COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Carnero Creek
EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	confluence with South Fork & Middle Fork Carnero Creeks UTM North: 4196212.69 UTM East: 377513.93
LOWER TERMINUS:	confluence with Mogotas Arroyo UTM North: 4190411.28 UTM East: 387851.17
WATER DIVISION:	3
WATER DISTRICT:	27
COUNTY:	Saguache
WATERSHED:	Saguache
CWCB ID:	19/3/A-001
RECOMMENDER:	Colorado Parks and Wildlife (CPW)
LENGTH:	9.81 miles
FLOW RECOMMENDATION:	2.2 cfs (12/01 - 02/29) 2.6 cfs (03/01 - 11/30)

Carnero 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 a reach of Carnero Creek because it has a natural environment that can be preserved to a reasonable degree. Carnero Creek is located within Saguache County and originates at the confluence of the Middle and South Forks of Carnero Creek at an elevation of approximately 8,600 ft. Carnero Creek flows west approximately 15 miles before flow becomes subsurface in the San Luis Valley at an elevation of approximately 8,000 ft (See Vicinity Map). The proposed reach extends from the confluence with the South Fork and Middle Fork Carnero Creeks downstream to the confluence with the Mogotas Arroyo. The BLM manages two percent of the land on the 9.81 mile proposed reach and 98 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.

Carnero Creek has a natural environment consisting of self-sustaining populations of brown trout and white sucker, and small numbers of Rio Grande cutthroat trout (RGCT). RGCT is classified as a Tier 1 priority species in the 2015 State Wildlife Action Plan, which has the highest conservation priority in the state. RGCT is classified as a State Species of Special Concern and is considered Sensitive by the U.S. Forest Service (USFS) and Bureau of Land Management (BLM). CPW fishery survey data indicates self-sustaining populations of RGCT, brown trout, and white sucker. Carnero Creek was originally identified in the Rio Grande Cutthroat Trout Conservation Plan as having conservation populations of RGCT with essentially pure genetics. Since then, genetic analyses in the Rio Grande basin have shed light on introgression associated with the Yellowstone cutthroat trout. Although the importance of mainstem Carnero Creek in cutthroat conservation is currently being reassessed, this reach has a valuable natural environment consisting of multiple different species of fish, a significant macroinvertebrate community, and diverse riffle, pool, and glide habitat for the fish species listed above.

Table 1. List of species identified in Carnero Creek.

Species Name	Scientific Name	Status
brown trout	*Salmo trutta*	None
white sucker	*Catostomus commersonii*	None
Rio Grande cutthroat trout	*Oncorhynchus clarkii virginalis*	State – Species of Special Concern Federal - Sensitive Species

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. However, the R2Cross model also contains the Thorne and Zevenbergen subroutine, which uses field measured bed material grain size to estimate velocity. This method is not constrained by the accuracy range of the Manning's n subroutine.

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 two 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 2.15 cfs, which meets 2 of 3 criteria, and a summer flow of 2.60 cfs, which meets 3 of 3 criteria.

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

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
CPW	06/25/2018 #1	1.80	N/A	3.30[1]	3.40[1]
CPW	06/25/2018 #2	1.80	N/A	1.00[1]	1.80[1]
			Mean	2.15	2.60

1 = Thorne and Zevenberg subroutine was used due to Manning's n results that were outside of the accuracy range. The measured D84 was 0.31 feet

ISF Recommendation
CPW recommends the following flows based on R2Cross modeling analyses, biological expertise, and staff's water availability analysis.

2.2 cfs from December 1 through February 29 to maintain 2 of 3 instream flow criteria during the winter base flow period.

2.6 cfs from March 1 through November 30 to meet 3 of 3 instream flow criteria and help provide sufficient habitat during critical periods for cutthroat trout life stage requirements.

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 Carnero Creek is 114 square miles, with an average elevation of 9,958 ft and average annual precipitation of 25.67 inches (See the Hydrologic Features Map). There are several surface water diversions located in the basin tributary to the proposed lower terminus. Due to the number and volume of these diversions, streamflow is somewhat altered from natural conditions.

Available Data

The Carnero Creek near La Garita gage (USGS 08230500) is located approximately 2.7 miles upstream from the lower terminus. The gage period of record includes 1919 to present. The drainage basin tributary to the Carnero Creek gage is 106 square miles with an average elevation of 10,056 ft and average precipitation of 26.53 inches. This gage started operating year round in 1945 and provides important information for evaluating water availability. The gage is influenced by many of the same diversions that affect the proposed ISF reach. This gage is used in all further analysis and is referred to as the Carnero Creek gage.

Two diversions are located between the gage and the lower terminus and are therefore not taken into account by the gage. These diversions include Holland Ditch (total decreed rate of 13.16 cfs) and the La Magotes Ditch (1.82 cfs appropriation 1875). Records for these diversions begin in 1950. Upon further staff investigation, the La Magotes Ditch diverts a negligible amount, especially in the last 20 years, and has a median diversion amount of 0 year round. Diversion record comments recorded by the water commissioner often say “No water available,” which in this situation usually means that water is not legally available (personal communication, Dist. 25-26-27 Water Commissioner William Redden 10/23/2018). Along with the La Magotes Ditch, most of the diversions upstream from the gage are not diverting regularly, according to the water commissioner. The most senior diversions on Carnero Creek exist downstream from the lower terminus. The water commissioner confirmed that the most senior diverter, the Omnibus Ditch (42.72 cfs), is located approximately 0.2 miles downstream from the proposed lower terminus and often pulls water through the proposed reach to its headgate.

CWCB staff made one site visit during the R2Cross measurements with CPW on the proposed reach of Carnero Creek as summarized. No additional spot measurements of streamflow were made.

Data Analysis

The Carnero Creek gage and available diversion records from the Holland Ditch were used to estimate streamflow in the ISF reach. The effects of the diversions below the gage were accounted for by subtracting the diversion records from the gage record. The analysis was completed from 1950 to 2017 based on the availability of diversion records and year round gage records. The adjusted gage

data was not scaled to the lower terminus because the difference in contributing drainage basin was small (less than 5% adjustment to streamflow). Median streamflow and the 95% confidence interval for median streamflow were calculated for the adjusted Carnero Creek gage record.

Water Availability Summary
The hydrographs (See Complete and Detailed Hydrographs) show median and 95% confidence interval for median streamflow estimated at the lower terminus of Carnero Creek. The proposed ISF is below the median streamflow estimate most of the time and below the 95% confidence interval for median streamflow at all times. Staff concludes that water is available for appropriation on Carnero Creek

Material Injury
Because the proposed ISF on Carnero 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.

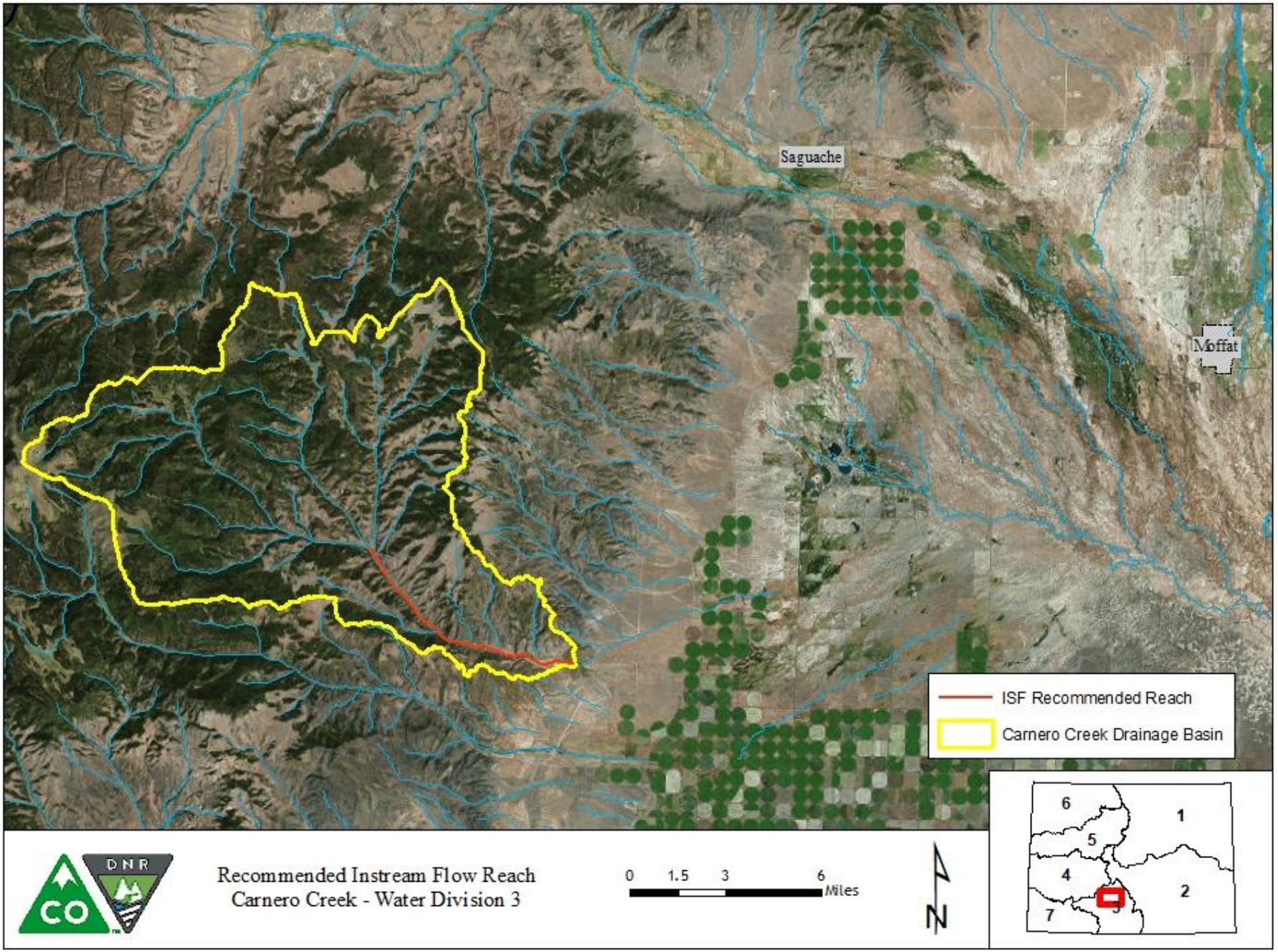
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

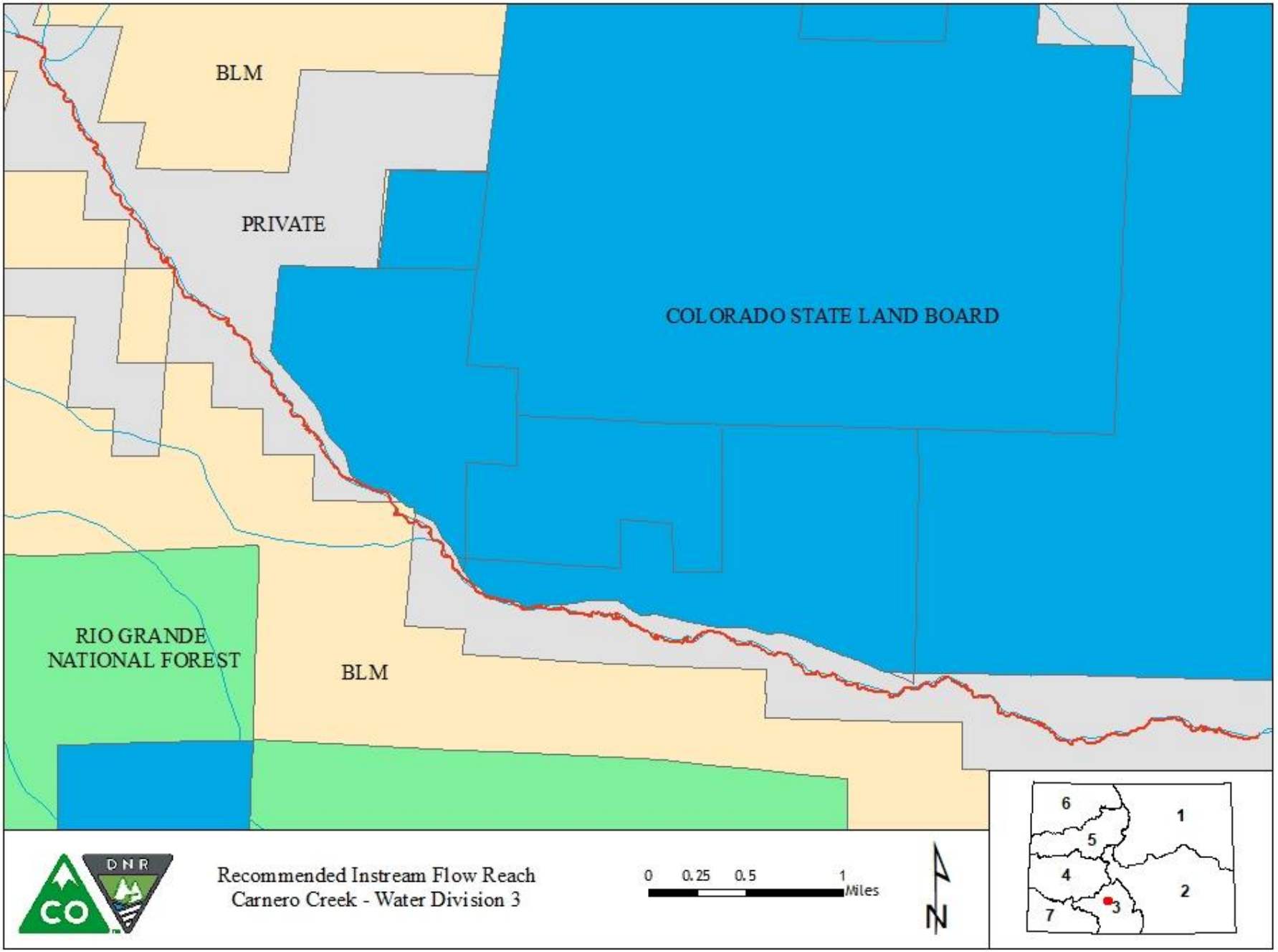
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

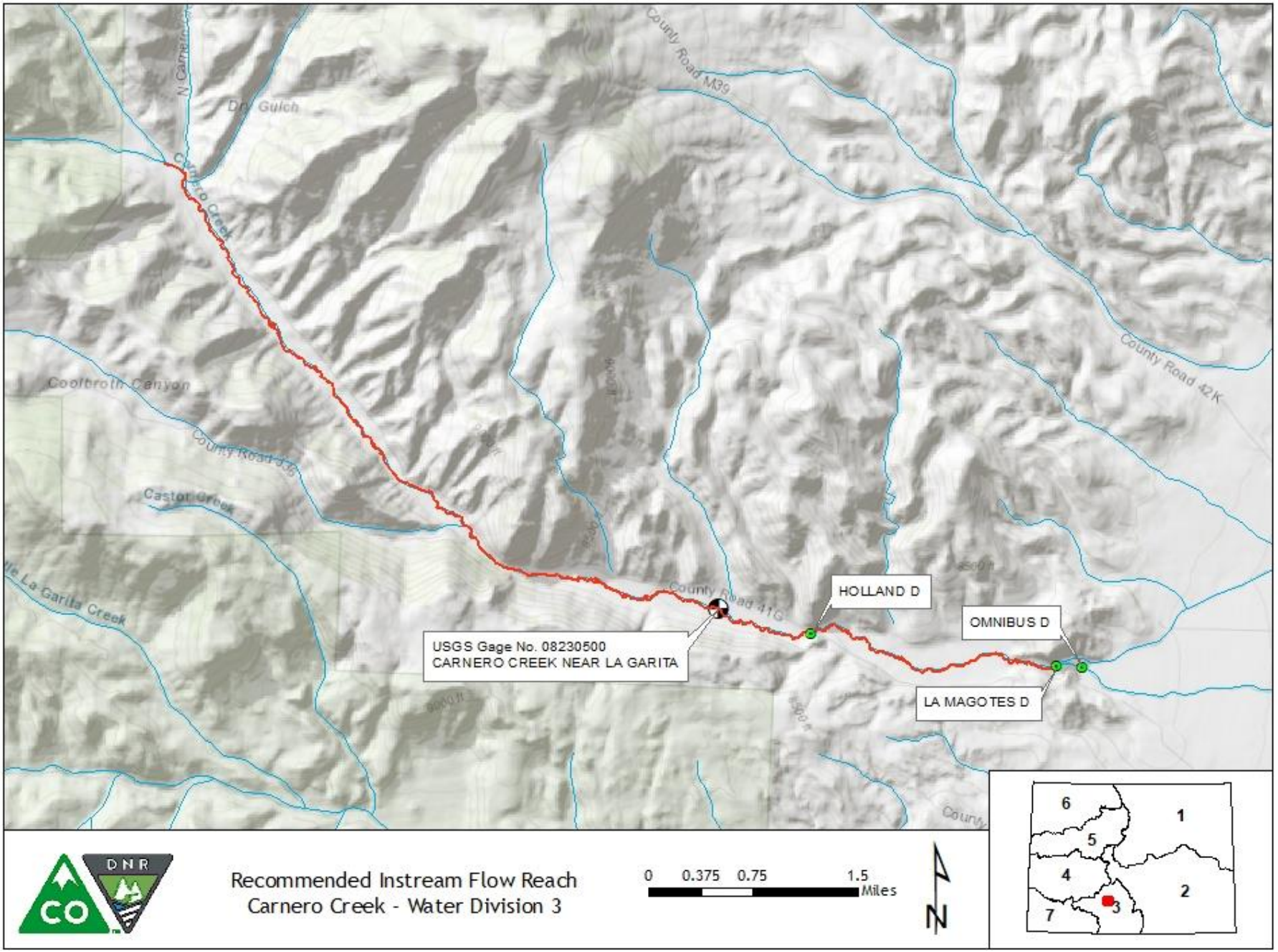
VICINITY MAP



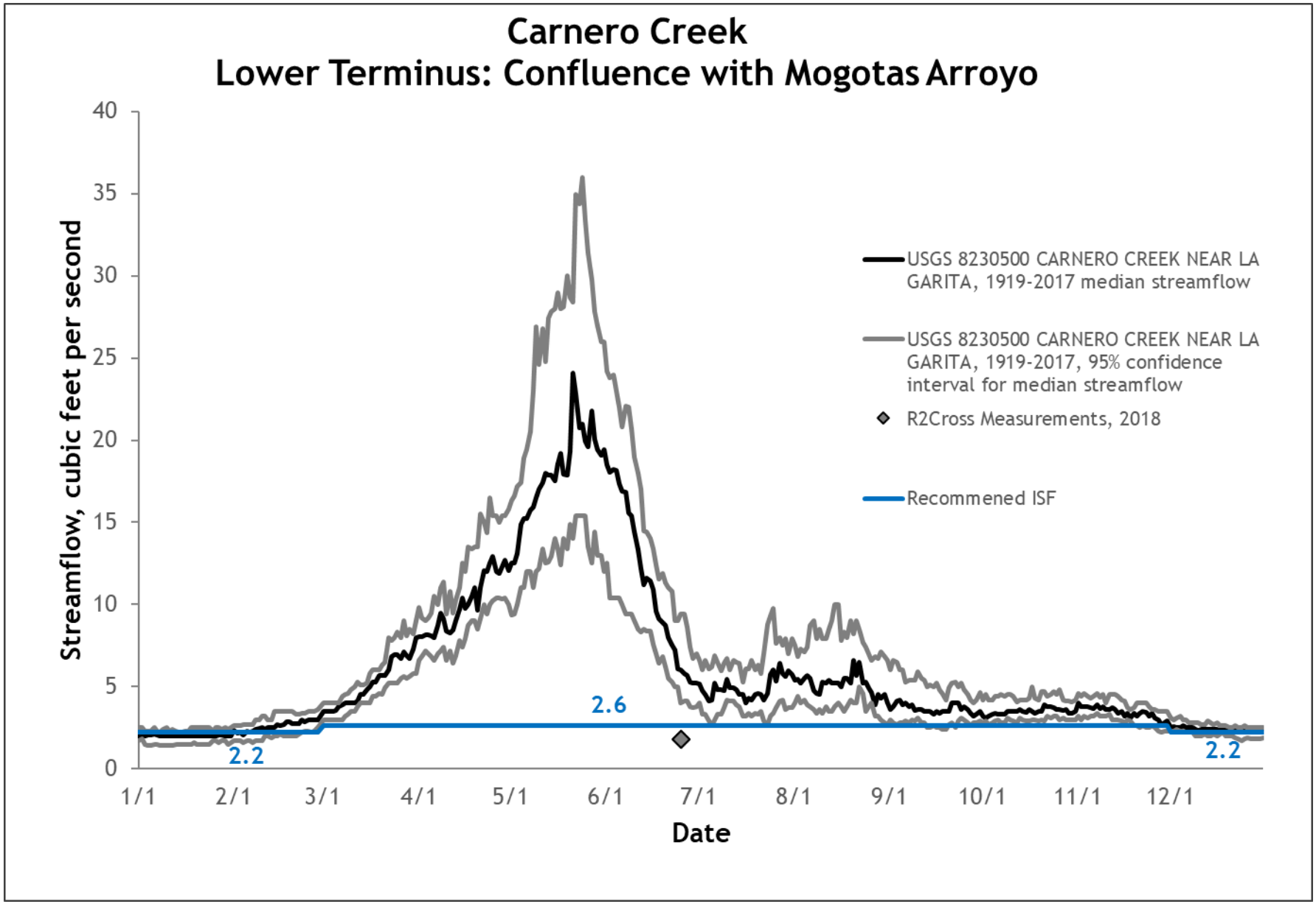
LAND OWNERSHIP MAP



HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



DETAILED HYDROGRAPH