COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Fourmile Creek
EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	Headwaters in the vicinity of UTM North: 4520769.45	UTM East: 296207.17
LOWER TERMINUS:	Norma Ryan Ditch headgate UTM North: 4523918.74	UTM East: 292918.30
WATER DIVISION:	6	
WATER DISTRICT:	54	
COUNTY:	Moffat	
WATERSHED:	Little Snake	
CWCB ID:	17/6/A-003	
RECOMMENDER:	Bureau of Land Management (BLM)	
LENGTH:	3.13 miles	
FLOW RECOMMENDATION:	3.8 (5/1 - 6/30) 0.97 (7/1 - 7/31) 0.41 (8/1 - 3/31) 1.3 (4/1 - 4/30)	

Fourmile 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.

The BLM recommended that the CWCB appropriate an ISF water right on a reach of Fourmile Creek. Fourmile Creek originates on the western flank of Mount Oliphant in the Elkhead Mountains, about 24 miles northeast of Craig at an elevation of approximately 9,600 ft. The creek flows in a northwesterly direction as it drops to an elevation of approximately 6,240 where it joins the Little Snake River. The recommended reach is located within Moffat County (See Vicinity Map) and extends from Fourmile Creek's headwaters downstream to the Norma Ryan Ditch headgate. Forty-eight percent of the land on the 3.13 mile proposed reach is publicly owned and managed by the BLM and U.S. Forest Service; the remaining land is privately held (See Land Use Map). The BLM recommended this reach of Fourmile Creek because it has a natural environment that can be preserved to a reasonable degree with an ISF water right.

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/2017ProposedISFRecommendations.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 the 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.

Fourmile Creek is a cold-water, high gradient stream in a densely forested environment. The stream is confined by bedrock in most locations. The stream generally has medium to large-sized substrate, consisting of cobbles and small boulders. The stream consists mostly of a series of pools broken by short drops and waterfalls. As such, the creek has abundant pool habitat for overwintering fish, but runs and riffle habitat are very limited, which limits reproduction. Abundant beaver ponds also assist in maintaining pool habitat for the fish population.

Fisheries surveys have revealed a self-sustaining population of native cutthroat trout (See Table 1). Genetic testing revealed that the population is a genetically pure population of Yampa River lineage. Colorado Parks and Wildlife has designated the fish in this creek as a core conservation population. Intensive macro-invertebrate surveys have not been conducted, but spot samples have revealed various species of mayfly, caddisfly, and stonefly.

The riparian community is generally comprised of spruce and alder at higher elevation and willow and aspen at lower elevation. The riparian community is in excellent condition, and provides abundant shading and cover for fish habitat.

Table 1. List of species identified in Fourmile Creek.

Species Name	Scientific Name	Status
Colorado River cutthroat trout	*Oncorhynchus clarkii pleuriticus*	State – Species of Special Concern; BLM - 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.

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 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). 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 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 2.32 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 3.76 cfs, which meets 3 of 3 criteria and is within the accuracy range of the R2Cross model.

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

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
BLM	06/16/2015	4.78	1.91 - 11.95	2.42	3.76
BLM	07/08/2015	1.19	0.48 - 2.98	2.21	Out of range
			Mean	2.32	3.76

ISF Recommendation

BLM's analysis of this data, coordinated with Colorado Parks and Wildlife, indicates that the following flows are needed to preserve the fishery and natural environment to a reasonable degree. BLM's recommendation was modified slightly by staff to conform to a standard number of significant digits in ISF water court applications. The final recommendations numbers are as follows:

> 3.8 cubic feet per second (cfs) is recommended during the snowmelt runoff period from May 1 to June 30. This recommendation is driven by the average velocity criteria. This portion of the creek is at high altitude and the fish growth and recruitment season is short. It is important to protect a flow rate that makes most of this habitat available to the fish population while they are completing critical life history functions during the warm weather months.
>
> 0.97 cfs is recommended from July 1 to July 31. This recommendation is driven by water availability. While this flow rate does not meet at least two instream flow criteria, it provides substantially more habitat than is available during base flow periods.
>
> 0.41 cfs is recommended from August 1 to March 31. This recommendation is driven by very limited water availability. 0.4 cubic feet per second should keep pools well oxygenated and at an acceptable temperature during late summer, and it should prevent pools from freezing, allowing the fish population to successfully overwinter. Even though the base flow in this creek is small, it is extremely consistent, allowing the fishery to persist.
>
> 1.3 cfs is recommended during the initial part of the snowmelt period, from April 1 to April 30. This recommendation is driven by limited water availability. Depending upon variations in stream temperatures, the fish population may start spawning in April, and protecting sufficient spawning habitat is important.

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 Fourmile Creek is 3.42 square miles, with an average elevation of 9,100 ft and average annual precipitation of 38.17 inches (See the Vicinity Map). There are no known surface water diversions in the drainage basin tributary to the proposed ISF on Fourmile Creek.

Available Data

There is not a current or historic daily streamflow gage on Fourmile Creek. There was a historic gage, but it only measured peak flows and therefore is not particularly useful for this analysis. A number of gages were examined to determine if there was a representative gage in the area. The closest gage is Willow Creek near Dixon, CO (USGS 09258000) which was located in the adjacent drainage basin to the north, roughly 6.2 miles northwest from the proposed lower terminus of Fourmile Creek. The period of record for this gage is 10/1/1953 to 9/30/1993 (downloaded from HydroBase on 11/9/2016). The drainage basin of the Willow Creek gage is 24.8 square miles with an average elevation of 8,060 ft and average annual precipitation of 28.11 inches. This results in a proration factor of 0.187 using the area-precipitation method. The area-precipitation method estimates streamflow based on the ratio of the precipitation weighted drainage area at the lower terminus location to that of the gage location. There are a number of relatively small active diversions on Willow Creek, but diversion records are not maintained. The largest water right is the Perkins Fox Ditch (WDID 5400554, 10 cfs absolute, appropriation dates 1889, 1891, 1896). This diversion structure appears to divert upstream from the gage for use on lands downstream from the gage. There are fairly consistent diversion records from the late 1950s through about 2005 with additional years of records both before and after that time period. Casey Fawcett (District 54 Water

Commissioner) estimated that ditch loss is approximately 40% to 50% due to the length of the ditch, construction materials, and issues with animals undermining the ditch.

The Norma Ryan Ditch (3 cfs, appropriation date 1919) is located at the lower terminus of the proposed Fourmile Creek ISF reach. This structure has diversion records between 1936 and the present; however, not all years have records.

BLM staff made a number of streamflow measurements on Fourmile Creek. The best available access point is located approximate 1.5 miles upstream from the lower terminus. A total of 3 measurements were available for inclusion in this analysis. CWCB staff made one streamflow measurement on the proposed reach of Fourmile Creek. All known measurements are summarized in Table 3.

Table 3. Summary of streamflow measurement visits and results for Fourmile Creek.

Visit Date	Flow (cfs)	Method	Party
07/20/2016	1.19	Wading, Marsh McBirney	CWCB
08/22/2016	0.72	unknown	BLM
09/26/2016	1.02	unknown	BLM
10/28/2016	0.76	unknown	BLM

Data Analysis

The Willow Creek near Dixon gage represents the best available streamflow data to estimate streamflow on Fourmile Creek. Natural streamflow on Willow Creek was estimated by adding 50% of the recorded diversions from the Perkins Fox Ditch to the Willow Creek gage data. The adjusted Willow Creek gage data was then scaled by 0.187 to the lower terminus of Fourmile Creek. Median streamflow and 95% confidence intervals for media streamflow were calculated.

The median diversion and 95% confidence intervals for the median diversion for the Norma Ryan Ditch were calculated based on the available record, 1936 to 2015 (downloaded from HydroBase on 10/7/2016). The diversion rates from that structure are typically less than the proposed ISF; however, the timing of ditch use confirms that Fourmile and Willow Creek have similar runoff periods.

Measurements made by the BLM staff on Fourmile Creek suggest that significantly more water may be available than indicated by the Willow Creek analysis; however, this cannot be confirmed without making substantially more measurements.

Water Availability Summary

The hydrographs (See Complete and Detailed Hydrographs) show the median streamflow and 95% confidence intervals for the median streamflow calculated from the scaled Willow Creek near Dixon gage and the available streamflow measurements on Fourmile Creek. The proposed ISF rate is below median streamflow the majority of the time and below the upper 95% confidence interval at all times. The median and 95% confidence intervals of the median diversion of the Norma Ryan Ditch are included to provide additional information. Staff concludes that water is available for appropriation on Fourmile Creek.

Material Injury
Because the proposed ISF on Fourmile 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. (2016), 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.

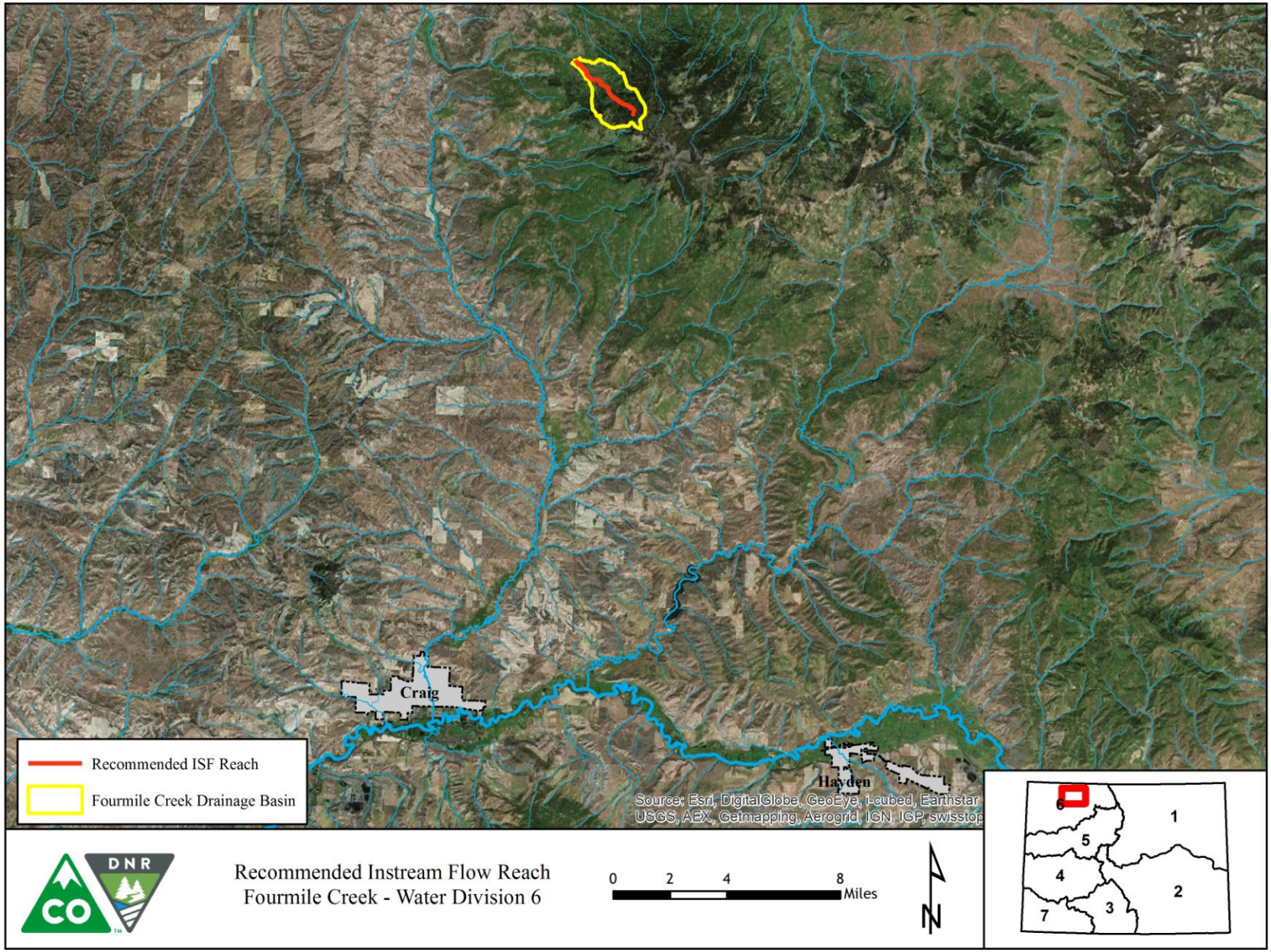
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

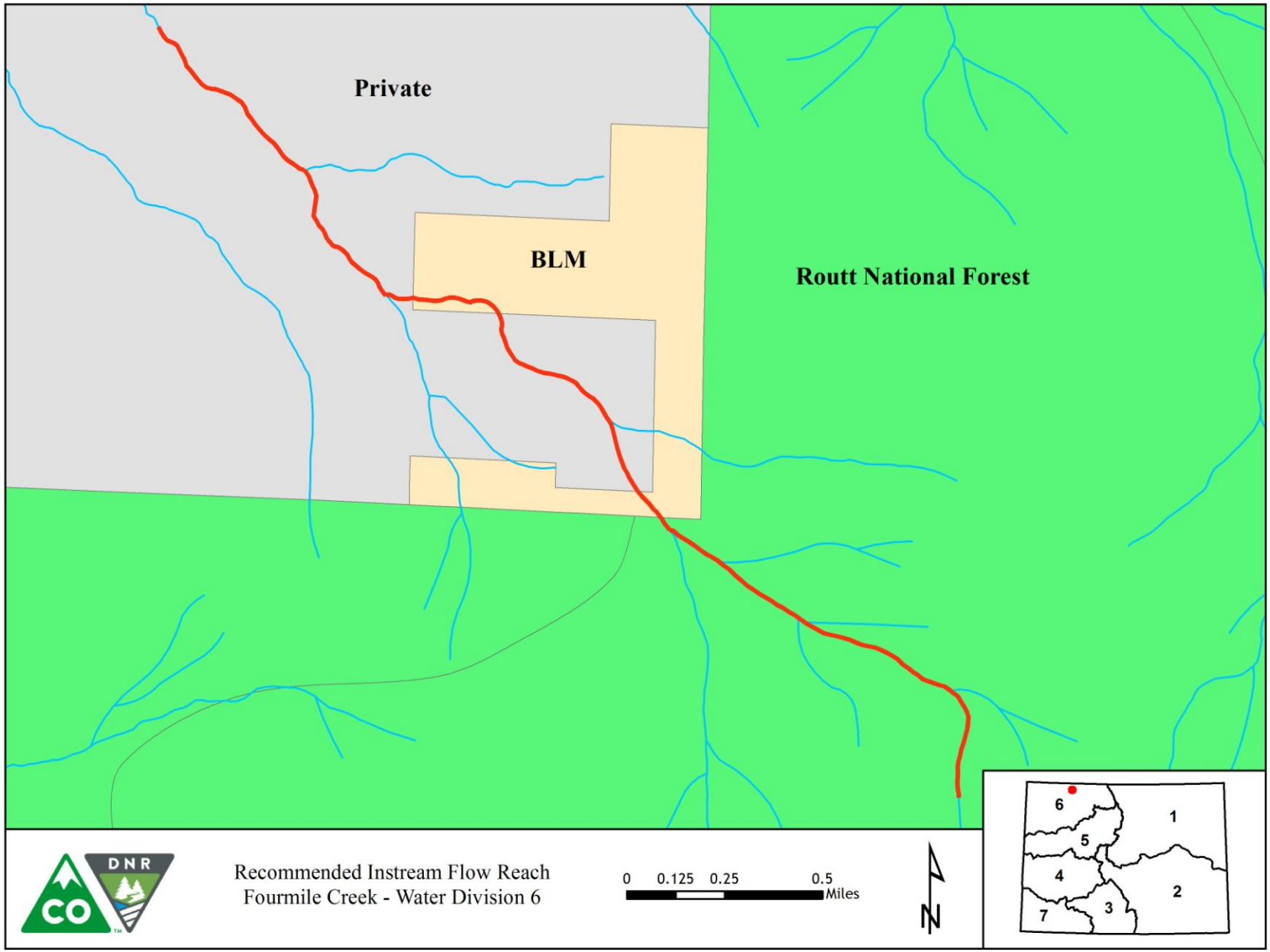
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

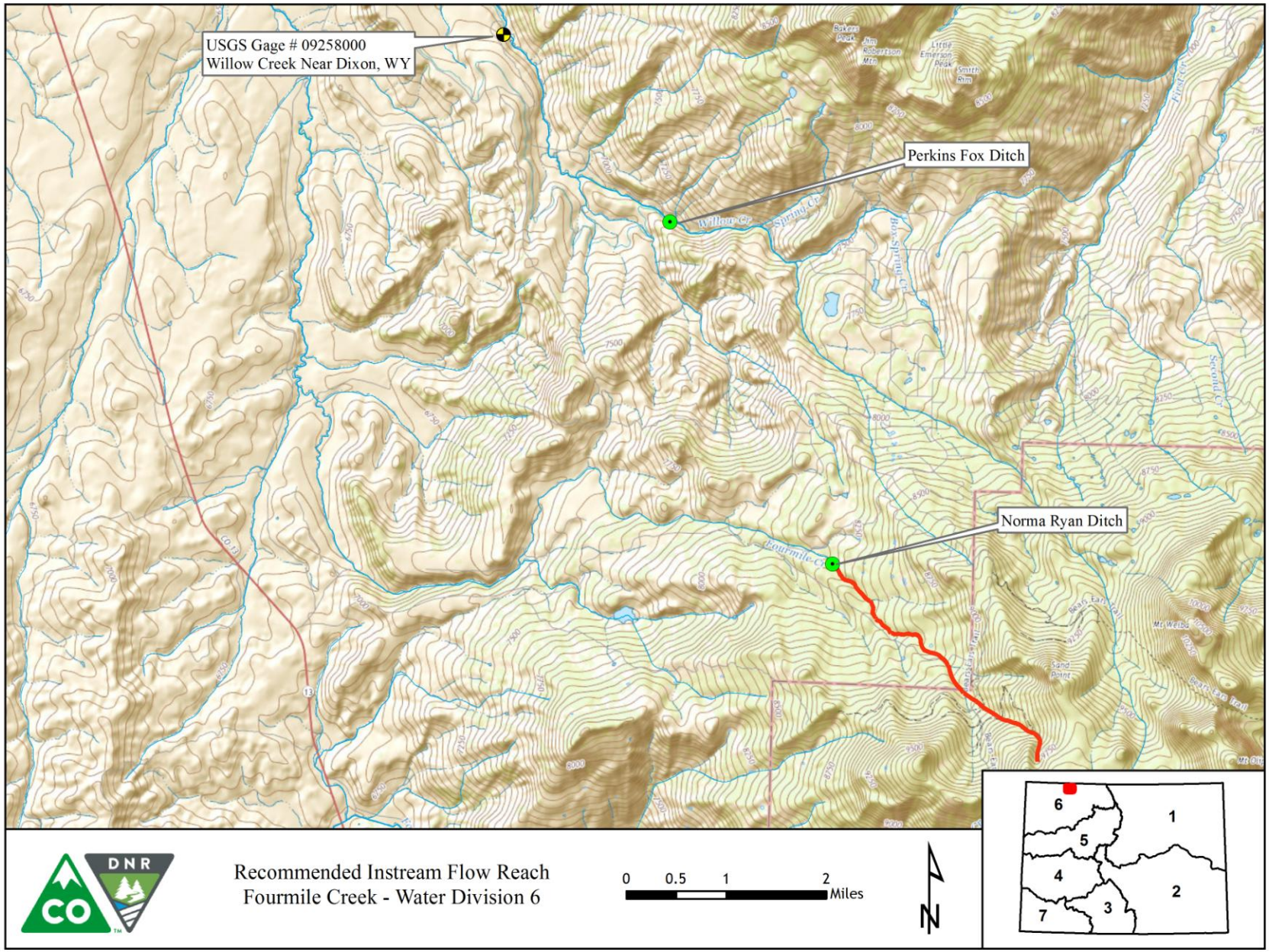
VICINITY MAP



LAND OWNERSHIP MAP



HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH