COLORADO
Colorado Water Conservation Board
Department of Natural Resources

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2019 Instream Flow Recommendations

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COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Baker Creek
EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	headwaters in the vicinity of UTM North: 4134666.58 UTM East: 485496.58
LOWER TERMINUS:	Forest Service property boundary UTM North: 4133589.16 UTM East: 488637.74
WATER DIVISION:	2
WATER DISTRICT:	16
COUNTY:	Huerfano
WATERSHED:	Huerfano
CWCB ID:	10/2/A-004
RECOMMENDER:	Colorado Parks and Wildlife (CPW)
LENGTH:	2.13 miles
FLOW RECOMMENDATION:	2.1 cfs (05/01 - 06/30) 1.3 cfs (07/01 - 08/31) 0.5 cfs (09/01 - 03/31) 1.0 cfs (04/01 - 04/30)

Baker 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.

Colorado Parks and Wildlife (CPW) recommended that the CWCB appropriate an ISF water right on a reach of Baker Creek because it has a natural environment that can be preserved to a reasonable degree. Baker Creek is located within Huerfano County and originates at an elevation of approximately 11,500 feet in the Sangre de Cristo Mountains, flowing east 3.5 miles to the confluence with the Cucharas River at an elevation of 8,783 feet (See Vicinity Map). The proposed reach extends from the headwaters downstream to the U.S. Forest Service property boundary. One hundred percent of the land on the 2.13 mile proposed reach is public land managed by the U.S. Forest Service (See Land Ownership Map).

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/2019ProposedISFRecommendations.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 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.

Baker Creek is a first order high-gradient stream with a somewhat confined channel. Substrate ranges from boulder to cobble. Abundant large wood in the channel creates channel complexity and fish habitat. The large wood also creates debris jams throughout the channel, increasing floodplain connectivity and creating important fish habitat. The riparian area is comprised of abundant willows and cottonwoods that shade the channel and provide cover for the fish community. Observations by CPW staff indicate the stream environment of Baker Creek supports brook trout (*Salvelinus fontinalis*).

Table 1. List of species identified in Baker Creek.

Species Name	Scientific Name	Status
brook trout	*Salvelinus fontinalis*	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
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 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). 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 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 0.90 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 2.10 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 Baker Creek.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
CPW	05/11/2006 #1	1.46	0.58 - 3.65	0.60	2.10
CPW	11/21/2016 #1	0.74	0.30 - 1.85	1.20	Out of range
			Mean	0.90	2.10

ISF Recommendation
CPW recommended ISF flows based on R2Cross modeling analyses, biological expertise, and a preliminary assessment of water availability. CWCB Staff's water availability analysis determined that water was limited in some cases. The following flows represent the final recommendation which has been modified in collaboration with CPW due to water availability limitations.

0.5 cfs from September 1 through March 31 is recommended during the winter base flow period. This base flow rate is sufficient for fish overwintering by maintaining velocities that prevent freezing and maintaining adequate depths at microhabitats across the reach, preserving habitat availability within the wetted channel.

1.0 cfs from April 1 through April 30 is recommended to provide adequate protection of the natural environment on the rising limb of the hydrograph.

2.1 cfs from May 1 through June 30 is recommended for the spring runoff period. This flow rate will preserve the natural environment by achieving all three instream flow criteria.

1.3 cfs from July 1 through August 31 is recommended to provide adequate protection of the natural environment on the receding limb of the hydrograph. This flow rate in combination with the April 1 through April 30 recommendation will support fish spawning, development, and rearing activities that require sufficient depths for seasonal fish migrations and egg incubation. This flow rate was modified due to 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.

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.). 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 Baker Creek is 2.5 square miles, with an average elevation of 10,848 ft and average annual precipitation of 30.6 inches (See the Hydrologic Features Map). There are no known surface water diversions, reservoirs, or transbasin imports or exports. Hydrology in this drainage basin represents natural flow conditions.

Available Data
There are no current or historic streamflow gages in the vicinity of the proposed ISF reach. The nearest gage is the Cucharas River at Boyd Ranch near La Veta gage (USGS 07114000) located approximately 7.2 miles downstream on the Cucharas River. The gage has a period of record from 1934 to present. The drainage basin of the gage is 53.1 square miles, with an average elevation of 9,884 ft and average annual precipitation of 27.28 inches. Several surface diversions exist between the proposed lower terminus and the gage, totaling approximately 65 cfs in decreed water rights. Many of the larger rights appear to be used consistently based on the available diversion records. Due to the combination of water diversions and the large difference in drainage basin size that results in a small proration factor, this gage is not suitable for estimating streamflow on the proposed ISF reach.

CWCB staff made four streamflow measurements on the proposed reach of Baker Creek as summarized in Table 3.

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

Visit Date	Flow (cfs)	Collector
10/26/2010	1.17	CWCB
08/07/2014	1.63	CWCB
09/11/2015	1.30	CWCB
10/29/2018	0.32	CWCB

Data Analysis
StreamStats provides the best available estimate of streamflow on Baker Creek.

Water Availability Summary
The hydrograph (See Complete Hydrograph) shows StreamStats results for mean-monthly streamflow. Staff has concluded that water is available for appropriation.

Material Injury
Because the proposed ISF on Baker 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. (2018), 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.

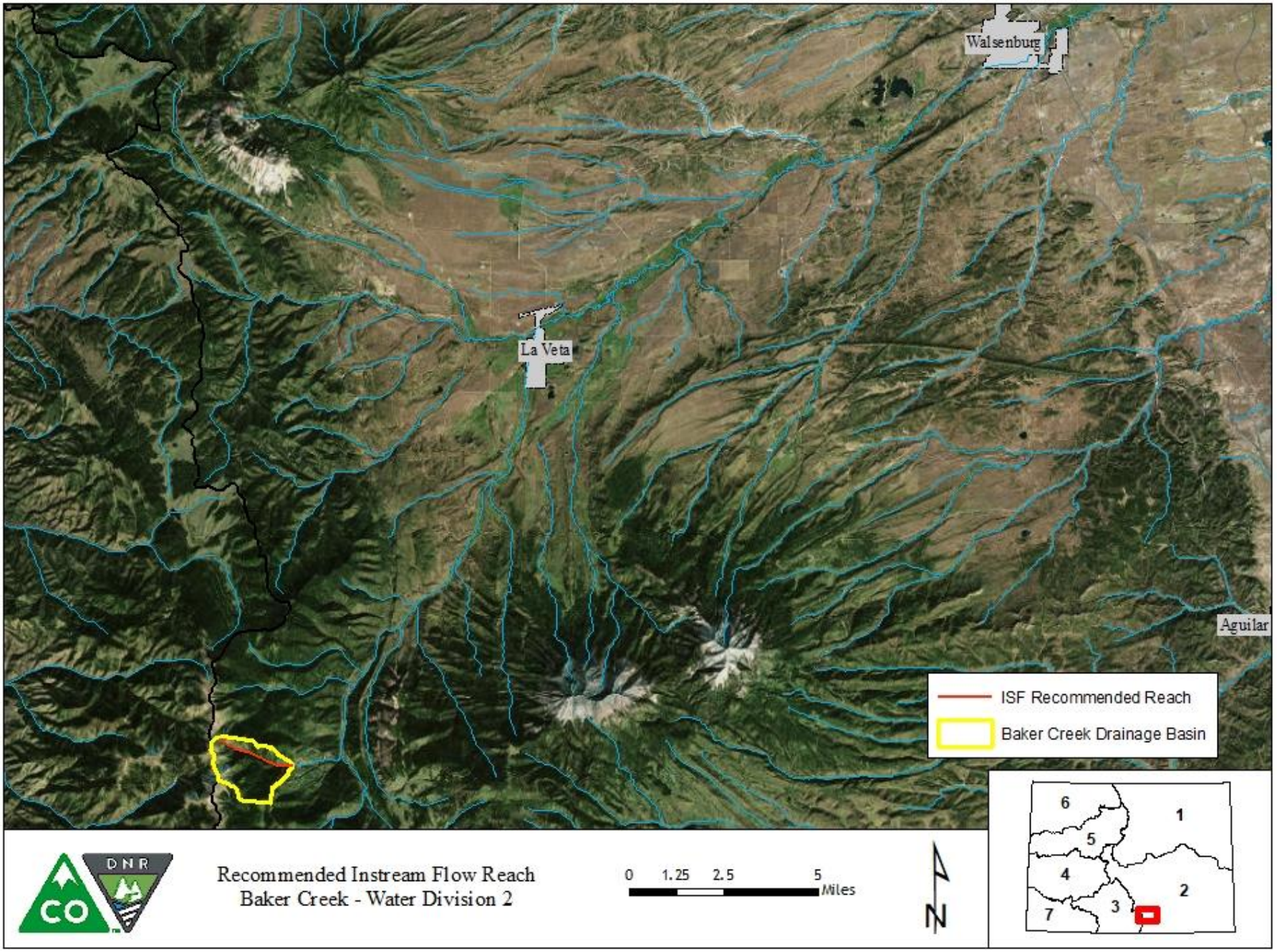
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

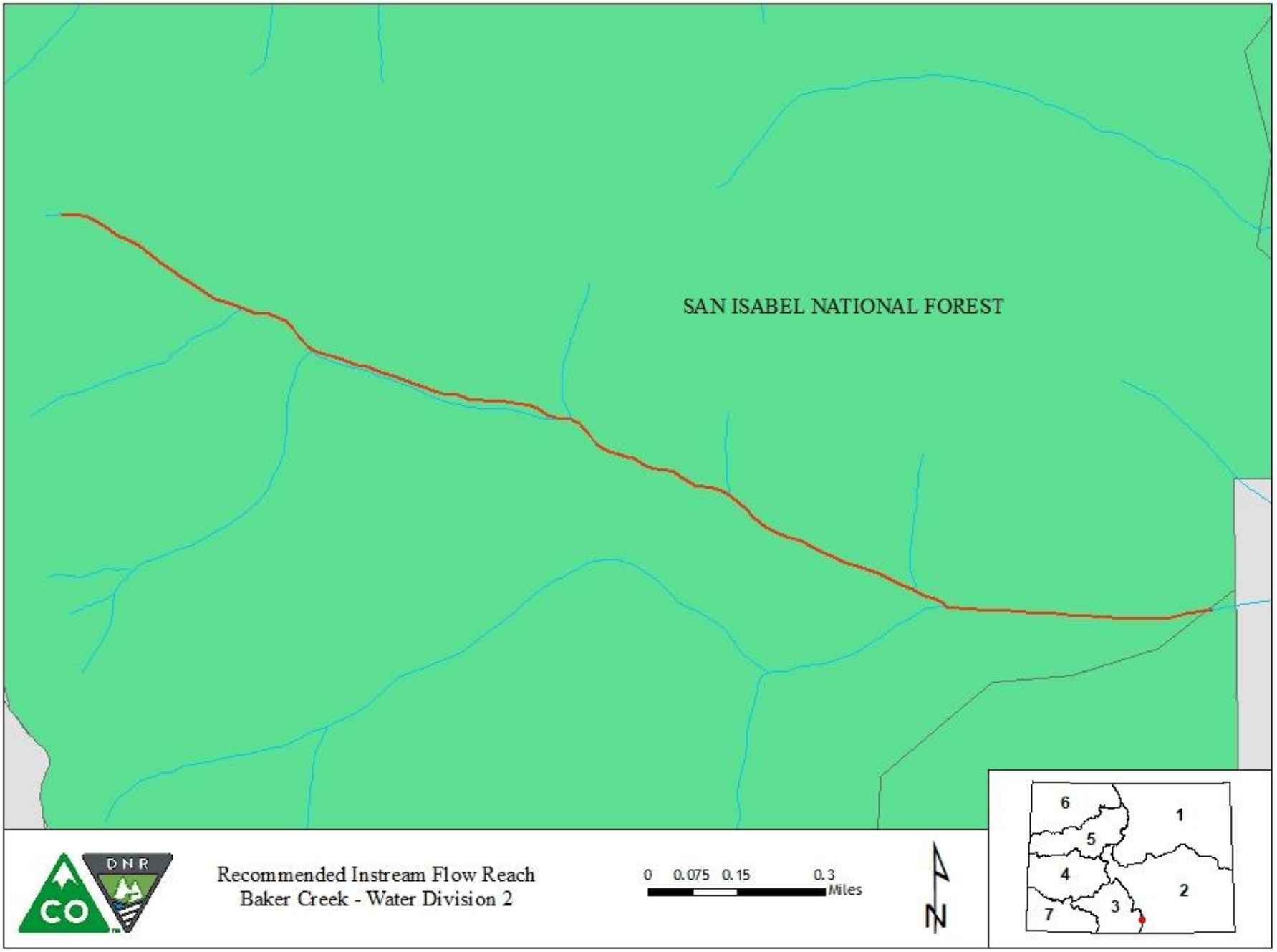
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

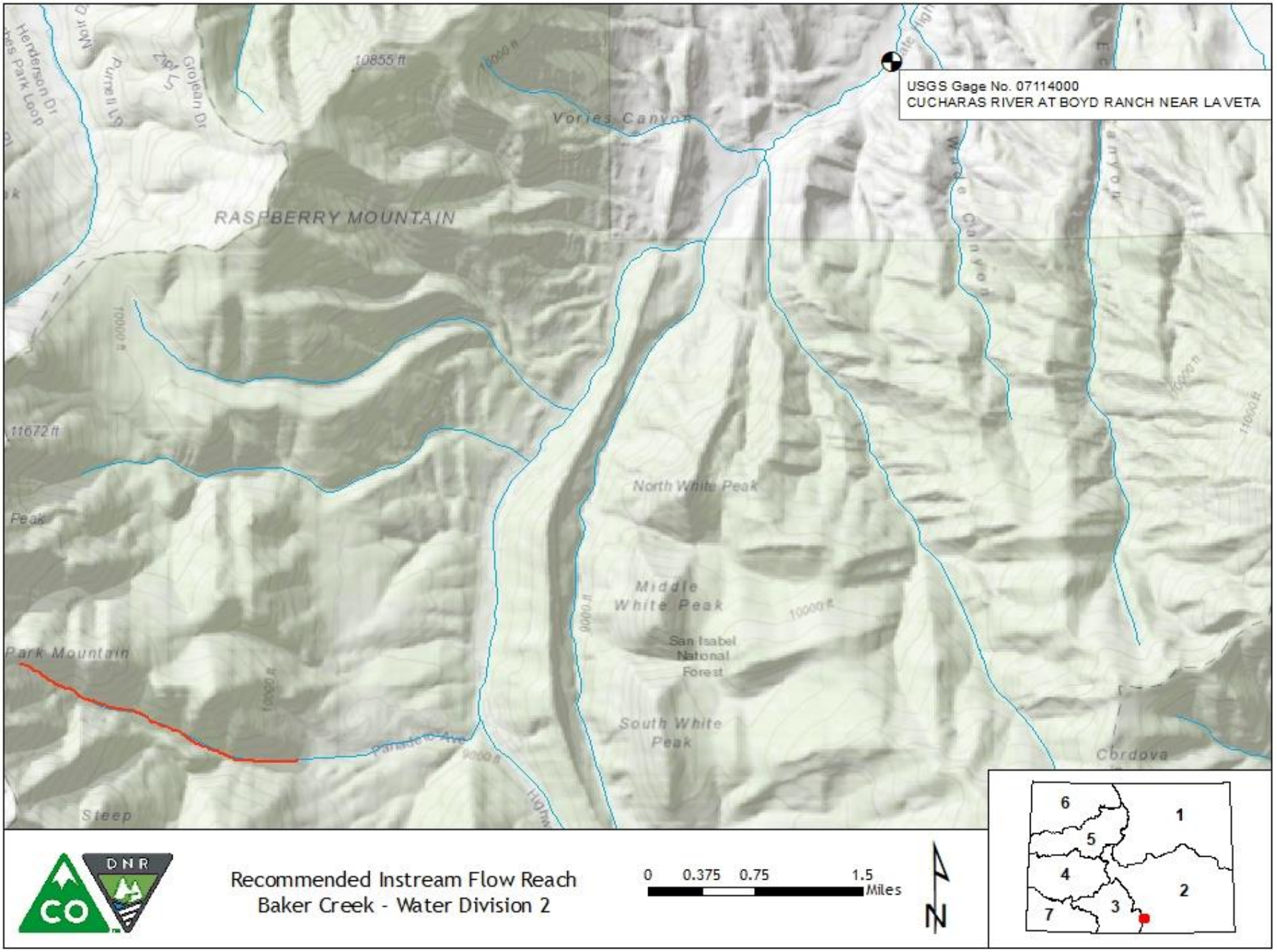
VICINITY MAP



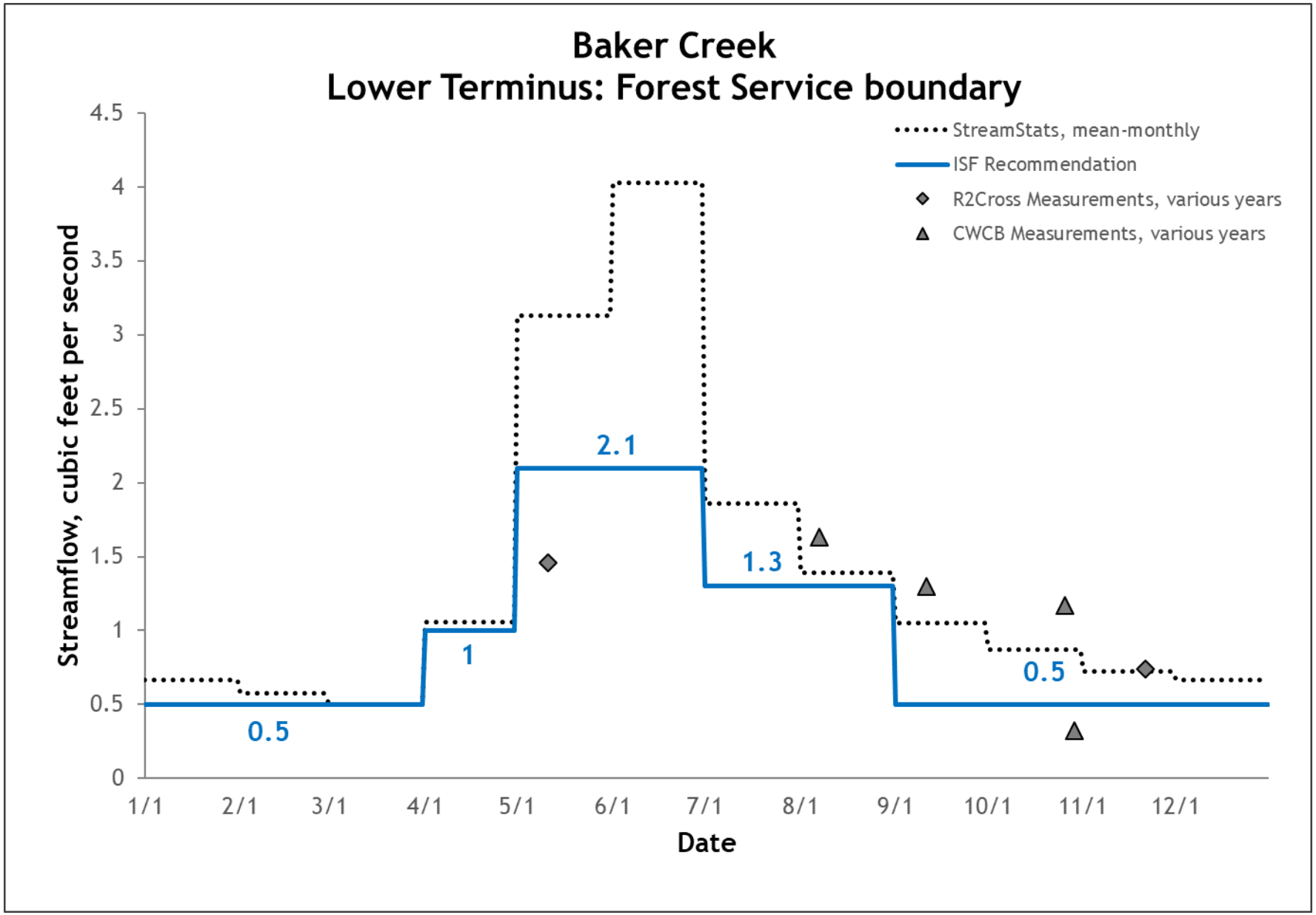
LAND OWNERSHIP MAP



HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



COLORADO
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Department of Natural Resources

Bonnett Creek
EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	headwaters in the vicinity of UTM North: 4138962.59 UTM East: 486695.74
LOWER TERMINUS:	confluence with the Cucharas River UTM North: 4137528.63 UTM East: 491728.78
WATER DIVISION:	2
WATER DISTRICT:	16
COUNTY:	Huerfano
WATERSHED:	Huerfano
CWCB ID:	10/2/A-005
RECOMMENDER:	Colorado Parks and Wildlife (CPW)
LENGTH:	4.05 miles
FLOW RECOMMENDATION:	0.4 cfs (09/01 - 03/31) 1.0 cfs (04/01 - 06/30) 0.55 cfs (07/01 - 08/31)

Bonnett 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.

CPW recommended that the CWCB appropriate an ISF water right on this reach of Bonnett Creek because it has a natural environment that can be preserved to a reasonable. Bonnett Creek is located within Huerfano County and originates at an elevation of approximately 10,000 ft in the Sangre de Cristo Mountains. Bonnett Creek flows east four miles to the confluence with the Cucharas River at an elevation of approximately 8,389 ft (See Vicinity Map). The proposed reach extends from the headwaters downstream to the confluence with the Cucharas River. The U.S. Forest Service manages 82 percent of the land on the 4.05 mile proposed reach and 18 percent is privately owned (See Land Ownership Map).

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/2019ProposedISFRecommendations.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 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.

Bonnett Creek is a first order, high-gradient stream with a somewhat confined channel. Substrate ranges from cobble to boulder. Fishery surveys indicate the stream environment of Bonnett Creek supports brook trout (*Salvelinus fontinalis*).

Table 1. List of species identified in Bonnett Creek.

Species Name	Scientific Name	Status
brook trout	*Salvelinus fontinalis*	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
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 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). 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 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 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 winter flow of 0.57 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 0.96 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 Bonnett Creek.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
USFS	07/15/1992 #1	0.42	0.17 - 1.05	0.48	Out of range
CPW	06/16/2016 #2	0.84	0.34 - 2.10	0.66	1.22
CPW	06/16/2016 #3	1.10	0.44 - 2.75	0.58	0.69
			Mean	0.57	0.96

ISF Recommendation
CPW recommended ISF flows based on R2Cross modeling analyses, biological expertise, and a preliminary assessment of water availability. CWCB Staff's water availability analysis determined that water was limited in some cases. The following flows represent the final recommendation which has been modified in collaboration with CPW due to water availability limitations.

0.4 cfs from September 1 through March 31 is recommended for fish overwintering during the base flow period. This flow rate will achieve the percent wetted perimeter criteria across the reach and maintain velocities and depths that are suitable for fish to occupy microhabitats within the reach.

1.0 cfs from April 1 through June 30 is recommended during the snowmelt runoff period. The proposed summer flow recommendation will preserve the natural environment by meeting all three instream flow criteria.

0.55 cfs is recommended from July 1 through August 31 for protection of the receding limb of the hydrograph in order to achieve suitable velocities and wetted perimeter during the late summer. This combination will support fish spawning, development, and rearing. This flow rate was modified due to 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.

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). 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 Bonnett Creek is 2.63 square miles, with an average elevation of 9,891 ft and average annual precipitation of 26.63 inches (See the Hydrologic Features Map). There are no known surface water diversions or reservoirs within the basin tributary to the proposed ISF. Hydrology in this drainage basin represents natural flow.

Available Data
There are no current or historic streamflow gages in the vicinity of the proposed ISF reach. The nearest gage is the Cucharas River at Boyd Ranch near La Veta gage (USGS 07114000) located approximately 3.5 miles downstream on the Cucharas River. The gage has a period of record from 1934 to present. The drainage basin of the gage is 53.1 square miles, with an average elevation of 9884 ft and average annual precipitation of 27.28 inches. Several surface diversions exist between the proposed lower terminus and the gage, totaling approximately 65 cfs in decreed water rights. Many of the larger rights appear to be used consistently based on the available diversion records. Due to the combination of water diversions and the large difference in drainage basin size that results in a small proration factor, this gage is not suitable for estimating streamflow on the proposed ISF reach.

CWCB staff made four streamflow measurements on the proposed reach of Bonnet Creek as summarized in Table 3.

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

Visit Date	Flow (cfs)	Collector
09/08/2011	0.10	CWCB
06/29/2012	0.22	CWCB
08/07/2014	0.36	CWCB
09/11/2015	0.10	CWCB

Data Analysis
StreamStats provides the best available estimate of streamflow on Baker Creek.

Water Availability Summary
The hydrograph (See Complete Hydrograph) shows StreamStats results for mean-monthly streamflow. Staff has concluded that water is available for appropriation.

Material Injury
Because the proposed ISF on Bonnett 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. (2018), 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.

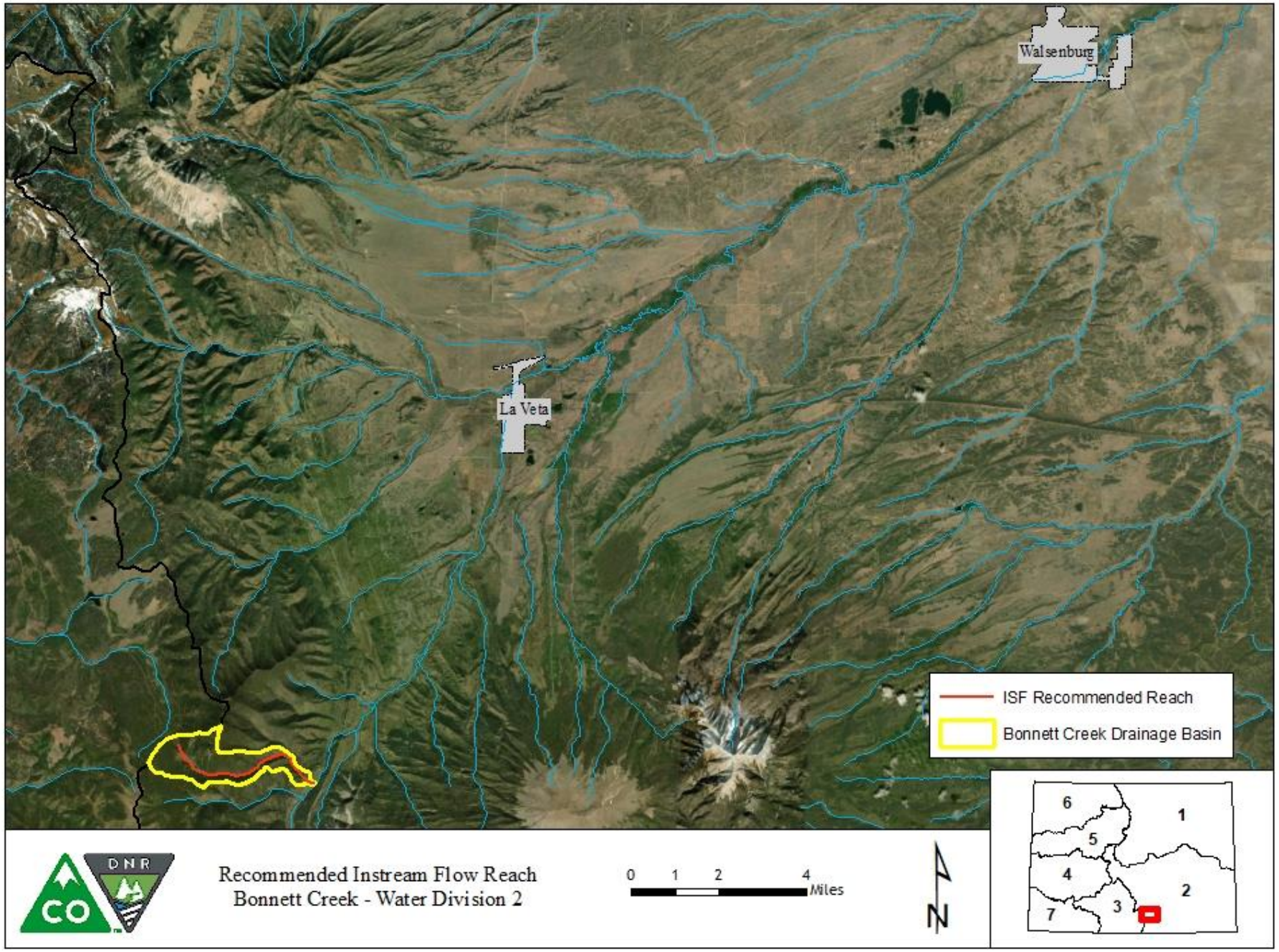
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

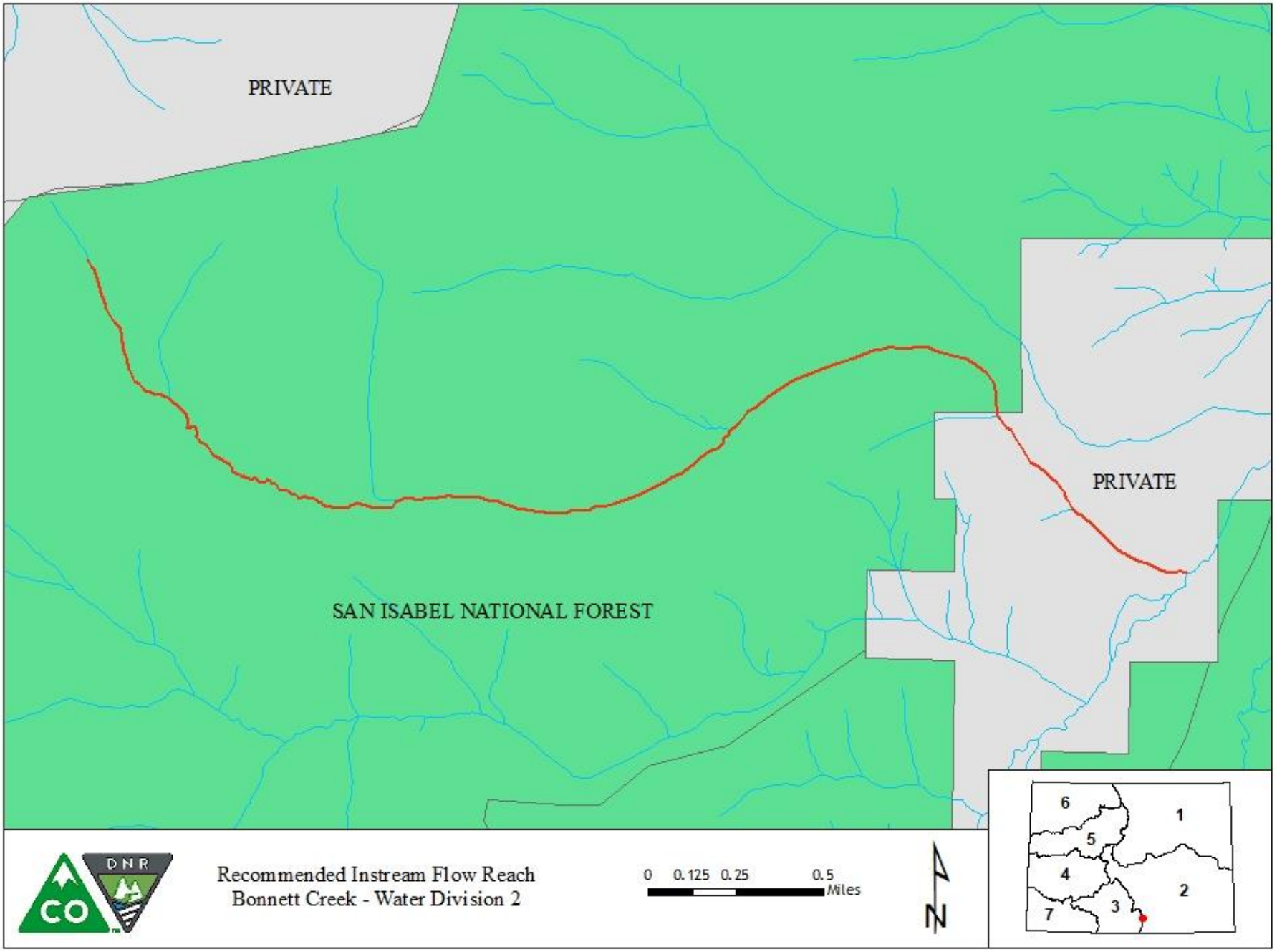
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

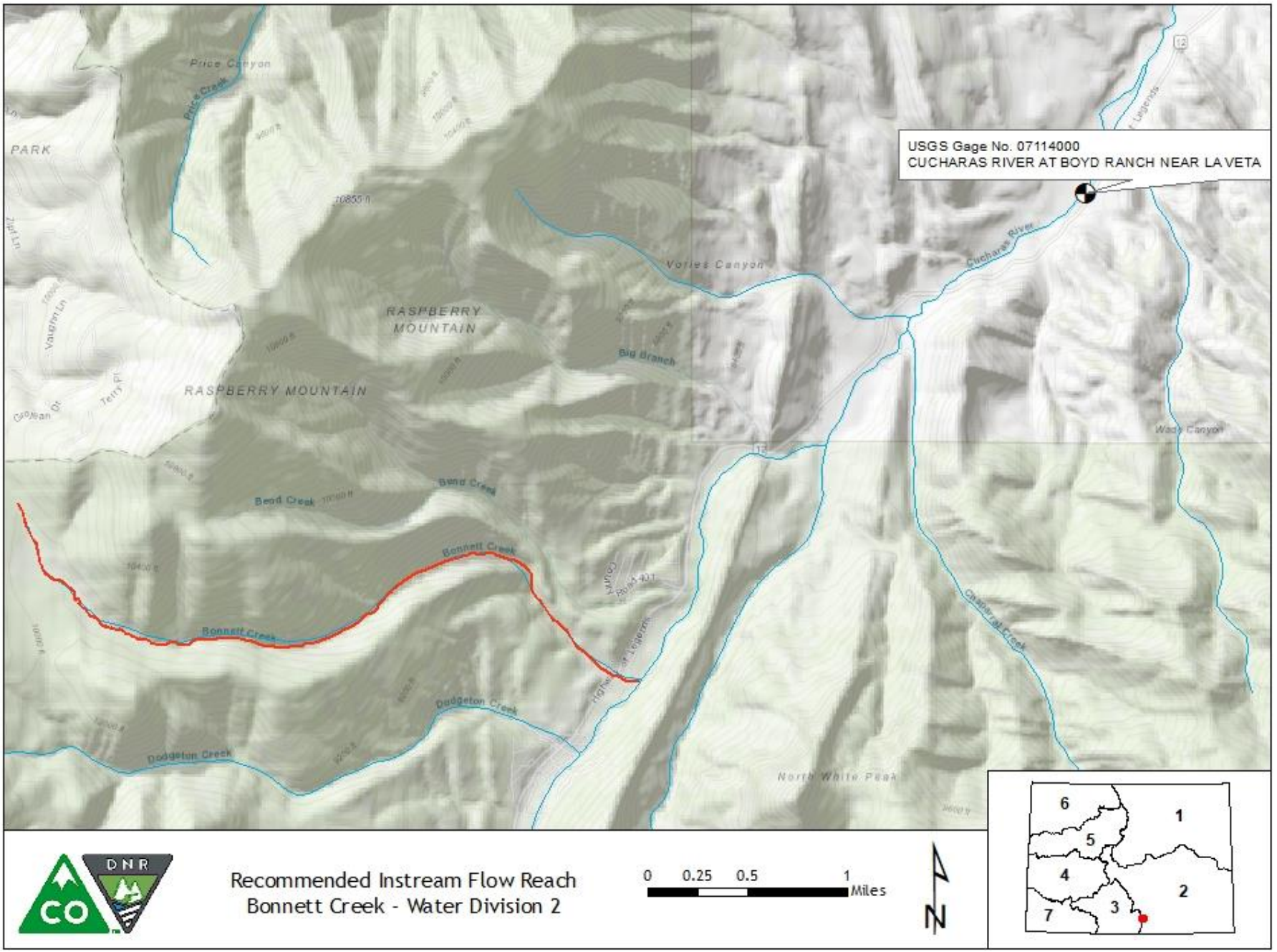
VICINITY MAP



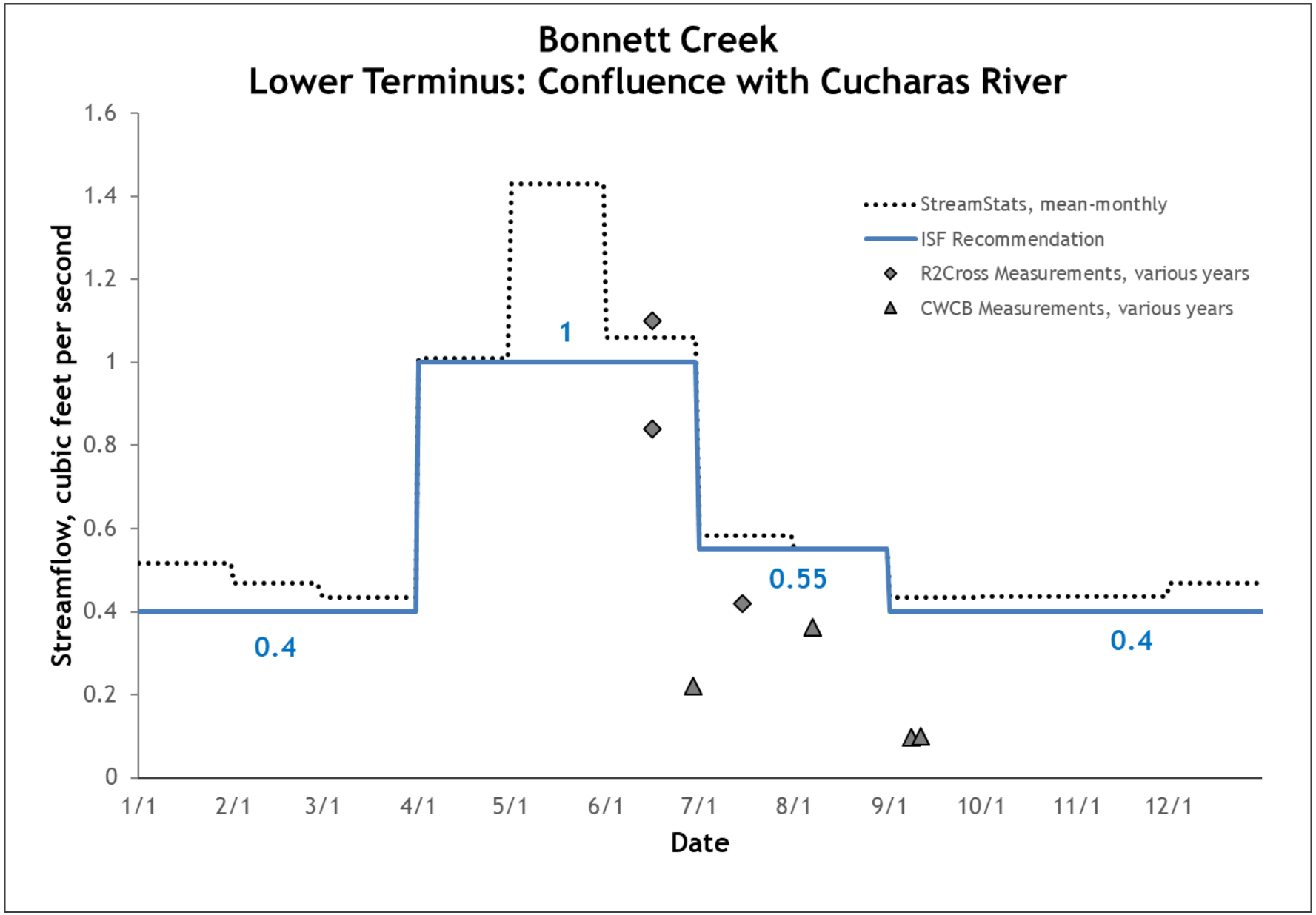
LAND OWNERSHIP MAP



HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Stout Creek
EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	BLM/USFS Property Boundary UTM North: 4248489.60 UTM East: 425206.65
LOWER TERMINUS:	confluence with an unnamed tributary at UTM North: 4248935.65 UTM East: 426072.66
WATER DIVISION:	2
WATER DISTRICT:	12
COUNTY:	Fremont
WATERSHED:	Arkansas Headwaters
CWCB ID:	19/2/A-001
RECOMMENDER:	Bureau of Land Management (BLM)
LENGTH:	0.62 miles
FLOW RECOMMENDATION:	3.5 cfs (05/01 - 06/30) 1.5 cfs (07/01 - 08/31) 0.6 cfs (09/01 - 04/30)

Stout 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 Stout Creek because it has a natural environment that can be preserved to a reasonable degree with an ISF water right. Stout Creek is located within Fremont County and originates from Stout Creek Lake at an elevation of approximately 11,770 ft on the east slope of the Sangre de Cristo Mountains. Stout Creek flows northwest for approximately 7.35 miles to the confluence with the Arkansas River at an elevation of approximately 5,640 ft (See Vicinity Map). The proposed reach extends from the BLM/USFS property boundary downstream to the confluence with an unnamed tributary. The Bureau of Land Management and U.S. Forest Service manage 42 percent of the land on the 0.62 mile proposed reach (See Land Ownership Map).

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/2019ProposedISFRecommendations.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 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.

Stout Creek is a cold water, high gradient stream. The reach that is the subject of this recommendation flows through alluvial fans on the eastern slopes of the Sangre de Cristo Range. This portion of Stout Creek has large substrate with boulders up to four feet in diameter. The large substrate and steep gradient provide fish habitat consisting primarily of pools separated by large drops, with few riffles. Water quality is excellent for supporting salmonid fish species. Fish surveys indicate that Stout Creek supports self-sustaining populations of brook trout and brown trout. Spot surveys indicated abundant populations of stonefly and caddisfly. The creek also supports a vigorous riparian community comprised of white fir, maple, and aspen. The riparian community provides ample cover and shading for the creek, and contributes to bank stability.

Table 1. List of species identified in Stout Creek.

Species Name	Scientific Name	Status
brook trout	*Salvelinus fontinalis*	None
brown trout	*Salmo trutta*	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.

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 1.54 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 3.46 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 Stout Creek.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
BLM	07/10/2017 #1	3.48	1.39 - 8.70	1.54	3.43
BLM	07/10/2017 #2	3.48	1.39 - 8.70	Out of range	3.48
			Mean	1.54	3.46

ISF Recommendation

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

3.5 cubic feet per second is recommended during the snowmelt runoff period from May 1 to June 30. This recommendation is driven by the average velocity criteria. Given the small amount of riffle habitat in this reach, it is important to provide velocities that are suitable for spawning trout.

1.5 cubic feet per second is recommended during summer from July 1 to August 31. This recommendation is driven by the wetted perimeter 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.

0.6 cubic feet per second is recommended from September 1 to April 30. This recommendation is driven by limited water availability. This flow rate should prevent complete icing of the numerous pools in this reach, allowing the fish population to overwinter.

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 Stout Creek is 2.77 square miles, with an average elevation of 11,030 ft and average annual precipitation of 19.83 inches (See the Hydrologic Features Map). No active surface water diversions were identified in the proposed ISF reach; therefore, hydrology in this drainage basin represents natural flow conditions.

Available Data
There is not a current or historic streamflow gage on Stout Creek or any nearby creek that would be suitable for estimating flow on Stout Creek. There is one diversion structure in the vicinity of the lower terminus, the Woods Pasture Ditch (WDID 1200586, 1.26 cfs, appropriation 1882). Further investigations by Water Commissioner Dan Henrichs revealed that this structure is likely located on the unnamed tributary to Stout Creek, rather than on the proposed ISF reach on Stout Creek (personal communication, Dan Henrichs 11/14/2018).

CWCB staff made one streamflow measurement on the subject reach of Stout Creek as summarized in Table 3.

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

Visit Date	Flow (cfs)	Collector
10/03/2018	0.03	CWCB

Data Analysis
StreamStats provides the best available estimate of streamflow on Stout Creek.

Water Availability Summary
The hydrograph (See Complete Hydrograph) shows StreamStats results for mean-monthly streamflow. Staff has concluded that water is available for appropriation.

Material Injury
Because the proposed ISF on Stout 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. (2018), 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.

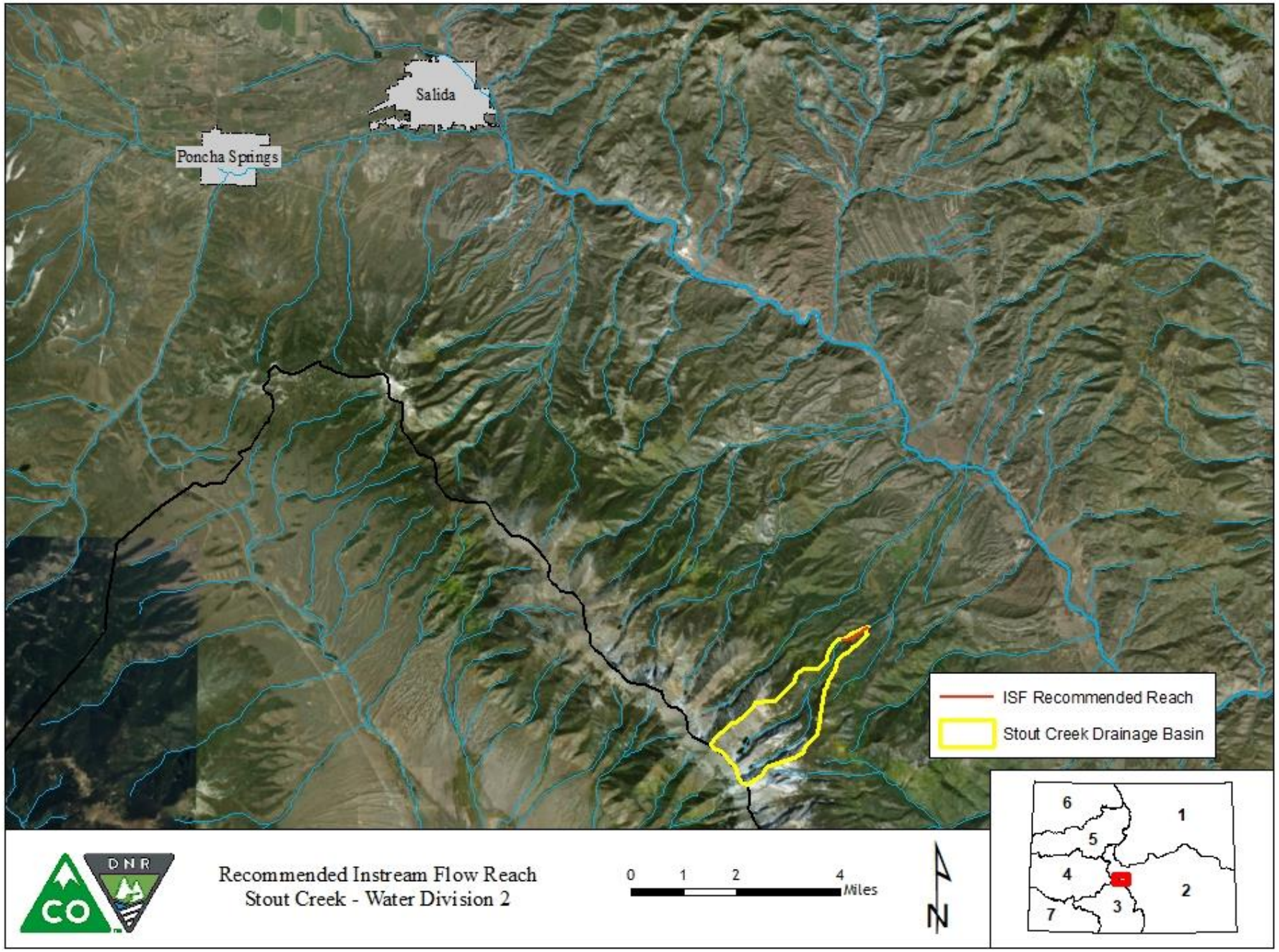
Nehring, B.R., 1979, Evaluation of Instream Flow Methods and Determination of Water Quantity Needs for Streams in the State of Colorado, Colorado Division of Wildlife.

Metadata Descriptions

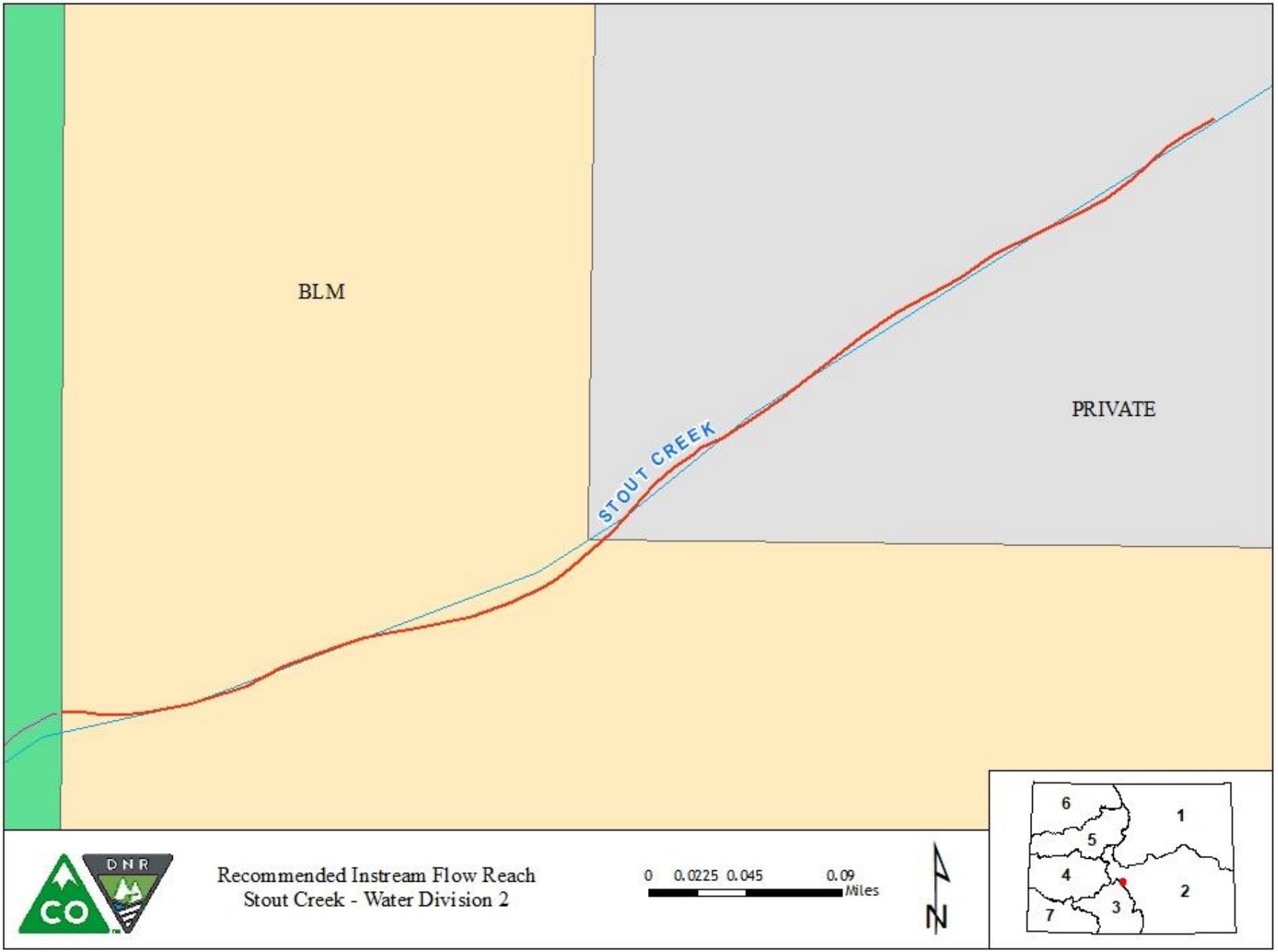
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

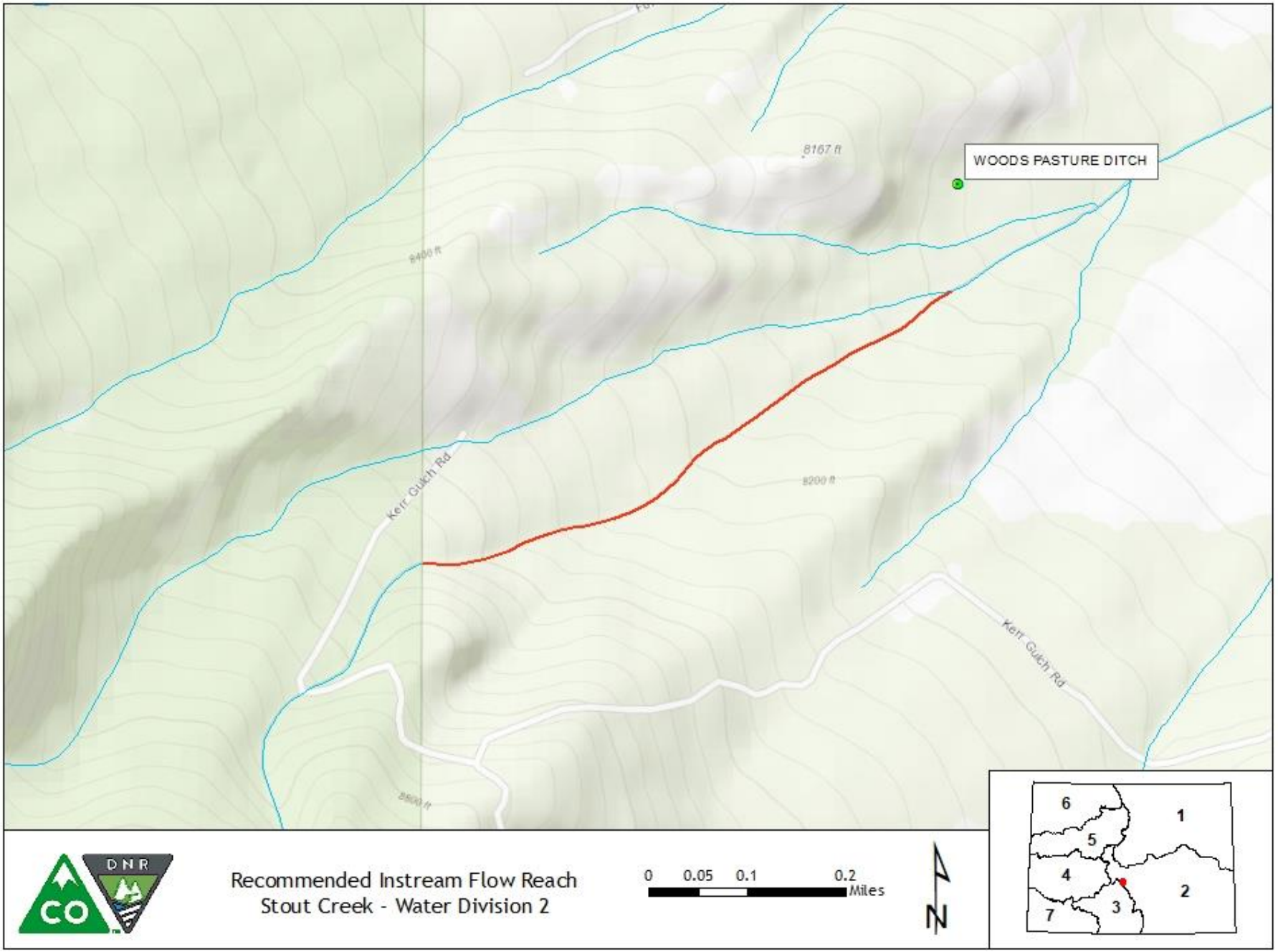
VICINITY MAP



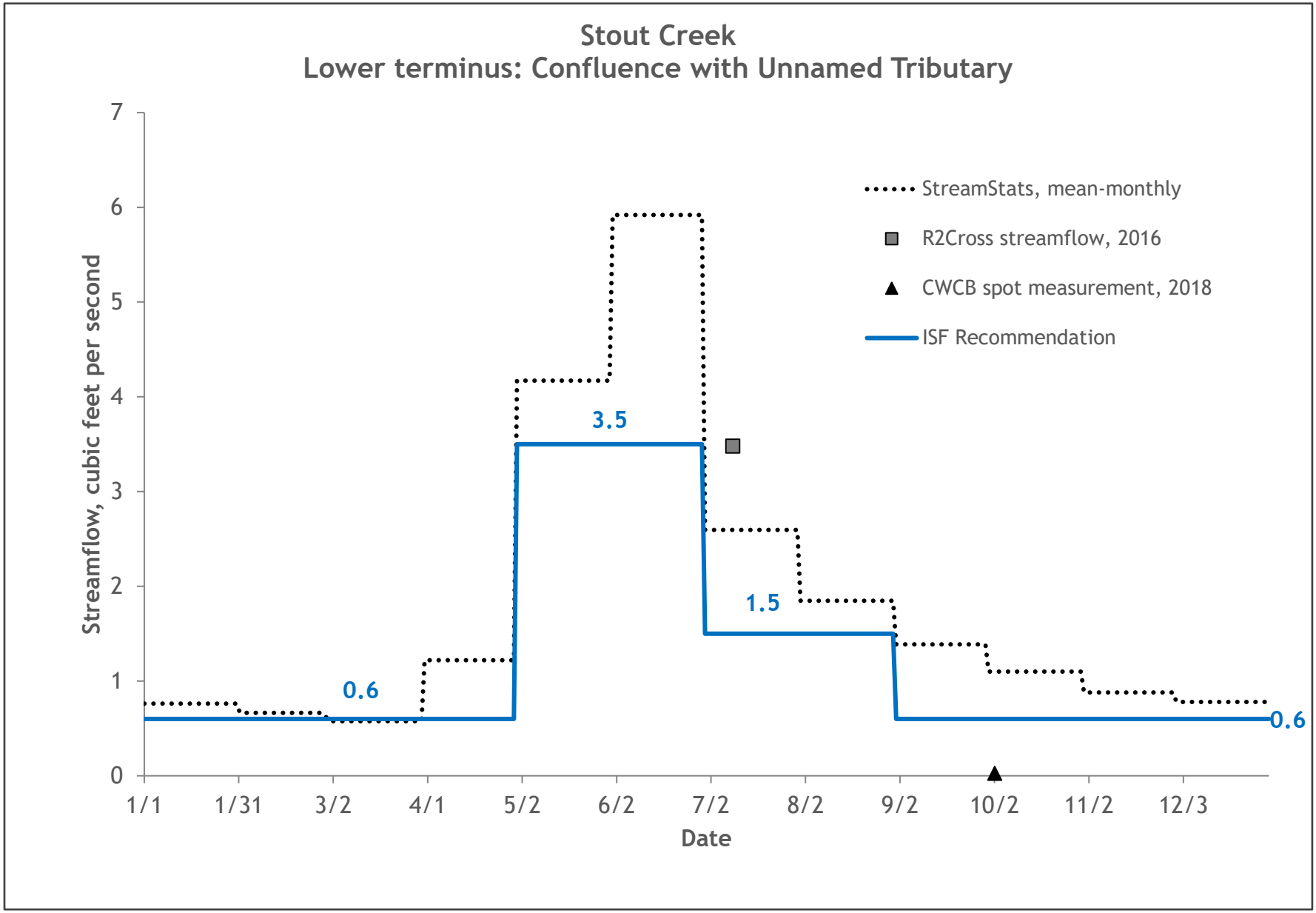
LAND OWNERSHIP MAP



HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Carnero Creek
EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	confluence with South Fork & Middle Fork Carnero Creeks UTM North: 4196212.69 UTM East: 377513.93
LOWER TERMINUS:	confluence with Mogotas Arroyo UTM North: 4190411.28 UTM East: 387851.17
WATER DIVISION:	3
WATER DISTRICT:	27
COUNTY:	Saguache
WATERSHED:	Saguache
CWCB ID:	19/3/A-001
RECOMMENDER:	Colorado Parks and Wildlife (CPW)
LENGTH:	9.81 miles
FLOW RECOMMENDATION:	2.2 cfs (12/01 - 02/29) 2.6 cfs (03/01 - 11/30)

Carnero 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.

CPW recommended that the CWCB appropriate an ISF water right on a reach of Carnero Creek because it has a natural environment that can be preserved to a reasonable degree. Carnero Creek is located within Saguache County and originates at the confluence of the Middle and South Forks of Carnero Creek at an elevation of approximately 8,600 ft. Carnero Creek flows west approximately 15 miles before flow becomes subsurface in the San Luis Valley at an elevation of approximately 8,000 ft (See Vicinity Map). The proposed reach extends from the confluence with the South Fork and Middle Fork Carnero Creeks downstream to the confluence with the Mogotas Arroyo. The BLM manages two percent of the land on the 9.81 mile proposed reach and 98 percent is privately owned (See Land Ownership Map).

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/2019ProposedISFRecommendations.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 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.

Carnero Creek has a natural environment consisting of self-sustaining populations of brown trout and white sucker, and small numbers of Rio Grande cutthroat trout (RGCT). RGCT is classified as a Tier 1 priority species in the 2015 State Wildlife Action Plan, which has the highest conservation priority in the state. RGCT is classified as a State Species of Special Concern and is considered Sensitive by the U.S. Forest Service (USFS) and Bureau of Land Management (BLM). CPW fishery survey data indicates self-sustaining populations of RGCT, brown trout, and white sucker. Carnero Creek was originally identified in the Rio Grande Cutthroat Trout Conservation Plan as having conservation populations of RGCT with essentially pure genetics. Since then, genetic analyses in the Rio Grande basin have shed light on introgression associated with the Yellowstone cutthroat trout. Although the importance of mainstem Carnero Creek in cutthroat conservation is currently being reassessed, this reach has a valuable natural environment consisting of multiple different species of fish, a significant macroinvertebrate community, and diverse riffle, pool, and glide habitat for the fish species listed above.

Table 1. List of species identified in Carnero Creek.

Species Name	Scientific Name	Status
brown trout	*Salmo trutta*	None
white sucker	*Catostomus commersonii*	None
Rio Grande cutthroat trout	*Oncorhynchus clarkii virginalis*	State – Species of Special Concern Federal - 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.

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 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). 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. However, the R2Cross model also contains the Thorne and Zevenbergen subroutine, which uses field measured bed material grain size to estimate velocity. This method is not constrained by the accuracy range of the Manning's n subroutine.

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 2.15 cfs, which meets 2 of 3 criteria, and a summer flow of 2.60 cfs, which meets 3 of 3 criteria.

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

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
CPW	06/25/2018 #1	1.80	N/A	3.30[1]	3.40[1]
CPW	06/25/2018 #2	1.80	N/A	1.00[1]	1.80[1]
			Mean	2.15	2.60

1 = Thorne and Zevenberg subroutine was used due to Manning's n results that were outside of the accuracy range. The measured D84 was 0.31 feet

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

2.2 cfs from December 1 through February 29 to maintain 2 of 3 instream flow criteria during the winter base flow period.

2.6 cfs from March 1 through November 30 to meet 3 of 3 instream flow criteria and help provide sufficient habitat during critical periods for cutthroat trout life stage requirements.

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.

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). 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 Carnero Creek is 114 square miles, with an average elevation of 9,958 ft and average annual precipitation of 25.67 inches (See the Hydrologic Features Map). There are several surface water diversions located in the basin tributary to the proposed lower terminus. Due to the number and volume of these diversions, streamflow is somewhat altered from natural conditions.

Available Data

The Carnero Creek near La Garita gage (USGS 08230500) is located approximately 2.7 miles upstream from the lower terminus. The gage period of record includes 1919 to present. The drainage basin tributary to the Carnero Creek gage is 106 square miles with an average elevation of 10,056 ft and average precipitation of 26.53 inches. This gage started operating year round in 1945 and provides important information for evaluating water availability. The gage is influenced by many of the same diversions that affect the proposed ISF reach. This gage is used in all further analysis and is referred to as the Carnero Creek gage.

Two diversions are located between the gage and the lower terminus and are therefore not taken into account by the gage. These diversions include Holland Ditch (total decreed rate of 13.16 cfs) and the La Magotes Ditch (1.82 cfs appropriation 1875). Records for these diversions begin in 1950. Upon further staff investigation, the La Magotes Ditch diverts a negligible amount, especially in the last 20 years, and has a median diversion amount of 0 year round. Diversion record comments recorded by the water commissioner often say “No water available,” which in this situation usually means that water is not legally available (personal communication, Dist. 25-26-27 Water Commissioner William Redden 10/23/2018). Along with the La Magotes Ditch, most of the diversions upstream from the gage are not diverting regularly, according to the water commissioner. The most senior diversions on Carnero Creek exist downstream from the lower terminus. The water commissioner confirmed that the most senior diverter, the Omnibus Ditch (42.72 cfs), is located approximately 0.2 miles downstream from the proposed lower terminus and often pulls water through the proposed reach to its headgate.

CWCB staff made one site visit during the R2Cross measurements with CPW on the proposed reach of Carnero Creek as summarized. No additional spot measurements of streamflow were made.

Data Analysis

The Carnero Creek gage and available diversion records from the Holland Ditch were used to estimate streamflow in the ISF reach. The effects of the diversions below the gage were accounted for by subtracting the diversion records from the gage record. The analysis was completed from 1950 to 2017 based on the availability of diversion records and year round gage records. The adjusted gage

data was not scaled to the lower terminus because the difference in contributing drainage basin was small (less than 5% adjustment to streamflow). Median streamflow and the 95% confidence interval for median streamflow were calculated for the adjusted Carnero Creek gage record.

Water Availability Summary
The hydrographs (See Complete and Detailed Hydrographs) show median and 95% confidence interval for median streamflow estimated at the lower terminus of Carnero Creek. The proposed ISF is below the median streamflow estimate most of the time and below the 95% confidence interval for median streamflow at all times. Staff concludes that water is available for appropriation on Carnero Creek

Material Injury
Because the proposed ISF on Carnero 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. (2018), 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.

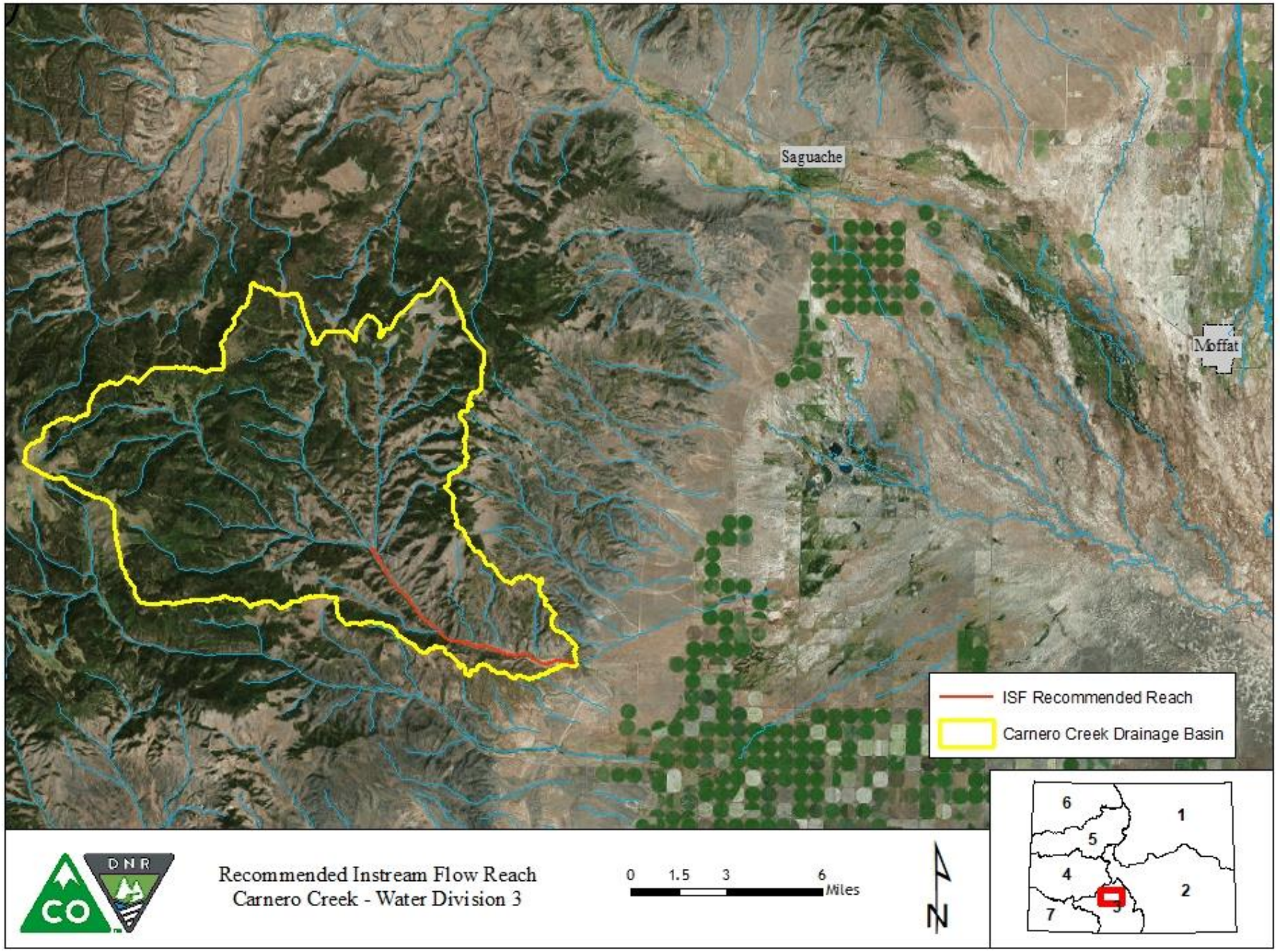
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

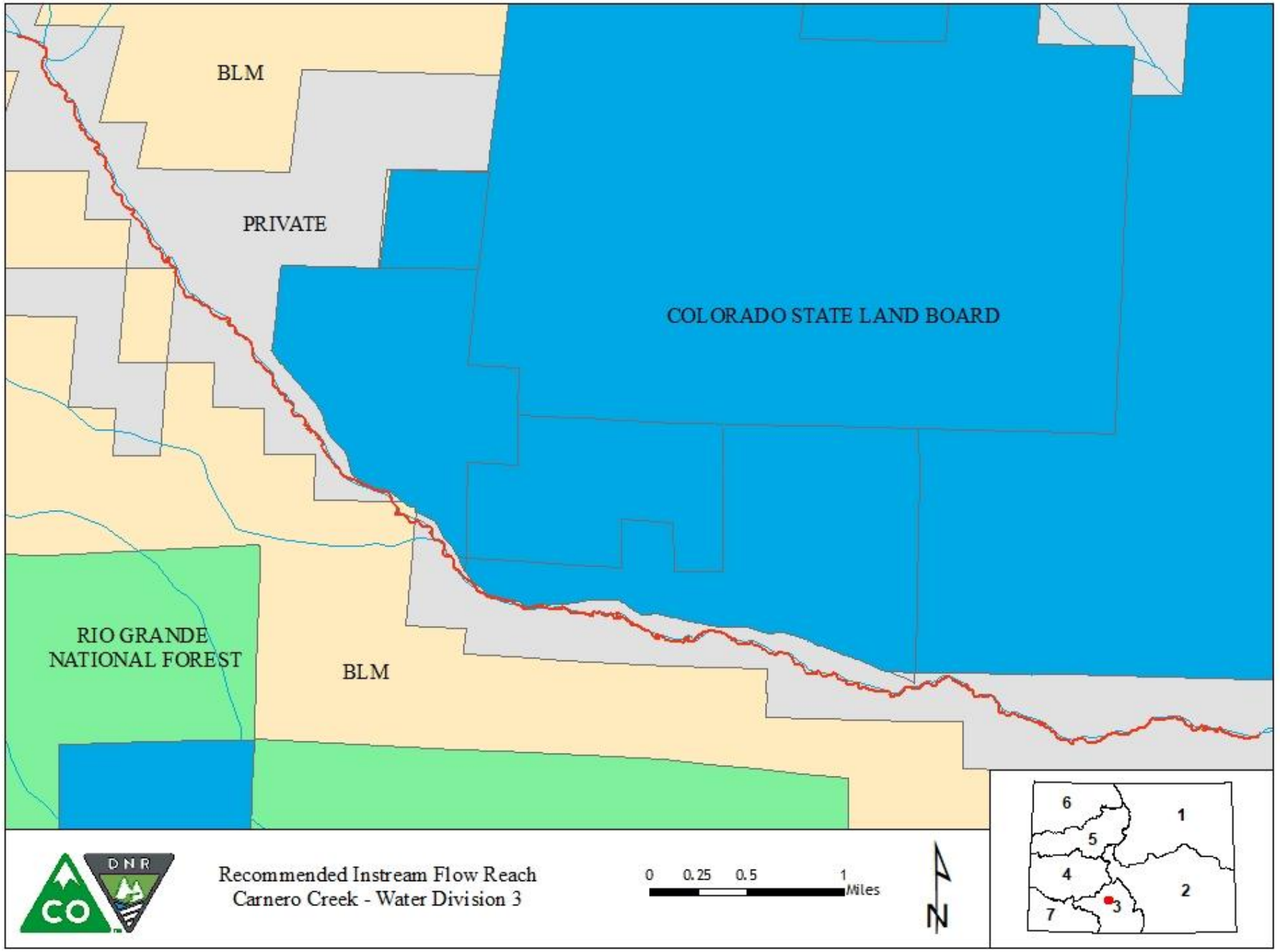
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

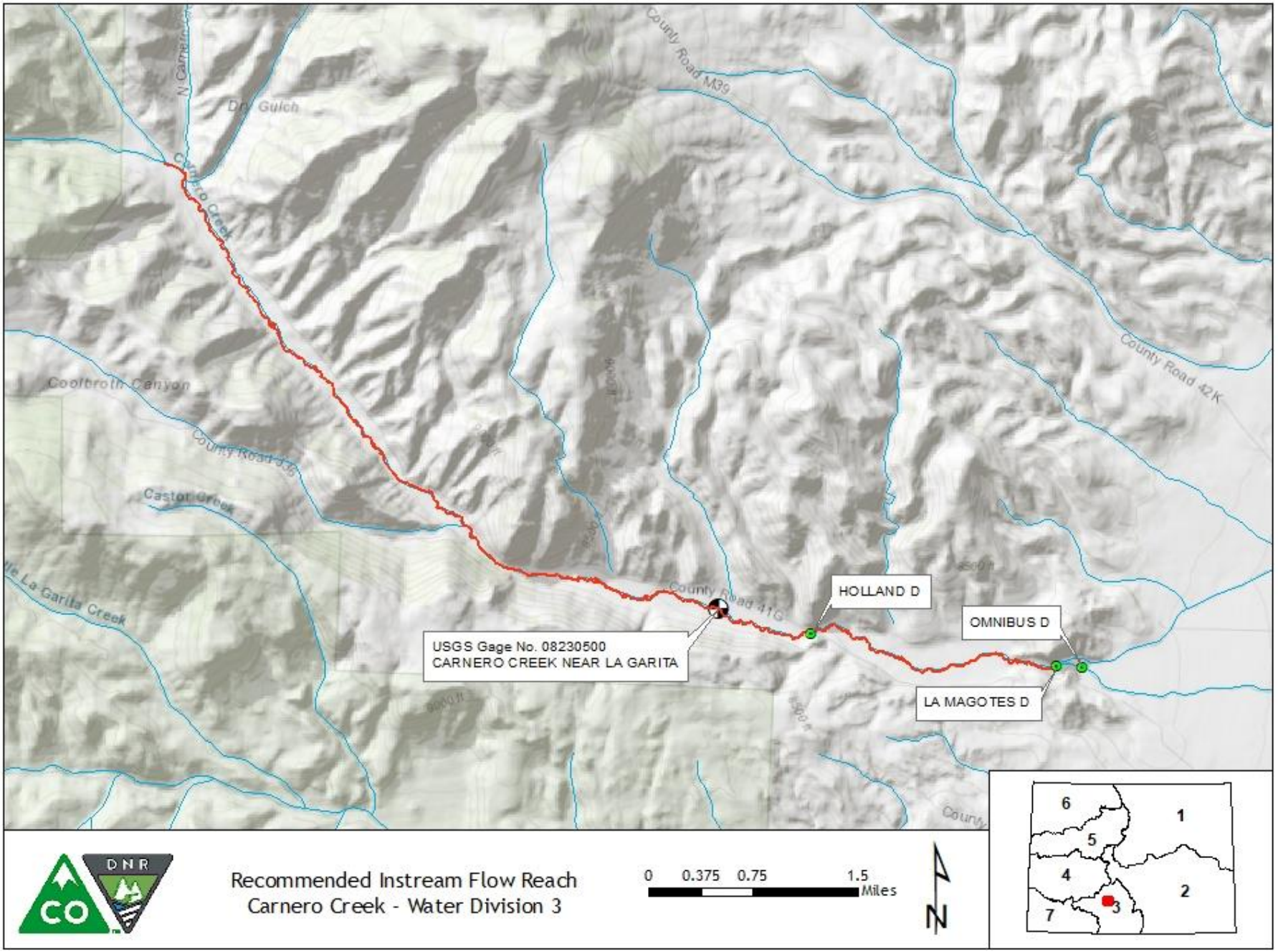
VICINITY MAP



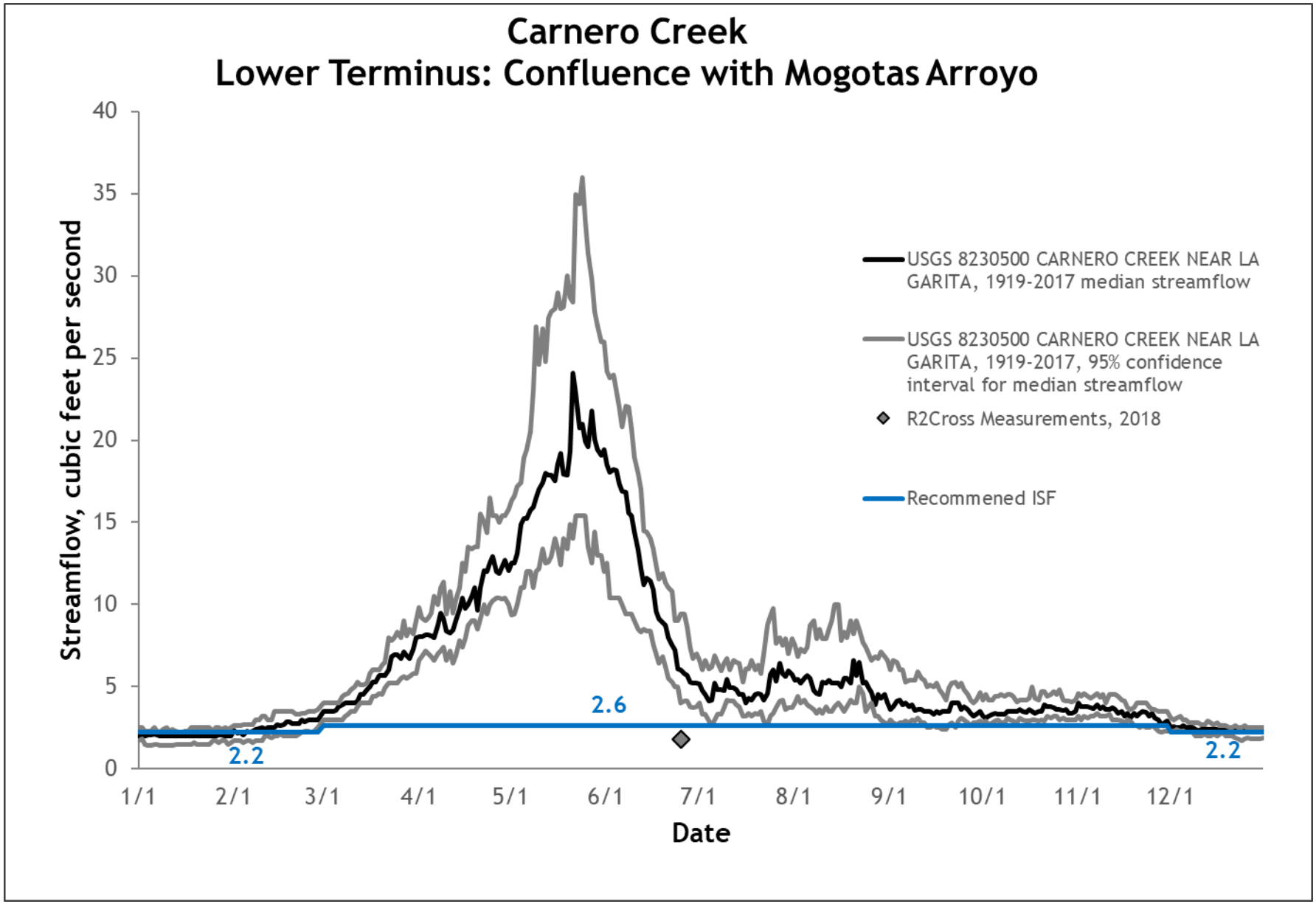
LAND OWNERSHIP MAP



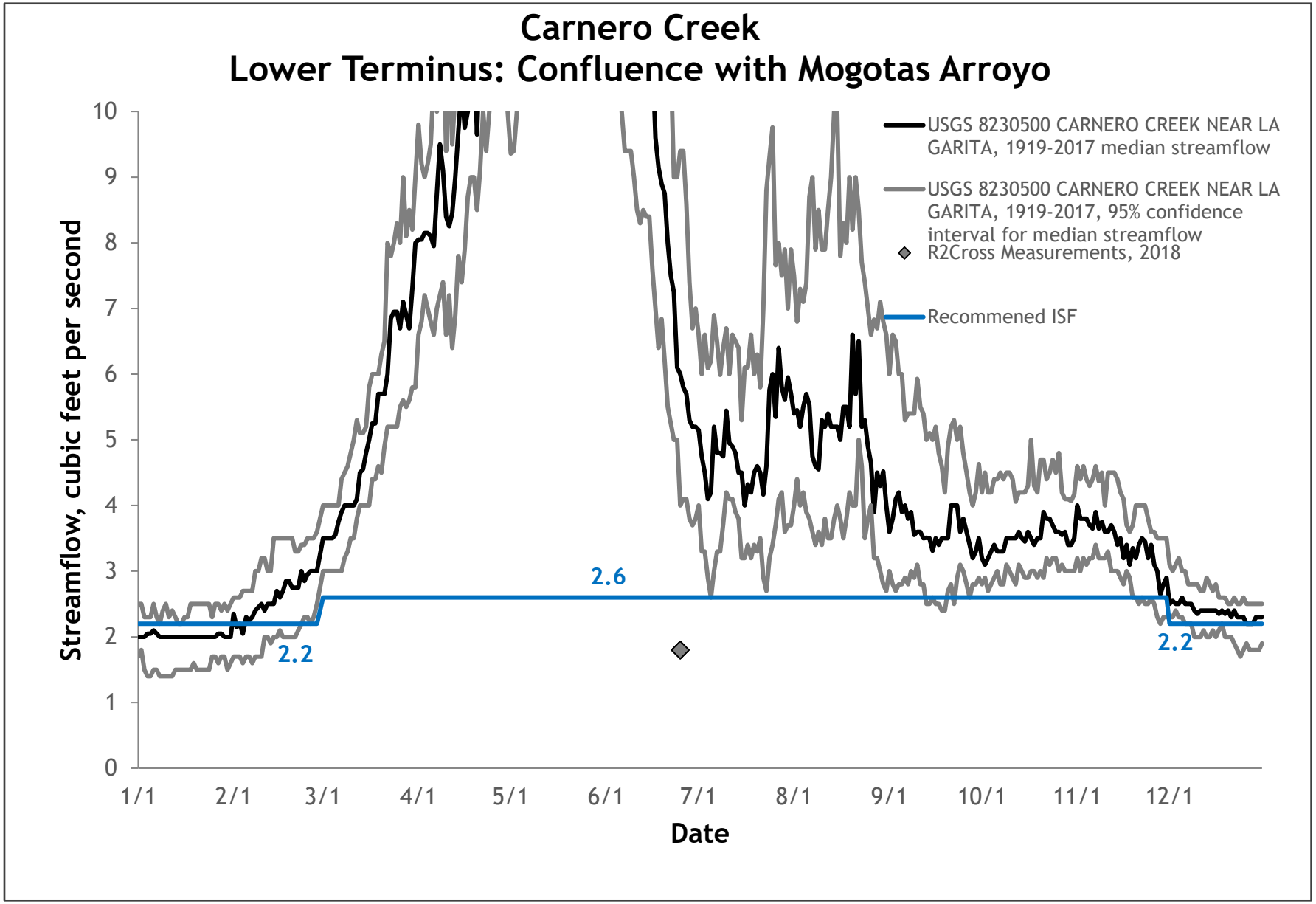
HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



DETAILED HYDROGRAPH



COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Cold Spring Creek
EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	Amalla Spring UTM North: 4223358.35 UTM East: 343427.98
LOWER TERMINUS:	confluence Pauline Creek UTM North: 4223387.43 UTM East: 345270.75
WATER DIVISION:	4
WATER DISTRICT:	28
COUNTY:	Saguache
WATERSHED:	Tomichi
CWCB ID:	19/4/A-002
RECOMMENDER:	Bureau of Land Management (BLM)
LENGTH:	1.23 miles
FLOW RECOMMENDATION:	0.25 cfs (07/01 - 04/30) 0.40 cfs (05/01 - 06/30)

Cold Spring 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 Cold Spring Creek because it has a natural environment that can be preserved to a reasonable degree. Cold Spring Creek is located within Saguache County (See Vicinity Map), and originates at an elevation of approximately 9,695 ft. Cold Spring Creek flows east for 1.23 miles to the confluence with Pauline Creek at an elevation of approximately 9,432 ft. The proposed reach extends from Amalla Spring downstream to the confluence with Pauline Creek. The BLM manages 40 percent of the land on the 1.23 mile proposed reach and 60 percent is privately owned (See Land Ownership Map).

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/2019ProposedISFRecommendations.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 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.

Cold Spring Creek is a moderate gradient stream that flows through a shallow valley averaging approximately one-eighth mile in width. The upper part of the reach has large substrate, including many boulders. The lower part of reach has small substrate consisting of sand and gravel.

Cold Spring Creek supports a natural environment that is highly reliant on consistent discharge from Amalla Spring. The creek is not known to support a fishery. However, the creek supports an abundant and diverse macroinvertebrate community, abundant aquatic vegetation such as watercress, and a very healthy riparian community that includes willow species, blue spruce, and gooseberry.

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 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 1). 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 0.42 cubic feet per second (cfs), which meets 2 of 3 criteria and is within the accuracy range of the R2Cross model. The R2Cross model did not produce in range results for a summer flow rate that meets the 3 of 3 criteria.

Table 1. Summary of R2Cross transect measurements and results for Cold Spring Creek.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
BLM	06/30/2016 # 1	0.49	0.20 - 1.23	0.43	Out of range
BLM	06/30/2016 # 2	0.39	0.16 - 0.98	0.40	Out of range
			Mean	0.42	

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

0.4 cubic feet per second is recommended during the snowmelt runoff period from May 1 to June 30. This recommendation is driven by the wetted perimeter criteria. The higher flows that occur during snowmelt recharge the alluvial aquifer that supports the healthy riparian community.

0.25 cubic feet per second is recommended from July 1 to April 30. This recommendation is driven by limited water availability. The base flow provided by the spring maintains aquatic vegetation that requires fairly consistent flow rates and high water quality. In addition, the consistent discharge of high quality water from the spring provides ideal macroinvertebrate habitat.

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.

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). 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 Cold Spring Creek is 8.84 square miles, with an average elevation of 10,207 ft and average annual precipitation of 19.23 inches (See the Hydrologic Features Map). Cold Springs Creek becomes a perennial stream where a number of unnamed tributaries come together; however, consistent streamflow generally occurs downstream from Amalla Spring (Roy

Smith, personal communication). There are water rights on four springs in the basin tributary to the proposed ISF. The largest of these is located approximately 400 feet upstream from the upper terminus (Coleman Ranches Spring No. 1, appropriation date 11/30/1982, 0.5 cfs). This water right is decreed for irrigation and domestic uses. The domestic uses are for a cow camp, but there are no diversion records, and no irrigated lands associated with this structure are identified in HydroBase. The current water commissioner was not aware of any irrigated lands and did not see evidence of a measuring device or active ditch during a site visit on 11/21/2018 (personal communication, Jack Brazinsky, 11/21/2018). Based on limited water use in the basin, hydrology in this drainage basin represents natural flow conditions.

Available Data

There is not a current or historic streamflow gage on Cold Spring Creek or any nearby creek that would be suitable for estimating flow on Cold Spring Creek.

CWCB staff installed a pressure transducer near the upper terminus in May 2017 in an effort to better understand the hydrology associated with the stream. Streamflow and stage were measured periodically through 2018; however, it was not possible to develop a reliable rating curve due to growth of aquatic vegetation, which altered the stage-discharge relationship seasonally. Nevertheless, the 17 measurements of streamflow provide an indication of available streamflow and are summarized in Table 2.

Table 2. Summary of Streamflow Measurement Visits and Results for Cold Spring Creek.

Visit Date	Flow (cfs)	Collector
11/7/2018	0.09	BLM
9/10/2018	0.09	BLM
7/10/2018	0.07	BLM
6/5/2018	0.07	BLM
5/11/2018	0.07	CWCB
5/10/2018	0.11	BLM
10/17/2017	0.12	BLM
9/12/2017	0.08	BLM
8/25/2017	0.23	BLM
8/14/2017	0.3	BLM
8/2/2017	0.19	CWCB
7/25/2017	0.32	BLM
7/10/2017	0.31	BLM
6/21/2017	0.44	BLM
6/8/2017	0.44	BLM

Data Analysis
The best available information for streamflow on Cold Spring Creek includes the StreamStats estimates of mean-monthly flow and the measured streamflow at the spring. The StreamStats results provide an estimate of the amount of water available during spring runoff. The measured streamflow from the spring provides more detailed information for 2017 and 2018. These measurements reflect a relatively high runoff year (2017) and a very low runoff year (2018).

Water Availability Summary
The hydrograph (See Complete Hydrograph) shows StreamStats results for mean-monthly streamflow and all available streamflow measurements. The proposed ISF rate is below the StreamStats estimates and generally between the 2017 and 2018 field measurements. Based on the available data, Staff has concluded that water is available for appropriation.

Material Injury
Because the proposed ISF on Cold Spring 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. (2018), 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.

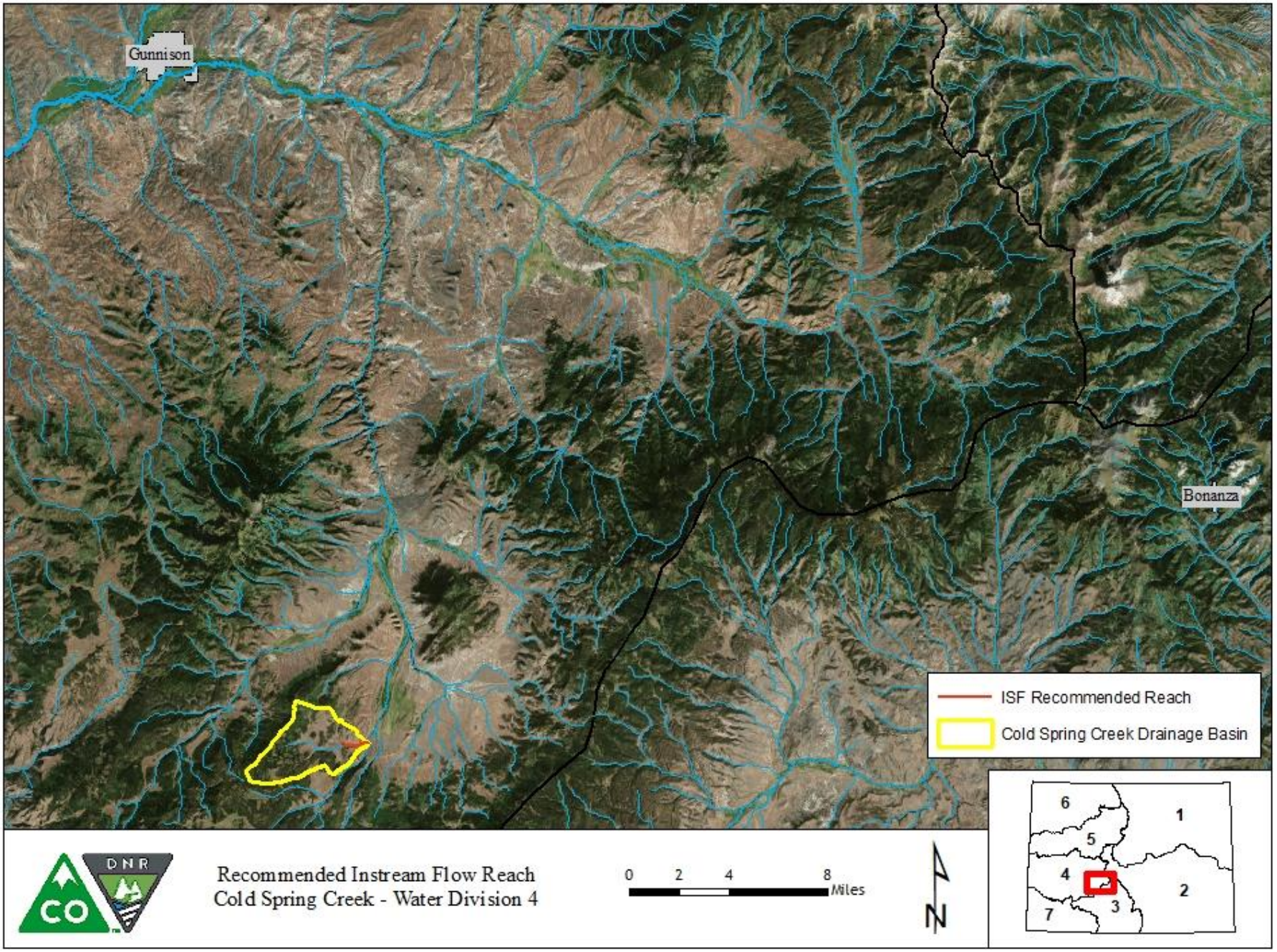
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

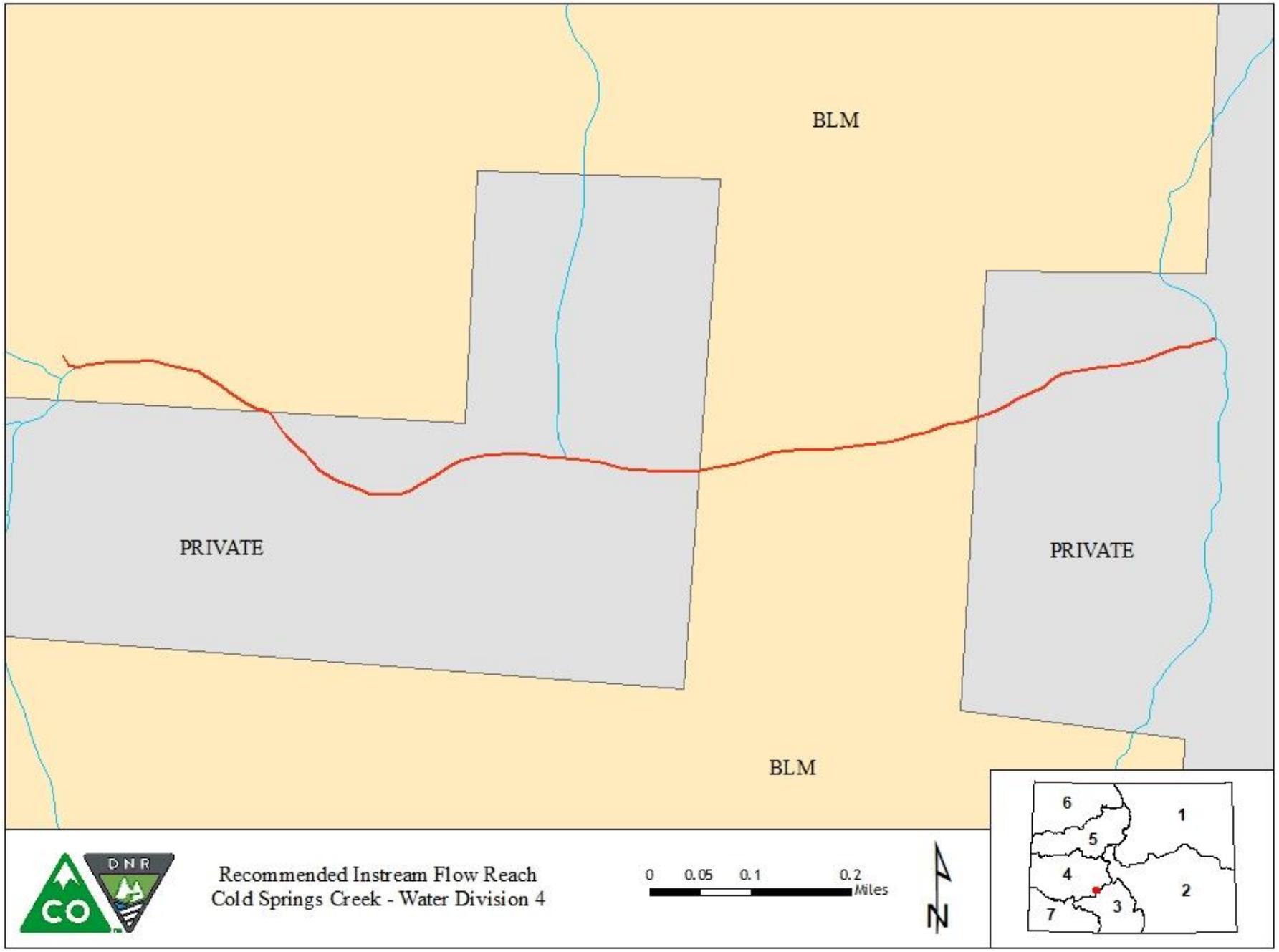
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

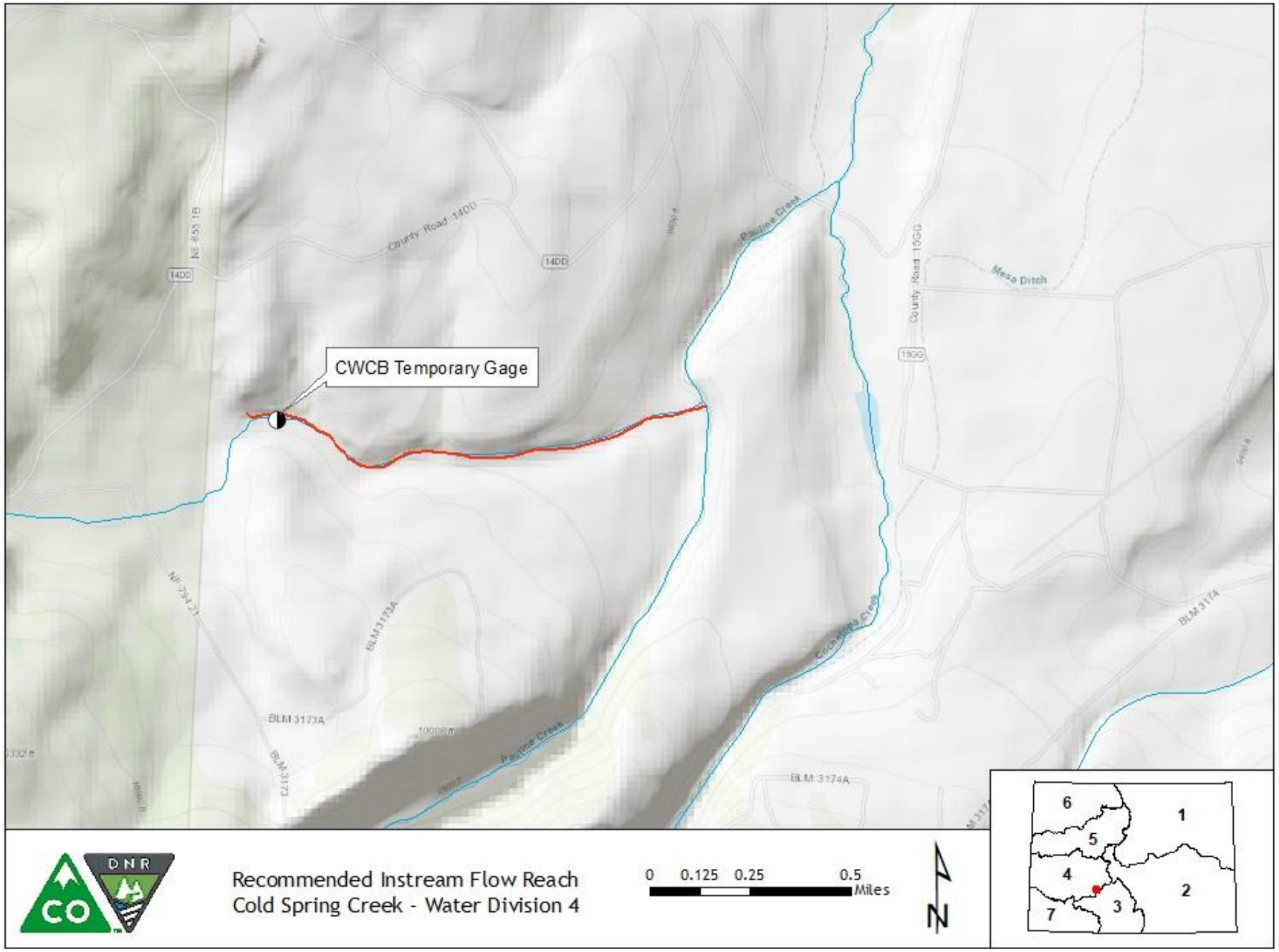
VICINITY MAP



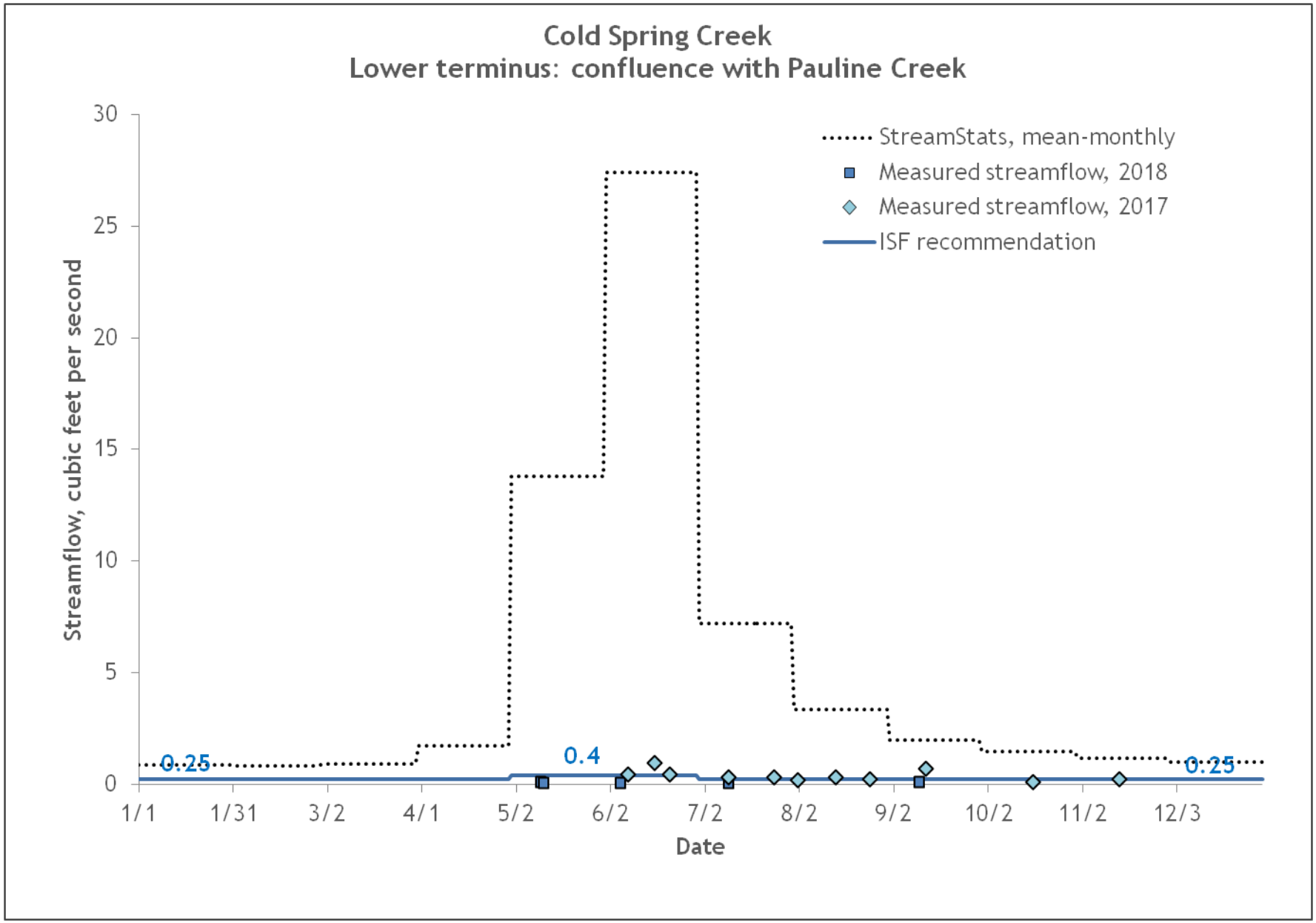
LAND OWNERSHIP MAP



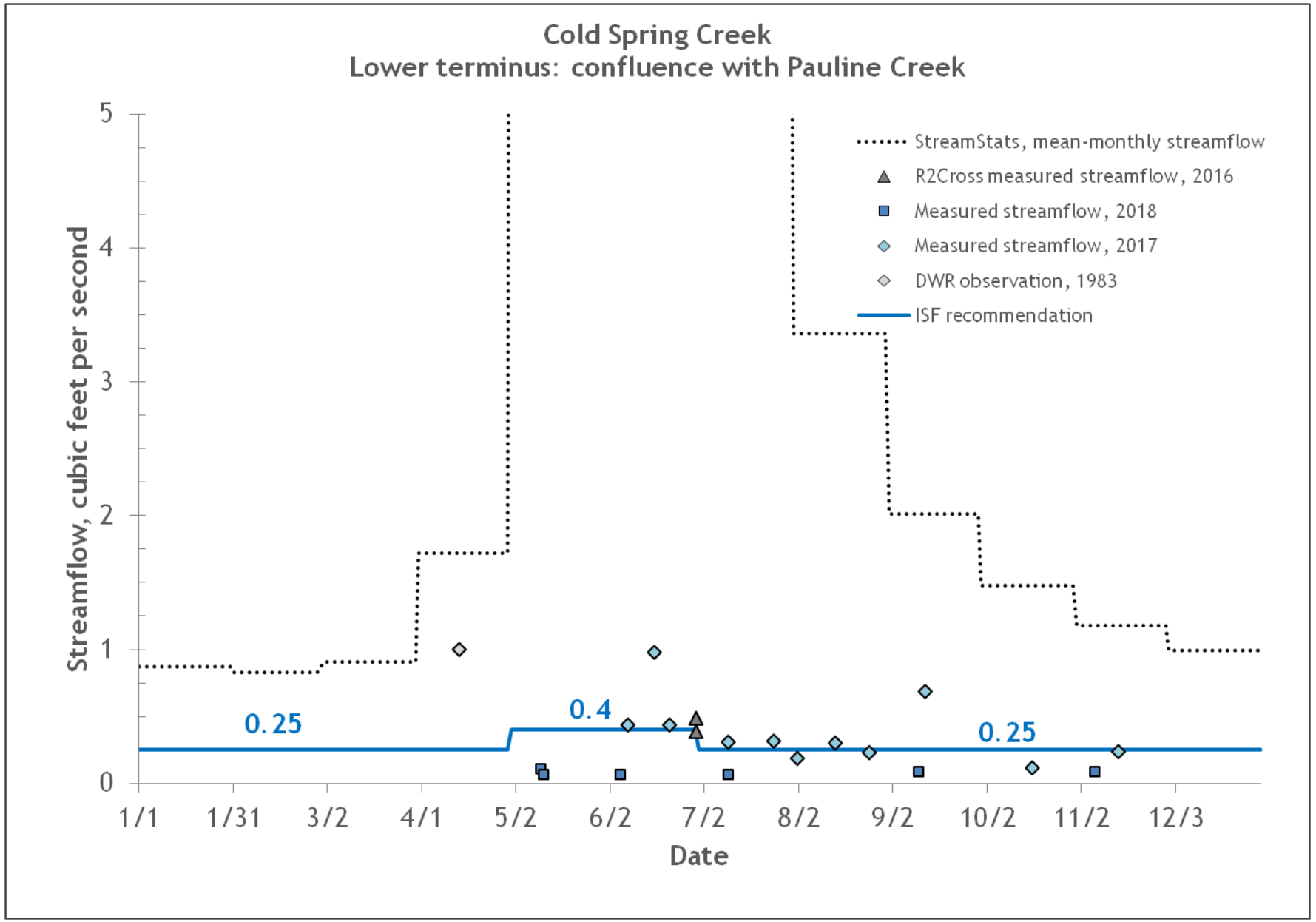
HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



DETAILED HYDROGRAPH



COLORADO
Colorado Water Conservation Board
Department of Natural Resources

East Fork Little Cimarron River

EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	headwaters in the vicinity of UTM North: 4233197.29 UTM East: 287899.31
LOWER TERMINUS:	confluence with the Little Cimarron River UTM North: 4241814.80 UTM East: 284446.65
WATER DIVISION:	4
WATER DISTRICT:	62
COUNTY:	Gunnison
WATERSHED:	Upper Gunnison
CWCB ID:	19/4/A-001
RECOMMENDER:	Bureau of Land Management (BLM)
LENGTH:	6.45 miles
FLOW RECOMMENDATION:	1.0 cfs (01/01 - 04/30) 2.8 cfs (05/01 - 06/30) 1.2 cfs (07/01 - 12/31)

East Fork Little Cimarron River

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 the East Fork Little Cimarron River because it has a natural environment that can be preserved to a reasonable degree. The East Fork Cimarron River is located within Gunnison County and originates at approximately 10,520 ft in elevation. It flows north from the foothills of the Cimarron Mountains for 6.45 miles before joining the Little Cimarron River at an elevation of approximately 8,492 ft (See Vicinity Map). The proposed reach extends from the headwaters downstream to the confluence with the Little Cimarron River. The Bureau of Land Management and U.S. Forest Service manage 65 percent of the land on the 6.45 mile proposed reach and 35 percent is privately owned (See Land Ownership Map).

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/2019ProposedISFRecommendations.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 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.

The East Fork Little Cimarron River is a cold-water, high gradient stream. It flows through a canyon with a valley floor averaging one-eighth mile in width. In the upper four miles, the river flows through several meadows with alluvial deposits. In the lower two miles, it flows through a narrow valley and is confined by bedrock. The river generally has medium to large-sized substrate, consisting of gravels, small cobbles, and small boulders. The river has a good mix of pools, small riffles, and runs.

Fisheries surveys have revealed a self-sustaining population of brook trout, and numerous fish of diverse age classes were observed during site visits. Fish cover is abundant in the form of large wood and over-hanging banks. Intensive macro-invertebrate surveys have not been conducted, but spot samples have revealed various species of mayfly, caddisfly, and stonefly.

In open meadow areas, the riparian community is generally comprised of willows, grasses, and sedges. In more confined reaches, the riparian community is generally comprised of blue spruce,

aspen, willow species, and alder. The riparian community is in very good condition, and provides shading and cover for fish habitat.

Table 1. List of species identified in East Fork Little Cimarron River.

Species Name	Scientific Name	Status
brook trout	*Salvelinus fontinalis*	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 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 six 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 1.20 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 2.84 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 East Fork Little Cimarron River.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
BLM	06/28/2017 #1	1.76	0.70 - 4.40	2.40	Out of range
BLM	06/28/2017 #2	2.21	0.88 - 5.53	1.63	2.84
BLM	07/12/2016 #1	0.64	0.26 - 1.60	1.13	Out of range
BLM	07/12/2016 #2	0.58	0.23 - 1.45	0.65	Out of range
BLM	07/28/2015 #1	0.45	0.18 - 1.13	0.59	Out of range
BLM	07/28/2015 #2	0.49	0.20 - 1.23	0.82	Out of range
			Mean	1.20	2.84

ISF Recommendation

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

2.8 cfs is recommended during the snowmelt runoff period from May 1 to June 30. This recommendation is driven by the average velocity criteria. Because this river is narrow and has limited physical habitat, 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 stage functions.

1.2 cfs is recommended from July 1 to December 31. This recommendation is driven by the depth and wetted perimeter criteria. As mentioned above, this river is narrow and has very limited physical habitat. This flow rate will allow passage between pools for full usage of the limited habitat.

1.0 cfs is recommended from January 1 to April 30. This flow rate is limited by water availability, but should prevent pools from freezing, allowing the fish population to successfully overwinter. Even though the base flow in this river is small, it is extremely consistent, allowing the fishery to persist.

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.

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). 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 Little Cimarron River is 6.76 square miles, with an average elevation of 10,216 ft and average annual precipitation of 27.05 inches (See the Hydrologic Features Map). There is a small on-channel reservoir located within the reach that is an undecreed flow-through pond used for stock and recreation. This pond does not appear to have any effect on water availability. There are no other decreed surface water diversions within the basin tributary to the proposed ISF. Due to the lack of diversions, hydrology in the drainage basin represents natural flow conditions.

Available Data

There are no current or historic streamgages in the vicinity of the proposed ISF reach or nearby drainages that would be representative of streamflow in this reach. In some cases, diversion records can be used to provide an indication of water availability in the stream reach; however, there are no known surface diversions.

CWCB staff made two streamflow measurements on the proposed reach of East Fork Little Cimarron River as summarized in Table 3. Staff measured 0.16 cfs on the lower portion of the reach as the river flows through a narrow, steep canyon with large boulder and cobble substrate. The second streamflow measurement (0.23 cfs) was collected upstream in a low gradient reach that meanders through a broad, open valley.

Table 3. Summary of Streamflow Measurement Visits and Results for East Fork Little Cimarron River.

Visit Date	Flow (cfs)	Collector
06/27/2018	0.23	CWCB
06/27/2018	0.16	CWCB

Data Analysis
StreamStats provides the best available estimate of streamflow on East Fork Little Cimarron River.

Water Availability Summary
The hydrograph (See Complete Hydrograph) shows StreamStats results for mean-monthly streamflow. Staff has concluded that water is available for appropriation.

Material Injury
Because the proposed ISF on East Fork Little Cimarron 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. (2018), 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.

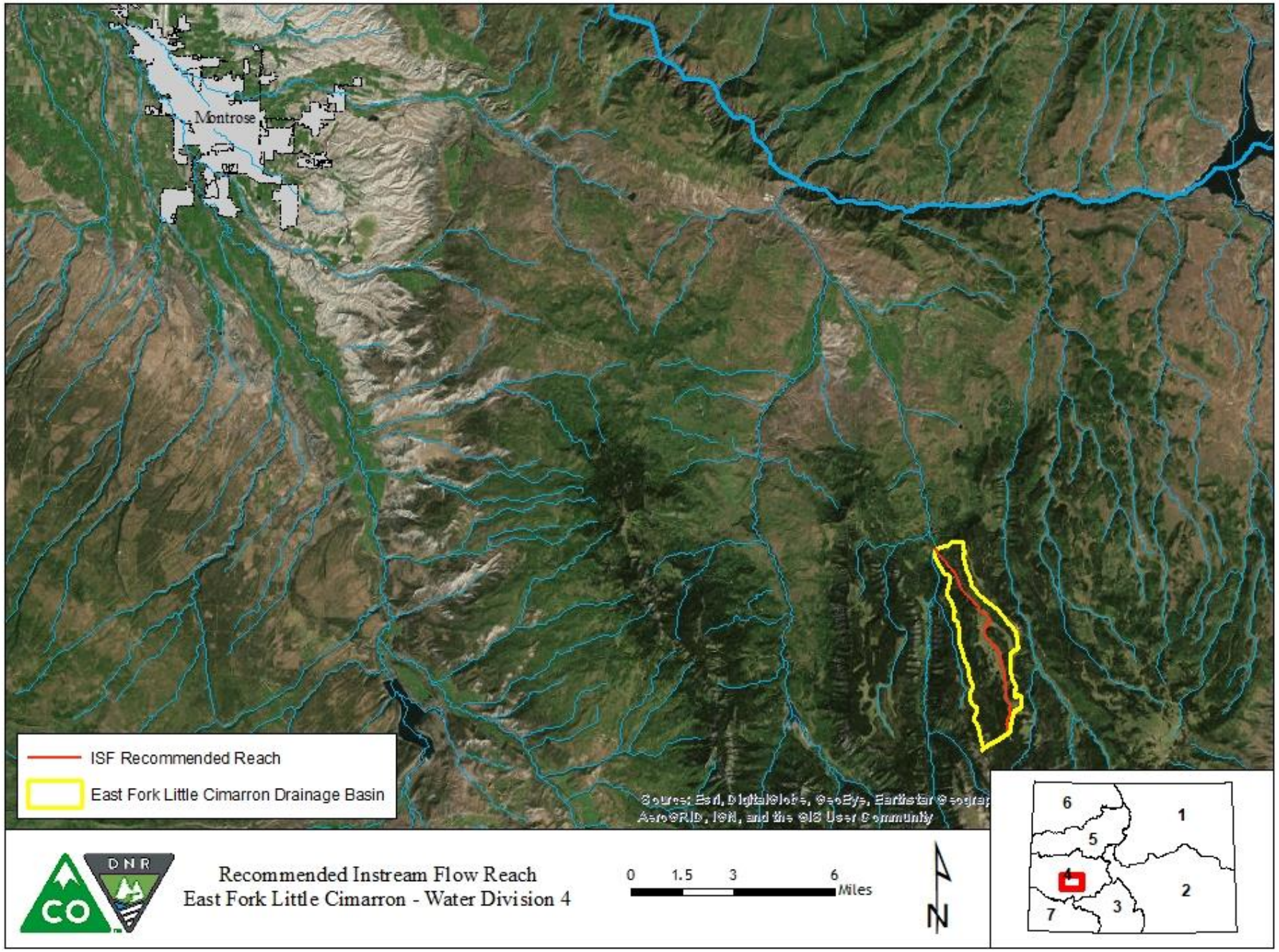
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

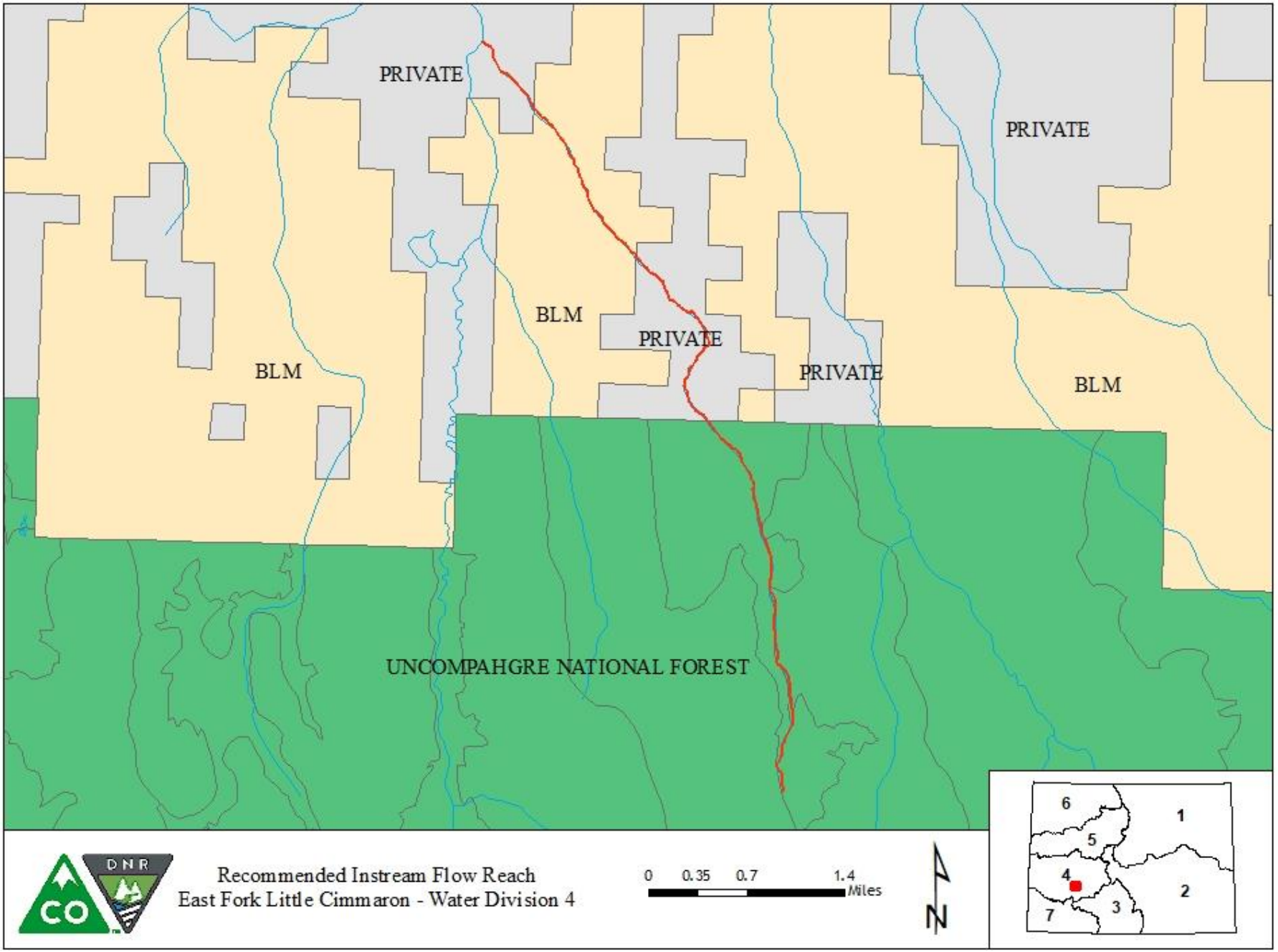
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

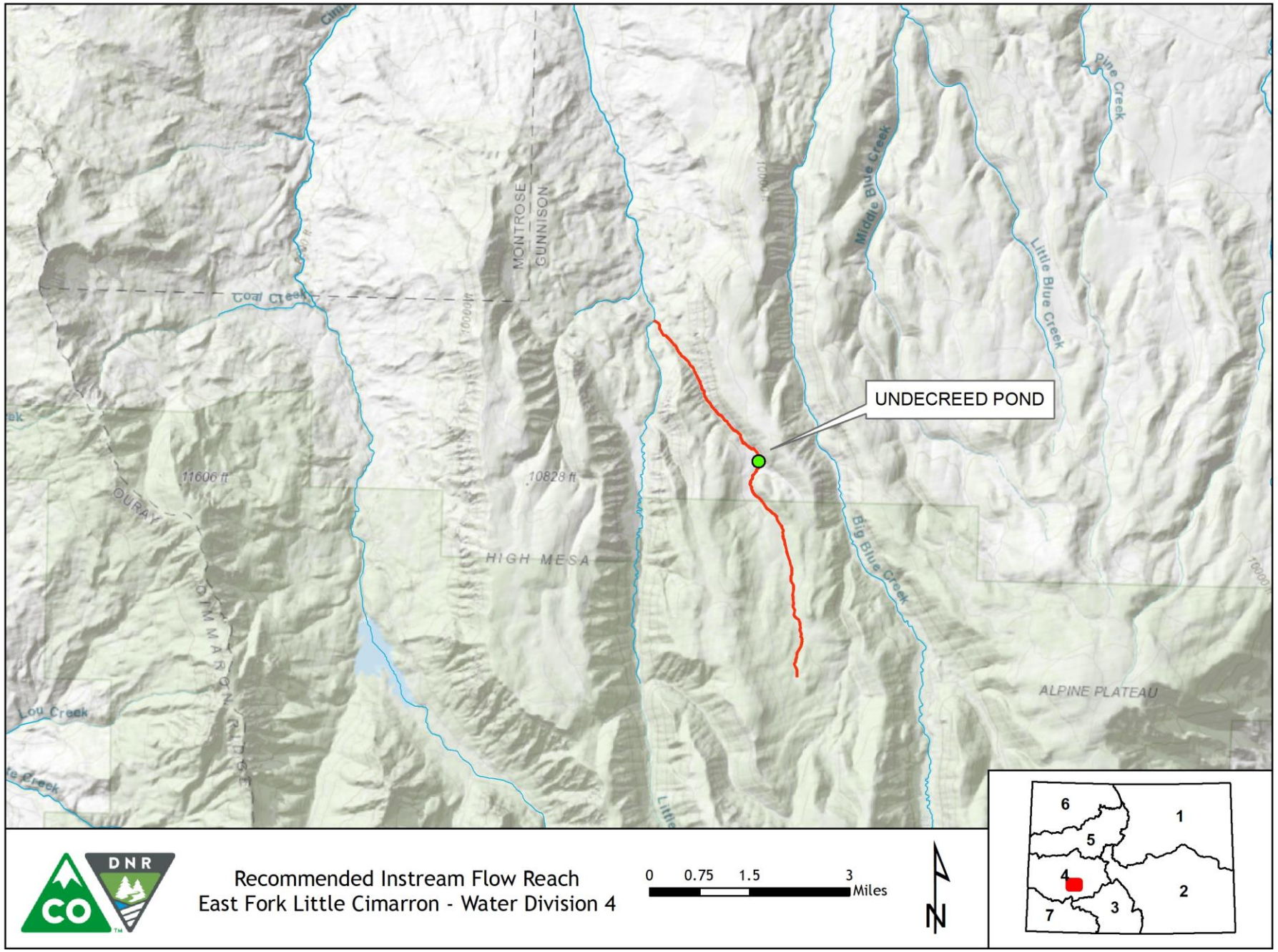
VICINITY MAP



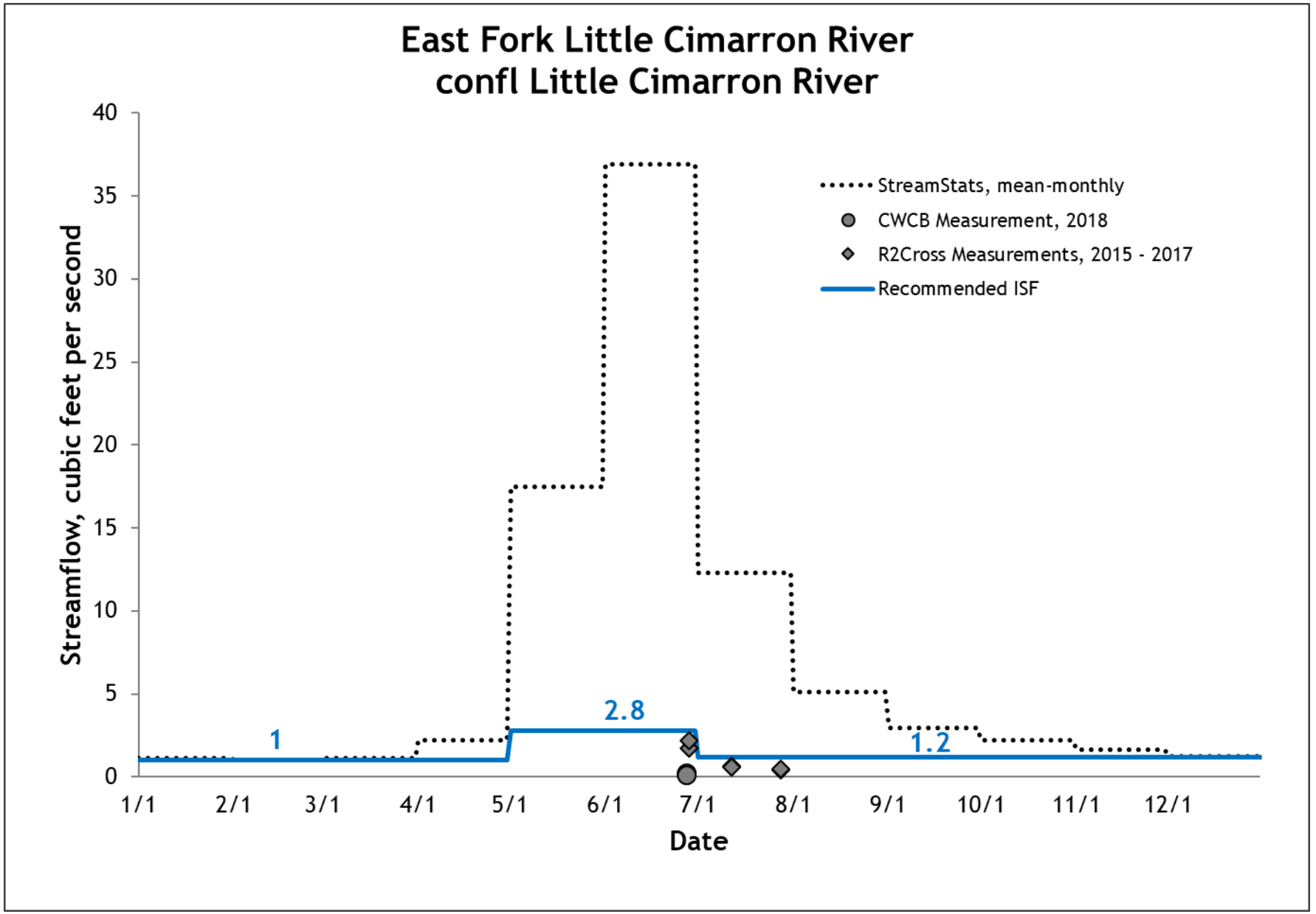
LAND OWNERSHIP MAP



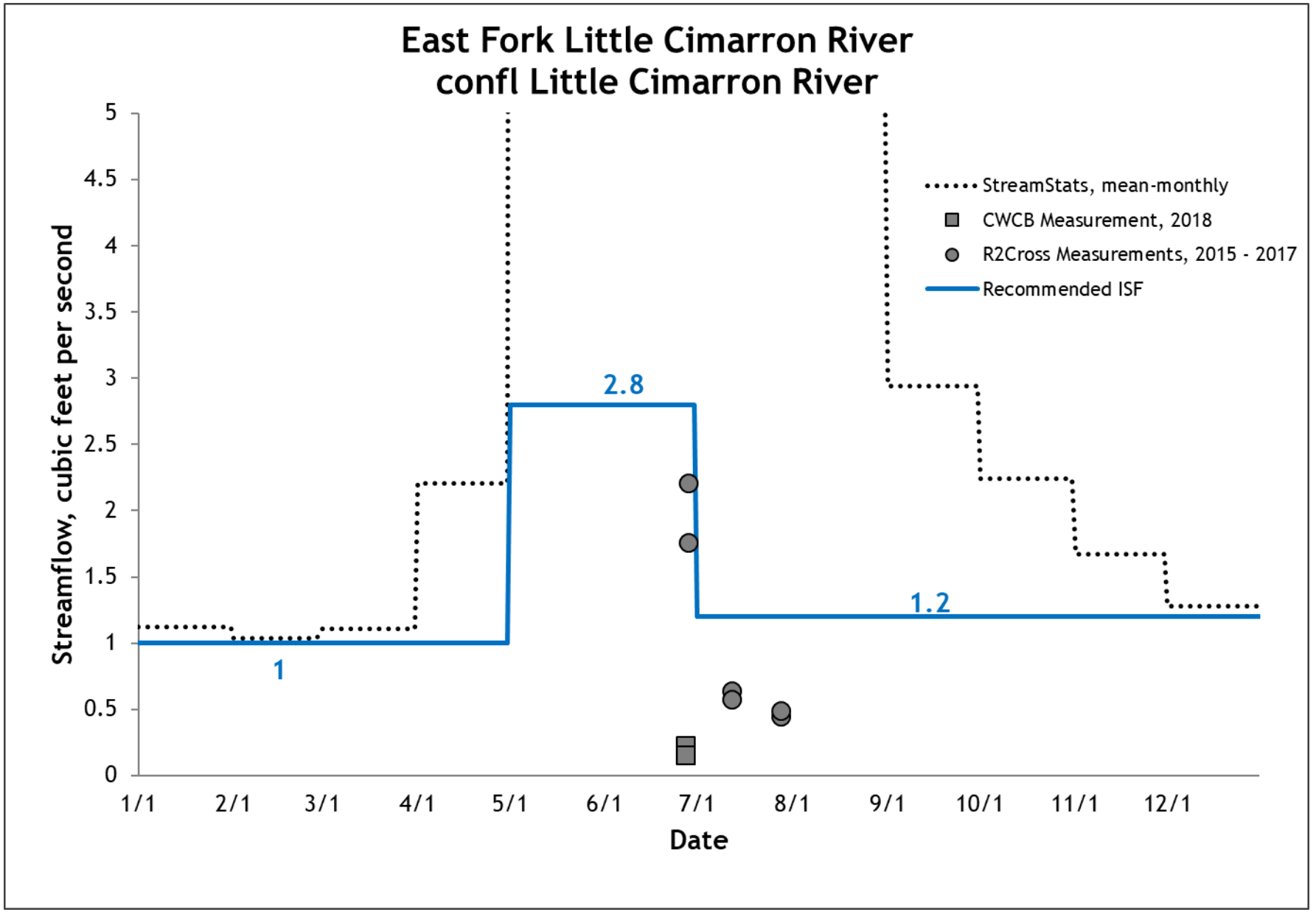
HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



DETAILED HYDROGRAPH



COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Gold Creek
EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	headwaters in the vicinity of UTM North: 4284386.51 UTM East: 363395.53
LOWER TERMINUS:	Tarkington Ditch headgate UTM North: 4270404.77 UTM East: 359675.26
WATER DIVISION:	4
WATER DISTRICT:	28
COUNTY:	Gunnison
WATERSHED:	Tomichi
EXISTING ISF:	80W0135, 7.0 cfs (01/01 - 12/31)
CWCB ID:	19/4/A-005
RECOMMENDER:	High Country Conservation Advocates (HCCA)
LENGTH:	10.32 miles
FLOW RECOMMENDATION:	4.0 cfs (04/15 - 07/10)

Gold 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.

HCCA recommended that the CWCB appropriate an increase to the existing ISF water right on a reach of Gold Creek. Gold Creek is located within Gunnison County and originates at an elevation of approximately 11,600 ft near the eastern boundary of the Fossil Ridge Wilderness Area. The stream flows south 11 miles to the confluence with Quartz Creek at an elevation of approximately 8,560 ft (See Vicinity Map). The proposed reach extends from the headwaters downstream to the Tarkington Ditch headgate. The U.S. Forest Service manages 67 percent of the land on the 10.32 mile proposed reach and the remaining 33 percent is privately owned (See Land Ownership Map). The current ISF water right does not provide sufficient physical habitat during the warm weather portions of the year when the fish populations are feeding, growing, and spawning.

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/2019ProposedISFRecommendations.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 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.

Gold Creek is a cold-water, high gradient stream located in Gunnison County, Colorado. The stream substrate ranges from small gravels to medium boulders. There is a mixture of riffles and small pools that provide excellent habitat for fish and other aquatic life. Sampling conducted by Colorado Parks and Wildlife in 2001 identified a healthy brook trout population. An abundance of fish of differing sizes was observed by HCCA and Alpine Environmental Consultants during field reconnaissance and sampling in 2017. In addition to supporting a healthy aquatic ecosystem, flows in Gold Creek help support a robust riparian area. The riparian community is primarily pine/spruce forest near the headwaters of the creek. The riparian area along the middle section of the creek is primarily composed of willow and alder. A mixture of willows and irrigated pasture prevails toward the bottom of the creek, near Ohio City and the confluence with Quartz Creek. The riparian zone is in good condition and provides shade and cover for the fish community. There are both active and abandoned beaver ponds at several locations alongside the creek.

Table 1. List of species identified in Gold Creek.

Species Name	Scientific Name	Status
brook trout	*Salvelinus fontinalis*	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

HCCA 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). HCCA 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 one transect 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 7.00 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 11.00 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 Gold Creek.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
HCCA	10/04/2017	7.37	2.95 - 18.43	7.00	11.00

ISF Recommendation

The HCCA recommended the following flows based on R2Cross modeling analyses, biological expertise, and preliminary water availability analysis. CWCB Staff's water availability analysis determined that water was limited in some cases. The following flows represent the final recommendation which has been modified in collaboration with HCCA due to water availability limitations.

Based on analysis of R2Cross results, an increase of 4.0 cfs to the existing 7.0 cfs is recommended to preserve the natural environment on Gold Creek from April 15 to July 10. The combined total of the two ISF water rights would be 11.0 cfs which satisfies all three of the required hydrologic criteria. This flow duration was modified due to water availability limitations.

No recommendation is being made at this time for the period July 11 to April 14.

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.

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). 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 Gold Creek is 30.2 square miles, with an average elevation of 10,808 ft and average annual precipitation of 24.8 inches (See the Vicinity Map). A number of surface water diversions were identified in the drainage basin tributary to and along the proposed ISF on Gold Creek. These structures divert approximately 25 cfs and include 178.9 AF in reservoir storage.

Available Data

There is not a current or historic daily streamflow gage on Gold Creek. The nearest gage was located on Quartz Creek approximately 1.5 miles downstream from the confluence with Gold Creek (USGS 09281000, Quartz Creek near Ohio City, CO). This historic gage operated from 1937 to 1950 and 1959 to 1970 for a total of 24 years of record. The drainage basin of the Quartz Creek gage is 107 square miles with an average elevation of 10,619 ft and average annual precipitation of 23.4 inches. This results in a proration factor of 0.30 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 approximately 187 cfs in decreed surface water diversions and approximately 210 AF in reservoir storage in the drainage basin of the Quartz Creek gage.

In some cases, diversion records can be used to provide an indication of water availability in a stream reach. The Tarkington Ditch (WDID 2800704, 17.921 cfs, appropriation date 1891) is located at the lower terminus of the proposed Gold Creek ISF reach. This structure has diversion records between 1970 and 2017. The Tarkington Ditch routinely leaves some water in Gold Creek to be picked up downstream (personal communication, Bob Hurford, 12/28/2018); therefore, the diversion record may not reflect the total amount of water available in the stream.

CWCB staff made two streamflow measurements on the subject reach of Gold Creek at a location approximately 2.8 miles upstream from the lower terminus, summarized in Table 3. There are a number of intervening water rights located between the measurement location and the proposed lower terminus.

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

Visit Date	Flow (cfs)	Collector
05/24/2018	23.74	CWCB
04/04/2018	3.41	CWCB

Data Analysis
The Quartz Creek gage provides the best available information during spring runoff, which typically starts earlier than the irrigation season. The Quartz Creek gage data was scaled by 0.30 to the lower terminus of Gold Creek. No adjustments were made to account for the diversions that impact the Quartz Creek gage or the proposed ISF reach. Median streamflow and the upper 95% confidence interval for median streamflow were calculated.

During the irrigation season, the Tarkington Ditch provides the best available information about water availability. The Tarkington Ditch starts diversions between early April and late June. This structure rarely diverts the entire decreed flow rate; however, it is unclear whether this is due to limited water or some other reason. The median diversion and 95% confidence intervals for the median diversion for the Tarkington Ditch were calculated based on the available record, 1969 to 2017 (downloaded from HydroBase on 11/2/2018).

Water Availability Summary
The hydrographs (See Complete and Detailed Hydrographs) show median streamflow and 95% confidence intervals for the median streamflow calculated from the scaled Quartz Creek gage and the median diversion and upper 95% confidence interval for the median diversion for the Tarkington Ditch. The proposed ISF is below the median streamflow based on the Quartz Creek gage the majority of the time and below the upper 95% confidence interval at all times. The proposed ISF is below the upper 95% confidence interval for the median Tarkington Ditch diversions from 6/1 to 7/10 during the primary irrigation season. Staff concludes that water is available for appropriation on Gold Creek.

Material Injury
Because the proposed ISF on Gold 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. (2018), 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.

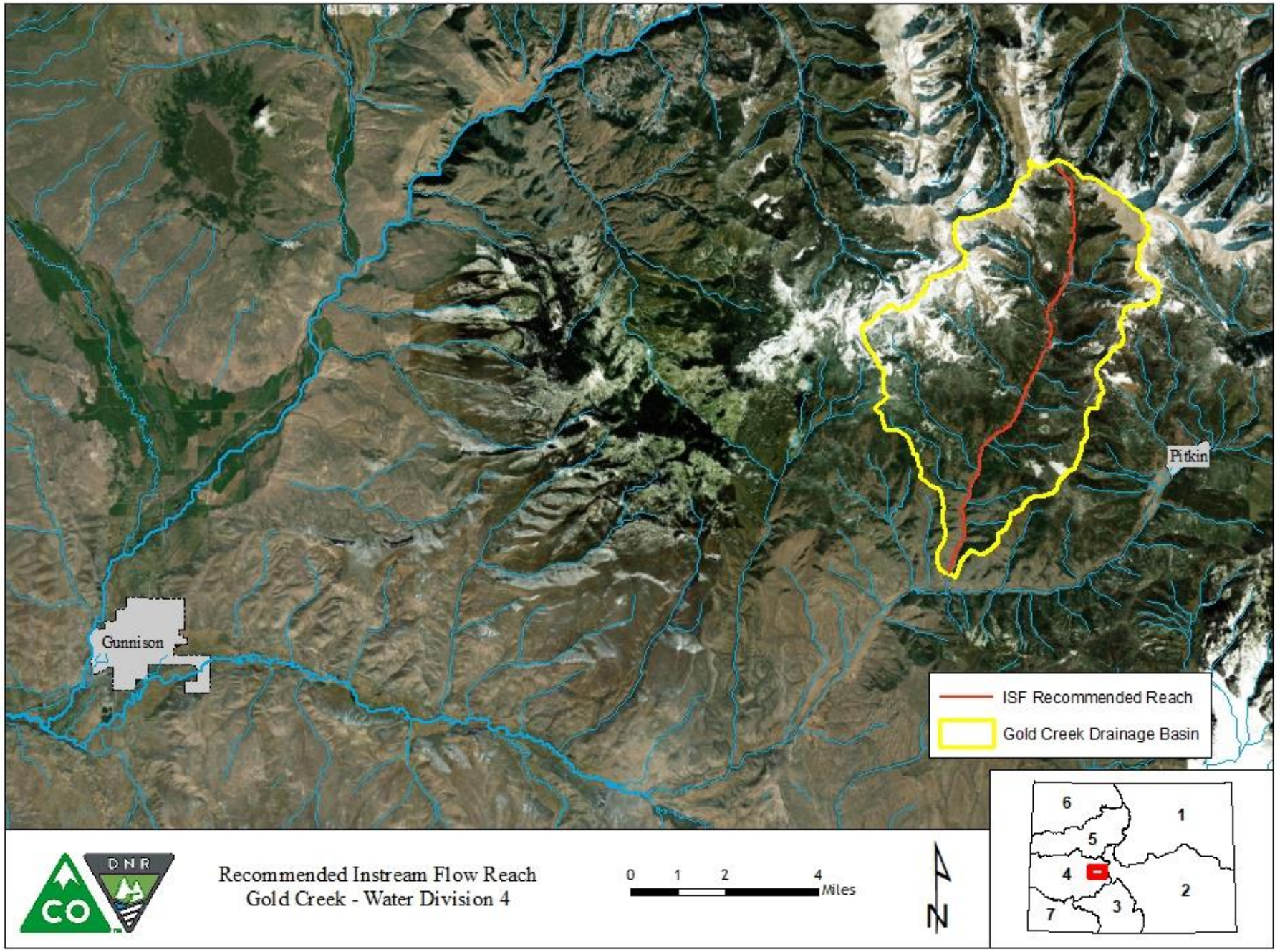
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

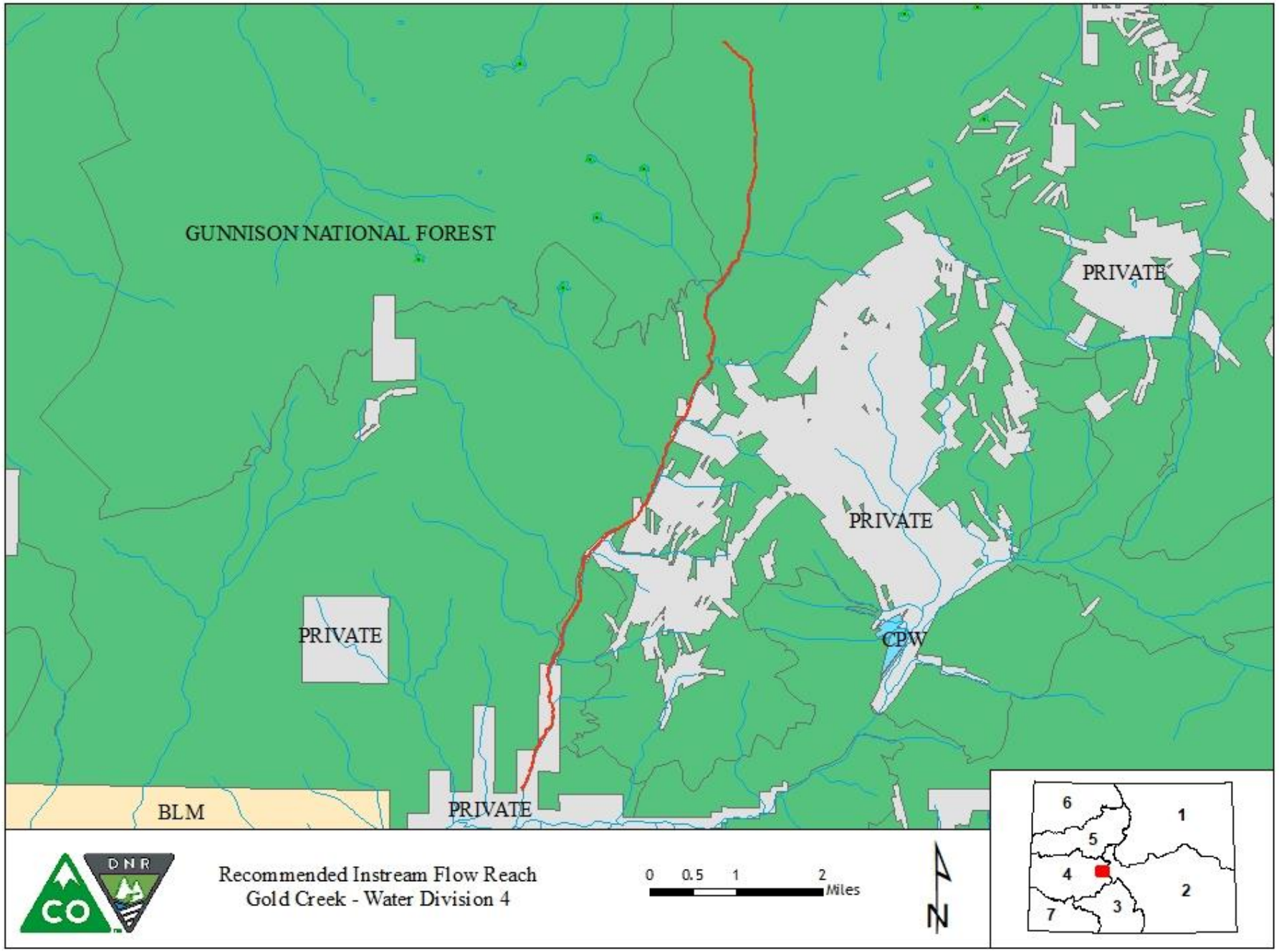
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

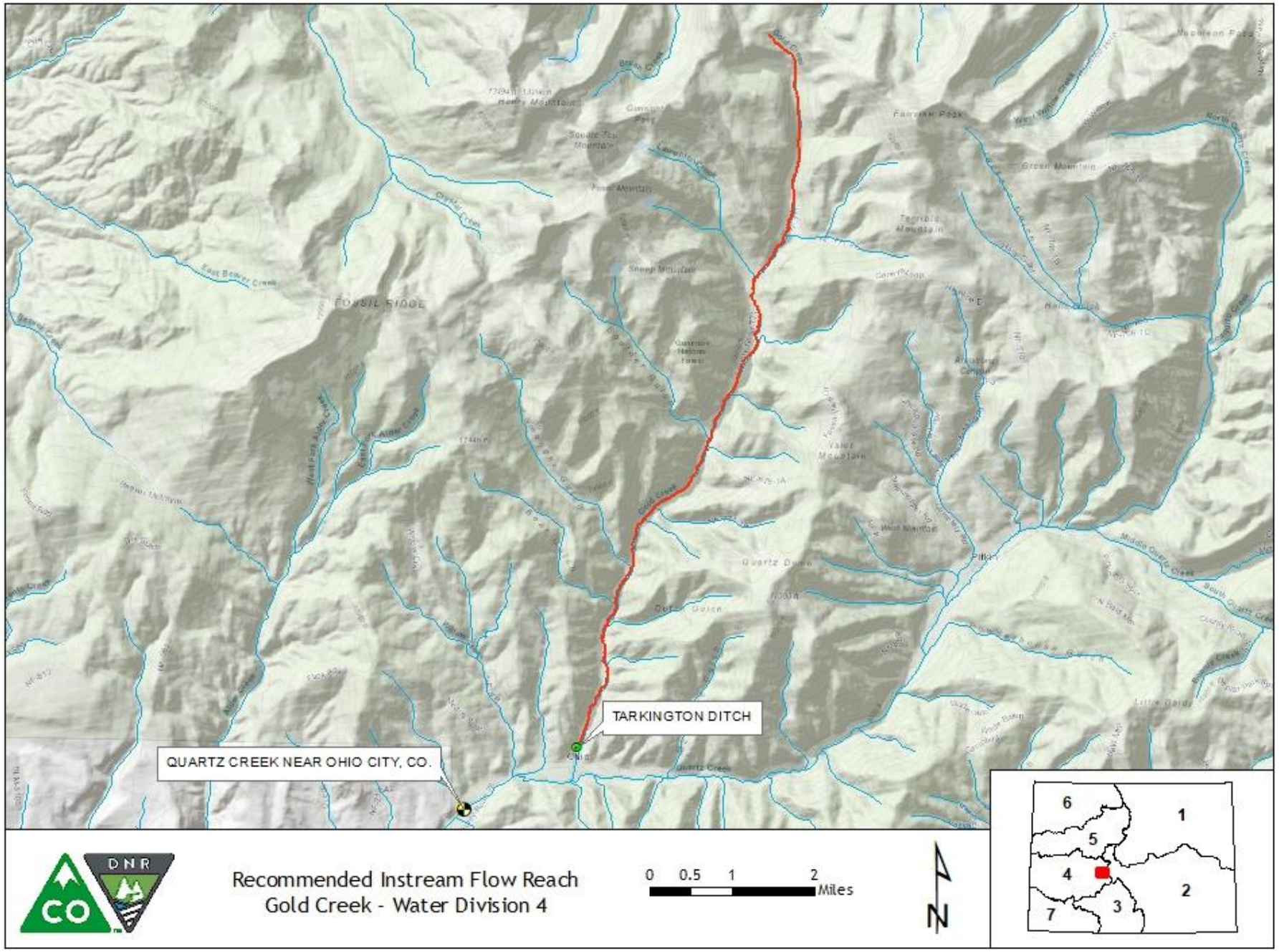
VICINITY MAP



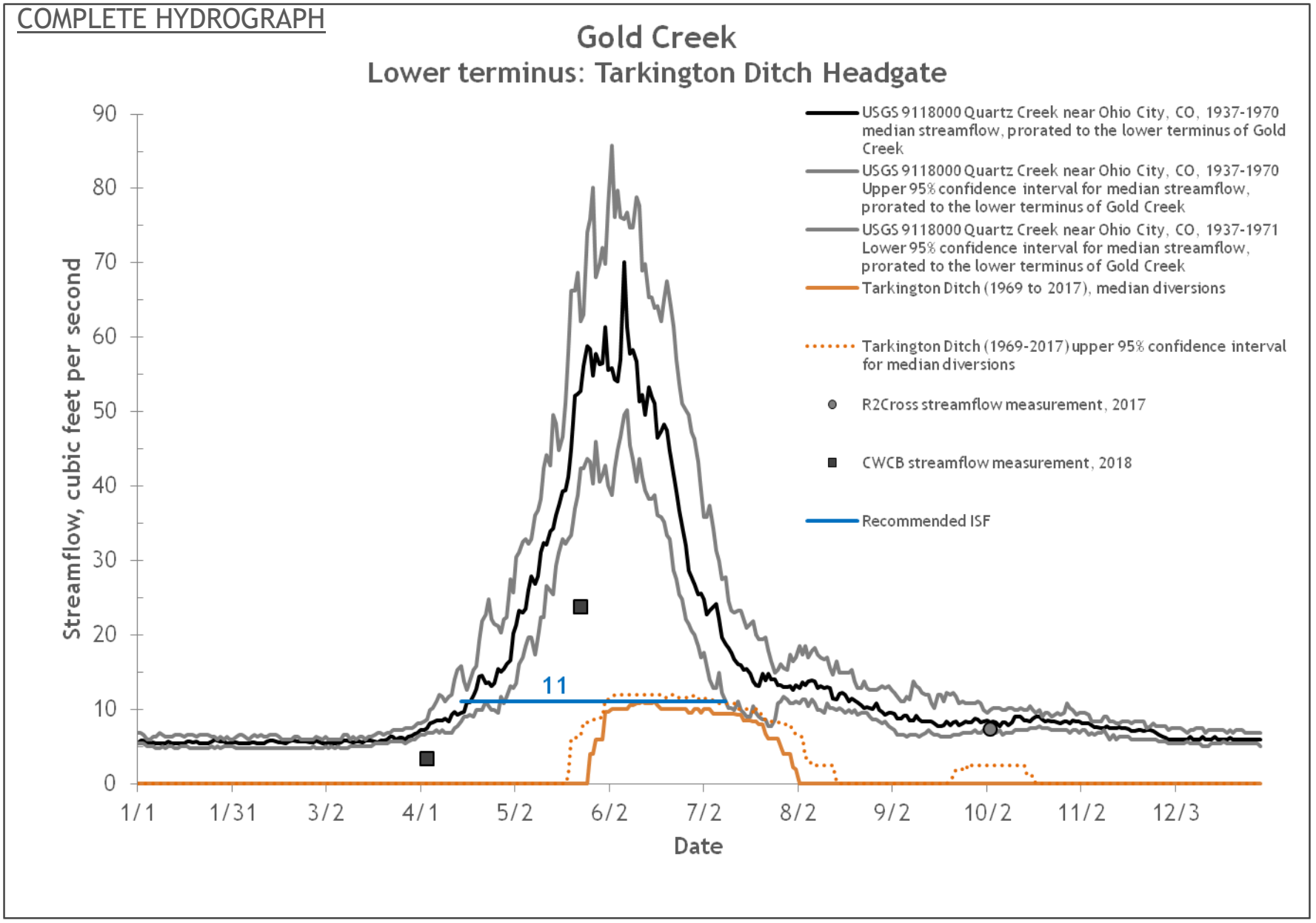
LAND OWNERSHIP MAP



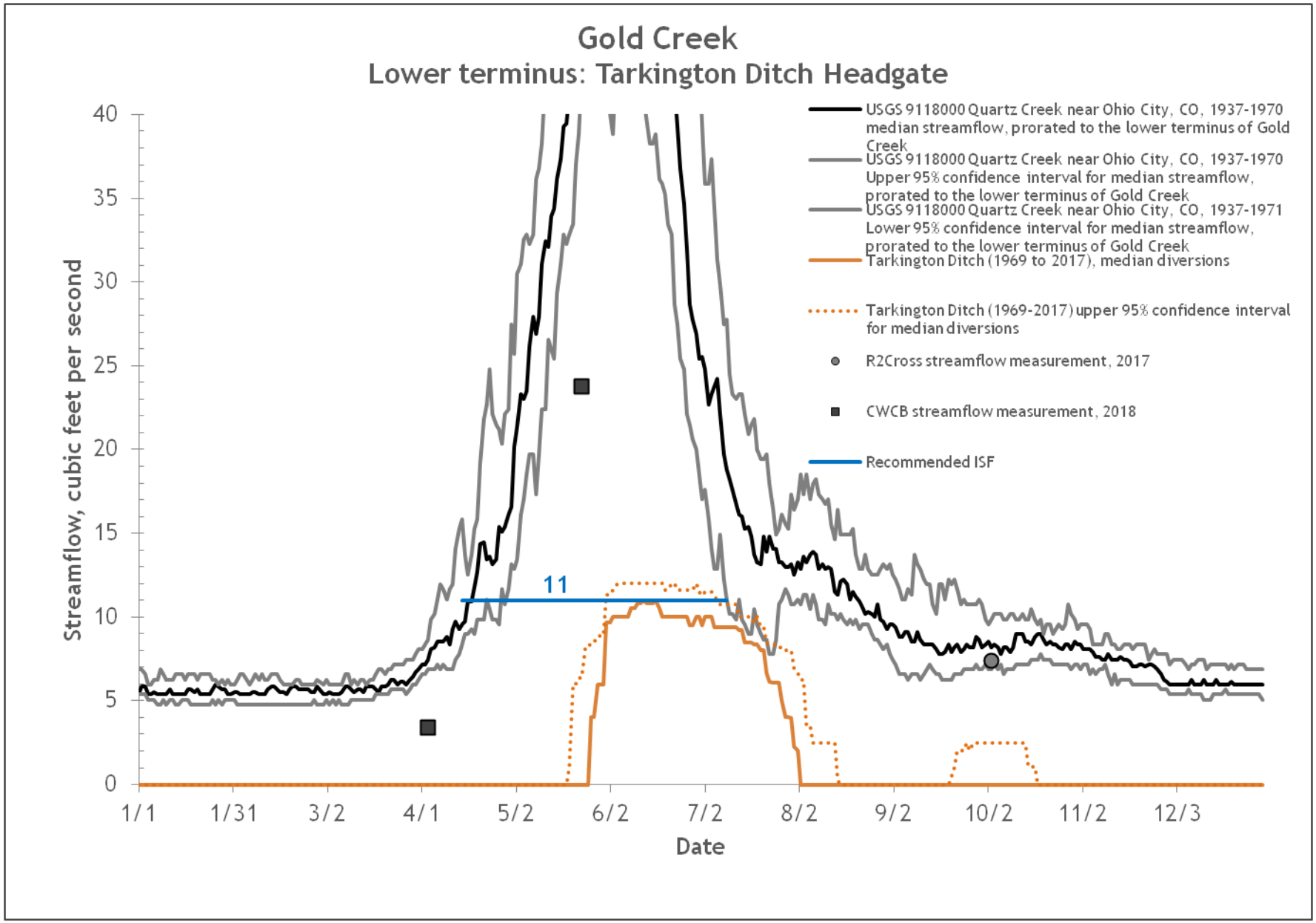
HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



DETAILED HYDROGRAPH



COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Marvine Creek

EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	outlet of Lower Marvine Lake UTM North: 4424055.13 UTM East: 296243.96
LOWER TERMINUS:	confluence with West Marvine Creek UTM North: 4432955.16 UTM East: 291464.01
WATER DIVISION:	6
WATER DISTRICT:	43
COUNTY:	Rio Blanco
WATERSHED:	Upper White
CWCB ID:	18/6/A-007
RECOMMENDER:	Colorado Parks and Wildlife (CPW)
LENGTH:	7.1 miles
FLOW RECOMMENDATION:	5.9 cfs (11/01 – 03/31) 13.1 cfs (04/01 – 10/31)

Marvine 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.

CPW recommended that the CWCB appropriate an ISF water right on a reach of Marvine Creek because it has a natural environment that can be preserved to a reasonable degree. Marvine Creek is located within Rio Blanco County and originates from Marvine Lake at an elevation of 9,314 ft. The stream flows northwest to the confluence with the North Fork White River at an elevation of approximately 7,462 ft (See Vicinity Map). The proposed reach extends from the outlet of Lower Marvine Lake downstream to the confluence with West Marvine Creek. The U.S. Forest Service manages 91 percent of the land on the 7.1 mile proposed reach and 9 percent is privately owned (See Land Ownership Map).

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/2019ProposedISFRecommendations.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 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.

The recommended reach of Marvine Creek starts as a first order stream and becomes a second order stream lower in the reach. The stream channel is primarily a single thread channel flowing through mostly forested cover. Throughout this reach of Marvine Creek, there is an abundance of pool, riffle, and glide habitat types. There is some large wood in the stream contributing to side channel and pool habitat. Substrate generally ranges from large boulders to small cobble. Past CPW fishery surveys indicate presence of Colorado River cutthroat trout (CRCT) and brook trout. The CRCT is a Tier 1 priority species in the 2015 State Wildlife Action Plan, which has the highest conservation priority in the state. CRCT is classified as a state Species of Special Concern and is considered a Sensitive Species by the Bureau of Land Management (BLM) and USFS.

Table 1. List of species identified in Marvine Creek.

Species Name	Scientific Name	Status
Colorado River cutthroat trout	*Oncorhynchus clarkii pleuriticus*	State - Species of Special Concern Federal – Sensitive Species
brook trout	*Salvelinus fontinalis*	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

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 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). 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. However, the R2Cross model also contains the Thorne and Zevenbergen subroutine, which uses field measured bed material grain size to estimate velocity. This method is not constrained by the accuracy range of the Manning's n subroutine.

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 four transects on 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 5.9 cfs, which meets 2 of 3 criteria, and a summer flow of 13.1 cfs, which meets 3 of 3 criteria.

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

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
CPW	07/12/2018 #1	48.00	N/A	2.20[1]	12.80[1]
CPW	07/12/2018 #2	48.00	N/A	6.20[1]	12.50[1]
CPW	09/13/2018 #3	51.00	N/A	7.80[1]	10.40[1]
CPW	09/13/2018 #4	51.00	N/A	7.30[1]	16.70[1]
			Mean	5.9	13.1

1 = Thorne and Zevenberg subroutine was used due to Manning's n results that were outside of the accuracy range. The measured D84 was 0.34 feet in cross-sections #1 and #2 feet and 0.58 feet in cross-sections #3 and #4

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

5.9 cfs from November 1 to March 31 meets 2 of 3 instream flow criteria and will provide suitable overwintering habitat during the baseflow period.

13.1 cfs from April 1 through October 31 meets 3 of 3 instream flow criteria during critical periods for fish migration, spawning, and rearing.

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.

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). 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 Marvine Creek is 40.2 square miles, with an average elevation of 10,068 ft and average annual precipitation of 40.04 inches (See the Hydrologic Features Map). There are four spring water rights in the basin. These water uses appear to be small, and hydrology in this basin essentially represents the natural flow.

Available Data

There are no current or historic streamflow gages located within the proposed ISF reach. There is a historic streamgage, Marvine Creek near Buford, CO (USGS 0902500), approximately 2.5 miles northwest of and downstream from the proposed lower terminus on Marvine Creek near the confluence of the North Fork White River. The historic gage has a continuous period of record (POR) from September 1972 to September 1984. The drainage basin for the historic gage is 59.9 square miles, with an average elevation of 9,813 ft and average annual precipitation of 37.71 inches. This gage will be referred to as the Marvine Creek gage in this analysis. The Marvine Creek gage is downstream from a number of surface water diversions that alter the hydrology measured by the gage. This may underestimate the amount of water available in the proposed ISF reach that is not impacted by water uses.

CWCB staff made one streamflow measurement on the subject reach of Marvine Creek as summarized in Table 3.

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

Visit Date	Flow (cfs)	Collector
06/28/2017	102.70	CWCB

Data Analysis

Due to the short period of record available at the Marvine Creek gage, staff took additional steps to evaluate the record. Staff examined streamflow gages and climate stations in the area and found that the historic gage, North Fork White River at Buford, CO (USGS 09303000), has a continuous POR from 1951 – 2001 and is located about 7.5 miles from the Marvine Creek gage. The average annual streamflow for the North Fork White River gage was 227,419 AF. During the 12 years the Marvine Creek gage operated (1972-1984), eight years had above average annual streamflows. During the same 12 years, the average annual streamflow at the North Fork White River gage was 236,754 AF, approximately 5% above the 50-year average. Therefore, the Marvine Creek gage record likely represents slightly above average streamflow conditions.

The Marvine Creek gage was analyzed from 9/1/1972 to 9/30/1984 based on gage data and diversion records available through HydroBase on 10/26/2018. Because streamflow at the Marvine gage is affected by a number of upstream diversions, an effort was made to estimate natural streamflow at the gage location. The majority of these diversions irrigate land adjacent to Marvine Creek and upstream from the historic gage. These diversions hold a total of 55.15 cfs of decreed rights. There are also several storage rights above the gage location on Marvine Creek that total 108.65 AF of storage. The return flows from most of the intervening diversions likely accrue to the stream above the gage and are included in the gage record. The gage records and the diversion records also did not overlap in most cases. Due to these and other limitations, the intervening diversions were not used to adjust the gage record. However, the Marvine Ditch 1 is used to irrigate land downstream from the gage and most or all return flows accrue below the gage. Therefore, the diversions from Marvine Ditch 1 were added to the Marvine Creek gage record in an effort to better represent natural flow conditions. Nevertheless, not all water uses were accounted for and the adjusted gage record still reflects a fairly significant amount of impacts from water withdrawals.

The adjusted gage record was then scaled by 0.398 to the lower terminus 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. Median streamflow was calculated using the adjusted scaled Marvine Creek gage record. The 95% confidence intervals were not able to be calculated due to the short period of record.

Water Availability Summary
The hydrograph (See Complete Hydrograph) shows median streamflow estimated at the lower terminus of Marvine Creek. The proposed ISF is below the median streamflow estimate at all times. Staff concludes that water is available for appropriation on Marvine Creek.

Material Injury
Because the proposed ISF on Marvine 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. (2018), 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.

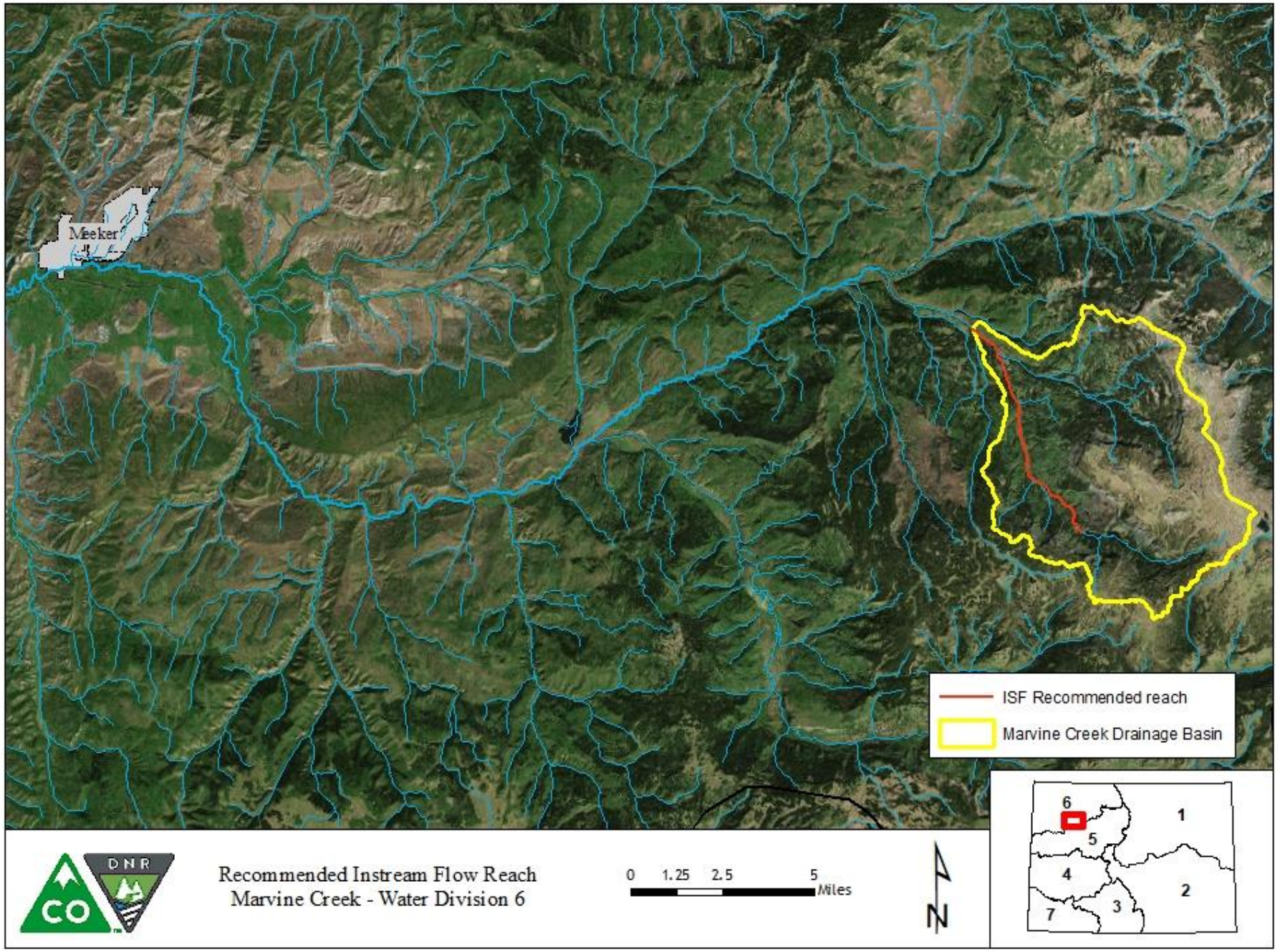
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

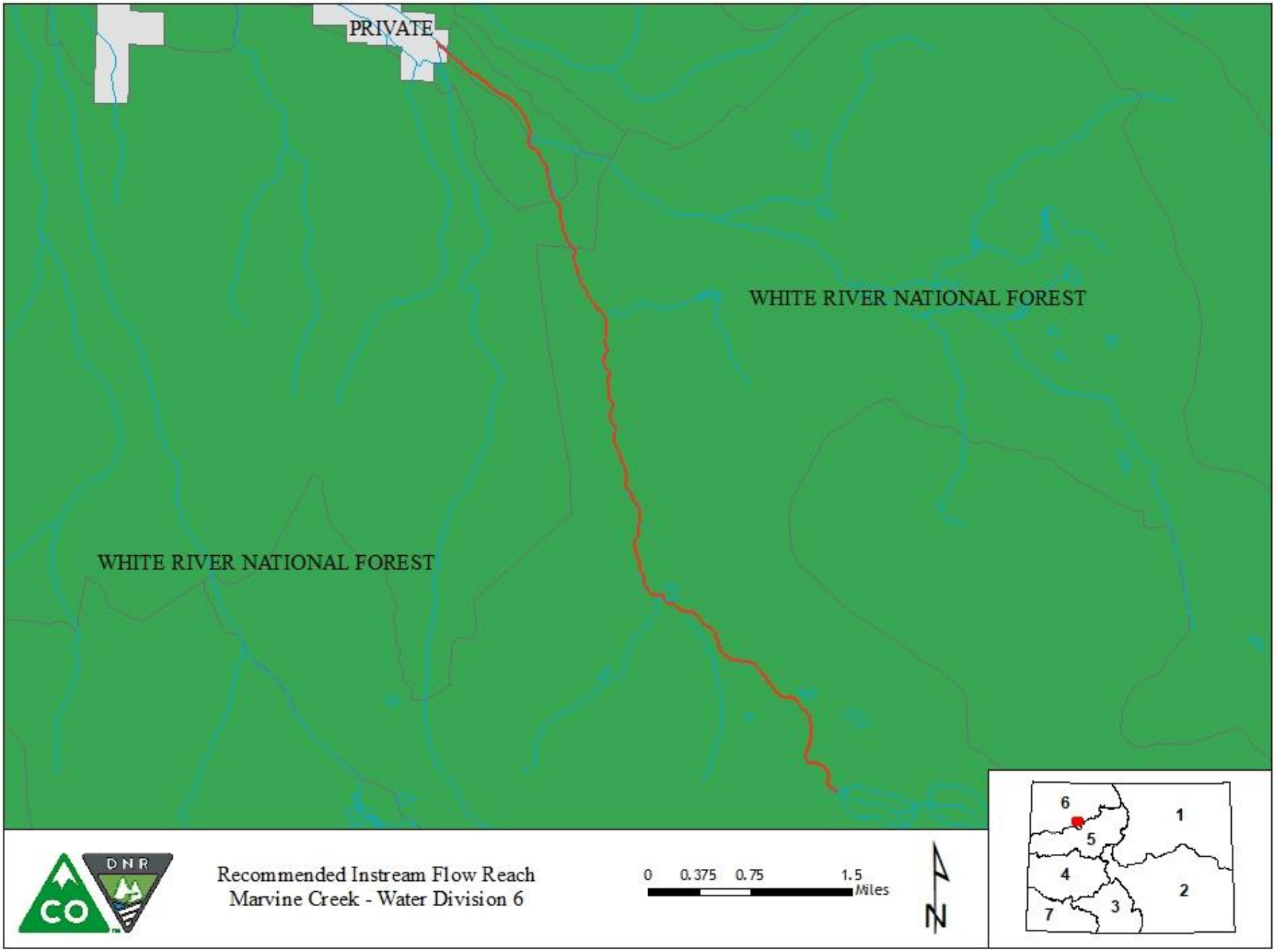
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

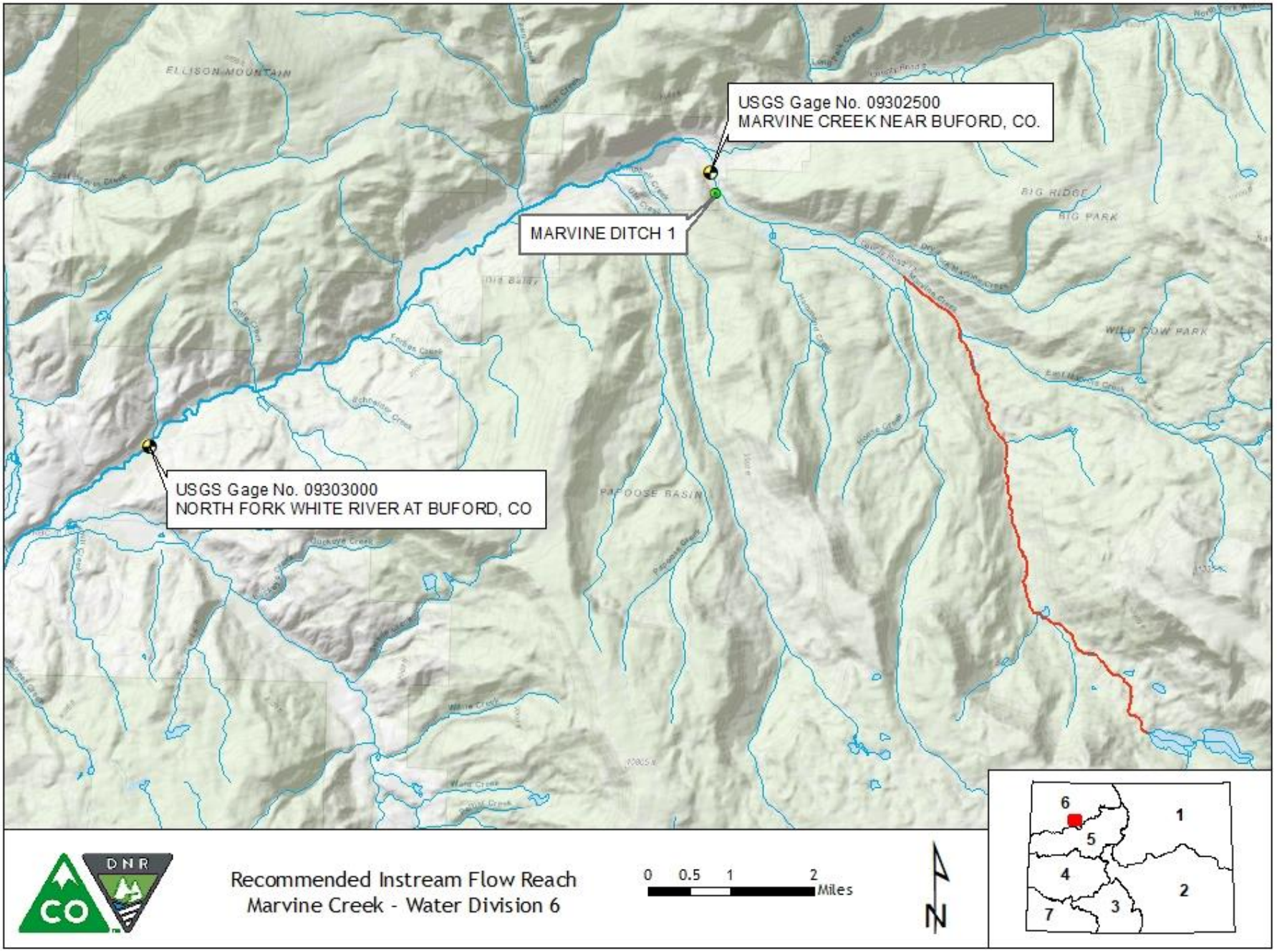
VICINITY MAP



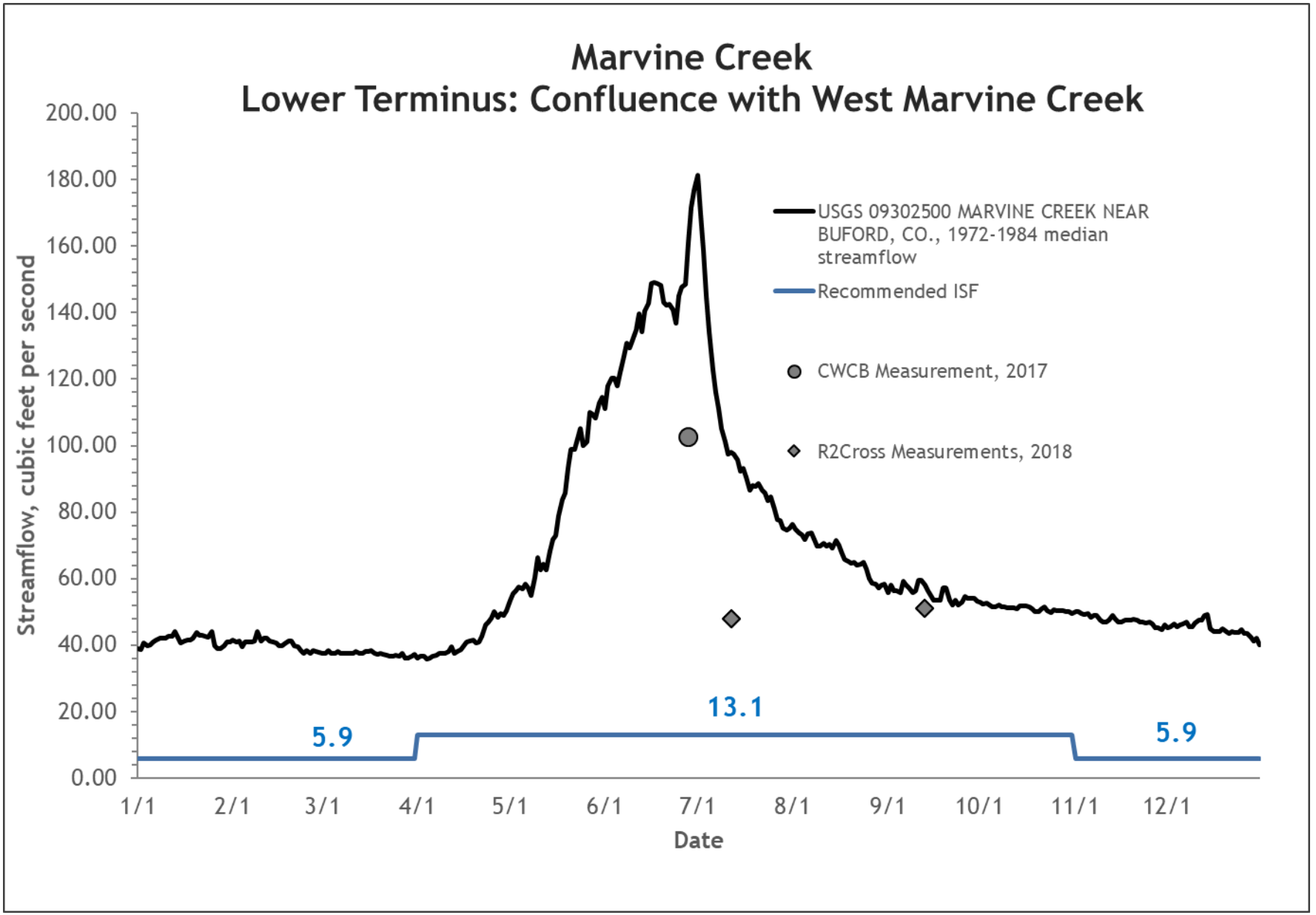
LAND OWNERSHIP MAP



HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



COLORADO
Colorado Water Conservation Board
Department of Natural Resources

North Fork White River (Upper)

EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	outlet of Trappers Lake UTM North: 4429787.37 UTM East: 309550.88
LOWER TERMINUS:	confluence with Skinny Fish Creek UTM North: 4431907.38 UTM East: 308777.90
WATER DIVISION:	6
WATER DISTRICT:	43
COUNTY:	Garfield
WATERSHED:	Upper White
CWCB ID:	18/6/A-008
RECOMMENDER:	Colorado Parks and Wildlife (CPW)
LENGTH:	1.52 miles
FLOW RECOMMENDATION:	2.0 cfs (11/01 - 03/31) 3.5 cfs (04/01 - 10/31)

North Fork White River (Upper)

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.

CPW recommended that the CWCB appropriate an ISF water right on a reach of the North Fork White River because it has a natural environment that can be preserved to a reasonable degree. The North Fork White River is located within Garfield County and originates from Wall Lake in the Flat Tops Wilderness Area at an elevation of approximately 11,000 ft. The river flows west 33 miles to the confluence with the South Fork White River at an elevation of approximately 7,000 ft (See Vicinity Map). The proposed reach extends from the outlet of Trappers Lake downstream to the confluence with Skinny Fish Creek. The U.S. Forest Service (USFS) manages one hundred percent of the land on the 1.52 mile proposed reach (See Land Ownership Map).

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/2019ProposedISFRecommendations.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 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.

The North Fork White River upstream of Ripple Creek, is a moderate gradient, third order stream. The riparian area is a mix of open meadows and spruce and fir forest with abundant aspens covering the valley sides. Large wood and boulders contribute to channel complexity and create fish habitat throughout the upper North Fork White River. Numerous large tributaries throughout the upper reaches of the stream provide well-connected and diverse habitat types for fish. Past CPW fishery surveys indicate the presence of Colorado River cutthroat trout (CRCT), mountain whitefish, rainbow trout, and brook trout. CRCT is a Tier 1 priority species in the 2015 State Wildlife Action Plan, which has the highest conservation priority in the state. CRCT is classified as a state Species of Special Concern and is considered a Sensitive Species by the Bureau of Land Management (BLM) and USFS. While CRCT is the main species of concern in this basin, other native species, namely mountain whitefish, would benefit from the conservation efforts for the CRCT. In addition to the native species present in the North Fork White River, this reach supports a diverse sport fishery of brook and rainbow trout.

A key component of habitat protection is flow protection. Flow reduction can impact habitat availability and quality, can cause water quality and temperature issues, and can reduce overall population and habitat connectivity. The hydrology of the North Fork White River will likely continue to provide a high annual peak flow for spring spawning species (since minimal water uses presently occur in the basins above the proposed ISF reach), but protection of base flows is an important component of ISF protection. Overwintering adult habitat for CRCT is often a limiting factor for these fish populations. This reach of the North Fork White River provides good habitat for various life stages of fish.

Table 1. List of species identified in the North Fork White River.

Species Name	Scientific Name	Status
Colorado River cutthroat trout	*Oncorhynchus clarkii pleuriticus*	State - Species of Special Concern Federal – Sensitive Species
mountain whitefish	*Prosopium williamsoni*	None
brook trout	*Salvelinus fontinalis*	None
rainbow trout	*Oncorhynchus mykiss*	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.

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 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). 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. However, the R2Cross model also contains the Thorne and Zevenbergen subroutine, which uses field measured bed material grain size to estimate velocity. This method is not constrained by the accuracy range of the Manning's n subroutine.

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 2.00 cfs, which meets 2 of 3 criteria, and a summer flow of 3.50 cfs, which meets 3 of 3 criteria.

Table 2. Summary of R2Cross transect measurements and results for the North Fork White River.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
CPW	07/10/2018 #1	5.60	N/A	2.50[1]	4.20[1]
CPW	07/10/2018 #2	5.60	N/A	1.50[1]	2.80[1]
			Mean	2.00	3.50

1 = Thorne and Zevenberg subroutine was used due to Manning's n results that were outside of the accuracy range. The measured D84 was 0.66 feet

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

2.0 cfs from November 1 through March 31 meets 2 of 3 instream flow criteria and will provide sufficient protection of aquatic habitat during base flows for overwintering.

3.5 cfs from April 1 through October 31 meets 3 of 3 instream flow criteria and will provide sufficient protection of aquatic habitat during snowmelt runoff and during critical periods for fish spawning, rearing, and development.

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 the North Fork White River is 21.4 square miles, with an average elevation of 10,725 ft and average annual precipitation of 44.24 inches. The North Fork White River has one diversion, Trappers Lake Ditch (WDID 4300972, 2.3 cfs), that feeds the Trappers Lake Retaining Pond located adjacent to the river (See the Hydrologic Features Map). Due to this surface water diversion, hydrology in this drainage basin does not represent natural flow.

Available Data

There is not a current streamflow gage on this reach of the North Fork White River. There are two historic gages in the vicinity of the proposed ISF reach. The North Fork White River above Ripple C, NR Trappers Lake CO (USGS 09302420) was located approximately 4.5 miles downstream from the proposed lower terminus. This gage was not used in this analysis due to the large difference in drainage basin size. The North Fork White River Below Trappers Lake, CO (USGS 093002400) is located near the upper terminus of the reach. The North Fork White River Below Trappers Lake, CO (below Trappers Lake gage) has a continuous period of record from 10-1-1956 to 09-30-1965. The gage has a drainage area of 20.2 square miles, with an average annual precipitation of 44.7 inches.

CWCB staff made one site visit during the R2Cross measurements with CPW on the subject reach of the North Fork White River. No other spot measurements were made on this reach.

Data Analysis

Due to the short period of record available at the below Trappers Lake gage, staff took additional steps to evaluate the record. Staff examined other gages in the region in an attempt to find a gage that could be used to extend the record through regression analysis. However, none of the gages evaluated produced a reasonable regression coefficient to be suitable for regression extension. Staff also examined streamflow gages in the region to evaluate the average annual streamflow in the area. The North Fork White River at Buford, CO (USGS 09303000) is located approximately 20.3 miles

southwest from the below Trappers Lake gage and has a continuous period of record from 1951-2002. The total average annual streamflow at the North Fork White River at Buford gage while it operated was 227,419 AF. During the 10 years of operation of the below Trappers Lake gage, 4 years were above average and 6 years of below average streamflow. This likely indicates that below Trappers Lake gage records represent near average conditions.

The North Fork White River gage was used as is, without accounting for the effects of the Trapper's Lake Ditch diversion which is located between the gage and the proposed lower terminus. The decreed diversion rate is small relative to the amount of water available and accounting for this diversion would not change the water availability determination. In addition, the water commissioner indicated that the diversion is rarely used (personal communication, Shanna Lewis, 11/08/2018) and the diversion records and the gage records do not overlap. The North Fork White River gage was scaled using the area-precipitation method to scale the gage data to the lower terminus on North Fork White River. The scaled median streamflow was calculated. The 95% confidence intervals were not calculated due to the short period of record at the North Fork White River gage.

Water Availability Summary
The hydrographs (See Complete and Detailed Hydrographs) show median streamflow estimated at the lower terminus of North Fork White River. The proposed ISF is below the median streamflow estimate at all times. Staff concludes that water is available for appropriation on this reach of the North Fork White River.

Material Injury
Because the proposed ISF on this reach of the North Fork White 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. (2018), 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.

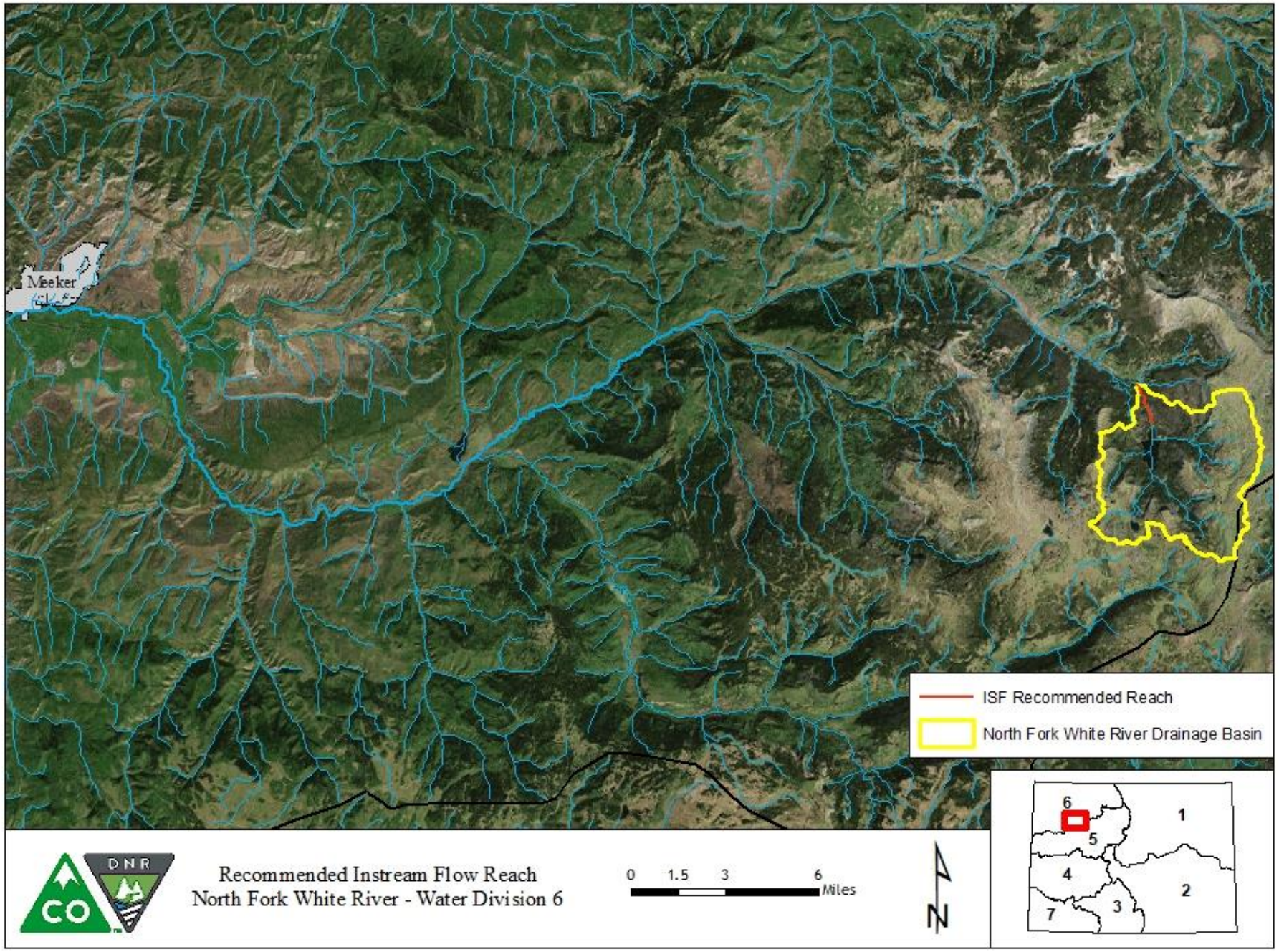
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

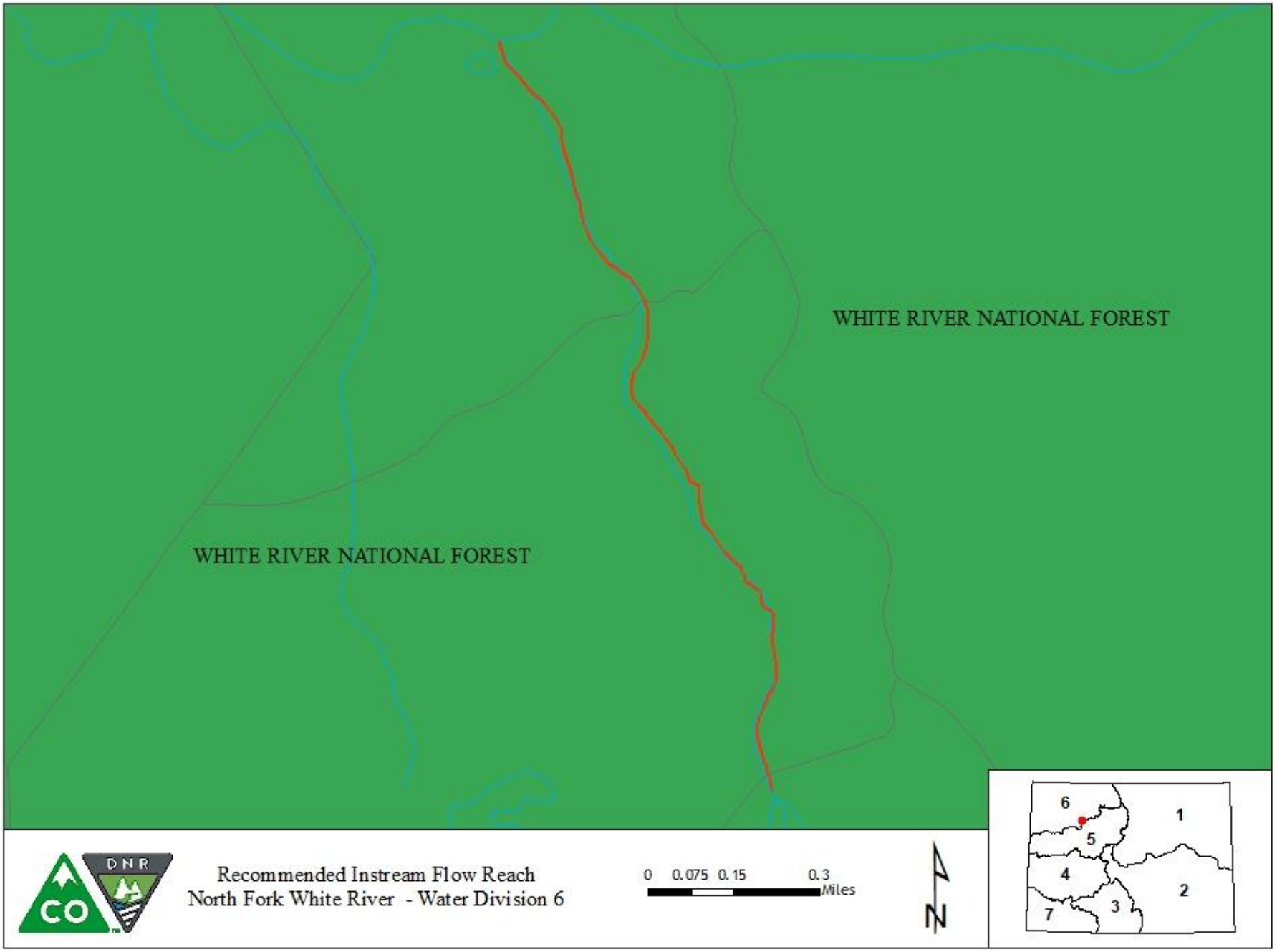
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

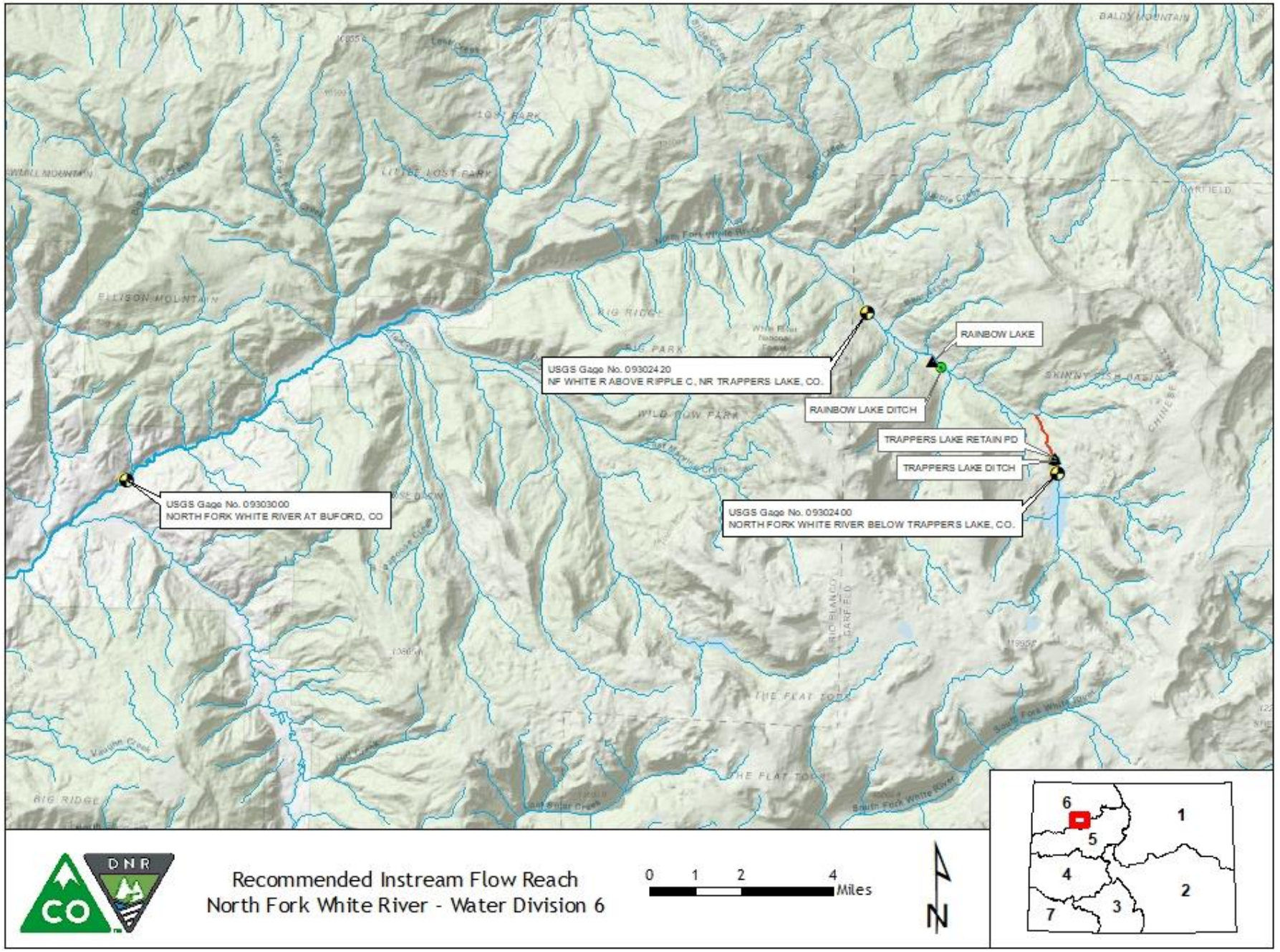
VICINITY MAP



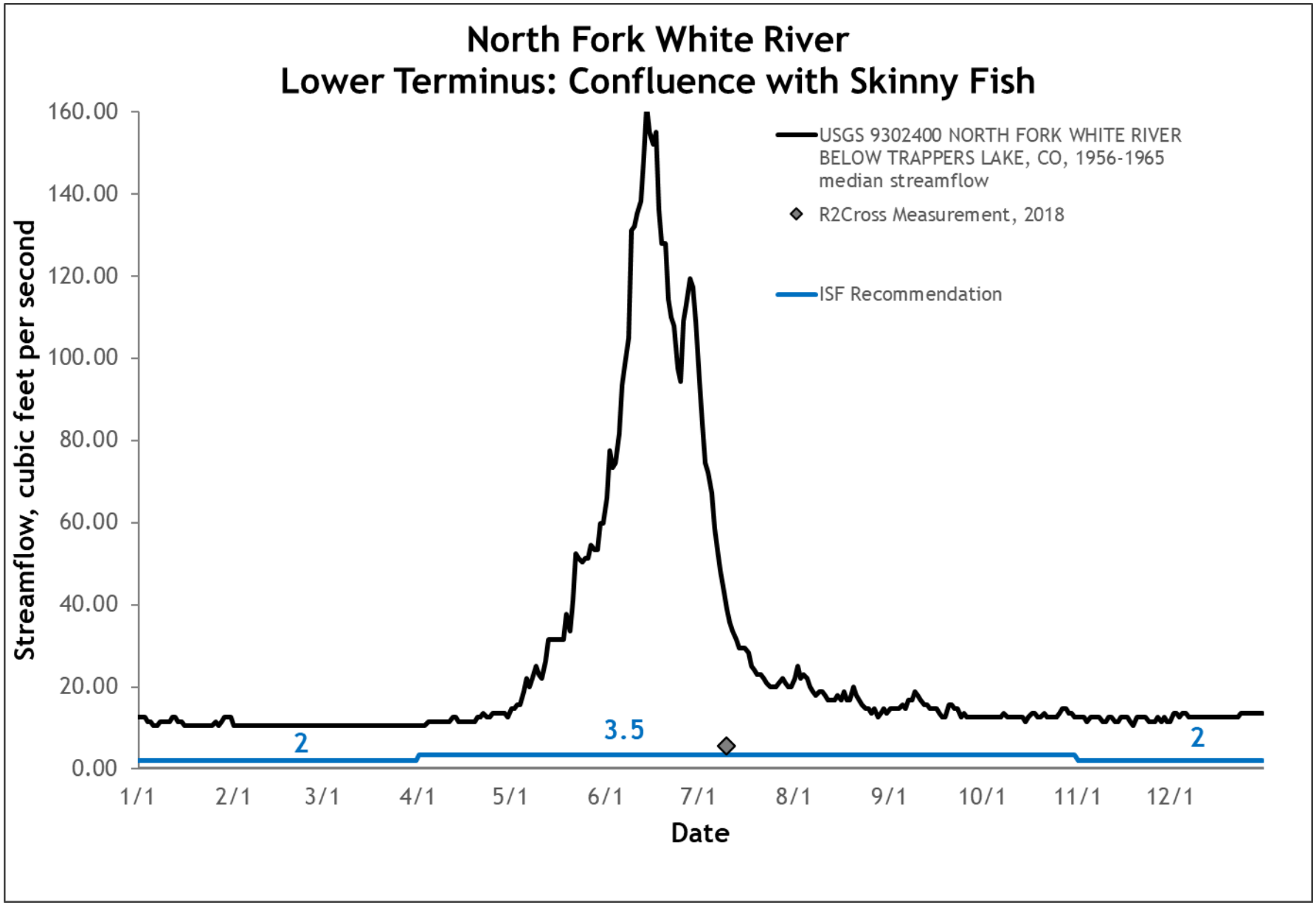
LAND OWNERSHIP MAP



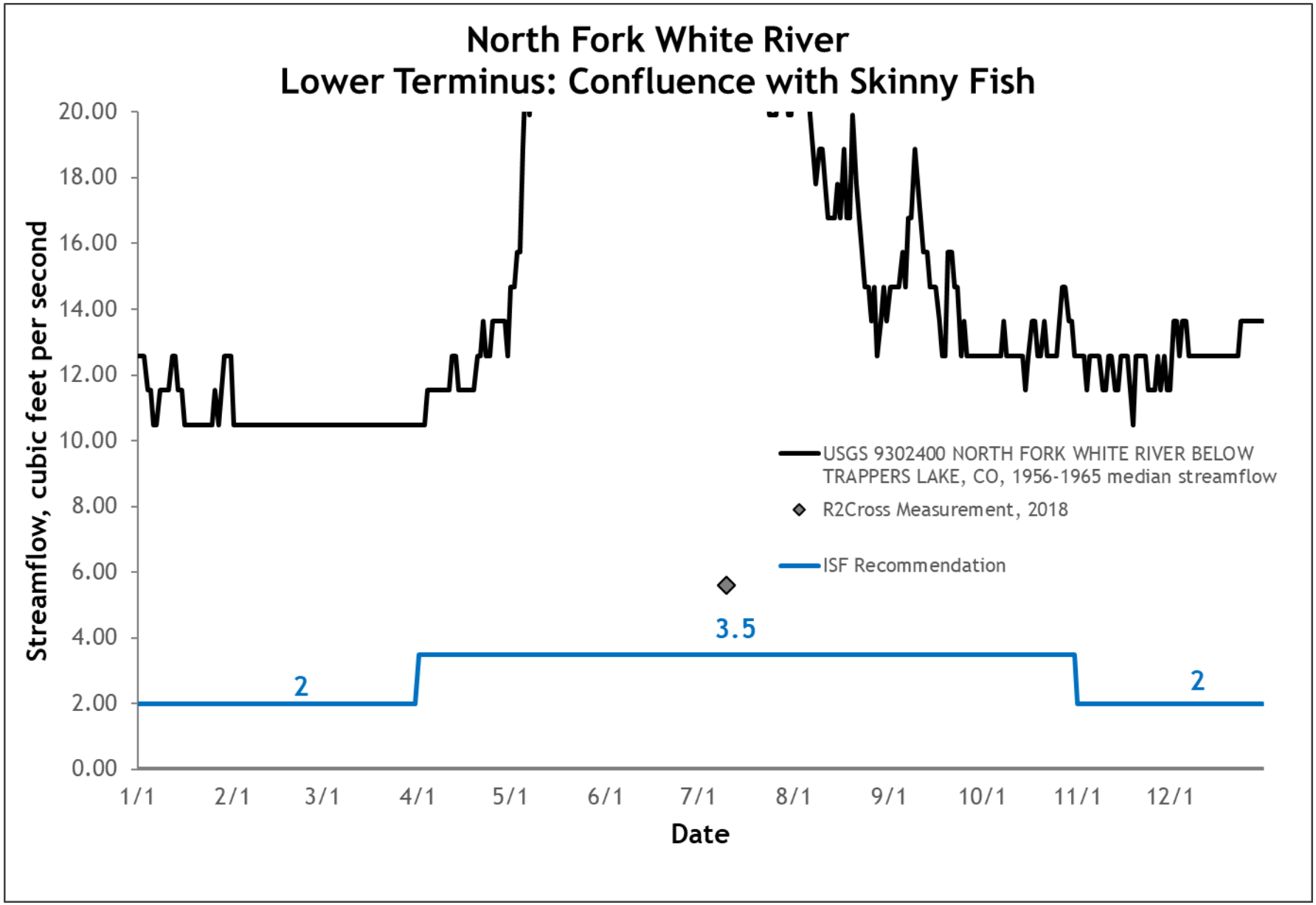
HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



DETAILED HYDROGRAPH



COLORADO
Colorado Water Conservation Board
Department of Natural Resources

North Fork White River (Middle)

EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	confluence with Skinny Fish Creek UTM North: 4431907.38 UTM East: 308777.90
LOWER TERMINUS:	confluence with Big Fish Creek UTM North: 4433402.35 UTM East: 305702.92
WATER DIVISION:	6
WATER DISTRICT:	43
COUNTY:	Garfield, Rio Blanco
WATERSHED:	Upper White
CWCB ID:	18/6/A-016
RECOMMENDER:	Colorado Parks and Wildlife (CPW)
LENGTH:	2.47 miles
FLOW RECOMMENDATION:	7.8 cfs (11/01 - 04/30) 34 cfs (05/01 - 10/31)

North Fork White River (Middle)

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.

CPW recommended that the CWCB appropriate an ISF water right on a reach of North Fork White River because it has a natural environment that can be preserved to a reasonable degree. The North Fork White River is located within Garfield County and originates from Wall Lake in the Flat Tops Wilderness Area at an elevation of approximately 11,000 ft. The river flows west 33 miles to the confluence with the South Fork White River at an elevation of approximately 7,000 ft (See Vicinity Map). The proposed reach extends from the confluence with Skinny Fish Creek downstream to the confluence with Big Fish Creek. One hundred percent of the land on the 2.47 mile proposed reach is privately owned (See Land Ownership Map).

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/2019ProposedISFRecommendations.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 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.

The North Fork White River upstream of Ripple Creek, is a moderate gradient, third order stream. The riparian area is a mix of open meadows and spruce and fir forest with abundant aspens covering the valley sides. Large wood and boulders contribute to channel complexity and create fish habitat throughout the upper North Fork White River. Numerous large tributaries throughout the upper reaches of the stream provide well-connected and diverse habitat types for fish. Past CPW fishery surveys indicate the presence of Colorado River cutthroat trout (CRCT), mountain whitefish, rainbow trout, and brook trout. CRCT is a Tier 1 priority species in the 2015 State Wildlife Action Plan, which has the highest conservation priority in the state. CRCT is classified as a state Species of Special Concern and is considered a Sensitive Species by the Bureau of Land Management (BLM) and USFS. While CRCT is the main species of concern in this basin, other native species, namely mountain whitefish, would benefit from the conservation efforts for the CRCT. In addition to the native species present in the North Fork White River, this reach supports a diverse sport fishery of brook and rainbow trout.

A key component to habitat protection is flow protection. Flow reduction can impact habitat availability and quality, can cause water quality and temperature issues, and can reduce overall population and habitat connectivity. The hydrology of the North Fork White River will likely continue to provide a high annual peak flow for spring spawning species (since minimal water uses presently occur in the basins above the potential ISF segments), but protection of base flows is an important component of ISF protection. Overwintering adult habitat for CRCT is often a limiting factor for these fish populations. This reach of the North Fork White River provides good habitat for various life stages of fish.

Table 1. List of species identified in the North Fork White River.

Species Name	Scientific Name	Status
Colorado River cutthroat trout	*Oncorhynchus clarkii pleuriticus*	State - Species of Special Concern Federal – Sensitive Species
mountain whitefish	*Prosopium williamsoni*	None
brook trout	*Salvelinus fontinalis*	None
rainbow trout	*Oncorhynchus mykiss*	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

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 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). 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. However, the R2Cross model also contains the Thorne and Zevenbergen subroutine, which uses field measured bed material grain size to estimate velocity. This method is not constrained by the accuracy range of the Manning's n subroutine.

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 7.80 cfs, which meets 2 of 3 criteria, and a summer flow of 34.00 cfs, which meets 3 of 3 criteria.

Table 2. Summary of R2Cross transect measurements and results for the North Fork White River.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
CPW	07/11/2018 #1	42.80	N/A	2.50[1]	24.50[1]
CPW	07/11/2018 #2	42.80	N/A	13.10[1]	43.50[1]
			Mean	7.80	34.00

1 = Thorne and Zevenberg subroutine was used due to Manning's n results that were outside of the accuracy range. The measured D84 was 0.63 feet.

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

7.8 cfs from November 1 to April 30 meets 2 of 3 instream flow criteria during the winter baseflow period and will provide sufficient overwintering habitat for fish.

34 cfs from May 1 through October 31 meets 3 of 3 instream flow criteria during critical periods for native fish migration, spawning, and rearing.

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 the North Fork White River is 35.8 square miles, with an average elevation of 10,595 feet and average annual precipitation of 43.1 inches (See the Hydrologic Features Map). There is one diversion, Trappers Lake Ditch, upstream from the proposed lower terminus on the North Fork White River. Trappers Lake Ditch (WDID 4300972, 2.3 cfs) feeds the Trappers Lake Retaining Pond located adjacent to the River. There is also one surface water diversion located on a tributary to the North Fork White River that alters streamflow from natural conditions.

Available Data
There is not a current streamflow gage on this reach of the North Fork White River, but there are two historic gages in the vicinity of the proposed ISF reach. The North Fork White River Below Trappers Lake, CO (USGS 093002400) is located approximately 2.2 miles downstream from the proposed lower terminus of the reach. This gage was not used in this analysis due to the large difference in drainage basin size. The North Fork White River above Ripple Creek, near Trappers Lake CO (USGS 09302420), was identified approximately 2.2 miles downstream from the proposed lower terminus. The North Fork White River above Ripple Creek, near Trappers Lake gage (above Ripple Creek gage) has a continuous period of record from 10-1-1965 to 09-30-1973. The gage has a drainage area of 62.5 square miles, with an average annual precipitation of 41.71 inches. This historic gage was influenced by the same diversions that affect the proposed ISF reach.

CWCB staff made one site visit during the R2Cross meausrements with CPW on the proposed reach of North Fork White River.

Data Analysis
Due to the short period of record available at the above Ripple Creek gage, staff took additional steps to evaluate the record. Staff examined other gages in the region in an attempt to find a gage that could be used to extend the record through regression analysis. However, none of the gages evaluated produced a regression coefficient suitable for regression extension. Staff also examined

streamflow gages in the region to evaluate the average annual streamflow in the area. The North Fork White River at Buford, CO (USGS 09303000) is located approximately 18.1 miles downstream from the above Ripple Creek gage and has a continuous period of record from 1951-2002. The total average annual streamflow at the North Fork White River at Buford gage while it operated was 227,419 AF. During the 9 years of operation of the above Ripple Creek gage, 4 years were above average and 5 years were below average streamflow. This likely indicates that the above Ripple Creek gage records represent close to average conditions.

The above Ripple Creek gage record was scaled by 0.59 to the lower terminus 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. The effects of the diversions from Rainbow Lake Ditch and Trappers Lake Ditch as well as those on tributaries to the North Fork White River were assumed to be included in the gage data. Median streamflow was calculated using the scaled above Ripple Creek gage record. 95% confidence intervals were not calculated due to the short period of record.

Water Availability Summary
The hydrographs (See Complete and Detailed Hydrographs) show median streamflow estimated at the lower terminus of the proposed North Fork White River ISF. The proposed ISF is below the median streamflow estimate at all times. Staff concludes that water is available for appropriation on this reach of the North Fork White River.

Material Injury
Because the proposed ISF on this reach of the North Fork White 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. (2018), 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.

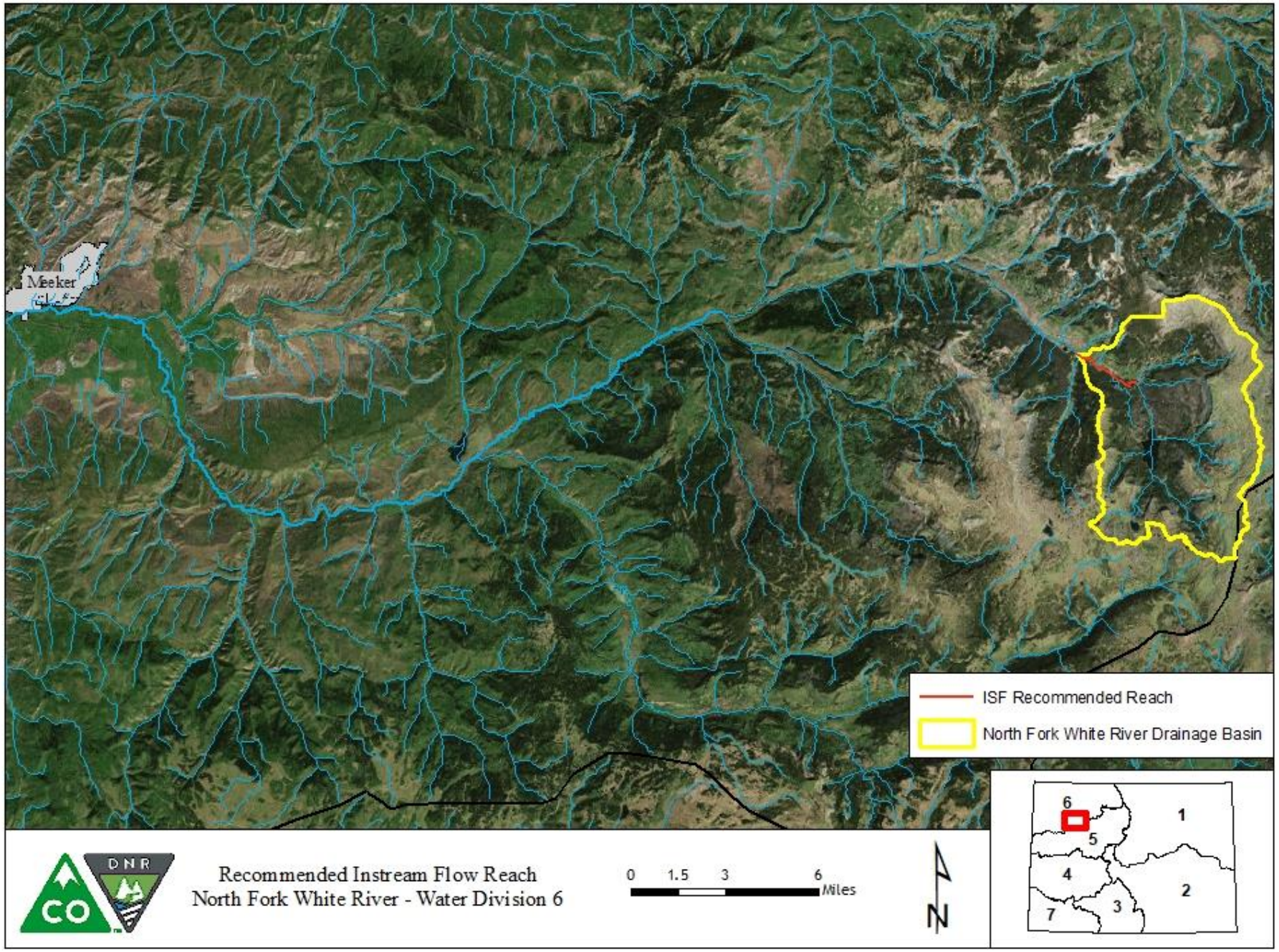
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

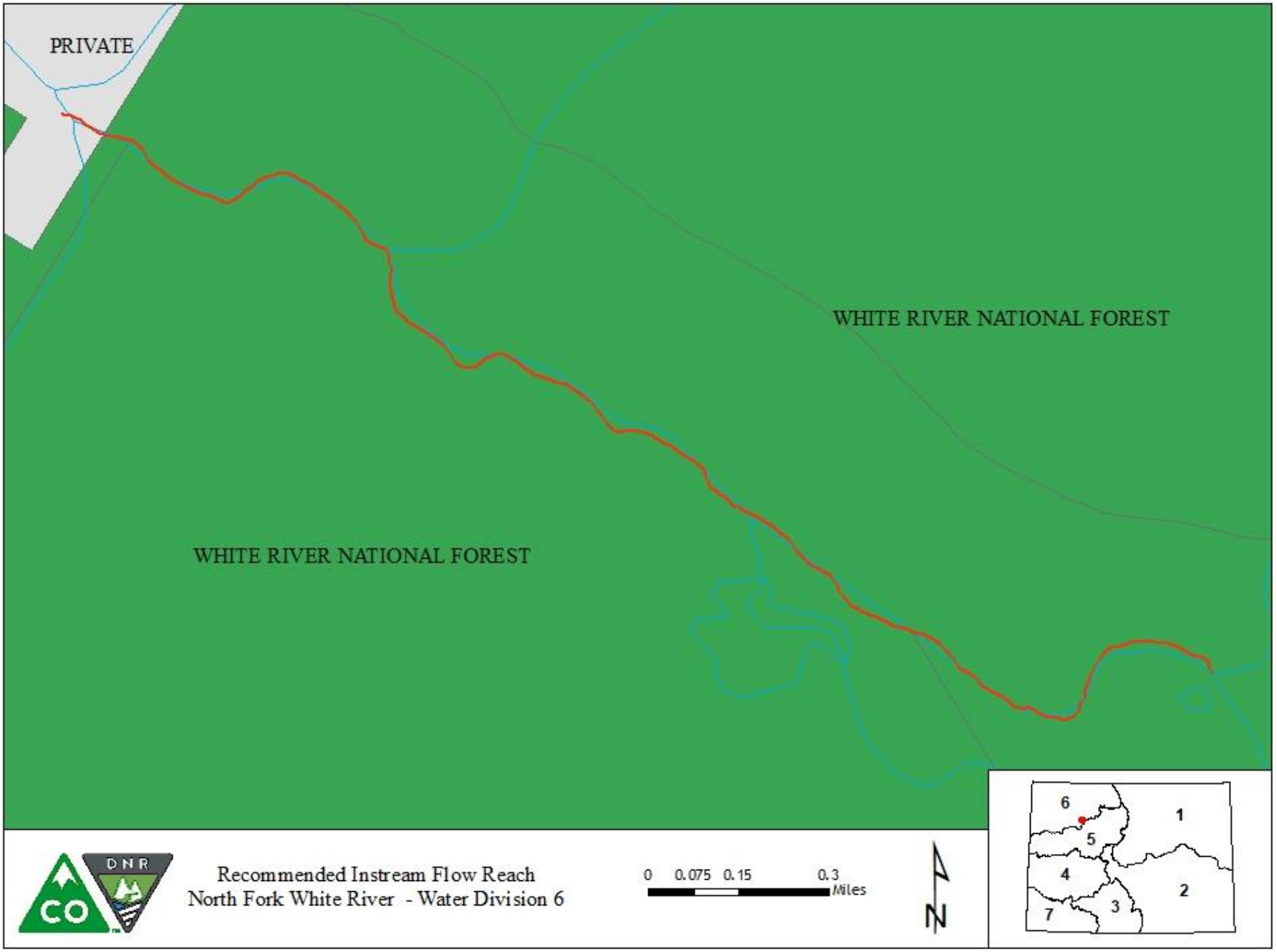
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

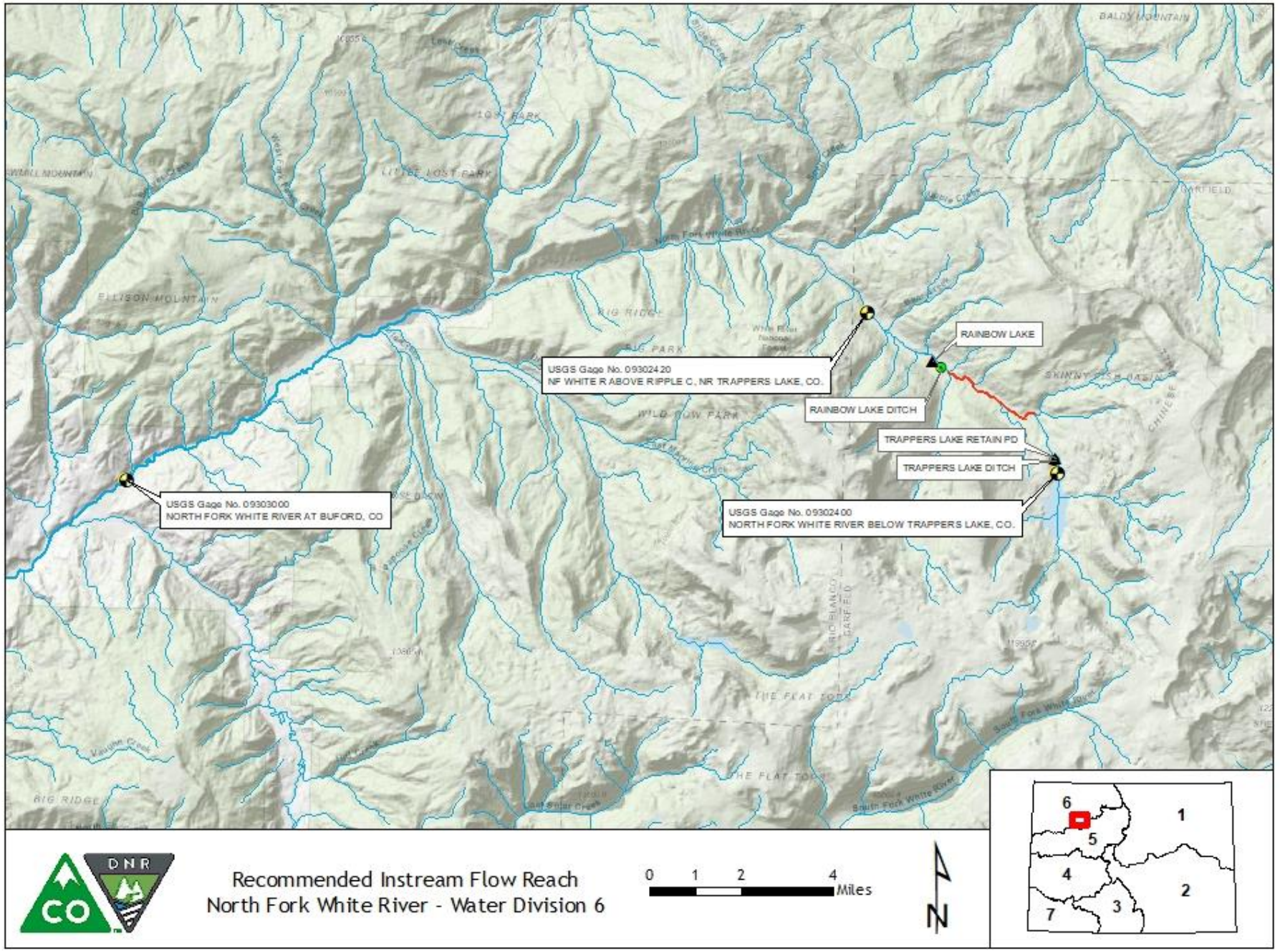
VICINITY MAP



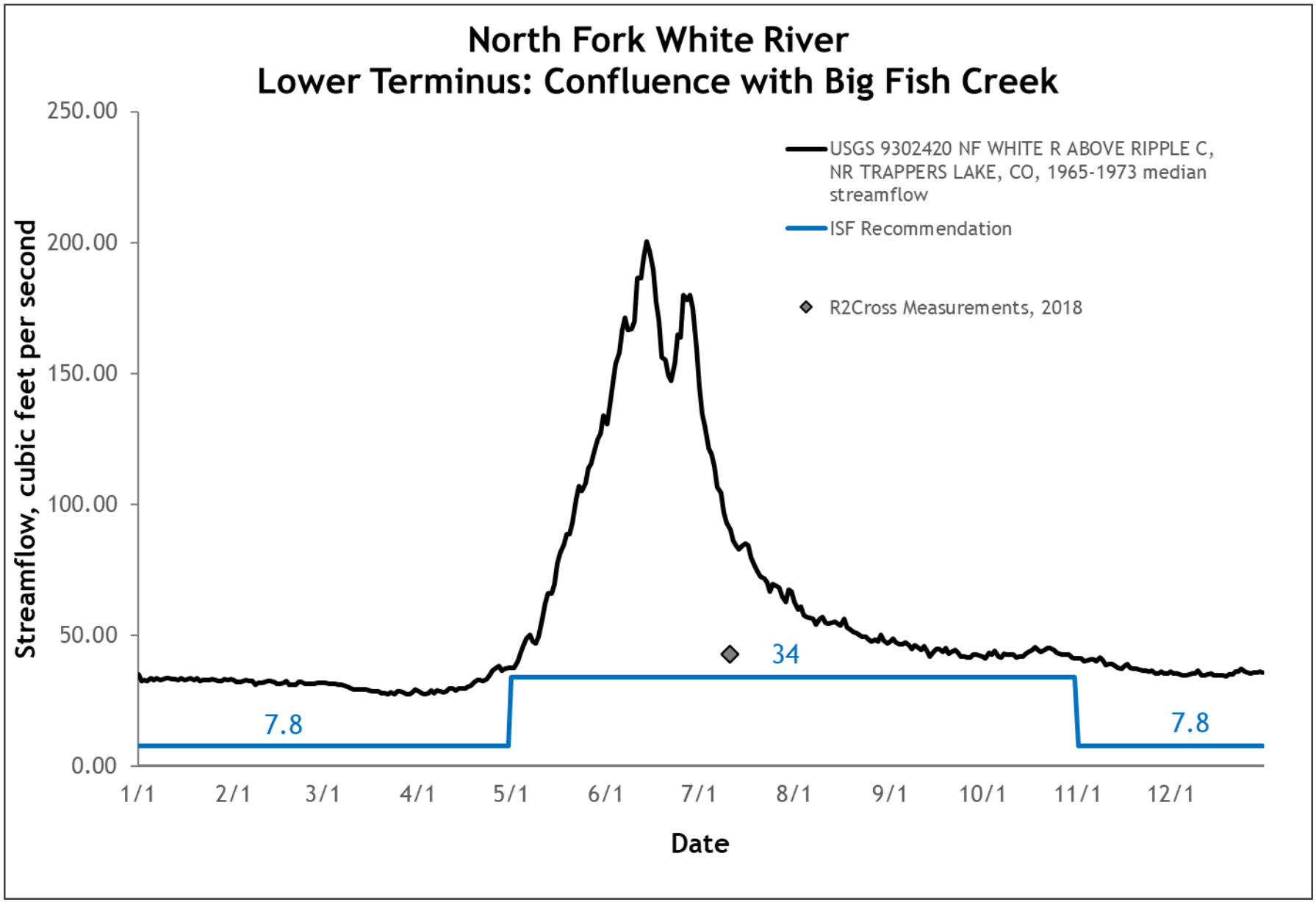
LAND OWNERSHIP MAP



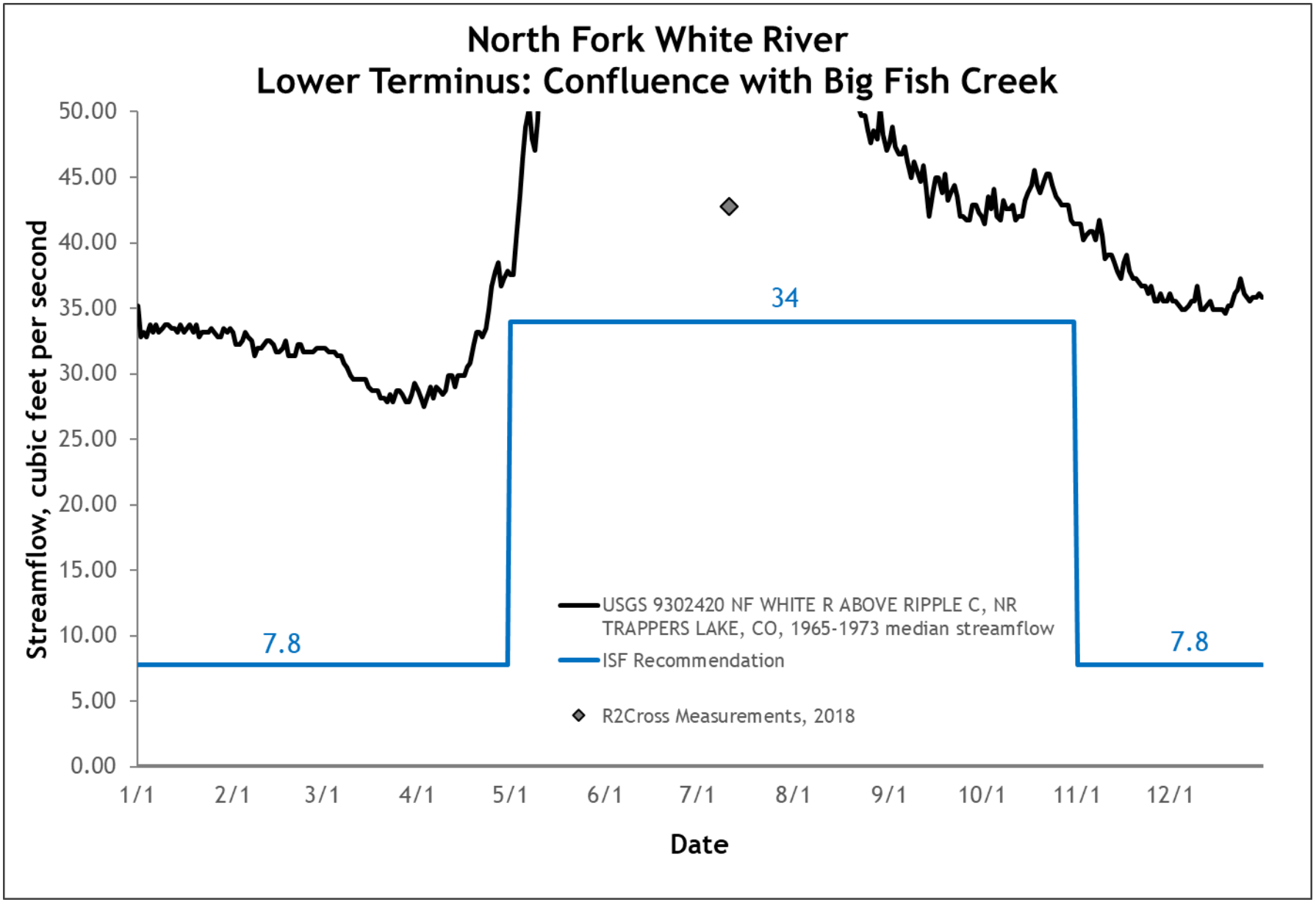
HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



DETAILED HYDROGRAPH



COLORADO
Colorado Water Conservation Board
Department of Natural Resources

North Fork White River (Lower)

EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	confluence with Big Fish Creek UTM North: 4433402.35 UTM East: 305702.92
LOWER TERMINUS:	confluence with Ripple Creek UTM North: 4437555.31 UTM East: 300814.97
WATER DIVISION:	6
WATER DISTRICT:	43
COUNTY:	Rio Blanco
WATERSHED:	Upper White
CWCB ID:	18/6/A-017
RECOMMENDER:	Colorado Parks and Wildlife (CPW)
LENGTH:	4.38 miles
FLOW RECOMMENDATION:	23 cfs (11/16 - 05/10) 74 cfs (05/11 - 09/15) 60 cfs (09/16 - 11/15)

North Fork White River (Lower)

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.

CPW recommended that the CWCB appropriate an ISF water right on a reach of North Fork White River because it has a natural environment that can be preserved to a reasonable degree. The North Fork White River is located within Garfield County and originates from Wall Lake in the Flat Tops Wilderness Area at an elevation of approximately 11,000 ft. The river flows west 33 miles to the confluence with the South Fork White River at an elevation of approximately 7,000 ft (See Vicinity Map). The proposed reach extends from the confluence with Big Fish Creek downstream to the confluence with Ripple Creek. The U.S. Forest Service manages 70 percent of the land on the 4.38 mile proposed reach and 30 percent is privately owned (See Land Ownership Map).

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/2019ProposedISFRecommendations.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 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.

The North Fork White River upstream of Ripple Creek, is a moderate gradient, third order stream. The riparian area is a mix of open meadows and spruce and fir forest with abundant aspens covering the valley sides. Large wood and boulders contribute to channel complexity and create fish habitat throughout the upper North Fork White River. Numerous large tributaries throughout the upper reaches of the stream provide well-connected and diverse habitat types for fish. Past CPW fishery surveys indicate the presence of Colorado River cutthroat trout (CRCT), mountain whitefish, rainbow trout, and brook trout. CRCT is a Tier 1 priority species in the 2015 State Wildlife Action Plan, which has the highest conservation priority in the state. CRCT is classified as a state Species of Special Concern and is considered a Sensitive Species by the Bureau of Land Management (BLM) and USFS. While CRCT is the main species of concern in this basin, other native species, namely mountain whitefish, would benefit from the conservation efforts for the CRCT. In addition to the native species present in the North Fork White River, this reach supports a diverse sport fishery of brook and rainbow trout.

A key component to habitat protection is flow protection. Flow reduction can impact habitat availability and quality, can cause water quality and temperature issues, and can reduce overall population and habitat connectivity. The hydrology of the North Fork White River will likely continue to provide a high annual peak flow for spring spawning species (since minimal water uses presently occur in the basins above the potential ISF segments), but protection of base flows is an important component of ISF protection. Overwintering adult habitat for CRCT is often a limiting factor for these fish populations. This reach of the North Fork White River provides good habitat for various life stages of fish.

Table 1. List of species identified in the North Fork White River.

Species Name	Scientific Name	Status
Colorado River cutthroat trout	*Oncorhynchus clarkii pleuriticus*	State - Species of Special Concern Federal – Sensitive Species
mountain whitefish	*Prosopium williamsoni*	None
rainbow trout	*Oncorhynchus mykiss*	None
brook trout	*Salvelinus fontinalis*	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.

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 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). 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. However, the R2Cross model also contains the Thorne and Zevenbergen subroutine, which uses field measured bed material grain size to estimate velocity. This method is not constrained by the accuracy range of the Manning's n subroutine.

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 22.85 cfs, which meets 2 of 3 criteria, and a summer flow of 74.45 cfs, which meets 3 of 3 criteria.

Table 2. Summary of R2Cross transect measurements and results for the North Fork White River.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
CPW	09/12/2018 #1	67.74	N/A	16.90[1]	77.80[1]
CPW	09/12/2018 #2	55.60	N/A	28.80[1]	71.10[1]
			Mean	22.85	74.45

1 = Thorne and Zevenberg subroutine was used due to Manning's n results that were outside of the accuracy range. The measured D84 was 0.40 feet.

ISF Recommendation
CPW recommended ISF flows based on R2Cross modeling analyses, biological expertise, and a preliminary assessment of water availability. CWCB Staff's water availability analysis determined that water was limited in some cases. The following flows represent the final recommendation which has been modified in collaboration with CPW due to water availability limitations.

23 cfs from November 16 through May 10 meets 2 of 3 instream flow criteria and will provide sufficient protection of aquatic habitat during base flows for overwintering.

74 cfs from May 11 through September 15 meets 3 of 3 instream flow criteria and will provide sufficient protection of aquatic habitat during snowmelt runoff and during critical periods for fish spawning, rearing, and development. The duration of this flow rate was modified due to water availability limitations.

60 cfs from September 16 through November 15 will provide sufficient habitat during the fall period as fish habitat requirements transition to winter conditions.

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 this reach of the North Fork White River is 67.4 square miles, with an average elevation of 10,306 feet and average annual precipitation of 41.28 inches (See the Hydrologic Features Map). There are two surface water diversions in the North Fork White River basin tributary to the proposed ISF reach - Rainbow Lake Ditch and Trappers Lake Ditch. Trappers Lake Ditch (WDID 4300972, 2.3 cfs) feeds the Trappers Lake Retaining Pond located adjacent to the river. Rainbow Lake Ditch (WDID 4300888, 35 cfs) diverts yearlong to Rainbow Lake for fish and recreation. During the summer months, water is used at a hydroelectric facility to generate power for the Rainbow Lake Ditch owner's ranch. There are also several surface water diversions located on tributaries to the North Fork White River that alter streamflow from natural conditions.

Available Data

There is not a current streamflow gage on this reach of the North Fork White River. There are two historic gages in the vicinity of the proposed ISF reach. The North Fork White River Below Trappers Lake, CO (USGS 093002400) is located approximately 7.5 miles upstream from the proposed lower terminus of the reach. This gage was not used in this analysis due to the large difference in drainage basin size. The North Fork White River above Ripple Creek, near Trappers Lake CO (USGS 09302420), was identified approximately 0.6 miles upstream from the proposed upper terminus. The North Fork White River above Ripple Creek, near Trappers Lake gage (above Ripple Creek gage) has a continuous period of record from 10-1-1965 to 09-30-1973. The gage has a drainage area of 62.5 square miles, with an average annual precipitation of 41.71 inches. This historic gage was influenced by the same diversions that affect the proposed ISF reach.

CWCB staff made one site visit during the R2Cross measurements with CPW on the subject reach of North Fork White River.

Data Analysis
Due to the short period of record available at the above Ripple Creek gage, staff took additional steps to evaluate the record. Staff examined other gages in the region in an attempt to find a gage that could be used to extend the record through regression analysis. However, none of the gages evaluated produced a regression coefficient suitable for regression extension. Staff also examined streamflow gages in the region to evaluate the average annual streamflow in the area. The North Fork White River at Buford, CO (USGS 09303000) is located approximately 18.1 miles downstream from the above Ripple Creek gage and has a continuous period of record from 1951-2002. The total average annual streamflow at the North Fork White River at Buford gage while it operated was 227,419 AF. During the 9 years of operation of the above Ripple Creek gage, 4 years were above average and 5 years were below average streamflow. This likely indicates that the above Ripple Creek gage records represent close to average conditions.

The above Ripple Creek gage record was scaled by 1.07 to the lower terminus 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. The effects of the diversions from Rainbow Lake Ditch and Trappers Lake Ditch as well as those on tributaries to the North Fork White River were assumed to be included in the gage data. Median streamflow was calculated using the scaled above Ripple Creek gage record. 95% confidence intervals were not calculated due to the short period of record.

Water Availability Summary
The hydrographs (See Complete and Detailed Hydrographs) show median streamflow estimated at the lower terminus of the proposed North Fork White River ISF. The proposed ISF is below the median streamflow estimate at all times. Staff concludes that water is available for appropriation on this reach of the North Fork White River.

Material Injury
Because the proposed ISF on this reach of the North Fork White 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. (2018), 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.

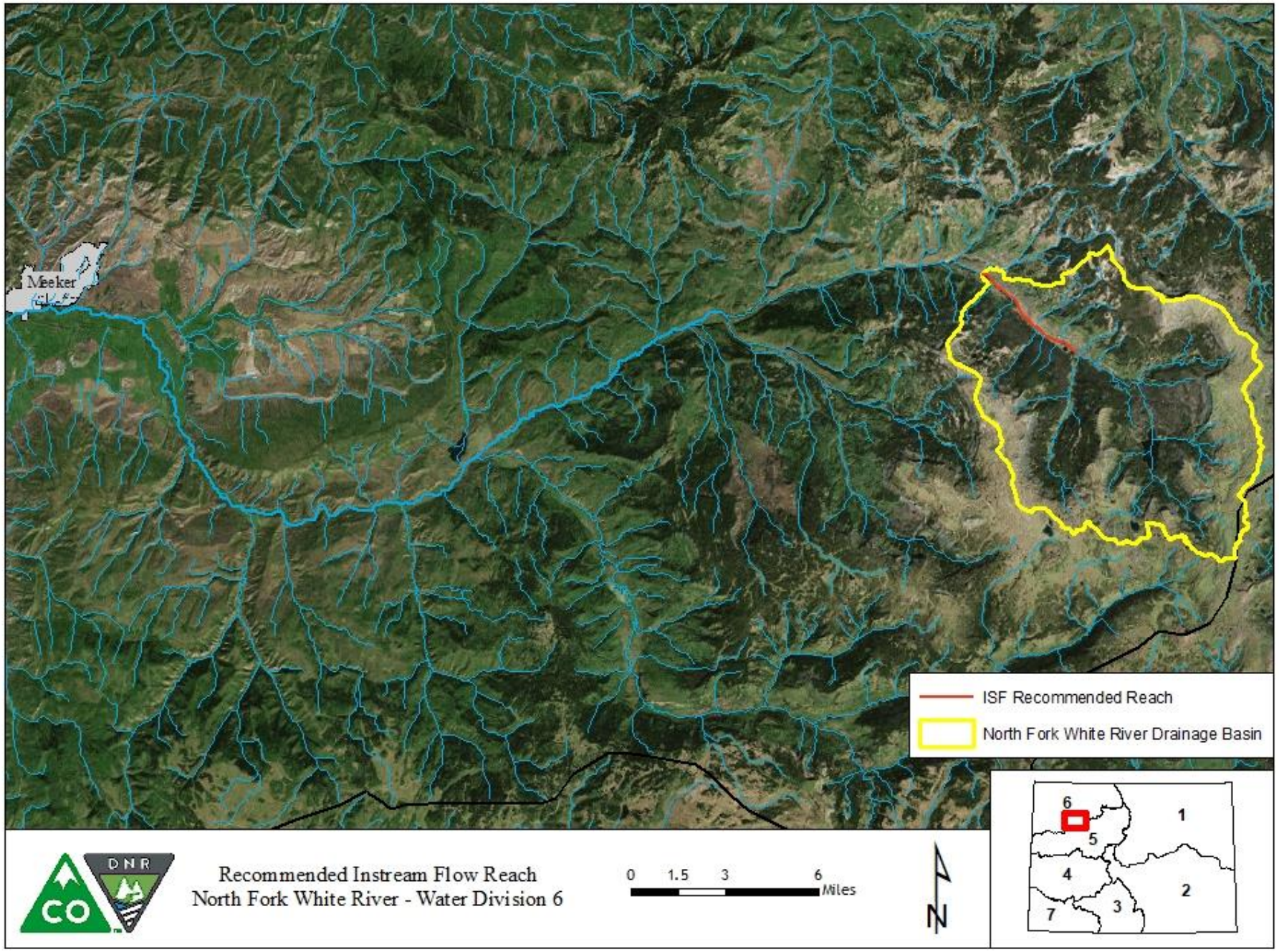
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

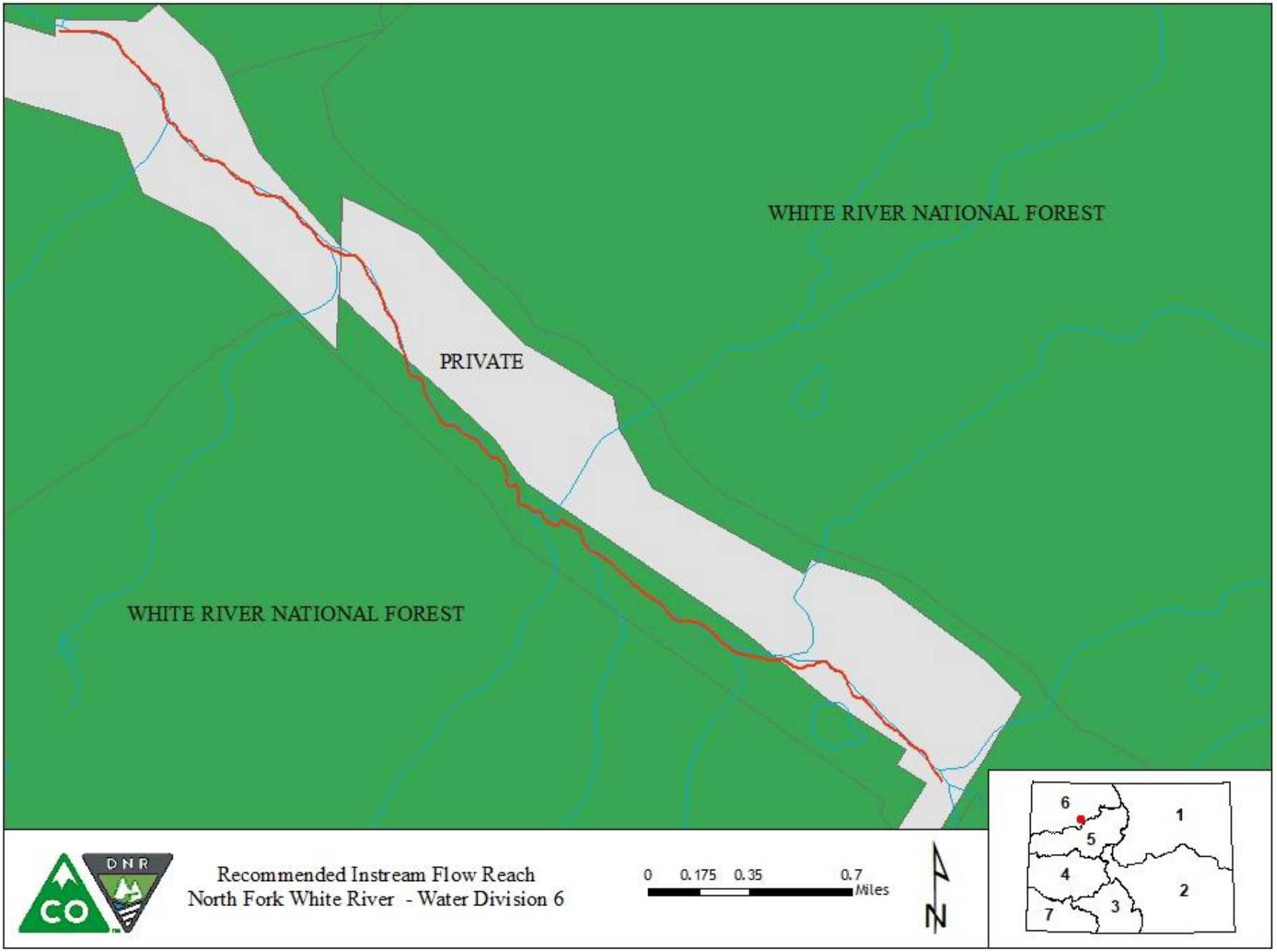
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

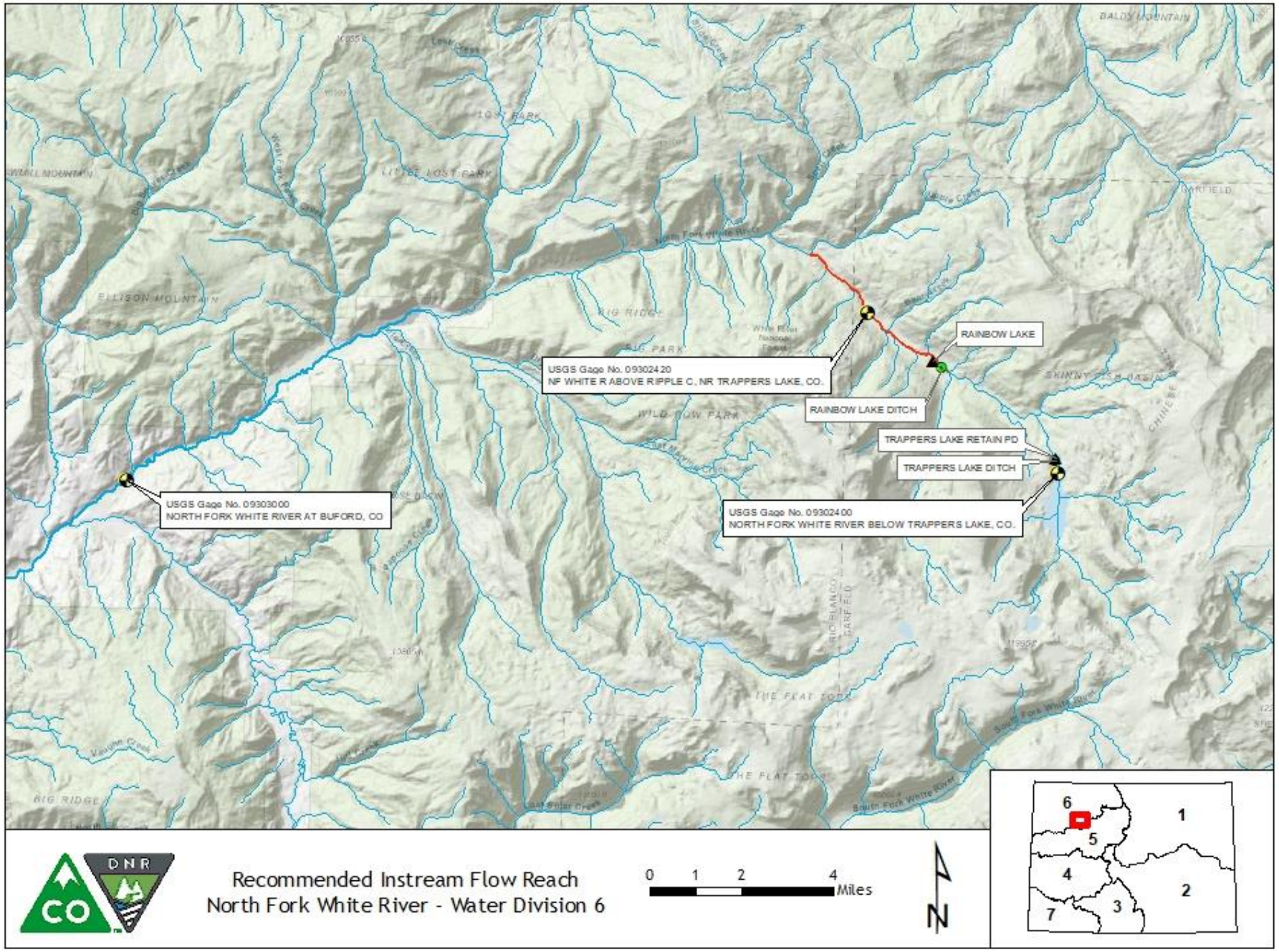
VICINITY MAP



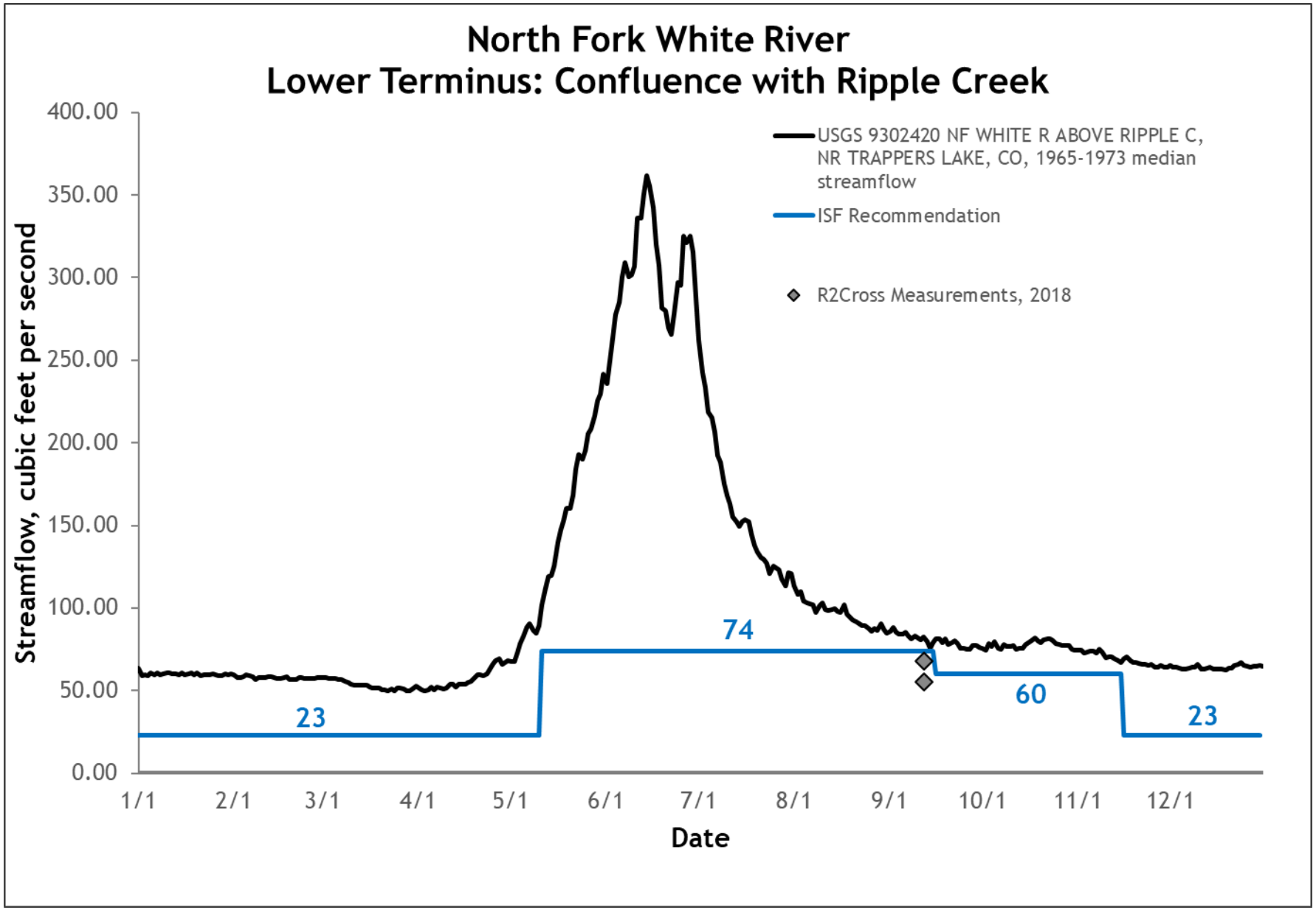
LAND OWNERSHIP MAP



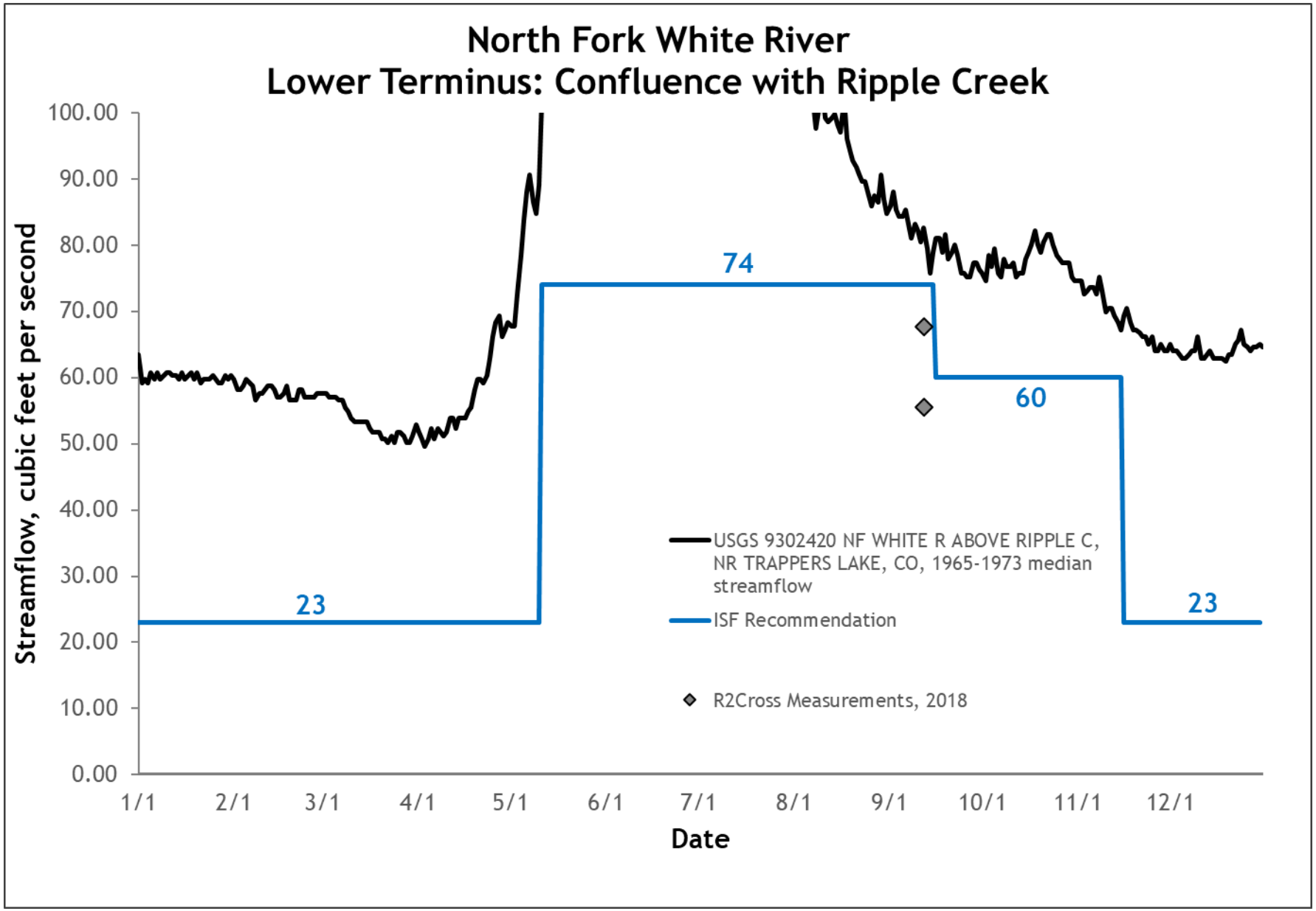
HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



DETAILED HYDROGRAPH



COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Trout Creek
EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	confluence with an unnamed tributary at UTM North: 4457645.23 UTM East: 323578.92
LOWER TERMINUS:	Koll Ditch headgate UTM North: 4464276.41 UTM East: 329133.88
WATER DIVISION:	6
WATER DISTRICT:	57
COUNTY:	Routt
WATERSHED:	Upper Yampa
EXISTING ISF:	77W1338, 5 cfs (01/01 - 12/31)
CWCB ID:	19/6/A-009
RECOMMENDER:	Bureau of Land Management (BLM)
LENGTH:	6.64 miles
FLOW RECOMMENDATION:	2.0 cfs (11/01 - 03/31) 8.0 cfs (04/01 - 07/31) 7.0 cfs (08/01 - 10/31)

Trout 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 increase to the existing ISF water right on a reach of Trout Creek. Trout Creek is located within Routt County and originates in the Flat Tops Mountains at an elevation of approximately 11,250 ft. The stream flows north 43 miles to the confluence with the Yampa River at an elevation of approximately 6,500 ft (See Vicinity Map). The proposed reach extends from the confluence with an unnamed tributary downstream to the Koll Ditch headgate. The BLM manages 11 percent of the land on the 6.64 mile proposed reach, and 89 percent is privately owned (See Land Ownership Map). The current ISF water right does not provide sufficient physical habitat during the warm weather portions of the year when the fish populations are feeding, growing, and spawning. The proposed increase in flow rates during winter is warranted to make much of the physical habitat in the stream channel less susceptible to freezing.

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/2019ProposedISFRecommendations.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 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.

Trout Creek is a cold water, moderate gradient stream. The reach that is the subject of this recommendation flows through a valley that ranges from 1/8 to 1/2 mile in width. The upper part of the reach flows through agricultural lands used for livestock grazing, while the lower part of the reach flows through a confined canyon that is largely in natural condition. Substrate is generally from medium to large size, ranging from 4-inch cobbles to small boulders. Water quality is good for supporting salmonid fish species, but during July and August, temperatures can approach the maximum temperatures that trout can tolerate.

Fish surveys indicate a diverse and self-sustaining fish community. Trout Creek provides habitat for brook trout, brown trout, Colorado River cutthroat trout, mottled sculpin, speckled dace, and mountain sucker. Spot surveys have indicated abundant populations of stonefly and caddisfly.

Table 1. List of species identified in Trout Creek.

Species Name	Scientific Name	Status
brook trout	*Salvelinus fontinalis*	None
brown trout	*Salmo trutta*	None
Colorado River cutthroat trout	*Oncorhynchus clarkii pleuriticus*	State - Species of Special Concern Federal - Sensitive Species
mottled sculpin	*Cottus bairdii*	None
mountain sucker	*Catostomus platyrhynchus*	State - Species of Special Concern Federal – Sensitive Species
speckled dace	*Rhinichthys osculus*	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.

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 7.53 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 13.04 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 Trout Creek.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
BLM	08/12/2017 #1	9.43	3.77 - 23.58	9.27	13.28
BLM	08/12/2017 #2	8.58	3.43 - 21.45	5.79	12.80
			Mean	7.53	13.04

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

8.0 cubic feet per second increase is recommended during the snowmelt runoff period and early summer, from April 1 to July 31. This recommendation is driven by the average depth criteria. In many locations, the Trout Creek channel is wide with large substrate, so meeting the depth criteria is important for passage between rocks and between pools. Implementing this recommendation would increase the instream flow rate during this time period to a total of 13.0 cubic feet per second.

7.0 cubic feet per second increase is recommended during late summer and early fall, from August 1 to October 31. This recommendation is driven by limited water availability. 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. Implementing this recommendation would increase the instream flow rate during this time period to a total of 12.0 cubic feet per second.

2.0 cubic feet per second increase is recommended during the cold temperature portion of the year, from November 1 through March 31. This recommendation is driven by limited water availability but comes very close to meeting the wetted perimeter criteria and the velocity criteria. This flow rate should prevent complete icing of the numerous pools in this reach, allowing the fish population to overwinter. Implementing this recommendation would increase the instream flow rate during this time period to a total of 7.0 cubic feet per second.

The BLM believes an instream flow increase for Trout Creek is warranted because of physical habitat characteristics. The R2Cross data summarized above clearly indicates that the current instream flow water right does not provide sufficient physical habitat during the warm weather portions of the year when the fish populations are feeding, growing, and spawning. When the existing instream flow rights are applied to the cross-sections that were collected, the stream would exhibit 40 percent to 66 percent wetted perimeter. However, this habitat is not highly usable by the fish population, because 5.0 cfs constrains the habitat to an average depth of 0.22 to 0.26 feet. An average habitat

depth of 0.22 to 0.26 feet is not sufficient in a stream that averages 35 to 40 feet in top width. During the warm weather season, the fish populations need to have access to as much of the stream channel as possible for feeding, resting, and spawning if they are to survive the pronounced cold winters in this canyon. The increase in flow rates during winter is warranted because the average depths associated with 7.0 cfs make much of the physical habitat in the stream channel less susceptible to freezing.

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 Trout Creek is 32.2 square miles, with an average elevation of 9,477 ft and average annual precipitation of 33.55 inches (See the Vicinity Map). There are a number of known surface water diversions in the drainage basin tributary to the proposed ISF on Trout Creek. These structures potentially divert approximately 105.5 cfs and include the Sheriff Reservoir (986 AF) and an additional 61 AF in other storage. The Alex Ditch (1.28 cfs, appropriation

dates 1912 and 1948) is the only diversion structure located within the proposed reach. This water right is relatively small and has sporadic diversion records.

Available Data
There is not a current or historic daily streamflow gage on Trout Creek. However, the Edna Mine measured streamflow at a location near the proposed lower terminus from 1989 to 2009 (Edna Mine site identifier TR-a). These measurements were reported to the Department of Reclamation, Mining and Safety on an approximately monthly basis for April through October (Edna Mine, 2010).

The Koll Ditch (WDID 5700635, 13.22 cfs, appropriation dates 1894, 1903, and 1949) is the proposed lower terminus. This structure has diversion records between 1938 and 2017.

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

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

Visit Date	Flow (cfs)	Collector
05/07/2018	64.58	CWCB
10/09/2018	9.59	CWCB

Data Analysis
The Edna Mine made 144 streamflow measurements between 1989 and 2009. These measurements were made at various times throughout the month, but typically on the first of the month from 1999 to 2009. All measurements for a given month were used to determine the median measured streamflow for that month.

The Koll Ditch is located near the proposed lower terminus, but does not sweep the stream (personal communication, Brian Romig, November 2018). Therefore, the diversion record is not a good proxy for the total amount of water available at that location. The diversions also typically start in late May and end by early September which limit information during runoff, late fall, and winter. Because of these limitations, the Koll Ditch was not used as a primary source of information about water availability.

Water Availability Summary
The hydrographs (See Complete and Detailed Hydrographs) show the median of monthly measured streamflow values from the Edna Mine data and mean-monthly streamflow from StreamStats. There is good agreement between the mean of the measured values and StreamStats values between April and October. However, StreamStats is generally higher, which is not unexpected given that StreamStats does not explicitly account for water diversions. During the winter, there is little water use in the Trout Creek basin and StreamStats provides an estimate of streamflow conditions. The proposed ISF rate is below the median monthly streamflow measurements from April through October and below the StreamStats mean-monthly flow from November through March. Staff concludes that water is available for appropriation on Trout Creek.

Material Injury
Because the proposed ISF on Trout 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. (2018), 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.

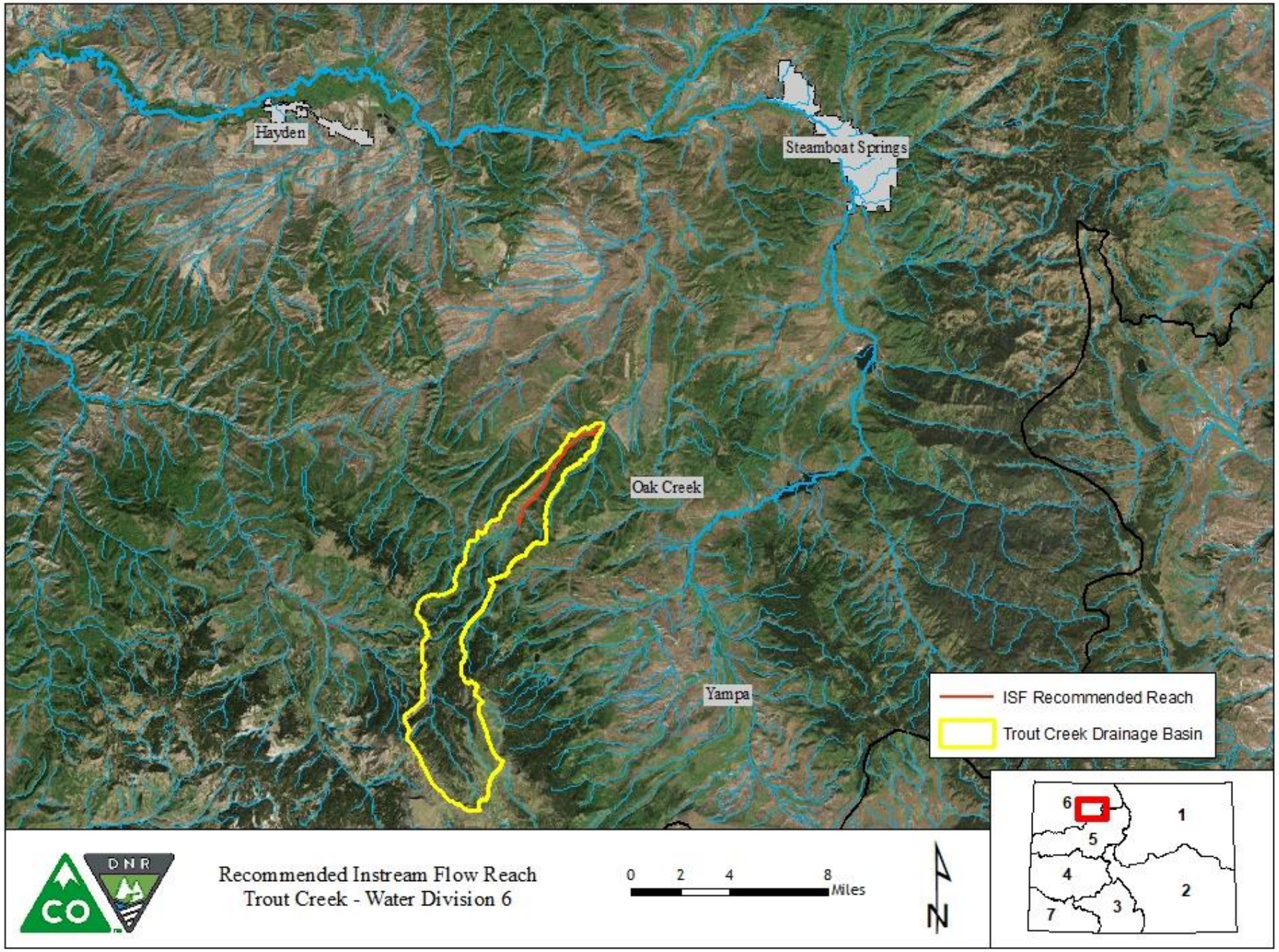
Nehring, B.R., 1979, Evaluation of Instream Flow Methods and Determination of Water Quantity Needs for Streams in the State of Colorado, Colorado Division of Wildlife.

WWC Engineering, 2010, 2009 Annual Hydrology Report – Edna Mine. Available at DMRS laserfiche: http://10.14.11.214/drmsimaging/0/doc/904586/Page1.aspx?searchid=faed753d-29fc-4589-95ea-c127f0e3c102.

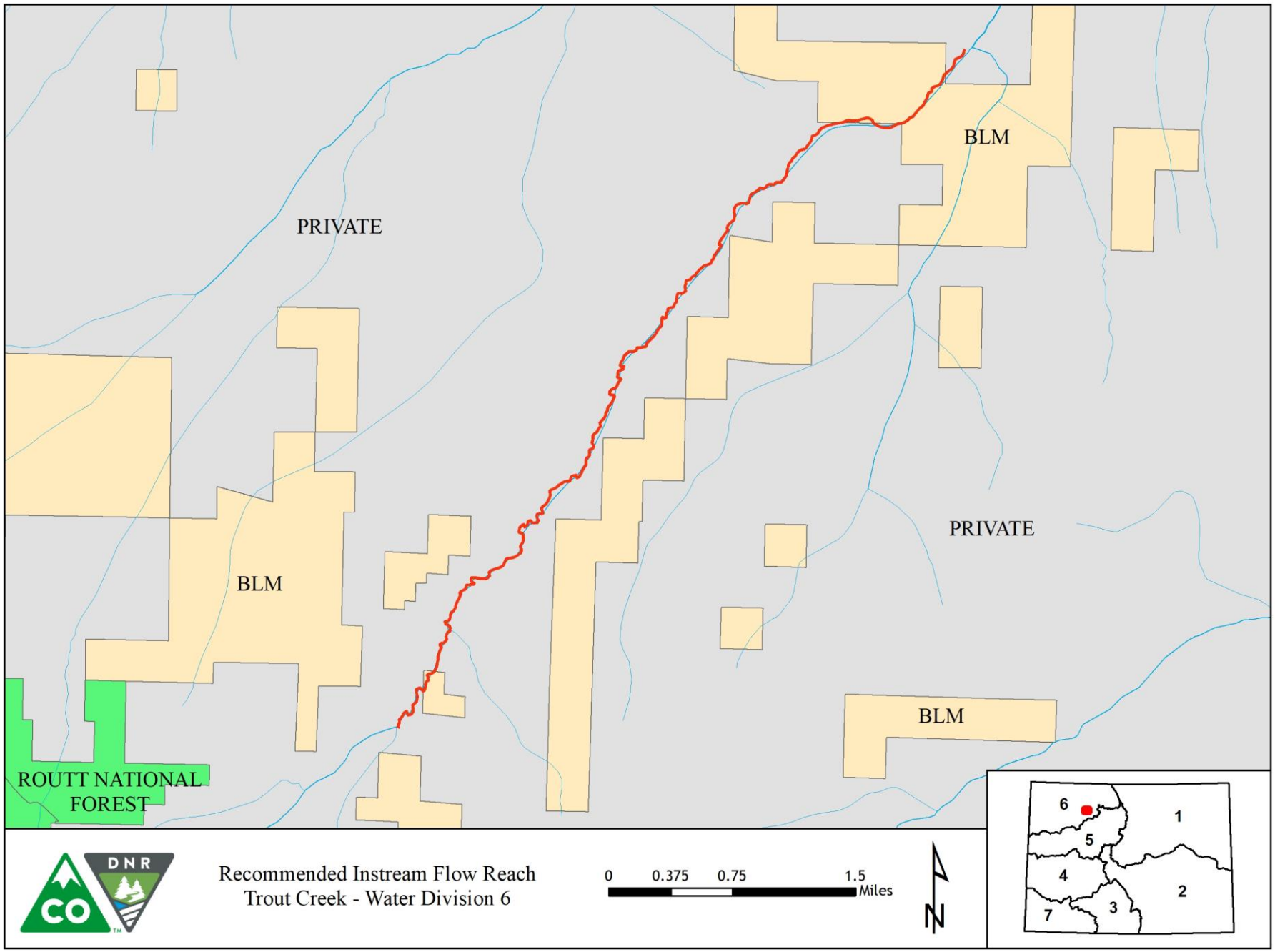
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

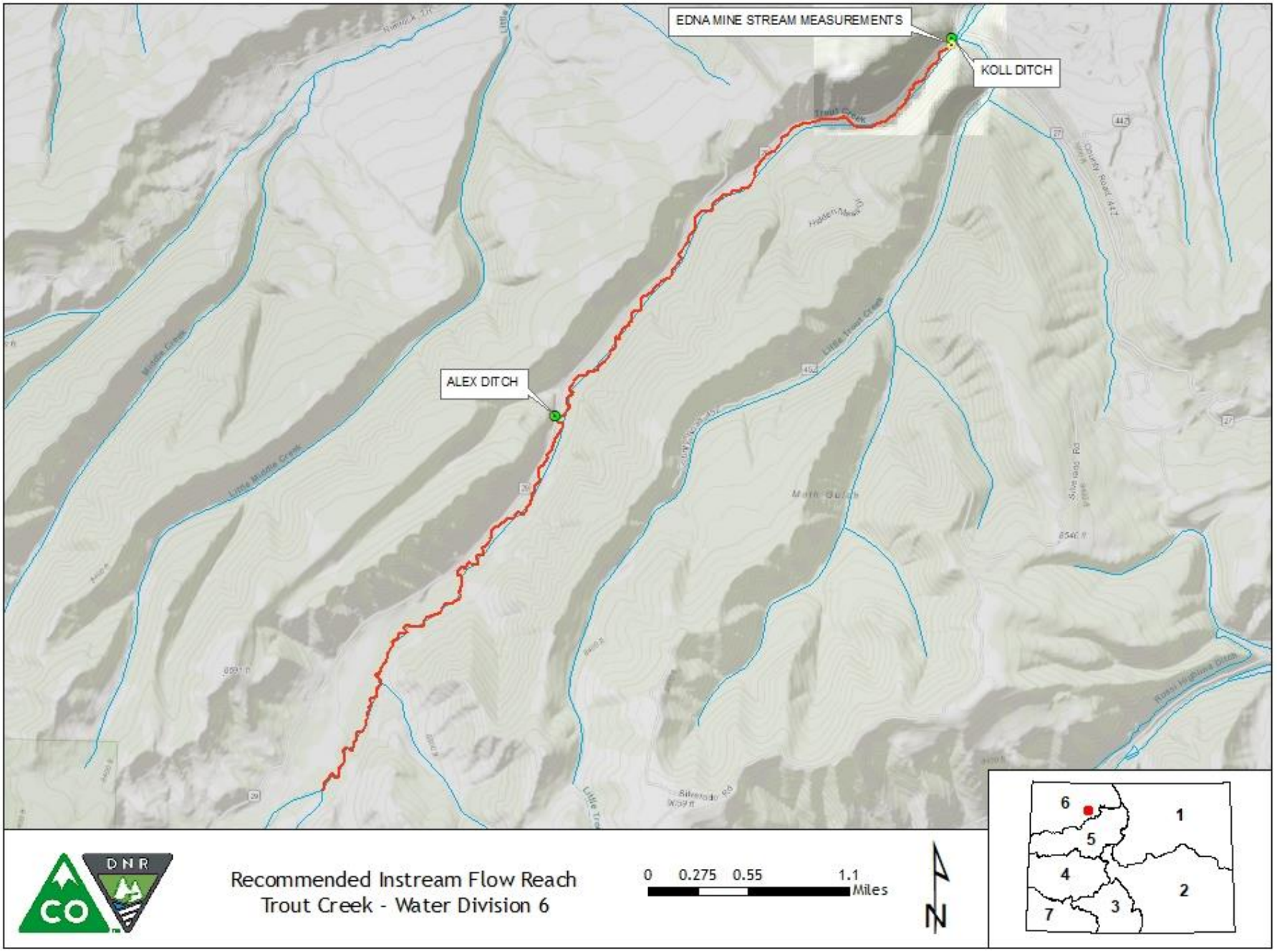
VICINITY MAP



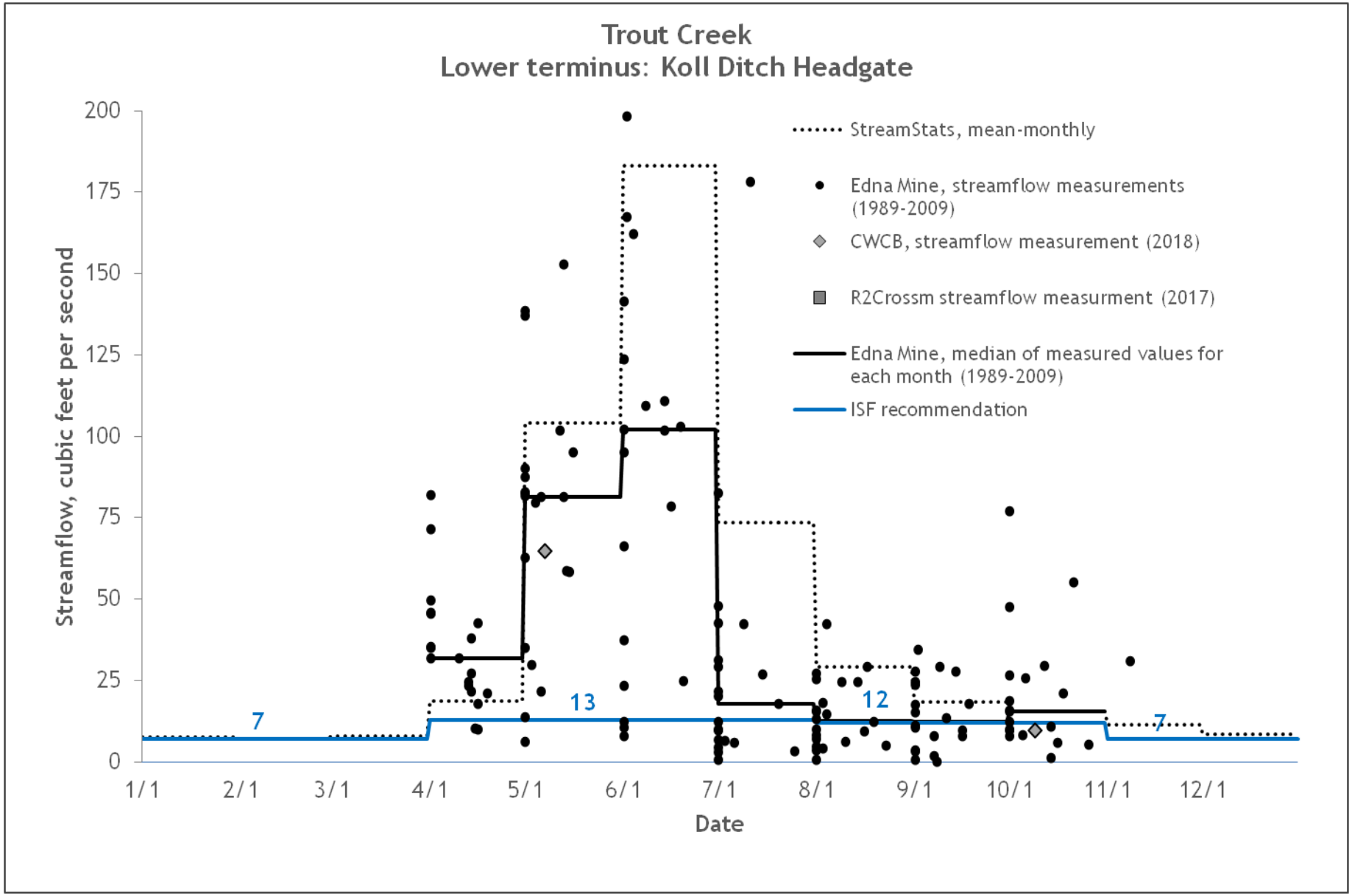
LAND OWNERSHIP MAP



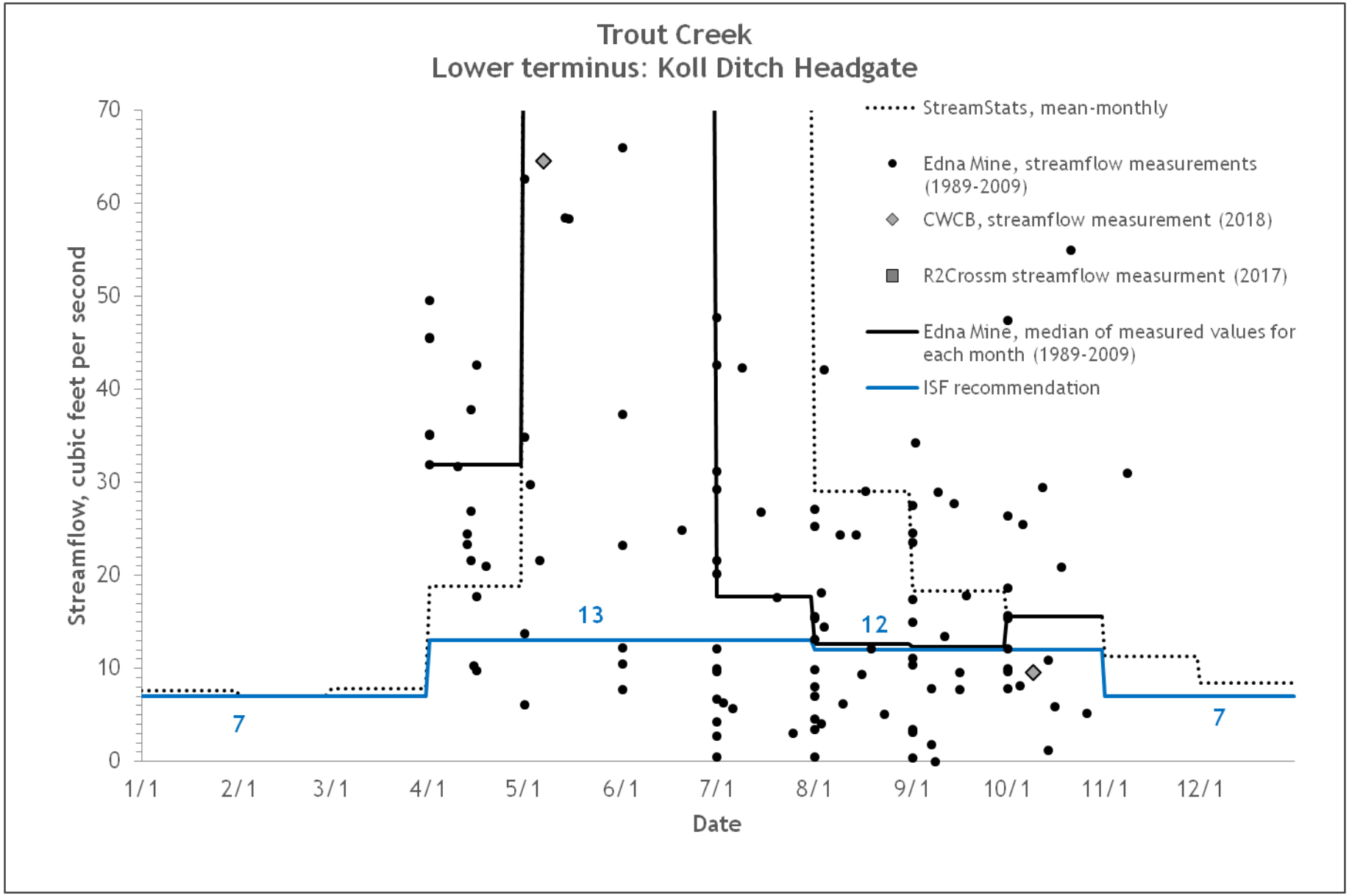
HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



DETAILED HYDROGRAPH



COLORADO
Colorado Water Conservation Board
Department of Natural Resources

West Marvine Creek

EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	headwaters in the vicinity of UTM North: 4422407.10 UTM East: 295929.96
LOWER TERMINUS:	West Marvine Ditch headgate UTM North: 4432396.94 UTM East: 291578.55
WATER DIVISION:	6
WATER DISTRICT:	43
COUNTY:	Rio Blanco
WATERSHED:	Upper White
CWCB ID:	18/6/A-010
RECOMMENDER:	Colorado Parks and Wildlife (CPW)
LENGTH:	9.08 miles
FLOW RECOMMENDATION:	2.9 cfs (11/01 - 03/31) 4.6 cfs (04/01 - 10/31)

West Marvine 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.

CPW recommended that the CWCB appropriate an ISF water right on a reach of West Marvine Creek because it has a natural environment that can be preserved to a reasonable. West Marvine Creek is located within Rio Blanco County and originates from an unnamed lake in the Flat Tops Mountains at an elevation of approximately 10,866 ft, flowing north to the confluence with Marvine Creek at an elevation of approximately 7,800 ft (See Vicinity Map). The proposed reach extends from the headwaters downstream to the West Marvine Ditch headgate. The U.S. Forest Service manages 100 percent of the land on the 9.08 mile proposed reach (See Land Ownership Map).

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/2019ProposedISFRecommendations.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 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.

The recommended reach of West Marvine Creek is a first order stream flowing through a variety of valley types with both forested cover and open lands (meadows and pasture lands). Throughout this reach of West Marvine Creek, there is an abundance of pool, riffle, and glide habitat types. Significant large wood in the stream contributes to side channel and pool habitat. Substrate generally ranges from large boulders to small cobble. Past CPW fishery surveys indicate presence of Colorado River cutthroat trout (CRCT) and brook trout. CRCT is a Tier 1 priority species in the 2015 State Wildlife Action Plan, which has the highest conservation priority in the state. CRCT is classified as a state Species of Special Concern and is considered a Sensitive Species by the Bureau of Land Management (BLM) and USFS. The CRCT population in West Marvine Creek is an important population, as they are isolated from downstream fish populations by the dry stream channel that exists below the West Marvine Ditch diversion.

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

Species Name	Scientific Name	Status
Colorado River cutthroat trout	*Oncorhynchus clarkii pleuriticus*	State - Species of Special Concern Federal – Sensitive Species
brook trout	*Salvelinus fontinalis*	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

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 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). 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. However, the R2Cross model also contains the Thorne and Zevenbergen subroutine, which uses field measured bed material grain size to estimate velocity. This method is not constrained by the accuracy range of the Manning's n subroutine.

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 2.9 cfs, which meets 2 of 3 criteria, and a summer flow of 4.6 cfs, which meets 3 of 3 criteria.

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

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
CPW	09/13/2018 #1	1.40	0.56 - 3.50	2.60	2.80
CPW	09/13/2018 #2	1.40	N/A	3.10[1]	6.30[1]
			Mean	2.9	4.6

1 = Thorne and Zevenberg subroutine was used due to Manning's n results that were outside of the accuracy range. The measured D84 was 0.36 feet

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

2.9 cfs from November 1 through March 31 meets 2 of 3 instream flow criteria and will provide suitable overwintering habitat during the base flow period.

4.6 cfs from April 1 through October 31 meets 3 of 3 instream flow criteria during critical periods for fish migration, spawning, and rearing.

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.

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). 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 West Marvine Creek is 8.52 square miles, with an average elevation of 10,018 ft and average annual precipitation of 38.69 inches (See the Hydrologic Features Map). Because there are no surface water diversions in the basin tributary to the proposed ISF reach, hydrology in the basin represents natural flow conditions.

Available Data

There are no current or historic streamflow gages located within the proposed ISF reach. There is a historic streamgage, Marvine Creek near Buford, CO (USGS 0902500), approximately 2.6 miles northwest of the proposed lower terminus on Marvine Creek near the confluence of the North Fork White River. The historic gage has a continuous period of record (POR) from September 1972 to September 1984. The drainage basin for the historic gage is 59.9 square miles, with an average elevation of 9,813 ft and average annual precipitation of 37.71 inches. This gage will be referred as the Marvine Creek gage in this analysis. The Marvine Creek gage is downstream from a number of surface water diversions that alter the hydrology measured by the gage. This may underestimate the amount of water available in the proposed ISF reach that is not impacted by water uses.

CWCB staff made one streamflow measurement on the proposed reach of West Marvine Creek as summarized in Table 3.

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

Visit Date	Flow (cfs)	Collector
06/28/2017	8.01	CWCB

Data Analysis

Due to the short POR available at the Marvine Creek gage, staff took additional steps to evaluate the record. Staff examined the streamflow gages and climate stations in the area and found that the historic gage, North Fork White River at Buford, CO (USGS 09303000), has a continuous POR from 1951 – 2001 and is located about 7.5 miles from the Marvine Creek gage. The average annual streamflow for the North Fork White River gage was 227,419 AF. During the 12 years the Marvine Creek gage operated (1972-1984), eight years had above average annual streamflows. During the same 12 years, the average annual streamflow at the North Fork White River gage was 236,754 AF, approximately 5% above the 50-year average. Therefore, the Marvine Creek gage record likely represents slightly above average streamflow conditions.

The Marvine Creek gage was analyzed from 9/1/1972 to 9/30/1984 based on gage data and diversion records available through HydroBase on 10/26/2018. Because streamflow at the Marvine Creek gage is affected by a number of upstream diversions, an effort was made to estimate natural streamflow at the gage location. The majority of these diversions irrigate land adjacent to Marvine Creek and upstream from the historic gage. These diversions hold a total of 55.15 cfs of decreed rights. There

are also several storage rights above the gage location on Marvine Creek that total 108.65 AF of storage. The return flows from most of the intervening diversions likely accrue to the stream above the gage and are included in the gage record. The gage records and the diversion records also did not overlap in most cases. Due to these and other limitations, the intervening diversions were not used to adjust the gage record. However, the Marvine Ditch 1 is used to irrigate land downstream from the gage and most or all return flows accrue below the gage. Therefore, the diversions from Marvine Ditch 1 were added to the Marvine Creek gage record in an effort to better represent natural flow conditions. Nevertheless, not all water uses were accounted for and the adjusted gage record still reflects a fairly significant amount of impacts from water withdrawals.

Water Availability Summary
The hydrograph (See Complete Hydrograph) shows median streamflow estimated at the lower terminus of West Marvine Creek. The proposed ISF is below the median streamflow estimate at all times. Staff concludes that water is available for appropriation on West Marvine Creek.

Material Injury
Because the proposed ISF on West Marvine 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. (2018), 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.

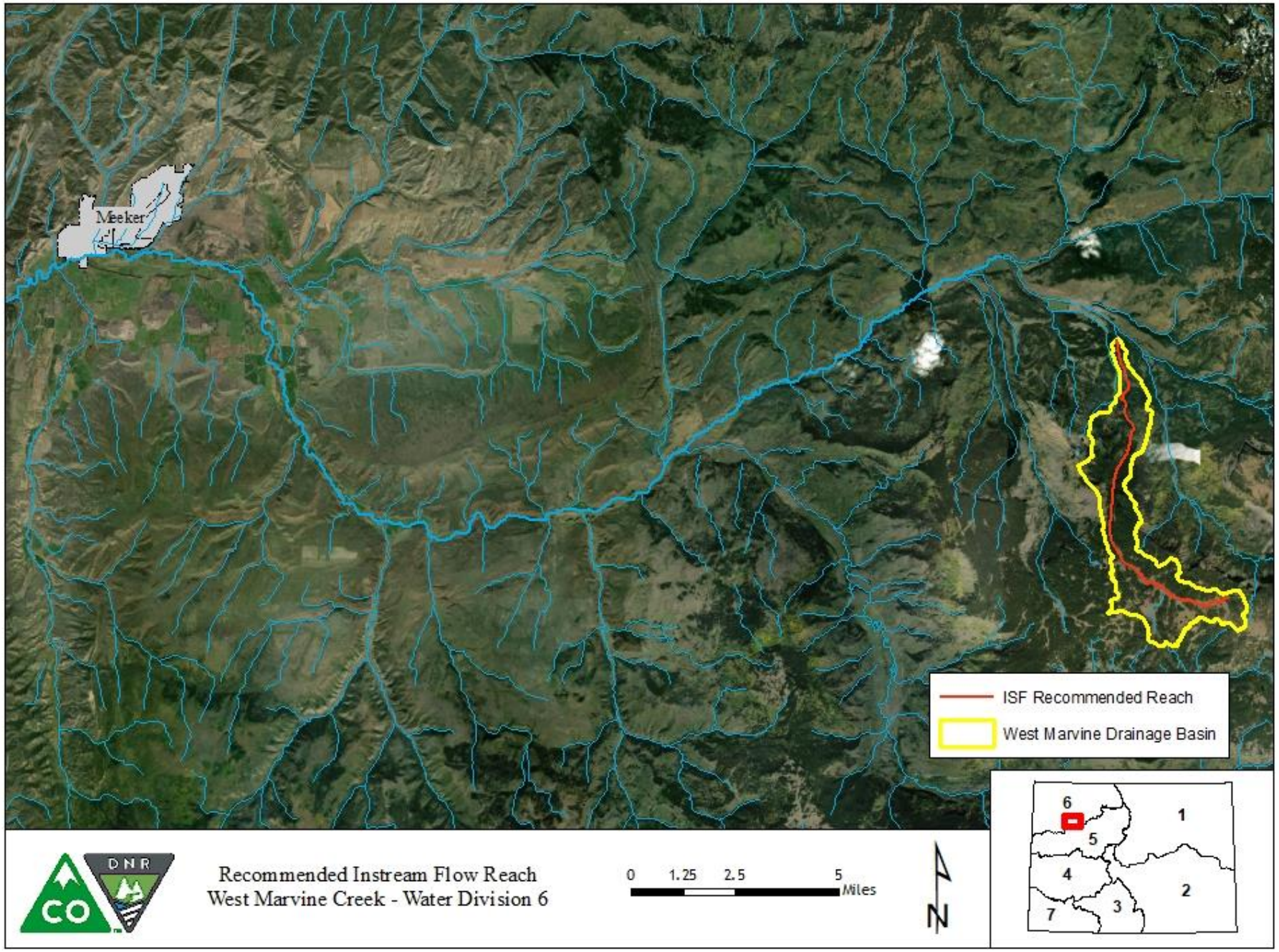
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

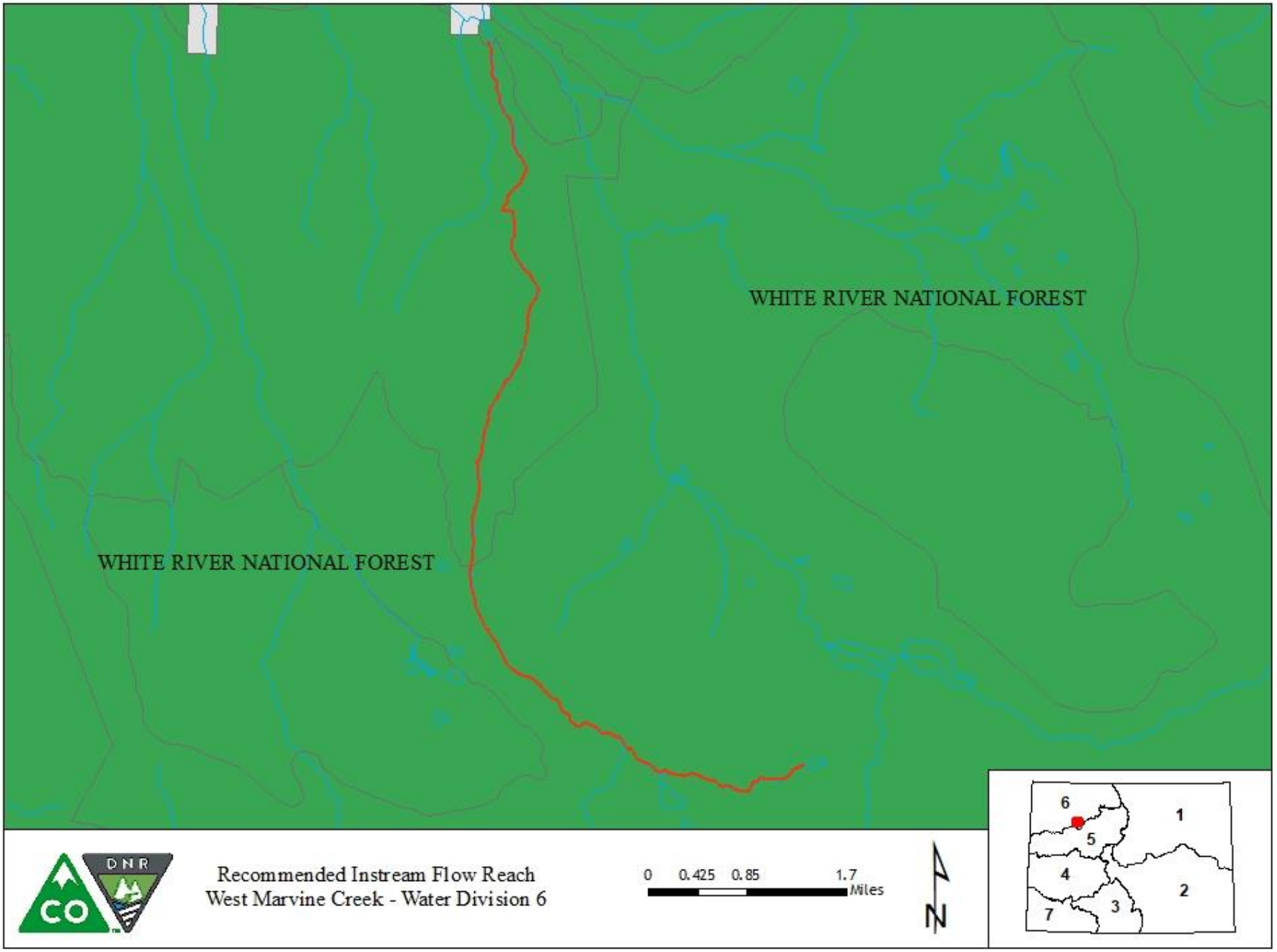
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

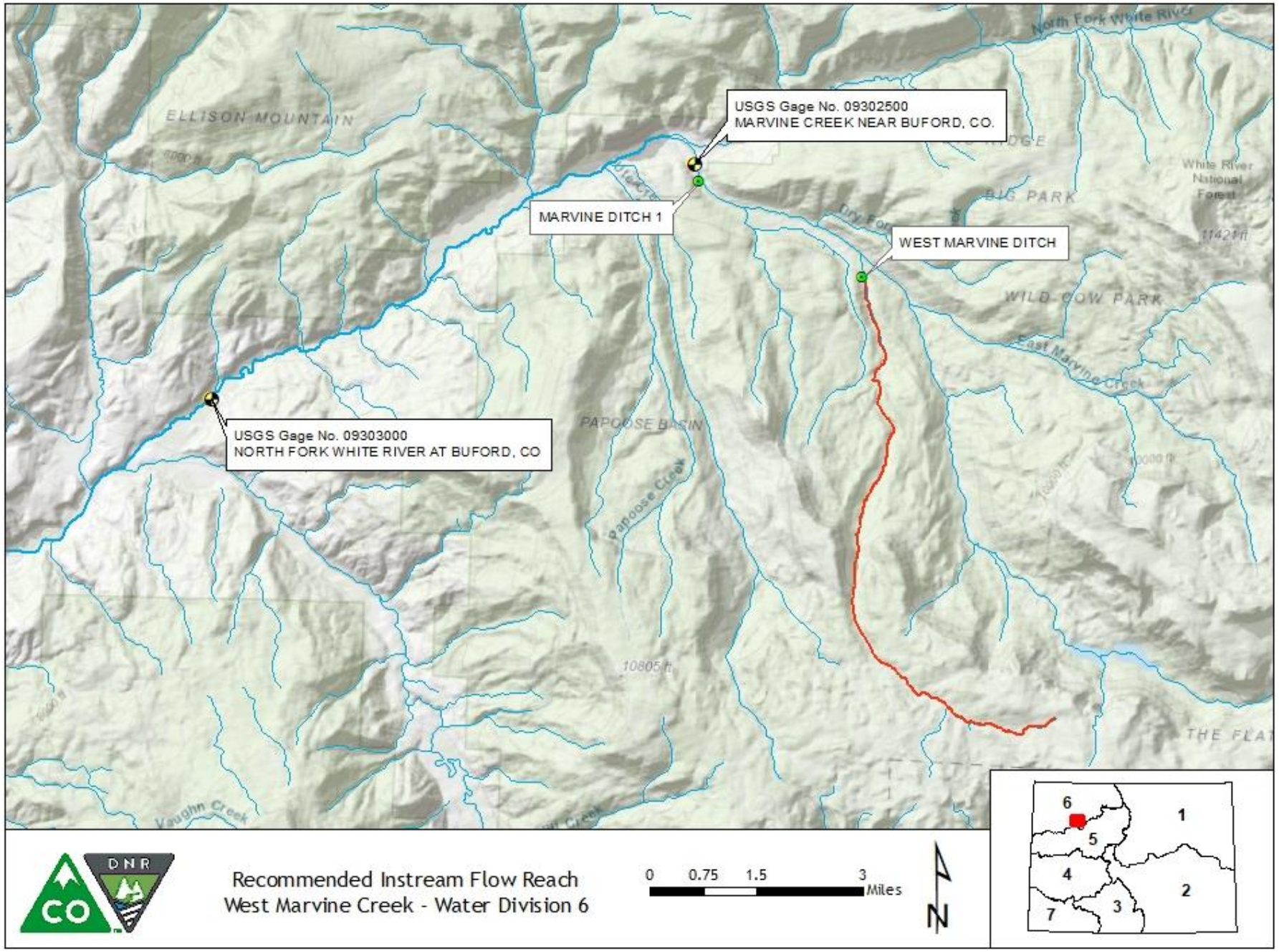
VICINITY MAP



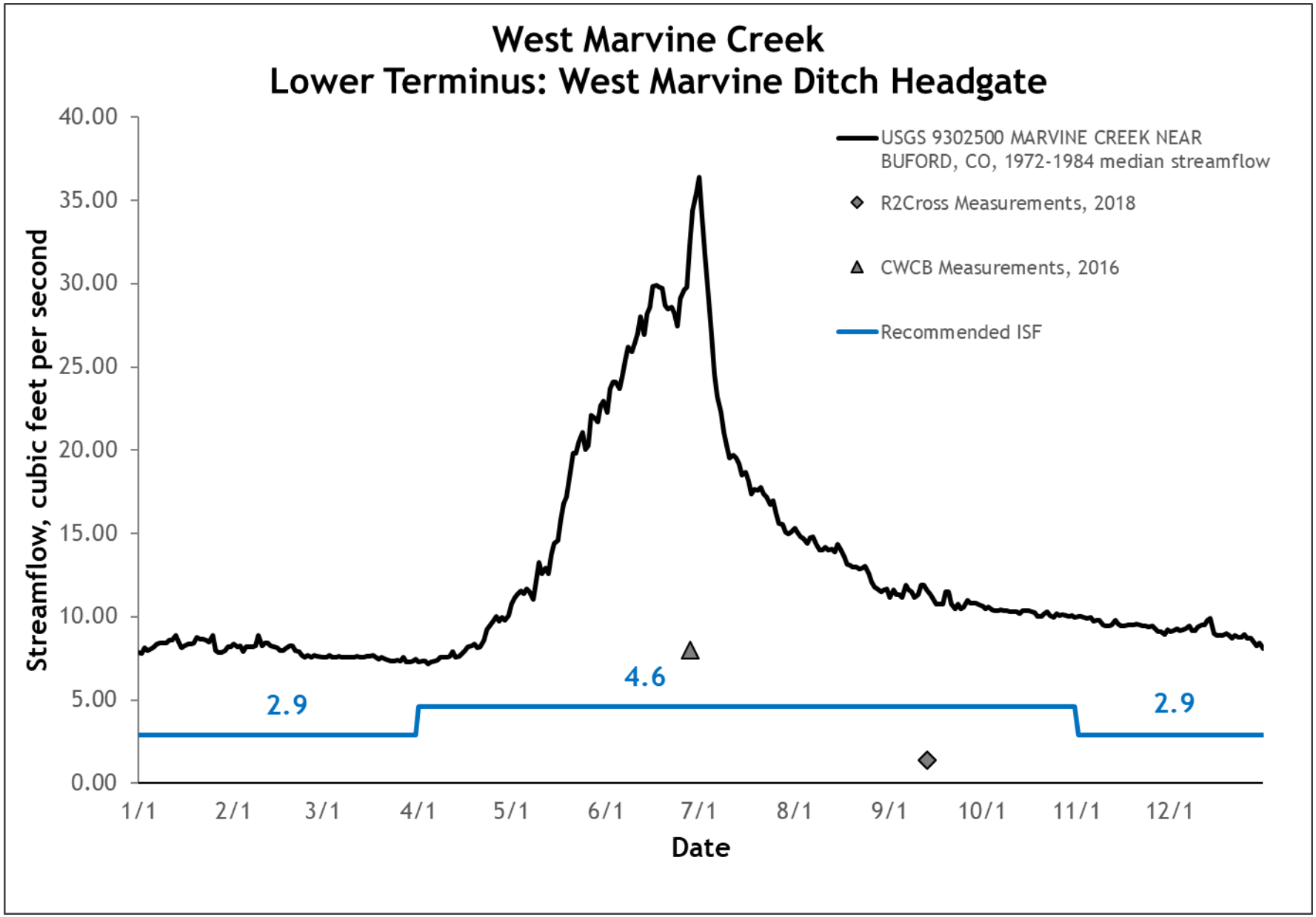
LAND OWNERSHIP MAP



HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Disappointment Creek (Upper)

EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	confluence with Morrison Creek UTM North: 4194988.94 UTM East: 202844.92
LOWER TERMINUS:	historic USGS gage (Disappointment Creek near Dove Creek, CO) UTM North: 4198182.88 UTM East: 184833.22
WATER DIVISION:	7
WATER DISTRICT:	69
COUNTY:	Dolores
WATERSHED:	Upper Dolores
CWCB ID:	18/7/A-001
RECOMMENDER:	Bureau of Land Management (BLM)
LENGTH:	21.71 miles
FLOW RECOMMENDATION:	1.8 cfs (01/01 - 01/31) 2.6 cfs (02/01 - 03/15) 14 cfs (03/16 - 06/30) 8.0 cfs (07/01 - 07/15) 5.8 cfs (07/16 - 07/31) 2.2 cfs (08/01 - 12/31)

Disappointment Creek (Upper)

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 this reach of Disappointment Creek because it has a natural environment that can be preserved to a reasonable degree. Disappointment Creek is located within Dolores and San Miguel Counties and originates at an elevation of approximately 10,800 ft. Disappointment Creek flows west 68.5 miles to the confluence with the Dolores River at an elevation of approximately 5,528 ft (See Vicinity Map). The proposed reach extends from the confluence with Morrison Creek downstream to the historic USGS gage, Disappointment Creek near Dove Creek, CO (USGS 09168100). Twenty percent of the land on the 21.71 mile proposed reach is public land managed by the Bureau of Land Management or U.S. Forest Service (See Land Ownership Map).

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/2019ProposedISFRecommendations.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 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.

This upper reach of Disappointment Creek is a low to moderate gradient stream that flows through a broad canyon and is confined by bedrock in numerous locations. The riparian community is comprised of narrowleaf cottonwood, river hawthorn, willows, sedges, rushes, and common reed. Substrate size ranges from gravel to small boulders with a good mix of riffle, run, and pool habitat to support fish populations. Water temperatures and food sources are suitable for native species. While no fish surveys have been conducted in this proposed ISF reach, numerous fish species have been documented by the BLM and CPW upstream and downstream. The lower reach of Disappointment Creek (below the USGS gage and subject of a separate ISF recommendation) provides important habitat for flannelmouth sucker and roundtail chub that migrate seasonally from the Dolores River. Above the confluence with Morrison Creek and upstream from this proposed ISF reach, CPW documented Colorado River cutthroat trout and speckled dace in 2016. CPW surveys also discovered a pure population of green lineage Colorado River cutthroat trout in the headwaters. Based on this information, there is a high probability

that both cold and warmwater fish species use portions of this proposed reach either seasonally or as resident. CWCB staff also observed macroinvertebrates in this reach in 2017.

Table 1. List of species identified upstream and downstream from the subject reach of Disappointment Creek.

Species Name	Scientific Name	Status
Colorado River cutthroat trout	*Oncorhynchus clarkii pleuriticus*	State – Species of Special Concern Federal – Sensitive Species
speckled dace	*Rhinichthys osculus*	None
flannelmouth sucker	*Catostomus latipinnis*	None
roundtail chub	*Gila robusta*	State - Species of Special Concern Federal – 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 in 2016 (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 8.00 cubic feet per second (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 13.73 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 upper Disappointment Creek.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
BLM	06/29/2016 #3	7.73	3.09 - 19.33	8.39	9.08
BLM	06/29/2016 #4	8.02	3.21 - 20.05	7.61	18.37
			Mean	8.00	13.73

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

14.0 cubic feet per second is recommended from March 16 through June 30. In the cross-sections measured, this recommendation is driven by the average depth and wetted perimeter criteria. This flow rate should also serve to recharge the alluvial aquifer that supports the riparian community.

8.0 cubic feet per second is recommended from July I through July 15, which meets two of the three instream flow criteria, and should provide sufficient mobility and physical habitat for fish during a high temperature period of the year.

5.8 cubic feet per second is recommended from July 16 through July 31, which protects as much flow as possible during this high temperature period and will provide mobility to assist fish in moving toward cooler pool habitats. This flow rate also assists in providing groundwater supplies to the riparian zone when evapotranspiration rates are the highest of the year.

2.2 cubic feet per second is recommended from August I through December 31. This a base flow rate that will provide pool habitat and maintain adequate groundwater levels in alluvial aquifers through the end of the growing season.

1.8 cubic feet per second is recommended from January I to January 31. This flow rate should prevent icing in pools, maintain wet rooting zones for the riparian community, and support macroinvertebrate communities in the hyporheic zone below the channel bed.

2.6 cubic feet per second is recommended from February 1 to March 15. As initial snowmelt runoff begins, this flow rate will start increasing groundwater levels in alluvial aquifers as the riparian community starts to become active.

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 Disappointment Creek is 147 square miles, with an average elevation of 7,390 ft and average annual precipitation of 21.45 inches (See the Hydrologic Features Map). The Disappointment Creek basin supports agriculture, among other uses. Hydrology is altered by water use within the basin. A number of diversion structures are located within the proposed reach, including the Knight-Embling Ditch (WDID 690512, appropriation dates 1885,1895, 1901, 1906, 1932, 1935, 7.365 cfs), the Henry M Knight Ditch (WDID 900508, appropriation date 1883, 1 cfs), and the Southside Ditch (WDID 6900523, appropriation dates 1902 and 1930, 0.26 cfs).

Available Data
There is not an active streamflow gage on the proposed reach of Disappointment Creek, but there are two historical gages with available data. The Disappointment Creek near Dove Creek, CO gage (USGS 09168100, period of record 8/1/1957 – 9/29/1986) was located at the proposed lower terminus. The drainage basin of the gage is 147 square miles, with an average elevation of 7,930 ft and average

annual precipitation of 21.45 inches. The Disappointment Creek near Cedar, CO gage (USGS 09168500, period of record 3/1/1953 –9/29/1956) was located approximately 8 miles downstream from the proposed lower terminus. The drainage basin of the gage is 168 square miles, with an average elevation of 7,800 ft and average annual precipitation of 20.8 inches. Both gages are impacted by diversion practices upstream.

CWCB staff made one streamflow measurement on the subject reach of Disappointment Creek as summarized in Table 3.

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

Visit Date	Flow (cfs)	Collector
06/01/2017	63.81	CWCB

Data Analysis
Staff's analysis focused on the upper gage, Disappointment Creek near Dove Creek, CO (USGS 09168100), which has a longer period of record than the lower gage and was located at the lower terminus. Because this gage is below all diversion structures, the analysis includes the impact from water uses upstream and within the proposed ISF reach. Median streamflow and 95% confidence intervals for median streamflow were calculated for the adjusted Disappointment Creek near Dove Creek, CO gage record.

Water Availability Summary
The hydrographs (See Complete Hydrograph and Detailed Hydrograph) show median streamflow based on the Disappointment Creek gage record. The proposed ISF rate is below the median streamflow for the majority of the time. Staff has concluded that water is available for appropriation.

Material Injury
Because the proposed ISF on Disappointment 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. (2019), 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.

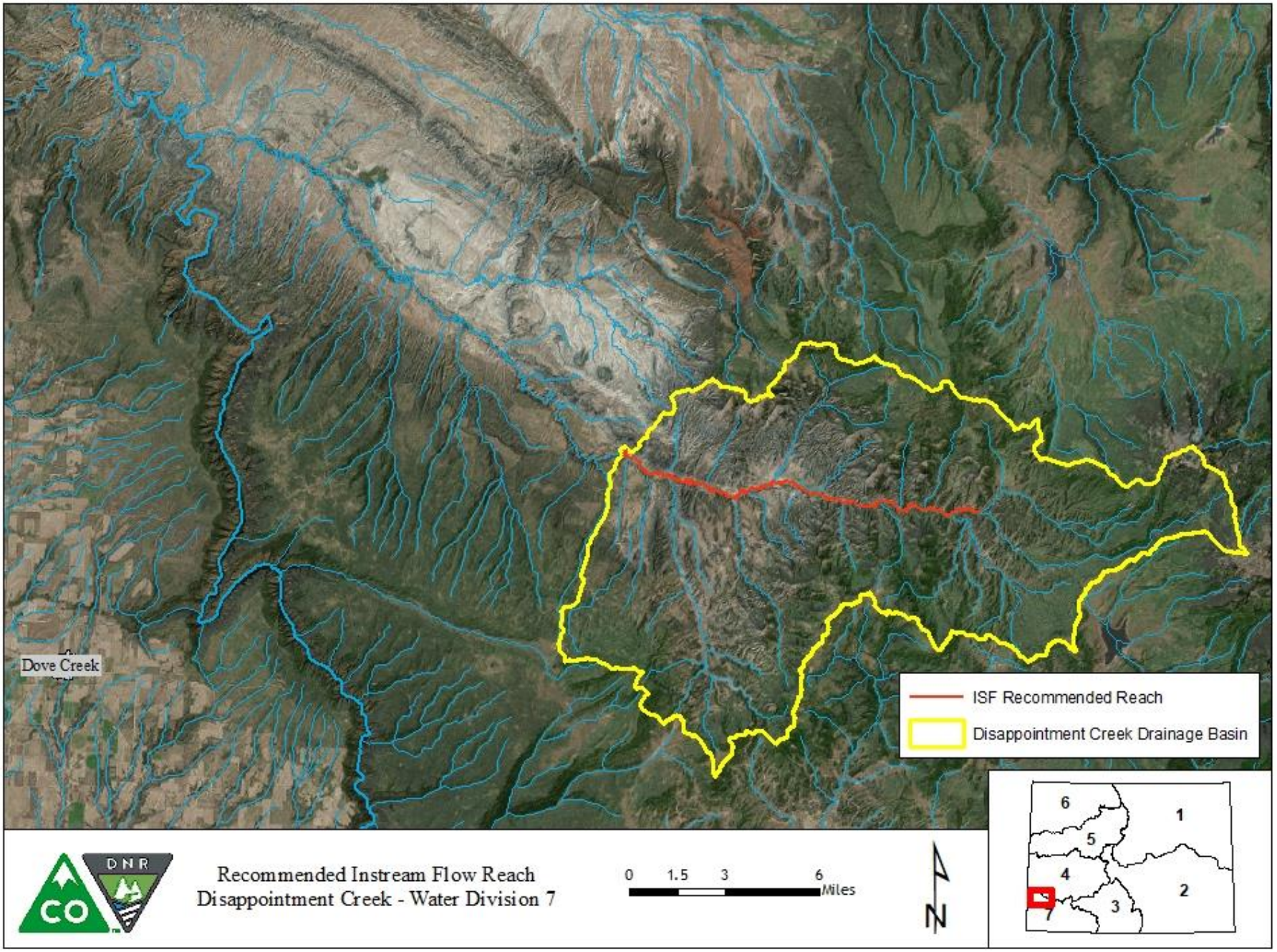
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

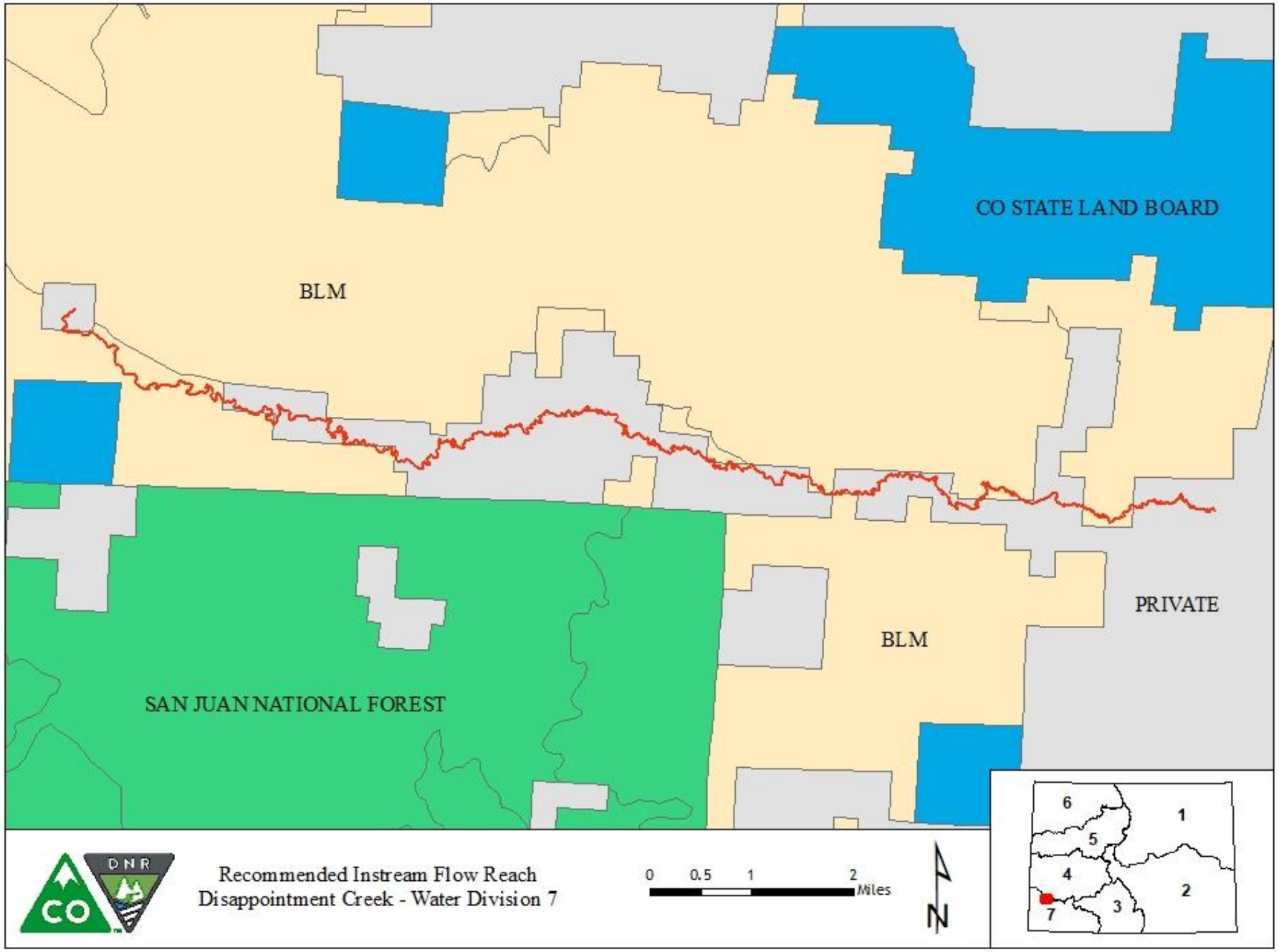
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

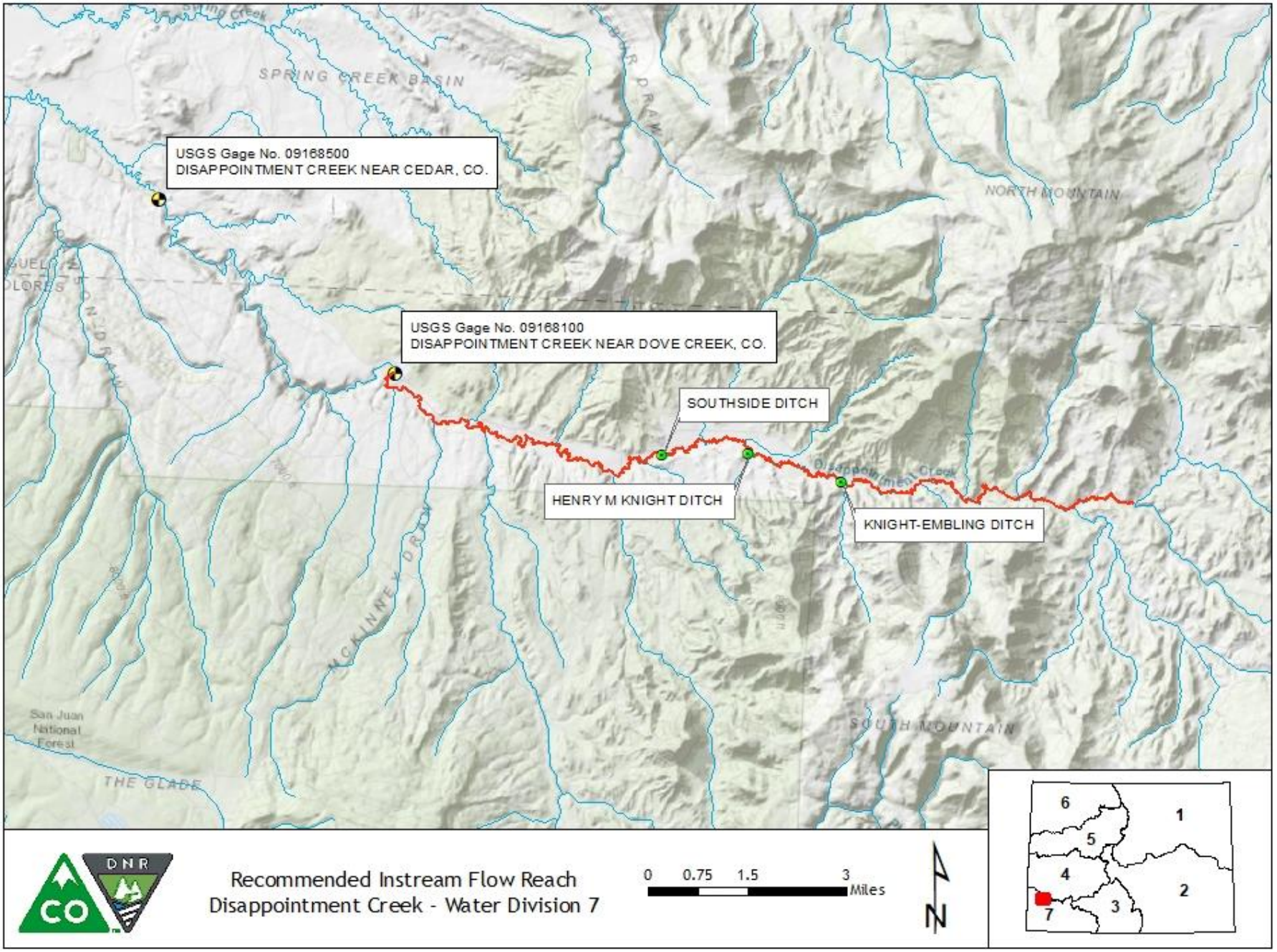
VICINITY MAP



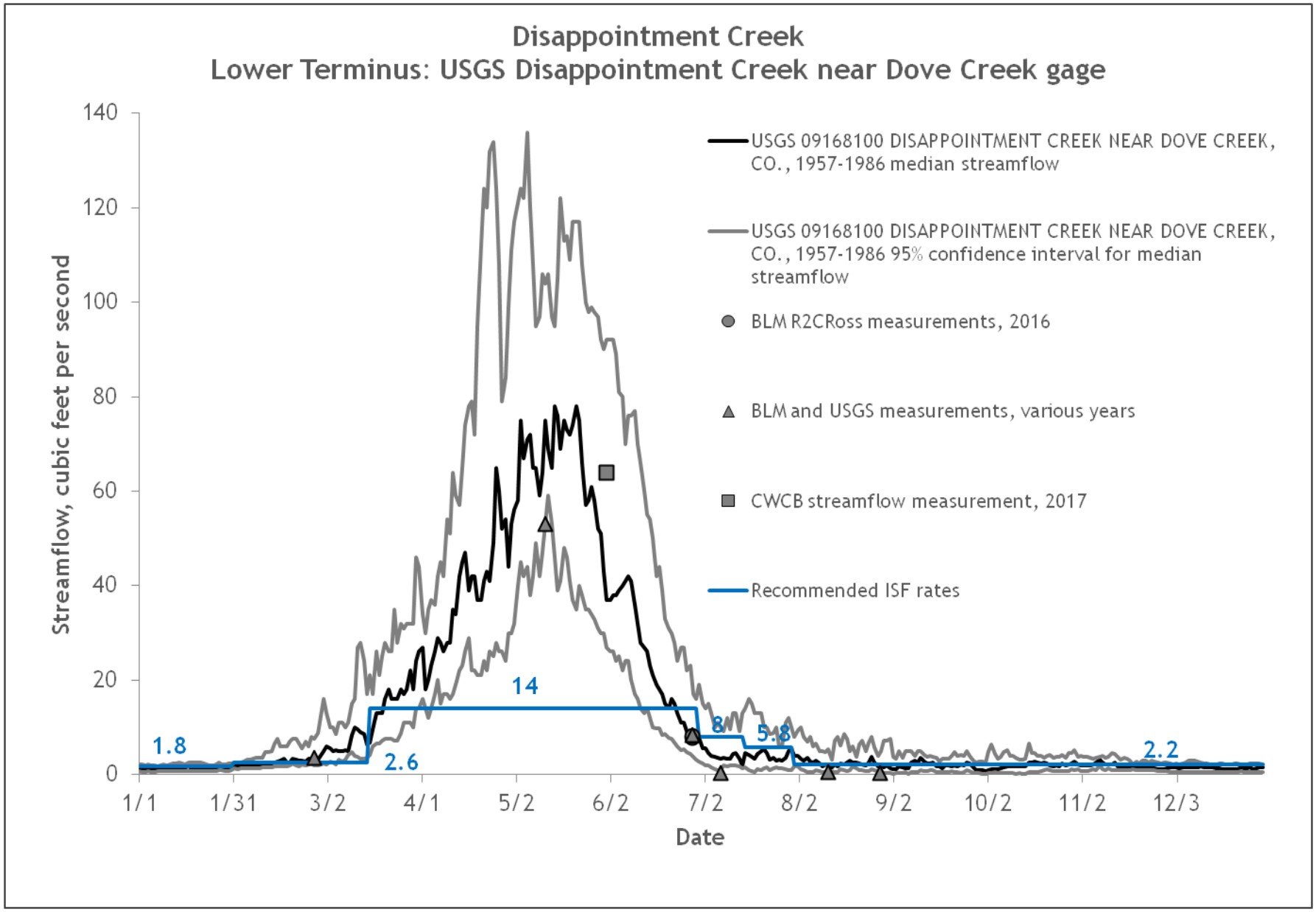
LAND OWNERSHIP MAP



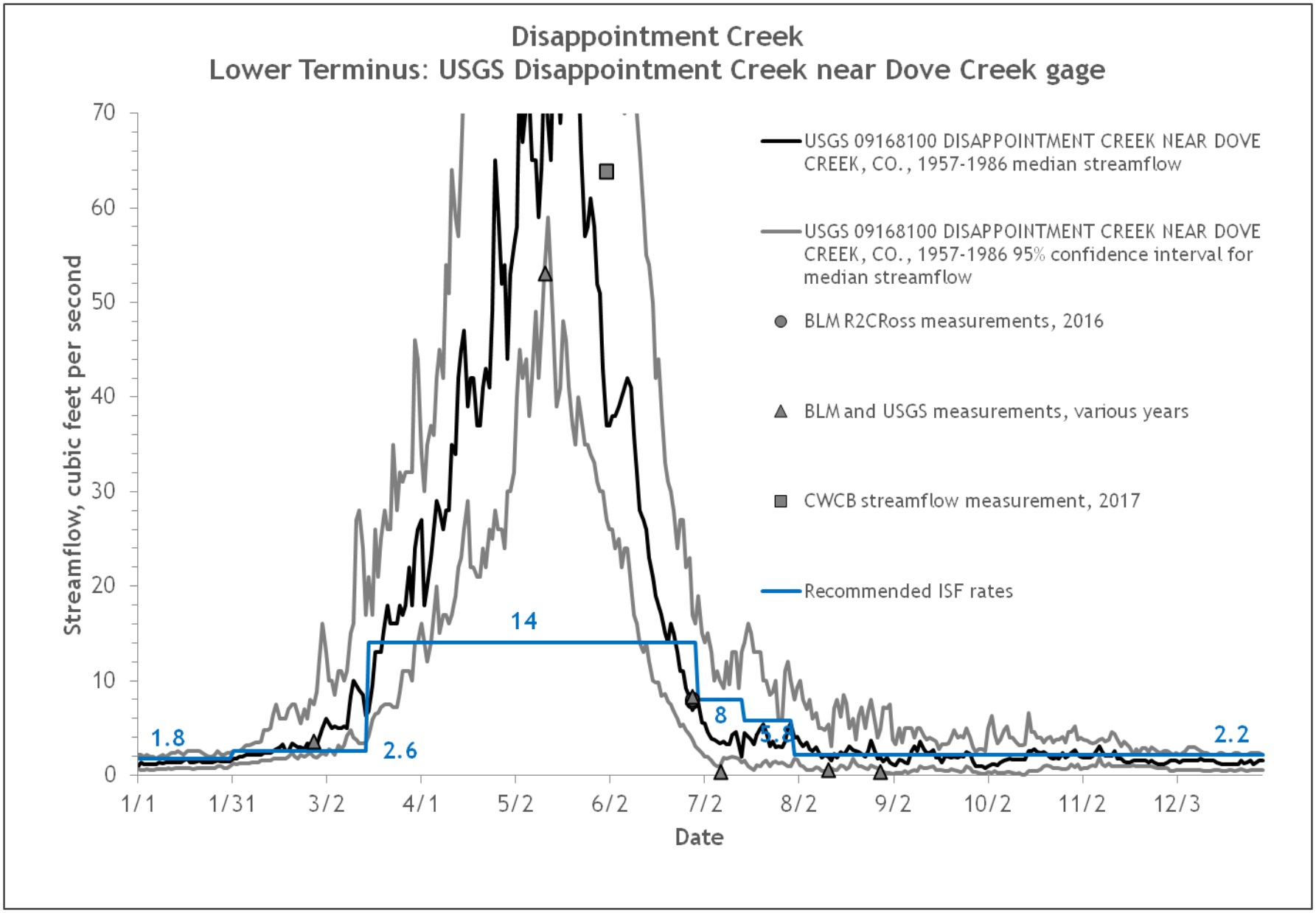
HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



DETAILED HYDROGRAPH



COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Disappointment Creek (Lower)

EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	historic USGS gage (Disappointment Creek near Dove Creek, CO) UTM North: 4198182.88 UTM East: 184833.22
LOWER TERMINUS:	confluence with the Dolores River UTM North: 4214275.33 UTM East: 162893.62
WATER DIVISION:	7
WATER DISTRICT:	69
COUNTY:	Dolores, San Miguel
WATERSHED:	Upper Dolores
CWCB ID:	18/7/A-007
RECOMMENDER:	Bureau of Land Management (BLM)
LENGTH:	37.8 miles
FLOW RECOMMENDATION:	5.0 cfs (03/01 - 03/15) 9.8 cfs (03/16 - 06/15) 5.0 cfs (06/16 - 06/30)

Disappointment Creek (Lower)

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 this reach of Disappointment Creek because it has a natural environment that can be preserved to a reasonable degree. Disappointment Creek is located within Dolores and San Miguel Counties and originates at an elevation of approximately 10,823 ft, flowing west 68.5 miles to the confluence with the Dolores River at an elevation of approximately 5,528 ft (See Vicinity Map). The proposed reach extends from the historic USGS gage, Disappointment Creek near Dove Creek, CO (USGS 09168100), downstream to the confluence with the Dolores River. Forty-seven percent of the land on the 37.8 mile proposed reach is public land managed by the Bureau of Land Management, U.S. Forest Service, or the State of Colorado (See Land Ownership Map).

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/2019ProposedISFRecommendations.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 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.

The subject reach of Disappointment Creek is a low to moderate gradient stream located within a wide valley with few bedrock constraints, allowing the stream to cut new channels during high flow events. Substrate size is generally small, ranging from silt to eight-inch cobbles. This lower reach of Disappointment Creek is comprised primarily of pools with significantly fewer riffles compared to the upper reach that is upstream of the USGS gage and the subject of a separate ISF recommendation. Water temperatures and food sources are suitable for native species. Because of the geologic composition of Disappointment Valley and its groundwater flow system, this lower reach has very high conductivity and salinity readings. Poor water quality in this reach restricts fish usage to periods of snowmelt runoff and heavy monsoonal periods, when relatively clean surface waters can dilute the poor quality associated with groundwater inflow to the creek. Despite periods of poor water quality, this reach provides important habitat for flannelmouth sucker and roundtail chub that migrate seasonally from the Dolores River. The riparian community is comprised of narrowleaf cottonwood, river hawthorn, willows, sedges, rushes, and common reed.

Table 1. List of species identified in Disappointment Creek.

Species Name	Scientific Name	Status
flannelmouth sucker	*Catostomus latipinnis*	None
roundtail chub	*Gila robusta*	State - Species of Special Concern Federal – 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 four 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 2.81 cubic feet per second (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 9.80 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 Disappointment Creek.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
BLM	06/29/2016, #1	14.68	5.87 - 36.70	Out of range	13.22
BLM	06/29/2016, #2	14.96	5.98 - 37.40	Out of range	6.79
BLM	06/29/2017, #1	1.38	0.55 - 3.45	1.85	Out of range
BLM	06/29/2017, #5	6.10	2.44 - 15.25	3.77	9.40
			Mean	2.81	9.80

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

5.0 cubic feet per second is recommended from March 1 through March 15. This period corresponds to the first portion of snowmelt runoff. During this period, it is important to saturate the alluvial aquifer so that the riparian community can access moisture at the start of the growing season. In addition, this flow rate will prepare the stream channel for access by native fishes. This flow should also maintain macroinvertebrate communities in the hyporheic zone below the channel bed.

9.8 cubic feet per second is recommended from March 16 through June 15, which corresponds to the period when native fishes are spawning in the creek. In most of the cross sections collected, this recommendation is driven by the average depth criteria. Given the wide channel, it is important to maintain sufficient depth to allow native species to pass through riffles to spawning locations.

5.0 cubic feet per second is recommended from June 16 through June 30. This period corresponds to the last portion of snowmelt runoff. During this period, it is important to saturate the alluvial aquifer so that the riparian community has sufficient moisture to make it through the dry period that follows during summer and fall. In addition, this flow rate will assist passage for young of the year fish as they move toward the Dolores River, and will assist in maintaining the macroinvertebrate community.

No flow recommendation is made for the period between July 1 and February 29 because of limited water availability due to natural conditions and irrigation practices.

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 this proposed ISF on Disappointment Creek is 346.00 square miles, with an average elevation of 7,280 ft and average annual precipitation of 18.30 inches (See the Hydrologic Features Map). The Disappointment Creek basin supports agriculture, among other uses. Hydrology is altered by water use within the basin.

Available Data
There is not an active streamflow gage on the proposed reach of Disappointment Creek, but there are two historical gages with available data. The Disappointment Creek near Dove Creek, CO gage (USGS 09168100, period of record 8/1/1957 – 9/29/1986) was located at the proposed lower terminus. The drainage basin of the gage is 147 square miles, with an average elevation of 7,930 ft and average annual precipitation of 21.45 inches. The Disappointment Creek near Cedar, CO gage (USGS 09168500, period of record 3/1/1953 – 09/29/1956) was located approximately 8 miles downstream from the proposed lower terminus. The drainage basin of the gage is 168 square miles, with an average elevation of 7,800 ft and average annual precipitation of 20.8 inches. Both gages are impacted by diversion practices upstream.

A number of on-channel diversions were identified between the upper gage and the lower terminus. These include Disappointment Ditch (WDID 6900503, appropriation dates 1886, 1892, 1913, 19.94 cfs), the Dawson-Hammond Ditch (WDID 6900502, appropriation dates 1885, 1886, 1911, 5.47 cfs), the Northside Ditch (WDID 6900519, appropriation date 1893, 0.2 cfs), Horseshoe Ditch (WDID 690051, appropriation date 1908, 15 cfs), and Pine Arroya Ditch (WDID 6900520, 1883, 1888, 1911,

6.1 cfs). The diversion records typically start in the late 1940s; however, the Northside Ditch does not have records until 1986 and no recorded use until 2002.
CWCB staff made one streamflow measurement on the subject reach of Disappointment Creek as summarized in Table 3.

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

Visit Date	Flow (cfs)	Collector
06/01/2017	54.01	CWCB

Data Analysis
The two historic gages did not operate concurrently; therefore, it was not possible to extend the record of the lower gage using regression analysis. Due to this, Staff's analysis focuses on the upper gage (UGS 09168100), which has a longer more recent record, and the available diversion records below this gage. The effects of the diversions below the gage were accounted for by subtracting the diversion records from the gage record for the full gage record. This assumes that no return flows accrue to the stream, which likely underestimates streamflow. The Northside Ditch diversions were not subtracted because none occurred during the gage record; however, the decreed amount is relatively small, 0.2 cfs. The adjusted gage data was not scaled to the lower terminus due to uncertainty in the amount of streamflow that may accrue downstream from the gage. Median streamflow and 95% confidence intervals for median streamflow were calculated for the adjusted Disappointment Creek gage record.

Water Availability Summary
The hydrographs (See Complete Hydrograph and Detailed Hydrograph) show median streamflow and 95% confidence intervals for the median streamflow based on the adjusted Disappointment Creek gage record. The proposed ISF rate is below the median streamflow the majority of the time. The proposed ISF rate is below the 95% confidence interval of the median at all times. Staff has concluded that water is available for appropriation.

Material Injury
Because the proposed ISF on Disappointment 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. (2018), 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.

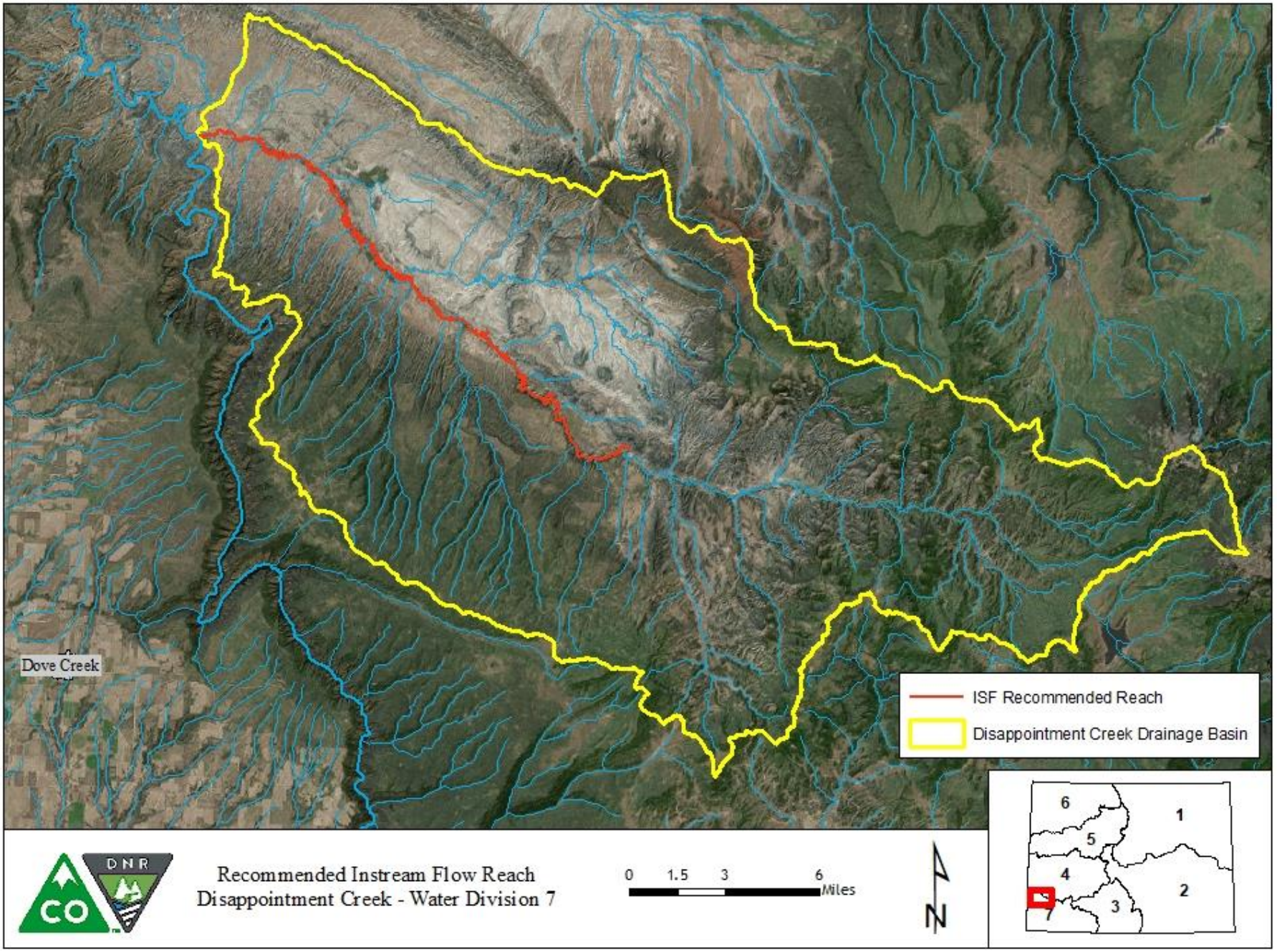
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

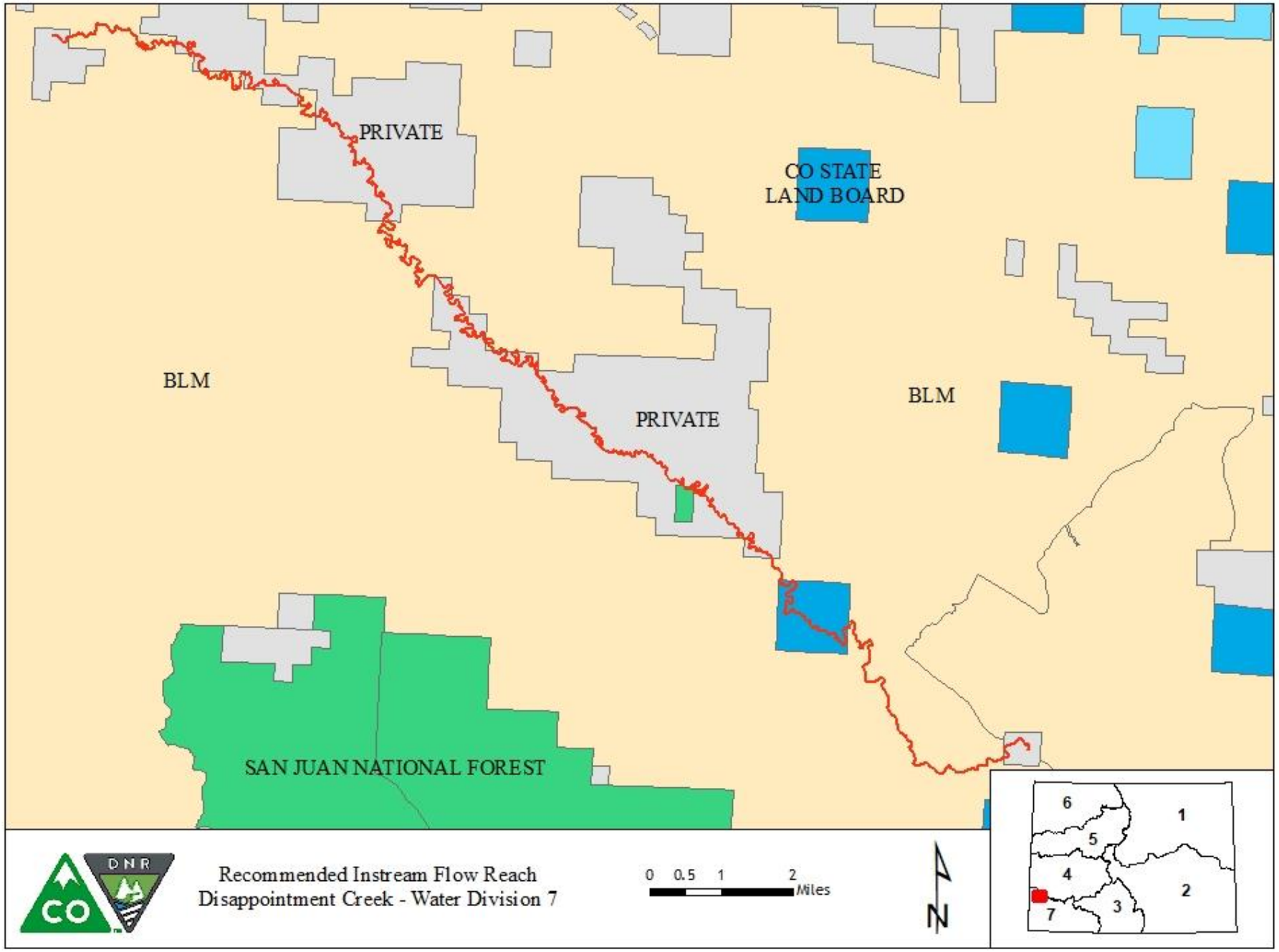
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

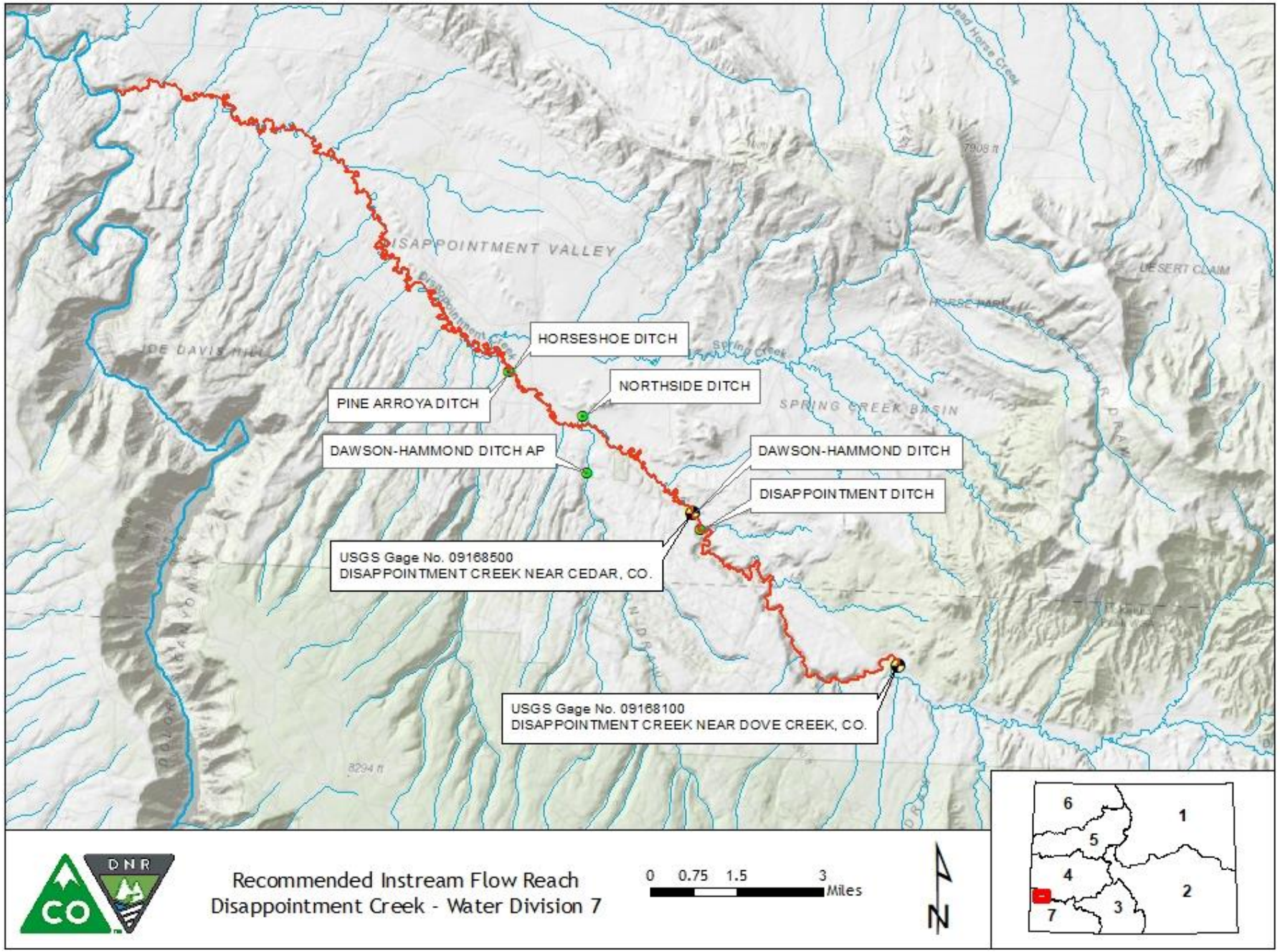
VICINITY MAP



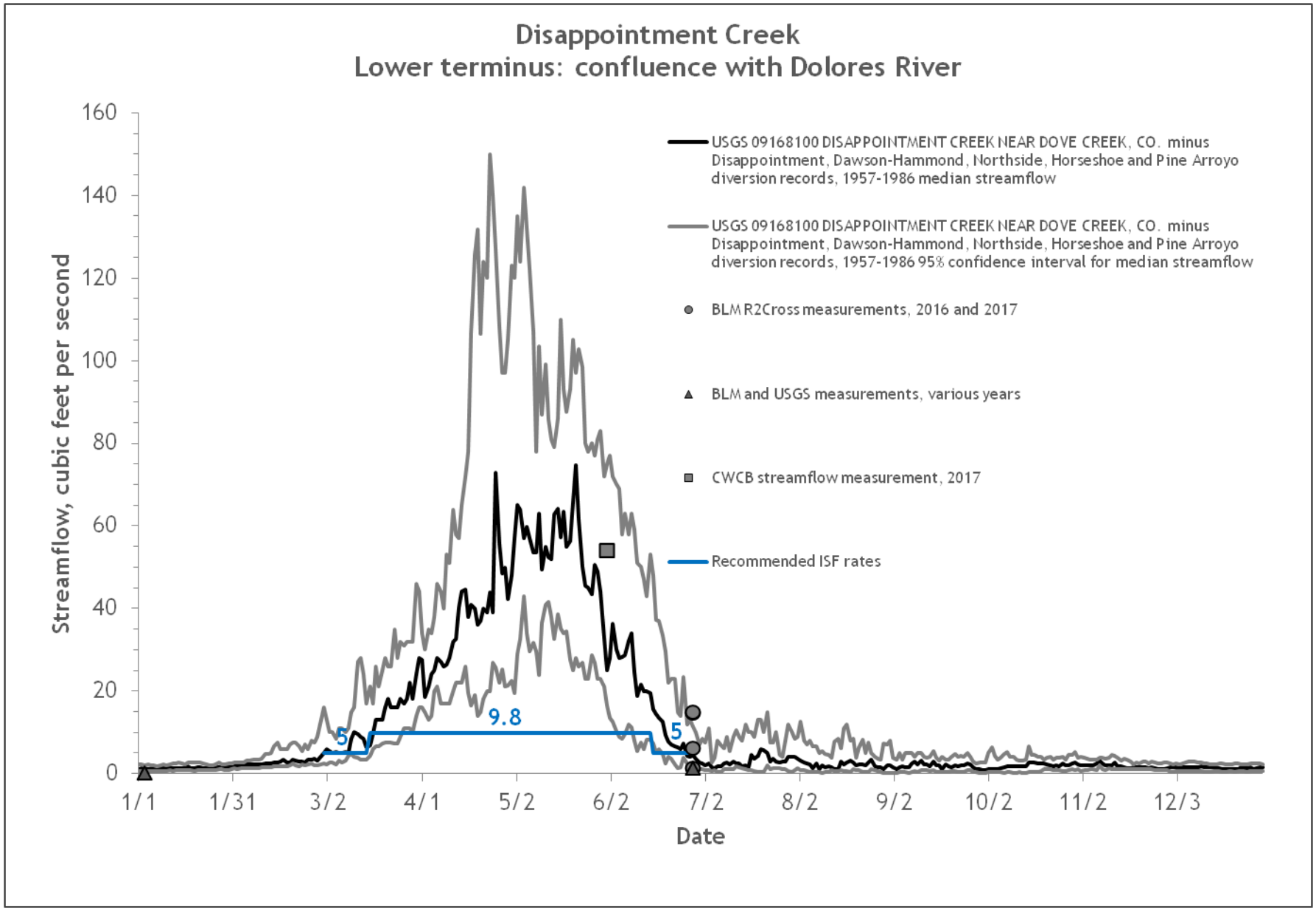
LAND OWNERSHIP MAP



HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



DETAILED HYDROGRAPH