East Fork Arkansas River Executive Summary

CWCB STAFF INSTREAM FLOW RECOMMENDATION
March 10, 2021

UPPER TERMINUS:	headwaters in the vicinity of UTM North: 4353749.78 UTM East: 399540.97
LOWER TERMINUS:	confluence Chalk Creek UTM North: 4356126.94 UTM East: 394793.07
WATER DIVISION:	2
WATER DISTRICT:	11
COUNTY:	Lake
WATERSHED:	Arkansas Headwaters
CWCB ID:	20/2/A-001
RECOMMENDER:	Bureau of Land Management (BLM)
LENGTH:	6.46 miles
FLOW RECOMMENDATION:	0.25 cfs (12/16 - 04/30) 7 cfs (05/01 - 07/31) 2.8 cfs (08/01 - 09/20) 0.7 cfs (09/21 – 12/15)

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.

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.

Recommended ISF Reach
The Bureau of Land Management (BLM) recommended that the CWCB appropriate an ISF water right on a reach of the East Fork Arkansas River because it has a natural environment that can be preserved to a reasonable degree. The proposed reach extends from the East Fork Arkansas River's headwaters downstream to confluence with Chalk Creek. The CWCB holds an existing ISF on the East Fork Arkansas from the confluence of Chalk Creek down to the confluence with Tennessee Creek. The East Fork Arkansas River is located within Lake County (See Vicinity Map), and originates on the south flank of Mount Arkansas at an elevation of approximately 12,500 feet. It flows 20.5 miles to the confluence with Tennessee Creek at an elevation of approximately 9,740 feet. Fifty-seven percent of the land on the 6.46 mile proposed reach is privately owned, 10% is owned by the BLM and 33% is owned by the U.S. Forest Service (See Land Ownership Map). The largest private landowner is the Climax Molybdenum Company.

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.

The East Fork Arkansas River is a cold water stream that runs through a high elevation mountain valley with a moderate to high gradient. The floor of the valley is approximately half a mile wide with patches of bedrock outcroppings and alluvial deposits. The stream runs through alternating reaches of bedrock and alluvial deposits and has a variety of habitats that are good for aquatic community diversity. Substrate in the reaches with bedrock controls tends to have large boulders up to two feet in diameter. In the reaches running through alluvial deposits, there are more riffles and the substrate consists primarily of gravels and cobbles up to six inches in diameter.

Restoration work has been completed in sections of the East Fork Arkansas, particularly in the vicinity of the Climax Molybdenum mine, which has improved the riparian community and bank

stability. The riparian community includes willow, spruce, river birch, and sedges. There is also good floodplain connectivity supporting wetland communities.

Surveys completed by the BLM and Colorado Parks and Wildlife have found self-supporting populations of brook trout. Fish have been regularly sighted at the location of CWCB's temporary stream gage. Macroinvertebrate populations of mayfly, stonefly, and caddisfly have also been observed.

Table 1. List of species identified in East Fork Arkansas River.

Species Name	Scientific Name	Protection Status
brook trout	*Salvelinus fontinalis*	None
blue-winged olive mayfly	*Baetis spp.*	None
stonefly	*Plecoptera*	None
caddisfly	*Trichoptera*	None
willow	*Salix spp.*	None
spruce	*Picea spp.*	None
river birch	*Betula nigra*	None
sedge	*Carex*	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

BLM 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). BLM 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

The BLM collected R2Cross data 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 2.80 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 7.02 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 East Fork Arkansas River.

Date, Xsec #	Top Width (feet)	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
09/17/2018, 1	22.77	1.62	0.65 - 4.05	2.80	Out of range
08/08/2017, 1	27.83	17.50	7.00 - 43.75	Out of range	7.02
			Mean	2.80	7.02

ISF Recommendation

The BLM recommended flow rates of 7.0 cfs from May 1 to July 31, 2.8 cfs from August 1 to September 30, and 1.2 cfs from October 1 to April 30 based on R2Cross results and a preliminary water availability analysis. The BLM recommendation was modified by staff as a result of water availability. The final recommended flow rates are as follows:

7.0 cfs from May 1 to July 31. This recommendation is driven by the average depth criteria. Given the small amount of riffle habitat in this reach, it is important to provide depths that are suitable for trout that are spawning in riffles during the snowmelt runoff period.

2.8 cfs from August 1 to September 20. This recommendation is driven by the average velocity criteria. This flow rate will maintain sufficient physical habitat in the creek for the fish population to complete important parts of their life cycle before cold temperatures reduce fish activity for the winter.

0.7 cfs from September 21 to December 15. This flow rate was driven by water availability limitations.

0.25 cfs from December 16 to April 30. This flow rate was driven by 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.

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 East Fork Arkansas River is 7.42 square miles, with an average elevation of 11,956 feet and average annual precipitation of 27.74 inches (See the Hydrologic Features Map). Climax Molybdenum Company (Climax) owns and mines on a portion of the drainage basin and uses East Fork Arkansas River diversions to assist with its operations. There are no other surface water diversions in the proposed reach.

Climax operates three transbasin diversions (Table 3) that divert water from the East Fork Arkansas drainage and release it in the Ten Mile Creek drainage. These transbasin diversions are operated year round. Diversions from each of these rights, which are made from off channel ponds, do not dry up the stream, according to Climax personnel (personal communication, 12/9/20). There are no significant tributaries between the Climax Mine diversions and the

proposed lower terminus. Due to these transbasin diversions, hydrology in this drainage basin does not represent natural flow conditions.

Table 3. Structures located within the proposed ISF reach on East Fork Arkansas Creek.

WDID	Structure Name	Total Decreed Flow Rate, cfs	Appropriation Dates
1101223	Storke Wastewater Pumpstation	10	2012
1100759	Stevens and Leitner	1.086 maximum allowable transbasin use	1873
3604677	Climax Domestic* Pipeline	unknown	

*This structure is listed in Hydrobase and was discussed by personnel from Climax, but Staff has been unable to determine the flow rate associated with this structure.

Staff spoke with Climax personnel (Aaron Hilshorst, Manager of Land and Water Resources and Emmanuel Orilogi, Engineer) regarding the mine's operations in the East Fork Arkansas drainage area in December of 2020. The Storke Wastewater Pumpstation collects impacted snowmelt runoff and stormwater from 93.3 acres of mine land and diverts impaired water into the Ten Mile Creek drainage basin for treatment and release. Due to the junior nature of this right, replacements are made through a number of sources; however, the upstream most replacement location is at the lower terminus of the proposed ISF reach. Additionally, Climax operates the Stevens and Leiter Well, also commonly known as the Arkansas Well, and Climax Domestic Pipeline, which are also transbasin diversions to the Ten Mile Creek drainage basin.

According to accounting for 2017-2020 submitted to the Division of Water Resources, the Storke Wastewater Pumpstation operates year round. During runoff when the pumpstation appears to be running constantly, the peak median diversion was 2.6 AF per day. Starting in July and continuing through the fall, median diversions were less than 0.5 AF per day. Diversions during winter (approximately November through April), are made very infrequently and typically at rates less than 0.1 AF per day.

The Stevens and Leiter Well is allowed a maximum of 1.086 cfs of transbasin diversions according to its decree. Monthly diversion records from 2017-2020 show that this right is exercised year round. The Climax Domestic Pipeline is used for domestic purposes at the mine's mill in the Ten Mile Creek drainage basin. According to monthly diversion records on CDSS, the Climax Domestic Pipeline operates year round with average monthly diversions ranging from 35.8 AF to 20.9 AF.

Available Data and Analysis

CWCB Gage and Staff Measurements

There are no current or historical gages on the proposed ISF reach. Due to limited available data, CWCB staff installed a temporary streamflow gage on the East Fork Arkansas River located approximately 0.1 miles upstream from the proposed lower terminus. The temporary gage has operated since July of 2019. This gage location records the impact from consumptive uses in the basin (in other words, water lost to transbasin use is reflected in the gage data). Due to the short period of record, median streamflow was not calculated on a daily basis. However, median winter flows were calculated from November 1st to April 30th to assess baseflows, which are typically fairly consistent.

Due to the short period of record, staff examined a nearby streamgage to assess how 2019 and 2020 compared hydrologically to a longer record. The East Fork Arkansas River at US HWY 24, near Leadville, CO (USGS 07079300) gage is located approximately 6.9 miles southwest from the lower terminus. The gage record is from 1990 to present. The gage is affected by diversions, including transbasin imports, but because it is not affected by reservoir releases, it is adequate for evaluating annual hydrologic patterns. Based on this analysis, 2019 had the fourth highest total annual streamflow volume on record. 2020 was in the 25th percentile for total annual streamflow. Staff also computed median flows at the East Fork Arkansas gage and compared them to flows from 2019 and 2020. Due to a prolonged and above average snowpack, the 2019 runoff was delayed compared to most years. Runoff did not start until June 1 and the higher than normal peak occurred on June 30. Flows remained above median for the majority of the summer. However, due to a dry summer and fall, 2019 flows quickly dropped back down to median around September. The 2020 runoff and peak flows occurred approximately in line with the median record, but dry conditions caused flows to drop below median starting on June 8.

CWCB staff made eight streamflow measurements to support development of a rating curve for the temporary gage and provide additional information.

Table 4. Summary of Streamflow Measurement Visits and Results for East Fork Arkansas River.

Visit Date	Flow (cfs)	Collector
07/17/2019	72.58	CWCB
08/13/2019	20.11	CWCB
10/09/2019	2.02	CWCB
07/13/2020	18.43	CWCB
08/05/2020	8.79	CWCB
09/23/2020	3.89	CWCB
12/08/2020	0.74	CWCB
02/01/2021	0.42	CWCB

Water Availability Summary

The hydrographs below show streamflow data, streamflow measurements, and the proposed ISF. With the exception of short timeframes during the winter, the temporary gage data demonstrates that the recommended flow rates occur during the proposed timeframes in 2020 (an exceptionally dry year), leading staff to believe that these proposed flow rates are available in most years. In addition, baseflows typically remains consistent from year to year. Staff relied on the 2019-2020 winter baseflows to determine winter water availability. The median daily average flow during the winter recommendation timeframe (December 16 to April 30) was 0.3 cfs, which is higher than the 0.25 cfs recommended flow rate. Staff has concluded that water is available for appropriation.

Material Injury
Because the proposed ISF on East Fork Arkansas River 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.

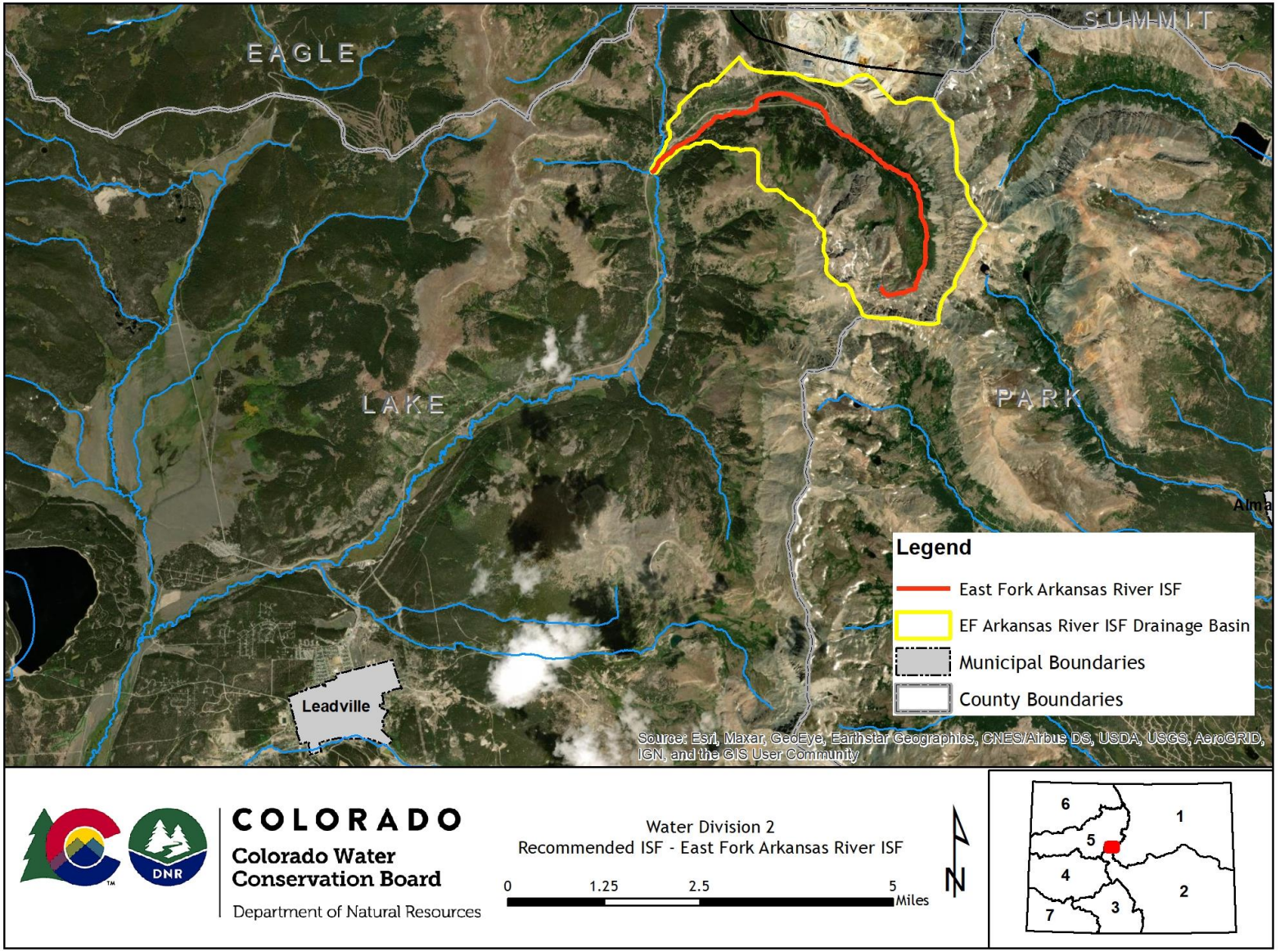
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

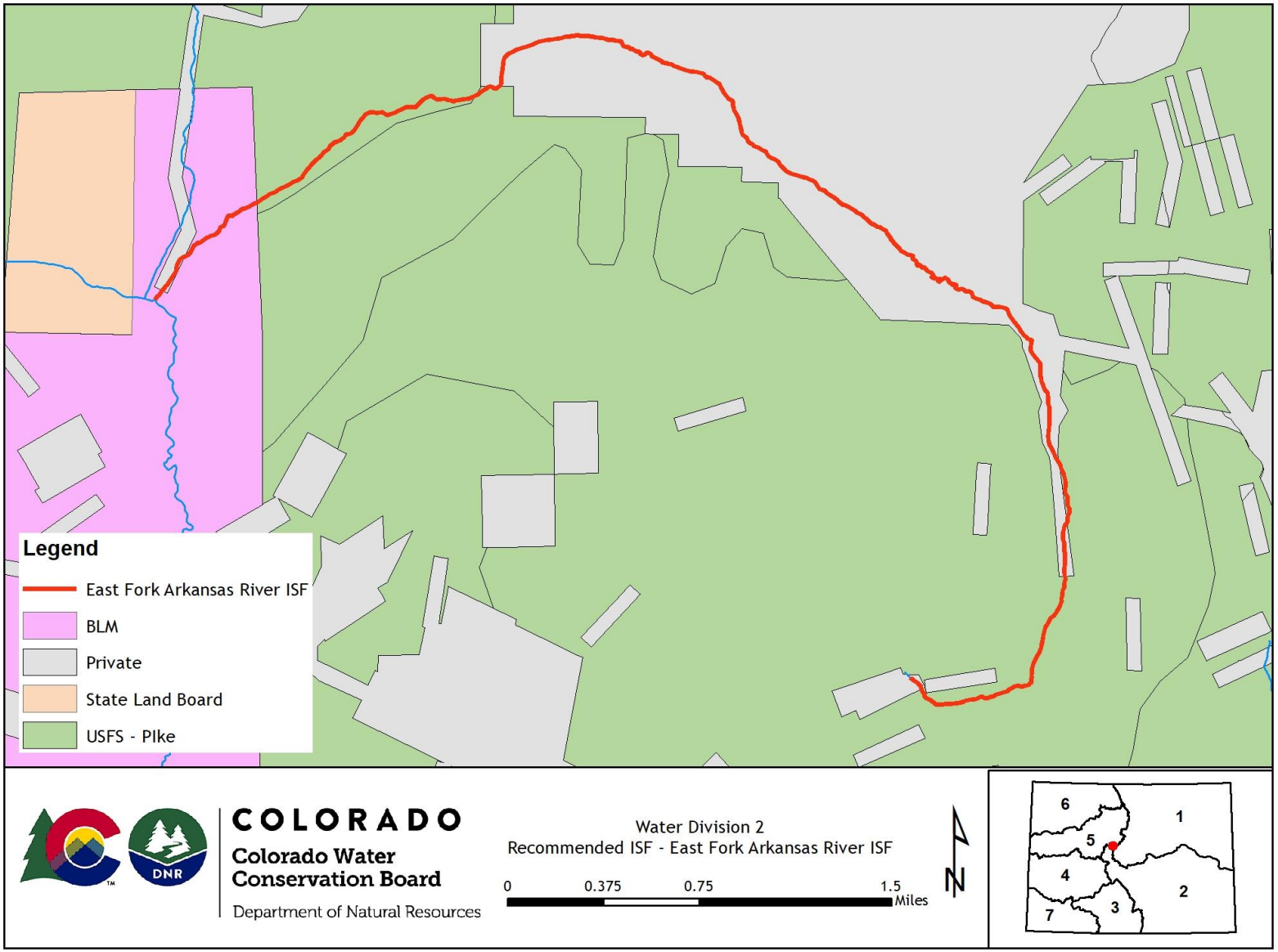
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

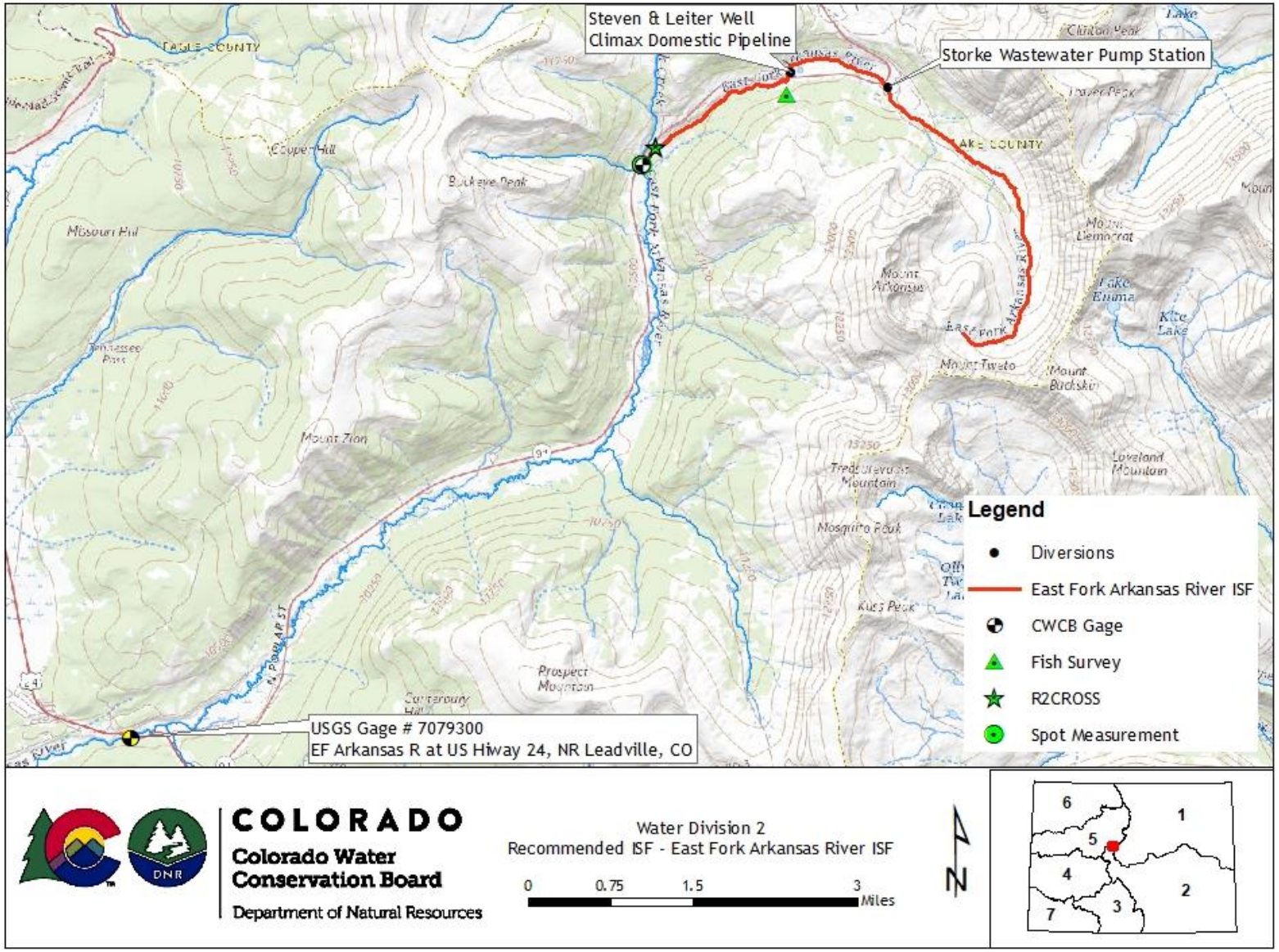
VICINITY MAP



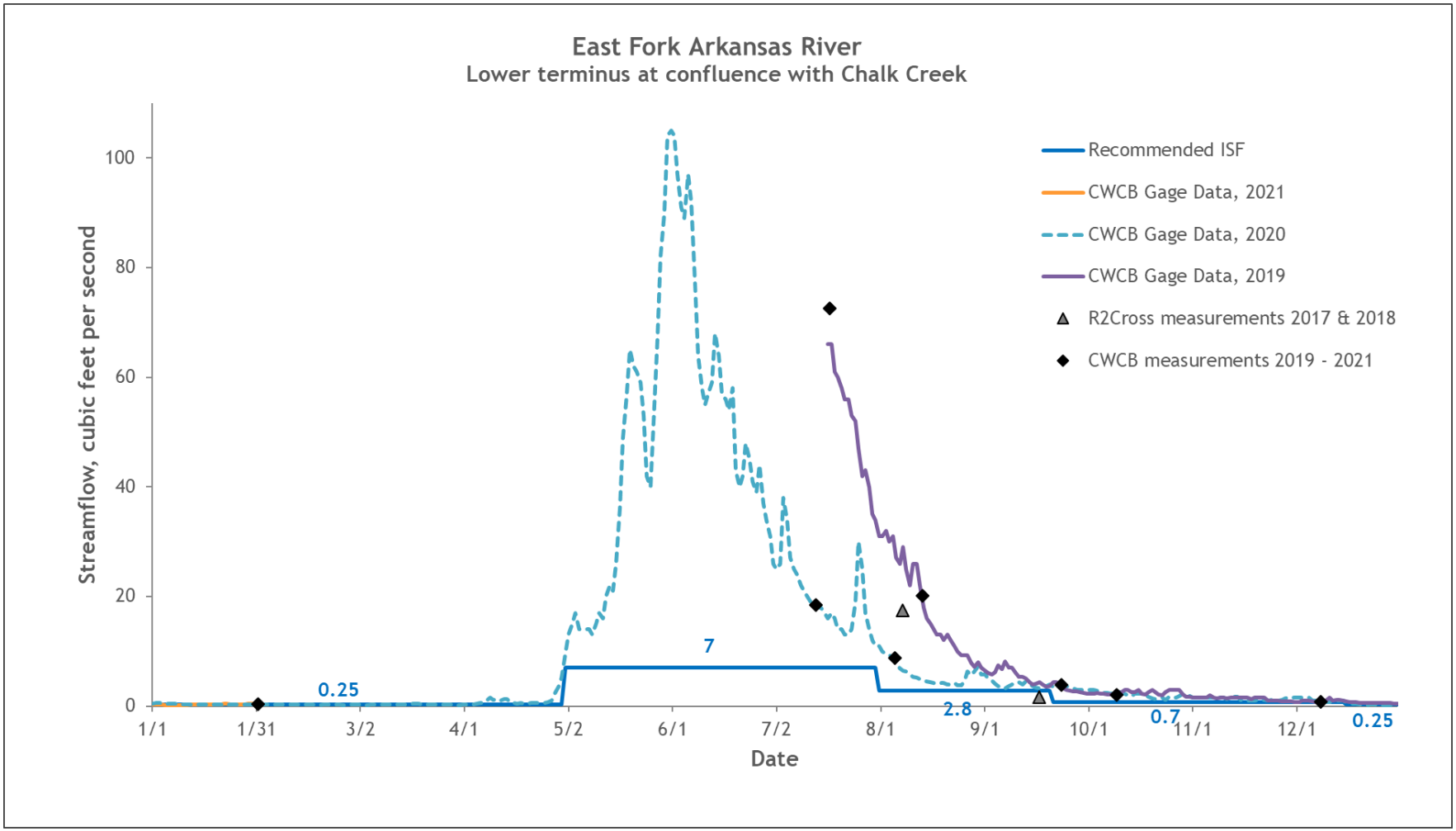
LAND OWNERSHIP MAP



HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



DETAILED HYDROGRAPH