COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Bonnett Creek
EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	headwaters in the vicinity of UTM North: 4138962.59 UTM East: 486695.74
LOWER TERMINUS:	confluence with the Cucharas River UTM North: 4137528.63 UTM East: 491728.78
WATER DIVISION:	2
WATER DISTRICT:	16
COUNTY:	Huerfano
WATERSHED:	Huerfano
CWCB ID:	10/2/A-005
RECOMMENDER:	Colorado Parks and Wildlife (CPW)
LENGTH:	4.05 miles
FLOW RECOMMENDATION:	0.4 cfs (09/01 - 03/31) 1.0 cfs (04/01 - 06/30) 0.55 cfs (07/01 - 08/31)

Bonnett Creek

Introduction

Colorado's General Assembly created the Instream Flow and Natural Lake Level Program in 1973, recognizing "the need to correlate the activities of mankind with some reasonable preservation of the natural environment" (see 37-92-102 (3), C.R.S.). The statute vests the Colorado Water Conservation Board (CWCB or Board) with the exclusive authority to appropriate and acquire instream flow (ISF) and natural lake level water rights (NLL). Before initiating a water right filing, the Board must determine that: 1) there is a natural environment that can be preserved to a reasonable degree with the Board's water right if granted, 2) the natural environment will be preserved to a reasonable degree by the water available for the appropriation to be made, and 3) such environment can exist without material injury to water rights.

CPW recommended that the CWCB appropriate an ISF water right on this reach of Bonnett Creek because it has a natural environment that can be preserved to a reasonable. Bonnett Creek is located within Huerfano County and originates at an elevation of approximately 10,000 ft in the Sangre de Cristo Mountains. Bonnett Creek flows east four miles to the confluence with the Cucharas River at an elevation of approximately 8,389 ft (See Vicinity Map). The proposed reach extends from the headwaters downstream to the confluence with the Cucharas River. The U.S. Forest Service manages 82 percent of the land on the 4.05 mile proposed reach and 18 percent is privately owned (See Land Ownership Map).

The information contained in this report and the associated supporting data and analyses (located at http://cwcb.state.co.us/environment/instream-flow-program/Pages/2019ProposedISFRecommendations.aspx) form the basis for staff's ISF recommendation to be considered by the Board. This report provides sufficient information to support the CWCB findings required by ISF Rule 5i on natural environment, water availability, and material injury.

Natural Environment

CWCB staff relies on the recommending entity to provide information about the natural environment. In addition, staff reviews information and conducts site visits for each recommended ISF appropriation. This information is used to provide the Board with a basis for determining that a natural environment exists.

Bonnett Creek is a first order, high-gradient stream with a somewhat confined channel. Substrate ranges from cobble to boulder. Fishery surveys indicate the stream environment of Bonnett Creek supports brook trout (*Salvelinus fontinalis*).

Table 1. List of species identified in Bonnett Creek.

Species Name	Scientific Name	Status
brook trout	*Salvelinus fontinalis*	None

ISF Quantification

CWCB staff relies upon the biological expertise of the recommending entity to quantify the amount of water required to preserve the natural environment to a reasonable degree. CWCB staff performs a thorough review of the quantification analyses completed by the recommending entity to ensure consistency with accepted standards.

Quantification Methodology
CPW staff used the R2Cross methodology to develop the initial ISF recommendation. The R2Cross method is based on a hydraulic model and uses field data collected in a stream riffle (Espegren, 1996). Riffles are most easily visualized as the stream habitat types that would dry up first should streamflow cease. The field data collected consists of streamflow measurements and surveys of channel geometry at a transect and of the longitudinal slope of the water surface.

The field data is used to model three hydraulic parameters: average depth, average velocity, and percent wetted perimeter. Maintaining these hydraulic parameters at adequate levels across riffle habitat types also will maintain aquatic habitat in pools and runs for most life stages of fish and aquatic macro-invertebrates (Nehring, 1979). CPW staff interprets the model results to develop an initial recommendation for summer and winter flows. The summer flow recommendation is based on meeting 3 of 3 hydraulic criteria. The winter flow recommendation is based on meeting 2 of 3 hydraulic criteria. The model's suggested accuracy range is 40% to 250% of the streamflow measured in the field. Recommendations that fall outside of the accuracy range may not give an accurate estimate of the hydraulic parameters necessary to determine an ISF rate.

The R2Cross methodology provides the biological quantification of the amount of water needed for summer and winter periods based on empirical studies of fish species preferences. The recommending entity uses the R2Cross results and its biological expertise to develop an initial ISF recommendation. CWCB staff then evaluates water availability for the reach typically based on median hydrology (see the Water Availability section below for more details). The water availability analysis may indicate less water is available than the initial recommendation. In that case, the recommending entity either modifies the magnitude and/or duration of the recommended ISF rates if the available flows will preserve the natural environment to a reasonable degree, or withdraws the recommendation.

Data Analysis
R2Cross data was collected at three transects for this proposed ISF reach (Table 2). Results obtained at more than one transect are averaged to determine the R2Cross flow rate for the reach of stream. The R2Cross model results in a winter flow of 0.57 cfs, which meets 2 of 3 criteria and is within the accuracy range of the R2Cross model. The R2Cross model results in a summer flow of 0.96 cfs, which meets 3 of 3 criteria and is within the accuracy range of the R2Cross model.

Table 2. Summary of R2Cross transect measurements and results for Bonnett Creek.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
USFS	07/15/1992 #1	0.42	0.17 - 1.05	0.48	Out of range
CPW	06/16/2016 #2	0.84	0.34 - 2.10	0.66	1.22
CPW	06/16/2016 #3	1.10	0.44 - 2.75	0.58	0.69
			Mean	0.57	0.96

ISF Recommendation
CPW recommended ISF flows based on R2Cross modeling analyses, biological expertise, and a preliminary assessment of water availability. CWCB Staff's water availability analysis determined that water was limited in some cases. The following flows represent the final recommendation which has been modified in collaboration with CPW due to water availability limitations.

0.4 cfs from September 1 through March 31 is recommended for fish overwintering during the base flow period. This flow rate will achieve the percent wetted perimeter criteria across the reach and maintain velocities and depths that are suitable for fish to occupy microhabitats within the reach.

1.0 cfs from April 1 through June 30 is recommended during the snowmelt runoff period. The proposed summer flow recommendation will preserve the natural environment by meeting all three instream flow criteria.

0.55 cfs is recommended from July 1 through August 31 for protection of the receding limb of the hydrograph in order to achieve suitable velocities and wetted perimeter during the late summer. This combination will support fish spawning, development, and rearing. This flow rate was modified due to water availability limitations.

Water Availability
CWCB staff conducts hydrologic analyses for each recommended ISF appropriation to provide the Board with a basis for making the determination that water is available.

Water Availability Methodology
Each recommended ISF reach has a unique flow regime that depends on variables such as the timing, magnitude, and location of water inputs (such as rain, snow, and snowmelt) and water losses (such as diversions, reservoirs, evaporation and transpiration, groundwater recharge, etc). Although extensive and time-consuming investigations of all variables may be possible, staff takes a pragmatic and cost-effective approach to analyzing water availability. This approach focuses on streamflows and the influence of flow alterations, such as diversions, to understand how much water is physically available in the recommended reach.

Staff's hydrologic analysis is data-driven, meaning that staff gathers and evaluates the best available data and uses the best available analysis method for that data. Whenever possible, long-term stream gage data (period of record 20 or more years) will be used to evaluate streamflow. Other streamflow information such as short-term gages, temporary gages, spot streamflow measurements, diversion records, and StreamStats will be used when long-term gage data is not available. StreamStats, a statistical hydrologic program, uses regression equations developed by the USGS (Capesius and Stephens, 2009) to estimate mean flows for each month based on drainage basin area and average drainage basin precipitation. Diversion records will also be used to evaluate the effect of surface water diversions when necessary. Interviews with water commissioners, landowners, and ditch or reservoir operators can provide additional information. A range of analytical techniques may be employed to extend gage records, estimate streamflow in ungaged locations, and estimate the effects of diversions. The goal is to obtain the most detailed and reliable estimate of hydrology using the most efficient analysis technique.

The final product of the hydrologic analysis used to determine water availability is a hydrograph, which shows streamflow and the proposed ISF rate over the course of one year. The hydrograph will show median daily values when daily data is available; otherwise, it will present mean-monthly streamflow values. Staff will calculate 95% confidence intervals for the median streamflow if there is sufficient data. Statistically, there is 95% confidence that the true value of the median streamflow is located within the confidence interval.

Basin Characteristics
The drainage basin of the proposed ISF on Bonnett Creek is 2.63 square miles, with an average elevation of 9,891 ft and average annual precipitation of 26.63 inches (See the Hydrologic Features Map). There are no known surface water diversions or reservoirs within the basin tributary to the proposed ISF. Hydrology in this drainage basin represents natural flow.

Available Data
There are no current or historic streamflow gages in the vicinity of the proposed ISF reach. The nearest gage is the Cucharas River at Boyd Ranch near La Veta gage (USGS 07114000) located approximately 3.5 miles downstream on the Cucharas River. The gage has a period of record from 1934 to present. The drainage basin of the gage is 53.1 square miles, with an average elevation of 9884 ft and average annual precipitation of 27.28 inches. Several surface diversions exist between the proposed lower terminus and the gage, totaling approximately 65 cfs in decreed water rights. Many of the larger rights appear to be used consistently based on the available diversion records. Due to the combination of water diversions and the large difference in drainage basin size that results in a small proration factor, this gage is not suitable for estimating streamflow on the proposed ISF reach.

CWCB staff made four streamflow measurements on the proposed reach of Bonnet Creek as summarized in Table 3.

Table 3. Summary of Streamflow Measurement Visits and Results for Baker Creek.

Visit Date	Flow (cfs)	Collector
09/08/2011	0.10	CWCB
06/29/2012	0.22	CWCB
08/07/2014	0.36	CWCB
09/11/2015	0.10	CWCB

Data Analysis
StreamStats provides the best available estimate of streamflow on Baker Creek.

Water Availability Summary
The hydrograph (See Complete Hydrograph) shows StreamStats results for mean-monthly streamflow. Staff has concluded that water is available for appropriation.

Material Injury
Because the proposed ISF on Bonnett Creek is a new junior water right, the ISF can exist without material injury to other water rights. Under the provisions of section 37-92-102(3)(b), C.R.S. (2018), the CWCB will recognize any uses or exchanges of water in existence on the date this ISF water right is appropriated.

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.

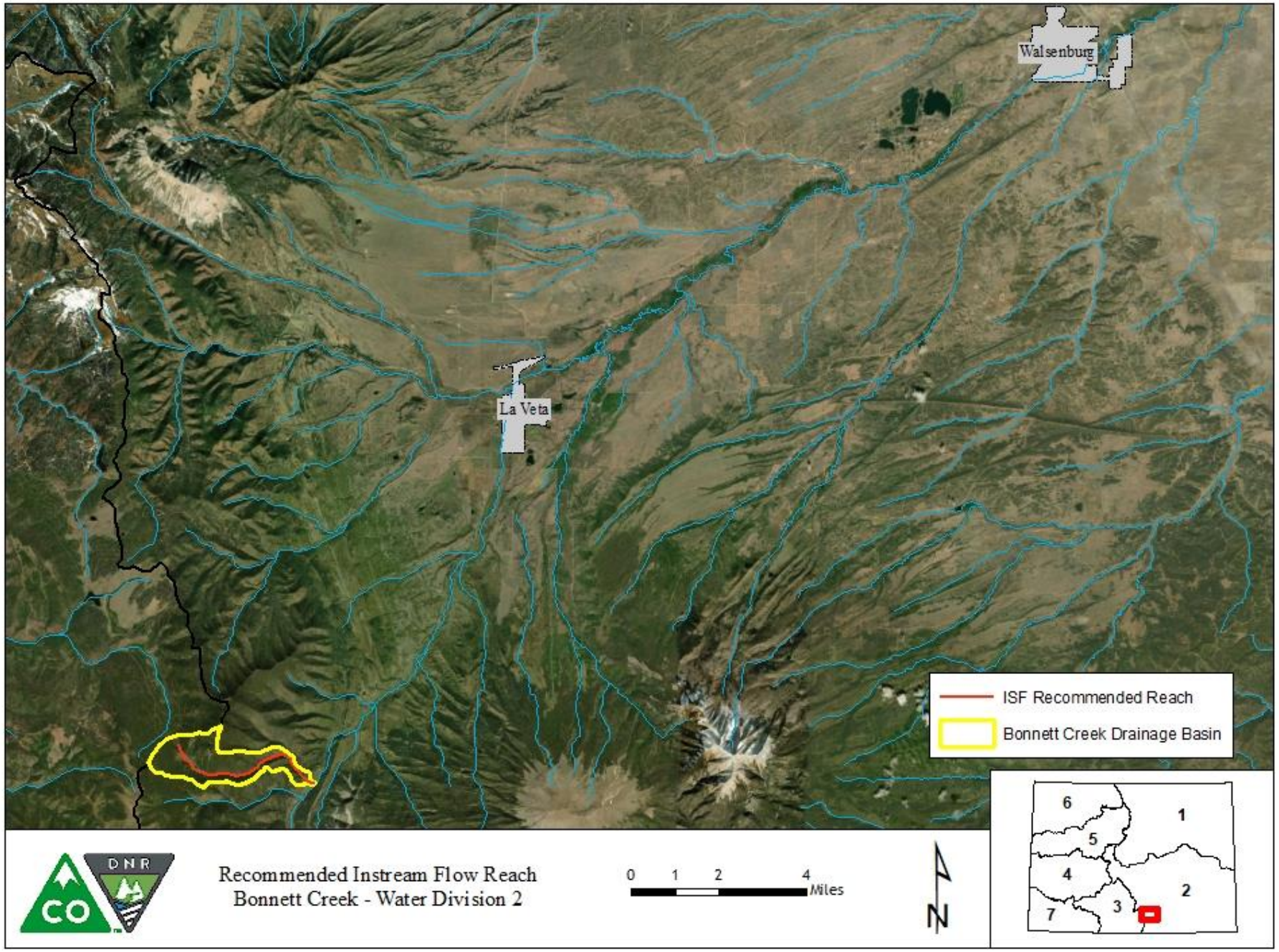
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

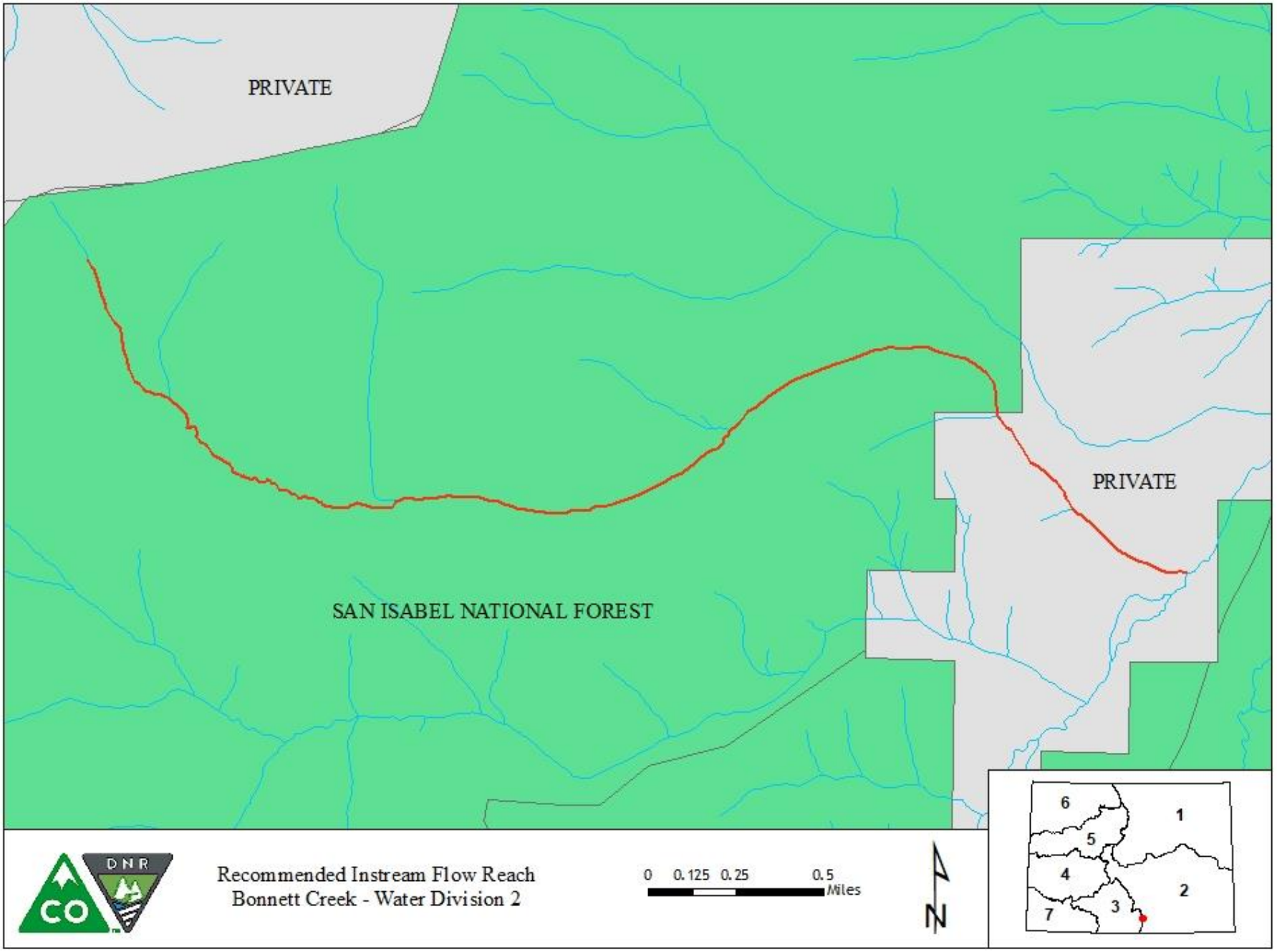
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

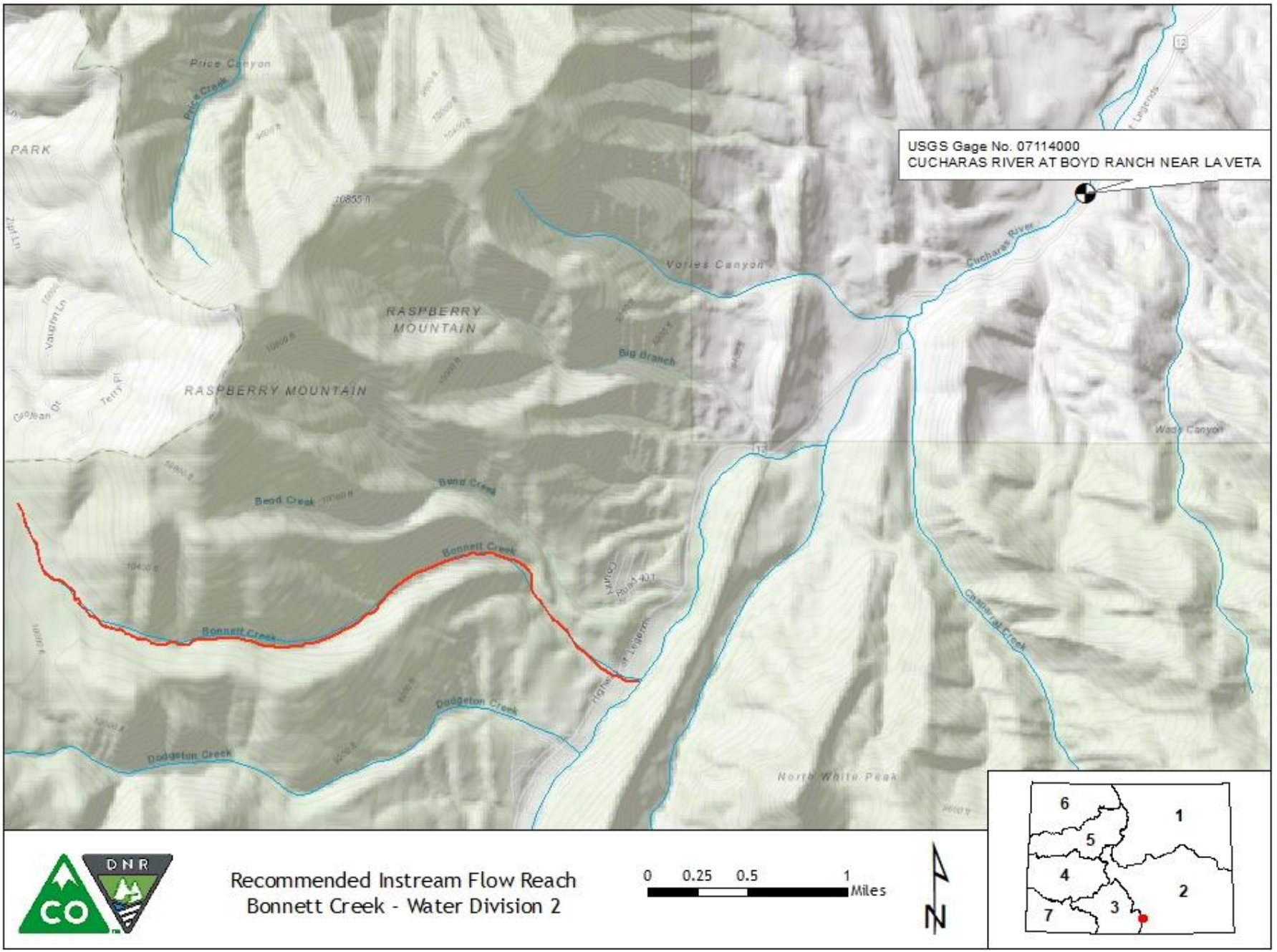
VICINITY MAP



LAND OWNERSHIP MAP



HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH