greatly dependent upon shading from riparian and forest cover. Due to the location of this stream reach, stream temperatures should remain cold enough to sustain cold-water habitat. The stream connects to the floodplain during spring runoff providing connectivity adjacent to the terrestrial environment. The upper half of the reach is quite steep and the lower half has a more gentle gradient; the overall gradient of this reach of Rock Creek is about 8%. Given the variation in gradient and valley types it is reasonable to assume that the habitat is fairly diverse. The habitat in the upper portion of the reach (in the confined valley) is a sequence of plunge-pools and the lower portion of the reach (in the unconfined valley) has aquatic habitat consisting of riffle-pool sequences. Rock Creek's stream banks are relatively intact within the recommended reach; some additional high quality habitat exists where the banks are well vegetated and undercutting has occurred.

**Table 1.** Estimate of the percentage of public and private land within the recommended reach of Rock Creek.

Upper	Lower	Total Length	Approximate Land Ownership				
Terminus	Terminus	(miles)	%Private	%Public			
Headwaters	natural falls	4.7	0	100+			

<sup>+ = 100%</sup> of the public lands are managed by the USFS.

### **Aquatic Environment**

The upper sections of Rock Creek have been identified by CPW biologists as an ideal location for the establishment of a conservation population of greenback cutthroat trout. This creek is a high elevation montane stream and therefore provides ideal habitat for this subspecies. Following this determination by CPW, a reclamation project was conducted in the upper reaches (in 2015) to remove all of the non-native salmonids from the system. Non-native salmonids hybridize and compete with the native trout (Greenback Cutthroat Trout Recovery Team, 1977). Following the 2015 reclamation project, Rock Creek was stocked twice with the Bear Creek strain of greenback cutthroat trout. The Bear Creek strain is the last known population of genetically pure greenbacks (Bear Creek is located northwest of Colorado Springs). To ensure long term isolation of the stocked greenback cutthroat trout, Rock Creek has a natural fish passage barrier in the recommended segment. The location of the Rock Creek fish passage barrier is at an elevation of 9,907 feet. Rock Creek above the barrier was sampled in 2016 and greenbacks were the only species collected – so the barrier is effective in isolating the stocked fish.

According to CPW published information (2016) and Recovery Team documents (1977), greenbacks prefer clear, cold, headwater streams and mountain lakes with clean gravel substrate and an abundant supply of food (aquatic and terrestrial insects). Rock Creek has all of these characteristics. All of this information leads to the conclusion that a natural environment exists in Rock Creek, a natural environment that would certainly benefit from the protection provided by a CWCB ISF water right.

Table 2. Natural environment information for Rock Creek within the recommended reach.

Species Name	Scientific Name	Status
greenback cutthroat trout	Oncorhynchus clarki stomias	Federally Threatened State Threatened

### **ISF Quantification**

### **R2CROSS Results:**

In 2016, CPW staff collected stream cross-sectional data at one site on Rock Creek. While this data was collected at a site slightly downstream of the recommended reach; we are of the opinion that the stream channel characteristics of this location are consistent with and representative of the channel within the recommended reach. The data was collected late in the season when the flows in Rock Creek were near baseflow. There are no perennial tributaries to Rock Creek in the vicinity of the data collection site so the flows measured at that site were identical to the flows up in the recommended ISF reach. Initial biological instream flow recommendations were developed utilizing the standard application of the R2CROSS methodology (Espegren 1996). R2CROSS uses field data collected in a riffle stream habitat types; riffles are the limiting habitat type in streams during low flow events. The field data includes a survey of stream channel geometry, a longitudinal slope of the water surface, and a streamflow measurement at the designated cross section location. After processing this data with R2CROSS, a winter and summer flow recommendation was developed utilizing the R2CROSS criteria described in Nehring (1979) and Espergren (1996); the R2CROSS hydraulic criteria are average depth, average velocity, and wetted perimeter. Maintaining these hydraulic parameters at adequate levels across riffle habitat types will also maintain aquatic habitat in pools and runs for most life stages of fish and aquatic invertebrates (Nehring 1979). Table 3 (below) summarizes the R2CROSS results for the Rock Creek data set.

**Table 3.** Summary of the R2CROSS results Rock Creek. Q measured is the discharge measured in the field, 40%-250% is the confidence interval in which flow criteria should be met, flow meeting two criteria is the winter flow recommendation, and flow meeting three criteria is the summer flow recommendation.

Entity	Date Measured	Q measured	40%-250%	Flow Meeting Two Criteria	Flow Meeting Three Criteria
CPW	9/27/2016	2.24 cfs	0.9-5.6 cfs	2.16 cfs	3.82 cfs

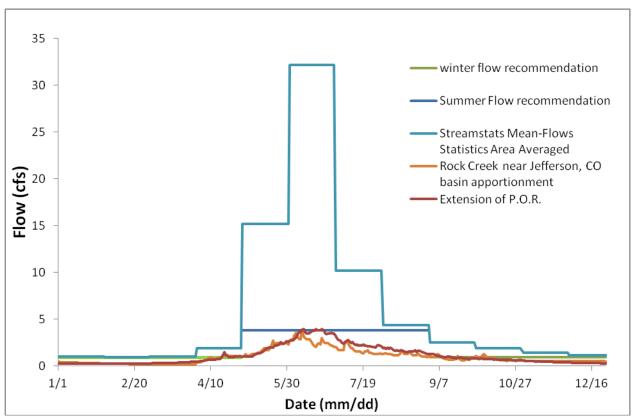
### ISF Recommendation:

From the above table, the R2CROSS-based winter flow recommendation is the flow that meets two of the three hydraulic criteria. Similarly, the R2CROSS-based summer flow recommendation is the flow meets all three of the hydraulic criteria. The Rock Creek ISF recommendation is 2.2 cfs for the winter season and 3.8 cfs for the summer season.

### **Water Availability:**

Division of Water Resources data indicates that there are no existing water rights within this reach of Rock Creek. Also, since the flow is not impacted by any upstream diversions, the USGS StreamStats mean monthly flow prediction tool is a valid tool for preliminary water availability

analyses. In addition to StreamStats, daily streamflow information is also available from the USGS; there is a gage on Rock Creek with a short period of record and a gage on Tarryall Creek with a longer and somewhat intermittent period of record. We looked at a basin area apportionment of the Tarryall Creek gage and an extension of the period of record for the Rock Creek gage using the temporal overlap with the Tarryall Creek gage. All of this data is displayed on the hydrograph below (Figure 2).



**Figure 2**. Hydrograph showing the winter and summer ISF recommendations, the Streamstats derived mean monthly flow statistics for the Rock Creek basin, the basin apportionment of the Rock Creek near Jefferson, CO (USGS 06699000) gage (1986-1999), and an extension of the period of record (P.O.R) of the Rock Creek gage using the Tarryall Creek near Jefferson, CO gage (USGS 06699005).

### **Seasonal ISF Recommendation**

The above preliminary water availability (Figure 2) illustrates mixed results but the measured flows at the time of CPW and CWCB site visits seem to be closer to the StreamStats hydrology than they are to the gage data manipulations. Preliminarily, the R2CROSS flow recommendations appear to be available for an ISF appropriation on Rock Creek. The StreamStats hydrograph also provides information on the seasonality of the R2CROSS flow recommendations. After considering the preliminary water availability information, CPW concludes that the following flows are necessary to preserve the greenback cutthroat fishery and natural environment in Rock Creek. 3.8 cubic feet per second is recommended for the summer high flow season (to provide spawning and fry emergence habitat) and this flow

appears to be available from May 1<sup>st</sup> through August 31<sup>st</sup>. Similarly, 0.9 cubic feet per second is recommended for the winter base flow (to provide over-wintering adult habitat) period; this flow appears to be available for the remainder of the year from September 1<sup>st</sup> to April 30<sup>th</sup>.

### **Citations**

- Capesius, J.P. and V.C. Stephens, 2009, Regional regression equations for estimation of natural streamflow statistics in Colorado, Scientific Investigations Report 2009-5136. (USGS StreamStats)
- Colorado Parks and Wildlife. *Colorado Parks & Wildlife Species Profiles*. N.p., n.d. Web. 29 Nov. 2016.
- Colorado Parks and Wildlife. *Colorado Parks & Wildlife Greenback Cutthroat Trout*. N.p., n.d. Web. 29 Nov. 2016.
- Epegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.
- Nehring, B.R., 1979, Evaluation of Instream Flow Methods and Determination of Water Quantity Needs for Streams in the State of Colorado, Colorado Division of Wildlife.
- Greenback Cutthroat Trout Recovery Team, and David L. Langlois, 1977, Greenback cutthroat trout recovery plan, US Fish and Wildlife Service.

### **Appendices**

**Appendices A:** R2CROSS output for cross-section performed on Rock Creek.

### **Photos:**

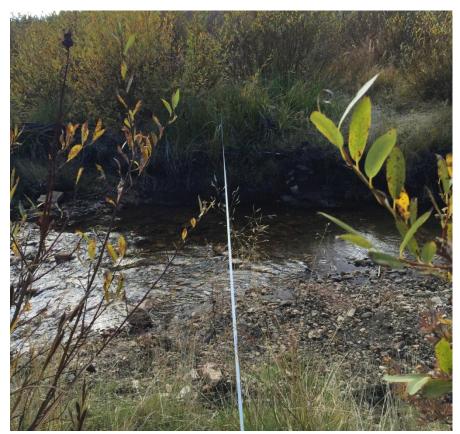


Figure 3. View across Rock Creek R2CROSS site.



**Figure 4.** Looking downstream at Rock Creek R2CROSS cross-section site. Page **9** of **11** 



Figure 5. Looking upstream at Rock Creek R2CROSS cross-section site.



Figure 6. Natural environment of Rock Creek

Page **10** of **11** 



Figure 7. Natural environment of Rock Creek.



### **FIELD DATA FOR INSTREAM FLOW DETERMINATIONS**



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XS NUMBER:	1			4.00	8.80			0.00	0.00	0.00
	9/27/2016			7.40	9.30			0.00	0.00	0.00
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USGS MAP:				14.20	10.05	0.40	1.12	0.16	0.18	9.65
USFS MAP				14.60	10.05	0.45	1.04	0.18	0.19	9,60
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# COLORADO WATER CONSERVATION BOARD INSTREAM FLOW / NATURAL LAKE LEVEL PROGRAM STREAM CROSS-SECTION AND FLOW ANALYSIS

### LOCATION INFORMATION

STREAM NAME:

XS LOCATION: XS NUMBER:	20 m D/S from	n culvert
DATE: OBSERVERS:	27-Sep-16 CT, JS, TD	끂
1/4 SEC: SECTION: TWP: RANGE: PM:	Lat: 39.35594 Long: -105.67 0 0	<del>-</del>
COUNTY: WATERSHED: DIVISION: DOW CODE:	Park N. Fk. S. Plat 1 0	te
USGS MAP: USFS MAP:	0	
SUPPLEMENTAL DATA		*** NOTE *** Leave TAPE WT and TENSION at defaults for data collected
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Rock Creek

STREAM NAME:

Rock Creek

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20 m D/S from culvert

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XS NUMBER:

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### VALUES COMPUTED FROM RAW FIELD DATA

FEATURE		VERT	WATER		WETTED	WATER	AREA	Q	% Q
	DIST	DEPTH	DEPTH	VEL	PERIM.	DEPTH	(Am)	(Qm)	CELL
S	0.00	6.85			0.00		0.00	0.00	0.0%
GL	1.70	7.85			0.00		0.00	0.00	0.0%
-	4.00	8.80	*		0.00		0.00	0.00	0.0%
	7.40	9.30			0.00		0.00	0.00	0.0%
WL	9.40	9.63	0.00	0.00	0.00		0.00	0.00	0,0%
	9.80	9.75	0.15	0.81	0.42	0.15	0.06	0.05	2.2%
	10.20	9.70	0.20	1.22	0.40	0.20	0.08	0.10	4.4%
	10.60	9.85	0.20	1.63	0.43	0.20	0.08	0.13	5.8%
	11.00	9.90	0.25	1.33	0.40	0.25	0.10	0.13	5.9%
	11.40	9.85	0.25	1.38	0.40	0.25	0.10	0.14	6.2%
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	12,20	9.85	0.15	1.00	0.40	0.15	0.06	0.06	2.7%
	12.60	9.80	0.15	1.08	0.40	0.15	0.06	0.06	2.9%
	13.00	9.95	0.30	1.27	0.43	0.30	0.12	0.15	6.8%
	13.40	10.00	0.40	1.18	0.40	0.40	0.16	0.19	8.4%
	13.80	10.05	0.45	1.15	0.40	0.45	0.18	0.21	9.2%
	14.20	10.05	0.40	1.12	0.40	0.40	0.16	0.18	8.0%
	14.60	10.05	0.45	1.04	0.40	0.45	0.18	0.19	8.3%
	15.00	10.10	0.50	0.98	0.40	0.50	0.20	0.20	8.7%
	15.40	10.00	0.45	0.97	0.41	0.45	0.18	0.17	7.8%
	15.80	10.00	0.40	0.64	0.40	0.40	0.16	0.10	4.6%
	16.20	10.05	0.45	0.64	0.40	0.45	0.14	0.09	3.9%
	16.40	10.00	0.45	0.44	0.21	0.45	0.14	0.06	2.6%
WL	16.80	9.66	0.00	0.00	0,52		0.00	0.00	0.0%
	17.00	9.20			0.00		0.00	0.00	0.0%
	17.50	7.75			0.00		0.00	0.00	0.0%
GL	18.30	7.45			0.00		0.00	0.00	0.0%
S	21.00	6.70			0.00		0.00	0.00	0.0%
	TALS				7.65	0.5	2.19	2.24	100.0%

Manning's n = Hydraulic Radius=

(Max.)

0.0746 0.28640242 STREAM NAME:

Rock Creek

XS LOCATION:

20 m D/S from culvert

XS NUMBER:

1

### WATER LINE COMPARISON TABLE

WATER	MEAS	COMP	AREA
LINE	AREA	AREA	ERROR
	2.19	1.98	-9.6%
9.40	2.19	4.01	83.2%
9.42	2.19	3.84	75.1%
9.44	2.19	3.66	67.1%
9.46	2.19	3.49	59.3%
9.48	2.19	3.32	51.5%
9.50	2.19	3.15	43.9%
9.52	2.19	2.99	36.4%
9.54	2.19	2.82	29.0%
9.56	2.19	2.67	21.7%
9.58	2.19	2.51	14.6%
9.60	2.19	2.35	7.5%
9.61	2.19	2.28	4.0%
9.62	2.19	2.20	0.6%
9.63	2.19	2.13	-2.8%
9.64	2.19	2.05	-6.2%
9.65	2.19	1.98	-9.6%
9.66	2.19	1.91	-12.9%
9.67	2.19	1.83	-16.3%
9.68	2.19	1.76	-19.6%
9.69	2.19	1.69	-22.9%
9.70	2.19	1.62	-26.1%
9.72	2.19	1.48	-32.6%
9.74	2.19	1.34	-38.7%
9.76	2.19	1.21	-44.6%
9.78	2.19	1.09	-50.4%
9.80	2.19	0.96	-56.0%
9.82	2.19	0.84	-61.5%
9.84	2.19	0.73	-66,5%
9.86	2.19	0.64	-70,8%
9.88	2.19	0.55	-74.8%
9.90	2.19	0.47	-78.4%

WATERLINE AT ZERO AREA ERROR =

9.617

STREAM NAME:

Rock Creek

XS LOCATION:

20 m D/S from culvert

XS NUMBER:

Constant Manning's n

\*GL\* = lowest Grassline elevation corrected for sag STAGING TABLE

\*WL\* = Waterline corrected for variations in field measured water surface elevations and sag

_	DIST TO	TOP	AVG.	MAX.	4854	WETTED	PERCENT	HYDR	FLOW	AVG. VELOCITY
	WATER	WIDTH	DEPTH	DEPTH	AREA	PERIM. (FT)	WET PERIM (%)	RADIUS (FT)	(CFS)	(FT/SEC)
-	(FT)	(FT)	(FT)	(FT)	(SQ FT)	(F1)	(%)	(F1)	(CPS)	(11000)
r.	7.85	15.77	1.54	2.25	24.30	17.53	100.0%	1.39	71.21	2,93
	8.62	13.63	0.95	1,48	12.95	14,69	83.8%	0.88	28.06	2,17
	8.67	13.49	0.91	1,43	12.27	14.51	82.8%	0.85	25.87	2.11
	8.72	13.35	0.87	1.38	11.60	14.32	81.7%	0.81	23.76	2.05
	8.77	13.22	0,83	1.33	10.93	14.14	80.7%	0.77	21.72	1.99
	8.82	12.98	0.79	1.28	10.28	13,86	79.1%	0.74	19.85	1,93
	8.87	12.62	0.76	1,23	9.64	13,46	76.8%	0.72	18.18	1.89
	8.92	12.27	0.74	1.18	9.02	13.07	74,5%	0.69	16.60	1.84
	8.97	11.91	0.71	1.13	8.41	12.67	72.3%	0.66	15.09	1.79
	9.02	11.55	0.68	1.08	7.82	12.27	70.0%	0.64	13.67	1.75
	9.07	11.19	0.65	1,03	7.26	11.88	67.6%	0.61	12.32	1.70
	9.12	10.84	0.62	0.98	6.71	11.48	65.5%	0.58	11.05	1.65
	9.17	10.48	0.59	0.93	6.17	11.08	63.2%	0.56	9,85	1.60
	9,22	10.12	0.56	0.88	5,66	10.69	61.0%	0.53	8.73	1.54
	9.27	9.76	0.53	0.83	5.16	10.29	58.7%	0.50	7.68	1.49
	9,32	9.41	0.50	0.78	4.68	9.91	56.5%	0.47	6.70	1,43
	9.37	9.09	0.48	0.73	4.22	9.54	54.5%	0.44	5.77	1.37
	9,42	8.76	0.43	0.68	3.77	9.18	52.4%	0.41	4.92	1.30
	9.47	8.44	0.40	0.63	3.34	6.62	50.3%	0.38	4.13)	1.23
	9.52	8.11	0.36	0.58	2.93	6.46	48.3%	0.35	3.40	1.16
	9.57	7.79	0.32	0.53	2.53	8.10	46.2%	0.31	2.75	1.09
Ľ.	9.62	7.46	0.29	0,48	2.15	7.74	44.1%	0.28	(2.16)	1.00
	9.67	7.25	0.25	0.43	1.78	7.48	42.7%	0.24	1.62	0.91
	9.72	6.78	0.21	0.38	1.43	6.99	39.9%	0.20	1.17	0.82
	9.77	6.28	(0.18	0.33	1,11	6.45	36.8%	0.17	0.80	0.73
	9.82	5.49	0.15	0.28	0.80	5.63	32.1%	0.14	0.52	0.64
	9.87	4.20	0.13	0.23	0.56	4.30	24.5%	0.13	0.34	0.61
	9.92	3.57	0.11	0.18	0.37	3.63	20.7%	0.10	0.19	0.52
	9.97	3.26	0.06	0.13	0.20	3.30	18.8%	0.06	0.07	0.37
	10.02	2.07	0.03	0.08	0.06	2.09	11.9%	0.03	0.01	0.23
	10.07	0.33	0.01	0.03	0.00	0.34	1.9%	0.01	0.00	0.14

$$\frac{2/3}{50.0\%} = \frac{3/3}{50.0\%} = \frac{4.13 \text{ cfs}}{x}$$

$$\frac{50.3\%}{50.0\%} = \frac{206.5}{x} \times = 4.105 \approx 4.11 \text{ cfs}$$

$$\frac{48.3\%}{50.0\%} = \frac{3.4 \text{ cfs}}{x} \times = 4.105 \approx 4.11 \text{ cfs}$$

$$\frac{48.3\%}{50.0\%} = \frac{3.4 \text{ cfs}}{x} \times = \frac{4.11 + 3.5\lambda}{3.8\lambda \text{ cfs}} = 3.815 \approx 3.82 \text{ cfs}$$

STREAM NAME: XS LOCATION: XS NUMBER:

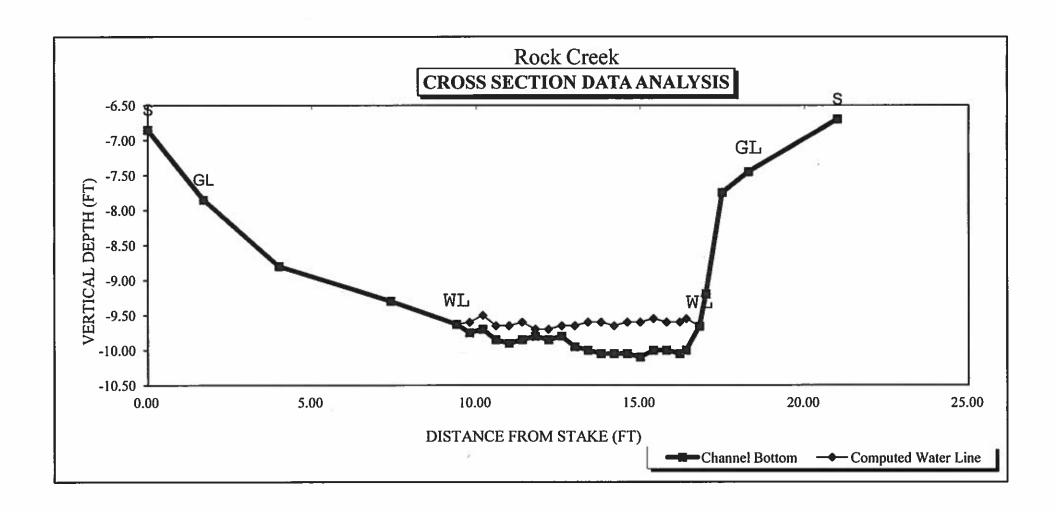
Rock Creek

20 m D/S from culvert

1

### SUMMARY SHEET

MEASURED FLOW (Qm)=	2.24	cfs	RECOMMENDED INST	TREAM FLOW:
CALCULATED FLOW (Qc)=	2.16	cfs	=======================================	**********
(Qm-Qc)/Qm * 100 =	3.8	%		
,			FLOW (CFS)	PERIOD
MEASURED WATERLINE (WLm)=	9.65	ft	*********	=======
CALCULATED WATERLINE (WLc)=	9.62	ft		
(WLm-WLc)/WLm * 100 =	0.3			
(**************************************	0.0	74		
MAX MEASURED DEPTH (Dm)=	0.50	64		
MAX CALCULATED DEPTH (Dc)=	0.48			_
(Dm-Dc)/Dm * 100	4.4			
(DM-DC)/DM - 100	4.4	7/0		
MEAN VELOCITY-	4.00	Minne		
MEAN VELOCITY=		ft/sec		
MANNING'S N=	0.075			
SLOPE=	0.014	ft/ft		
440		-4-		
.4 * Qm =	707	cfs		
2,5 ° Qm=	5,6	cfs		
	(*120	1 - 1 - 1 - 1 - 1		
Section 2000 - Account as the		00 I+		
	The state of the s			
32 20 24 V 12 - 1			The state of the s	0.00
RECOMMENDATION BY:		AGENCY		DATE:
CWCB REVIEW BY:				DATE:



### Discharge Measurment Field Visit Data Report (Filters: Name begins with Rock Creek; Processing Status = Moving Forward;)

Div	Name	CWCB Case Number	Segment ID	Meas. Date	UTM	Location	Flow Amount (cfs)	Meas #	Rating	Station ID
1	Rock Creek		16/1/A-004		UTMx: 441032.542 UTMy: 4358371.406	Rock Creek near End of County Road 221	28.2	002	Good	ROCCROB 5
1	Rock Creek		16/1/A-004		UTMx: 441058.65 UTMy: 4358469.554	Rock Creek near end of road	3.72			
1	Rock Creek		16/1/A-004		UTMx: 441028.1857 UTMy: 4358374.9908	Rock Creek Near Wilderness Boundary	2.24	.003	Good (<=5%)	RCNRWIL D

Friday, December 16, 2016 Page 1 of 1

### General Site Field Visit Data Report (Filters: Name begins with Rock Creek;)

Туре		Div	Name	CWCB (Number		ID Vis	t Date	Location	Description			
Stream		1	Rock Creek		)4 8/2	5/2016	Rock Cr	eek				
	Remarks	Date	Remark									
		26/08/16 15:52	Arrive campgro	ound along Rock Cree	ek with good measure	k with good measurement site, GPS RC001.						
		26/08/16 16:05	Scouting for go campground.	ood cross section can	ne across two 8 inch t	rout in a pool near	the					
		26/08/16 16:13	26/08/16 16:13 Set up cross section for discharge spot measurement at campground near end of Forest Service Road 133, near wilderness boundary. GPS RC002 and measurement RCNRWILD.003.									
		26/08/16 17:03	debris, good si	nuosity, mixed bed of	ndant and diverse ripa f sand/gravel/cobbles/l d access to areas of th	ooulders, good roo		,				
	GPS Log	GPS Date	Device	GPSPoint Name	Latitude	Longitude	UTM	Zone	UTM Easting	UTMNorthing	Horizontal Accuracy	GPSDescription
		26/08/16 16:02	Phone (BJE)	RC001	39.373110	-105.684604					10.000000	Campground along Rock Creek with good measurement site.
		26/08/16 16:19	Phone (BJE)	RC002	39.372798	-105.684649					10.000000	Spot discharge measurement site, RCNRWILD.003.
	Photo Log	Photo Date	Camera	Media Type	Photo Video ID	Caption				Photo Comment		_
		26/08/16 16:52	iPhone (BJE)	Photograph		Spot diacharge	measurem	ent cross	s section			
		Link: https://1b679d	: :435a9c0cb855a4-	5e783ede762bf50824	13fd6d1ba1484df.ssl.d	cf2.rackcdn.com/if	ormbuilder.	.com/461	577/_data461577	7_cwcb_general_sub	form_photos/fie	eld_1658494440582b956e1a2bf.jp

Friday, December 16, 2016 Page 1 of 1



Date Generated: Mon Dec 14 2015

**File Information** 

**Mounting Correction** 

File Name ROCCROB5.002.WAD Start Date and Time 2015/06/04 15:10:46 **Site Details** 

Site Name ROCK CR AT OBS 005 Operator(s) BRIAN EPSTEIN

**System Information** Sensor Type FlowTracker Serial # P2354 **CPU Firmware Version** 3.9 Software Ver 2.30

(English Units) Units Distance ft Velocity ft/s ft^2 Area Discharge cfs

**Discharge Uncertainty** Category **Stats** Accuracy 1.0% 1.0% 0.2% 4.0% Depth 3.2% Velocity 0.8% Width 0.1% 0.1% Method 2.2% 3.0% # Stations 3.9% 5.2% **Overall** 

**Summary** 40 # Stations 17 Averaging Int. Start Edge LEW 8.000 **Total Width** Mean SNR 51.9 dB **Total Area** 7.288 Mean Temp 42.05 °F Mean Depth 0.911 Disch. Equation Mid-Section Mean Velocity 3.8665

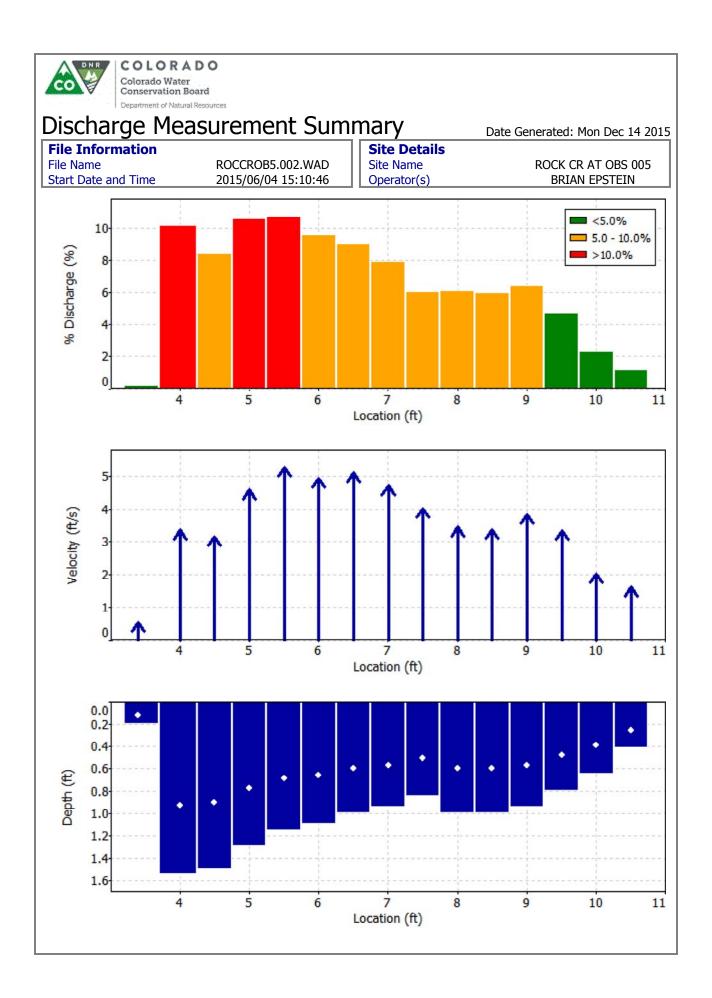
0.0%

**Total Discharge** 28.1773

Measurement Results												
St	Clock	Loc	Method	Depth	%Dep	MeasD	Vel	CorrFact	MeanV	Area	Flow	%Q
0	15:10	3.00	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0
1	15:10	3.40	0.6	0.200	0.6	0.080	0.5397	1.00	0.5397	0.100	0.0540	0.2
2	15:12	4.00	0.6	1.550	0.6	0.620	3.3730	1.00	3.3730	0.852	2.8754	10.2
3	15:13	4.50	0.6	1.500	0.6	0.600	3.1683	1.00	3.1683	0.750	2.3762	8.4
4	15:16	5.00	0.6	1.300	0.6	0.520	4.6027	1.00	4.6027	0.650	2.9914	10.6
5	15:17	5.50	0.6	1.150	0.6	0.460	5.2841	1.00	5.2841	0.575	3.0382	10.8
6	15:18	6.00	0.6	1.100	0.6	0.440	4.9557	1.00	4.9557	0.550	2.7258	9.7
7	15:19	6.50	0.6	1.000	0.6	0.400	5.1106	1.00	5.1106	0.500	2.5553	9.1
8	15:20	7.00	0.6	0.950	0.6	0.380	4.7205	1.00	4.7205	0.475	2.2425	8.0
9	15:22	7.50	0.6	0.850	0.6	0.340	4.0367	1.00	4.0367	0.425	1.7157	6.1
10	15:23	8.00	0.6	1.000	0.6	0.400	3.4646	1.00	3.4646	0.500	1.7323	6.1
11	15:24	8.50	0.6	1.000	0.6	0.400	3.3888	1.00	3.3888	0.500	1.6944	6.0
12	15:25	9.00	0.6	0.950	0.6	0.380	3.8465	1.00	3.8465	0.475	1.8273	6.5
13	15:26	9.50	0.6	0.800	0.6	0.320	3.3593	1.00	3.3593	0.400	1.3435	4.8
14	15:28	10.00	0.6	0.650	0.6	0.260	2.0374	1.00	2.0374	0.325	0.6621	2.3
15	15:29	10.50	0.6	0.420	0.6	0.168	1.6339	1.00	1.6339	0.210	0.3431	1.2
16	15:29	11.00	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.

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Date Generated: Mon Dec 14 2015

**File Information** 

File Name ROCCROB5.002.WAD Start Date and Time ROCK CR AT OBS 005

Start Date and Time ROCK CR AT OBS 005

Operator(s) BRIAN EPSTEIN

**Site Details** 

Quality Control								
St	Loc	%Dep	Message					
1	3.40	0.6	High angle: -36					

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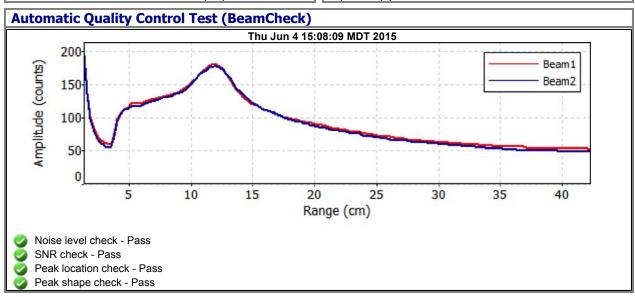
Date Generated: Mon Dec 14 2015

**File Information** 

File Name ROCCROB5.002.WAD Start Date and Time 2015/06/04 15:10:46

**Site Details**Site Name

Site Name ROCK CR AT OBS 005 Operator(s) BRIAN EPSTEIN



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Date Generated: Mon Dec 14 2015

**File Information** 

File Name ROCCROB5.001.WAD Start Date and Time 2015/06/04 13:28:56

Site Details

Site Name ROCK CR AT OBS 005 Operator(s) BRIAN EPSTEIN

**System Information** 

Sensor Type FlowTracker
Serial # P2354
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 **Stats** 1.0% Accuracy 1.0% 0.3% 1.7% Depth Velocity 1.9% 1.6% Width 0.2% 0.2% Method 1.4% # Stations 4.2% Overall 4.9% 2.5%

**Summary** 

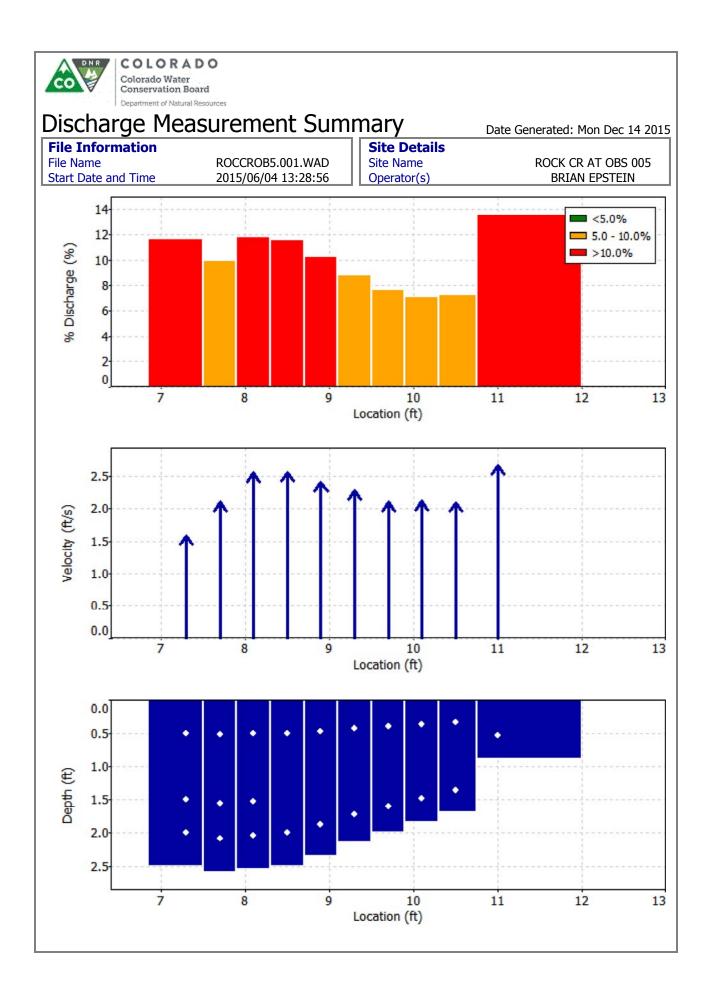
Averaging Int. 40 # Stations 12 Start Edge LEW **Total Width** 6.600 Mean SNR 48.7 dB **Total Area** 9.917 Mean Temp 42.45 °F Mean Depth 1.503 Disch. Equation Mid-Section Mean Velocity 2.2271

**Total Discharge** 22.0867

[5	Supplemental Data									
#	Time	Location	<b>Gauge Height</b>	<b>Rated Flow</b>	Comments					
1	Thu Jun 4 14:22:23 MDT 2015	13.000				DS CONTRL CNG				

Me	asuren	nent R	esults									
St	Clock	Loc	Method	Depth	%Dep	MeasD	Vel	CorrFact	MeanV	Area	Flow	%Q
0	13:28	6.40	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0
1	13:36	7.30	0.2/0.6/0.8	2.500	0.2	2.000	<i>1.7940</i>	1.00	1.5908	1.625	2.5854	11.7
1	13:37	7.30	0.2/0.6/0.8	2.500	0.6	1.000	1.8389					
1	13:35	7.30	0.2/0.6/0.8	2.500	0.8	0.500	0.8914					
2	13:42	7.70	0.8/0.6/0.2	2.600	0.2	2.080	2.3497	1.00	2.1139	1.041	2.2000	10.0
2	<i>13:40</i>	7.70	0.8/0.6/0.2	2.600	0.6	1.040	2.3054					
2	13:39	7.70	0.8/0.6/0.2	2.600	0.8	0.520	1.4951					
3	13:44	8.10	0.2/0.6/0.8	2.550	0.2	2.040	2.6900	1.00	2.5607	1.021	2.6135	11.8
3	13:45	8.10	0.2/0.6/0.8	2.550	0.6	1.020	2.6847					
3	13:46	8.10	0.2/0.6/0.8	2.550	0.8	0.510	2.1834					
4	13:50	8.50	0.8/0.2	2.500	0.2	2.000	2.8481	1.00	2.5668	1.001	2.5684	11.6
4	13:49	8.50	0.8/0.2	2.500	0.8	0.500	2.2854					
5	13:54	8.90	0.2/0.8	2.350	0.2	1.880	2.6447	1.00	2.4117	0.941	2.2686	10.3
5	13:56	8.90	0.2/0.8	2.350	0.8	0.470	2.1788					
6	14:00	9.30	0.8/0.2	2.150	0.2	1.720	2.6040	1.00	2.2863	0.861	1.9674	8.9
6	13:58	9.30	0.8/0.2	2.150	0.8	0.430	1.9685					
7	14:02	9.70	0.2/0.8	2.000	0.2	1.600	2.3022	1.00	2.1138	0.801	1.6922	7.7
7	14:03	9.70	0.2/0.8	2.000	0.8	0.400	1.9255					
8	14:06	10.10	0.8/0.2	1.850	0.2	1.480	2.3133	1.00	2.1283	0.741	1.5760	7.1
8	14:04	10.10	0.8/0.2	1.850	0.8	0.370	1.9432					
9	14:07	10.50	0.2/0.8	1.700	0.2	1.360	2.2037	1.00	2.1040	0.764	1.6066	7.3
9	14:08	10.50	0.2/0.8	1.700	0.8	0.340	2.0043					
10	14:16	11.00	0.6	0.900	0.6	0.360	2.6765	1.00	2.6765	1.124	3.0085	13.6
11	14:16	13.00	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0

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Date Generated: Mon Dec 14 2015

File InformationFile NameROCCROB5.001.WADStart Date and TimeROCCROB5.001.WADSite NameROCK CR AT OBS 005Operator(s)BRIAN EPSTEIN

Qua	Quality Control								
St Loc %Dep Message									
1 7.30 0.2 High angle: -24									
			High standard error: 0.137						
			High standard error: 0.131						
		0.8	High SNR variation during measurement: 6.9,6.9						
		0.8	High standard error: 0.141						
2	7.70	0.8	High standard error: 0.103						
10	11.00	0.6	High number of spikes: 6						
		0.6	High angle: -37						
		0.6	High SNR variation during measurement: 6.0,6.0						
		0.6	High standard error: 0.342						

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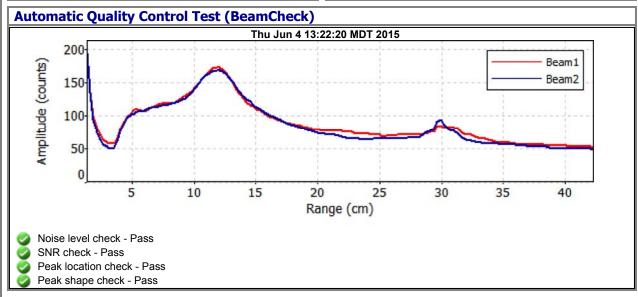
Date Generated: Mon Dec 14 2015

**File Information** 

File Name ROCCROB5.001.WAD Start Date and Time 2015/06/04 13:28:56

**Site Details**Site Name

Site Name ROCK CR AT OBS 005 Operator(s) BRIAN EPSTEIN



Page 4 of 4 12/14/2015

### State of Colorado

### Colorado Water Conservation Board

Field Notes

ROCK Creek Field Recon
10:30 Arrive Rock Creek and County Road 39
10:51 GPS Point: Rock Crobs 401
- Pock Creek at County Road 39
10:52 Pic 078 Rock Creek downstream of County Mous
39 culvent, taken from road on left built
10:53 Pic 079 Rock Creek upstream of County Road
39 colvert, then from road on top of cultert
10:54 Vid 080 vido sare as pc 078
11:06 GPS Point: RockCr 8002
- Carty Road 39 ~ 40 feet above Dock Creek on
Cialet Side of creak
11:07 Mack Crapk dawnstran of GRS Agint
11:07 VIDOR Crelk downstream of GPS point 11:07 VIDOR2 ROCK Creek Anning from Mistream of
GDS part to dangerenn
11:29 GPS Point: Rocker 603
- at camparand off of Forest Rd 133
11:30 Pic 085 long standing heaver ponth complex.
appears Rock Cr groded, or expanded outlet
on right title of fond
11:35 GPS POINT: Pack Cr MOH
- hillside across from and averlooking comparound
- hillside across from and averlooking comparand 11:36 PicOSH Rak (rest faver pand (some as PicOS))
from opposite side (1664)
11:37-11:38 Panoranic Pics 085-087 from yestream
to downstream
12:15 GPS Point: Rock Cr805
-comparound foot bridge over Kall Craft
12:16 PCL 098 looking upstream
12:16 li 089 politu dounstlean
- in this vicinity Upont-step character to
Rock Crock, all established beautr ponds
and nice willow assemblying

State of Colorado - Colorado Water Conservation Board - Field Notes (Continued)
Rock Creek Field Recon (continued)
112073 GRS Anat 1 Carrie Cloth G
- Just before road turns to trail 12:25 Pic 090 good example of pool giving
12:25 Air 090 good example of And airing
way To Step
CEBBIA: Rocky odg
- Set of X-Sechan at last himbur:
14:30 Pic Ogy Companyon for Pic Obb, slows after D
14:30 Pic 091 Comparison for Pic 000, shows after D 14:32 Pic 092 Comparison for Pic 089, """
14:44 Mic 093 X- Section from Left Plank after
Land Chark
- derive a registrarent southern changed
downstream downed by this lodge, hate level at x-sition dropped
hate level at x-8000 deppel
· water level drop by 0.8-fect
o decked whochy at various points
increased to ~ 4ft/s
15:01 Mic 694 using free mark (durk) 10 slow
mater land decrease, tape reversely
15:04 Pic 095 1 15:03 Mc 096 same as above
15:06 X-Report Pic 097 nonurant . 000
15:34 wis red V- entire (Many)
15:34 più 098 X- section from about
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Notes By: Bris Epten YYYY-MM-DD: 2015-06-04 Page 3 of 6
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Page <u>3</u> of <u>6</u>		State of Colorado	Meas. No.:	<i> ФФ</i> 1							
YYYY: 2015	Colorad	o Water Conservat	Division:	1							
MM-DD:06-04	ADV Di	scharge Measureme	ent Notes	District:							
Station Name:	Station Name: ROCCROBS										
	Rock River, Creek, Canal, Ditch										
A( Near)Above, I	A(Near)Above, Below end County Road 221										
Latitude: N 39°22'22.08" Longitude: W 105°41'0451" NACK											
Party: Orign /=n+cin											
Conditions											
Weather:	~60°F N	bothy sunni	1								
Wind Spd / Dir:	light L va		Water Temp:	t vol. state full de la	nd 2 staden met mellete inderense trettet vistert van dientemplassen voorgegege						
X-Sec Desc:	8174	W.J.		with filter this of the descendence constitute.	eta, ili Teleste dale saldin dalem ekyremeden oya egy pyryyy						
Flow Conds:	Hendy	until end	Ten condi	hers chem	en to the territories and the territories depole to the territories and the territories and the territories and territories an						
Control Desc.;	NA	ela el Maria de la Caracteria de la composición de servición de servición de la composición de servición de s Caracteria de la composición de la comp	त्रका व्यापा हिराकाम (रेशाहरूका सम्बद्धा व्यापाल विक्रिकी १५८) क्रिकी हुन्ह	i Valenti estat Terressa Miller i en consesti un sensi	et traffi vilolisisi - aktivatella etoliku oʻs rasii vilopoping iso oʻs						
Meas	urement Rated: Excele	nt (2%) / Good (5%) / Fa	air (8%) / (Poor (>8%)	based on the above cor	nditions]						
		Water Lev	el Reading								
Time	Staff Gage	Pressure Trans.	Time	Staff Gage	Pressure Trans.						
	· in the second										
and the state of t	Committee and the committee an		MERITARIA (CONTRACTOR CONTRACTOR AND	il and decreasions proceed a continue on accommo	en production and the contract of the contract						
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Time;			Correct MGH								
	5	Discharge N	leasurement								
Manufacturer:	SonTek	Model:	FlowTracker	S/N:	P2354 / P2355						
Firmware:	3.9	Software:	2.20								
Diag Test File:	(Yes) or No	Raw Data File:	ROLLROS	35.001							
Meas Type:	Wading / Boat / B	ridge / Cableway		Method:	0.0						
		NA	ft. or mi / upstream	ı or downstream o							
Start Edge: /_l	≥W 6.4	End Edge:	W 13.00	Total Width:	6.6						
Start Time:	13:24	End Time:	14:18								
Discharge:	22.086	Unsertainty:	4.9	# Stations:	12						
Mean v:	2.121	Width	6.6	Mean d:	1.50						
Max v:	2.677	Area:	9,917	Max d:	2.60						
Mean SNR:	48.7	σV:	0-097	Mean Temp:	42.5						
Meas. By:	BE	namente en secre presidente de construições produces en secretarios de construições de constru	Notes By:	ふど	the course of th						
Processed By:			Reviewed By:								

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Ho G. L. d. not had levater been training
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-> queckly ended because anter level from
*Measurement may underpredict  in quickly ended because autor level try  last station depth decreased because of
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o Skinnel de gal Cara de al de
Skypey to end, forcing larger extracted section for last area
echen for 1951 Circle
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Page <u>S</u> of <u>&amp;</u>		State of Colorado	Meas. No.: ゆめ2							
YYYY: JOIS	Colorado	Water Conservati	on Board	Division:						
MM-DD:06-04	ADV Dis	charge Measureme	ent Notes	District:						
Station Name:	Station Name: ROCCLOB5									
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At, Near, Above, Below Cal County Road 221										
Latitude: N 39° 22′ 22, 26" Longitude[v/05° 41′045] "NAN8]										
Party: Brian Enstein										
Conditions										
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Mean SNR:	51.8	σv:	0.097	Mean Temp:	42.1					
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