Redstone Creek Executive Summary

CWCB STAFF INSTREAM FLOW RECOMMENDATION
January 25-26, 2021

UPPER TERMINUS:	headwaters UTM North: 4496738.38	UTM East: 472174.81
LOWER TERMINUS:	confluence Buckhorn Creek UTM North: 4480748.18	UTM East: 482372.71
WATER DIVISION:	1	
WATER DISTRICT:	4	
COUNTY:	Larimer	
WATERSHED:	Big Thompson	
CWCB ID:	20/1/A-001	
RECOMMENDER:	Colorado Parks and Wildlife, Larimer County Department of Natural Resources (CPW, LCDNR)	
LENGTH:	16.33 miles	
FLOW RECOMMENDATION:	6.2 cfs (05/01 – 06/15)	

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

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.

Colorado Parks and Wildlife (CPW) and Larimer County Department of Natural Resources (LCDNR) recommended that the CWCB appropriate an ISF water right on a reach of Redstone Creek because it has a natural environment that can be preserved to a reasonable degree. The proposed reach extends from the headwaters downstream to the confluence with Buckhorn Creek. Redstone Creek is located within Larimer County near Masonville (See Vicinity Map), and originates on the north side of Buckhorn Mountain at an elevation of approximately 7,500 feet. Redstone Creek flows in a southerly direction for 16 miles before it joins Buckhorn Creek at an elevation of 5,350 feet. Ninety-eight percent of the land on the 16.33 mile proposed reach is privately owned, 1% of the land is owned by Larimer County and the remaining 1% is owned by the Northern Colorado Water Conservancy District (See Land Ownership Map).

The information contained in this Executive Summary and the associated supporting data and analyses form the basis for staff's ISF recommendation to be considered by the Board. This Executive Summary provides sufficient information to support the CWCB findings required by ISF Rule 5i on natural environment, water availability, and material injury. Additional supporting information is located at: https://cwcb.colorado.gov/2021-isf-recommendations.

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.

Redstone Creek contains a variety of stream features, large woody debris, and shade from the riparian community providing good fish habitat in the stream. The lower portion of the reach on Larimer County Open Land is low gradient and characterized by a mixture of riffles, runs, glides and pools. Substrate varies from medium sized cobble to sand.

CPW documented creek chub, longnose dace, and white sucker populations in Redstone Creek in 1993. No fish were observed during recent site visits, but macroinvertebrate populations are present, including: caddisfly adults and nymphs, mayfly nymphs, diptera larvae, and water striders. A wide range of birds and wildlife have also been noted in the area, including golden eagles, elk, and western rattlesnake.

The riparian community includes well-established mature cottonwood gallery forests and junipers along the recommended reach. Upland species in the basin include mountain mahogany

and Bell's twin pod. Bell's twin pod is a species endemic to the northern Front Range and is considered to be imperiled at a global and state level by the Colorado Natural Heritage program.

Table 1. List of species identified in Redstone Creek.

Species Name	Scientific Name	Protection Status
creek chub	*Semotilus atromaculatus*	None
longnose sucker*	*Catostomus catostomus*	None
white sucker*	*Catostomus commersonii*	None
caddisfly	*Trichoptera*	None
fly larve	*Diptera*	None
Mayfly	*Ephemeroptera*	None
Bell's twin pod	*Physaria bellii*	State and globally imperiled
Cottonwood	*Populus spp.*	None

*indicates fish species native to Colorado (East slope)

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 a stream habitat type that are most easily visualized as sections of the stream that would dry up first should streamflow cease. The data collected consists of a streamflow measurement, survey of channel geometry and features at a single transect, and survey 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 macroinvertebrates (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 amount of water needed for summer and winter periods. 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

CPW collected R2Cross data 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 summer flow of 6.15 cfs, which meets 3 of 3 criteria and is within the accuracy range of the R2Cross model. R2Cross field data and model results can be found in the appendix to this report.

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

Date, Xsec #	Top Width (feet)	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
05/30/2019, 1	23.90	11.56	4.62 - 28.90	Out of range	Out of range
05/30/2019, 2	24.50	11.41	4.56 - 28.53	Out of range	7.33
04/29/2020, 3	23.29	12.00	4.80 - 30.00	Out of range	4.96
			Mean		6.15

ISF Recommendation

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

6.2 cfs is recommended from May 1 through June 15. This flow rate will provide adequate depth and percent wetted perimeter across the surveyed riffles, although velocity of 1 ft/s is not met in the widest riffle cross-section.

CPW does not recommend a winter recommendation due to water availability.

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.

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 Redstone Creek is 30.9 square miles, with an average elevation of 6,690 feet and average annual precipitation of 19.59 inches (See the Hydrologic Features Map). Redstone Creek experiences flashy spring flows driven by low elevation snow melt and rain events. The hydrology is driven by melt from low elevation snowpack, with the highest elevation of contributing snowpack at no more than 8,300 feet. Groundwater seeps have been observed by CWCB staff during spring snow melt. Flows in the stream typically recede in mid to late summer.

There is one decreed surface water diversion, Soderberg Bros Ditch 1 (WDID 400882, appropriation date 1971, 2 cfs) located 8.5 miles upstream from the lower terminus. Lastly, there are a large number of small ponds that total 26.5 AF of decreed storage in the basin. Due to limited surface water diversions and storage, hydrology in the basin largely reflects natural flow patterns.

Data Analysis

CWCB Gage

There is no current or historic gage on Redstone Creek. Due to the limited available data, CWCB staff installed a temporary gage near the location of the lower terminus. This gage location records the impacts from consumptive uses in the basin. The gage was operated from June 2019 to present. Median hydrology was not calculated due to the short period of record.

Due to the short period of record, staff evaluated the Buckhorn Creek near Masonville, CO gage (USGS 06739500, period of record 1947-1955, 1959-1977, and 1993 – present), located 3.2 miles south of the proposed lower terminus, to assess how 2019 and 2020 compared hydrologically to a longer record. The Buckhorn gage changed to a seasonal gage in 2014, so the total annual streamflow could not be assessed. However, in comparison to median flows, 2019 had a late and above average runoff flow followed by a dry summer that lead to flows quickly receding to

median around mid-July. In 2020, runoff peaked quite a bit earlier than typical, and a dry spring and summer lead to flows well below median starting in mid-May and continuing for the remainder of the year.

Representative Gage Analysis
Because the Buckhorn Creek near Masonville gage has a longer period of record, it was also used to estimate streamflow on Redstone Creek. The Buckhorn Creek gage has a drainage basin of 135 square miles, average precipitation of 20.42 inches, and an average elevation of 7,403 feet. There are approximately 75 cfs of decreed water rights and 2,500 AF of decreed storage in the basin. This gage is more heavily impacted by water use than Redstone Creek. The use of this gage in the analysis likely under-estimates streamflow on Redstone Creek.

The area-precipitation method was used to scale the Buckhorn Creek gage to the lower terminus of Redstone Creek. The method estimates streamflow based on the ratio of the precipitation weighted drainage area. The scaling factor for Redstone Creek basin at the lower terminus is 0.22. Median streamflow and 95% confidence intervals for median streamflow were calculated.

CWCB Staff Measurements
CWCB staff made five streamflow measurements on the proposed reach of Redstone Creek to support development of a rating curve for the temporary gage and provide additional information as summarized in Table 3.

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

Visit Date	Flow (cfs)	Collector
05/13/2020	4.82	CWCB
4/29/2020	11.56	CWCB
4/29/2020	12.44	CWCB
7/15/2019	1.02	CWCB
6/5/2019	5.66	CWCB

Water Availability Summary
The Complete Hydrograph shows streamflow collected at the CWCB gage, the prorated Buckhorn Creek gage daily median flows with 95% confidence intervals, and the proposed ISF rate. Knowing that 2020 runoff occurred earlier than typical, staff determined that the recommended flow rate likely does not occur until May 1st in most years. Additionally, the recommended flow rate is generally below the median of the prorated Buckhorn Creek gage and below the upper 95% confidence interval for median flow at all times. This is a seasonal recommendation because the CWCB gage did not record baseflows in 2019 or 2020. Based on the available information and the observed patterns of streamflow on Redstone Creek, staff believes that water is available for a seasonal ISF appropriation.

Material Injury
Because the proposed ISF on Redstone 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. (2020), 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.

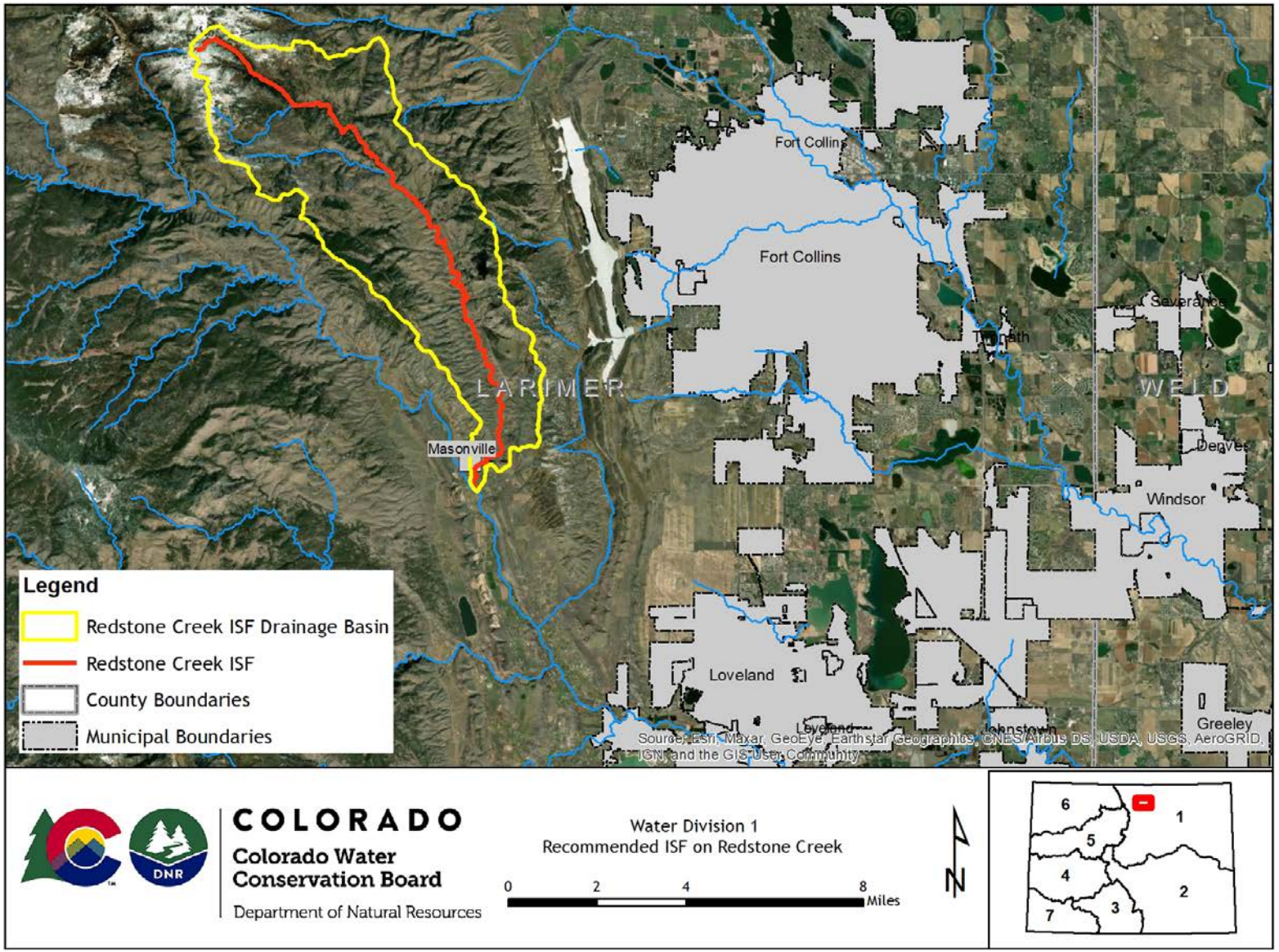
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

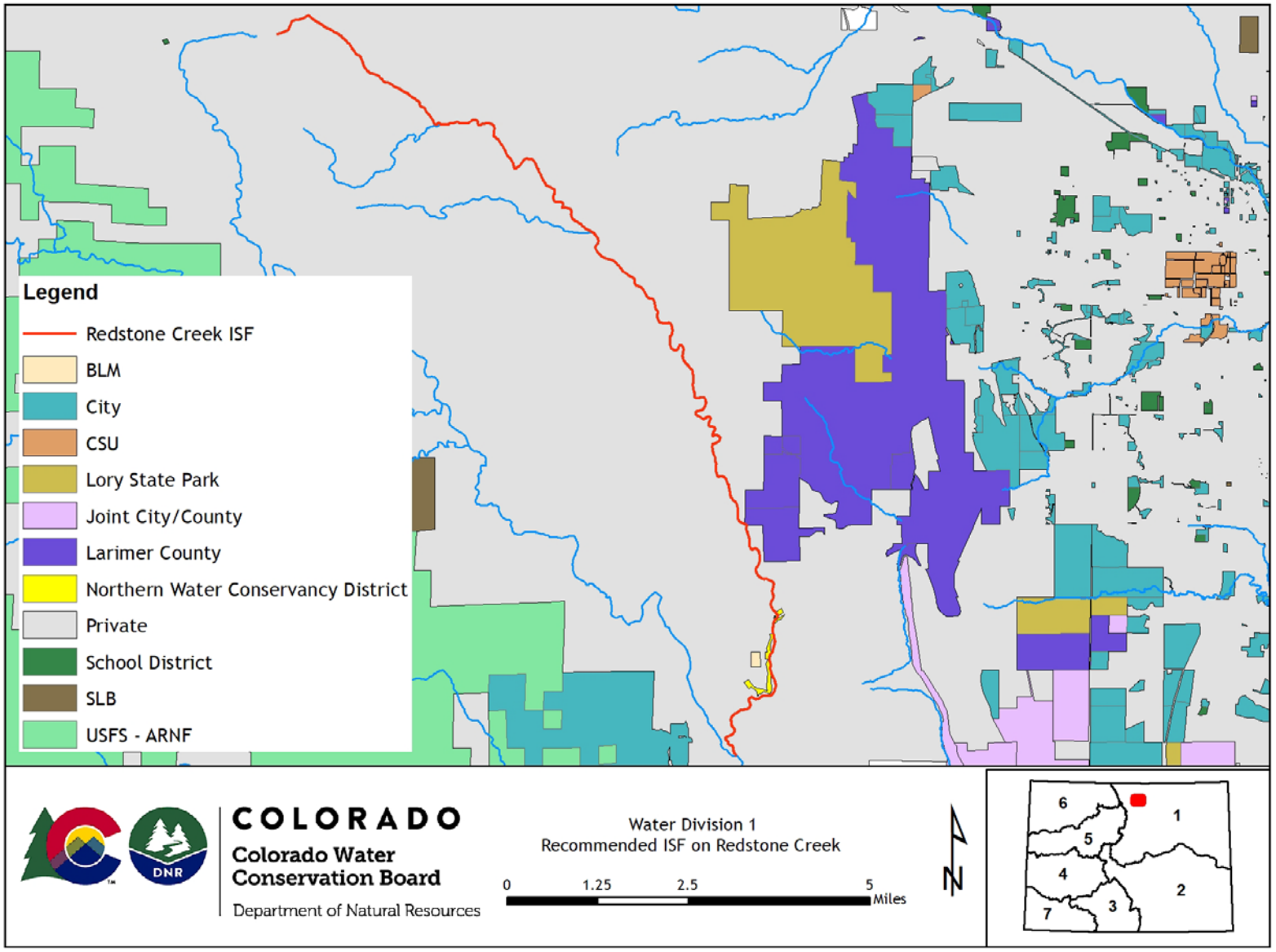
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

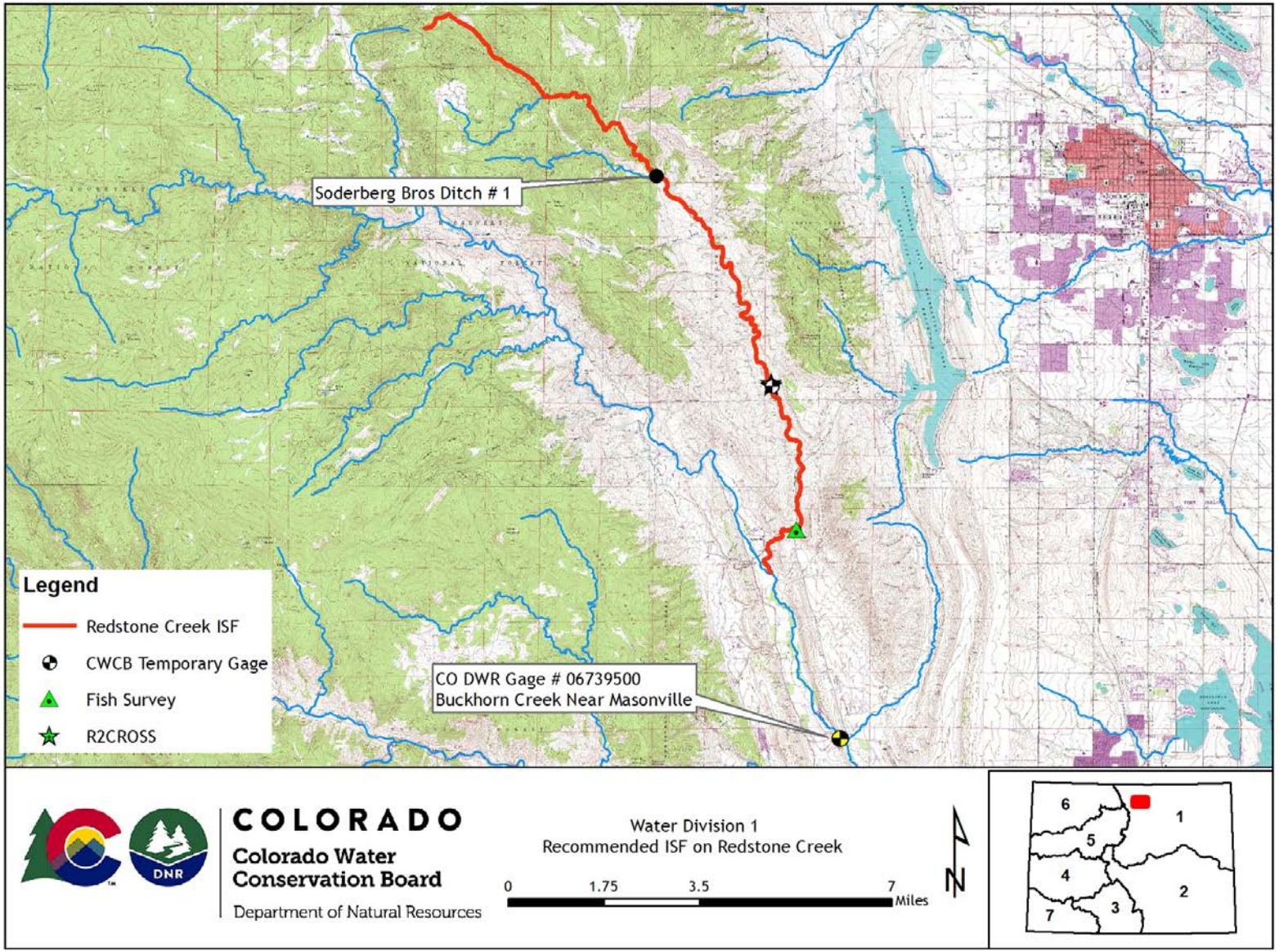
VICINITY MAP



LAND OWNERSHIP MAP



HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH