COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Little Sand Creek
EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	Headwaters in the Vicinity of UTM North: 4155370.98 UTM East: 295092.17
LOWER TERMINUS:	Confluence Weminuche Creek at UTM North: 4145491.80 UTM East: 301670.41
WATER DIVISION:	7
WATER DISTRICT:	78
COUNTY:	Hinsdale
WATERSHED:	Piedra
CWCB ID:	17/7/A-002
RECOMMENDER:	U.S. Forest Service (USFS)
LENGTH:	8.1 miles
FLOW RECOMMENDATION:	1.5 cfs (12/01 - 02/29) 1.9 cfs (03/01 - 03/31) 3.6 cfs (04/01 - 04/15) 6.6 cfs (04/16 - 07/31) 3.0 cfs (08/01 - 09/15) 2.2 cfs (09/16 - 09/30) 3.0 cfs (10/01 - 11/30)

Little Sand 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 USFS recommended that the CWCB appropriate an ISF water right on a reach of Little Sand Creek. Little Sand Creek originates in the San Juan National Forest at an elevation of approximately 10,630 feet and it flows in a southeasterly direction as it drops to an elevation of 7,700 where it joins Weminuche Creek. The proposed ISF reach is located within Hinsdale County (See Vicinity Map) and extends from the headwaters downstream to confluence with Weminuche Creek. One hundred percent of the land on the 8.1 mile proposed reach is owned and managed by the USFS (See Land Ownership Map). The USFS recommended this reach of Little Sand Creek because it has a natural environment that can be preserved to a reasonable degree with an ISF water right.

The information contained in this report and the associated supporting data and analyses (located at http://cwcb.state.co.us/environment/instream-flow-program/Pages/2017ProposedISFRecommendations.aspx) form the basis for staff's ISF recommendation to be considered by the Board. This report provides sufficient information to support the CWCB findings required by ISF Rule 5i on 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 natural resource values which contribute to the overall natural environment to be preserved in Little Sand Creek include hybrid cutthroat trout, brook trout, aquatic macroinvertebrates, riparian vegetation, wetlands, and water-dependent wildlife. Little Sand Creek is tributary to Weminuche Creek and it serves as important spawning habitat for the resident brown trout fishery in Weminuche Creek.

Little Sand Creek is a cold-water, moderate-to-high gradient mountain stream which flows through a forested landscape. The upper and middle portions of the reach are confined and exhibit low sinuosity, with little to no floodplain. Portions of the mid and upper watershed burned in 2012 during the Little Sand Wildfire. The lower portion of the reach is lower gradient, is more sinuous, and has a developed floodplain with associated wetlands and meadows. Numerous beaver ponds exist in the lower portions of the reach. In general, the condition of Little Sand Creek is good.

Fisheries surveys were conducted by Colorado Parks and Wildlife (CPW) and the USFS in 1976 and 1999, respectively. The stream contains a self-sustaining population of hybridized cutthroat trout *(Oncorhynchus clarki spp.)* and brook trout *(Salvelinus fontinalis)*.

Riparian vegetation is a key component of stream health for Little Sand Creek. The riparian corridor is in good condition and provides abundant woody debris, shade, cover, nutrients, and aquatic habitat. It is comprised of a mix of conifers, aspen, alder, willow, and narrowleaf cottonwood. Numerous beaver dams have created habitat complexity and associated wetlands.

Table 1. List of species identified in Little Sand Creek.

Species Name	Scientific Name	Status
brook trout	*Salvelinus fontinalis*	None
Colorado River cutthroat trout	*Oncorhynchus clarkii*	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

USFS 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). USFS 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 using the Manning's n subroutine 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 five transects for this proposed ISF reach (Table 2). Results obtained at more than one transect are averaged to determine the R2Cross flow rate for the reach of stream. The R2Cross model results in a winter flow of 1.9 cfs, which meets 2 of 3 criteria and a summer flow of 6.6 cfs, which meets 3 of 3 criteria.

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

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
USFS	07/14/2016 # 2	0.92	0.37 - 2.30	3.2 *	4.4 *
USFS	07/14/2016 # 3	0.73	0.29 - 1.83	1.1	7.6 *
USFS	08/31/2016 # 4	1.27	0.51 - 3.18	3.3 *	16.3 *
USFS	08/31/2016 # 5	0.97	0.39 - 2.43	1.4	2.7 *
USFS	08/31/2016 # 6	0.81	0.32 - 2.03	0.6	2.0 *
			Mean	1.9	6.6

** Results calculated using the R2Cross Thorne-Zevenbergen subroutine.*

ISF Recommendation
The USFS recommends the following flows based on R2Cross modeling analyses and biological expertise: 1.5 cfs (12/01 - 02/29),1.9 cfs (03/01 - 03/31), 3.6 cfs 04/01 - 04/15), 6.6 cfs (04/16 - 07/31), 3.0 cfs (08/01 - 09/15), 2.4 cfs (09/16 - 09/30), and 3.0 cfs(10/01 - 11/30).

The USFS recommendation was modified by staff as a result of water availability which lowered the rate from 2.4 cfs from 9/16 – 9/30 to 2.2 cfs. The final recommended ISF rates are as follows: 1.5 cfs (12/01 - 02/29), 1.9 cfs (03/01 - 03/31), 3.6 cfs (04/01 - 04/15), 6.6 cfs (04/16 - 07/31), 3.0 cfs (08/01 - 09/15), 2.2 cfs (09/16 - 09/30), and 3.0 cfs (10/01 - 11/30).

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 Little Sand Creek is 10.60 square miles, with an average elevation of 9,200 ft and average annual precipitation of 26.64 inches (See the Hydrologic Features Map). There are no known surface water diversions in the drainage basin tributary to the proposed ISF on Little Sand Creek. Hydrology in this drainage basin represents natural conditions.

Available Data

There is not a current or historic streamflow gage on Little Sand Creek. There are several historic gages in the region near Little Sand Creek including: the Middle Fork Piedra River near Pagosa Springs, CO (USGS 09347200 1969-1975), the Middle Fork Piedra River near Dyke (USGS 09347205, 1977-1983), Weminuche Creek near Bridge Ra Station, near Pagosa Springs, CO (USGS 09349000, 1937-1949), West Fork San Juan River above Borns Lake, near Pagosa Springs, CO (USGS 09340500, 1937-1953), Wolf Creek near Pagosa Springs, CO (USGS 09341200, 1968-1975), and Wolf Creek at Wolf Creek Campground near Pagosa Springs, CO gage (USGS 09341300 1984-1987 and 1997-1999). The two gages on Wolf Creek were identified as most similar in drainage basin area and precipitation, although farther away than other gages. The Wolf Creek gages also have few diversions; these diversions can be accounted for with available diversion records.

The upstream most gage on Wolf Creek is Wolf Creek near Pagosa Springs, CO (USGS 09341200, 1968-1975), which is approximately 19.7 miles east from the proposed lower terminus. The drainage basin of the Wolf Creek near Pagosa gage is gage is 14.1 square miles with an average elevation of 10,600 ft and average annual precipitation of 47.87 inches. The lower gage, Wolf Creek at Wolf Creek Campground near Pagosa Springs, CO gage (USGS 09341300 1984-1987 and was operated seasonally from 1997-1999), was installed approximately 1,800 ft downstream from the upper gage. The drainage basin of the Wolf Creek at Wolf Creek Campground gage is 17.9 square miles with an average elevation of 10,500 ft and average annual precipitation of 46.29 inches. A transbasin diversion, with alternate points near Wolf Creek Pass, exports water to Division 3 (Treasure Pass

Ditch Division, appropriation date 1922, 7 cfs absolute). This diversion reduces streamflow for both gages on Wolf Creek; however, diversion records were available. One other small diversion exists on a tributary to the lower Wolf Creek gage. Bruce Spruce Ditch (appropriation date 1936, 2.68 cfs) diverts water from fall creek and any return flows accrue below the lower gage. No other surface water diversions appear to exist upstream for the gages.

CWCB staff made one streamflow measurement on the proposed reach of Little Sand Creek as summarized in Table 3. Because this measurement was made relatively high in the drainage basin, it was not plotted on the hydrograph.

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

Visit Date	Flow (cfs)	Collector
09/06/2016	0.54	CWCB

Data Analysis

Staff examined available climate stations and found that the Pagosa Springs climate station (Station USC00056258, downloaded 2/28/2017) was located in vicinity of the Wolf Creek gages and Little Sand Creek. This station is located 14.5 miles southwest from the Wolf Creek gage locations and roughly 18.5 miles southeast from the proposed lower terminus on Little Sand Creek. The station has a relatively long period of record (1906 to 2016), although there are several periods without data. The average annual precipitation at the Pagosa Springs station for the period of record (based on 57 years with 350 or more days of data) was 20.2 inches. During the complete years the Wolf Creek gages operated (1969 to 1975 and 1985 to 1986), the average precipitation was 22.2 inches. Based on the available data, the Wolf Creek gage records may represent slightly above average precipitation conditions.

The Wolf Creek near Pagosa gage was analyzed using the period of record available (1968-1975). Transbasin exports from the Treasure Pass Ditch (WDID 0934100) were added to the gage data to estimate natural streamflow. The adjusted gage record was scaled by 0.42 to the lower terminus on Little Sand Creek 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 Wolf Creek at Wolf Creek Campground gage was analyzed using the period of record available (1984-1987 and 1997-1999). Transbasin exports from the Treasure Pass ditch and in-basin diversions from Bruce Spruce Ditch were added to the gage data to estimate natural streamflow. The adjusted gage record was scaled by 0.34 to the lower terminus on Little Sand Creek using the area-precipitation method. The scaled data from both gages was combined resulting in 10 to 13 years of data, depending on the day of the year. Median stream flow was calculated; however, 95% confidence intervals were not calculated due to the short period of record from the combined gage data sets.

Water Availability Summary

The hydrographs (Complete and Detailed Hydrographs) show the median streamflow from the scaled adjusted data from the Wolf Creek gages. The proposed ISF rate is below the median streamflow. Staff concludes that water is available for appropriation on Little Sand Creek.

Material Injury
Because the proposed ISF on Little Sand Creek is a new junior water right, the ISF can exist without material injury to other water rights. Under the provisions of section 37-92-102(3)(b), C.R.S. (2016), the CWCB will recognize any uses or exchanges of water in existence on the date this ISF water right is appropriated.

Citations
Capesius, J.P. and V.C. Stephens, 2009, Regional regression equations for estimation of natural streamflow statistics in Colorado, Scientific Investigations Report 2009-5136.

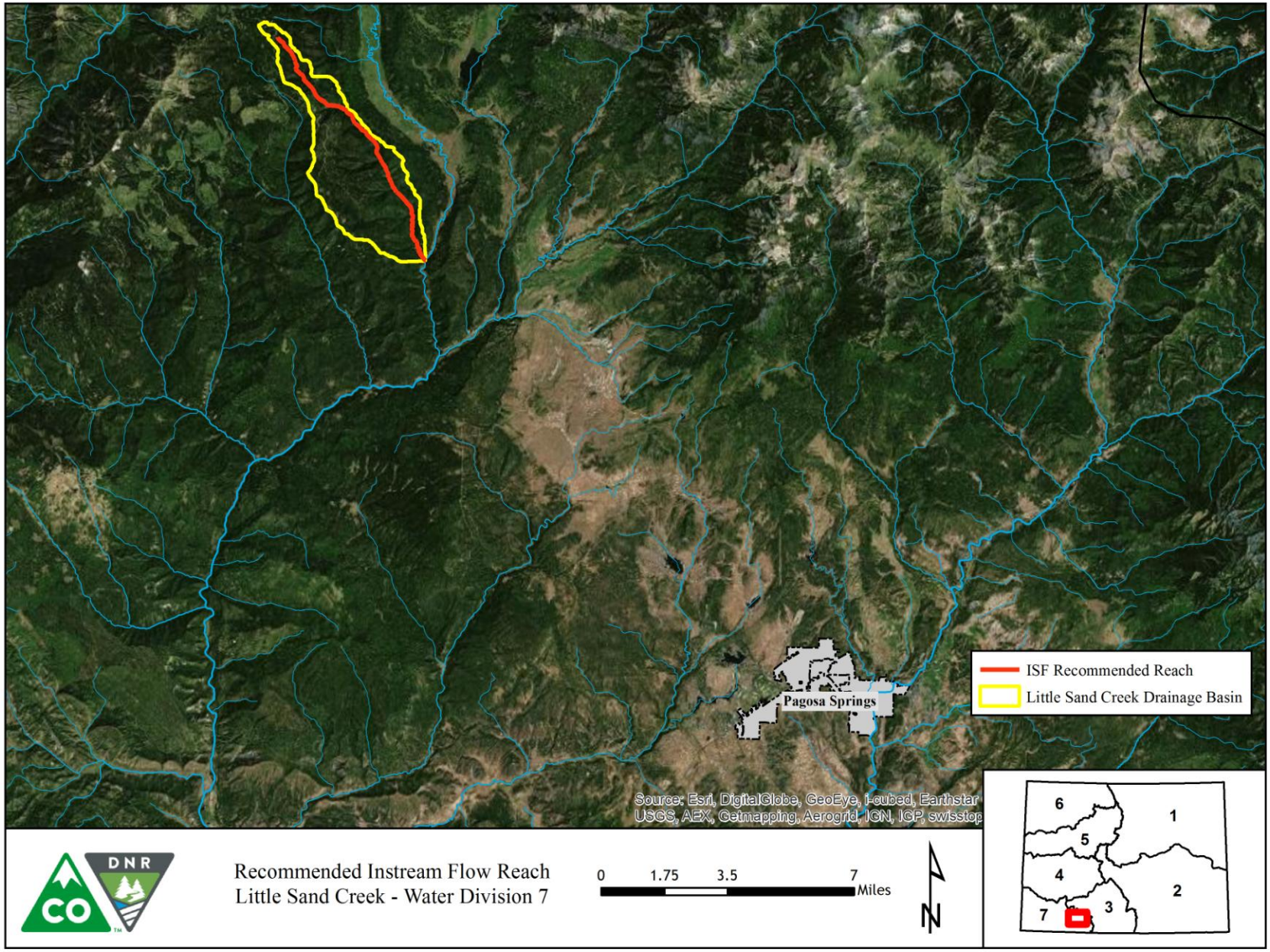
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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

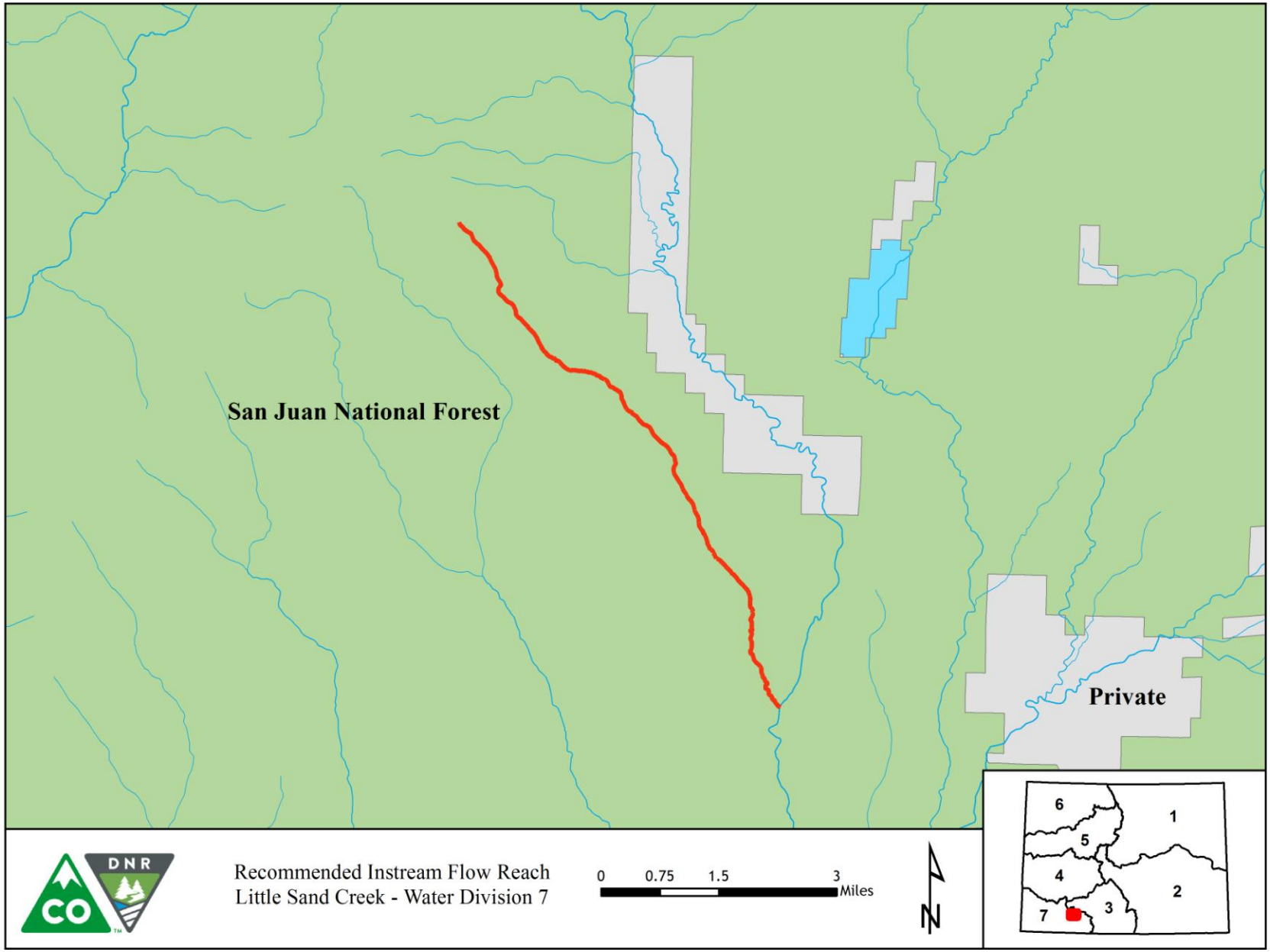
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

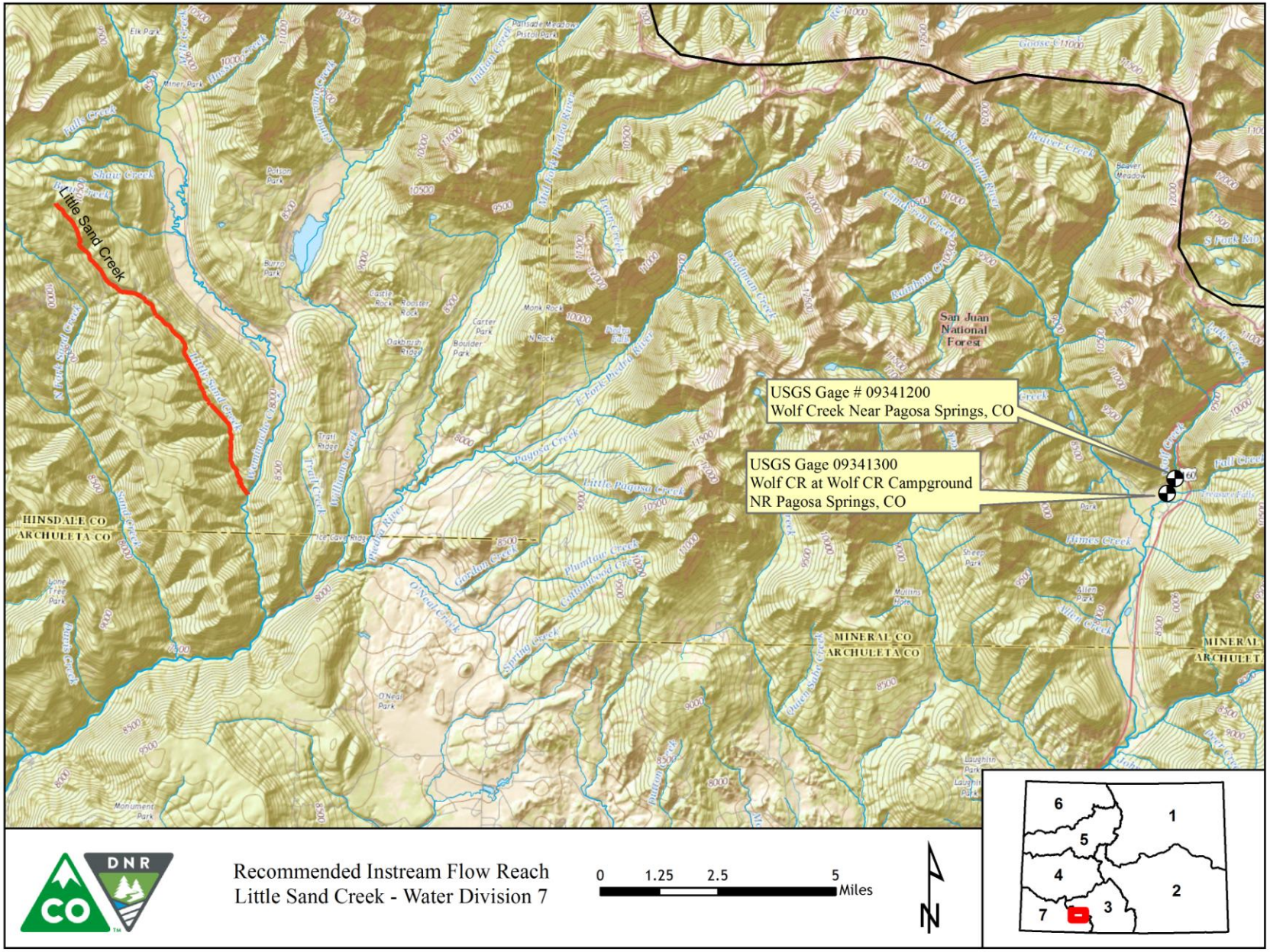
VICINITY MAP



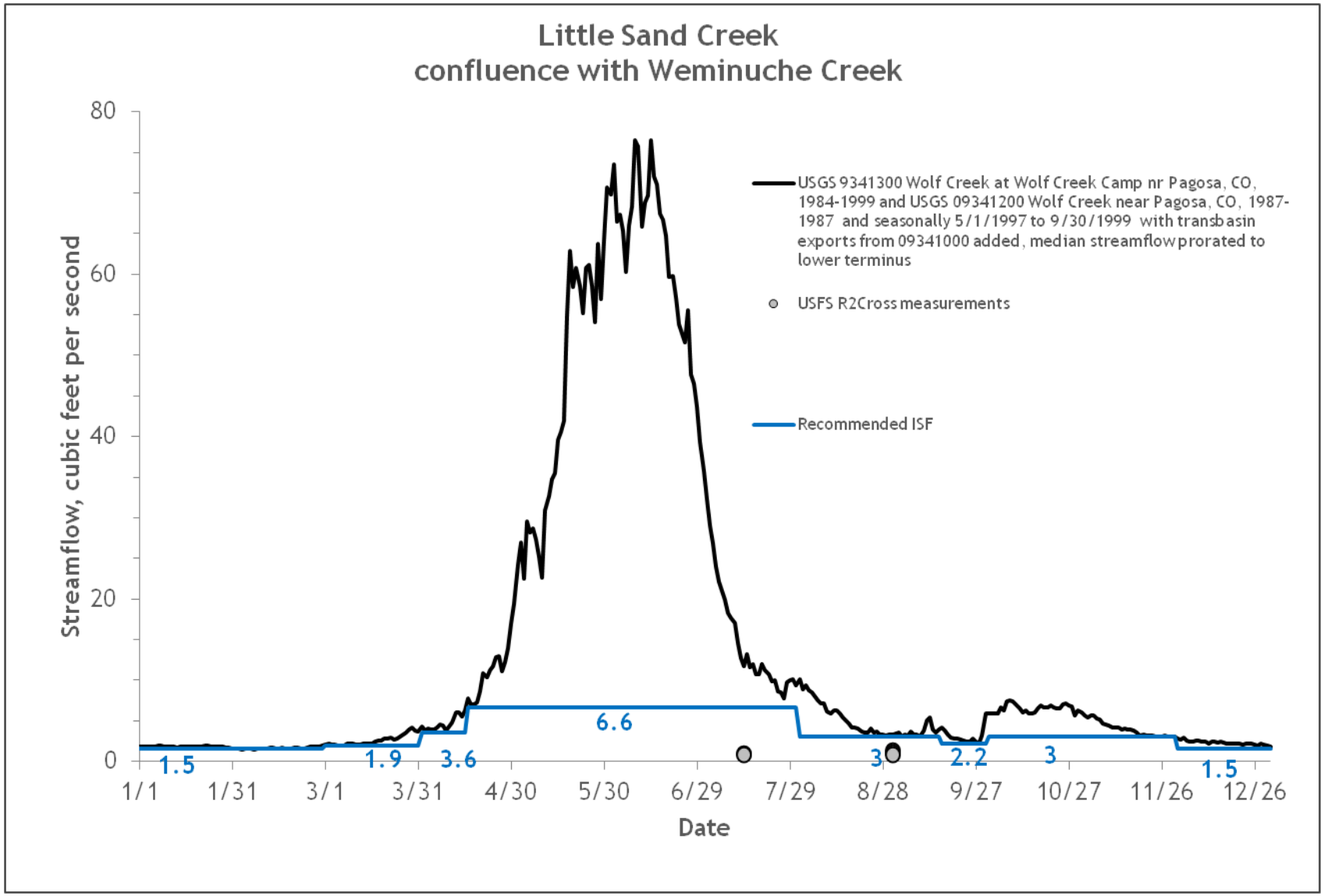
LAND OWNERSHIP MAP



HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



DETAILED HYDROGRAPH