West Muddy Creek Executive Summary

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	confluence with Sheep Creek at UTM North: 4325599.99 UTM East: 286097.65
LOWER TERMINUS:	confluence with Muddy Creek at UTM North: 4319399.06 UTM East: 295770.58
WATER DIVISION/DISTRICT:	4/40
COUNTY:	Gunnison
WATERSHED:	North Fork Gunnison
CWCB ID:	21/4/A-011
RECOMMENDER:	Bureau of Land Management (BLM)
LENGTH:	8.78 miles
FLOW RECOMMENDATION:	5.1 cfs (08/01 - 03/15) 12.9 cfs (03/16 - 06/30) 8.0 cfs (07/01 - 07/31)

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

The BLM recommended that the CWCB appropriate an ISF water right on a reach of West Muddy Creek at the January 2020 ISF workshop. West Muddy Creek is located within Gunnison County (See Vicinity Map), and is approximately 17 miles northeast of Paonia, CO. The stream originates on the eastern slope of Chalk Mountain and flows southeast until it reaches the confluence with East Muddy Creek, a tributary of Muddy Creek, a tributary to the North Fork Gunnison River, which is tributary to the Gunnison River.

The proposed ISF reach extends from the confluence with Sheep Creek downstream to the confluence with Muddy Creek for a total of 8.78 miles. Twelve percent of the land on the proposed reach is BLM, 30% is managed by the United States Forest Service and 58% is privately owned (See Land Ownership Map). BLM is interested in protecting this stream to preserve the natural environment in and around Gunnison County. BLM's management goals include maintaining and enhancing habitat that supports fish species and functional riparian and wetland systems. Establishing an ISF water rights will assist in meeting these BLM objectives.

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 West Muddy Creek was sent to the mailing list in November 2023, March 2023, March 2022, March 2021, and March 2020. Staff sent letters to identified landowners adjacent to West Muddy Creek based on information from the county assessor's website. A public notice about this recommendation was also published in the Crested Butte News on January 5, 2024.

Staff presented information about the ISF program and this recommendation to the Gunnison County Board of County Commissioners on November 10, 2020, September 13, 2022, and October 24, 2023. Staff met with Luke Reschke, District 40 Lead Water Commissioner, and Doug Christner, District 40 Water Commissioner, on September 26, 2023 to better understand the administration on West Muddy Creek and its tributaries. In addition, CWCB staff and BLM staff met with stakeholders from the area on November 28, 2023. This included a presentation on

the West Muddy and East Muddy Creek ISF recommendations and discussions and questions about the purpose of ISF protection, stock uses, water availablity, and other concerns.

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.

West Muddy Creek is a cool-water, moderate gradient stream. The upper four miles of the reach flow through a valley approximately 0.5 miles in width with some meadows and irrigated fields. The lower four miles flow through a narrow mountain valley approximately 0.25 miles in width. The stream cuts through alluvial deposits in some locations and is constrained by bedrock in locations where the stream comes close to valley walls. The upper four miles of the creek generally has medium sized substrate, ranging from silt to one-foot boulders, while the lower four miles of the creek generally have large-sized substrate, ranging from small cobbles to two-foot boulders. The stream has a good mix of pool and riffle habitat for supporting native fish species.

Fisheries surveys have revealed self-sustaining populations of bluehead suckers, speckled dace, and mottled sculpin, all of which are native species (Table 1). Bluehead suckers appear on BLM's sensitive species list, and BLM is a signatory to a multi-party, multi-state conservation agreement for that species that is designed to prevent a listing of bluehead suckers under the Endangered Species Act. The stream also supports self-sustaining populations of brook trout, rainbow trout, and white suckers, all of which are introduced species. Northern leopard frogs (see photo below), which also appear on BLM's sensitive species list, have been documented along the creek.

Table 1. List of species identified in West Muddy Creek.

Species Name	Scientific Name	Status
brook trout	*Salvelinus fontinalis*	None
white-blue sucker hybrid	*Catostomus commersoni x discobolus*	None
bluehead sucker	*Catostomus discobolus*	State - Species of Greatest Conservation Need
mottled sculpin	*Cottus bairdii*	None
speckled dace	*Rhinichthys osculus*	None
rainbow trout	*Oncorhynchus mykiss*	None
northern leopard frog	*Rana pipiens*	State - Species of Greatest Conservation Need State - Species of Special Concern

West Muddy Creek, northern leopard frog

The riparian community in this part of West Muddy Creek is mostly comprised of willow species, alder, narrowleaf cottonwood and spruce. In general, the riparian community is in good condition, provides substantial shading and cover for fish habitat, and provides stream stability during flood events.

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

BLM 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). BLM 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
BLM collected R2Cross data at five 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 5.45 cfs and a summer flow of 12.91 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 West Muddy Creek.

Date, XS #	Top Width (feet)	Streamflow (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
06/01/2018, 1	33.50	4.73	3.28	10.08
06/01/2018, 2	33.49	5.82	4.41	12.34
05/11/2021, 1	47.04	33.34	7.43	19.16
08/06/2021, 1	30.13	4.57	3.39	13.65
08/06/2021, 2	36.16	4.57	8.75	9.30
			5.45	12.91

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

5.1 cfs is recommended from August 1 to March 15; this flow rate is reduced due to water availability limitations. This flow rate comes very close to meeting two of the three instream flow criteria in the cross-sections analyzed. This flow rate should maintain sufficiently cool temperatures in pools during late summer and should prevent icing in pools during the winter.

12.9 cfs is recommended from March 16 to June 30 to meet three of three criteria. This recommendation is for the snowmelt runoff period and is driven by the average velocity criteria.

8.0 cfs is recommended from July 1 to July 31; this flow rate is reduced due to water availability limitations. This rate provides the maximum amount of physical habitat possible to the fish community consistent with water availability constraints, which is important objective during this high growth period.

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 West Muddy Creek is 97.85 square miles, with an average elevation of 8,751 feet and average annual precipitation of 24.88 inches (See the Hydrologic Features Map). West Muddy Creek is a cold-water, moderate gradient snowmelt driven hydrologic system with influence from mid-season monsoonal periods. Run off initiates in early April and generally reaches peak flow conditions by early to mid-May. Streamflow conditions are generally lowest in August and September during late summer. Hydrology is altered by both irrigation practices and reservoir storage and releases.

Water Rights Assessment
There are 48 active water rights on West Muddy Creek and its tributaries. These include up to 120 cfs of direct flow ditch diversions, with seasonal limitations, and 6,450 acre-feet of reservoir storage. There are also two ISF water rights within the basin, one on an upper reach of West Muddy Creek from the headwaters to the confluence with Cow Creek (case number 84CW0411) the other on Dyke Creek, a tributary to the upper reach of West Muddy Creek (case number 04CW0157).

The Overland Reservoir (WDID 4003399) is located relatively high in the system on Cow Creek, a tributary to West Muddy Creek. The Overland Reservoir is decreed for 6,200 acre feet of the

above-mentioned storage rights and stores water from Cow Creek which is exported for irrigation and stock uses outside of the West Muddy basin. Exported water from the Cow Creek basin is recorded in diversion records from the Overland Ditch "Cow Creek" (WDID 4000585). Between 2017 and 2023 diversion records show that between 84.3 (2018) and 4952.01 (2017) acre feet is exported typically from April to October. By late July or early August, the Overland Ditch on Cow Creek is no longer in priority and all natural streamflow from Cow Creek continues downstream to Paonia Reservoir via West Muddy Creek (personal communication, Water Commissioner Luke Reschke, 9/26/2023 and 1/03/2024).

The North Fork Gunnison River is often under administration with calls extending up both West and East Muddy Creek. The priority calling dates are typically in the late 1800s to early 1900's, but the exact priority can shift through the season. Typically, the call is on by late-July, but some calls have occurred as early as June. North Fork Water Conservancy District was decreed multiple points of exchange upstream of Paonia Reservoir in case number 05CW0236, with up to a volumetric limit of 2,000 acre feet. According to Water Commissioner Luke Reschke, in most years this exchange starts towards the end of July and the seasonal limit is reached by early to mid-September (personal communication, 9/26/2023 and 1/03/2024).

Data Collection and Analysis

Representative Gage Analysis

No current or long-term gages exist within the reach extent for the ISF recommendation on West Muddy Creek. There are three historic gages on West Muddy Creek above the confluence with Cow Creek that monitored stream conditions from the mid-1950's though the mid-1970's. Due to the extent of downstream uses on the main channel and tributaries, CWCB staff opted to install a temporary gage at the lower terminus of the current recommended ISF reach on West Muddy Creek.

Gage Analysis

In the absence of representative gage data on West Muddy Creek, CWCB installed a temporary gage (West Muddy gage) at the lower terminus of the reach, 500 feet above the confluence where West Muddy Creek and East Muddy Creek combine to create Muddy Creek. This gage included a Hobo MX2001 pressure transducer recorded at a 15-minute interval that was installed on May 19, 2021 and maintained through present. Gaged West Muddy streamflow data is analyzed through August 15, 2023. The gage was ice affected at times each winter and the pressure transducer failed for two weeks during the rising limb of runoff in 2022. The 2022/2023 winter received less precipitation than the 2023/2024 winter and this is reflected in the hydrographs for each year. In 2022, streamflow peaked in early May at less than 200 cfs and gradually reached baseflow conditions by mid-July. In 2023 streamflow peaked at over 400 cfs, 10 days earlier than 2022 and maintained high flows longer than the previous year. The two years monitored two different hydrologic regimes during the period of record (POR), representing variability in patterns of streamflow generation and timing.

Staff analyzed total streamflow from the Division of Water Resources Muddy Creek above Paonia Reservoir, CO gage (MUDAPRCO) during its POR from 1985 to present to contextualize gaged data on West Muddy gage. MUDAPRCO is located approximately 2,300 ft downstream from the confluence of East and West Muddy Creek. Annual yield at MUDAPRCO shows 2021, 2022 and 2023 were below the 25th percentile yield.

The West Muddy gage was used in conjunction with the MUDAPRCO gage to estimate streamflow for a longer period of record on West Muddy Creek. Staff developed a linear model (LM) by comparing streamflow data from the two gages from 5/19/2021 – 8/15/2023. The two gages have over 450 days of data in common, only these daily data were used in the development of the LM. The resulting model shows the gages are highly correlated with an r^2 value of over 0.95. The estimated West Muddy gage record was developed by applying the LM to the entire MUDAPRCO POR (10/1/1985 – 8/15/2023). The resulting West Muddy Creek streamflow estimates a nearly 40-year POR. This long-term record was then used to calculate daily median streamflow (See Complete and Detailed Hydrographs). Given that the impacts of diversions and reservoir releases are reflected in gage records at West Muddy and at MUDAPRCO, no further adjustments were made.

CWCB staff made 18 streamflow measurements on the proposed reach of West Muddy Creek, in support of rating curve development the West Muddy gage, as summarized in Table 3.

Table 3. Summary of streamflow measurements for West Muddy Creek.

Visit Date	Flow (cfs)	Collector
05/19/2021	33.39	CWCB
06/17/2021	0.35	CWCB
07/17/2021	0.00	CWCB
07/21/2021	0.00	CWCB
08/18/2021	0.62	CWCB
09/14/2021	0.54	CWCB
11/02/2021	2.63	CWCB
02/22/2022	0.50	CWCB
05/05/2022	125.39	CWCB, DWR
05/23/2022	57.57	CWCB
06/23/2022	8.36	CWCB
08/19/2022	3.03	CWCB
09/29/2022	0.93	CWCB
04/20/2023	163.44	CWCB, DWR
06/06/2023	250.00	CWCB
07/27/2023	5.19	CWCB
08/15/2023	0.98	CWCB
11/06/2023	4.48	CWCB

Water Availability Summary

The hydrograph shows estimated median streamflow as described in the temporary gage section above along with the proposed ISF rate (See Complete Hydrograph). The proposed ISF flow rate

is below the median streamflow. Staff has concluded that water is available for appropriation on West Muddy Creek.

MATERIAL INJURY

Because the proposed ISF on West Muddy 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

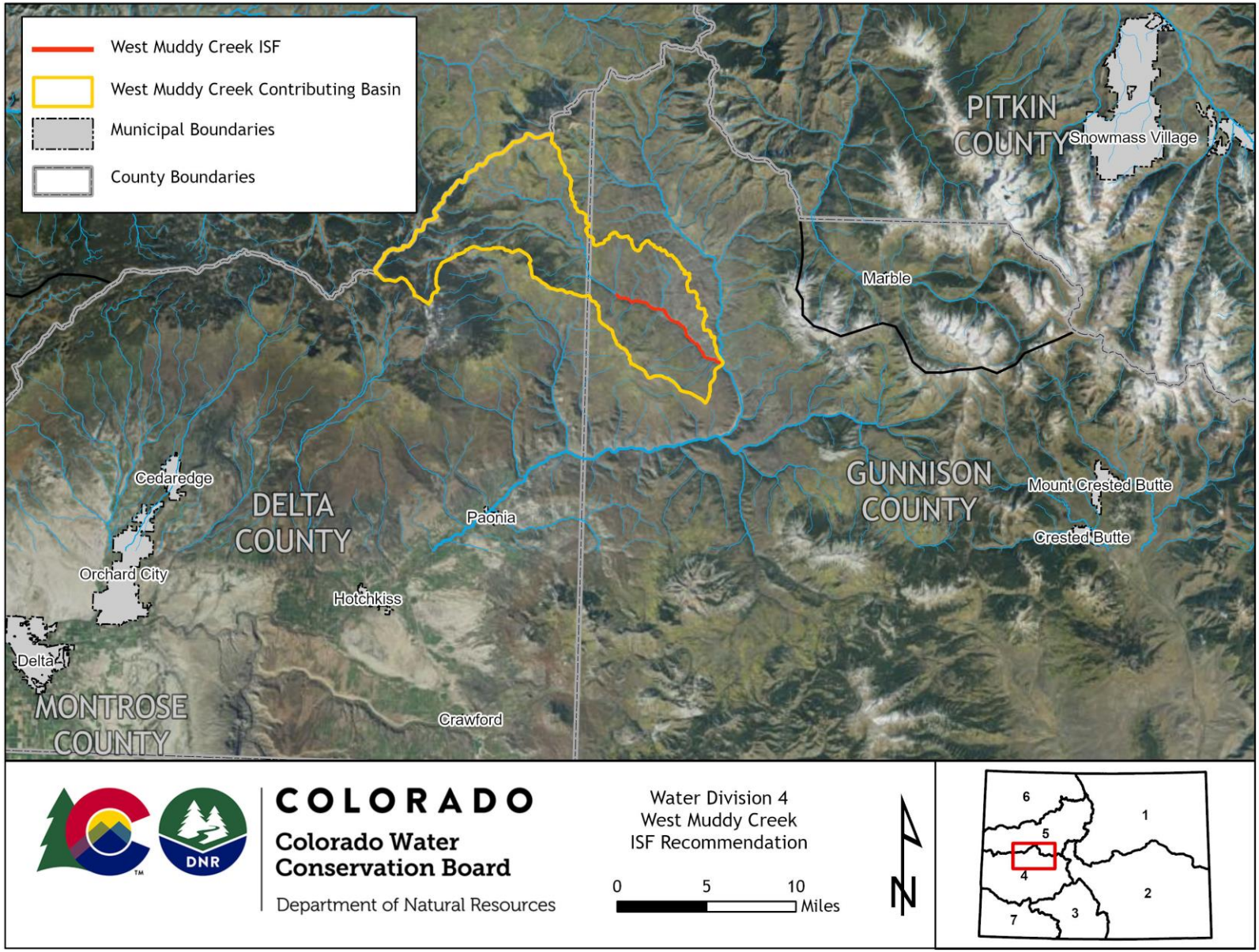
Nehring, B.R., 1979, Evaluation of instream flow methods and determination of water quantity needs for streams in the state of Colorado, Colorado Division of Wildlife.

Metadata Descriptions

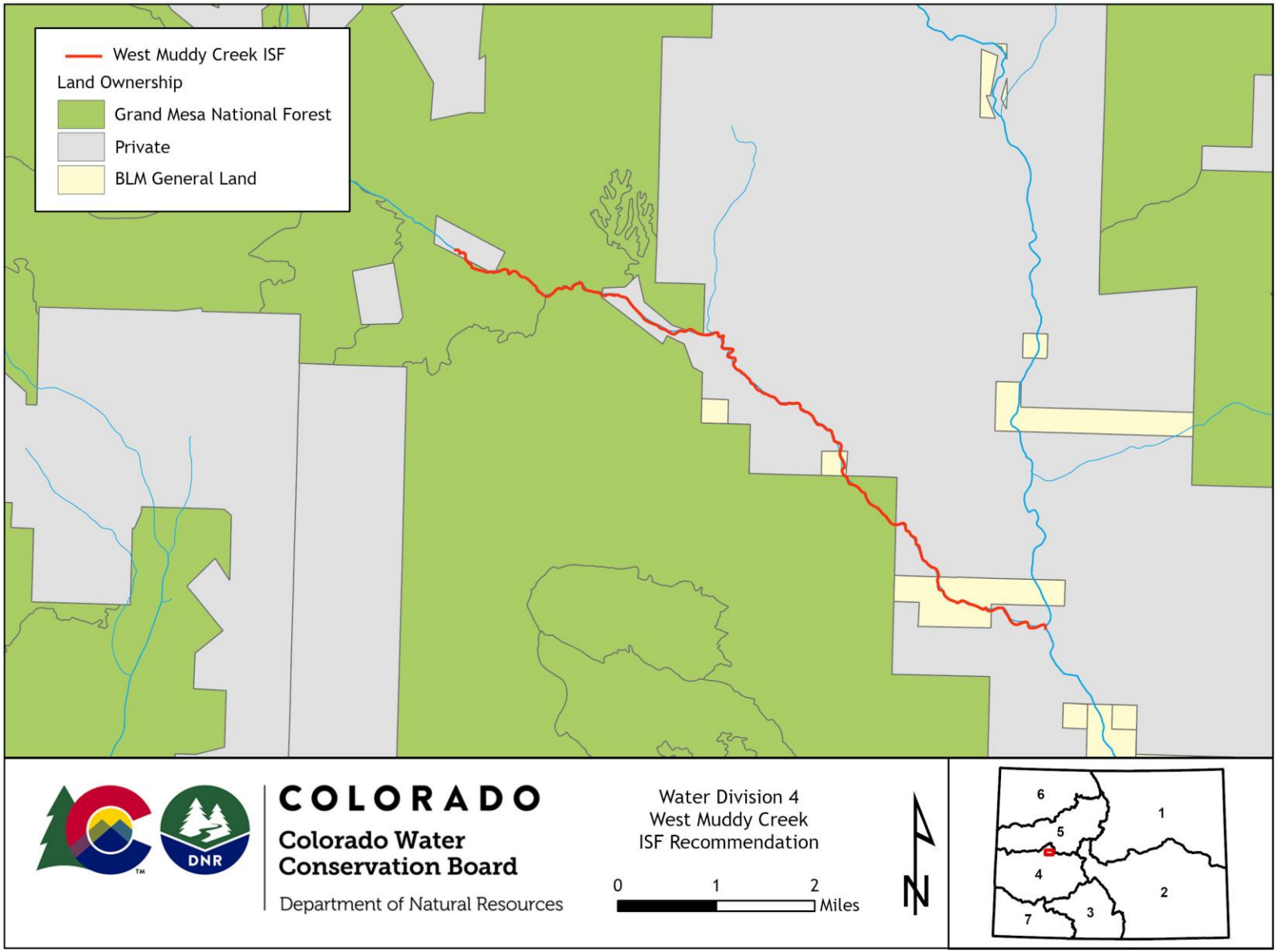
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

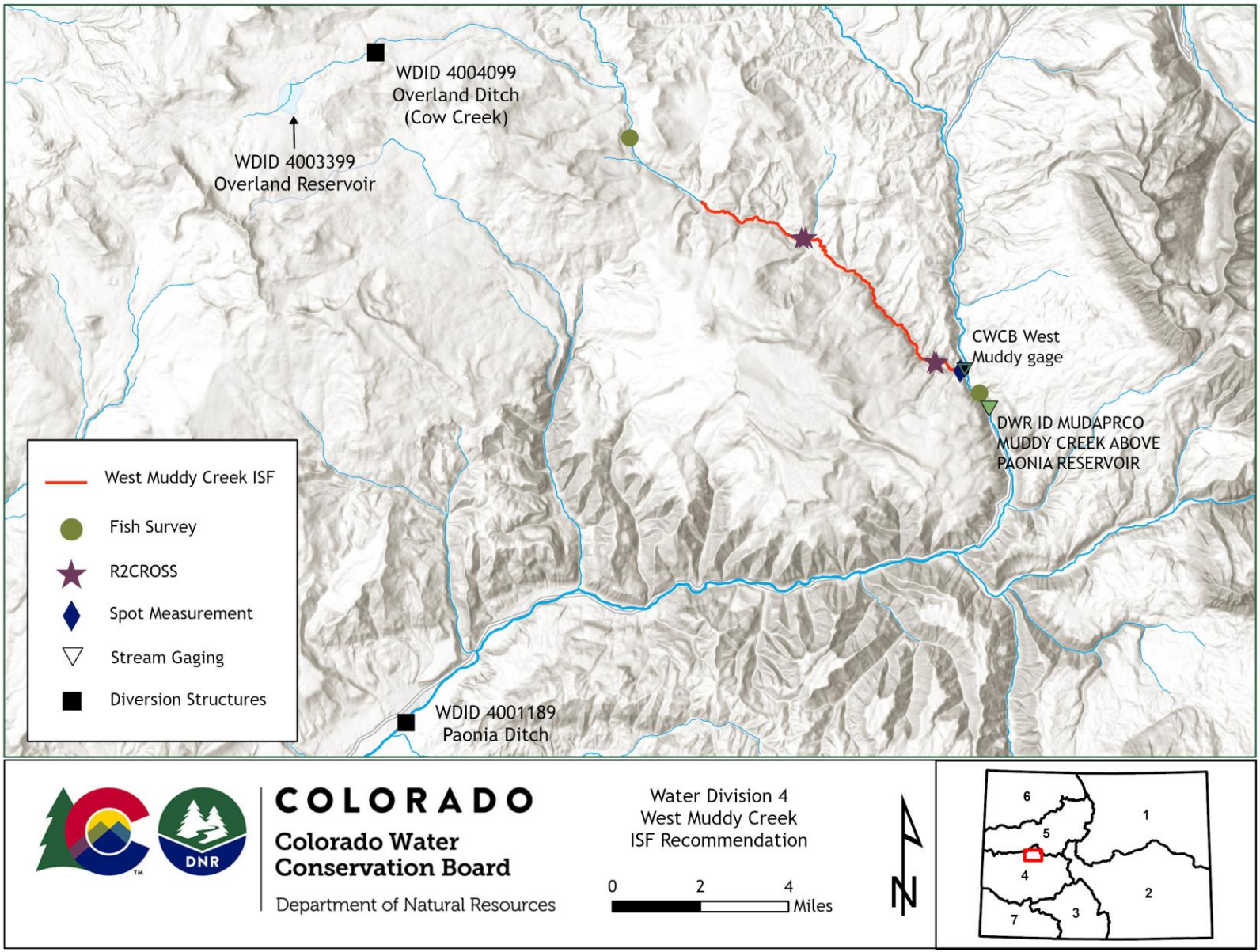
VICINITY MAP



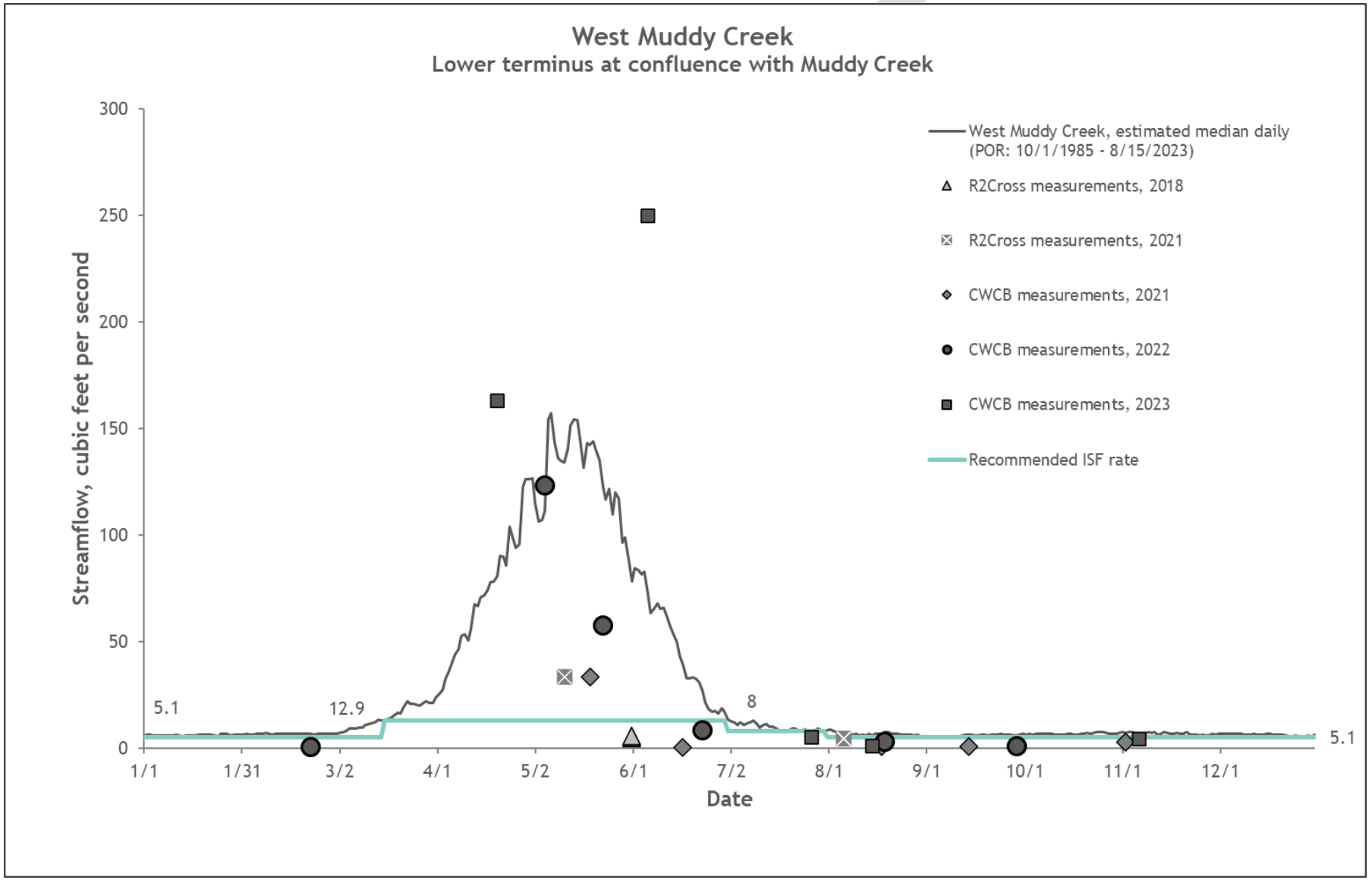
LAND OWNERSHIP MAP



HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



DETAILED HYDROGRAPH