Square Top Creek Executive Summary

CWCB STAFF INSTREAM FLOW RECOMMENDATION
January 29-30, 2024

UPPER TERMINUS:	outlet of Lower Square Top Lake at UTM North: 4382563.18 UTM East: 436558.39
LOWER TERMINUS:	inlet of Duck Lake at UTM North: 4381723.00 UTM East: 437787.00
WATER DIVISION/DISTRICT:	1/80
COUNTY:	Clear Creek
WATERSHED:	Upper South Platte
CWCB ID:	16/1/A-003
RECOMMENDER:	Colorado Parks and Wildlife (CPW)
LENGTH:	1.08 miles
FLOW RECOMMENDATION:	0.1 cfs (09/01 - 03/31) 0.3 cfs (04/01 - 04/30) 1 cfs (05/01 - 05/31) 1.3 cfs (06/01 - 06/30) 0.8 cfs (07/01 - 07/31) 0.25 cfs (08/01 - 08/31)

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

BACKGROUND

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.

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/2024-isf-recommendations.

RECOMMENDED ISF REACH

CPW recommended that the CWCB appropriate an ISF water right on a reach of Square Top Creek at the January 2015 ISF workshop. Square Top Creek is located within Clear Creek County (See Vicinity Map), and is approximately eight miles south of Georgetown, CO. The stream originates in the mountains surrounding upper and lower Square Top Lakes and flows southeast until it reaches the confluence with Duck Lake. It then flows into Geneva Creek, a tributary to the North Fork South Platte River, which is ultimately a tributary to the South Platte River.

The proposed ISF reach extends from the outlet of Lower Square Top Lake downstream to the inlet of Duck Lake for a total of 1.08 miles. Approximately 56% of the land on the proposed reach is public lands managed under the United States National Forest and 44% is under private ownership (See Land Ownership Map). CPW is interested in protecting this stream to preserve the natural environment. CPW is working to establish a new conservation population of greenback cutthroat trout and believes that ISF protection on Square Top Creek is an imporant step in the overall conservation of greenback cutthroat trout.

OUTREACH

Stakeholder input is a valued part of the CWCB staff's analysis of ISF recommendations. Currently, more than 1,100 people subscribe to the ISF mailing list. Notice of the potential appropriation of an ISF water right on Square Top Creek was sent to the mailing list in November 2023, March 2023, November 2022, March 2022, March 2021, March 2020, March 2019, March 2018, and March 2017. Staff sent letters to identified landowners adjacent to Square Top Creek based on information from the county assessor's website. A public notice about this recommendation was also published in the Clear Creek Courant on December 14, 2023.

Staff presented information about the ISF program and this recommendation to the Clear Creek County Board of County Commissioners on October 20, 2020. In addition, staff spoke with Tim Buckly, District 80 Water Commissioner, on October 16, 2023 regarding water availability on Square Top Creek. Staff also spoke with Julie Holmes, a property owner near Duck Lake, on July 12, 2016 about the ISF program and hiking access.

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 provides the Board with a basis for determining that a natural environment exists.

Square Top Creek is a high-elevation headwaters creek located at the top of Guanella Pass. The creek flows into Duck Lake, an on-channel reservoir on Duck Creek, then into Geneva Creek and eventually the North Fork South Platte River. The creek's headwaters form downstream of two alpine lakes called Upper and Lower Square Top Lakes located at the base of 13,783-foot Square Top Mountain. The channel is extremely high-gradient and single thread with stream substrate that ranges from small gravels to medium-sized boulders. The channel is primarily large to medium-sized cobbles and small boulders that form a series of cascading step pools. Suitable trout habitat includes slower-velocity pocket pools, large volume step pools, and undercut banks.

In 2014 CPW biologists began a reclamation project with the goal of removing all non-native trout species to reestablish native greenback cutthroat trout. Following the 2014 reclamation effort, CPW biologists began monitoring the lake and stream system to ensure they were negative for whirling disease, a disease which cutthroat trout are highly susceptible to. CPW biologists wanted to ensure that whirling disease was eradicated in the system before stocking greenback cutthroat trout (see photos below). Following a negative whirling disease result in late 2022, Square Top Creek was stocked for the first time with young-of-the-year greenback cutthroat in 2023 (Table 1). Square Top Lakes were also stocked with yearling greenback cutthroat trout. By stocking distinct age classes in the lakes and stream, CPW biologists will be able to better understand movement patterns of fish between Square Top Creek and the lakes.

Greenback cutthroat trout stocking in Square Top Creek, August 2023

Table 1. List of species identified in Square Top Creek.

Species Name	Scientific Name	Status
greenback cutthroat trout	*Oncorhynchus clarkii stomias*	Federal - Threatened Species State - Species of Greatest Conservation Need State - Threatened Species
green stonefly	Alloperla pilosa	Globally – imperiled State – imperiled

Square Top Creek also supports a diverse macroinvertebrate community which includes multiple species of caddisflies and mayflies, diptera, dragonfly, and stonefly species. Additionally, Colorado Natural Heritage Program notes observations of Alloperla pilosa, a stonefly that is both state and globally imperiled. Plants observed in the field include short-fruited willow, watercress, and multiple types of wildflowers, including Rocky Mountain columbine and downy Indian-paintbrush.

ISF QUANTIFICATION

CWCB staff relies on 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 method 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; CWCB, 2022). Riffles are the stream habitat type that are most vulnerable to dry if streamflow ceases. The data collected consists of a streamflow measurement, a survey of channel geometry and features at a cross-section, and a survey of the longitudinal slope of the water surface.

The R2Cross model uses Ferguson's Variable-Power Equation (VPE) to estimate roughness and hydraulic conditions at different water stages at the measured cross-section (Ferguson, 2007; Ferguson, 2021). This approach is based on calibrating the model as described in Ferguson (2021). The model is used to evaluate three hydraulic criteria: 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 use the model results to develop an initial recommendation for summer and winter flows. The summer flow recommendation is based on the flow that meets all three hydraulic criteria. The winter flow recommendation is based on the flow that meets two of the three hydraulic criteria.

The R2Cross method estimates 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 Collection and 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 stream reach. The R2Cross model results in a winter flow of 0.73 cfs and a summer flow of 1.28 cfs. 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 Square Top Creek.

Date, XS #	Top Width (feet)	Streamflow (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
07/16/2019, 1	8.20	5.52	0.84	1.46
07/23/2019, 1	4.31	4.43	0.58	0.82
07/12/2023, 1	6.98	2.72	0.76	1.56
			0.73	1.28

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

0.3 cfs is recommended from April 1 to April 30 and mimics flow initiation; this flow rate is reduced due to water availability limitations. This flow rate will maintain sufficient depth and wetted perimeter for movement of greenback cutthroat as they transition from overwintering conditions to more activity as snowmelt begins.

1.0 cfs is recommended from May 1 to May 31; this flow rate is reduced due to water availability limitations. These hydraulic conditions will support trout as they transition to more metabolic activity as flows rise during the beginning of spring runoff.

1.3 cfs is recommended from June 1 to June 30; this flow rate meets all three hydraulic criteria; maintaining adequate depth, velocity, and wetted perimeter at all riffle cross-sections. This flow rate will support ideal conditions for feeding and spawning as the Greenback trout mature and grow.

0.8 cfs is recommended from July 1 to July 31; this flow rate is reduced due to water availability limitations. This flow rate maintains adequate depth, velocity, and wetted perimeter at most riffle cross-sections. This flow rate will support beneficial conditions for feeding and spawning and will maintain suitable resting habitats.

0.25 cfs is recommended from August 1 to August 31; this flow rate is reduced due to water availability limitations but will maintain sufficient depth and wetted perimeter. Sufficient resting habitats will be maintained.

0.1 cfs is recommended from September 1 to March 31 to protect baseflow conditions; this flow rate is reduced due to water availability limitations. This flow rate will provide sufficient wetted perimeter for yearling and age one cutthroat trout during the fall and into overwintering periods.

WATER AVAILABILITY

CWCB staff conducts hydrologic analyses for each recommended ISF appropriation to provide the Board with a basis for determining 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.). This approach focuses on streamflow 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) are used to evaluate streamflow. Other streamflow information such as short-term gages, temporary gages, spot streamflow measurements, diversion records, and regression-based models are used when long-term gage data is not available. CSUFlow18 is a multiple regression model developed by Colorado State University researchers using streamflow gage data collected between 2001 and 2018 (Eurich et al., 2021). This model estimates mean-monthly streamflow based on drainage basin area, basin terrain variables, and average basin precipitation and snow persistence. Diversion records are 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 from gage records; 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 Square Top Creek is 0.89 square miles, with an average elevation of 12,188 feet and average annual precipitation of 27.09 inches (See the Hydrologic Features Map). Square Top Creek is a high elevation, steep gradient, snowmelt driven hydrologic system. The reach experiences variable timing and magnitude of snowmelt, often peaking in mid-summer and maintaining higher flows late into the streamflow generation season.

Water Rights Assessment
There are no diversions within the reach of Square Top Creek recommended for an ISF. In 2017 CWCB appropriated NLL water rights on Upper and Lower Square Top Lakes which are located upstream from the proposed ISF on Square Top Creek (case number 17CW3189).

Data Collection and Analysis
Representative Gage Analysis
There are no current or historic gages on Square Top Creek. Staff investigated nearby gages for similarities in basin characteristics and hydrology. No gages were sufficiently similar to be used to estimate streamflow on Square Top Creek.

Multiple Regression Model
The CSUFlow18 regression model predicts mean-monthly flow in Square Top Creek and provides a conservative estimate for streamflow conditions. CPW's site specific knowledge of the reach as well as multiple field visits suggest that this model may underrepresent the amount and timing of water that is available in this reach.

CWCB staff made two streamflow measurements on the proposed reach of Square Top Creek as summarized in Table 3.

Table 3. Summary of streamflow measurements for Square Top Creek.

Visit Date	Flow (cfs)	Collector
07/11/2016	2.04	CWCB
07/23/2019	3.84	CWCB

Water Availability Summary
The hydrograph shows CSUFlow18 results for mean-monthly streamflow and includes the proposed ISF rate (See Complete Hydrograph). The proposed ISF flow rate is below the mean-monthly streamflow. Staff has concluded that water is available for appropriation.

MATERIAL INJURY
Because the proposed ISF on Square Top 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., the CWCB will recognize any uses or exchanges of water in existence on the date this ISF water right is appropriated.

ADDITIONAL INFORMATION

Citations
Colorado Water Conservation Board, 2022, R2Cross model- user's manual and technical guide. Retrieve from URL: https://r2cross.erams.com/

Eurich, A., Kampf, S.K., Hammond, J.C., Ross, M., Willi, K., Vorster, A.G. and Pulver, B., 2021, Predicting mean annual and mean monthly streamflow in Colorado ungauged basins, River Research and Applications, 37(4), 569-578.

Espegren, G.D., 1996, Development of instream flow recommendations in Colorado using R2CROSS, Colorado Water Conservation Board.

Ferguson, R.I., 2007. Flow resistance equations for gravel- and boulder-bed streams. Water Resources Research 43. https://doi.org/10.1029/2006WR005422

Ferguson, R.I., 2021. Roughness calibration to improve flow predictions in coarse-bed streams. Water Res 57. https://doi.org/10.1029/2021WR029979

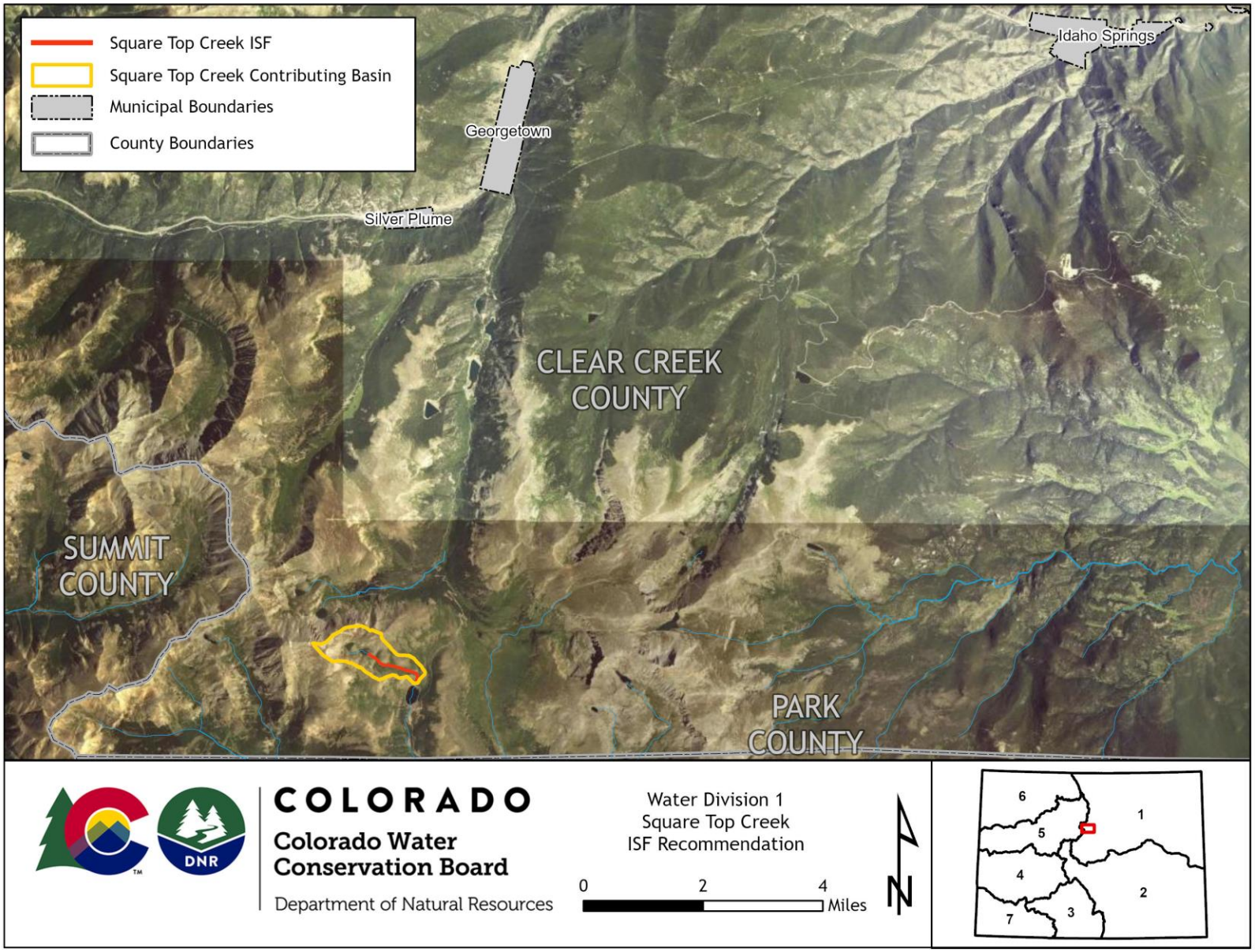
Nehring, B.R., 1979, Evaluation of instream flow methods and determination of water quantity needs for streams in the state of Colorado, Colorado Division of Wildlife.

Metadata Descriptions

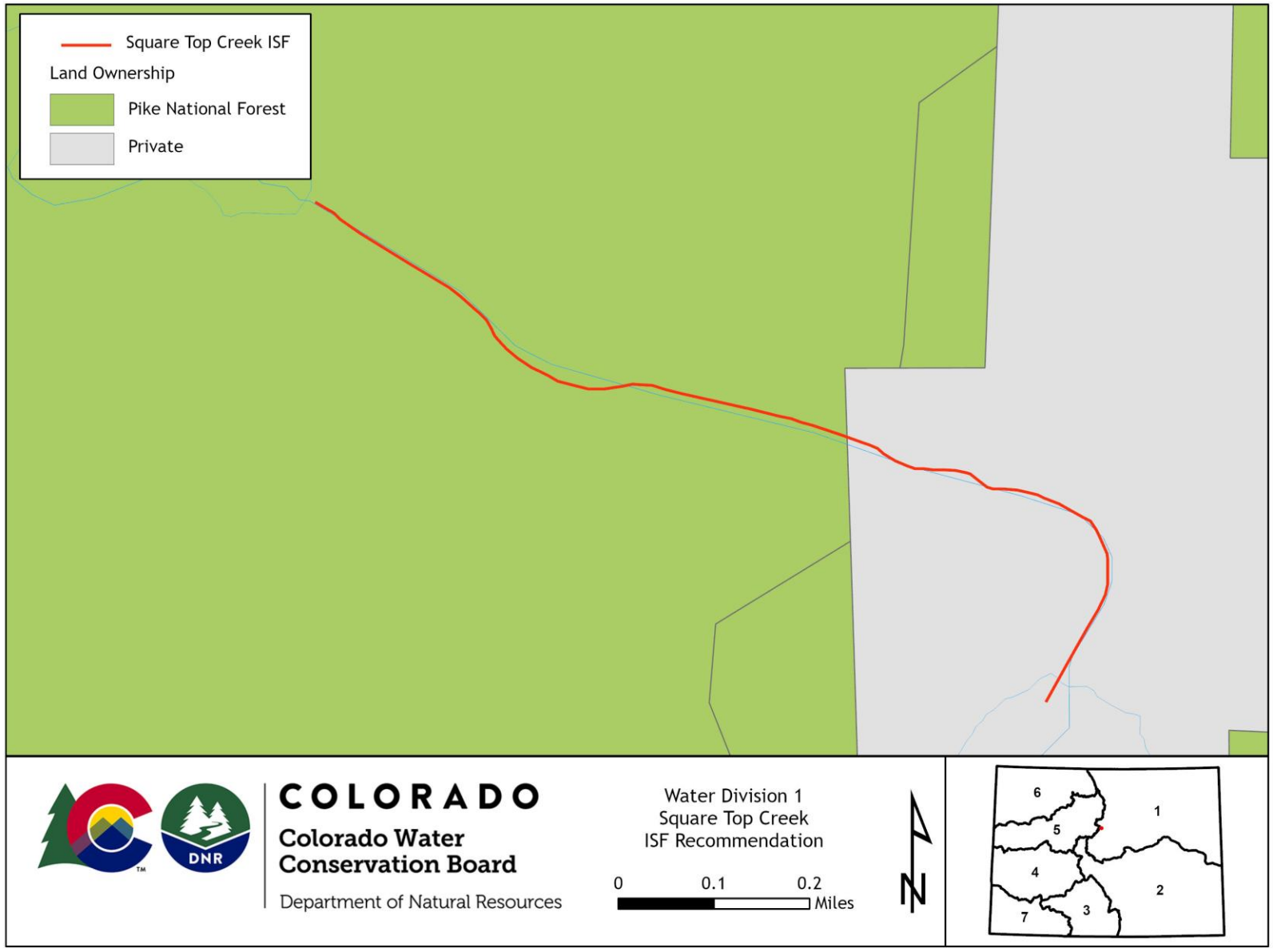
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

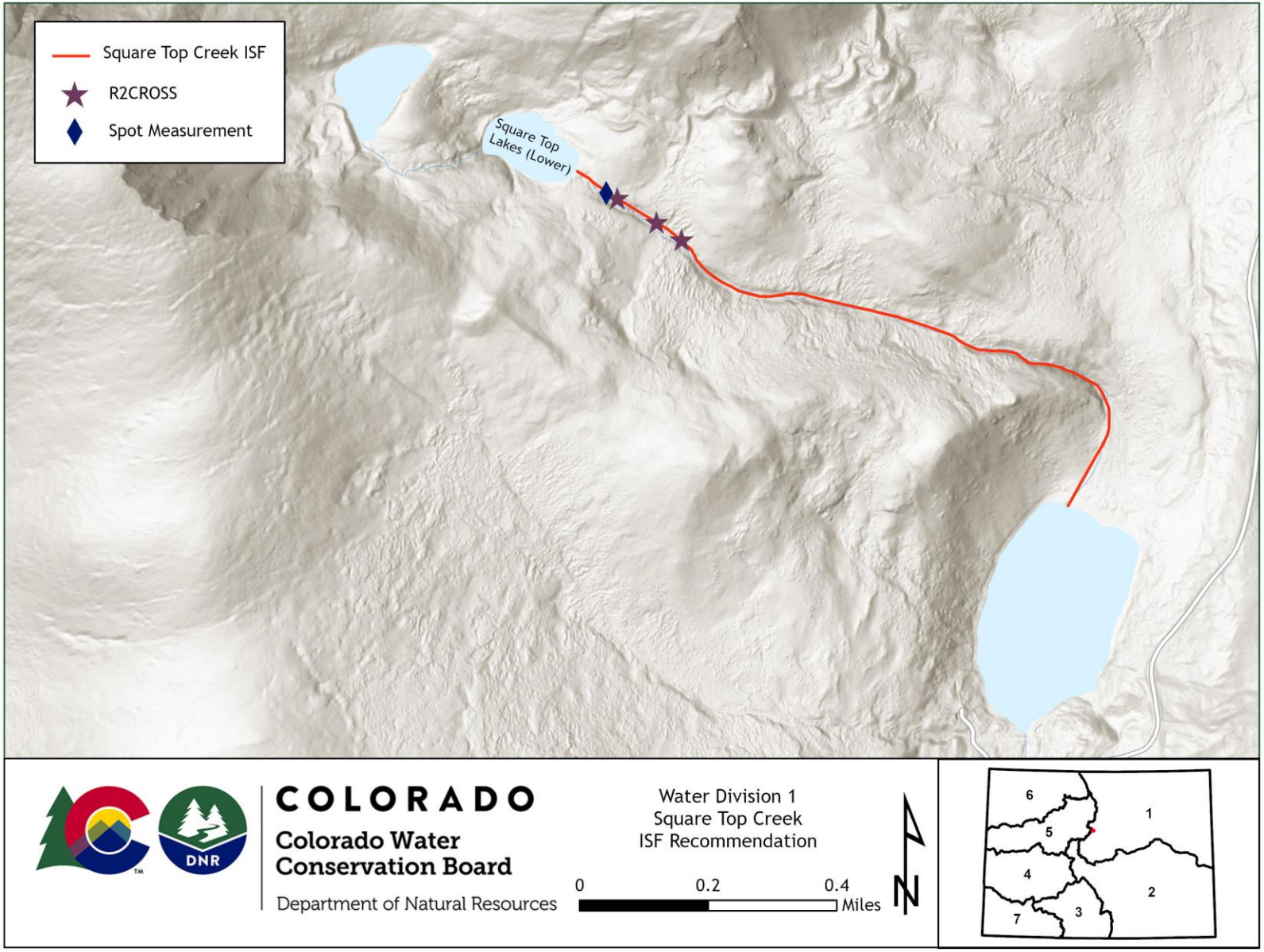
VICINITY MAP



LAND OWNERSHIP MAP



HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH