# 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

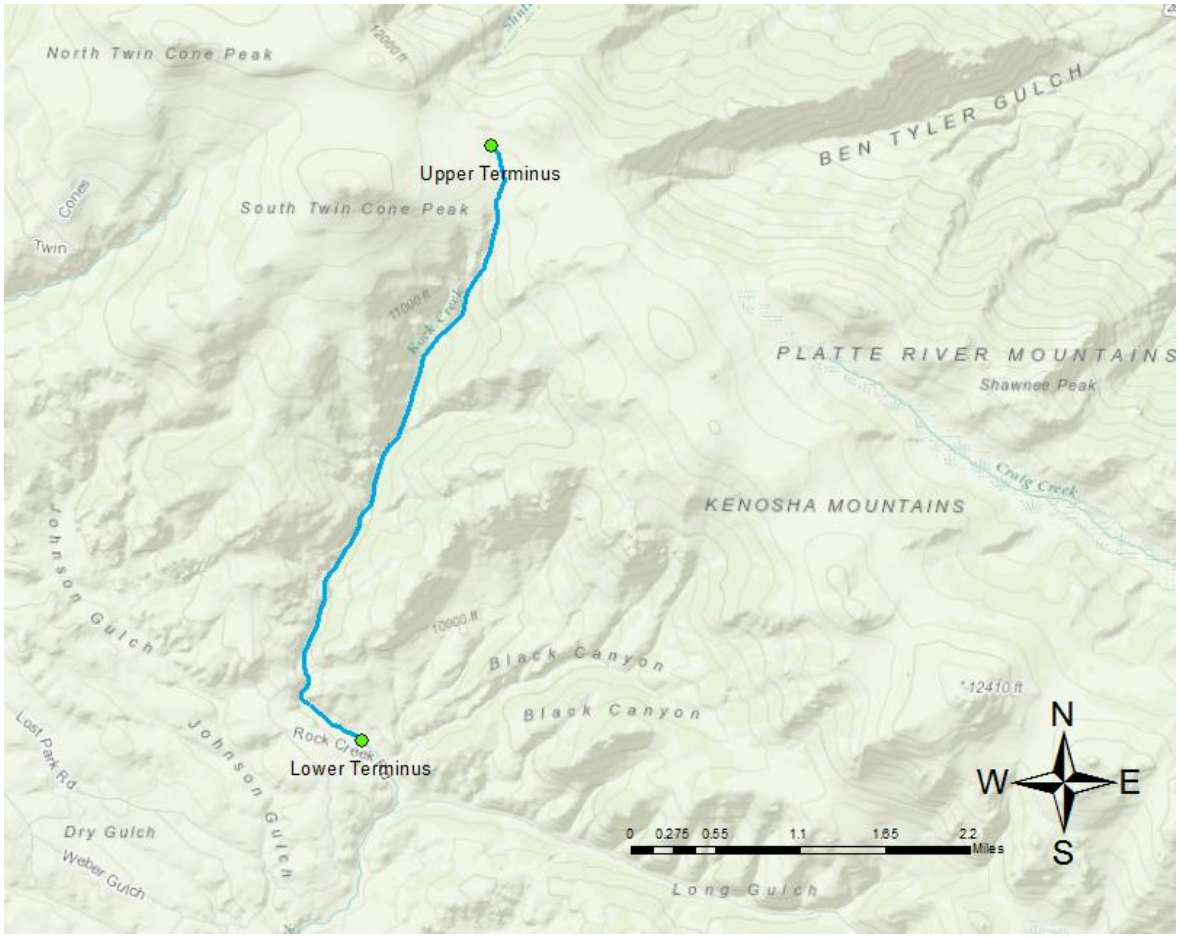



**Figure 1.** Map of the recommended reach of Rock Creek (blue), the green dots are the upper and lower termini of the ISF recommendation.

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

+ = 100% 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<br>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).

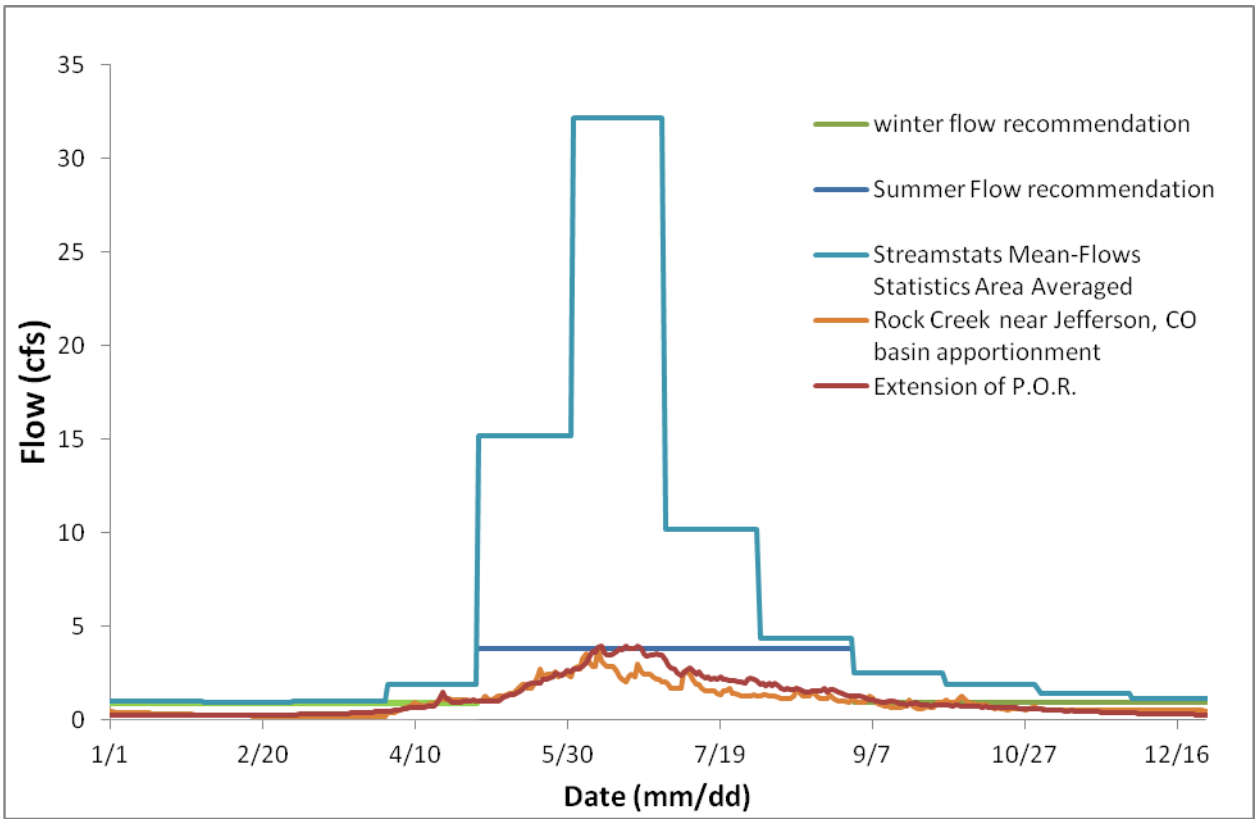



**Figure 2**. Hydrograph showing the winter and summer ISF recommendations, the Streamstats derived mean monthly flow statistics for the Rock Creek basin, the basin apportionment of the Rock Creek near Jefferson, CO (USGS 06699000) gage (1986-1999), and an extension of the period of record (P.O.R) of 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 1st through August 31st. 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 1st to April 30th.

## 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.

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

**Figure 6.** Natural environment of Rock Creek

**Figure 7.** Natural environment of Rock Creek.

COLORADO WATER CONSERVATION BOARD

# FIELD DATA FOR INSTREAM FLOW DETERMINATIONS

COLORADO DIVISION OF WILDLIFE

## LOCATION INFORMATION

| | | | | | |
|---|---|---|---|---|---|
| STREAM NAME: ROCK CREEK | | | | | CROSS-SECTION NO.: 1 |
| CROSS-SECTION LOCATION: 20m downstream from culvert of Rock Creek under Lost Park Rd. | | | | | |
| DATE: 9/27/16 | OBSERVERS: CT, JS, TD | | | | |
| LEGAL DESCRIPTION | ¼ SECTION: | SECTION: | TOWNSHIP: N/S | RANGE: E/W | PM: |
| COUNTY: Park | WATERSHED: N. Fk. S. Platte | | WATER DIVISION: 1 | | DOW WATER CODE: |
| MAP(S): USGS: Lat: 39.355948 Long: -105.674729 | | | | | |
| USFS: | | | | | |

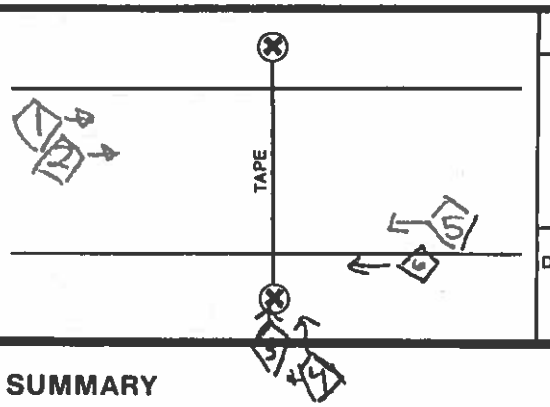
## SUPPLEMENTAL DATA

| | | | | |
|---|---|---|---|---|
| SAG TAPE SECTION SAME AS DISCHARGE SECTION: YES / NO | METER TYPE: | | | |
| 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: | | |

## 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 | 9.46 / 9.63 |
| ② WS Upstream | 0.00 | 9.55 |
| ③ WS Downstream | 0+22 | 9.86 |
| SLOPE | 0.31 / 22 = 0.014 | |

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 #ISF FD 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) At Point | Velocity (ft/sec) Mean in Vertical | Area ($ft^2$) | Discharge (cfs) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| S | 0.0 | | 6.85 | | | | | | | | |
| GL | 1.7 | | 7.85 | | | | | | | | |
| | 4 | | 8.80 | | | | | | | | |
| | ~~7~~ 9.4 | | 9.30 | | | | | | | | |
| WL | 9.4 | | 9.63 | 0 | | | | | | | |
| | .8 | | 9.75 | .15 | | | | .81 | | | |
| | 10.2 | | 9.70 | .2 | | | | 1.22 | | | |
| | .6 | | 9.85 | .2 | | | | 1.63 | | | |
| | 11 | | 9.90 | .25 | | | | 1.33 | | | |
| | 11.4 | | 9.85 | .25 | | | | 1.38 | | | |
| | .8 | | 9.80 | .10 | | | | .94 | | | |
| | 12.2 | | 9.85 | .15 | | | | 1.00 | | | |
| | .6 | | 9.70 | .15 | | | | 1.08 | | | |
| | 13 | | 9.95 | .30 | | | | 1.27 | | | |
| | .4 | | 10.00 | .40 | | | | 1.18 | | | |
| | .8 | | 10.05 | .45 | | | | 1.15 | | | |
| | 14.2 | | 10.05 | .40 | | | | 1.12 | | | |
| | .6 | | 10.05 | 1.45 | | | | 1.04 | | | |
| | 15 | | 10.10 | ~~0.50~~ | | | | .98 | | | |
| | 15.4 | | 10.00 | 0.45 | | | | .97 | | | |
| | .8 | | 10.00 | 0.40 | | | | .64 | | | |
| | 16.2 | | 10.05 | 0.45 | | | | .64 | | | |
| | 16.4 | | 10.00 | 0.45 | | | | .44 | | | |
| WL | 16.8 | | 9.66 | 0 | | | | | | | |
| | 17 | | 9.20 | | | | | | | | |
| | 17.5 | | 7.75 | | | | | | | | |
| GL | 18.3 | | 7.45 | | | | | | | | |
| S | 21 | | 6.70 | | | | | | | | |
| TOTALS: | | | | | | | | | | | |

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

## Data Input & Proofing

| | |
|---|---|
| STREAM NAME: | Rock Creek |
| XS LOCATION: | 20 m D/S from culvert |
| XS NUMBER: | 1 |
| DATE: | 9/27/2016 |
| OBSERVERS: | CT, JS, TD |
| 1/4 SEC: | Lat: 39.355948 |
| SECTION: | Long: -105.674729 |
| TWP: | |
| RANGE: | |
| PM: | |
| COUNTY: | Park |
| WATERSHED: | N. Fk. S. Platte |
| DIVISION: | 1 |
| DOW CODE: | |
| USGS MAP: | |
| USFS MAP: | |
| | Level and Rod Survey |
| TAPE WT: | 0.0106 lbs / ft |
| TENSION: | 99999 lbs |
| SLOPE: | 0.014 ft / ft |

CHECKED BY:.....DATE.....

ASSIGNED TO: .....DATE.....

Total Data Points = 28

| GL=1 | FEATURE | DIST | VERT DEPTH | WATER DEPTH | VEL | A | Q | Tape to Water |
|---|---|---|---|---|---|---|---|---|
| | S | 0.00 | 6.85 | | | 0.00 | 0.00 | 0.00 |
| 1 | GL | 1.70 | 7.85 | | | 0.00 | 0.00 | 0.00 |
| | | 4.00 | 8.80 | | | 0.00 | 0.00 | 0.00 |
| | | 7.40 | 9.30 | | | 0.00 | 0.00 | 0.00 |
| | WL | 9.40 | 9.63 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | | 9.80 | 9.75 | 0.15 | 0.81 | 0.06 | 0.05 | 9.60 |
| | | 10.20 | 9.70 | 0.20 | 1.22 | 0.08 | 0.10 | 9.50 |
| | | 10.60 | 9.85 | 0.20 | 1.63 | 0.08 | 0.13 | 9.65 |
| | | 11.00 | 9.90 | 0.25 | 1.33 | 0.10 | 0.13 | 9.65 |
| | | 11.40 | 9.85 | 0.25 | 1.38 | 0.10 | 0.14 | 9.60 |
| | | 11.80 | 9.80 | 0.10 | 0.94 | 0.04 | 0.04 | 9.70 |
| | | 12.20 | 9.85 | 0.15 | 1.00 | 0.06 | 0.06 | 9.70 |
| | | 12.60 | 9.80 | 0.15 | 1.08 | 0.06 | 0.06 | 9.65 |
| | | 13.00 | 9.95 | 0.30 | 1.27 | 0.12 | 0.15 | 9.65 |
| | | 13.40 | 10.00 | 0.40 | 1.18 | 0.16 | 0.19 | 9.60 |
| | | 13.80 | 10.05 | 0.45 | 1.15 | 0.18 | 0.21 | 9.60 |
| | | 14.20 | 10.05 | 0.40 | 1.12 | 0.16 | 0.18 | 9.65 |
| | | 14.60 | 10.05 | 0.45 | 1.04 | 0.18 | 0.19 | 9.60 |
| | | 15.00 | 10.10 | 0.50 | 0.98 | 0.20 | 0.20 | 9.60 |
| | | 15.40 | 10.00 | 0.45 | 0.97 | 0.18 | 0.17 | 9.55 |
| | | 15.80 | 10.00 | 0.40 | 0.64 | 0.16 | 0.10 | 9.60 |
| | | 16.20 | 10.05 | 0.45 | 0.64 | 0.14 | 0.09 | 9.60 |
| | | 16.40 | 10.00 | 0.45 | 0.44 | 0.14 | 0.06 | 9.55 |
| | WL | 16.80 | 9.66 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | | 17.00 | 9.20 | | | 0.00 | 0.00 | 0.00 |
| | | 17.50 | 7.75 | | | 0.00 | 0.00 | 0.00 |
| 1 | GL | 18.30 | 7.45 | | | 0.00 | 0.00 | 0.00 |
| | S | 21.00 | 6.70 | | | 0.00 | 0.00 | 0.00 |
| | | | | | Totals | 2.19 | 2.24 | |

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

## LOCATION INFORMATION

| | |
|---|---|
| STREAM NAME: | Rock Creek |
| XS LOCATION: | 20 m D/S from culvert |
| XS NUMBER: | 1 |
| DATE: | 27-Sep-16 |
| OBSERVERS: | CT, JS, TD |
| 1/4 SEC: | Lat: 39.355948 |
| SECTION: | Long: -105.674729 |
| TWP: | 0 |
| RANGE: | 0 |
| PM: | 0 |
| COUNTY: | Park |
| WATERSHED: | N. Fk. S. Platte |
| DIVISION: | 1 |
| DOW CODE: | 0 |
| USGS MAP: | 0 |
| USFS MAP: | 0 |

## SUPPLEMENTAL DATA

| | |
|---|---|
| TAPE WT: | 0.0106 |
| TENSION: | 99999 |

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

## CHANNEL PROFILE DATA

| | |
|---|---|
| SLOPE: | 0.014 |

INPUT DATA CHECKED BY: .....DATE.....

ASSIGNED TO: .....DATE.....

STREAM NAME: Rock Creek
XS LOCATION: 20 m D/S from culvert
XS NUMBER: 1

# DATA POINTS= 28

VALUES COMPUTED FROM RAW FIELD DATA

| | FEATURE | DIST | VERT DEPTH | WATER DEPTH | VEL | WETTED PERIM. | WATER DEPTH | AREA (Am) | Q (Qm) | % Q CELL |
|---|---|---|---|---|---|---|---|---|---|---|
| | S | 0.00 | 6.85 | | | 0.00 | | 0.00 | 0.00 | 0.0% |
| 1 | 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% |
| | | 11.80 | 9.80 | 0.10 | 0.94 | 0.40 | 0.10 | 0.04 | 0.04 | 1.7% |
| | | 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% |
| 1 | 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% |
| | TOTALS ---------- | | | | | 7.65 | 0.5 (Max.) | 2.19 | 2.24 | 100.0% |

Manning's n = 0.0746
Hydraulic Radius= 0.28640242

STREAM NAME: Rock Creek
XS LOCATION: 20 m D/S from culvert
XS NUMBER: 1

WATER LINE COMPARISON TABLE

| WATER LINE | MEAS AREA | COMP 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: 1

Constant Manning's n

STAGING TABLE

*GL* = lowest Grassline elevation corrected for sag
*WL* = Waterline corrected for variations in field measured water surface elevations and sag

| | DIST TO WATER (FT) | TOP WIDTH (FT) | AVG. DEPTH (FT) | MAX. DEPTH (FT) | AREA (SQ FT) | WETTED PERIM. (FT) | PERCENT WET PERIM (%) | HYDR RADIUS (FT) | FLOW (CFS) | AVG. VELOCITY (FT/SEC) |
|---|---|---|---|---|---|---|---|---|---|---|
| *GL* | 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 | 67.8% | 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 | 0.46 | 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 | 8.82 | 50.3% | 0.38 | 4.13 | 1.23 |
| | 9.52 | 8.11 | 0.36 | 0.58 | 2.93 | 8.46 | 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 |
| *WL* | 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 |

$\frac{2}{3}$ = 2.16 cfs $\frac{3}{3}$

$$\frac{50.3\%}{50.0\%} = \frac{4.13\ \text{cfs}}{X}$$

$$\frac{50.3X}{50.3} = \frac{206.5}{50.3} \quad X = 4.105 \approx 4.11\ \text{cfs}$$

$$\frac{48.3\%}{50.0\%} = \frac{3.4\ \text{cfs}}{X} \qquad \frac{4.11 + 3.52}{2} = 3.815 \approx 3.82\ \text{cfs}$$

$$\frac{48.3X}{48.3} = \frac{170}{48.3} \quad X = 3.519 \approx 3.52\ \text{cfs}$$

STREAM NAME: Rock Creek
XS LOCATION: 20 m D/S from culvert
XS NUMBER: 1

SUMMARY SHEET

| | | |
|---|---|---|
| MEASURED FLOW (Qm)= | 2.24 | cfs |
| CALCULATED FLOW (Qc)= | 2.16 | cfs |
| (Qm-Qc)/Qm * 100 = | 3.8 | % |
| MEASURED WATERLINE (WLm)= | 9.65 | ft |
| CALCULATED WATERLINE (WLc)= | 9.62 | ft |
| (WLm-WLc)/WLm * 100 = | 0.3 | % |
| MAX MEASURED DEPTH (Dm)= | 0.50 | ft |
| MAX CALCULATED DEPTH (Dc)= | 0.48 | ft |
| (Dm-Dc)/Dm * 100 | 4.4 | % |
| MEAN VELOCITY= | 1.00 | ft/sec |
| MANNING'S N= | 0.075 | |
| SLOPE= | 0.014 | ft/ft |
| .4 * Qm = | 0.9 | cfs |
| 2.5 * Qm= | 5.6 | cfs |

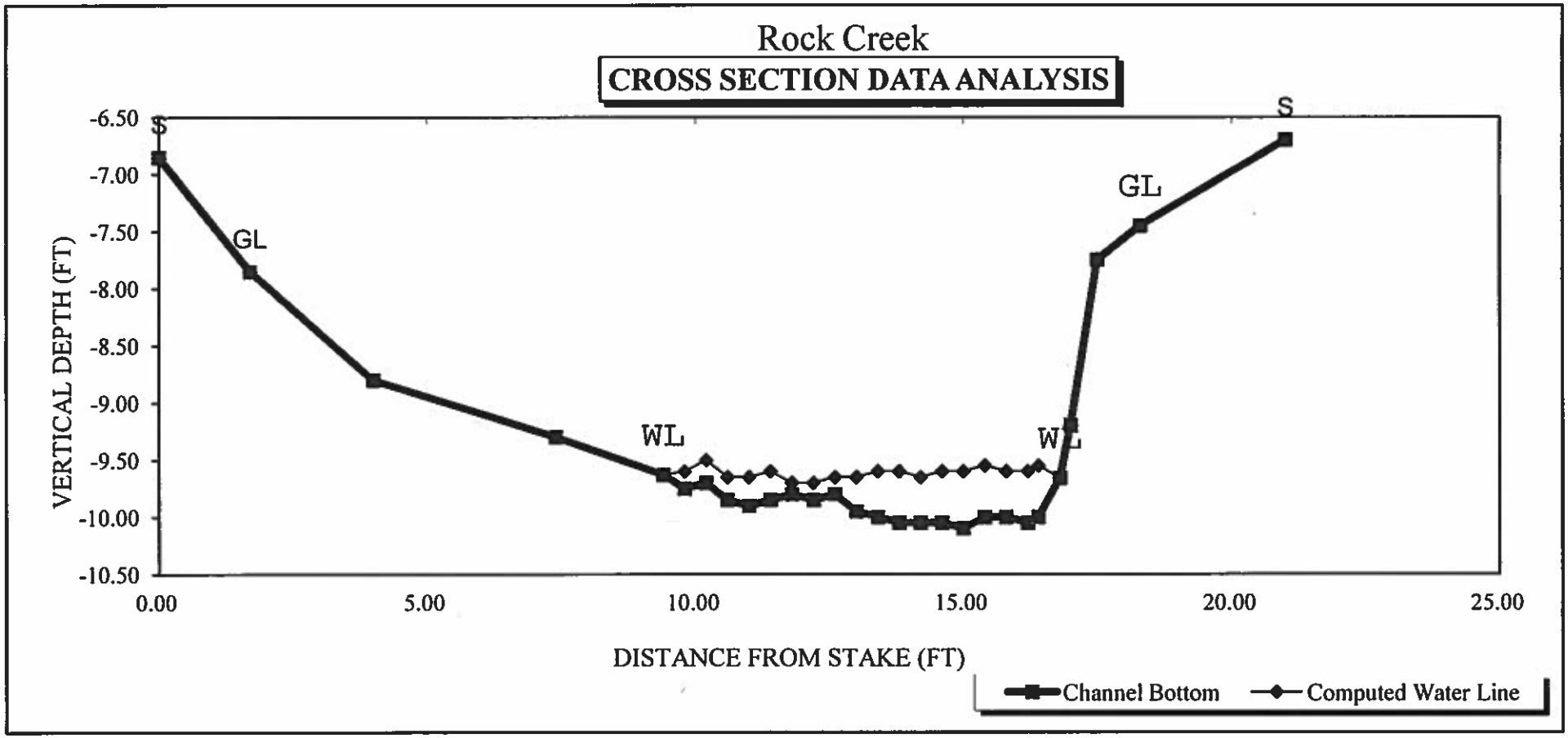
RECOMMENDED INSTREAM FLOW:

| FLOW (CFS) | PERIOD |
|---|---|
| | |
| | |
| | |
| | |

RATIONALE FOR RECOMMENDATION:

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

CWCB REVIEW BY: ..... DATE: .....


Rock Creek
CROSS SECTION DATA ANALYSIS
S
GL
WL
WL
GL
S
-6.50
-7.00
-7.50
-8.00
-8.50
-9.00
-9.50
-10.00
-10.50
VERTICAL DEPTH (FT)
0.00
5.00
10.00
15.00
20.00
25.00
DISTANCE FROM STAKE (FT)
Channel Bottom
Computed Water Line

**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 | 06/04/2015 | UTMx: 441032.542<br>UTMy: 4358371.406 | Rock Creek near End of County Road 221 | 28.2 | 002 | Good | ROCCROB5 |
| 1 | Rock Creek | | 16/1/A-004 | 08/27/2015 | UTMx: 441058.65<br>UTMy: 4358469.554 | Rock Creek near end of road | 3.72 | | | |
| 1 | Rock Creek | | 16/1/A-004 | 08/26/2016 | UTMx: 441028.1857<br>UTMy: 4358374.9908 | Rock Creek Near Wilderness Boundary | 2.24 | .003 | Good (<=5%) | RCNRWILD |

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

| Type | | Div | Name | CWCB Case Number | Segment ID | Visit Date | Location Description |
|---|---|---|---|---|---|---|---|
| Stream | | 1 | Rock Creek | | 16/1/A-004 | 8/26/2016 | Rock Creek |

Remarks

| Date | Remark |
|---|---|
| 26/08/16 15:52 | Arrive campground along Rock Creek with good measurement site, GPS RC001. |
| 26/08/16 16:05 | Scouting for good cross section came across two 8 inch trout in a pool near the campground. |
| 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 | Around measurement location: abundant and diverse riparian vegetation, lots of Woody debris, good sinuosity, mixed bed of sand/gravel/cobbles/boulders, good room for normal high flows to move, and good access to areas of the flood plain. |

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 measurement cross section | |
| Link: https://1b679d435a9c0cb855a4-5e783ede762bf508243fd6d1ba1484df.ssl.cf2.rackcdn.com/iformbuilder.com/461577/_data461577_cwcb_general_subform_photos/field_1658494440582b956e1a2bf.jpg | | | | | |

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

# Discharge Measurement Summary

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 | 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 | ISO | Stats |
|---|---|---|
| Accuracy | 1.0% | 1.0% |
| Depth | 0.2% | 4.0% |
| Velocity | 0.8% | 3.2% |
| Width | 0.1% | 0.1% |
| Method | 2.2% | - |
| # Stations | 3.0% | - |
| **Overall** | **3.9%** | **5.2%** |

## Summary

| | | | |
|---|---|---|---|
| Averaging Int. | 40 | # Stations | 17 |
| Start Edge | LEW | Total Width | 8.000 |
| 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 |
| | | **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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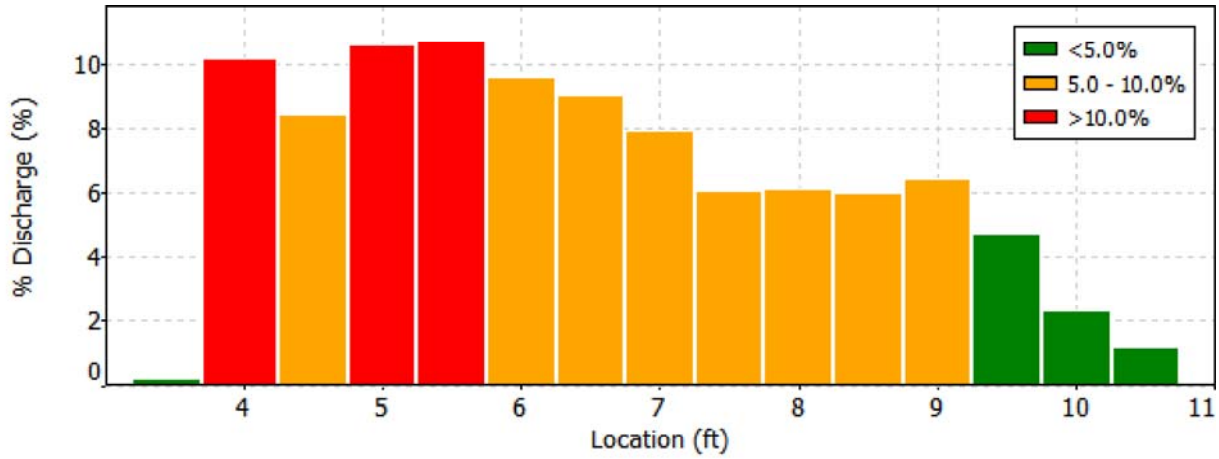
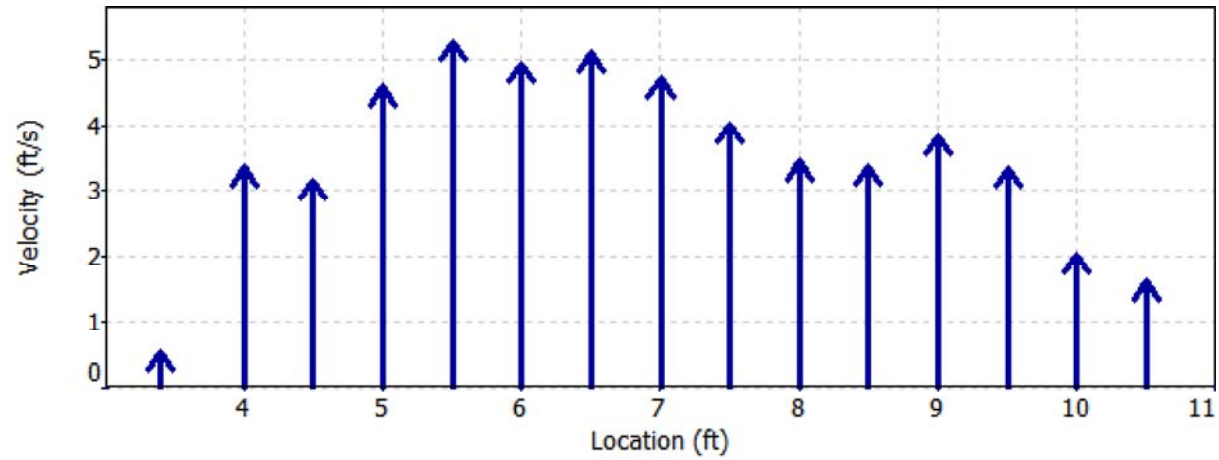
Department of Natural Resources

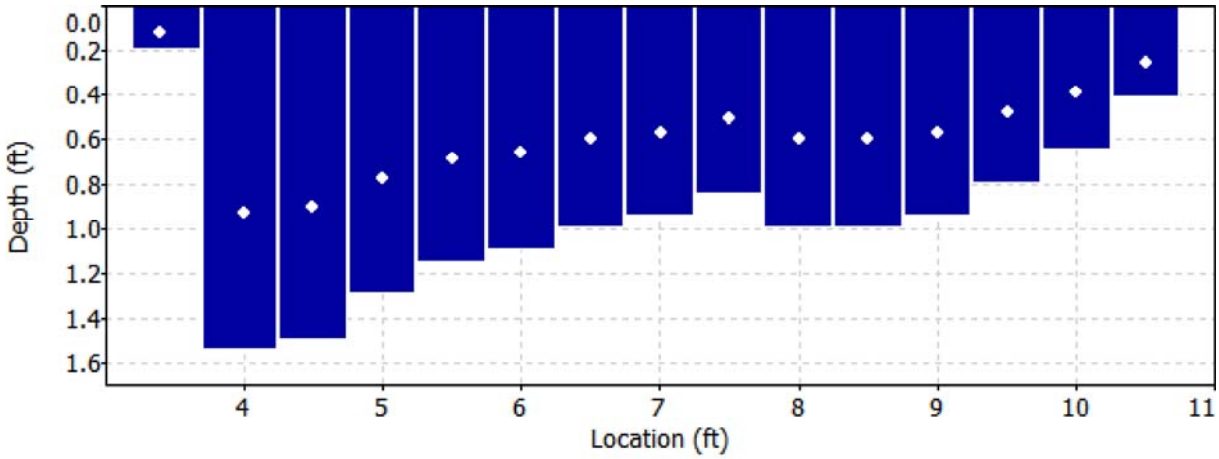
# Discharge Measurement Summary

Date Generated: Mon Dec 14 2015

| File Information | | Site Details | |
|---|---|---|---|
| File Name | ROCCROB5.002.WAD | Site Name | ROCK CR AT OBS 005 |
| Start Date and Time | 2015/06/04 15:10:46 | Operator(s) | BRIAN EPSTEIN |



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Department of Natural Resources

# Discharge Measurement Summary

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 | ROCK CR AT OBS 005 |
| Operator(s) | BRIAN EPSTEIN |

## Quality Control

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

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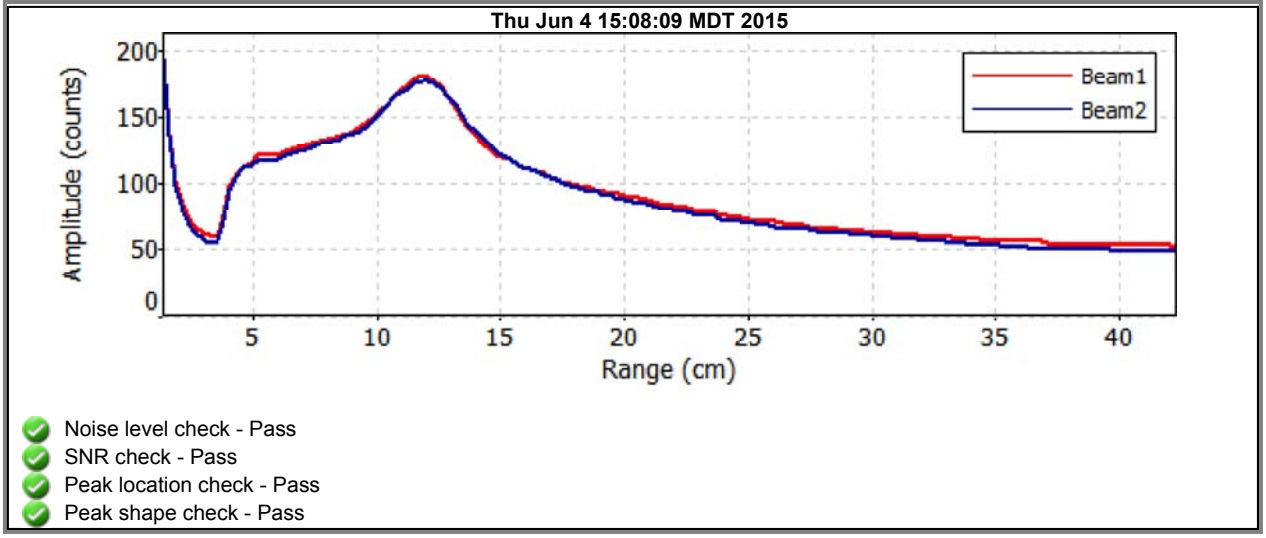
# Discharge Measurement Summary

Date Generated: Mon Dec 14 2015

| File Information | | Site Details | |
|---|---|---|---|
| File Name | ROCCROB5.002.WAD | Site Name | ROCK CR AT OBS 005 |
| Start Date and Time | 2015/06/04 15:10:46 | Operator(s) | BRIAN EPSTEIN |

## Automatic Quality Control Test (BeamCheck)




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

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# Discharge Measurement Summary

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 | ISO | Stats |
|---|---|---|
| Accuracy | 1.0% | 1.0% |
| Depth | 0.3% | 1.7% |
| 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** |

## Supplemental Data

| # | Time | Location | Gauge Height | Rated Flow | Comments |
|---|---|---|---|---|---|
| 1 | Thu Jun 4 14:22:23 MDT 2015 | 13.000 | | | DS CONTRL CNG |

## Measurement Results

| 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* | *1.7940* | *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* | *13:40* | *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 |

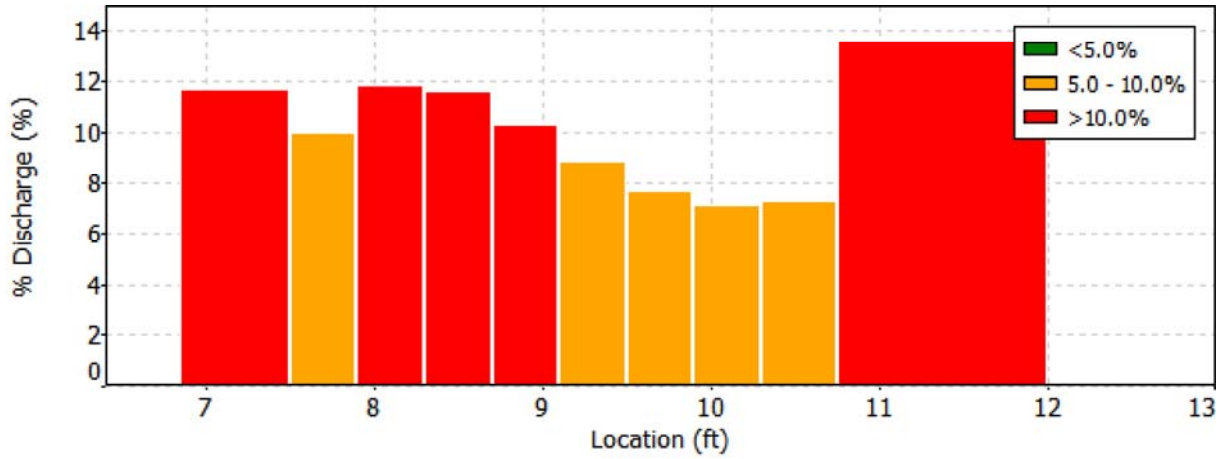
Rows in italics indicate a QC warning. See the Quality Control page of this report for more information.

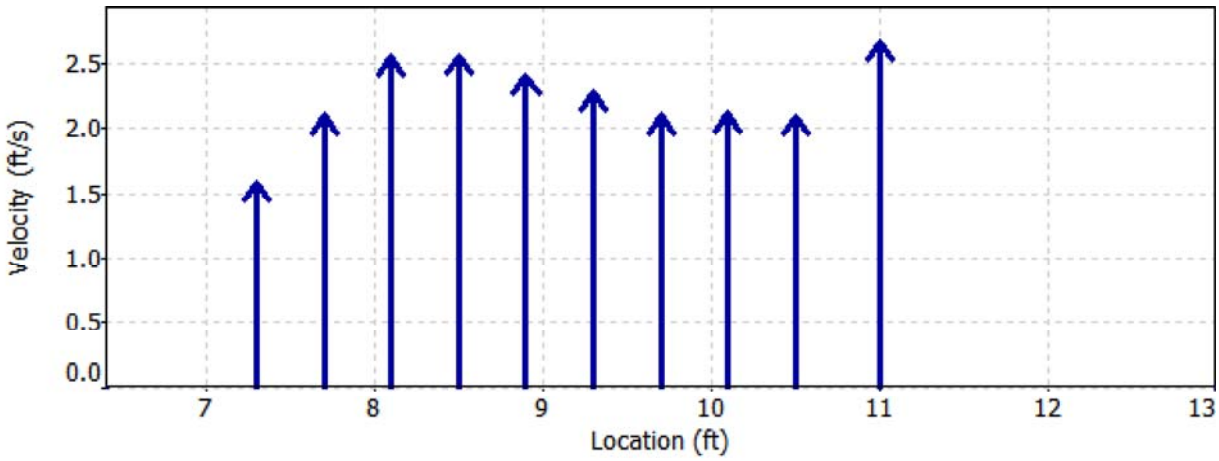
COLORADO
Colorado Water Conservation Board
Department of Natural Resources

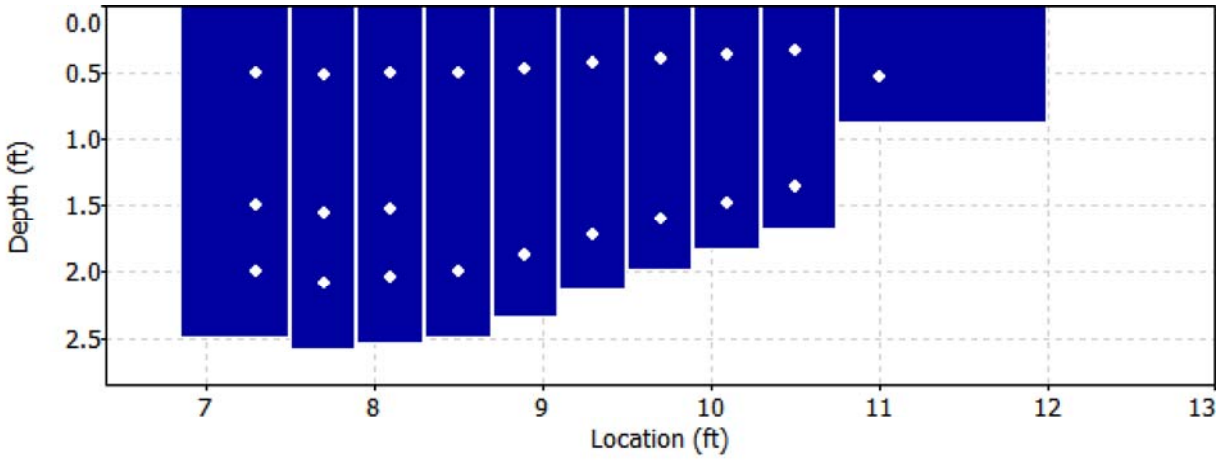
# Discharge Measurement Summary

Date Generated: Mon Dec 14 2015

| File Information | | Site Details | |
|---|---|---|---|
| File Name | ROCCROB5.001.WAD | Site Name | ROCK CR AT OBS 005 |
| Start Date and Time | 2015/06/04 13:28:56 | Operator(s) | BRIAN EPSTEIN |



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# Discharge Measurement Summary

Date Generated: Mon Dec 14 2015

| File Information | | Site Details | |
|---|---|---|---|
| File Name | ROCCROB5.001.WAD | Site Name | ROCK CR AT OBS 005 |
| Start Date and Time | 2015/06/04 13:28:56 | Operator(s) | BRIAN EPSTEIN |

## Quality Control

| St | Loc | %Dep | Message |
|---|---|---|---|
| 1 | 7.30 | 0.2 | High angle: -24 |
| | | 0.2 | High standard error: 0.137 |
| | | 0.6 | 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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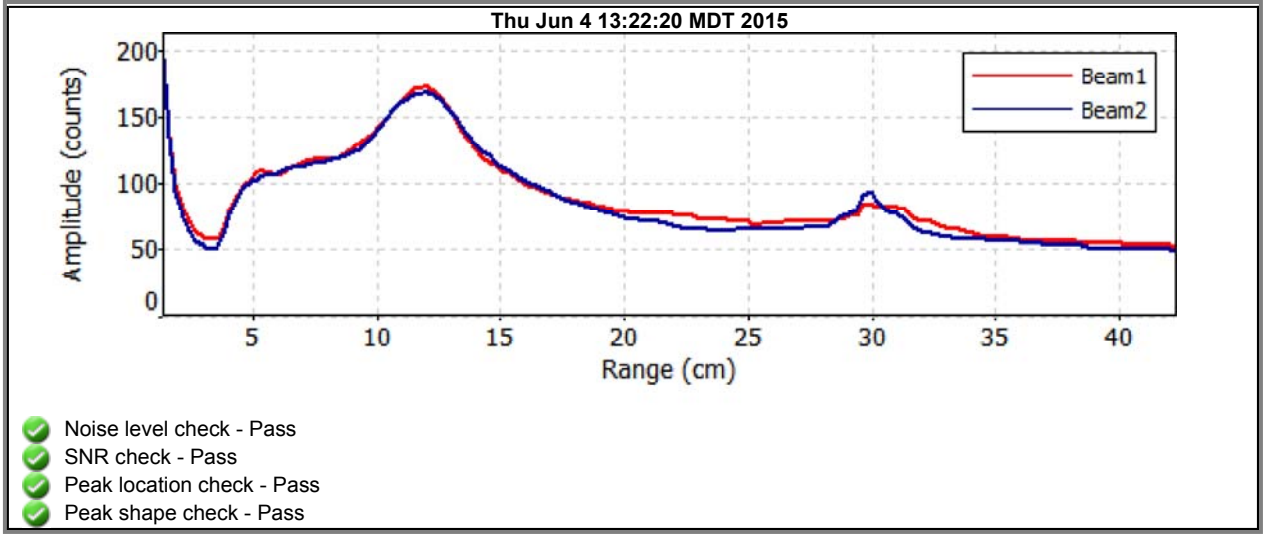
# Discharge Measurement Summary

Date Generated: Mon Dec 14 2015

| File Information | | Site Details | |
|---|---|---|---|
| File Name | ROCCROB5.001.WAD | Site Name | ROCK CR AT OBS 005 |
| Start Date and Time | 2015/06/04 13:28:56 | Operator(s) | BRIAN EPSTEIN |

## Automatic Quality Control Test (BeamCheck)




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

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: RockCrObs 001
- Rock Creek at County Road 39

10:52 Pic 078 Rock Creek downstream of County Road 39 culvert, taken from road on left bank

10:53 Pic 079 Rock Creek upstream of County Road 39 culvert, taken from road on top of culvert

10:54 Vid 080 video same as Pic 078

11:06 GPS Point: RockCr 002
- County Road 39 ~ 40 feet above Rock Creek on right side of creek

11:07 Pic 081 Rock Creek downstream of GPS point

11:07 Vid 082 Rock Creek running from upstream of GPS point to downstream

11:29 GPS Point: RockCr 003
- at campground off of Forest Rd 133

11:30 Pic 085 long standing beaver pond complex, appears Rock Cr eroded or expanded outlet on right side of pond

11:35 GPS Point: RockCr 004
- hillside across from and overlooking campground

11:36 Pic 084 Rock Creek beaver pond (same as Pic 083) from opposite side (left)

11:37-11:38 Panoramic Pics 085-087 from upstream to downstream

12:15 GPS Point: RockCr 005
- campground foot bridge over Rock Creek

12:16 Pic 088 looking upstream

12:16 Pic 089 looking downstream
- in this vicinity pool-step character to Rock Creek, old established beaver ponds and nice willow assemblages

Notes By: Brian Epstein YYYY-MM-DD: 2015-06-04 Page 1 of 6

Rock Creek Field Recon (continued)
12:23 GPS Point: RockCr006
- just before road turns to trail
12:25 Pic 090 good example of pool giving way to step

@ GPS Point: RockCr005
- set up X-section at foot bridge:
14:30 Pic 091 comparison for Pic 088, shows after Δ
14:32 Pic 092 Comparison for Pic 089, " " "
14:44 Pic 093 X-section from left bank after control change
- during q measurement something changed downstream, observed log jam/lodge, water level at X-section dropped
  - water level drop by 0.8 feet
  - checked velocity at various points increased to ~4 ft/s
15:01 Pic 094 using tree mark (stick) to show water level decrease, tape reversed
15:04 Pic 095 & 15:05 Pic 096 same as above with tape starting at zero
15:06 X-section Pic 097 measurement .002
15:14 Pic 098 X-section from above
* Completed second measurement to replace 1st because of change in conditions at measurement location

| Page 3 of 6 | State of Colorado | Meas. No.: 001 |
|---|---|---|
| YYYY: 2015 | **Colorado Water Conservation Board** | Division: 1 |
| MM-DD: 06-04 | ADV Discharge Measurement Notes | District: |

Station Name: ROCCROBS

Rock River, (Creek), Canal, Ditch

A (Near) Above, Below end County Road 221

Latitude: N 39°22'22.08" Longitude: W 105°41'04.51" NAD83

Party: Brian Epstein

**Conditions**

Weather: ~60°F Mostly sunny

Wind Spd / Dir: light & variable Water Temp:

X-Sec Desc: Sandy bed

Flow Conds: steady until end then conditions change

Control Desc.: N/A

Measurement Rated: Excelent (2%) / Good (5%) / Fair (8%) / (Poor (>8%)) [based on the above conditions]

**Water Level Reading**

| Time | Staff Gage | Pressure Trans. | Time | Staff Gage | Pressure Trans. |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

| Pressure Transducer Download | | Weighted MGH | | |
|---|---|---|---|---|
| File Name: | N/A | GH Corr. | | |
| Time: | | Correct MGH | | |

**Discharge Measurement**

| | | | | | |
|---|---|---|---|---|---|
| Manufacturer: | SonTek | Model: | FlowTracker | S/N: | P2354 / P2355 |
| Firmware: | 3.9 | Software: | 2.20 | | |
| Diag Test File: | (Yes) or No | Raw Data File: | ROCCROBS.001 | | |
| Meas Type: | (Wading) / Boat / Bridge / Cableway | | | Method: | 0.6 |
| | N/A ft. or mi / upstream or downstream of gage | | | | |
| Start Edge: | LEW 6.4 | End Edge: | REW 13.0 | Total Width: | 6.6 |
| Start Time: | 13:24 | End Time: | 14:18 | | |
| Discharge: | 22.086 | Unsertainty: | 4.9 | # Stations: | 12 |
| Mean v: | 2.227 | Width | 6.6 | Mean d: | 1.50 |
| Max v: | 2.677 | Area: | 9.917 | Max d: | 2.60 |
| Mean SNR: | 48.7 | σv: | 0.083 | Mean Temp: | 42.5 |

| Meas. By: | BJE | Notes By: | BJE |
|---|---|---|---|
| Processed By: | | Reviewed By: | |

Remarks:

14:16 loud noise from downstream and Ben observed a log release from snag ~ 40 feet downstream, water began rising rapidly at X-section
→ finished measurement so as not to capture change
→ at control change water level droped 0.8 feet
→ took comparison pictures (see page 2)

*Measurement may underpredict
→ quickly ended because water level drop
• last station depth decreased because of transient condition
• skipped to end, forcing larger estimated section for last area
• need to conduct another measurement

| Page 5 of 6 | State of Colorado | Meas. No.: 002 |
|---|---|---|
| YYYY: 2015 | **Colorado Water Conservation Board** | Division: 1 |
| MM-DD: 06-04 | ADV Discharge Measurement Notes | District: |

Station Name: ROCCR065

Rock River, (Creek), Canal, Ditch

At, (Near), Above, Below end County Road 221

Latitude: N 39°22'22.08" Longitude W 105°41'04.51" NAD83

Party: Brian Epstein

**Conditions**

Weather: ~60°F mostly sunny

Wind Spd / Dir: light & variable Water Temp:

X-Sec Desc: Sand bed

Flow Conds: steady with slight turbulence

Control Desc.: N/A

Measurement Rated: Excellent (2%) / (Good (5%)) / Fair (8%) / Poor (>8%) [based on the above conditions]

**Water Level Reading**

| Time | Staff Gage | Pressure Trans. | Time | Staff Gage | Pressure Trans. |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

Pressure Transducer Download

File Name: N/A

Time:

Weighted MGH

GH Corr.

Correct MGH

**Discharge Measurement**

| | | | | | |
|---|---|---|---|---|---|
| Manufacturer: | SonTek | Model: | FlowTracker | S/N: | (P2354) / P2355 |
| Firmware: | 3.9 | Software: | 2.20 | | |
| Diag Test File: | Yes or No | Raw Data File: | ROCCR065.002 | | |
| Meas Type: | (Wading) / Boat / Bridge / Cableway | | | Method: | 0.6 |
| | N/A ft. or mi / upstream or downstream of gage | | | | |
| Start Edge: | LEW 3.0 | End Edge: | REW 11.0 | Total Width: | 8.0 |
| Start Time: | 15:09 | End Time: | 15:30 | | |
| Discharge: | 29.176 | Unsertainty: | 3.9 | # Stations: | 17 |
| Mean v: | 3.867 | Width | 8.00 | Mean d: | 0.91 |
| Max v: | 5.294 | Area: | 7.287 | Max d: | 1.55 |
| Mean SNR: | 51.9 | σv: | 0.097 | Mean Temp: | 42.1 |

| | | | |
|---|---|---|---|
| Meas. By: | BJE | Notes By: | BJE |
| Processed By: | | Reviewed By: | |

Remarks: ROCCROD5.000 2

See page 2 for notes

→ this is the replacement measurement