COLORADO
Colorado Water Conservation Board
Department of Natural Resources

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TO: Colorado Water Conservation Board Members

FROM: Robert Viehl, Chief
Brandy Logan, Water Resource Specialist
Stream and Lake Protection Section

DATE: March 16, 2023

AGENDA ITEM: 14. Request to Form Intent to Appropriate ISF Water Rights in Water Division 4 on Cottonwood Creek, Monitor Creek, and Potter Creek (Montrose, & Delta Counties)

Staff Recommendation

Staff recommends that, pursuant to ISF Rule 5d. of the Rules Concerning the Colorado Instream Flow and Natural Lake Level Program, 2 CCR 408-2 (hereinafter, "ISF Rules"), the Board;

1. Declare its intent to appropriate an instream flow (ISF) water right on each stream segment listed in Table 1, including the development allowance described in this memo, and direct staff to publicly notice the Board's declaration of its intent to appropriate.

2. Establish the modified schedule in Table 2 for the notice and comment procedure.

Table 1. ISF water rights proposed in Water Division 4. These water rights would only be in effect April 1st through September 30th when the specified flow conditions are met.

Stream	Watershed	County	Length (miles)	Upper Terminus	Lower Terminus
Cottonwood Creek *(Increase)*	Lower Gunnison	Delta, Montrose	23.3	Hawkins Ditch headgate	confluence Roubideau Creek
	ISF protection initiates at 183 cfs and protects all unappropriated streamflow until flow rates recede to the existing 3.6 cfs ISF rate or 9/30, whichever occurs first.				
Monitor Creek *(Increase)*	Lower Gunnison	Montrose	8.29	confluence Little Monitor Creek	confluence Potter Creek
	ISF protection initiates at 111 cfs and protects all unappropriated streamflow until flow rates recede to the pending ISF of 4.6 cfs (4/1 – 5/31), 3.6 cfs (6/1 - 6/30) or 3.6 cfs if outside of these times or 9/30, whichever occurs first.				

Potter Creek *(Increase)*	Lower Gunnison	Montrose	8.10	USFS property boundary	confluence Monitor Creek
	ISF protection initiates at 177 cfs and protects all unappropriated streamflow until flow rates recede to the existing ISF of 4 cfs (4/1 - 6/15), 1.8 cfs (6/16 - 7/31), 1.4 cfs (8/1 - 2/29), or until 9/30, whichever occurs first.				
Potter Creek *(Increase)*	Lower Gunnison	Montrose	1.72	confluence Monitor Creek	confluence Roubideau Creek
	ISF protection initiates at 225 cfs and protects all unappropriated streamflow until flow rates recede to the existing ISF of 4 cfs (4/1 - 6/15), 1.8 cfs (6/16 - 7/31), 1.4 cfs (8/1 - 2/29), or until 9/30, whichever occurs first.				

Table 2. Modified schedule for the notice and comment procedure pursuant to ISF Rule 5.

Date	Action
May 17-18, 2023	Public comment at CWCB Meeting
May 31, 2023	Notice to Contest due
June 9, 2023	Deadline for notification to the ISF Subscription Mailing List of Notices to Contest (no notification if none received)
June 30, 2023	Notices of Party Status and Contested Hearing Participant Status due
July 19-20, 2023	If necessary, staff informs Board of Parties and Participants; Board sets the hearing date; and the Board may take final action on any uncontested ISF appropriations
November 2023	If necessary, ISF Contested Hearing conducted in conjunction with CWCB Meeting

Introduction

This memo provides an overview of the technical analyses performed by the recommending entities and CWCB staff on ISF recommendations in Water Division 4. This work was conducted to provide the Board with sufficient information to declare its intent to appropriate ISF water rights in accordance with the ISF Rules. The Board was also provided with an executive summary for each recommended stream segment (Attachments A-D). The executive summaries contain the technical basis for each appropriation.

In addition, the scientific data and technical analyses performed by the recommending entity are accessible on the Board's website at:

https://cwcb.colorado.gov/2023-isf-recommendations

Background

The Board's Instream Flow (ISF) Program provides for the preservation of the natural environment to a reasonable degree. In most cases, the natural environment preserved by ISF appropriations has been defined by the flow needs of aquatic species. These ISF flow rates provide some de facto protection of the riparian corridor. However, higher flows have been shown to be critical to preserve certain riparian communities. In some instances, the Board has recognized the need for additional protection of these riparian communities and appropriated all of the remaining unappropriated flow to address situations that required such riparian protection. This level of protection has historically been used on a limited basis. Examples include ISF appropriations on the Dead Horse Creek system, which forms Hanging Lake, to protect distinct assemblages of riparian vegetation and globally imperiled species; and on Big and Little Dominguez Creeks to protect not only fish populations but amphibians, aquatic insects, and rare communities of cottonwood trees and other riparian vegetation.

The BLM determined that portions of Cottonwood Creek, Monitor Creek, and Potter Creek are suitable for Wild and Scenic River designation based on riparian vegetation communities deemed Outstandingly Remarkable Values (ORVs). Although BLM recognized that Cottonwood Creek and Potter Creek already have some ISF protection, the suitability determination specifically noted that the current lack of flow protection for globally significant riparian values was a significant factor driving BLM's suitability determination. The Final Resource Management Plan for BLM's Uncompahgre Field Office stated that if scientific studies conclude that alternative forms of flow protection are in place and are sufficient to fully protect the flow-related ORVs, the BLM will determine it is unnecessary to quantify, assert, or adjudicate a federal reserved water right for these reaches if they are ultimately designated into the National Wild and Scenic River System.

As an alternative to a federal reserved water right, the BLM proposed an approach that would use the ISF Program to provide flow protection for these ORVs. The CWCB was briefed on this proposal in May 2014 for discussion and input. Based on feedback from the Board, the BLM submitted formal recommendations for these streams in 2017. Staff provided an update on efforts completed at the January 2023 meeting. Staff is now requesting that the Board form its intent to appropriate ISF water rights to protect riparian values on Cottonwood Creek, Monitor Creek and Potter Creek.

CWCB Authority

The General Assembly charged the CWCB with preserving portions of the natural environment for the people of Colorado. § 37-92-102(3), C.R.S.; *Colo. Water Conservation Bd. v. Farmers Water Dev. Co.*, 346 P.3d 52, 58 (Colo. 2015) ("We have consistently recognized that the CWCB acts to protect the environment on behalf of the public."); *Aspen Wilderness Workshop, Inc. v. Colo. Water Conservation Bd.*, 901 P.2d 1251, 1259 (Colo. 1995) (The CWCB "acts on behalf of the people of the state of Colorado and is thereby burdened with a fiduciary duty arising out of its unique statutory responsibilities."). To carry out the policy objective of protecting portions of the natural environment in Colorado, the General Assembly vested the CWCB with the "exclusive authority, on behalf of the people of the state of Colorado, to appropriate . . . such waters of natural streams and lakes as the board determines may be required for minimum stream flows . . . to preserve the natural environment to a reasonable degree." § 37–92–102(3), C.R.S..

Whether to make an ISF appropriation is "a policy determination within the discretion of the CWCB." *Farmers Water Dev. Co.*, 346 P.2d at 59. The CWCB is in charge of making these policy decisions because it has specific expertise regarding how to determine the minimum stream flows necessary to preserve the natural environment to a reasonable degree. *Id.; see Aspen*

Wilderness Workshop, Inc., 901 P.2d at 1256 (noting that the CWCB is "a unique entity charged with preserving the natural environment to a reasonable degree for the people of the State of Colorado"); *Colo. River Water Conservation Dist. v. Colo. Water Conservation Bd.*, 594 P.2d 570, 576 (Colo. 1979) ("Factual determinations regarding such questions as which areas are most amenable to preservation and what life forms are presently flourishing or capable of flourishing should be delegated to an administrative agency [CWCB] which may avail itself of expert scientific opinion. This is particularly true, considering that the General Assembly undoubtedly anticipated that the considerations for each locale might vary.") Therefore, based on the facts in each proposed appropriation and in accordance with applicable law, the CWCB has broad discretion to determine what minimum stream flows are necessary to preserve the natural environment to a reasonable degree.

Stakeholder Outreach

Since recommendations were formally submitted to the CWCB by the BLM in 2017, staff has been providing public notice in a variety of forums. Notices for these recommendations were sent to the ISF subscription mailing list in 2017, 2018, 2019, 2020, 2021, and 2022, notices were published in local newspapers in 2021 and 2022, presentations to County Commissioners were provided in 2017, 2019, and 2022, and landowners adjacent to the proposed ISF reaches were mailed letters.

Because the structure of the proposed ISF water right is new, meetings were held with the State Engineer and his staff to determine whether this water right would be administrable. Staff also held discussions with counsel from the Attorney General's office to ascertain if any legal issues would preclude a water right of this type from being decreed in water court.

Natural Environment

To appropriate ISF water rights on Cottonwood, Monitor, and Potter Creeks, the Board must determine that there is a natural environment on these streams. The BLM has conducted field surveys and studies of the natural environment resources on these streams and has found natural environments that can be preserved. The BLM's findings on the natural environment are fully documented in the BLM recommendation letter for each stream reach (Attachments E-G). A brief summary is provided in the following sections.

Riparian Community

The BLM found Cottonwood, Monitor, and Potter Creeks suitable for inclusion in the National Wild and Scenic Rivers System based in part on the presence of rare riparian communities that qualified as ORVs[1]. This finding was informed by surveys conducted by the Colorado Natural Heritage Program (CNHP),[2] which determined these streams contained rare plant communities that are imperiled and warrant conservation. The plant communities vary by stream but include

1The suitability determination for Cottonwood Creek was finalized as part of the Dominguez-Escalante National Conservation Area (NCA) Resource Management Plan in 2017. The suitability determinations for Monitor and Potter Creeks were finalized as part of the BLM's Uncompahgre Field Office Resource Management Plan in 2020.

2The Colorado Natural Heritage Program is Colorado's only comprehensive source of information on the status and location of Colorado's rarest and most threatened species and plant communities. CNHP is a non-academic department of the Warner College of Natural Resources at Colorado State University. It is also a member of the NatureServe Network, "which is an international network of partners that use the same scientific methodology to enable scientists to monitor the status of species and natural plant communities from state, national, and global perspectives."

assemblages of species that are rarely found in the same location, such as narrowleaf cottonwood and skunkbush sumac or narrowleaf cottonwood, strapleaf willow, and silvery buffaloberry. The streams also contain extensive areas of non-imperiled riparian communities, and all have high to very high biodiversity with few non-native species and minimal anthropogenic disturbance.

Preserving these rare riparian communities will provide important functions including maintaining overall system resiliency. Riparian areas help mitigate the impacts of floods by reducing water velocity, attenuating peak flows, and stabilizing streambanks. They also provide shade to reduce water temperatures and organic matter which provides habitat and food for the aquatic ecosystem. This diverse riparian community of native species is uniquely adapted to the Uncompahgre Plateau making it better able to rebound following disturbances such as severe storms, flooding, landslides, mudslides, and wildfires. Resiliency also mitigates the impact of those disturbances on the surrounding communities, which improves outcomes for both people and ecosystems.

Native Fish

Although not the primary basis for the proposed ISF, these creeks also provide important habitat for the three-species: Flannelmouth Sucker, Bluehead Sucker, and Roundtail Chub. These species are identified as Species of Greatest Conservation Need in Colorado and are part of a multi-state conservation agreement designed to prevent a listing of the species under the Endangered Species Act (Utah DNR, 2006). According to native fish research in the Roubideau Creek basin conducted by Colorado Parks and Wildlife (CPW), upwards of 25,000 fish use the Roubideau Creek drainage to spawn annually, with potentially thousands of fish using these proposed ISF reaches. High-flow events are critical because they allow fish to migrate into these tributaries to spawn. The fish also need gradually receding flow which allows for successful egg development and hatching, provides habitat for juvenile fish to grow and mature, and allows adult fish to move back into larger river systems before they become stranded. This highlights the importance of preserving high-flow events for these creeks, especially because few other accessible and flowing tributary networks remain in the region.

ISF Quantification

Flow Needs of Riparian Communities

The BLM reviewed scientific literature to identify the flow regime needed to support the riparian communities for these streams. This assessment found that these communities are highly dependent on infrequent flood or high-flow events that create disturbed areas and wet sediment deposits where plants can germinate by seed, root, or branch fragment propagation. Research also concludes that slowly receding flow rates after the event are important for maintaining water levels in the alluvial aquifer. This allows the roots of new seedlings to grow and remain in contact with the receding groundwater levels. Additional information about the flow needs of the riparian communities can be found in the executive summaries, letters of recommendation, and reports written by Dr. David Cooper (Attachments K-M).

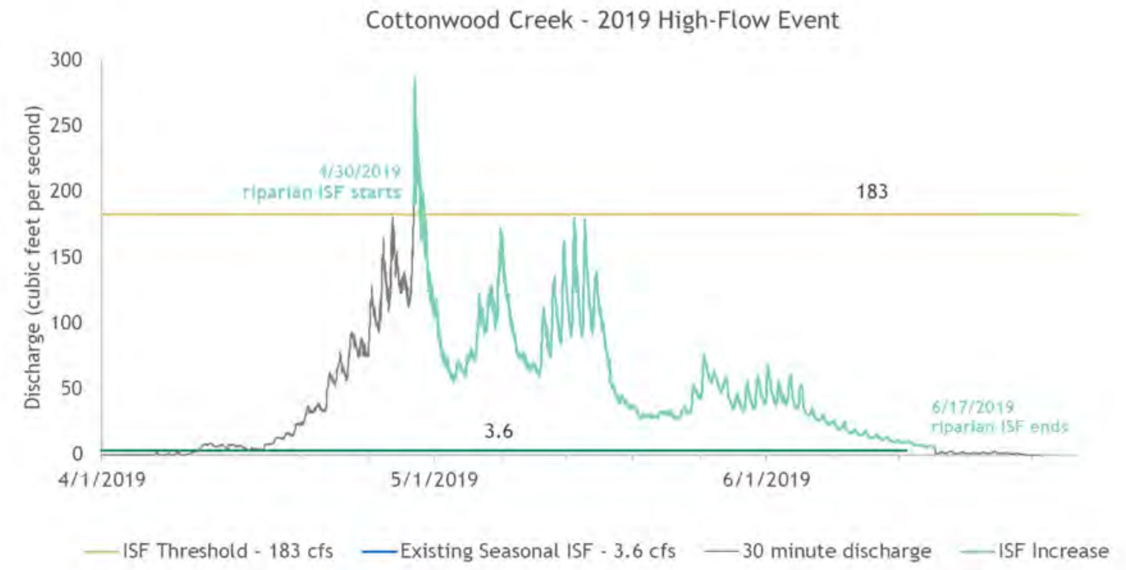
HEC-RAS Modeling

The BLM identified that bankfull, which is typically the elevation where streams start to access the floodplain and riparian vegetation, was an appropriate threshold necessary to preserve the riparian community. When streamflow is at bankfull conditions or above, the important processes required for the long-term survival of the plants can occur, including creating areas where wet sediment is deposited, seeds and branches are dispersed, nutrients are deposited on the floodplain, and recharge of the alluvial aquifer takes place. The flow rate associated with bankfull was determined based on field surveys and HEC-RAS modeling for each reach. HEC-RAS was developed by the U.S. Army Corps of Engineers and is widely used for hydraulic modeling of floods. Additional information about the HEC-RAS model is provided in the AECOM memo (Attachment H) and the executive summaries.

Proposed Structure of ISF Water Rights for Riparian Protection

The proposed approach consists of protecting a base flow component and a riparian flow component. The base flow component is protected by existing ISF water rights on the creeks (including the pending ISF water right on Monitor Creek that the Board formed the intent to appropriate in January 2023). The riparian flow component will be protected by an additional ISF water right (increase) to protect all flow in the creek from the point when the identified bankfull flow is reached down to the base flow component level from April 1 through September 30. The riparian-based ISF right would only be in effect if the bankfull threshold is reached, which is unlikely to occur each year. The April 1 through September 30 time frame corresponds to the portions of the year when the riparian community is actively growing and reproducing and when most high-flow events occur.

In the example on Cottonwood Creek below, streamflow reached the bankfull threshold of 183 cfs on 4/30/2019. This would initiate ISF protection of all streamflow until 6/17/2019 when streamflow decreased to 3.6 cfs, which is the value associated with the existing ISF on Cottonwood Creek that was decreed in 2006. Once that streamflow level is reached, the riparian-based ISF is no longer active.



Water Availability

Staff conducted water availability assessments by evaluating streamflow data from USGS, CWCB, and CPW temporary gages operated on all three streams. This data was used to describe the hydrologic regime and assess the potential frequency and duration of high-flow events that reached the identified bankfull thresholds or higher. In addition, staff analyzed the water rights tabulation for each stream to identify existing water uses and consulted with DWR staff. Unlike other ISF water rights, these ISF increases will only be in effect when the bankfull threshold is reached and only during a limited portion of the year. These proposed ISFs are not structured to occur year-round and are not expected to occur every year or even in most years. Therefore, median flow was not assessed in this analysis because the high-flow events necessary for the riparian community are not anticipated to occur on a median basis. The water availability assessments show that the bankfull threshold has been reached on each recommended stream reach. Staff concludes that water is available for the appropriations listed in Table 1 to preserve the natural environment to a reasonable degree.

Water Development Allowance

Staff met with staff for the Colorado River Water Conservation District (River District) to discuss the recommendations on Cottonwood, Monitor, and Potter Creeks. The River District expressed concerns that when these riparian ISFs are in effect, it is akin to an appropriation for all unappropriated flow during that time. The River District suggested a water development allowance (WDA) be created to protect the ability of future water users to appropriate and use water in these systems when the riparian ISFs are active. Future uses would not otherwise be precluded because the proposed ISFs would not protect high flows on a year-round basis and would not be in effect in all years.

CWCB staff contracted with SGM, Inc. (SGM) to complete an assessment of the amount of water needed for reasonable future uses in these systems. This included an assessment of potential future uses on federal lands (US Forest Service and BLM), state lands (CPW), and private lands in the basins. A draft report was prepared in June 2022 and presented to stakeholders. Subsequent conversations with stakeholders resulted in the need for additional refinements to the WDA. SGM refined the WDA by evaluating three scenarios for potential future water development. The scenario with the highest water demands for each stream was selected for the WDA (Table 3). The SGM report is attached as "Attachment I".

Staff believes that the natural environment on these systems can be protected even if the WDA is fully developed. The flow rates for the proposed WDAs are a small percentage of the flows that initiate ISF protections. The BLM is in agreement with CWCB staff that the recommended flow amounts sought on these three creeks minus the development allowance would represent the minimum amount needed to preserve the natural environment to a reasonable degree. The WDA values identified will be included in any potential final action the Board may take.

Table 3. Water Development Allowance.

Creek Name	Annual Amount (AF)	Max Diversion Amount (cfs)	Uses
Cottonwood Creek	562.2	2.6	Irrigation, domestic, stock watering, recreation, wildlife, piscatorial, fire-protection, and storage
Monitor Creek	1,627.1	7.29	
Potter Creek (Upper)	4.5	0.441	
Potter Creek (Lower)	1631.1	7.73	

Water Right Administration

Active administration of the proposed ISF rights will not be needed unless new junior water rights are established that will exceed the WDA. If that occurs, a new stream gage would need to be installed to administer any of the ISF water rights. Gages would need to be closely monitored to determine if the threshold flow has been reached, which would activate the proposed ISF water right. Monitoring of instantaneous values will be required because flows tend to increase rapidly at the start of a bankfull event and then decrease rapidly toward the end of a bankfull event. CWCB staff held meetings with the State Engineer and his staff to discuss the proposed structure of these water rights and potential administration. Other than difficulties associated with maintaining gages in these locations, no significant issues were identified by the State Engineer and his staff.

Public Comment on ISF Recommendations

Western Resource Advocates (WRA) are in support of these ISF recommendations (Attachment J). To help WRA understand the importance of the proposed ISFs to the three creeks' respective riparian communities, WRA hired Dr. David Cooper, a riparian and wetland ecohydrologist. Dr. Cooper is a senior research scientist (emeritus) in the Department of Forest and Rangeland

Stewardship at Colorado State University in Fort Collins where he works to understand the hydrologic regimes needed to support riparian and wetland ecosystems. Dr. Cooper conducted site visits in September 2021 and October 2022, reviewed existing data and reports, documented the processes required for riparian plants to become established and survive, and evaluated the importance of bankfull and higher flows for the riparian communities in reports for each stream (Attachments K-M). Dr. Cooper found that the riparian communities in Monitor Creek and Potter Creek in particular were among the best he had observed in the Uncompahgre Plateau. Dr. Cooper's reports confirm that the proposed ISF water rights are appropriate and critical for the establishment, maintenance and persistence of cottonwoods and many other species in the riparian zone.

The American Rivers Southwest River Protection Program (American Rivers) submitted a letter expressing support for these ISF recommendations (Attachment N). American Rivers believes using the ISF program to protect flows in Monitor, Potter, and Cottonwood Creeks will help protect the resilience of this important ecosystem. Audubon Rockies, a regional office of the National Audubon Society submitted a letter of support (Attachment P) for these recommendations as well. The letter included maps of specific habitat ranges surrounding the three creeks for the Southwestern Willow Flycatcher, Peregrine Falcon, and Brown-capped Rosy-finches.

Finally, CPW submitted a letter in support of these ISF recommendations (Attachment O). CPW believes that the BLM's recommendations are appropriate and necessary to support both globally rare riparian plant communities and native warm-water fishes. High-flow events cue spawning migrations for juvenile and adult warm-water fish, and influence wood and sediment recruitment in the stream which are key contributors to the habitat forming geomorphic processes that support healthy spawning beds and refugia for resident fish populations. CPW is a fish and wildlife management agency, a landowner, and a water user on Cottonwood and Roubideau Creeks at CPW's Escalante State Wildlife Area (SWA) Lower Roubideau Tract. In these roles, CPW believes the CWCB and BLM's approach to flow protection is reasonable and protects water users, including CPW, with a reasonable future development allowance.

Attachments

Attachment A: Cottonwood Creek Executive Summary
Attachment B: Monitor Creek Executive Summary
Attachment C: Potter Creek (Upper) Executive Summary
Attachment D: Potter Creek (Lower) Executive Summary
Attachment E: Cottonwood Creek BLM Recommendation Letter
Attachment F: Monitor Creek BLM Recommendation Letter
Attachment G: Potter Creek BLM Recommendation Letter
Attachment H: AECOM HEC-RAS Report
Attachment I: SGM Water Development Allowance Report
Attachment J: Western Resources Advocates Letter of Support
Attachment K: David J. Cooper, February 2023, "Assessment of BLM's Instream Flow Recommendation Cottonwood Creek, Uncompahgre Plateau Water Division 4"

Attachment L: David J. Cooper, February 2023, “Assessment of BLM’s Instream Flow Recommendation Monitor Creek, Uncompahgre Plateau Water Division 4”
Attachment M: David J. Cooper, February 2023, “Assessment of BLM’s Instream Flow Recommendation Potter Creek, Uncompahgre Plateau Water Division 4”
Attachment N: American Rivers Letter of Support
Attachment O: Colorado Parks and Wildlife Letter of Support
Attachment P: Audubon Rockies Letter of Support

Cottonwood Creek Executive Summary

CWCB STAFF INSTREAM FLOW RECOMMENDATION
March 15-16, 2023

UPPER TERMINUS:	Hawkins Ditch headgate UTM North: 4267895.51 UTM East: 206860.73
LOWER TERMINUS:	confluence with Roubideau Creek UTM North: 4289842.88 UTM East: 226016.62
WATER DIVISION:	4
WATER DISTRICT:	40
COUNTY:	Delta, Montrose
WATERSHED:	Lower Gunnison
CWCB ID:	18/4/A-006
RECOMMENDER:	Bureau of Land Management (BLM)
LENGTH:	23.33 miles
EXISTING INSTREAM FLOW:	4-06CW166, 3.6 cfs (4/1 – 6/15)
INCREASE INSTREAM FLOW RECOMMENDATION:	ISF protection initiates at 183 cfs and protects all unappropriated streamflow until flow rates recede to the existing 3.6 cfs ISF right. This water right will only be in effect 4/1 - 9/30.

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INTRODUCTION

Colorado's General Assembly created the Instream Flow and Natural Lake Level Program in 1973, recognizing "the need to correlate the activities of mankind with some reasonable preservation of the natural environment" (see 37-92-102 (3), C.R.S.). The statute vests the Colorado Water Conservation Board (CWCB or Board) with the exclusive authority to appropriate and acquire instream flow (ISF) and natural lake level water rights (NLL). Before initiating a water right filing, the Board must determine that: 1) there is a natural environment that can be preserved to a reasonable degree with the Board's water right if granted, 2) the natural environment will be preserved to a reasonable degree by the water available for the appropriation to be made, and 3) such environment can exist without material injury to water rights.

The information contained in this Executive Summary and the associated supporting data and analyses form the basis for staff's ISF recommendation to be considered by the Board. This Executive Summary provides sufficient information to support the CWCB findings required by ISF Rule 5i on natural environment, water availability, and material injury. Additional supporting information is located at: https://cwcb.colorado.gov/2023-isf-recommendations.

RECOMMENDED ISF REACH

The BLM recommended that the CWCB appropriate an increase to an existing ISF water right on a reach of Cottonwood Creek. Cottonwood Creek is located within Delta and Montrose counties (See Vicinity Map) and is approximately 4.5 miles southwest from the City of Delta. The stream originates on the Uncompahgre Plateau at an elevation of 9,300 feet and flows northeast for 30.8 miles until it reaches the confluence with Roubideau Creek which is a tributary to the Gunnison River. The existing ISF water right on Cottonwood Creek was appropriated in 2006 for 3.6 cfs (4/1-6/15). The proposed reach extends from Hawkins Ditch headgate downstream to the confluence with Roubideau Creek for a total of 23.33 miles. The land on the proposed reach is 76.5% BLM, 9.5% USFS, 7% state, and 7% privately owned (See Land Ownership Map).

BACKGROUND

The BLM found Cottonwood Creek suitable for inclusion in the National Wild and Scenic Rivers System based in part on the presence of rare riparian communities that qualified as outstandingly remarkable values (ORVs; BLM, 2017). An ORV is defined as a river-related value that is unique, rare, or exemplary, when compared to the other streams in the region. This finding was informed by surveys conducted by the Colorado Natural Heritage Program (CNHP)[1] that determined that Cottonwood Creek contained rare plant communities that warranted conservation (Damm and Stevens, 2000; Stephens et al., 1999). On Cottonwood Creek, CNHP identified vulnerable populations of narrowleaf cottonwood and skunkbush sumac that are rarely found in the same habitat.

Although BLM recognized that Cottonwood Creek has some ISF protection, the suitability determination specifically noted that the current lack of flow protection for globally significant

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1 The Colorado Natural Heritage Program is Colorado's only comprehensive source of information on the status and location of Colorado's rarest and most threatened species and plant communities. CNHP is a non-academic department of the Warner College of Natural Resources at Colorado State University. It is also a member of the NatureServe Network, "which is an international network of partners that use the same scientific methodology to enable scientists to monitor the status of species and natural plant communities from state, national, and global perspectives."

riparian values was a significant factor driving BLM's suitability determination. The BLM stated that if scientific studies conclude that alternative forms of flow protection are in place and are sufficient to fully protect the flow-related ORVs on Cottonwood Creek, the BLM will determine it is unnecessary to quantify, assert, or adjudicate a federal reserved water right for these segments if they are ultimately designated into the National Wild and Scenic River System.

At the request of the CWCB, BLM developed a concept to preserve the riparian communities of these streams using the ISF program. The proposed ISF is based on protecting high-flow events and the falling limb of the hydrograph which create the conditions necessary for seedlings to survive and sustain the population of the riparian community. This ISF increase would only be active during the primary growing season and only when flows are sufficiently high to provide benefits to the riparian community. At other times, the existing seasonal ISF would continue to provide some flow protection for aquatic habitat.

OUTREACH

Stakeholder input is a valued part of the CWCB staff's analysis of ISF recommendations. Currently, more than 1,100 people are subscribed to the ISF mailing list. Notice of the potential appropriation of an ISF water right on Cottonwood Creek was sent to the mailing list in November 2022, March 2022, November 2021, March 2021, November 2020, March 2020, November 2019, March 2019, March 2018, and March 2017. Staff also sent letters in March 2022 to all landowners adjacent to Cottonwood Creek according to the county assessors' website to notify them about the ISF recommendation. A public notice about this recommendation was also published in the Montrose Daily Press on January 8, 2022 and December 21, 2022.

Staff presented information about the ISF program and this recommendation to the Montrose County Board of County Commissioners on October 3, 2017, December 9, 2019, and November 21, 2022 and the Delta County Board of County Commissioners on December 9, 2019. In addition, staff spoke with State Engineer Kevin Rein on June 6, 2017, and with State Engineer Kevin Rein and Deputy State Engineer Tracy Kosloff on October 9, 2020 regarding the administrability of this ISF recommendation. Staff also communicated with Bob Hurford, Division Four Engineer and Luke Reschke, Lead Water Commissioner several times regarding water rights and water use practices on Cottonwood Creek.

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. Please see BLM's letter of recommendation which includes more detailed information about the plant communities, riparian flow needs, and the importance of protecting the riparian communities.

Riparian Community

Cottonwood Creek starts near Columbine Pass on the Uncompahgre Plateau, it descends through forested lands before carving a gradually deepening canyon. The valley floor contains a wide riparian corridor. CNHP surveys found that Cottonwood Creek supports a healthy riparian plant community that is part of the Rocky Mountain Lower Montane-Foothills Riparian Woodland and Shrubland Ecological System (CNHP website).

Specifically, Cottonwood Creek contains a population of a rare imperiled narrowleaf cottonwood and skunkbush sumac (*Populus angustifolia*/*Rhus trilobata*) riparian forest (Figure 1). Narrowleaf cottonwoods are members of the willow family that can grow up to 80 feet in height. Skunkbush sumac is a deciduous, flowering shrub, averaging four feet in height. Cottonwood Creek also includes extensive acreage of other non-imperiled riparian communities and species, that were noted by CNHP to be in very good condition such as Fremont cottonwood (*Populus deltoides ssp. Wislizenii*), red osier dogwood (*Cornus sericea*), silver buffaloberry (*Shepherdia argentea*), thin leaf alder (*Alnus incana*), strapleaf willow (*Salix ligulifolia*), and coyote willow (*Salix exigua*) (Damm and Stevens, 2000; Stephens et al., 1999).

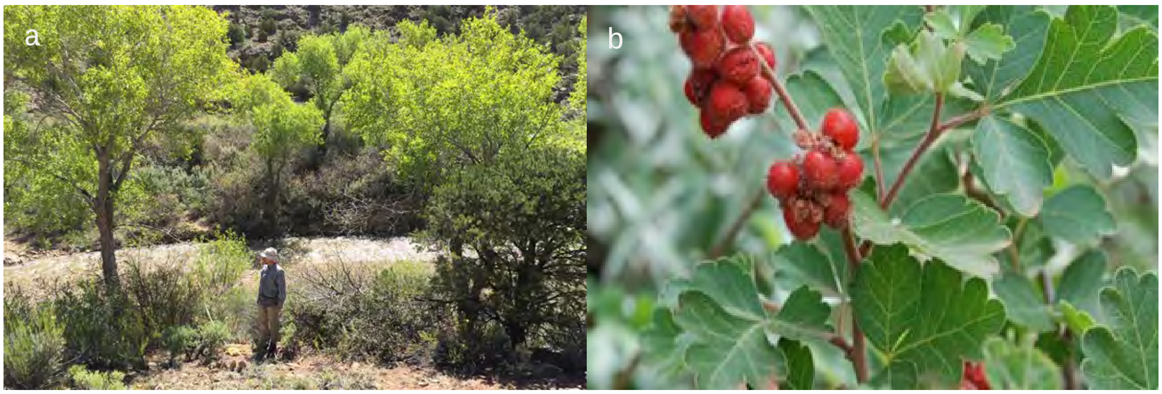


Figure 1. Images of species in the Cottonwood Creek riparian area. a) narrowleaf cottonwood and b) skunkbush sumac

The combination of narrowleaf cottonwood and skunkbush sumac is rated by CNHP as both globally and state vulnerable, which is defined as being at moderate risk of extinction with 21 to 100 occurrences of these communities in the world (Damm and Stevens, 2000). Even though the populations of narrowleaf cottonwood and skunkbush sumac are widely distributed, these species are rarely found growing in the same location because of their different habitat needs which are rarely met simultaneously.

CNHP included Cottonwood Creek as one of 25 wetland and riparian sites within Ouray and eastern Montrose counties that most merit conservation efforts and as one of four areas of local significance based on its ecosystem functions and values (Stephens et al.,1999). Both CNHP and BLM found Cottonwood Creek to have high biodiversity with the riparian community in good condition, few non-native species, and minimal anthropogenic disturbance. CNHP ranked Cottonwood Creek biodiversity as having high significance with an excellent example of good occurrences or state rate species.

CNHP designated the Cottonwood Creek watershed as a Potential Conservation Area (PCA) because highly functioning riparian areas with an intact assemblage of historic native species are so rare in the Uncompahgre River basin. PCAs focus on capturing the ecological processes necessary for the continued existence of plants or plant communities with natural heritage significance. PCAs are meant to be used for conservation planning purposes but have no legal status. CHNP states that, "the Cottonwood Creek Conservation PCA merits special status, such as designation as a BLM Area of Critical Environmental Concern (ACEC) or Research Natural Area." (Damm and Stevens, 2000)

Riparian communities are important because they provide many critical hydrologic, watershed, and ecosystem functions (Stephens et al., 1999). Hydrologically, riparian areas can help mitigate the impacts of floods by reducing water velocity and attenuating peak flows. They also stabilize streambanks and prevent erosion and unraveling of the channel during high-flow events. Heavily vegetated riparian corridors provide biogeochemical functions of filtering out sediment and toxins. Riparian communities directly support wildlife by providing diverse habitat types including forest, dense scrub, and shrub. In semi-arid regions of the western United States, an estimated 80% of mammals, birds, reptiles, and amphibians use riparian areas and wetlands for habitat throughout the year or as migratory rest stops (Somers and Floyd-Hanna, 1996). The riparian corridor also provides shade to reduce water temperatures and organic matter which provides habitat and food for the aquatic ecosystem.

Preserving the riparian corridor in Cottonwood Creek is warranted to preserve a rare riparian community that provides important functions including maintaining overall system resiliency. This riparian community is uniquely adapted to the Uncompaghre Plateau which includes extremes of high and low streamflow conditions in a semi-arid region. These diverse riparian communities of native species are well adapted to their location and are better able to withstand environmental stresses and catastrophic events. When a watershed is more resilient, it is better able to rebound following disturbances such as severe storms, flooding, landslides, mudslides, and wildfires. Resiliency also mitigates the impact of those disturbances on the surrounding communities, which improves outcomes for both people and ecosystems.

Native Fish

Although not the primary basis for the proposed ISF, Cottonwood Creek also provides important habitat for the three-species: Flannelmouth Suckers (*Catostomus latipinnis*), Bluehead Suckers (*Catostomus discobolus*), and Roundtail Chubs (*Gila robusta*). These species are identified by the state of Colorado as Species of Greatest Conservation Need and by the BLM as sensitive species. They are also subject to a multi-state conservation agreement designed to prevent a listing of the species under the Endangered Species Act (Utah DNR, 2006).

CPW has conducted extensive research on Cottonwood Creek and the Roubideau Creek basin including monitoring streamflow, fish sampling, and fish tracking to determine movement patterns and spawning site selection. CPW found that upwards of 25,000 fish use the Roubideau Creek drainage to spawn annually, with thousands of fish using tributaries such as Cottonwood Creek. Individual fish have very high annual spawning tributary fidelity in this area, with up to 77% of individuals returning to the drainage multiple years in a row (Thompson and Hooley-Underwood, 2019).

High-flow events are also important for the three-species. These species are cued to spawn when streamflow in the tributaries increases during runoff. A gradual receding flow after the spring peak supports the development of eggs, hatching, larvae development, provides habitat for juvenile fish to grow and mature, and allows adult fish to move back into larger river systems before they become stranded. These findings highlight the importance of Cottonwood Creek for the three-species, especially because few other accessible and flowing tributary networks remain.

ISF QUANTIFICATION

BLM staff, in conjunction with CWCB, evaluated the flow needs of the riparian communities and examined several methods to quantify the flow rates necessary to preserve the species.

Flow Needs of Riparian Communities

The BLM conducted a review of scientific literature to identify the flow regime needed to support the vulnerable narrowleaf cottonwood and skunkbush sumac riparian community (See BLM's recommendation letter for additional details). Considerable research has been conducted on the hydrologic conditions necessary for establishment and persistence of cottonwood trees. Those studies conclude that the persistence of cottonwood trees as part of a riparian community is highly dependent on infrequent flood or high-flow events (Cooper et al, 1999). High-flow events create disturbed areas and wet sediment deposits where cottonwood can germinate by seed, root, or branch fragment propagation (Scott et al., 1997).

Like cottonwood trees, skunkbush sumac also reproduces by seed and root sprouts, but the dominant form of reproduction is sprouting. Sprouting occurs more frequently in response to large disturbance events such as floods. However, unlike cottonwood trees, skunkbush sumac needs well-drained soils and will not tolerate long-duration high-flow events or high-water tables for long durations. BLM believes that the sandstone-based soils along Cottonwood Creek and the general short duration of high-flow events allows these species to survive and grow interspersed with the narrowleaf cottonwoods.

In addition to high-flow events, research also concludes that slowly receding flow rates after the event are important for maintaining water levels in the alluvial aquifer. This allows the roots of new seedlings to grow and remain in contact with the receding groundwater levels in riparian soils (Mahoney and Rood, 1998). Baseflows, which occur in later summer, fall, and winter, also maintain water levels in the alluvial aquifer, supporting deep-rooted cottonwoods and willows, which both require constant access to groundwater to prevent dieback of upper branches or mortality.

Because high-flow events are critical to long-term reproduction and success of the riparian community, BLM focused on identifying the flow rate that would start to access the riparian community. BLM identified that bankfull, which is typically the elevation where streams start to access the floodplain and inundate riparian vegetation, was an appropriate threshold necessary to preserve the riparian community. When streamflow is at bankfull conditions or above, important processes required for the long-term survival of the plants can occur, including creating areas where wet sediment is deposited, dispersal of seeds and branches, depositing nutrients on the floodplain, and recharge of the alluvial aquifer.

Hydraulic Modeling

BLM staff explored using the U.S. Forest Service's WinXSPRO model to identify the flow rate necessary to preserve the riparian communities. After evaluating the model, BLM and CWCB staff determined that the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center's River Analysis System (HEC-RAS) would produce more reliable results. HEC-RAS is widely used throughout the United States for hydraulic modeling of floods. This model uses multiple cross-sections to perform more advanced calculations than approaches that rely on single cross-sections. It is also capable of producing maps that illustrate the portions of the channel inundated at different flows. BLM and CWCB staff concluded that results from the HEC-RAS model were more appropriate and accurate for modeling high flows.

CWCB staff hired AECOM, an outside engineering firm, at the beginning of 2021 to collect detailed survey information and develop hydraulic models for the sites in each of the four proposed ISF reaches. CWCB Staff, BLM staff, and the AECOM surveyor selected a reach on Cottonwood Creek six miles upstream from the lower terminus. This site was selected based on the presence of the riparian species of interest and channel characteristics that were conducive to modeling efforts. In each selected site, AECOM surveyed cross-sections to measure channel geometry and floodplain topography. Bankfull indicators were identified by CWCB and BLM staff at each cross-section. In addition to elevation data, the AECOM surveyor also measured the location of debris piles deposited by exceptionally large and infrequent flow events. A total of eight cross-sections were surveyed on the selected reach of Cottonwood Creek.

AECOM then developed a hydraulic model for each reach using HEC-RAS version 5.0.7 (AECOM, 2021). Manning's n values were selected based on aerial imagery and photos collected during the field survey which showed the nature of the channel, bed material, and vegetation. These values were selected in accordance with Table 3-1 in the HEC-RAS 5.0.1 Reference Manual. On Cottonwood, the Manning's n value in the channel was set to 0.045, the values in the floodplain were set to between 0.055 and 0.07. Using an iterative process, discharge values for the minimum bankfull elevation and the minimum and maximum flood debris elevations were determined in each reach. The selected discharge minimized the difference between the modeled water surface elevation and the surveyed bankfull elevations.

For Cottonwood Creek, AECOM determined that the surveyed bankfull indicators correspond to a flow of 183 cfs (Table 1). The lower elevation flood debris corresponds to a streamflow of 974 cfs and the maximum elevation of the debris corresponds to a streamflow of 1247 cfs.

Table 1. HEC-RAS modeling results for Cottonwood Creek.

Parameter	Discharge (cfs)
Bankfull	183
Minimum elevation of flood debris	974
Maximum elevation of flood debris	1,247

ISF Recommendation

This recommended ISF water right is specifically structured to protect the high-flow component of the hydrologic regime that is critical to the persistence of riparian communities. This water right also protects the receding limb of the hydrograph. Protecting bankfull flows and the receding limbs of the hydrograph will provide the conditions necessary for reproduction and maintenance of the riparian communities. The BLM recommends the following flows based on modeling analyses and the biological needs of the riparian communities:

> When the flow rate reaches 183.0 cfs (bankfull flow), all flow in the creek should be protected until the flow rate recedes to 3.6 cfs, which is the flow rate associated with the existing ISF right from April 1 to June 15. If the threshold of 183.0 cfs is met outside of the April 1 to June 15 period associated with the

current CWCB water right, then flows should also be protected as they recede down to a 3.6 cfs flow rate.

BLM recommends that the proposed water right be in effect only during the April 1 to September 30 period, if the flow rate threshold is met. This time frame corresponds to the portion of the year when the riparian community is actively growing and reproducing, and when most high flow events occur due to snowmelt runoff and monsoonal thunderstorms. During years in which streamflow does not reach the proposed threshold, this instream flow water right for high-flow events would not be in effect.

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.). This approach focuses on streamflow and the influence of flow alterations, such as diversions, to understand how much water is physically available in the recommended reach.

Staff's hydrologic analysis is data-driven, meaning that Staff gathers and evaluates the best available data and uses the best available analysis method for that data. Whenever possible, long-term stream gage data (period of record 20 or more years) 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 to estimate a selected basin's streamflow statistics including flood discharge and frequency characteristics (Capesius and Stephens, 2009). 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.

Unlike other ISF water rights, this ISF will only be in effect when the bankfull threshold is reached and only during a limited portion of the year. This proposed ISF is not structured to occur year-round and is not expected to occur every year or even in most years. Therefore, median flow is not assessed in this analysis because the high-flow events necessary for the riparian community are not anticipated to occur on a median basis. Instead, the water availability analysis for Cottonwood Creek provides information about the known hydrology in the area, the available streamflow data for Cottonwood Creek, and the potential characteristics of these high-flow events.

Basin Characteristics
The drainage basin of the proposed ISF on Cottonwood Creek is 46.8 square miles, with an average elevation of 7,210 feet and average annual precipitation of 16.09 inches (See the Hydrologic Features Map). Hydrology throughout the Uncompahgre Plateau demonstrates a relatively early snowmelt runoff pattern that is also influenced by monsoon and late-season storms. This results in high-flow events that can occur between early spring and early summer due to snowmelt and high-flow events that can occur between summer and late fall due to rain events. A nearby gage, Roubideau Creek at mouth near Delta, CO gage (USGS 09150500, period of record 1939 to 1953 and 1976 to 1983), shows that most annual peaks occur in May but can occur as late as October (Figure 2).

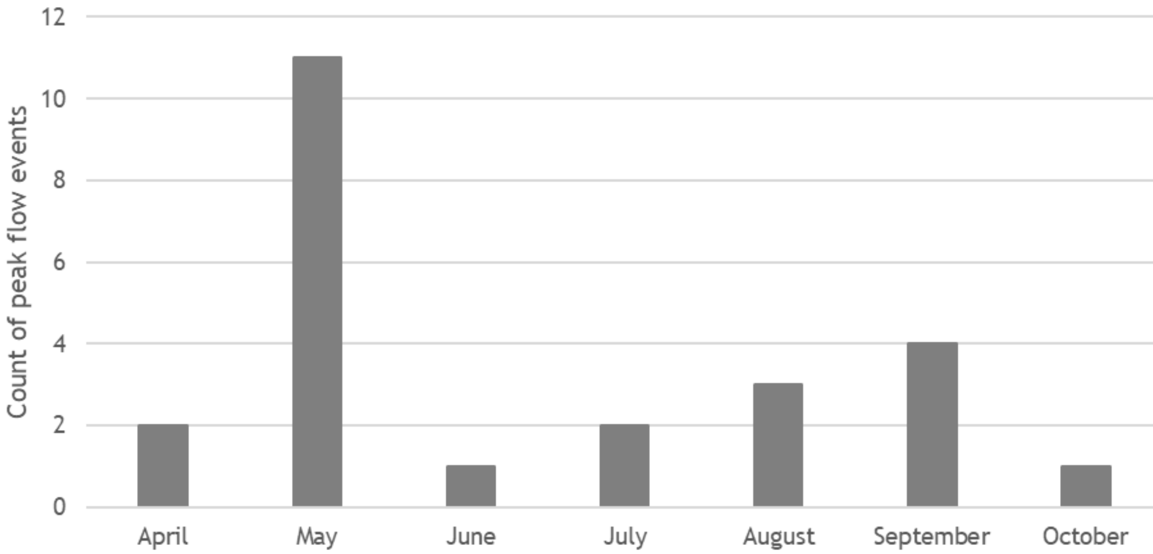


Figure 2. Number of times the peak occurred each month at the Roubideau Creek at mouth near Delta, CO peak flow gage data from 1939-1953 and 1976-1983.

Snowmelt runoff typically produces the high-flow event with the longest duration, which can last weeks to months. Rain events have the potential to produce very high flows but are typically short-duration events. Streamflow in this region can be highly variable, some years may have substantial flows while other years have little to no measurable flow.

Existing Water Uses
There are several water rights in the basin tributary to the proposed ISF on Cottonwood Creek. There are five active surface water diversions upstream from the proposed lower terminus. The sum of decreed surface water diversions is 84 cfs, with maximum recorded diversions totaling 44 cfs for all diversions. The largest of the five, the Hawkins Ditch (WDID 4001437, 31 cfs, appropriated in 1947), is located approximately 230 feet downstream of the proposed upper terminus. There are also 219 acre-feet in active storage rights and 0.066 cfs for two springs. None of these water rights are known to completely dry up Cottonwood Creek. Some diversions import or export water into the Cottonwood Creek basin. The Everlasting Ditch (WDID 4001435, 27 cfs, appropriated 1901) irrigates lands in both the Cottonwood Creek drainage basin and the adjacent drainage basin, Monitor Creek. In addition, the David Brother's Ditch (WDID 4001428, 2 cfs, appropriated in 1951, 10 cfs, appropriated in 1959) diverts water from the adjacent Dry Fork Escalante Creek which is used to irrigate lands in the Cottonwood Creek basin via the North

Fork Ditch (WDID 4001325, 3 cfs, appropriated in 1925, 10 cfs, appropriates in 1959) approximately 3.5 miles upstream of the upper terminus. Hydrology is altered by water use within the basin.

Data Collection and Analysis
A number of different sources of information were used to assess hydrology in Cottonwood Creek. Each source will be presented in subsections for clarity.

Representative gage analysis
There are no current or historic streamflow gages on Cottonwood Creek. No representative gages on nearby streams were identified due to a general lack of gages in the region and the high level of water use in the nearest streams with gages.

CPW Cottonwood Creek gage
Colorado Parks and Wildlife (CPW) CPW installs a temporary streamflow gage on Cottonwood Creek annually to monitor spring flows in conjunction with research on spawning movements of native sucker species. This gage (termed the CPW Cottonwood gage) is located about 0.1 miles upstream from the proposed lower terminus on Cottonwood Creek. The CPW gage is operated seasonally, typically from early spring in March or April through June or early July when the spawning migration is completed, and flows drop. The gage has operated most years from 2015 to present. The gage was not operated through late summer, fall, or winter and therefore does not record information from flow events during these portions of the year. As such, though they are assumed to exist and understood to be short in duration, there are no recorded late summer and early fall monsoon events in the CPW gage record. Streamflow measurements collected to maintain this gage as well as other measurements made by CPW and CWCB are included in the hydrograph. Staff then used the available data to develop a rating curve to determine streamflow during the gaged portions of the years with data.

During the time of data collection, the seasonal gage has collected a range of flows and events (See Complete and Detailed Hydrographs). The seasonal gage was not installed and no data was recorded in Cottonwood Creek during 2018 and 2021 due to extremely low flows and short flow durations from extreme drought conditions. In 2016, 2019, and 2022 the seasonal gage recorded several high-flow events. All other years show varied flow throughout the spring and early summer.

The CPW gage is affected by within basin diversions and diversions that both export and import water from the system. For a summary, please see existing water uses section above. Given that the impacts of diversions are reflected in gage records, no further adjustments were made to assess the impact on water available for the overbank thresholds on the instream flow reach.

Climate Conditions
The CPW Cottonwood Creek gage record period (2015-2022) was compared to a longer-term climate record for context. The nearest climate station with a relatively long record is at Columbine Pass (USS0008L02S, 1986 to 2022) located in the headwaters of Potter Creek, approximately 18 miles southwest from the proposed lower terminus. Figure 3 shows cumulative snow water equivalent (SWE) totals for 2015-2022 in comparison to the 30-year average (downloaded from the Colorado River Basin Forecast Center on 2/9/2023). Peak SWE in 2018 was the lowest on record, 2015, 2020 and 2021 were below average, 2016 was about average,

and 2017, 2019, and 2022 were above average. This information demonstrates a range of precipitation in the area during the CPW Cottonwood Creek gage record.

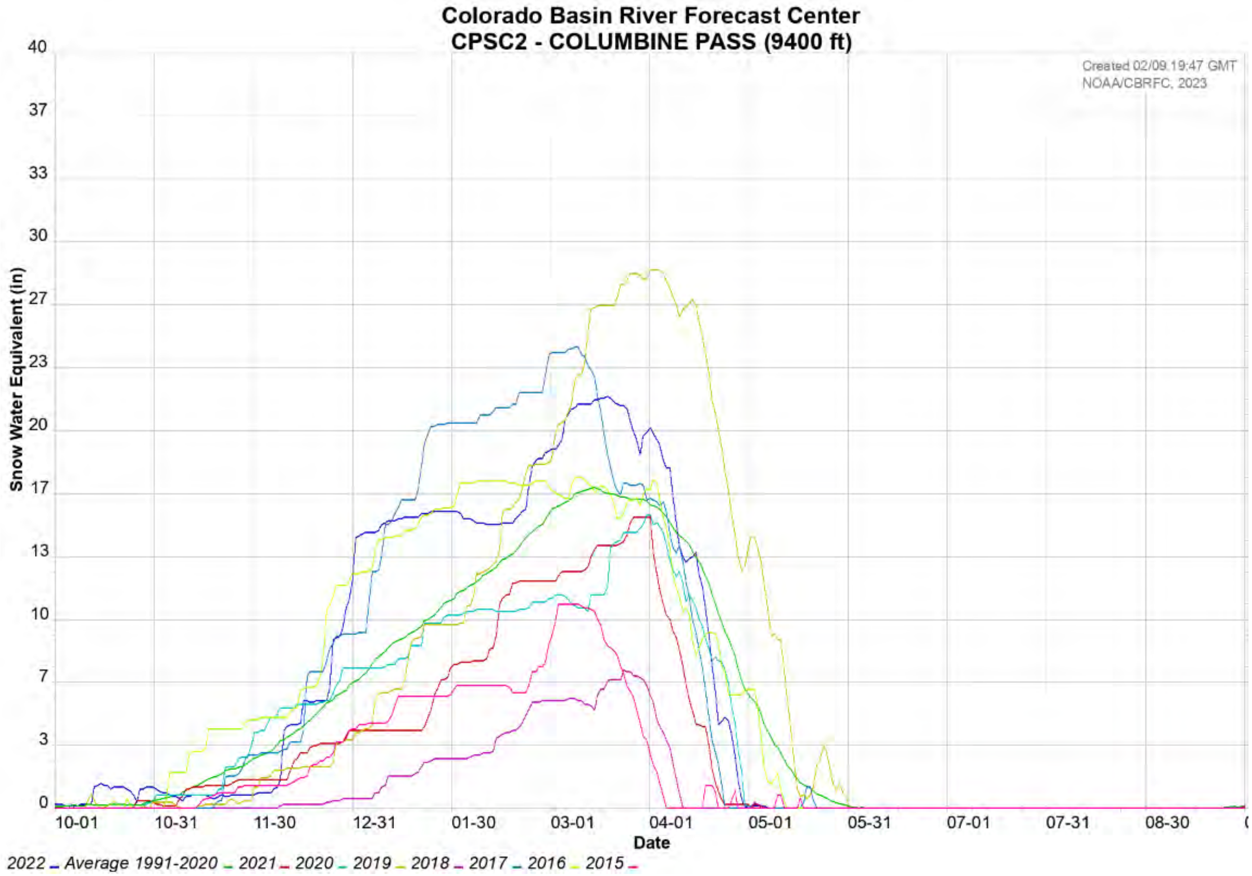


Figure 3. Cumulative SWE for 2014 to 2022 and median SWE from 1991 to 2020 downloaded from the Colorado River Basin Forecast Center on 12/19/2022. Source: NOAA Colorado Basin River Forecast Center

Staff also evaluated streamflow gages to better understand potential streamflow given that persistent low soil moisture in recent years has impacted how much snowfall becomes streamflow. The Dallas Creek gage and San Miguel gages (USGS 09147000 Dallas Creek near Ridgway and USGS 0917700 San Miguel River at Uravan) were selected because they were reasonably close to the Uncompaghre Plateau. The gages are not impacted by large reservoirs; however, they are in different basins and have significant water uses. Years with complete data (provisional or approved data, filling missing data in 2022 with the long-term average) from 1992 to 2022 was used to calculate annual water volumes and basic percentiles. Data from these gages show that 2019 was very wet (greater than 75th percentile); 2015 was wet to dry (greater than 50th percentile for the San Miguel and greater than the 75th percentile for Dallas Creek, 2016 and 2017 was wet or wettest (greater than the 50th percentile for the San Miguel River and greater than 75th percentile for Dallas Creek); 2018, 2020, 2021, and 2022 were in the driest category (less then 25th percentile). 2018 and 2020 were exceptionally dry with annual water volumes less than the 10th percentile. Therefore, the CPW Cottonwood Creek gage data contains a range of year types, but many years in the record are likely to reflect dry or exceptionally dry conditions.

High-Flow Characteristics

The ISF recommendation is based on the importance of high-flow events that help to maintain the rare riparian community on Cottonwood Creek. Based on the available information from the CPW gage, riparian flows would have been achieved in three of the six years the gage operated, with three separate events as shown in the Complete Hydrograph, the Detailed Hydrographs and Table 2. All three events lasted multiple days until flows receded to the existing ISF rate of 3.6 cfs. The highest daily average flow recorded at the CPW gage was 210 cfs and the highest instantaneous flow (based on a 30-minute interval reading) was 286 cfs.

Table 2. Duration and maximum streamflow for high-flow events that reached the bankfull threshold or higher in Cottonwood Creek (2015-2022).

Start Date	End Date	Duration (time)	Maximum flow (cfs)	Data Source
5/7/2016	5/27/2016	21 days	278	CPW gage
4/30/2019	6/17/2019	49 days	286	CPW gage
4/20/2022	5/20/2022	29 days	201	CPW gage

The USGS StreamStats model estimates several different peak flow statistics based on regional regression analysis using available streamflow data (Table 3). These estimates provide information about the potential frequency of high-flow events, but these estimates likely have high uncertainty due to the lack of streamflow gages in the region that can be used to inform the models. Nevertheless, these estimates suggest that the riparian threshold of 183 cfs could occur at the frequency of a 2-year peak flood event.

Table 3. StreamStats estimates of area-averaged high-flow events on Cottonwood Creek.

Peak Flow Statistic	Estimated Flow (cfs)
2 Year Peak Flood	217
5 Year Peak Flood	416
10 Year Peak Flood	584
25 Year Peak Flood	863
100 Year Peak Flood	1,350

Historical High-Flow Event Estimates

AECOM also surveyed the location of large piles of woody debris deposited by previous very infrequent high-flow events on the floodplain of the modeled stream site. The HEC-RAS model was used to estimate the flow necessary to reach the locations of the debris piles. This modeling work estimated that a flow of 974 cfs would reach the minimum elevation of the debris and a flow of 1,247 cfs would reach the high elevation of the debris. BLM estimated that some of the debris piles were deposited within the last ten years and BLM staff are aware of a very high-flow event that occurred in 2008 (Jedd Sondergard, BLM staff personal communication 4/6/2021). The observation of large piles of debris on the floodplain demonstrates that very high-flow events do occur and that these events can inundate large portions of the floodplain.

Water Availability Summary

The hydrographs of the available gage data, along with the AECOM estimates of high-flow events, and StreamStats estimates of peak flow events provide information about hydrology on Cottonwood Creek. These data demonstrate that high-flow events above the bankfull threshold of 183 cfs have occurred on Cottonwood Creek, although they do not occur in every year. Staff concludes that water is available for the appropriation as structured.

MATERIAL INJURY

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

ADDITIONAL INFORMATION

Citations

AECOM, 2021, Cottonwood, Monitor, and Potter Creek's survey and hydraulics. Memo to CWCB.

Bureau of Land Management. 2017. Record of decision and approved resource management plan for Dominguez-Escalante National Conservation Area.

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

Colorado Natural Heritage Program, Rocky Mountain lower montane-foothills riparian woodland and shrubland. https://cnhp.colostate.edu/projects/ecological-systems-of-colorado/details/?elementID=365200

Cooper D.J., Merritt, D.M., Anderson, D.C. and Chimner, R.A, 1999, Factors controlling the establishment of Fremont cottonwood seedlings on the Upper Green River, USA. Regulated Rivers: Research and Management, 15:419-440.

Damm, M., and J. Stevens, 2000, Assessment of riparian vegetation and wildlife habitat structure: North Fork of the Gunnison tributaries and lower Gunnison tributaries. Colorado Natural Heritage Program.

Mahoney, J.M. and S.B. Rood, 1998, Streamflow requirements for cottonwood seedling recruitment- an integrative model. Wetlands, 18; 634-645.

Scott, M.L., Auble, G.T., and Friedman, J.M.,1997, Flood dependency of cottonwood establishment along the Missouri River, Montana, USA. Ecological Applications, 7:677-690.

Somers, P. and L. Floyd-Hanna, 1996, Wetlands and riparian habitats, and rivers. In Blair, R., ed. pp. 175-192. The western San Juan Mountains: their geology, ecology, and human history. University Press of Colorado, Niwot, CO.

Stephens, T., D. Culver, J. Zoern, and P. Lyon, 1999, A natural heritage assessment of wetlands and riparian areas in Uncompahgre River basin: Eastern Montrose and Ouray Counties Volume II. Colorado Natural Heritage Program.

Thompson, K.G., and Z.E. Hooley-Underwood, 2019, Present distribution of three Colorado River basin native non-game fishes, and their use of tributaries. Technical publication No. 52, Colorado Parks and Wildlife Aquatic Research Section.

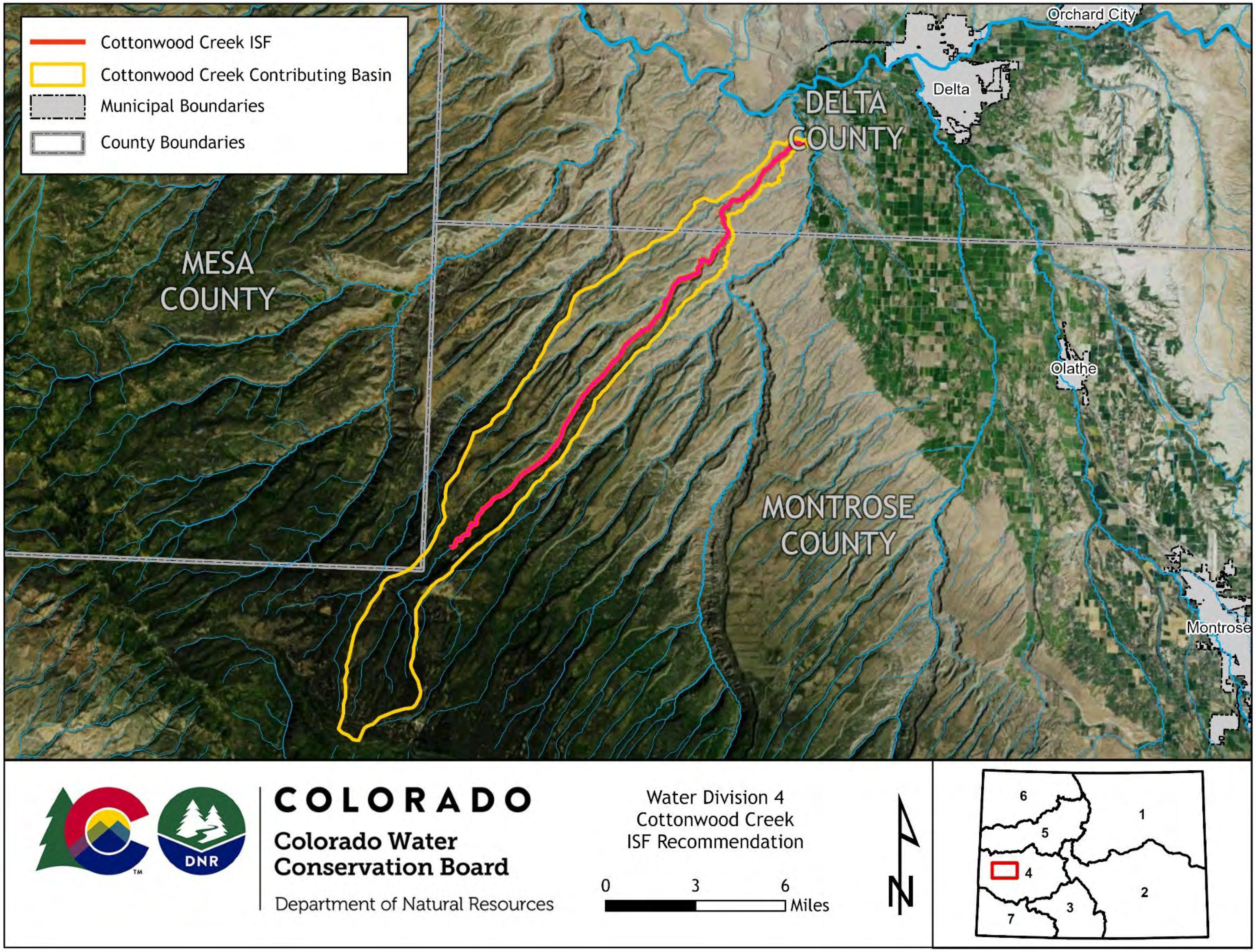
Utah Department of Natural Resources, Division of Wildlife Resources, 2006, Range-wide conservation agreement and strategy for Roundtail Chub *Gila robusta*, Bluehead Sucker *Catostomus discobolus*, and Flannelmouth Sucker *Catostomus latipinnis*.

Metadata Descriptions

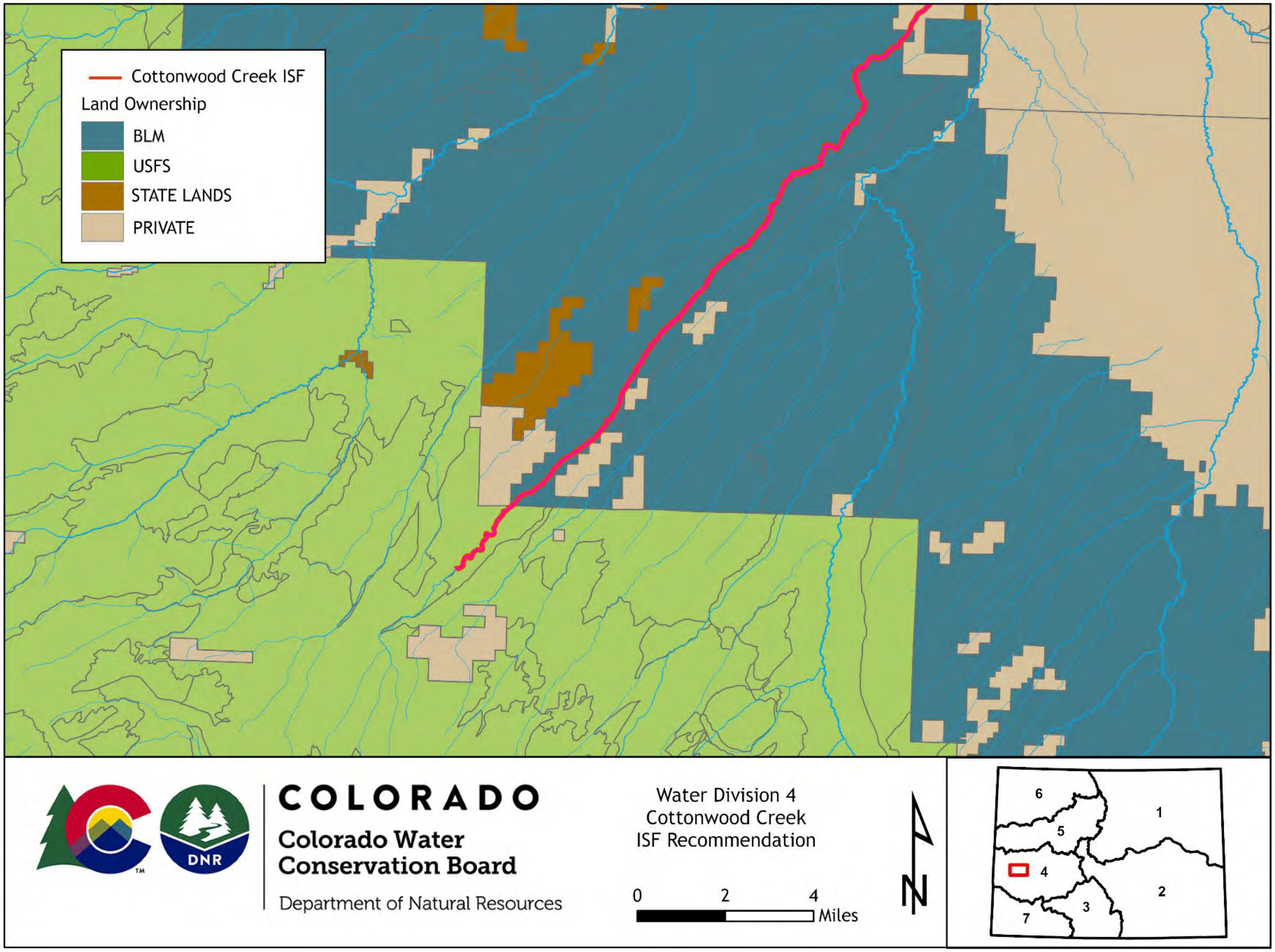
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

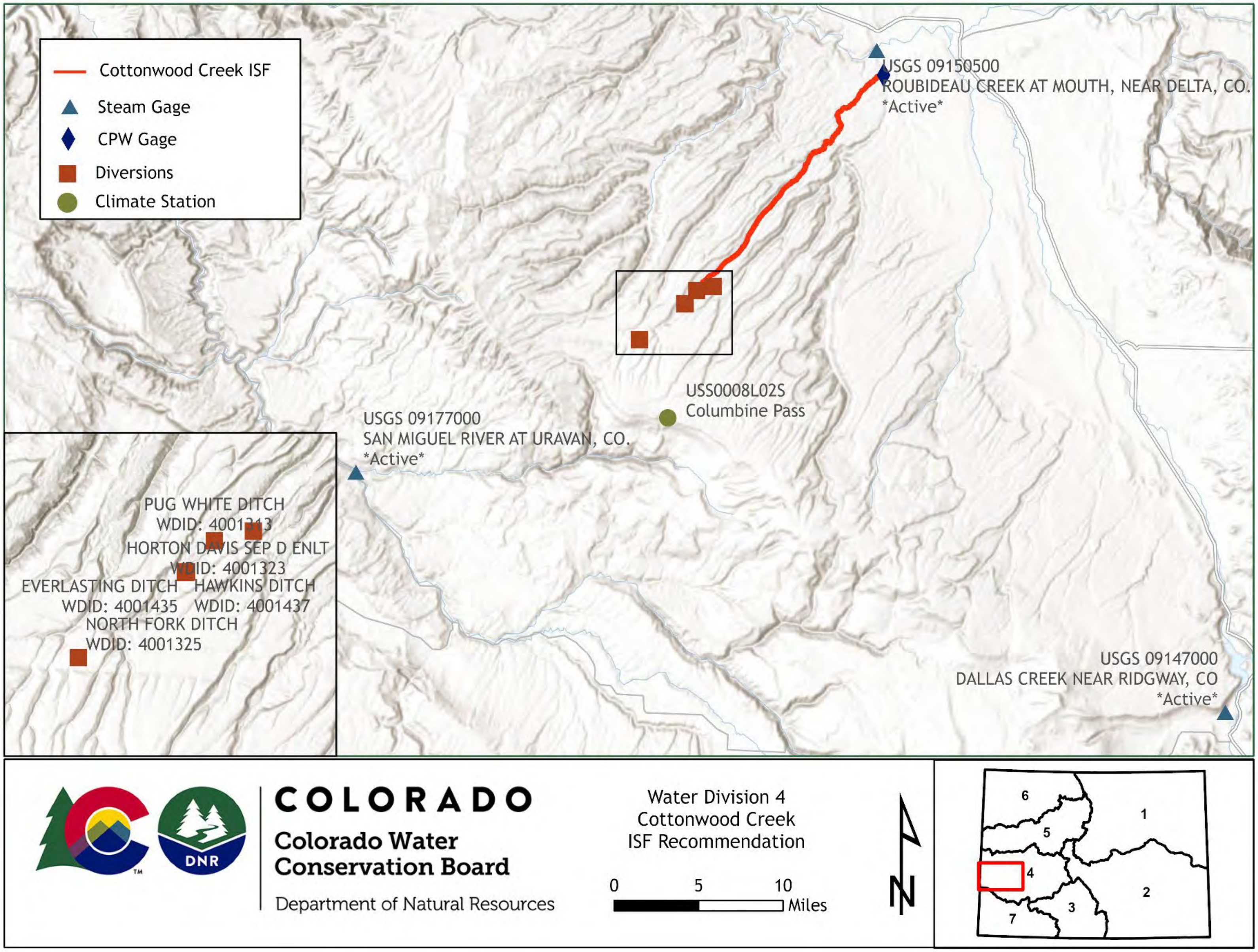
VICINITY MAP



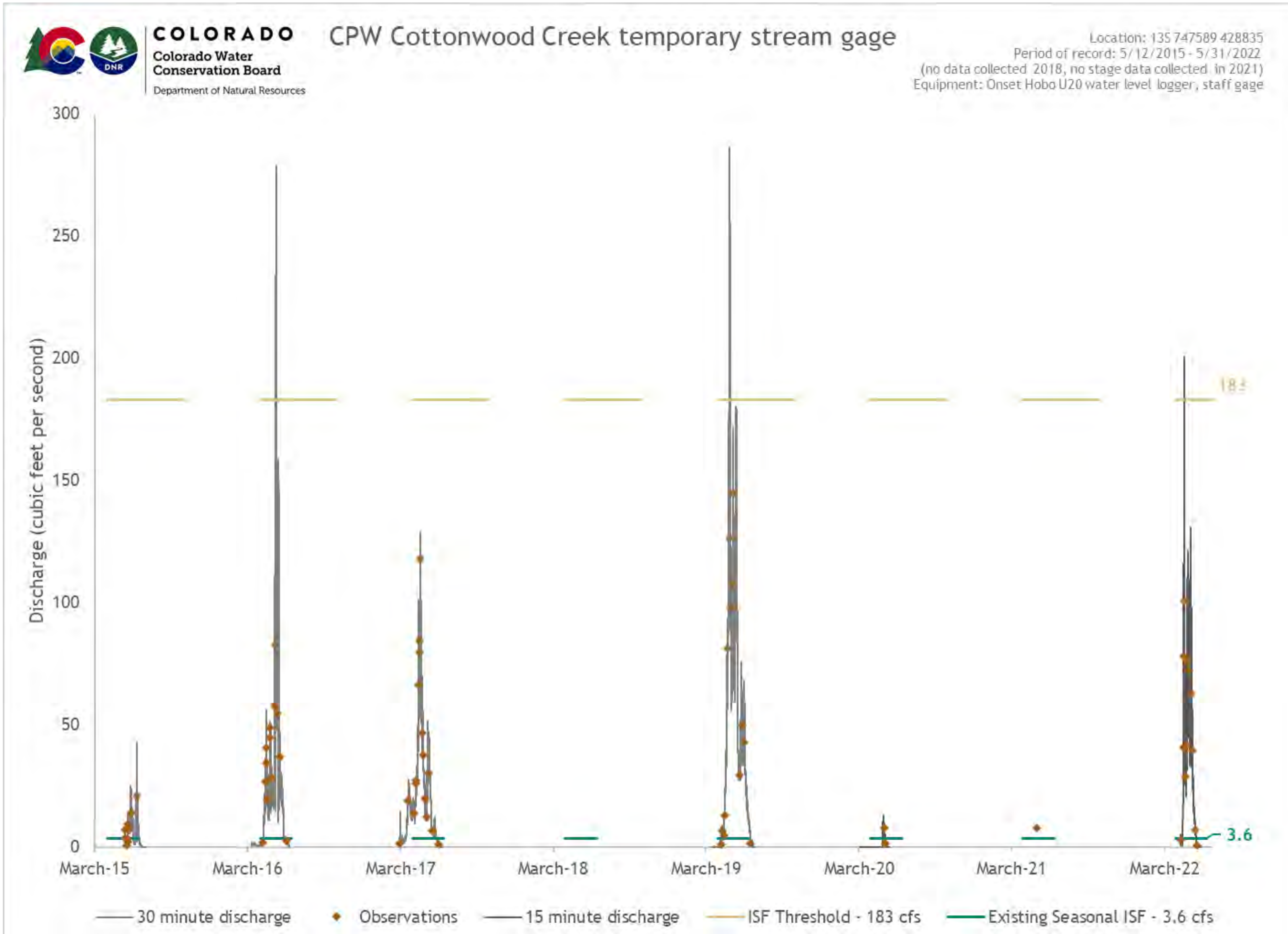
LAND OWNERSHIP MAP



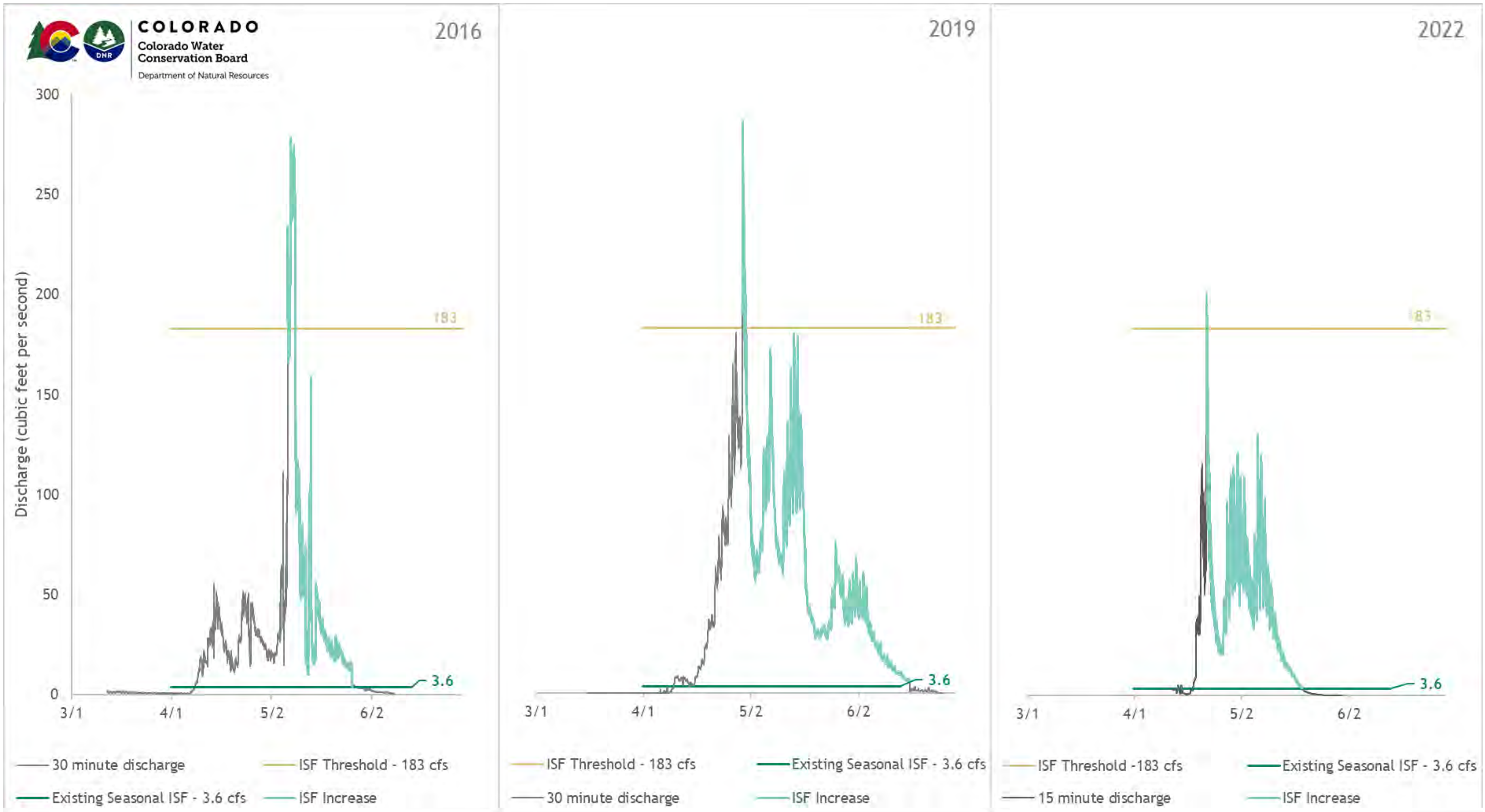
HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



DETAILED HYDROGRAPHS



Monitor Creek Executive Summary

CWCB STAFF INSTREAM FLOW RECOMMENDATION
March 15-16, 2023

UPPER TERMINUS:	confluence with Little Monitor Creek at UTM North: 4270075.83 UTM East: 212258.00
LOWER TERMINUS:	confluence Potter Creek at UTM North: 4279535.32 UTM East: 220671.03
WATER DIVISION:	4
WATER DISTRICT:	40
COUNTY:	Montrose
WATERSHED:	Lower Gunnison
CWCB ID:	18/4/A-008
RECOMMENDER:	Bureau of Land Management (BLM)
LENGTH:	8.29 miles
(Pending) ISF	4.6 cfs (4/1 – 5/31), 3.6 CFS (6/1 - 6/30) Status: CWCB formed intent to appropriate in January 2023
INCREASE ISF FLOW RECOMMENDATION:	ISF protection initiates at 111 cfs and protects all unappropriated streamflow until flow rates recede to the pending ISF (see above) of 3.6 cfs if outside of these times or 9/30, whichever occurs first. This flow protection will only be in effect 4/1 - 9/30 if the 111 cfs threshold is reached.

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

INTRODUCTION

Colorado's General Assembly created the Instream Flow and Natural Lake Level Program in 1973, recognizing "the need to correlate the activities of mankind with some reasonable preservation of the natural environment" (see 37-92-102 (3), C.R.S.). The statute vests the Colorado Water Conservation Board (CWCB or Board) with the exclusive authority to appropriate and acquire instream flow (ISF) and natural lake level water rights (NLL). Before initiating a water right filing, the Board must determine that: 1) there is a natural environment that can be preserved to a reasonable degree with the Board's water right if granted, 2) the natural environment will be preserved to a reasonable degree by the water available for the appropriation to be made, and 3) such environment can exist without material injury to water rights.

The information contained in this Executive Summary and the associated supporting data and analyses form the basis for staff's ISF recommendation to be considered by the Board. This Executive Summary provides sufficient information to support the CWCB findings required by ISF Rule 5i on natural environment, water availability, and material injury. Additional supporting information is located at: https://cwcb.colorado.gov/2023-isf-recommendations.

RECOMMENDED ISF REACH

BLM recommended that the CWCB appropriate an increase to an existing ISF water right on a reach of Monitor Creek. Monitor Creek is located within Montrose County and is approximately 24 miles west of the City of Montrose (See Vicinity Map). The stream originates on the east side of the Uncompahgre Plateau and flows northeast until it reaches the confluence with Potter Creek, which is a tributary to Roubideau Creek and the Gunnison River. In January 2023, the CWCB board formed its intent to appropriate an ISF water right on Monitor Creek to protect aquatic habitat. The pending ISF is seasonal due to limited water availability and has the following flow rates 4.6 cfs (4/1 – 5/31) and 3.6 CFS (6/1 - 6/30). The proposed reach for this recommendation extends from the confluence with Little Monitor Creek downstream to the confluence with Potter Creek for a total of 8.29 miles. The entire proposed reach is on BLM public land (See Land Ownership Map).

BACKGROUND

The BLM found Monitor Creek suitable for inclusion in the National Wild and Scenic Rivers System based in part on the presence of rare riparian communities that qualified as outstandingly remarkable values (ORVs; BLM, 2020). An ORV is defined as a river-related value that is unique, rare, or exemplary, when compared to the other streams in the region. This finding was informed by surveys conducted by the Colorado Natural Heritage Program[1] (CNHP) that determined that Monitor Creek contained rare plant communities that warranted conservation (Damm and Stevens, 2000; Stephens et al., 1999). On Monitor Creek, CNHP identified riparian communities that are rarely found in the same habitat.

[1] The Colorado Natural Heritage Program is Colorado's only comprehensive source of information on the status and location of Colorado's rarest and most threatened species and plant communities. CNHP is a non-academic department of the Warner College of Natural Resources at Colorado State University. It is also a member of the NatureServe Network, "which is an international network of partners that use the same scientific methodology to enable scientists to monitor the status of species and natural plant communities from state, national, and global perspectives."

Although BLM recognized that Monitor Creek will have some ISF protection based on the pending ISF, the suitability determination specifically noted that the current lack of flow protection for globally significant riparian values was a significant factor driving BLM's suitability determination. The Final Resource Management Plan for BLM's Uncompahgre Field Office stated that if scientific studies conclude that if alternative forms of flow protection are in place and are sufficient to fully protect the flow-related ORVs on Monitor and Potter Creeks, the BLM will determine it is unnecessary to quantify, assert, or adjudicate a federal reserved water right for these segments if they are ultimately designated into the National Wild and Scenic River System.

At the request of the CWCB, BLM developed a concept to preserve the riparian communities of these streams using the ISF program. The proposed ISF is based on protecting high-flow events and the falling limb of the hydrograph which create the conditions necessary for seedlings to survive and sustain the population of the riparian community. This ISF increase would only be active during the primary growing season and only when flows are sufficiently high to provide benefits to the riparian community. At other times, the pending ISF would continue to provide some flow protection for aquatic habitat.

OUTREACH

Stakeholder input is a valued part of the CWCB staff's analysis of ISF recommendations. Currently more than 1,100 people subscribe to the ISF mailing list. Notice of the potential appropriation of an ISF water right on Monitor Creek was sent to the mailing list in March 2017, March 2018, March 2019, November 2019, March 2020, November 2020, March 2021, November 2021, March 2022, and November 2022. Staff sent letters to identified landowners adjacent to Monitor Creek based on information from the county assessors' website. A public notice about this recommendation was also published in the Montrose Daily Press on December 21, 2022.

Staff presented information about the ISF program and this recommendation to the Montrose County Board of County Commissioners on October 3, 2017, December 9, 2019, and November 22, 2022. In addition, staff spoke with State Engineer Kevin Rein on June 6, 2017, and with State Engineer Kevin Rein and Deputy State engineer Tracy Kosloff on October 9, 2020 regarding the administrability of this ISF recommendation. Staff also communicated with Bob Hurford, Division Four Engineer and Luke Reschke, Lead Water Commissioner several times regarding water rights and water use practices on Monitor Creek.

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. Please see BLM's letter of recommendation which includes more detailed information about the plant communities, riparian flow needs, and importance of protecting the riparian communities.

Riparian Community

Monitor Creek starts near Columbine Pass on the Uncompahgre Plateau, it descends through forested lands before carving a gradually deepening canyon. The valley floor contains a wide riparian corridor. CNHP surveys found that Monitor Creek supports a healthy riparian plant community that is part of the Rocky Mountain Lower Montane-Foothills Riparian Woodland and Shrubland Ecological System (Stephens et al., 1999).

Specifically, Monitor Creek contains a population of apparently secure narrowleaf cottonwood and red osier dogwood (*Populus angustifolia/Cornus sericea*) riparian forest (Figure 1). Narrowleaf cottonwoods are members of the willow family that can grow up to 80 feet in height. Red osier dogwoods are woody deciduous shrub that can grow up to 20 feet in height. Monitor Creek also includes extensive acreage of other non-imperiled riparian communities and species, that were noted by CNHP to be in very good condition. These include a community of coyote willow (*Salix exigua*) and mesic garminoids western wet shrubland, as well as Fremont cottonwood (*Populus deltoides ssp. Wislizenii*), three square bulrush (*Schoenoplectus pungens*), Drummond's willow (*Salix drummondiana*), blue spruce (*Picea pungens*), and aspen (*Populus tremuloides*) (Damm and Stevens, 2000; Stephens et al., 1999).

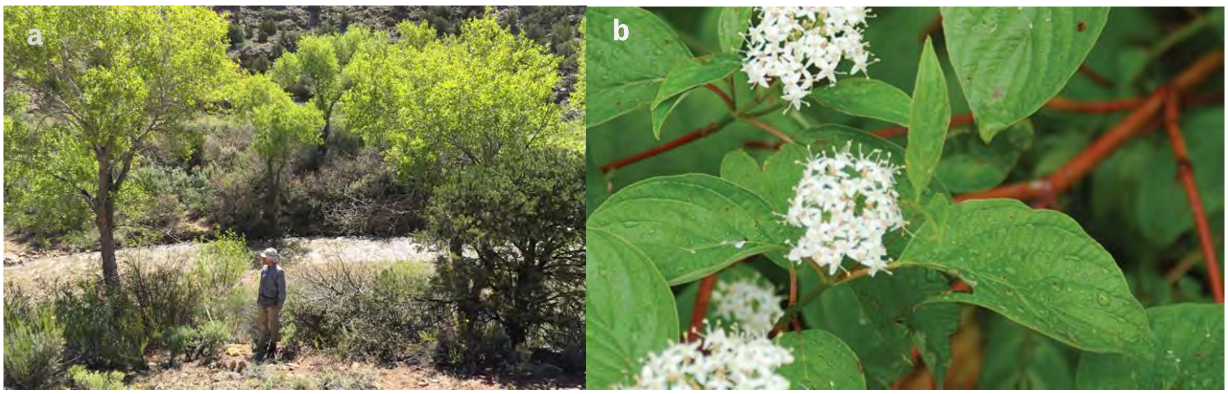


Figure 1. Images of species in the Monitor Creek riparian area. a) narrowleaf cottonwood and b) red osier dogwood

The combination of narrowleaf cottonwood and red osier dogwood is rated by CNHP as both globally and state apparently secure, which is defined as being quite rare in parts of its range with around 100 occurrences of these communities in the world (Stephens et al., 1999). Even though populations of narrowleaf cottonwood and populations of red osier dogwood are widely distributed, these species are rarely found growing in the same location because of their different habitat needs which are rarely met simultaneously.

Monitor Creek is a tributary to Potter Creek, which supports five globally imperiled riparian communities that are either vulnerable or imperiled within the state. BLM believes that given similar hydrology and soils along the two creeks, it is very likely that these vulnerable riparian communities also exist in the lower reaches of Monitor Creek near the confluence with Potter Creek and that they may exist in higher elevation portions of Monitor Creek. These communities include narrowleaf cottonwood/strapleaf willow/silver buffaloberry (*Populus angustifolia/ Salix ligulifolia/Shepherdia argentea) riparian forest,* narrowleaf cottonwood/skunkbush sumac (*Populus angustifolia/Rhus trilobata*) riparian forest, narrowleaf cottonwood/Douglas fir (*Populus angustifolia/ Pseudotsuga menziesii*) riparian woodland, Douglas fir/red osier dogwood (*Pseudotsuga menziesii/Cornus sericea*) riparian woodland, and narrowleaf cottonwood/red osier dogwood (*Populus angustifolia/Cornus sericea*) riparian woodland.

CNHP included Monitor Creek as one of 25 wetland and riparian sites within Ouray and eastern Montrose counties that most merit conservation efforts and as one of four areas of local significance based on its ecosystem functions and values (Stephens et al., 1999). Both CNHP and BLM found Monitor Creek to have high biodiversity with the riparian community in good condition, few non-native species, and minimal anthropogenic disturbance. CNHP ranked Monitor Creek biodiversity as having very high significance with one of the best examples of a community type, good occurrence of globally critically imperiled species, or an excellent occurrence of a globally imperiled or vulnerable species.

CNHP designated the Monitor Creek watershed as part of the Roubideau Potential Conservation Area (PCA) because highly functioning riparian areas with an intact assemblage of historic native species are so rare in the Uncompahgre River basin. PCAs focus on capturing the ecological processes necessary for the continued existence of plants or plant communities with natural heritage significance. PCAs are meant to be used for conservation planning purposes but have no legal status. CHNP states that, “the Roubideau Creek Conservation PCA merits special status, such as designation as a BLM Area of Critical Environmental Concern (ACEC) or Research Natural Area.” (Stephens et al., 1999)

Riparian communities are important because they provide many critical hydrologic, watershed, and ecosystem functions (Stephens et al., 1999). Hydrologically, riparian areas can help mitigate the impacts of floods by reducing water velocity and attenuating peak flows. They also stabilize streambanks and prevent erosion and unraveling of the channel during high-flow events. Heavily vegetated riparian corridors provide biogeochemical functions of filtering out sediment and toxins. Riparian communities directly support wildlife by providing diverse habitat types including forest, dense scrub, and shrub. In semi-arid regions of the western United States, an estimated 80% of mammals, birds, reptiles, and amphibians use riparian areas and wetlands for habitat throughout the year or as migratory rest stops (Somers and Floyd-Hanna, 1996). The riparian corridor also provides shade to reduce water temperatures and organic matter which provides habitat and food for the aquatic ecosystem.

Preserving the riparian corridor in Monitor Creek is warranted to preserve a rare riparian community that provides important functions including maintaining overall system resiliency. This riparian community is uniquely adapted to the Uncompahgre Plateau which includes extremes of high and low streamflow conditions in a semi-arid region. These diverse riparian communities of native species are well adapted to their location and are better able to withstand environmental stresses and catastrophic events. When a watershed is more resilient, it is better able to rebound following disturbances such as severe storms, flooding, landslides, mudslides, and wildfires. Resiliency also mitigates the impact of those disturbances on the surrounding communities, which improves outcomes for both people and ecosystems.

Native Fish

Although not the primary basis for the proposed ISF, Monitor Creek also provides important habitat for the three-species: Flannelmouth Suckers (*Catostomus latipinnis*), Bluehead Suckers (*Catostomus discobolus*), and Roundtail Chub (*Gila robusta*). These species are identified by the state of Colorado as Species of Greatest Conservation Need and by the BLM as sensitive species. They are also subject to a multi-state conservation agreement designed to prevent a listing of the species under the Endangered Species Act (Utah DNR, 2006).

Colorado Parks and Wildlife (CPW) has conducted extensive research on the Roubideau Creek basin including monitoring streamflow, fish sampling, and fish tracking to determine movement patterns and spawning site selection. CPW found that upwards of 25,000 fish use the Roubideau Creek drainage to spawn annually, with thousands of fish using tributaries such as Monitor Creek. Individual fish have very high annual spawning tributary fidelity in this area, with up to 77% of individuals returning to the drainage multiple years in a row (Thompson and Hooley-Underwood, 2019).

High-flow events are also important for the three-species. These species are cued to spawn when streamflow in the tributaries increases during runoff. A gradual receding flow after the spring peak supports the development of eggs, hatching, larvae development, provides habitat for juvenile fish to grow and mature, and allows adult fish to move back into larger river systems before they become stranded. These findings highlight the importance of Monitor Creek for the three-species, especially because few other accessible and flowing tributary networks remain.

ISF QUANTIFICATION

BLM staff, in conjunction with CWCB, evaluated the flow needs of the riparian communities and examined several methods to quantify the flow rates necessary to preserve the species.

Flow Needs of Riparian Communities

The BLM conducted a review of scientific literature to identify the flow regime needed to support the riparian community of Monitor Creek (See BLM's recommendation letter for additional details). Considerable research has been conducted on the hydrologic conditions necessary for establishment and persistence of cottonwood trees. Those studies conclude that the persistence of cottonwood trees as part of a riparian community is highly dependent on infrequent flood or high-flow events (Cooper et al., 1999). High-flow events create disturbed areas and wet sediment deposits where cottonwood can germinate by seed, root or branch fragment propagation (Scott et al., 1997).

Like cottonwood trees, red osier dogwood also reproduces by seed and root sprouts. Their reproduction requires soils that are saturated during the growing season. However, unlike cottonwood trees, red osier dogwood needs well-drained soils and will not tolerate long-duration high-flow events or high-water tables for long durations. The species prefers wetland margins where soils are inundated in spring but completely dry by late summer. BLM believes that the sandstone-based soils along Monitor Creek and the generally short duration of high-flow events allows these species to survive and grow interspersed with the narrowleaf cottonwoods.

In addition to high-flow events, research also concludes that slowly receding flow rates after the event are important for maintaining water levels in the alluvial aquifer. This allows the roots of new seedlings to grow and remain in contact with the receding groundwater levels in riparian soils (Mahoney and Rood, 1998). Baseflows, which occur in later summer, fall, and winter, also maintain water levels in the alluvial aquifer, supporting deep-rooted cottonwoods and willows, which both require constant access to groundwater to prevent die back of upper branches or mortality.

Because high-flow events are critical to long-term reproduction and success of the riparian community, BLM focused on identifying the flow rate that would start to inundate the riparian community. BLM identified that bankfull, which is typically the elevation where streams start to access the floodplain and riparian vegetation, was an appropriate threshold necessary to preserve the riparian community. When streamflow is at bankfull conditions or above, important processes required for the long-term survival of the plants can occur, including creating areas where wet sediment is deposited, dispersal of seeds and branches, depositing nutrients on the floodplain, and recharge of the alluvial aquifer.

Hydraulic Modeling
BLM staff explored using the U.S. Forest Service's WinXSPRO model to identify the flow rate necessary to preserve the riparian communities. After evaluating the model, BLM and CWCB staff determined that the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center's River Analysis System (HEC-RAS) would produce more reliable results. HEC-RAS is widely used throughout the United States for hydraulic modeling of floods. This model uses multiple cross-sections to perform more advanced calculations than approaches that rely on single cross-sections. It is also capable of producing maps that illustrate the portions of the channel inundated at different flows. BLM and CWCB staff concluded that results from the HEC-RAS model were more appropriate and accurate for modeling high-flows.

CWCB staff hired AECOM, an outside engineering firm, at the beginning of 2021 to collect detailed survey information and develop hydraulic models for the sites in each of the four proposed ISF reaches. CWCB Staff, BLM staff, and the AECOM surveyor selected a reach on Monitor Creek about 0.7 miles upstream from the lower terminus. This site was selected based on the presence of the riparian species of interest and channel characteristics that were conducive to modeling efforts. In each selected site, AECOM surveyed cross-sections to measure channel geometry and floodplain topography. Bankfull indicators were identified by CWCB and BLM staff at each cross-section. In addition to elevation data, the AECOM surveyor also measured the location of debris piles deposited by exceptionally large and infrequent flow events. A total of four cross-sections were surveyed on the selected reach of Monitor Creek

AECOM then developed a hydraulic model for each reach using HEC-RAS version 5.0.7 (AECOM, 2021). Manning's n values were selected based on aerial imagery and photos collected during the field survey which showed the nature of the channel, bed material, and vegetation. These values were selected in accordance with Table 3-1 in the HEC-RAS 5.0.1 Reference Manual. On Monitor Creek, the Manning's n values value in the channel was set to 0.05, the values in the floodplain were set to 0.05 and 0.07. Using an iterative process, discharge values were entered into the model to find the streamflow that best corresponded with the surveyed bankfull indicators and the lowest and highest elevation flood debris. The bankfull discharge minimized the difference between the modeled water surface elevation and the surveyed bankfull elevations.

On Monitor Creek, AECOM determined that the bankfull indicators correspond to a flow of 111 cfs (Table 1). The lower elevation flood debris corresponds to a streamflow of 1,960 cfs and the maximum elevation of the debris corresponds to a streamflow of 3,885 cfs.

Table 1. HEC-RAS modeling results for Monitor Creek.

Parameter	Discharge, cfs
Bankfull	111
Minimum elevation of flood debris	1,960
Maximum elevation of flood debris	3,885

ISF Recommendation

This recommended ISF water right is specifically structured to protect the high-flow component of the hydrologic regime that is critical to the persistence of riparian communities. This water right also protects the receding limb of the hydrograph. Protecting bankfull flows and the receding limbs of the hydrograph will provide the conditions necessary for the reproduction and maintenance of riparian communities. The BLM recommends the following flows based on modeling analyses and the biological needs of the riparian communities:

> When the flow rate reaches 111.0 cfs (bankfull flow), all flow in the creek should be protected until the flow rate recedes to the lowest flow rate associated with the pending ISF appropriation, which is the 3.6 cfs. If the threshold of 111.0 cfs is met outside of the April 1 to June 30 period associated with the recent CWCB appropriation, then flows should be protected as they recede down to a 3.6 cfs flow rate.
>
> BLM recommends that the proposed water right be in effect only during the April 1 to September 30 period, if the flow rate threshold is met. This time frame corresponds to the portion of the year when the riparian community is actively growing and reproducing and when most high-flow events occur due to snowmelt runoff and monsoonal thunderstorms. During years in which streamflow does not reach the proposed threshold, this instream flow water right for high-flow events would not be in effect.

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.). This approach focuses on streamflow and the influence of flow alterations, such as diversions, to understand how much water is physically available in the recommended reach.

Staff's hydrologic analysis is data-driven, meaning that Staff gathers and evaluates the best available data and uses the best available analysis method for that data. Whenever possible, long-term stream gage data (period of record 20 or more years) 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 to estimate a selected basin's streamflow statistics including flood discharge and frequency characteristics (Capesius and Stephens, 2009). 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.

Unlike other ISF water rights, this ISF will only be in effect when the bankfull threshold is reached and only during a limited portion of the year. This proposed ISF is not structured to occur year-round and is not expected to occur every year or even in most years. Therefore, median flow is not assessed in this analysis because the high-flow events necessary for the riparian community are not anticipated to occur on a median basis. Instead, the water availability analysis for Monitor Creek provides information about the known hydrology in the area, the available streamflow data for Monitor Creek, and the potential characteristics of these high-flow events.

Basin Characteristics

The drainage basin of the proposed ISF on Monitor Creek is 30.1 square miles, with an average elevation of 7,710 feet and average annual precipitation of 19.1 inches. Hydrology throughout the Uncompahgre Plateau demonstrates a relatively early snowmelt runoff pattern that is also influenced by monsoon and late-season storms. This results in high-flow events that can occur between early spring and early summer due to snowmelt and high-flow events that can occur between summer and late fall due to rain events. A nearby gage, Roubideau Creek at mouth near Delta, CO gage (USGS 09150500, period of record 1939 to 1953 and 1976 to 1983), shows that most annual peaks occur in May but can occur as late as October (Figure 2).

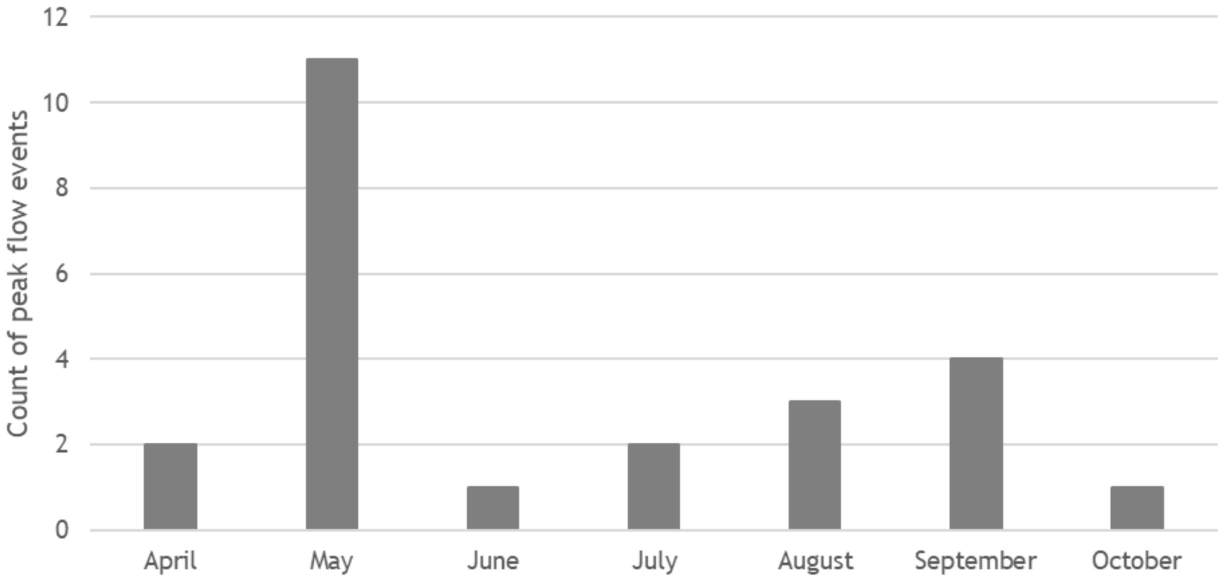


Figure 2. Number of times the peak occurred each month at the Roubideau Creek at mouth near Delta, CO peak flow gage data from 1939-1953 and 1976-1983.

Snowmelt runoff typically produces the high-flow events with the longest duration, which can last weeks to months. Rain events have potential to produce very high flows but are typically short duration events. Streamflow in this region can be highly variable, some years may have substantial flows while other years have little to no measurable flow.

Existing Water Uses

There are a number of water rights in the basin tributary to the proposed ISF on Monitor Creek. There are seven active surface water diversions upstream from the proposed upper terminus. The sum of active surface water diversions in the Monitor Creek basin is 67.13 cfs (See the Hydrologic Features Map and Detailed map). The largest of these is the Big Monitor Ditch No 1 (WDID 4001426, 51.85 cfs, appropriated in 1918). There are also 412 acre-feet in active storage rights, 0.53 cfs for a few springs and pipelines, and 0.4 cfs for well water rights. None of these water rights are known to completely dry up Monitor Creek. In addition, there are some diversions that import or export water into the Monitor basin. The Everlasting Ditch (WDID 4001435, 27 cfs, appropriated in 1901 and 1964), which diverts from Cottonwood Creek, irrigates lands in the Monitor Creek basin and may contribute additional flow. The 25 Mesa Upper Little Monitor Ditch (WDID 4001319, 7 cfs, appropriated in 1904) diverts water from Little Monitor Creek, which is used on lands in both the Monitor Creek and Cottonwood Creek basins. Based on these water uses, hydrology is altered.

Data Collection and Analysis

A number of different sources of information were used to assess hydrology in Monitor Creek. Each source will be presented in subsections for clarity.

Representative Gage Data

There are no current or historic streamflow gages on Monitor Creek. No representative gages on nearby streams were identified due to a general lack of gages in the region and the high level of water use in the nearest streams with gages.

CWCB Gage and Staff Measurements

CWCB staff installed a temporary gage on Monitor Creek approximately 150 feet upstream from the confluence with Potter Creek. This gage operated from 6/8/2017 through the present and data was processed through 6/30/2022. There are several data gaps in the record due to equipment failures, disruptions to gage maintenance due to COVID-19, and high-flow events that dislodged equipment The effect of upstream water uses in the basin are reflected in the gage record. Streamflow measurements collected to maintain this gage as well as other measurements made by BLM, USGS, CPW, and CWCB are included in the hydrograph.

The CWCB temporary gage data shows a wide range in streamflow between 2017 and 2022. There was little to no measured streamflow in 2018 or 2021 (although some data is missing in 2021), and just a short duration peak in 2020. Streamflow was higher in 2017, 2019, and 2022. High-flow events dislodged the gage equipment in the fall of 2017 and again in 2019 during runoff. See the complete hydrograph.

Climate Conditions

A nearby weather station was reviewed to assess how the 2017-2022 gage record compared to a longer-term record for the area. The nearest climate station with a relatively long record is at Columbine Pass (USS0008L02S, 1986 to 2022) located near the headwaters of Monitor Creek, approximately 17 miles southwest from the proposed lower terminus. Figure 3 below shows cumulative snow water equivalent (SWE) totals for 2017-2022 in comparison to the 30-year average (downloaded from the Colorado River Basin Forecast Center on 12/19/2022). Peak SWE in 2018 was the lowest on record, 2020 and 2021 were below average, and 2017, 2019, and 2022 were above average. This information demonstrates a range of precipitation in the area during the CWCB gage record.

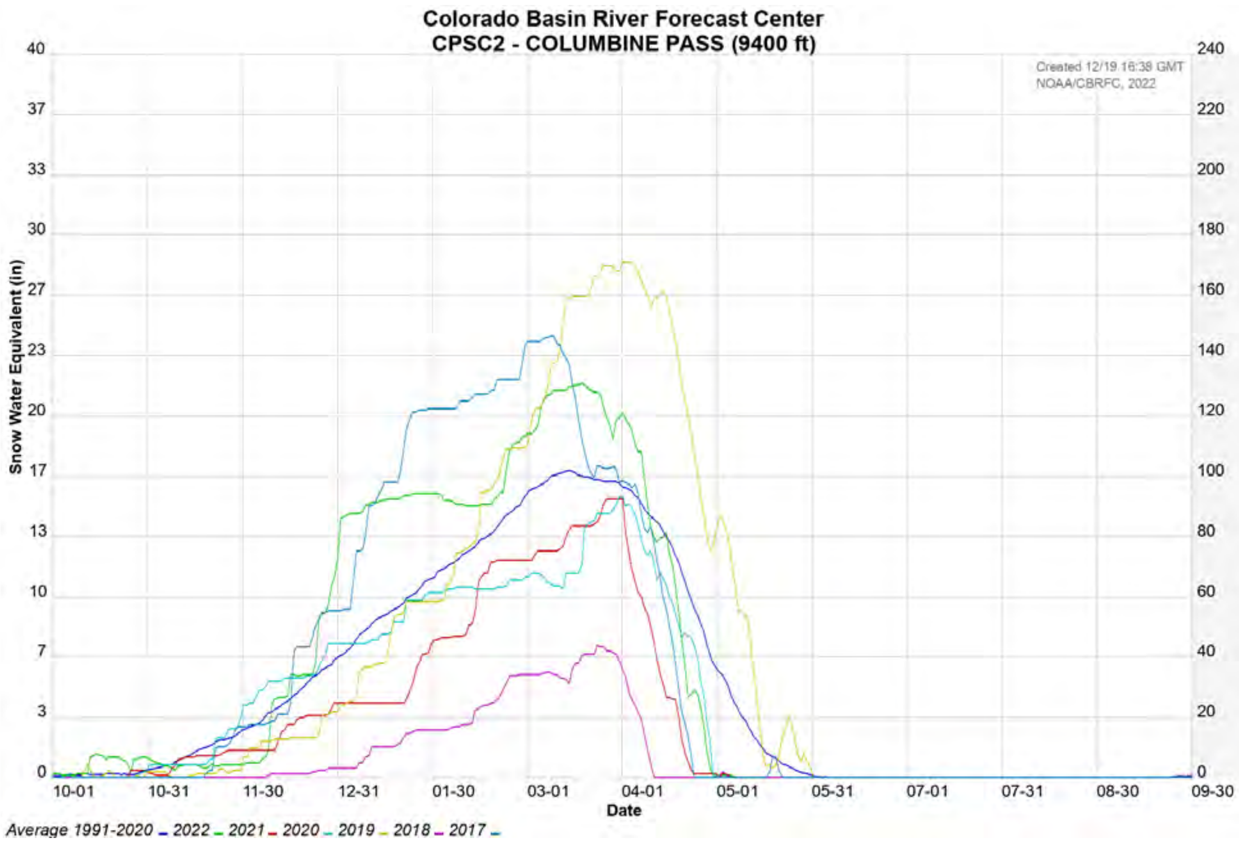


Figure 3. Cumulative SWE for 2014 to 2022 and median SWE from 1991 to 2020 downloaded from the Colorado River Basin Forecast Center on 12/19/2022. Source: NOAA Colorado Basin River Forecast Center

Staff also evaluated streamflow gages to better understand potential streamflow given that persistent low soil moisture in recent years has impacted how much snowfall becomes streamflow. The Dallas Creek gage and the San Miguel gage (USGS 09147000 Dallas Creek near Ridgway and USGS 0917700 San Miguel River at Uravan) were selected because they were reasonably close to the Uncompahgre Plateau. The gages are not impacted by large reservoirs; however, they are in different basins and have significant water uses. Years with complete data (provisional or approved data, filling missing data in 2022 with the long-term average) from 1992 to 2022 were used to calculate annual water volumes and basic percentiles. Data from these gages show that 2019 was very wet (greater than 75th percentile); 2017 was wet or wettest (greater than the 50th percentile for the San Miguel River and greater than 75th percentile for Dallas Creek); 2018, 2020, 2021, and 2022 were in the driest category (less than 25th percentile). 2018 and 2020 were exceptionally dry with annual water volumes less than the 10th percentile. Therefore, the CWCB gage data contains a range of year types, but many years in the record are likely to reflect dry or exceptionally dry conditions.

High-Flow Characteristics

The ISF recommendation is based on the importance of high-flow events that help to maintain the rare riparian community on Monitor Creek. Based on the available information from the

CWCB gage, riparian flows would have been achieved in three of the six years the gage operated, with four separate events as shown in Table 2 and Figure 4. Two of the events were very short duration, lasting less than a day. Two of the events were longer, lasting as much as 38 days in 2022. During the 2019 event, there is a gap in the gage record between 4/19 and 5/15 when data is not available. Because streamflow on either side of the gap reached the threshold flow rate of 111, staff assumed that flow rates remained high until they dropped rapidly to the pending ISF flow rates on 5/21 which would have ended riparian protection for that event. After 5/21 the flows increased significantly but would not have been protected as part of the proposed ISF, and only the pending ISF would have been in effect. In 2018, 2020, and 2021, the conditions to initiate the proposed ISF did not occur.

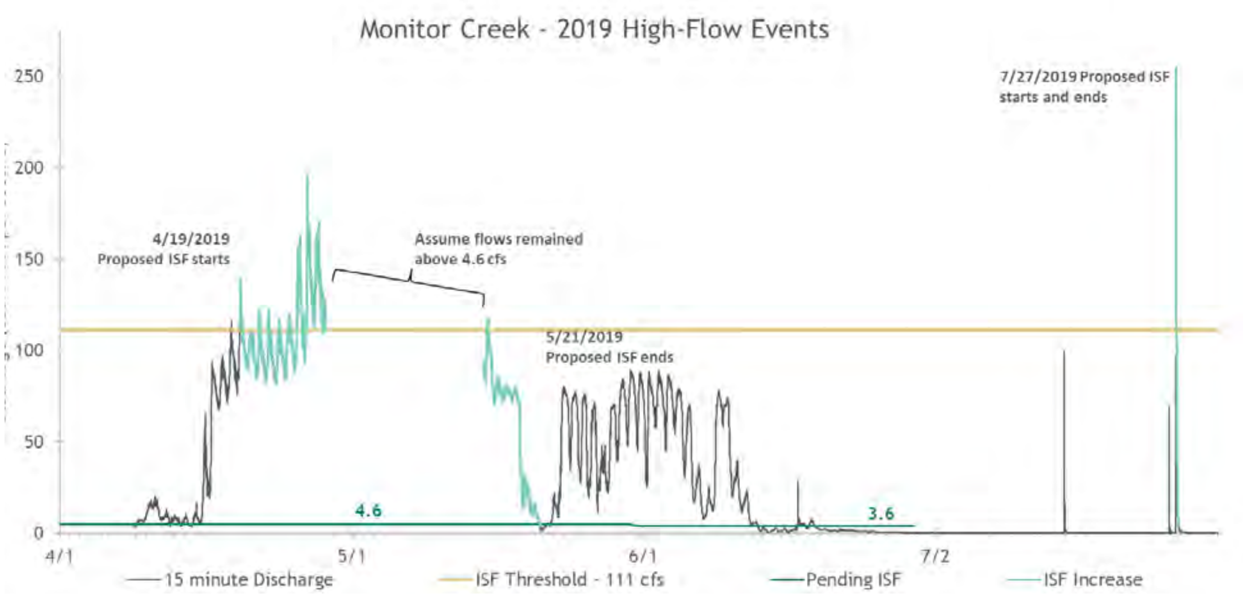


Figure 4. Hydrograph from the CWCB Monitor Creek gage showing streamflow in 2019 and times when the proposed ISF would be active.

Table 2. Duration and maximum streamflow for high-flow events that reached the bankfull threshold or higher in Monitor Creek (2017-2022).

Start Date	End Date	Duration (time)	Maximum flow (cfs)	Data Source
7/20/2017	7/20/2017	5 hours	221	CWCB gage
4/19/2019	5/21/2019	31 days	196	CWCB gage
7/27/2019	7/27/2019	6 hours	255	CWCB gage
4/20/2022	5/28/2022	38 days	121	CWCB gage

The USGS StreamStats model estimates different peak flow statistics based on regional regression analysis (Table 3). These estimates provide some information about the potential frequency of high-flow events, but the estimates may have high uncertainty in this area due to the lack of streamflow gages in the region that can be used to inform the models. Nevertheless, these estimates suggest that the bankfull threshold of 111 cfs could occur at the frequency of about a 2-year peak flood event.

Table 3. StreamStats estimates of area-averaged high-flow statistics for Monitor Creek.

Peak Flow Statistic	Estimated Flow, cfs
2 Year Peak Flood	98.5
5 Year Peak Flood	177
10 Year Peak Flood	237
25 Year Peak Flood	336
100 Year Peak Flood	520

Historical High-Flow Event Estimates

AECOM surveyed the location of large piles of woody debris deposited by previous very infrequent high-flow events on the floodplain of the modeled stream site. The HEC-RAS model was used to estimate the flow necessary to reach the locations of the debris piles. This modeling work estimated that a flow of 1,960 cfs would reach the minimum elevation of the debris. The BLM estimated that some of the debris piles were deposited within the last ten years. BLM staff are also aware of a substantial event that occurred in 2006 (Figure 5; Jedd Sondergard, BLM staff, personal communication on 4/6/2021). The observation of large piles of debris on the floodplain demonstrates that very high-flow events do occur and that these events can inundate large portions of the floodplain. The StreamStats peak flow statistics estimate that an event capable of reaching the lower elevation flood debris would likely occur very infrequently, at more than a 100-year event.

Figure 5. Photograph showing evidence of a high-flow event that pushed over vegetation on the floodplain in 2006.

Water Availability Summary

The available CWCB gage data, the AECOM high-flow estimates from flood debris, and StreamStats estimates of peak flow events provide an estimate of the range of streamflow conditions on Monitor Creek. These data demonstrate that high-flow events above the bankfull threshold of 111 cfs have occurred on Monitor Creek, although they do not occur every year. Staff concludes that water is available for the ISF appropriation as structured.

MATERIAL INJURY

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

ADDITIONAL INFORMATION

Citations

AECOM, 2021, Cottonwood, Monitor, and Potter Creek's survey and hydraulics. Memo to CWCB.

Bureau of Land Management, 2020, Record of decision and approved resource management plan for Uncompahgre Field Office, 2020.

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

Colorado Natural Heritage Program, Rocky Mountain lower montane-foothills riparian woodland and shrubland.
https://cnhp.colostate.edu/projects/ecological-systems-of-colorado/details/?elementID=365200

Cooper D.J., Merritt, D.M., Anderson, D.C. and Chimner, R.A, 1999, Factors controlling the establishment of Fremont cottonwood seedlings on the Upper Green River, USA. Regulated Rivers: Research and Management, 15:419-440.

Damm, M., and J. Stevens, 2000, Assessment of riparian vegetation and wildlife habitat structure: North Fork of the Gunnison tributaries and lower Gunnison tributaries. Colorado Natural Heritage Program.

Mahoney, J.M. and S.B. Rood, 1998, Streamflow requirements for cottonwood seedling recruitment- an integrative model. Wetlands, 18; 634-645.

Scott, M.L., Auble, G.T., and Friedman, J.M.,1997, Flood dependency of cottonwood establishment along the Missouri River, Montana, USA. Ecological Applications, 7:677-690.

Somers, P. and L. Floyd-Hanna, 1996, Wetlands and riparian habitats, and rivers. In Blair, R., ed. pp. 175-192. The western San Juan Mountains: their geology, ecology, and human history. University Press of Colorado, Niwot, CO.

Stephens, T., D. Culver, J. Zoern, and P. Lyon, 1999, A natural heritage assessment of wetlands and riparian areas in Uncompahgre River basin: Eastern Montrose and Ouray Counties Volume II. Colorado Natural Heritage Program.

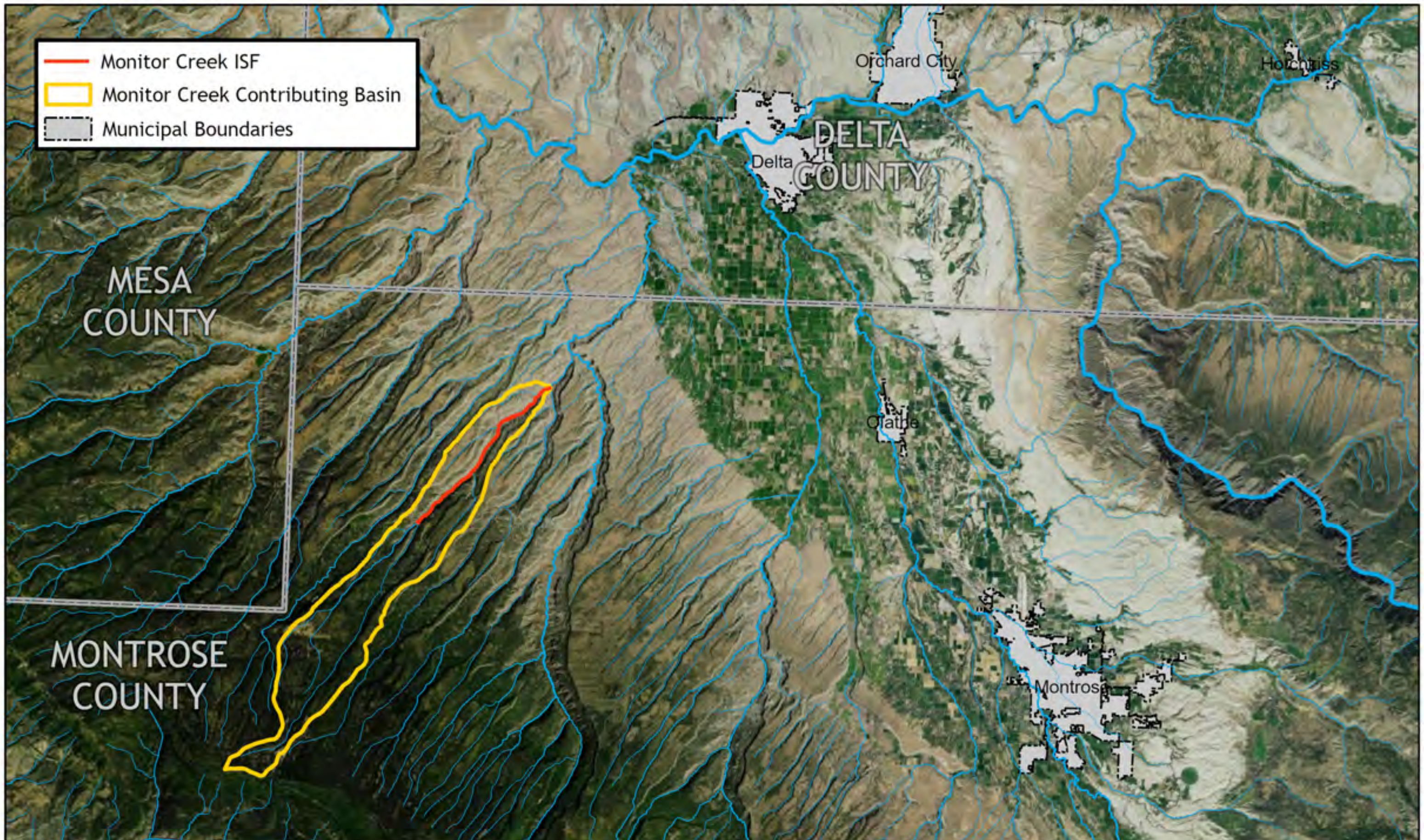
Thompson, K.G., and Z.E. Hooley-Underwood, 2019, Present distribution of three Colorado River basin native non-game fishes, and their use of tributaries. Technical publication No. 52, Colorado Parks and Wildlife Aquatic Research Section.

Utah Department of Natural Resources, Division of Wildlife Resources, 2006, Range-wide conservation agreement and strategy for Roundtail Chub *Gila robusta*, Bluehead Sucker *Catostomus discobolus*, and Flannelmouth Sucker *Catostomus latipinnis*.

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.



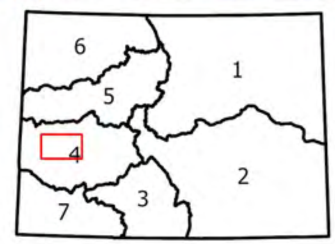
COLORADO

Colorado Water Conservation Board

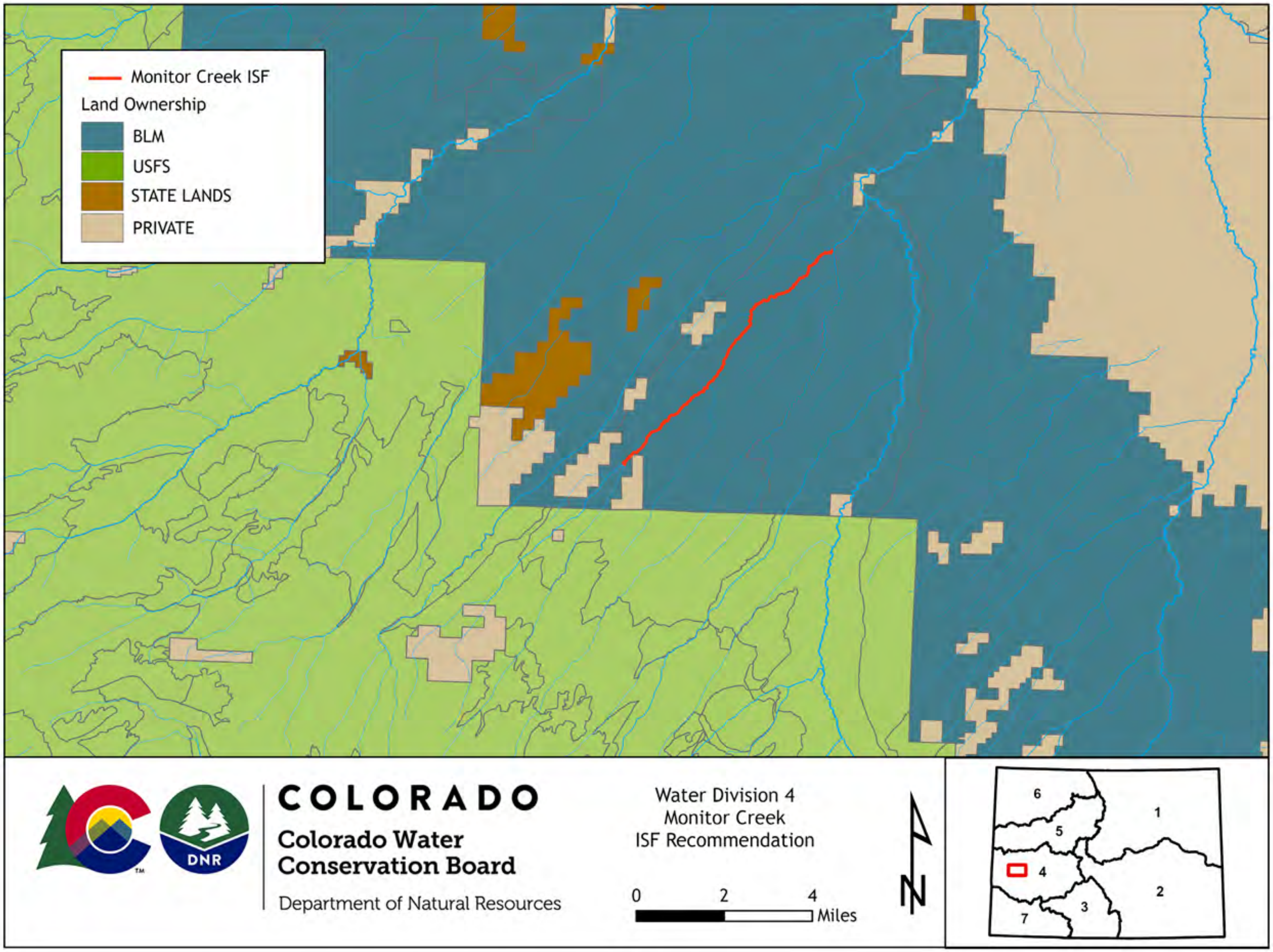
Department of Natural Resources

Water Division 4
Monitor Creek ISF Recommendation

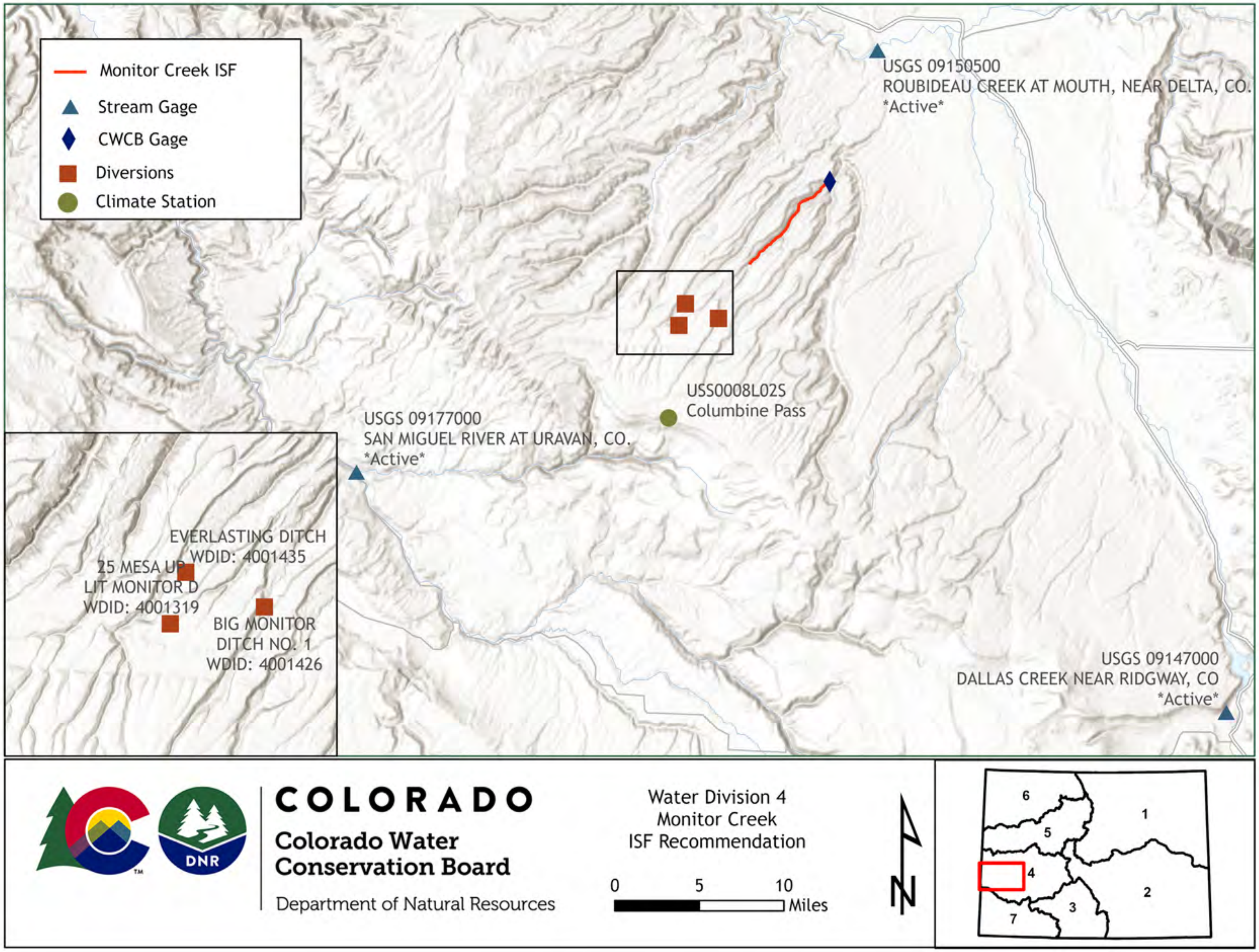
0 5 10 Miles



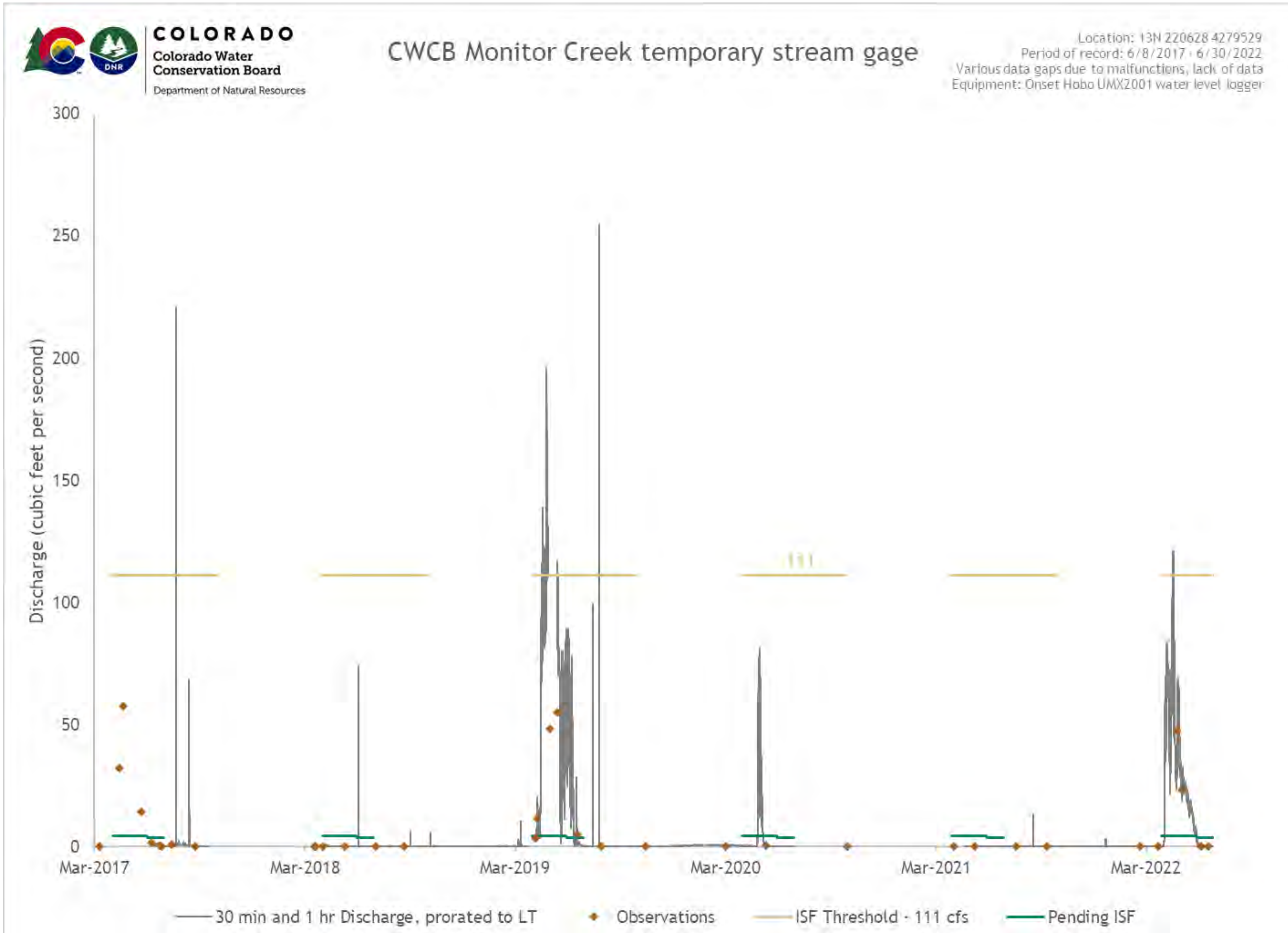
LAND OWNERSHIP MAP



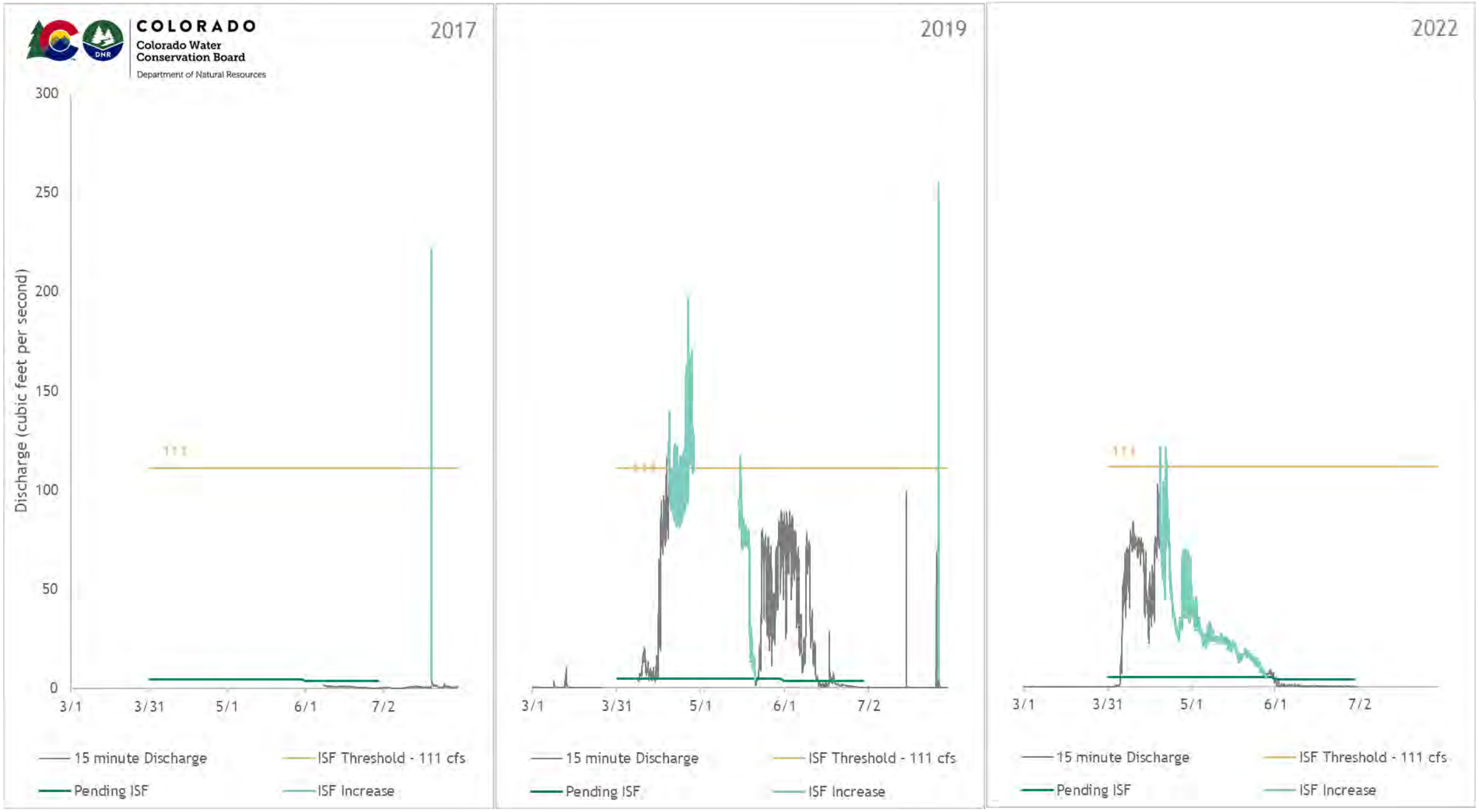
HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



DETAILED HYDROGRAPHS



Potter Creek (upper) Executive Summary

CWCB STAFF INSTREAM FLOW RECOMMENDATION
March 15-16, 2023

UPPER TERMINUS:	USFS Property Boundary UTM North: 4269972.26 UTM East: 216078.92
LOWER TERMINUS:	confluence with Monitor Creek UTM North: 4279535.32 UTM East: 220671.03
WATER DIVISION:	4
WATER DISTRICT:	40
COUNTY:	Montrose
WATERSHED:	Lower Gunnison
CWCB ID:	18/4/A-004
RECOMMENDER:	Bureau of Land Management (BLM)
LENGTH:	8.1 miles
EXISTING ISF:	04CW0161, 4 cfs (4/1-6/15), 1.8 cfs (6/16-7/31), 1.4 cfs (8/1-2/29), 1.8 cfs (3/1-3/31)
INCREASE FLOW RECOMMENDATION:	ISF protection initiates at 177 cfs and protects all unappropriated streamflow until flow rates recede to the existing ISF (see above) or until 9/30, whichever occurs first. The flow protection will only be in effect 4/1 – 9/30 if the 177 cfs threshold is reached.

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Department of Natural Resources

INTRODUCTION

Colorado's General Assembly created the Instream Flow and Natural Lake Level Program in 1973, recognizing "the need to correlate the activities of mankind with some reasonable preservation of the natural environment" (see 37-92-102 (3), C.R.S.). The statute vests the Colorado Water Conservation Board (CWCB or Board) with the exclusive authority to appropriate and acquire instream flow (ISF) and natural lake level water rights (NLL). Before initiating a water right filing, the Board must determine that: 1) there is a natural environment that can be preserved to a reasonable degree with the Board's water right if granted, 2) the natural environment will be preserved to a reasonable degree by the water available for the appropriation to be made, and 3) such environment can exist without material injury to water rights.

The information contained in this Executive Summary and the associated supporting data and analyses form the basis for staff's ISF recommendation to be considered by the Board. This Executive Summary provides sufficient information to support the CWCB findings required by ISF Rule 5i on natural environment, water availability, and material injury. Additional supporting information is located at: https://cwcb.colorado.gov/2023-isf-recommendations.

RECOMMENDED ISF REACH

The BLM recommended that the CWCB appropriate an increase to an existing ISF water right on a reach of Potter Creek. Potter Creek is located within Montrose County (See Vicinity Map) and is approximately 11 miles southwest from City of Delta. The stream originates on the east side of the Uncompahgre Plateau and flows northeast until it reaches the confluence with Roubideau Creek which is a tributary to the Gunnison River. The existing ISF water right on Potter Creek was appropriated in 2004 for the following flow rates and times; 4 cfs (4/1-6/15), 1.8 cfs (6/16-7/31), 1.4 cfs (8/1-2/29), 1.8 cfs (3/1-3/31). The proposed reach extends from the U.S. Forest Service Property Boundary downstream to the confluence with Monitor Creek for a total of 8.1 miles. The entire proposed reach is on public land managed by the BLM (See Land Ownership Map).

BACKGROUND

The BLM found upper Potter Creek suitable for inclusion in the National Wild and Scenic Rivers System based in part on the presence of rare riparian communities that qualified as outstandingly remarkable values (ORVs; BLM, 2020). This finding was informed by surveys conducted by the Colorado Natural Heritage Program (CNHP)[1] that determined that Potter Creek contained rare plant communities that warranted conservation (Damm and Stevens, 2000; Stephens et al., 1999). On Potter Creek, CNHP identified five imperiled and vulnerable riparian populations that are rarely found in the same habitat.

Although BLM recognized that Potter Creek has some ISF protection, the suitability determination specifically noted that the current lack of flow protection for globally significant riparian values was a significant factor driving BLM's suitability determination. The Final

[1] The Colorado Natural Heritage Program is Colorado's only comprehensive source of information on the status and location of Colorado's rarest and most threatened species and plant communities. CNHP is a non-academic department of the Warner College of Natural Resources at Colorado State University. It is also a member of the NatureServe Network, "which is an international network of partners that use the same scientific methodology to enable scientists to monitor the status of species and natural plant communities from state, national, and global perspectives."

Resource Management Plan for BLM's Uncompahgre Field Office stated that if scientific studies conclude that alternative forms of flow protection are in place and are sufficient to fully protect the flow-related ORVs on Monitor and Potter Creeks, the BLM will determine it is unnecessary to quantify, assert, or adjudicate a federal reserved water right for these segments if they are ultimately designated into the National Wild and Scenic River System.

At the request of the CWCB, BLM developed a concept to preserve the riparian communities of these streams using the ISF program. The proposed ISF is based on protecting high-flow events and the falling limb of the hydrograph which create the conditions necessary for seedlings to survive and sustain the population of the riparian community. This ISF increase would only be active during the primary growing season and only when flows are sufficiently high to provide benefits to the riparian community. At other times, the existing ISF would continue to provide some flow protection for aquatic habitat.

OUTREACH

Stakeholder input is a valued part of the CWCB staff's analysis of ISF recommendations. Currently, more than 1,100 people subscribe to the ISF mailing list. Notice of the potential appropriation of an ISF water right on Potter Creek was sent to the mailing list in November 2022, March 2022, November 2021, March 2021, November 2020, March 2020, November 2019, March 2019, March 2018, and March 2017. No private landowners were identified as being adjacent to this reach of Potter Creek. A public notice about this recommendation was published in the Montrose Daily Press on January 8, 2022 and December 21, 2022.

Staff presented information about the ISF program and this recommendation to the Montrose County Board of County Commissioners on October 3, 2017, December 9, 2019, and November 21, 2022. In addition, staff spoke with State Engineer Kevin Rein on June 6, 2017, and with State Engineer Kevin Rein, and Deputy State Engineer Tracy Kosloff on October 9, 2020 regarding the administrability of this ISF recommendation. Staff also communicated with Bob Hurford, Division Four Engineer and Luke Reschke, Lead Water Commissioner regarding water rights and water use practices on Potter Creek.

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. Please see BLM's letter of recommendation which includes more detailed information about the plant communities, riparian flow needs, and the importance of protecting the riparian communities.

Riparian Community

Potter Creek starts near Columbine Pass on the Uncompahgre Plateau, it descends through forested lands before carving a gradually deepening canyon. The valley floor contains a wide riparian corridor. CNHP surveys found that Potter Creek supports a healthy riparian plant community that is part of the Rocky Mountain Lower Montane-Foothills Riparian Woodland and Shrubland Ecological System (CNHP website).

Specifically, Potter Creek contains five rare, imperiled communities:

- A population of narrowleaf cottonwood, strapleaf willow, and silver buffaloberry (*Populus angustifolia/ Salix ligulifolia/Shepherdia argentea*) riparian forest
- A population of narrowleaf cottonwood and skunkbush sumac (*Populus angustifolia/Rhus trilobata*) riparian forest
- A population of narrowleaf cottonwood and Douglas fir (*Populus angustifolia/ Pseudotsuga menziesii*) riparian woodland
- A population of Douglas fir and red osier dogwood (*Pseudotsuga menziesii/Cornus sericea*) riparian woodland
- A population of narrowleaf cottonwood and red osier dogwood (*Populus angustifolia/Cornus sericea*) riparian woodland

Narrowleaf cottonwoods (Figure 1) are members of the willow family that can grow up to 80 feet in height. Strapleaf willows are deciduous shrubs that can grow up to six feet in height. Silver buffaloberry are deciduous, thicket-forming shrubs that are drought-hardy and can grow up to 20 feet in height. Skunkbush sumac is a deciduous, flowering shrub, averaging four feet in height. Douglas firs are evergreen pines that can grow to between 70 and 330 feet in height and can reach eight feet in diameter. Red osier dogwoods are woody deciduous shrub that can grow up to 20 feet in height.

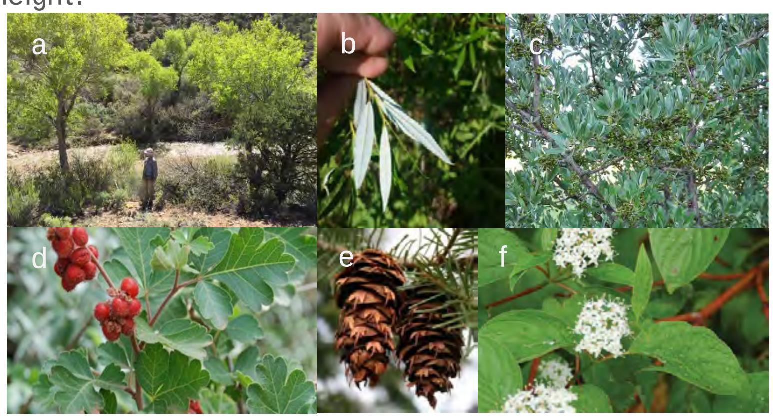


Figure 1. Images of species in the upper Potter Creek riparian area. a) narrowleaf cottonwood, b) strapleaf willow, c) silver buffaloberry, d) skunkbush sumac, e) Douglas fir, f) red osier dogwood

Potter Creek also includes extensive acreage of other non-imperiled riparian communities and species, that were noted by CNHP to be in very good condition such as Fremont cottonwood (*Populus deltoides ssp. Wislizenii*), thin leaf alder (*Alnus incana*), snowberry (*Symphoricarpos oreophilus*), Utah serviceberry (*Amelanchier utahensis*), and blue spruce (*Picea pungens*) (Damm and Stevens, 2000; Stephens et al., 1999).

The combination of narrowleaf cottonwood, strapleaf willow, and silver buffaloberry is rated by CNHP as both globally and state vulnerable, which is defined as being at moderate risk of extinction with 21 to 100 occurrences of these communities in the world (Damm and Stevens, 2000). The combination of narrowleaf cottonwood and skunkbush sumac is rated by CNHP as both globally and state vulnerable, which is defined as being at moderate risk of extinction with 21 to 100 occurrences of these communities in the world. The combination of narrowleaf cottonwood and Douglas fir is rated by CNHP as state imperiled and globally vulnerable, which is defined as being at high risk of extinction with 6 to 20 occurrences of these communities statewide and being at moderate risk of extinction with 21 to 100 occurrences of these communities in the world. The combination of Douglas fir and red osier dogwood is rated by CNHP as state imperiled and globally apparently secure, which is defined as being high risk of extinction with 6 to 20 occurrences of these communities statewide and being quite rare in parts of its range with around 100 occurrences in the world. The combination of narrowleaf cottonwood and red osier dogwood is rated by CNHP as both globally and state apparently secure, which is defined as being quite rare in parts of its range with around 100 occurrences in the world. Even though populations of these collective species are widely distributed, these species are rarely found growing in the same location as communities because of their different habitat needs which are rarely met simultaneously.

CNHP included Potter Creek as one of 25 wetland and riparian sites within Ouray and eastern Montrose counties that most merit conservation efforts and as one of four areas of local significance based on its ecosystem functions and values (Stephens et al., 1999). Both CNHP and BLM found Potter Creek to have high biodiversity with the riparian community in good condition, few non-native species, and minimal anthropogenic disturbance. CNHP ranked Potter Creek biodiversity as having very high significance with one of the best examples of a community type, good occurrence of globally critically imperiled species, or an excellent occurrence of a globally imperiled or vulnerable species.

CNHP designated the Potter Creek watershed as part of the Roubideau Potential Conservation Area (PCA) because highly functioning riparian areas with an intact assemblage of historic native species are so rare in the Uncompahgre River basin. PCAs focus on capturing the ecological processes necessary for the continued existence of plants or plant communities with natural heritage significance. PCAs are meant to be used for conservation planning purposes but have no legal status. CHNP states that, “the Roubideau Creek Conservation PCA merits special status, such as designation as a BLM Area of Critical Environmental Concern (ACEC) or Research Natural Area” (Stephens et al., 1999).

Riparian communities are important because they provide many critical hydrologic, watershed, and ecosystem functions (Stephens et al., 1999). Hydrologically, riparian areas can help mitigate the impacts of floods by reducing water velocity and attenuating peak flows. They also stabilize streambanks and prevent erosion and unraveling of the channel during high-flow events. Heavily vegetated riparian corridors provide biogeochemical functions of filtering out sediment and toxins. Riparian communities directly support wildlife by providing diverse habitat types including forest, dense scrub, and shrub. In semi-arid regions of the western United States, an estimated 80% of mammals, birds, reptiles, and amphibians use riparian areas and wetlands for habitat throughout the year or as migratory rest stops (Somers and Floyd-Hanna, 1996). The riparian corridor also provides shade to reduce water temperatures and organic matter which provides habitat and food for the aquatic ecosystem.

Preserving the riparian corridor in Potter Creek is warranted to preserve a rare riparian community that provides important functions including maintaining overall system resiliency. This riparian community is uniquely adapted to the Uncompahgre Plateau which includes extremes of high and low streamflow conditions in a semi-arid region. These diverse riparian communities of native species are well adapted to their location and are better able to withstand environmental stresses and catastrophic events. When a watershed is more resilient, it is better able to rebound following disturbances such as severe storms, flooding, landslides, mudslides, and wildfires. Resiliency also mitigates the impact of those disturbances on the surrounding communities, which improves outcomes for both people and ecosystems.

Native Fish

Although not the primary basis for the proposed ISF, Potter Creek also provides important habitat for the three-species: Flannelmouth Suckers (*Catostomus latipinnis*), Bluehead Suckers (*Catostomus discobolus*), and Roundtail Chub (*Gila robusta*). These species are identified by the state of Colorado as Species of Greatest Conservation Need and by the BLM as sensitive species. They are also subject to a multi-state conservation agreement designed to prevent a listing of the species under the Endangered Species Act (Utah DNR, 2006).

Colorado Parks and Wildlife (CPW) has conducted extensive research on in the Roubideau Creek basin including monitoring streamflow, fish sampling, and fish tracking to determine movement patterns and spawning site selection. CPW found that upwards of 25,000 fish use the Roubideau Creek drainage to spawn annually, with thousands of fish using tributaries such as Potter Creek. Individual fish have very high annual spawning tributary fidelity in this area, with up to 77% of individuals returning to the drainage multiple years in a row (Thompson and Hooley-Underwood, 2019).

High-flow events are also important for the three-species. These species are cued to spawn when streamflow in the tributaries increases during runoff. A gradual receding flow after the spring peak supports the development of eggs, hatching, larvae development, provides habitat for juvenile fish to grow and mature, and allows adult fish to move back into larger river systems before they become stranded. These findings highlight the importance of Potter Creek for the three-species, especially because few other accessible and flowing tributary networks remain.

ISF QUANTIFICATION

BLM staff, in conjunction with CWCB, evaluated the flow needs of the riparian communities and examined several methods to quantify the flow rates necessary to preserve the species.

Flow Needs of Riparian Communities

The BLM conducted a review of scientific literature to identify the flow regime needed to support the imperiled and vulnerable riparian communities of Potter Creek (See BLM's recommendation letter for additional details). Considerable research has been conducted on the hydrologic conditions necessary for establishment and persistence of cottonwood trees. Those studies conclude that the persistence of cottonwood trees as part of a riparian community is highly dependent on infrequent flood or high-flow events (Cooper et al., 1999). High-flow events create disturbed areas and wet sediment deposits where cottonwood can germinate by seed, root, or branch fragment propagation (Scott et al., 1997).

Like cottonwood trees, strapleaf willow, silver buffaloberry, skunkbush sumac, and red osier dogwood benefit from flood events. Strapleaf willow and silver buffaloberry seeds require disturbed areas and wet sediment deposits for germination and development. Skunkbush sumac and red osier dogwood also reproduce by seed and root sprouts. Sprouting occurs more frequently in response to large disturbance events such as floods. However, unlike cottonwood trees, skunkbush sumac, red osier dogwood, and silver buffaloberry need well-drained soils and will not tolerate long-duration high-flow events or high-water tables for long durations. BLM believes that the sandstone-based soils along Potter Creek and the generally short duration of high-flow events allows these species to survive and grow collectively.

In addition to high-flow events, research also concludes that slowly receding flow rates after the event are important for maintaining water levels in the alluvial aquifer. This allows the roots of new seedlings to grow and remain in contact with the receding groundwater levels in riparian soils (Mahoney and Rood, 1998). Baseflows, which occur in later summer, fall, and winter, also maintain water levels in the alluvial aquifer, supporting deep-rooted cottonwoods and willows, which both require constant access to groundwater to prevent dieback of upper branches or mortality.

Because high-flow events are critical to long-term reproduction and success of the riparian community, BLM focused on identifying the flow rate that would start to inundate the riparian community. BLM identified that bankfull, which is typically the elevation where streams start to access the floodplain and riparian vegetation, was an appropriate threshold necessary to preserve the riparian community. When streamflow is at bankfull conditions or above, important processes required for the long-term survival of the plants can occur, including creating areas where wet sediment is deposited, dispersal of seeds and branches, depositing nutrients on the floodplain, and recharge of the alluvial aquifer.

Hydraulic Modeling

BLM staff explored using the U.S. Forest Service's WinXSPRO model to identify the flow rate necessary to preserve the riparian communities. After evaluating the model, BLM and CWCB staff determined that the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center's River Analysis System (HEC-RAS) would produce more reliable results. HEC-RAS is widely used throughout the United States for hydraulic modeling of floods. This model uses multiple cross-sections to perform more advanced calculations than approaches that rely on single cross-sections. It is also capable of producing maps that illustrate the portions of the channel inundated at different flows. BLM and CWCB staff concluded that results from the HEC-RAS model were more appropriate and accurate for modeling high flows.

CWCB staff hired AECOM, an outside engineering firm, at the beginning of 2021 to collect detailed survey information and develop hydraulic models for the sites in each of the four proposed ISF reaches. CWCB Staff, BLM staff, and the AECOM surveyor selected a reach on upper Potter Creek about 0.4 miles upstream from the lower terminus. This site was selected based on the presence of the riparian species of interest and channel characteristics that were conducive to modeling efforts. In each selected site, AECOM surveyed cross-sections to measure channel geometry and floodplain topography. Bankfull indicators were identified by CWCB and BLM staff at each cross-section. In addition to elevation data, the AECOM surveyor also measured the location of debris piles deposited by exceptionally large and infrequent flow events. A total of five cross-sections were surveyed on the selected reach of upper Potter Creek.

AECOM then developed a hydraulic model for each reach using HEC-RAS version 5.0.7 (AECOM, 2021). Manning's n values were selected based on aerial imagery and photos collected during the field survey which showed the nature of the channel, bed material, and vegetation. These values were selected in accordance with Table 3-1 in the HEC-RAS 5.0.1 Reference Manual. On

Potter Creek, the Manning's n values value in the channel was set to 0.055, the values in the floodplain were set to between 0.06 and 0.07. Using an iterative process, discharge values were entered into the model to find the streamflow that best corresponded with the surveyed bankfull indicators and the lowest and highest elevation flood debris. The bankfull discharge minimized the difference between the modeled water surface elevation and the surveyed bankfull elevations.

On upper Potter Creek, AECOM determined that the surveyed bankfull indicators correspond to a flow of 177 cfs (Table 1). The lower elevation flood debris corresponds to a streamflow of 310 cfs and the maximum elevation of the debris corresponds to a streamflow of 753 cfs.

Table 1. HEC-RAS modeling results for upper Potter Creek.

Parameter	Discharge, cfs
Bankfull	177
Minimum elevation of flood debris	310
Maximum elevation of flood debris	753

ISF Recommendation

This recommended ISF water right is specifically structured to protect the high-flow component of the hydrologic regime that is critical to the persistence of riparian communities. This water right also protects the receding limb of the hydrograph. Protecting bankfull flows and the receding limbs of the hydrograph will provide the conditions necessary for the reproduction and maintenance of riparian communities. The BLM recommends the following flows based on modeling analyses and the biological needs of the riparian communities:

> When the flow rate reaches 177 cfs (bankfull flow), all flow in the creek should be protected until the flow rate recedes to the existing instream flow water right appropriated in 2004.
>
> BLM recommends that the proposed water rights be in effect only during the April 1 to September 30 period, if the flow rate threshold is met. This time frame corresponds to the portion of the year when the riparian community is actively growing and reproducing and when most high-flow events occur due to snowmelt runoff and monsoonal thunderstorms. During years in which streamflow does not reach the proposed threshold, this instream flow water right for high-flow events would not be in effect.

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 to estimate a selected basin's streamflow statistics including flood discharge and frequency characteristics (Capesius and Stephens, 2009). 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.

Unlike other ISF water rights, this ISF will only be in effect when the bankfull threshold is reached and only during a limited portion of the year. This proposed ISF is not structured to occur year-round and is not expected to occur every year or even in most years. Therefore, median flow is not assessed in this analysis because the high-flow events necessary for the riparian community are not anticipated to occur on a median basis. Instead, the water availability analysis for upper Potter Creek provides information about the known hydrology in the area, the available streamflow data in Potter Creek, and the potential characteristics of these high-flow events.

Basin Characteristics

The drainage basin of the proposed ISF on upper Potter Creek is 25.7 square miles, with an average elevation of 7,658 feet and average annual precipitation of 19.33 inches (See the Hydrologic Features Map). Hydrology throughout the Uncompahgre Plateau demonstrates a relatively early snowmelt runoff pattern that is also influenced by monsoon and late-season storms. This results in high-flow events that can occur between early spring and summer due to snowmelt and high-flow events that can occur between summer and late fall due to rain events. A gage on Roubideau Creek, located downstream from Cottonwood Creek, Monitor Creek, and Potter Creek (Roubideau Creek at mouth near Delta, CO gage, USGS 09150500, period of record 1939 to 1953 and 1976 to 1983) shows that most annual peaks occur in May but can occur as late as October (Figure 2).

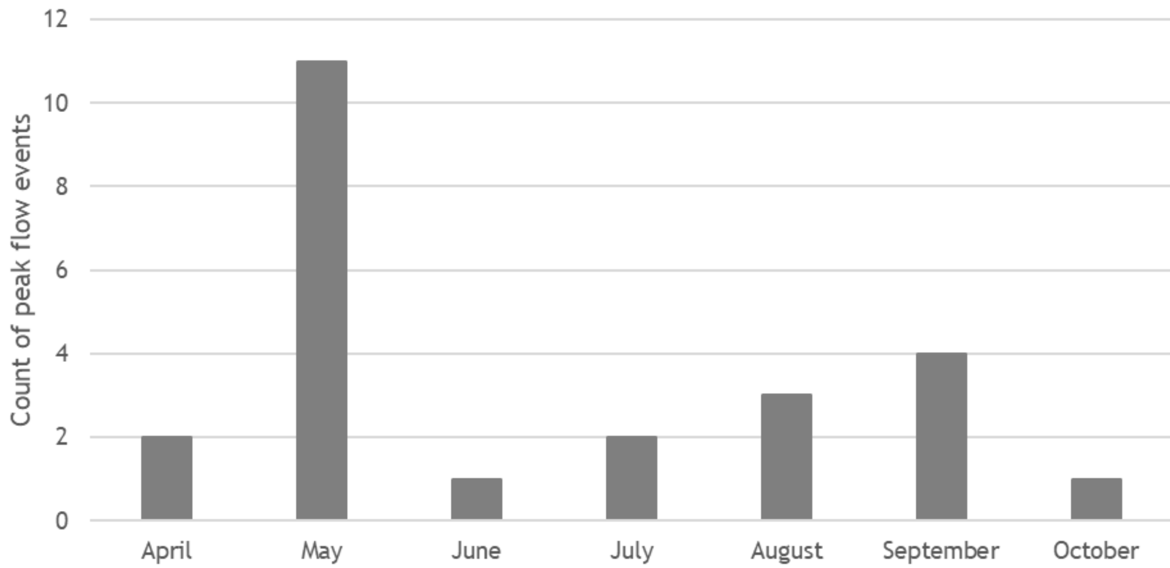


Figure 2. Number of times the peak occurred each month at the Roubideau Creek at mouth near Delta, CO peak flow gage data from 1939-1953 and 1976-1983.

Snowmelt runoff typically produces the high-flow event with the longest duration, which can last weeks to months. Rain events have the potential to produce very high flows but are typically short-duration events. Streamflow in this region can be highly variable, some years may have substantial flows while other years have little to no measurable flow.

Existing Water Uses

There are very few water rights in the basin tributary to the proposed ISF on Upper Potter Creek. There are four spring water rights for a total of 0.0638 cfs, one well, and 18 small reservoirs which have a total storage of 9.8 acre-feet. Two small springs are located within the proposed reach, but all other water rights are located upstream from the proposed reach. These water rights are unlikely to alter hydrology in the basin and streamflow is essentially natural.

Data Collection and Analysis

A number of different sources of information were used to assess hydrology in upper Potter Creek. Each source will be presented in subsections for clarity.

USGS Potter Creek gages

There are two historic USGS streamflow gages on Potter Creek. The Potter Creek near Olathe, CO gage (USGS 9149910, 1979-1981) was located approximately 2,000 ft upstream from the proposed lower terminus at the confluence with Monitor Creek. The Potter Creek near Columbine Pass gage (USGS 9149900, 1980-1981) was located above 5 miles upstream from the proposed reach. The Potter Creek near Olathe gage (termed USGS Potter gage here for simplicity) is more representative of the proposed ISF reach and is the only gage that was evaluated further.

The USGS Potter Creek gage, located near the lower terminus, has essentially the same drainage basin characteristics as the proposed lower terminus of this reach. It is also affected by the same limited water uses described above. These water uses have been in practice for some time and are included in the gage data. Due to the short record, Staff evaluated the Roubideau Creek at mouth near Delta, CO gage (USGS 09150500 or DWR ROUDELCO) to evaluate the 1979-1981 time period. The Roubideau Creek gage has been operated from October 1938 to October 1954, May 1976 to October 1983, and February 2004 to August 2008 for a total of 29 to 31 years of data depending on the day of the year. This analysis finds that the average annual flow volume at the Roubideau gage for Water Year 1980 and 1981 was 128% and 69% respectively of the long-term average. Therefore, the two years of available USGS data likely represent a relatively wet and a relatively dry year.

All available data for the USGS Potter Creek gage is shown in the USGS Potter Creek gage Completed and Detailed Hydrographs which includes daily average values and the annual peak for each year. This shows that the riparian threshold of 177 cfs was exceeded on 6/4/1980 when flows reached 277 cfs. The threshold was not met in 1981.

CPW Potter Creek gage

CPW installs a temporary streamflow gage on Potter Creek annually to monitor spring flows in conjunction with research on spawning movements of native sucker species. This gage (termed the CPW Potter gage) is located about 600 ft upstream from the confluence with Roubideau Creek, which is approximately 1.7 miles downstream from the lower terminus of this proposed reach. The CPW Potter gage is operated seasonally, typically from early spring in March or April through June or early July when the spawning migration is completed, and flows drop. The gage has operated in most years from 2015 to 2022. However, streamflow was too low to develop a rating in 2018, no equipment was deployed in 2020 due to low flows, and equipment malfunctioned in 2021. This gage is not operated through late summer, fall, or winter and therefore does not record information from any flow events during those portions of the year. CWCB staff helped maintain the gage by making multiple streamflow measurements. Staff then used the available data to develop a rating curve to determine streamflow during the gaged portions of the years with data.

Unlike the upper Potter reach, the CPW Potter gage is affected by several water rights. These water rights occur in the Monitor Creek basin and include active surface water diversions that total 67.13 cfs (See the Hydrologic Features Map and Detailed map). The largest of these is the Big Monitor Ditch No 1 (WDID 4001426, 51.85 cfs, appropriated in 1918). There are also 412 acre-feet in active storage rights, 0.53 cfs for springs and pipelines, and 0.4 cfs for well water rights. In addition, there are some diversions that import or export water into the Monitor basin. The Everlasting Ditch (WDID 4001435, 27 cfs, appropriated in 1901 and 1964), which diverts from Cottonwood Creek, irrigates lands in the Monitor Creek basin and may contribute additional flow. The 25 Mesa Upper Little Monitor Ditch (WDID 4001319, 7 cfs, appropriated in 1904) diverts water from Little Monitor Creek, which is used for ponds in the Cottonwood basin and to irrigate lands in both the Monitor Creek and Cottonwood Creek basins.

Climate Conditions

The CPW Potter Creek gage record period (2015-2022) was compared to a longer-term climate record for context. The nearest climate station with a relatively long record is at Columbine Pass (USS0008L02S, 1986 to 2022) located in the headwaters of Potter Creek, approximately 18 miles southwest from the proposed lower terminus. Figure 3 shows cumulative snow water equivalent (SWE) totals for 2015-2022 in comparison to the 30-year average (downloaded from the Colorado River Basin Forecast Center on 2/9/2023). Peak SWE in 2018 was the lowest on record, 2015, 2020 and 2021 were below average, 2016 was about average, and 2017, 2019, and 2022 were above average. This information demonstrates a range of precipitation in the area during the CPW Potter Creek gage record.

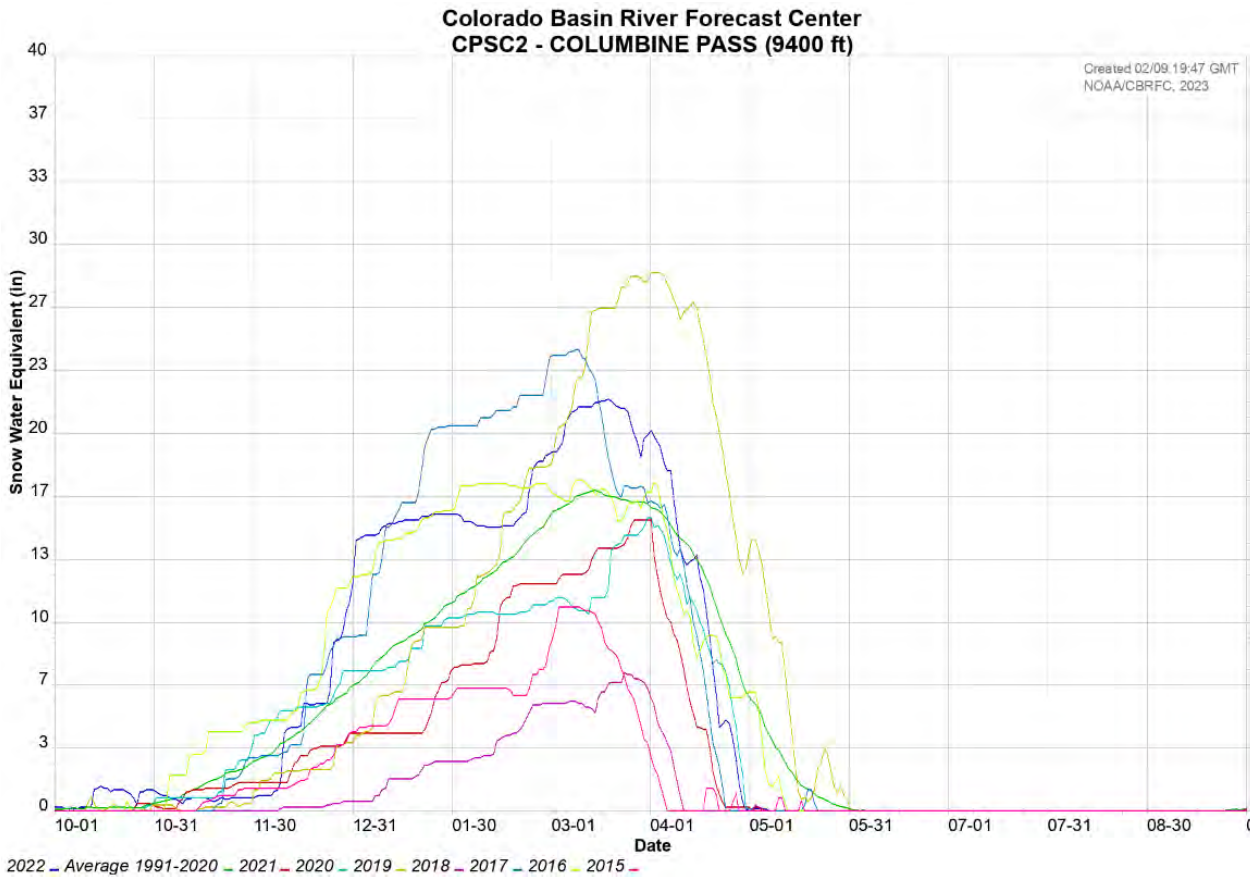


Figure 3. Cumulative SWE for 2015 to 2022 and average SWE from 1991 to 2020 downloaded from the Colorado River Basin Forecast Center on 2/9/2023.

Staff also evaluated streamflow gages to better understand potential streamflow given that persistent low soil moisture in recent years has impacted how much snowfall becomes streamflow. The Dallas Creek gage and San Miguel gages (USGS 09147000 Dallas Creek near Ridgway and USGS 0917700 San Miguel River at Uravan) were selected because they were reasonably close to the Uncompahgre Plateau. The gages are not impacted by large reservoirs; however, they are in different basins and have significant water uses. Years with complete data (provisional or approved data, filling missing data in 2022 with the long-term average) from 1992 to 2022 was used to calculate annual water volumes and basic percentiles. Data from these gages show that 2019 was very wet (greater than 75th percentile); 2015 was wet to dry (greater than 50th percentile for the San Miguel and greater than the 75th percentile for Dallas Creek, 2016 and 2017 was wet or wettest (greater than the 50th percentile for the San Miguel River and greater than 75th percentile for Dallas Creek); 2018, 2020, 2021, and 2022 were in the driest category (less then 25th percentile). 2018 and 2020 were exceptionally dry with annual water volumes less than the 10th percentile. Therefore, the CPW Potter Creek gage data contains a range of year types, but many years in the record are likely to reflect dry or exceptionally dry conditions.

Based on the existing water use practices in the basin, the streamflow measured at the CPW Potter Creek gage does not reflect natural hydrology. This means that prorating the CPW Potter Creek gage data to the upper Potter Creek lower terminus (that does not have any diversions) may underestimate the amount of water in upper Potter Creek. Nevertheless, the CPW Potter Creek gage, which has a drainage basin that is 25.5 square miles and an average annual precipitation of 19.4 inches, was prorated to the upper Potter Creek lower terminus using a proration factor of 0.459 based on the precipitation-area weighted method.

The resulting estimated hydrology in upper Potter Creek shows a range in streamflow between 2015 and 2022. The highest flows occurred in 2019. There were clear snowmelt runoff events in 2022, 2017, and 2016. Flows were lower in 2015 and very low in 2018 and 2020. There is no data for 2021 due to equipment malfunctions. Based on the CPW Potter Creek gage estimates, the riparian threshold of 177 cfs did not occur between 2015 and 2022.

Direct Flow Measurements
CWCB and BLM staff made 13 flow measurements in the upper Potter Creek reach, as summarized in Table 2.

Table 2. Summary of streamflow measurements for upper Potter Creek.

Visit Date	Flow (cfs)	Collector
04/19/2017	94.80	CWCB
06/07/2017	1.59	CWCB
06/22/2017	0.01	CWCB
04/08/2019	1.98	CWCB
05/15/2019	83.60	CWCB
06/19/2019	5.16	CWCB
04/11/2019	3.26	CWCB
06/22/2022	0.01	CWCB
06/12/2014	0.55	BLM
04/08/2015	7.21	CWCB
04/08/2015	29.57	CWCB
04/13/2017	39.78	CPW
05/22/2017	23.60	BLM

High-Flow Characteristics

The ISF recommendation is based on the importance of high-flow events that help to maintain the rare riparian community on Potter Creek. Based on the available information from the USGS and CPW gages, riparian flows would have been achieved only one time out of the approximate 9 years of record (1980-1981, 2015-2021, and 2022). This event started on 6/4/1980 and would have ended on 6/30/1980 when streamflow dropped below the 2004 ISF flow rate of 1.8 cfs, lasting for a total of 26 days (Table 3).

Table 3. Duration and maximum streamflow for riparian flows in Potter Creek.

Start Date	End Date	Duration, days	Maximum flow, cfs	Data Source
6/4/1980	6/30/1980	26	277	USGS Potter Gage (9149910)

Although the CPW Potter Creek gage does not include data collected during later summer or fall, it is likely that monsoon events do occur in this system. These events have the potential to reach the riparian threshold. For example, the CWCB Monitor Creek gage located in the adjacent and similarly sized basin, measured two high-flow events later in the summer of 2017 and 2019 (see the Monitor Creek March 2023 Executive Summary for more information). These events, if prorated to the Upper Potter Creek basin, were above the 177 cfs riparian threshold.

The USGS StreamStats model estimates different peak flow statistics based on regional regression analysis (Table 4). These estimates provide some information about the potential frequency of high-flow events, but the estimates may have high uncertainty in this area due to the lack of streamflow gages in the region that can be used to inform the models. Nevertheless, these estimates suggest that the riparian threshold of 177 could occur at the frequency of about a 2-year peak flood event.

Table 4. StreamStats estimates of area-averaged high-flow events on upper Potter Creek.

Peak Flow Statistic	Estimated Flow, cfs
2 Year Peak Flood	174
5 Year Peak Flood	326
10 Year Peak Flood	454
25 Year Peak Flood	663
100 Year Peak Flood	1020

High-Flow Event Estimates

AECOM also surveyed the location of large piles of woody debris deposited by previous very infrequent high-flow events on the floodplain of the modeled stream site. The HEC-RAS model was used to estimate the flow necessary to reach the locations of the debris piles. This modeling work estimated that a flow of 310 cfs would reach the minimum elevation of the debris and a flow of 753 cfs would reach the high elevation of the debris. The observation of large piles of debris on the floodplain demonstrates that very high-flow events do occur and that these events can inundate large portions of the floodplain. The StreamStats peak flow statistics estimate that an event capable of reaching the lower elevation flood debris could occur on a 5-year frequency.

Water Availability Summary

The USGS and CPW Potter Creek gages, the AECOM high-flow estimates from flood debris, and StreamStats estimates of peak flow events provide an estimate of the range of streamflow conditions on Potter Creek. These data demonstrate that a high-flow event above the bankfull threshold of 177 cfs occurred in 1980 and that other events may have occurred more recently based on woody debris on the floodplain. In addition, it is likely that rain events later in the summer also reach the riparian threshold based on measured high-flows in the adjacent Monitor Creek basin. Staff has concluded that water is available for ISF appropriation as structured.

MATERIAL INJURY

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

ADDITIONAL INFORMATION

Citations

AECOM, 2021, Cottonwood, Monitor, and Potter Creek's survey and hydraulics. Memo to CWCB.

Bureau of Land Management, 2020, Record of decision and approved resource management plan for Uncompahgre Field Office, 2020.

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

Colorado Natural Heritage Program, Rocky Mountain lower montane-foothills riparian woodland and shrubland. https://cnhp.colostate.edu/projects/ecological-systems-of-colorado/details/?elementID=365200

Cooper D.J., Merritt, D.M., Anderson, D.C. and Chimner, R.A, 1999, Factors controlling the establishment of Fremont cottonwood seedlings on the Upper Green River, USA. Regulated Rivers: Research and Management, 15:419-440.

Damm, M., and J. Stevens, 2000, Assessment of riparian vegetation and wildlife habitat structure: North Fork of the Gunnison tributaries and lower Gunnison tributaries. Colorado Natural Heritage Program.

Mahoney, J.M. and S.B. Rood, 1998, Streamflow requirements for cottonwood seedling recruitment- an integrative model. Wetlands, 18; 634-645.

Scott, M.L., Auble, G.T., and Friedman, J.M.,1997, Flood dependency of cottonwood establishment along the Missouri River, Montana, USA. Ecological Applications, 7:677-690.

Somers, P. and L. Floyd-Hanna, 1996, Wetlands and riparian habitats, and rivers. In Blair, R., ed. pp. 175-192. The western San Juan Mountains: their geology, ecology, and human history. University Press of Colorado, Niwot, CO.

Stephens, T., D. Culver, J. Zoern, and P. Lyon, 1999, A natural heritage assessment of wetlands and riparian areas in Uncompahgre River basin: Eastern Montrose and Ouray Counties Volume II. Colorado Natural Heritage Program.

Thompson, K.G., and Z.E. Hooley-Underwood, 2019, Present distribution of three Colorado River basin native non-game fishes, and their use of tributaries. Technical publication No. 52, Colorado Parks and Wildlife Aquatic Research Section.

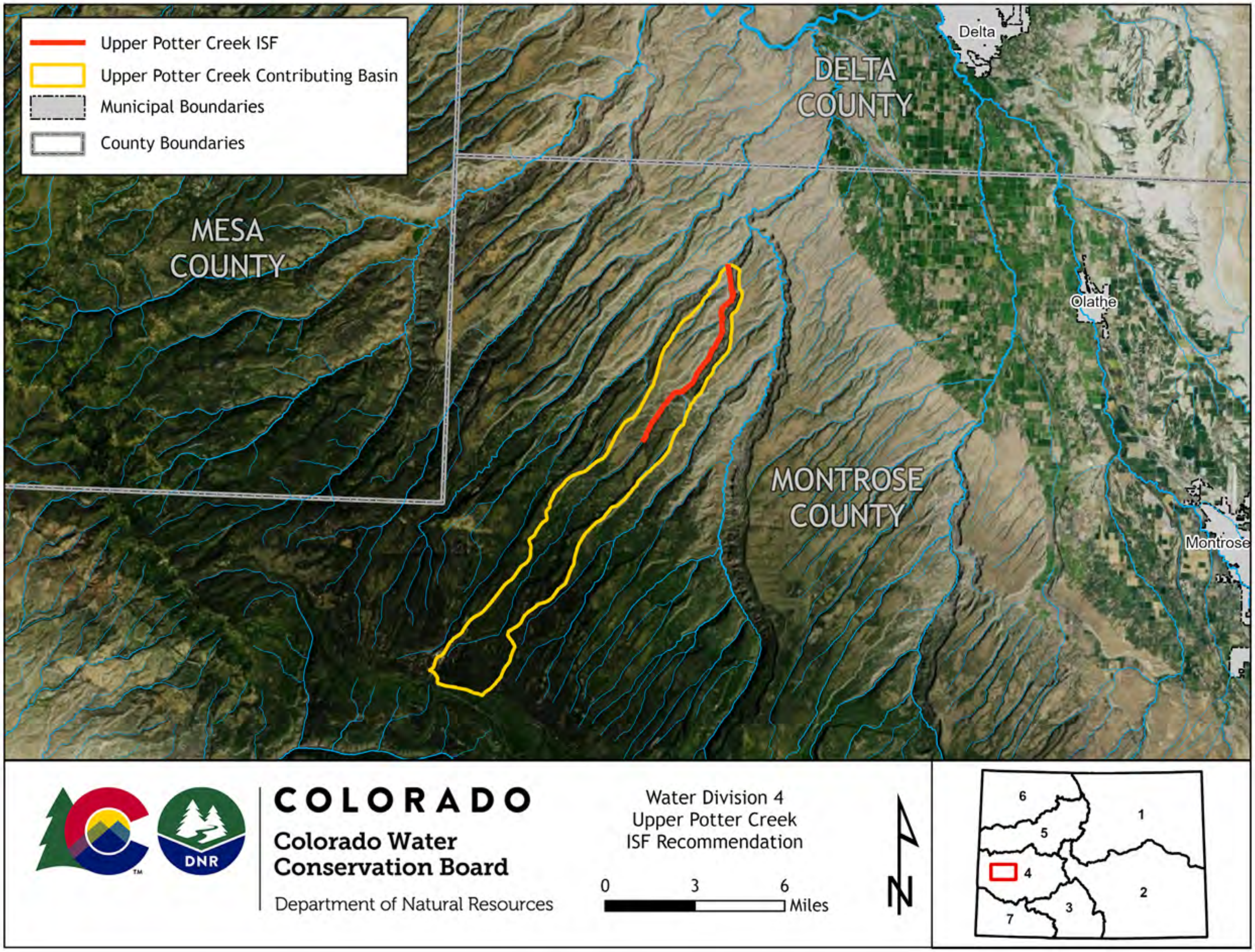
Utah Department of Natural Resources, Division of Wildlife Resources, 2006, Range-wide conservation agreement and strategy for Roundtail Chub *Gila robusta*, Bluehead Sucker *Catostomus discobolus*, and Flannelmouth Sucker *Catostomus latipinnis*.

Metadata Descriptions

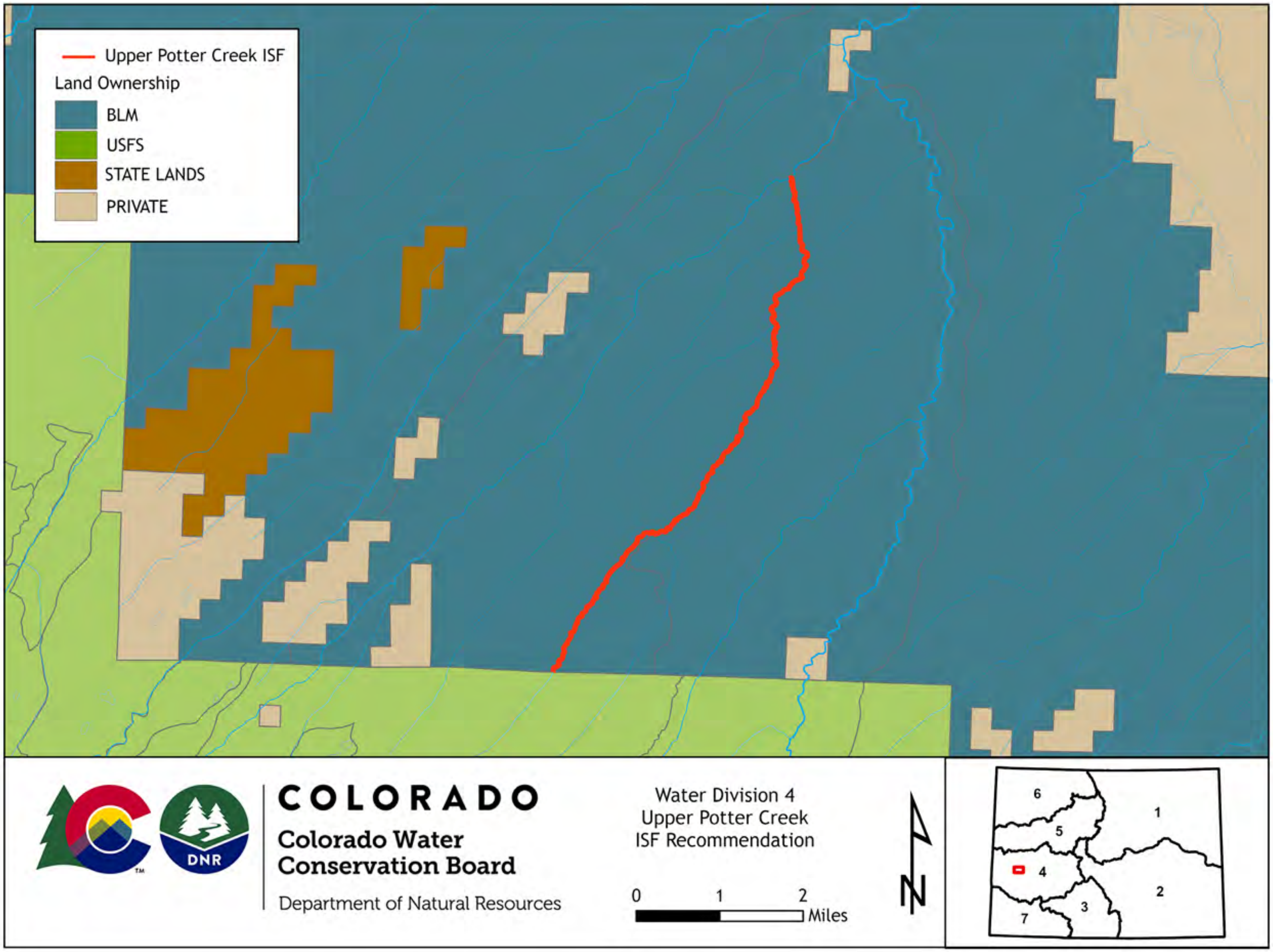
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

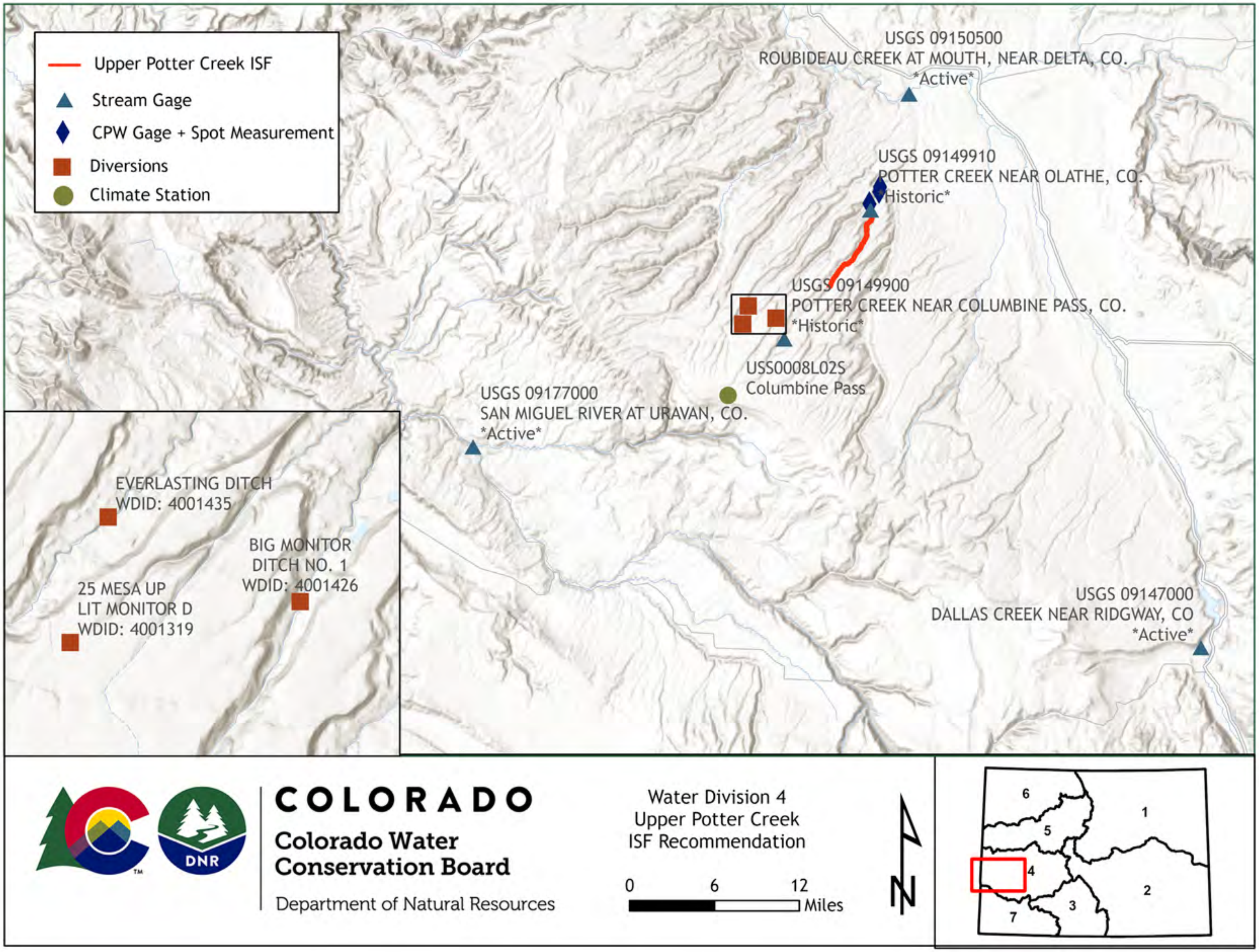
VICINITY MAP



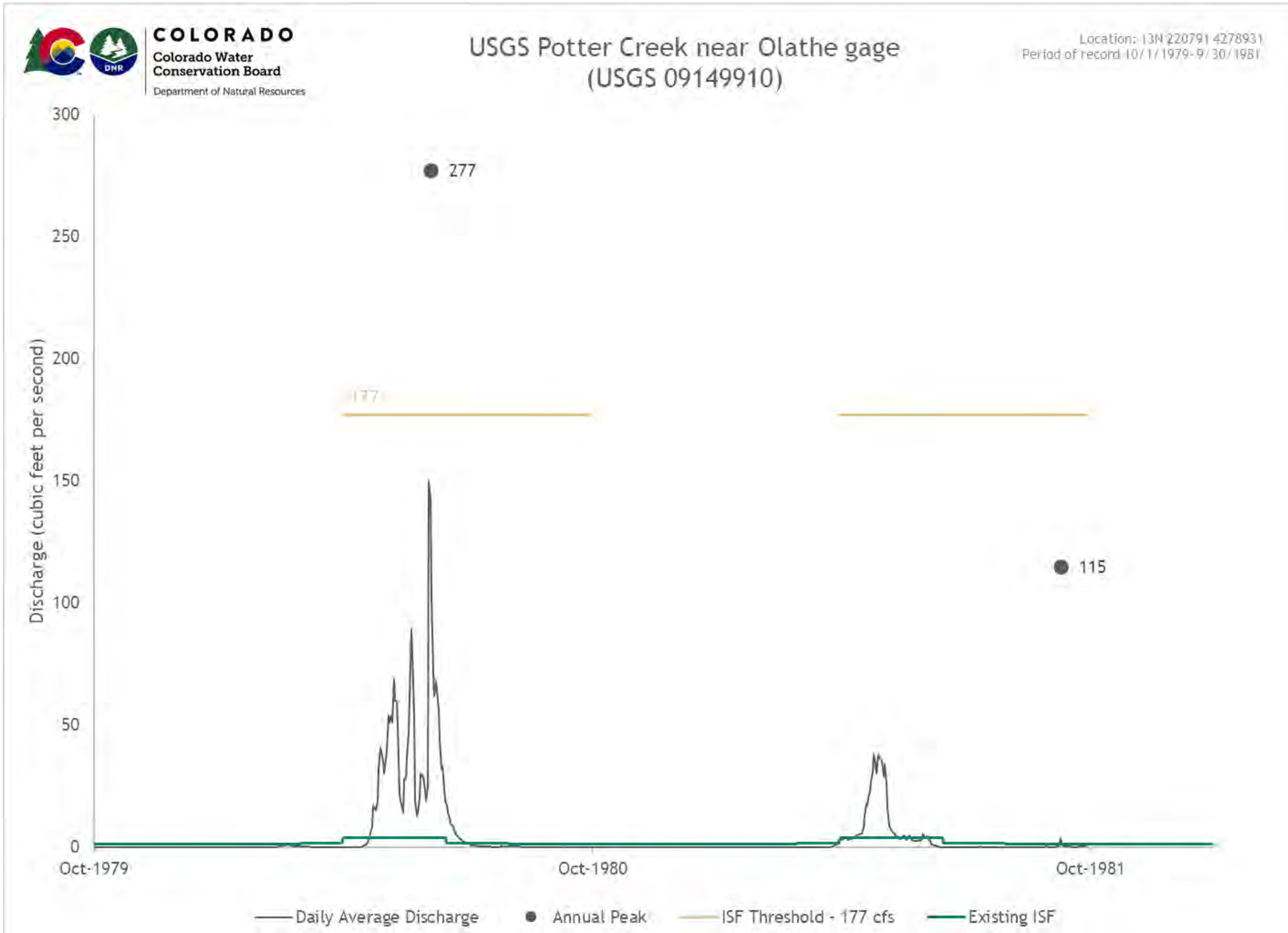
LAND OWNERSHIP MAP



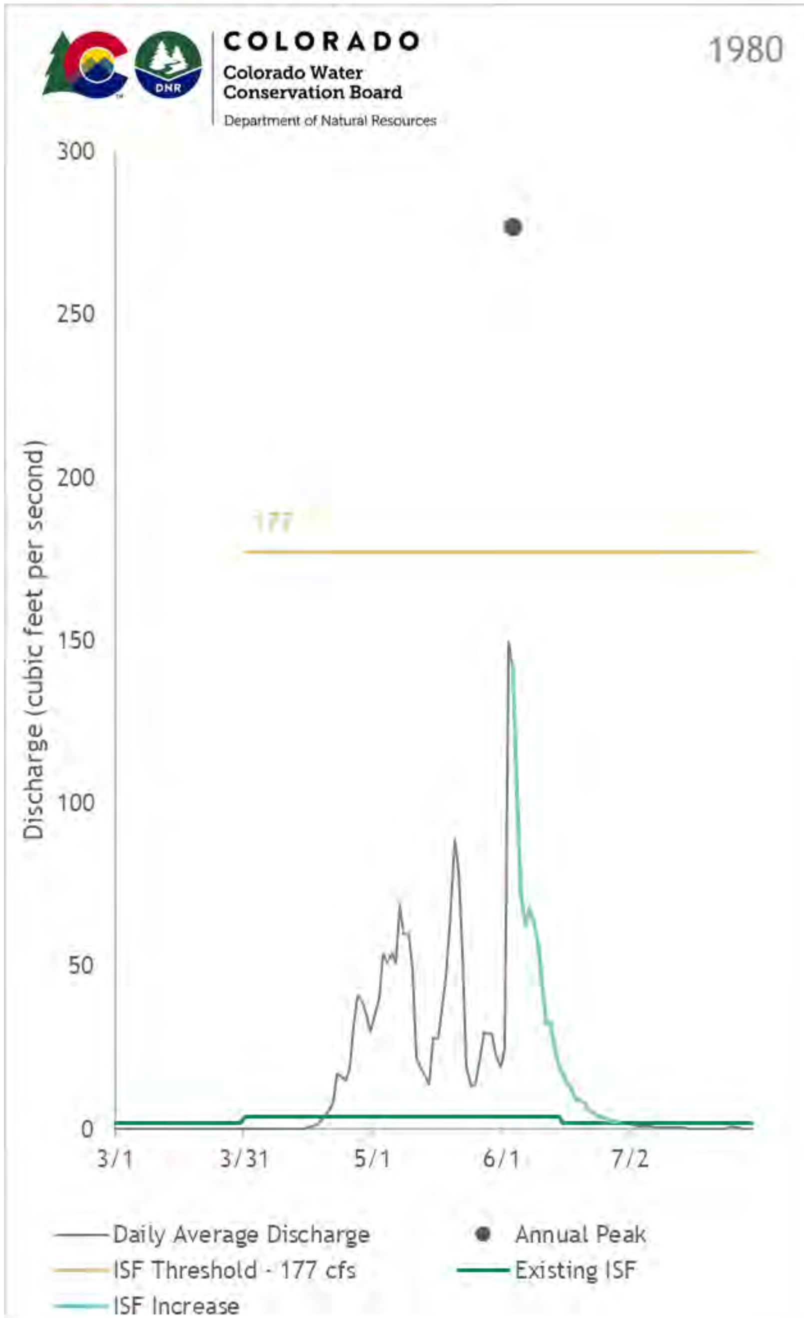
HYDROLOGIC FEATURES MAP



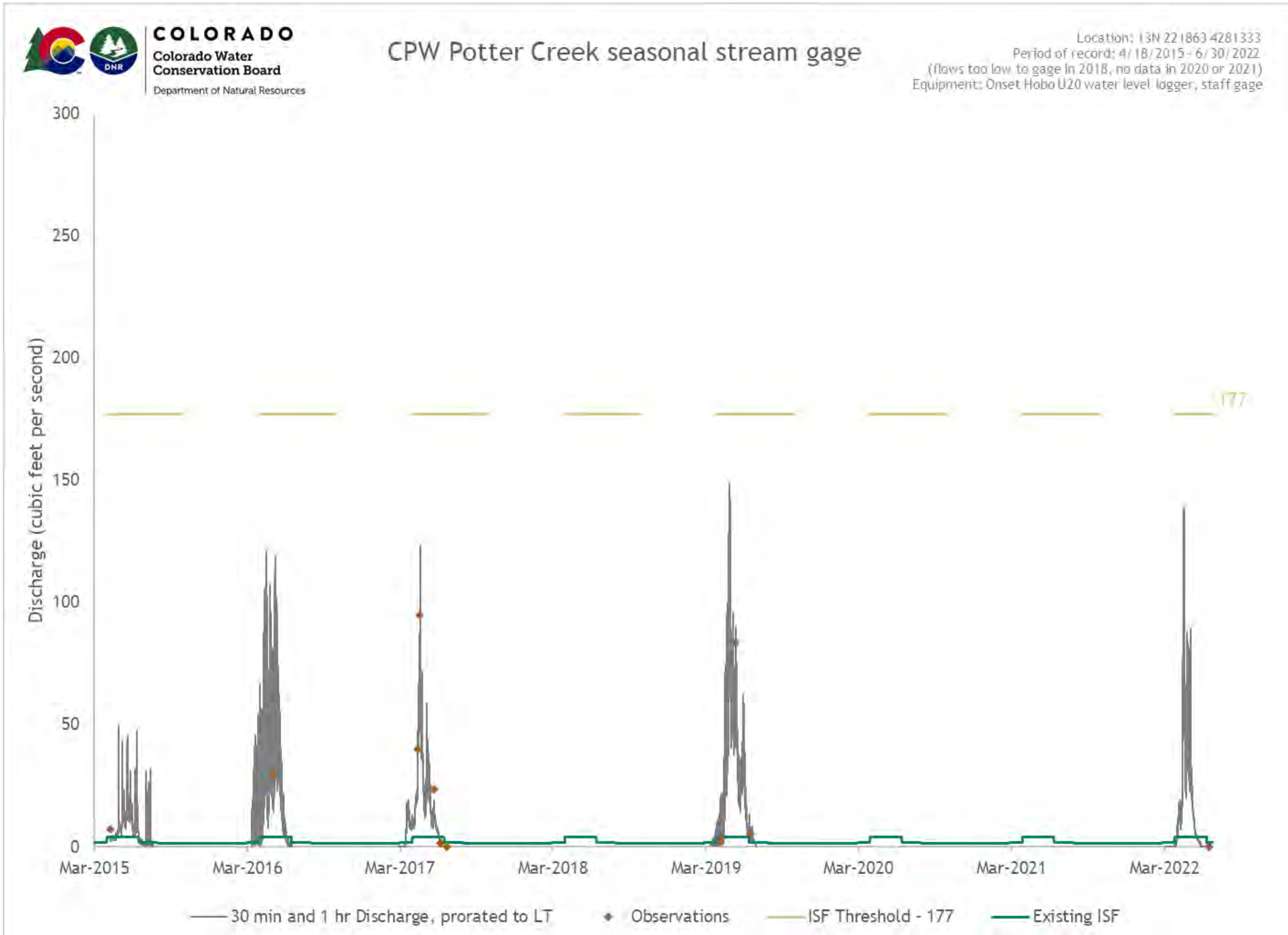
USGS POTTER CREEK GAGE COMPLETE HYDROGRAPH



USGS POTTER CREEK GAGE DETAILED HYDROGRAPH



CPW POTTER CREEK GAGE COMPLETE HYDROGRAPH



Potter Creek (lower) Executive Summary

CWCB STAFF INSTREAM FLOW RECOMMENDATION
March 15-16, 2023

UPPER TERMINUS:	confluence with Monitor Creek UTM North: 4279535.32 UTM East: 220671.03
LOWER TERMINUS:	confluence with Roubideau Creek UTM North: 4281496.83 UTM East: 221904.86
WATER DIVISION:	4
WATER DISTRICT:	40
COUNTY:	Montrose
WATERSHED:	Lower Gunnison
CWCB ID:	18/4/A-007
RECOMMENDER:	Bureau of Land Management (BLM)
LENGTH:	1.72 miles
EXISTING ISF:	04CW0161, 4 cfs (4/1-6/15), 1.8 cfs (6/16-7/31), 1.4 cfs (8/1-2/29), 1.8 cfs (3/1-3/31)
INCREASE FLOW RECOMMENDATION:	ISF protection initiates at 225 cfs and protects all unappropriated streamflow until flow rates recede to the existing ISF (see rates above) or until 9/30, whichever occurs first. This flow protection will only be in effect 4/1 – 9/30 if the 225 cfs threshold is reached.

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

INTRODUCTION

Colorado's General Assembly created the Instream Flow and Natural Lake Level Program in 1973, recognizing "the need to correlate the activities of mankind with some reasonable preservation of the natural environment" (see 37-92-102 (3), C.R.S.). The statute vests the Colorado Water Conservation Board (CWCB or Board) with the exclusive authority to appropriate and acquire instream flow (ISF) and natural lake level water rights (NLL). Before initiating a water right filing, the Board must determine that: 1) there is a natural environment that can be preserved to a reasonable degree with the Board's water right if granted, 2) the natural environment will be preserved to a reasonable degree by the water available for the appropriation to be made, and 3) such environment can exist without material injury to water rights.

The information contained in this Executive Summary and the associated supporting data and analyses form the basis for staff's ISF recommendation to be considered by the Board. This Executive Summary provides sufficient information to support the CWCB findings required by ISF Rule 5i on natural environment, water availability, and material injury. Additional supporting information is located at: https://cwcb.colorado.gov/2023-isf-recommendations.

RECOMMENDED ISF REACH

The BLM recommended that the CWCB appropriate an increase to an existing ISF water right on a reach of Potter Creek. Potter Creek is located within Montrose County (See Vicinity Map) and is approximately 10 miles southwest of the City of Delta. The stream originates on the east side of the Uncompahgre Plateau and flows northeast until it reaches the confluence with Roubideau Creek which is a tributary to the Gunnison River. The existing ISF water right on Potter Creek was appropriated in 2004 for the following flow rates and times; 4 cfs (4/1-6/15), 1.8 cfs (6/16-7/31), 1.4 cfs (8/1-2/29), 1.8 cfs (3/1-3/31). The proposed reach extends from the confluence with Monitor Creek downstream to the confluence with Roubideau Creek for a total of 1.72 miles. The entire proposed reach is located on BLM land (See Land Ownership Map).

BACKGROUND

The BLM found Potter Creek suitable for inclusion in the National Wild and Scenic Rivers System based in part on the presence of rare riparian communities that qualified as outstandingly remarkable values (ORVs; BLM, 2020). This finding was informed by surveys conducted by the Colorado Natural Heritage Program (CNHP)[1] in the 1990s that determined that Potter Creek contained rare plant communities that warranted conservation (Damm and Stevens, 2000; Stephens et al., 1999). On Potter Creek, CNHP identified five imperiled and vulnerable riparian communities with species that are rarely found in the same habitat.

Although BLM recognized that Potter Creek has some ISF protection, the suitability determination specifically noted that the current lack of flow protection for globally significant riparian values was a significant factor driving BLM's suitability determination. The Final Resource Management Plan for BLM's Uncompahgre Field Office stated that if scientific studies

[1] The Colorado Natural Heritage Program is Colorado's only comprehensive source of information on the status and location of Colorado's rarest and most threatened species and plant communities. CNHP is a non-academic department of the Warner College of Natural Resources at Colorado State University. It is also a member of the NatureServe Network, "which is an international network of partners that use the same scientific methodology to enable scientists to monitor the status of species and natural plant communities from state, national, and global perspectives."

conclude that alternative forms of flow protection are in place and are sufficient to fully protect the flow-related ORVs on Monitor and Potter Creeks, the BLM will determine it is unnecessary to quantify, assert, or adjudicate a federal reserved water right for these segments if they are ultimately designated into the National Wild and Scenic River System.

At the request of the CWCB, BLM developed a concept to preserve the riparian communities of these streams using the ISF program. The proposed ISF is based on protecting high-flow events and the falling limb of the hydrograph which create the conditions necessary for seedlings to survive and sustain the population of the riparian community. This ISF increase would only be active during the primary growing season and only when flows are sufficiently high to provide benefits to the riparian community. At other times, the existing seasonal ISF would continue to provide some flow protection for aquatic habitat.

OUTREACH

Stakeholder input is a valued part of the CWCB staff's analysis of ISF recommendations. Currently, more than 1,100 people subscribe to the ISF mailing list. Notice of the potential appropriation of an ISF water right on Potter Creek was sent to the mailing list in November 2022, March 2022, November 2021, March 2021, November 2020, March 2020, November 2019, March 2019, March 2018, and March 2017. No private landowners were identified as being adjacent to Potter Creek. A public notice about this recommendation was also published in the Montrose Daily Press on January 8, 2022 and December 21, 2022.

Staff presented information about the ISF program and this recommendation to the Montrose County Board of County Commissioners on October 3, 2017, December 9, 2019, and November 21, 2022. In addition, staff spoke with State Engineer Kevin Rein on June 6, 2017, State Engineer Kevin Rein and Deputy State Engineer Tracy Kosloff on October 9, 2020 regarding the administrability of this ISF recommendation. Staff also communicated with Bob Hurford, Division Four Engineer and Luke Reschke, Lead Water Commissioner regarding water rights and water use practices on Potter Creek.

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. Please see BLM's letter of recommendation which includes more detailed information about the plant communities, riparian flow needs, and the importance of protecting the riparian communities.

Riparian Community

Potter Creek starts near Columbine Pass on the Uncompahgre Plateau, it descends through forested lands before carving a gradually deepening canyon. The valley floor contains a wide riparian corridor. CNHP surveys found that Potter Creek supports a healthy riparian plant community that is part of the Rocky Mountain Lower Montane-Foothills Riparian Woodland and Shrubland Ecological System (CNHP website).

Specifically, Potter Creek contains five rare, imperiled communities:

- A population narrowleaf cottonwood, strapleaf willow, and silver buffaloberry (*Populus angustifolia/ Salix ligulifolia/Shepherdia argentea*) riparian forest
- A population of narrowleaf cottonwood and skunkbush sumac (*Populus angustifolia/Rhus trilobata*) riparian forest
- A population of narrowleaf cottonwood and Douglas fir (*Populus angustifolia/ Pseudotsuga menziesii*) riparian woodland
- A population of Douglas fir and red osier dogwood (*Pseudotsuga menziesii/Cornus sericea*) riparian woodland
- A population of narrowleaf cottonwood and red osier dogwood (*Populus angustifolia/Cornus sericea*) riparian woodland.

Narrowleaf cottonwoods (Figure 1) are members of the willow family that can grow up to 80 feet in height. Strapleaf willows are deciduous shrubs that can grow up to six feet in height. Silver buffaloberry are deciduous, thicket-forming shrubs that are drought-hardy and can grow up to 20 feet in height. Skunkbush sumac is a deciduous, flowering shrub, averaging four feet in height. Douglas firs are evergreen pines that can grow to between 70 and 330 feet in height and can reach eight feet in diameter. Red osier dogwoods are woody deciduous shrubs that can grow up to 20 feet in height.

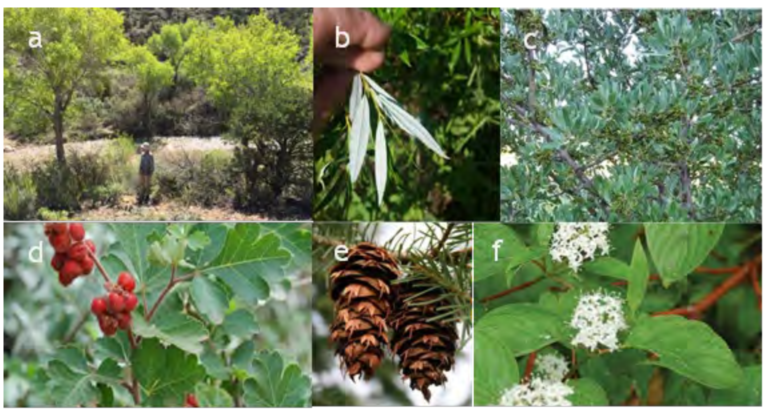


Figure 1. Assembled images of species in the lower Potter Creek riparian area. a) narrowleaf cottonwood, b) strapleaf willow, c) silver buffaloberry, d) skunkbush sumac, e) Douglas fir, f) red osier dogwood

Potter Creek also includes extensive acreage of other non-imperiled riparian communities and species, that were noted by CNHP to be in very good condition such as Fremont cottonwood (*Populus deltoides ssp. Wislizenii*), thin leaf alder (*Alnus incana*), snowberry (*Symphoricarpos oreophilus*), Utah serviceberry (*Amelanchier utahensis*), and blue spruce (*Picea pungens*) (Damm and Stevens, 2000; Stephens et al., 1999).

The combination of narrowleaf cottonwood, strapleaf willow and silver buffaloberry is rated by CNHP as both globally and state vulnerable, which is defined as being at moderate risk of extinction with 21 to 100 occurrences of these communities in the world (Stephens et al., 1999). The combination of narrowleaf cottonwood and skunkbush sumac is rated by CNHP as both globally and state vulnerable, which is defined as being at moderate risk of extinction with 21 to 100 occurrences of these communities in the world. The combination of narrowleaf cottonwood and Douglas fir is rated by CNHP as state imperiled and globally vulnerable, which is defined as being at high risk of extinction with 6 to 20 occurrences of these communities statewide and being at moderate risk of extinction with 21 to 100 occurrences of these communities in the world. The combination of Douglas fir and red osier dogwood is rated by CNHP as state imperiled and globally apparently secure, which is defined as being high risk of extinction with 6 to 20 occurrences of these communities statewide and being quite rare in parts of its range with around 100 occurrences in the world. The combination of narrowleaf cottonwood and red osier dogwood is rated by CNHP as both globally and state apparently secure, which is defined as being quite rare in parts of its range with around 100 occurrences in the world. Even though populations of these collective species are widely distributed, these species are rarely found growing in the same location as communities because of their different habitat needs which are rarely met simultaneously.

CNHP included Potter Creek as one of 25 wetland and riparian sites within Ouray and eastern Montrose counties that most merit conservation efforts and as one of four areas of local significance based on its ecosystem functions and values (Stephens et al., 1999). Both CNHP and BLM found Potter Creek to have high biodiversity with the riparian community in good condition, few non-native species, and minimal anthropogenic disturbance. CNHP ranked Potter Creek biodiversity as having very high significance with one of the best examples of a community type, good occurrence of globally critically imperiled species, or an excellent occurrence of a globally imperiled or vulnerable species.

CNHP designated the Potter Creek watershed as part of the Roubideau Potential Conservation Area (PCA) because highly functioning riparian areas with an intact assemblage of historic native species are so rare in the Uncompahgre River basin. PCAs focus on capturing the ecological processes necessary for the continued existence of plants or plant communities with natural heritage significance. PCAs are meant to be used for conservation planning purposes but have no legal status. CHNP states that, “the Roubideau Creek Conservation PCA merits special status, such as designation as a BLM Area of Critical Environmental Concern (ACEC) or Research Natural Area.” (Stephens et al., 1999)

Riparian communities are important because they provide many critical hydrologic, watershed, and ecosystem functions (Stephens et al., 1999). Hydrologically, riparian areas can help mitigate the impacts of floods by reducing water velocity and attenuating peak flows. They also stabilize streambanks and prevent erosion and unraveling of the channel during high-flow events. Heavily vegetated riparian corridors provide biogeochemical functions of filtering out sediment and toxins. Riparian communities directly support wildlife by providing diverse habitat types including forest, dense scrub, and shrub. In semi-arid regions of the western United States, an estimated 80% of mammals, birds, reptiles, and amphibians use riparian areas and wetlands for habitat throughout the year or as migratory rest stops (Somers and Floyd-Hanna, 1996). The riparian corridor also provides shade to reduce water temperatures and organic matter which provides habitat and food for the aquatic ecosystem.

Preserving the riparian corridor in Potter Creek is warranted to preserve a rare riparian community that provides important functions including maintaining overall system resiliency. This riparian community is uniquely adapted to the Uncompahgre Plateau which includes extremes of high and low streamflow conditions in a semi-arid region. These diverse riparian communities of native species are well adapted to their location and are better able to withstand environmental stresses and catastrophic events. When a watershed is more resilient, it is better able to rebound following disturbances such as severe storms, flooding, landslides, mudslides, and wildfires. Resiliency also mitigates the impact of those disturbances on the surrounding communities, which improves outcomes for both people and ecosystems.

Native Fish

Although not the basis for the proposed ISF, Potter Creek also provides important habitat for the three-species: Flannelmouth Suckers (*Catostomus latipinnis*), Bluehead Suckers (*Catostomus discobolus*), and Roundtail Chubs (*Gila robusta*). These species are identified by the state of Colorado as Species of Greatest Conservation Need and by the BLM as sensitive species. They are also subject to a multi-state conservation agreement designed to prevent a listing of the species under the Endangered Species Act (Utah DNR, 2006).

Colorado Parks and Wildlife (CPW) has conducted extensive research in the Roubideau Creek basin including monitoring streamflow, fish sampling, and fish tracking to determine movement patterns and spawning site selection. CPW found that upwards of 25,000 fish use the Roubideau Creek drainage to spawn annually, with thousands of fish using tributaries such as Potter Creek. Individual fish have very high annual spawning tributary fidelity in this area, with up to 77% of individuals returning to the drainage multiple years in a row (Thompson and Hooley-Underwood, 2019).

High-flow events are also important for the three-species. These species are cued to spawn when streamflow in the tributaries increases during runoff. A gradual receding flow after the spring peak supports the development of eggs, hatching, larvae development, provides habitat for juvenile fish to grow and mature, and allows adult fish to move back into larger river systems before they become stranded. These findings highlight the importance of Potter Creek for the three-species, especially because few other accessible and flowing tributary networks remain.

ISF QUANTIFICATION

BLM staff, in conjunction with CWCB, evaluated the flow needs of the riparian communities and examined several methods to quantify the flow rates necessary to preserve the species.

Flow Needs of Riparian Communities

The BLM conducted a review of scientific literature to identify the flow regime needed to support the imperiled and vulnerable riparian communities of Potter (See BLM's recommendation letter for additional details). Considerable research has been conducted on the hydrologic conditions necessary for establishment and persistence of cottonwood trees. Those studies conclude that the persistence of cottonwood trees as part of a riparian community is highly dependent on infrequent flood or high-flow events (Cooper et al., 1999). High-flow events create disturbed areas and wet sediment deposits where cottonwood can germinate by seed, root, or branch fragment propagation (Scott et al., 1997).

Like cottonwood trees, strapleaf willow, silver buffalo berry, skunkbush sumac, and red osier dogwood benefit from flood events. Strapleaf willow and silver buffaloberry seeds require disturbed areas and wet sediment deposits for germination and development. Skunkbush sumac, red osier dogwood also reproduces by seed and root sprouts. Sprouting occurs more frequently in response to large disturbance events such as floods However, unlike cottonwood trees, skunkbush sumac, red osier dogwood, and silver buffaloberry need well-drained soils and will not tolerate long-duration high-flow events or high-water tables for long durations. BLM believes that the sandstone-based soils along Potter Creek and the generally short duration of high-flow events allows these species to survive and grow collectively.

In addition to high-flow events, research also concludes that slowly receding flow rates after the event are important for maintaining water levels in the alluvial aquifer. This allows the roots of new seedlings to grow and remain in contact with the receding groundwater levels in riparian soils (Mahoney and Rood, 1998). Baseflows, which occur in later summer, fall, and winter, also maintain water levels in the alluvial aquifer, supporting deep-rooted cottonwoods and willows, which both require constant access to groundwater to prevent dieback of upper branches or mortality.

Because high-flow events are critical to long-term reproduction and success of the riparian community, BLM focused on identifying the flow rate that would start to inundate the riparian community. BLM identified that bankfull, which is typically the elevation where streams start to access the floodplain and riparian vegetation, was an appropriate threshold necessary to preserve the riparian community. When streamflow is at bankfull conditions or above, important processes required for the long-term survival of the plants can occur, including creating areas where wet sediment is deposited, dispersal of seeds and branches, depositing nutrients on the floodplain, and recharge of the alluvial aquifer.

Hydraulic Modeling

BLM staff explored using the U.S. Forest Service's WinXSPRO model to identify the flow rate necessary to preserve the riparian communities. After evaluating the model, BLM and CWCB staff determined that the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center's River Analysis System (HEC-RAS) would produce more reliable results. HEC-RAS is widely used throughout the United States for hydraulic modeling of floods. This model uses multiple cross-sections to perform more advanced calculations than approaches that rely on single cross-sections. It is also capable of producing maps that illustrate the portions of the channel inundated at different flows. BLM and CWCB staff concluded that results from the HEC-RAS model were more appropriate and accurate for modeling high flows.

CWCB staff hired AECOM, an outside engineering firm, at the beginning of 2021 to collect detailed survey information and develop hydraulic models for the sites in each of the four proposed ISF reaches. CWCB Staff, BLM staff, and the AECOM surveyor selected a reach on lower Potter Creek about 0.4 miles downstream from the upper terminus. This site was selected based on the presence of the riparian species of interest and channel characteristics that were conducive to modeling efforts. In each selected site, AECOM surveyed cross-sections to measure channel geometry and floodplain topography. Bankfull indicators were identified by CWCB and BLM staff at each cross-section. In addition to elevation data, the AECOM surveyor also measured the location of debris piles deposited by exceptionally large and infrequent flow events. A total of five cross-sections were surveyed on the selected reach of lower Potter Creek.

AECOM then developed a hydraulic model for each reach using HEC-RAS version 5.0.7 (AECOM, 2021). Manning's n values were selected based on aerial imagery and photos collected during the field survey which showed the nature of the channel, bed material, and vegetation. These values were selected in accordance with Table 3-1 in the HEC-RAS 5.0.1 Reference Manual. On Potter Creek, the Manning's n values value in the channel was set to 0.04, the values in the floodplain were set to between 0.055 and 0.065. Using an iterative process, discharge values were entered into the model to find the streamflow that best corresponded with the surveyed bankfull indicators and the lowest and highest elevation flood debris. The bankfull discharge minimized the difference between the modeled water surface elevation and the surveyed bankfull elevations.

On lower Potter Creek, AECOM determined that the surveyed bankfull indicators correspond to a flow of 255 cfs (Table 1). The lower elevation flood debris corresponds to a streamflow of 1,050 cfs and the maximum elevation of the debris corresponds to a streamflow of 2,030 cfs.

Table 1. HEC-RAS modeling results for lower Potter Creek.

Parameter	Discharge, cfs
Bankfull	225
Minimum elevation of flood debris	1,050
Maximum elevation of flood debris	2,030

ISF Recommendation

This recommended ISF water right is specifically structured to protect the high-flow component of the hydrologic regime that is critical to the persistence of riparian communities. This water right also protects the receding limb of the hydrograph. Protecting bankfull flows and the receding limbs of the hydrograph will provide the conditions necessary for the reproduction and maintenance of riparian communities. The BLM recommends the following flows based on modeling analyses and the biological needs of the riparian communities:

> When the flow rate reaches 225.0 cfs (bankfull flow), all flow in the creek should be protected until the flow rate recedes to the existing instream flow water right appropriated in 2004.
>
> BLM recommends that the proposed water right be in effect only during the April 1 to September 30 period, if the flow rate threshold is met. This time frame corresponds to the portion of the year when the riparian community is actively growing and reproducing, and when most high-flow events occur due to snowmelt runoff and monsoonal thunderstorms. During years in which streamflow does not reach the proposed threshold, this instream flow water right for high-flow events would not be in effect.

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 to estimate a selected basin's streamflow statistics including flood discharge and frequency characteristics (Capesius and Stephens, 2009). 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.

Unlike other ISF water rights, this ISF will only be in effect when the bankfull threshold is reached and only during a limited portion of the year. This proposed ISF is not structured to occur year-round and is not expected to occur every year or even in most years. Therefore, median flow is not assessed in this analysis because the high-flow events necessary for the riparian community are not anticipated to occur on a median basis. Instead, the water availability analysis for lower Potter Creek provides information about the known hydrology in the area, the available streamflow data in Potter Creek, and the potential characteristics of these high-flow events.

Basin Characteristics

The drainage basin of the proposed ISF on lower Potter Creek is 57 square miles, with an average elevation of 7,645 feet and average annual precipitation of 18.99 inches (See the Hydrologic Features Map). Hydrology throughout the Uncompahgre Plateau demonstrates a relatively early snowmelt runoff pattern that is also influenced by monsoon and late-season storms. This results in high-flow events that can occur between early spring and summer due to snowmelt and high-flow events that can occur between summer and late fall due to rain events. A gage on Roubideau Creek, located downstream from Cottonwood Creek, Monitor Creek, and Potter Creek (Roubideau Creek at mouth near Delta, CO gage, USGS 09150500, period of record 1939 to 1953 and 1976 to 1983) shows that most annual peaks occur in May but can occur as late as October (Figure 2).

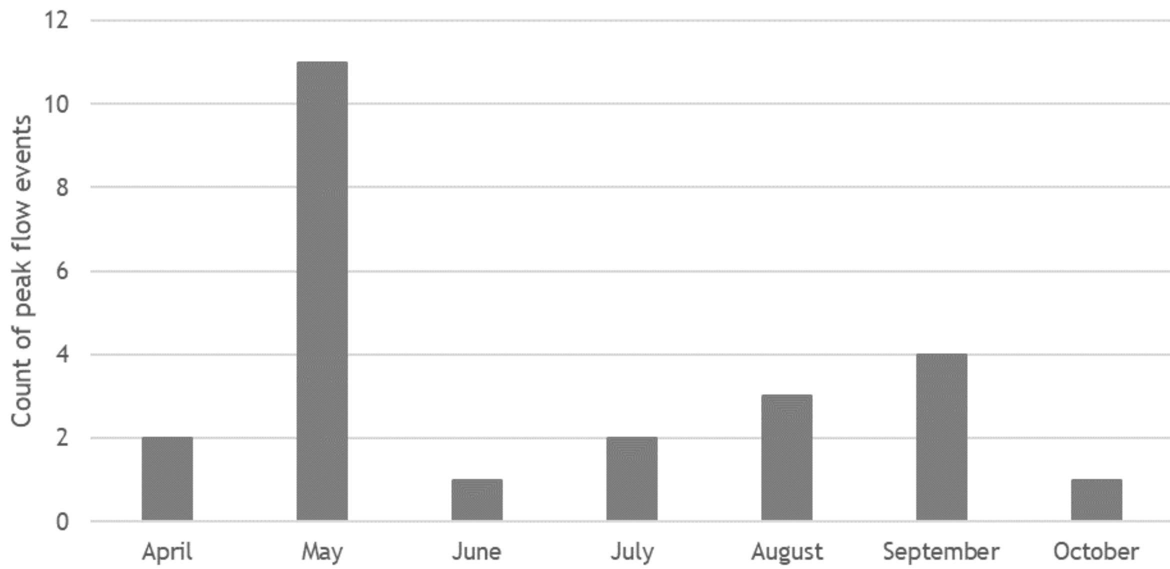


Figure 2. Number of times the peak occurred each month at the Roubideau Creek at mouth near Delta, CO peak flow gage data from 1939-1953 and 1976-1983.

Snowmelt runoff typically produces the high-flow event with the longest duration, which can last weeks to months. Rain events have the potential to produce very high flows but are typically short-duration events. Streamflow in this region can be highly variable, some years may have substantial flows while other years have little to no measurable flow.

Existing Water Uses

There are very few water rights in the basin tributary to the proposed ISF on upper Potter Creek but Monitor Creek, which is a tributary to lower Potter Creek, has significantly more water use. In total, there are 67.13 cfs in active surface water diversions in the entire lower Potter basin (See the Hydrologic Features Map and Detailed map). The largest of these is the Big Monitor Ditch No 1 (WDID 4001426, 51.85 cfs, appropriated in 1918). There are also 421.8 acre-feet in active storage rights, 0.56 cfs for a few springs and pipelines, and 0.4 cfs for well water rights. In addition, there are some diversions that import or export water into the Monitor basin. The Everlasting Ditch (WDID 4001435, 27 cfs, appropriated in 1901 and 1964), which diverts from Cottonwood Creek, irrigates lands in the Monitor Creek basin and may contribute additional flow. The 25 Mesa Upper Little Monitor Ditch (WDID 4001319, 7 cfs, appropriated in 1904) diverts water from Little Monitor Creek, which is used on lands in both the Monitor Creek and Cottonwood Creek basins. All of these water uses occur upstream from the proposed ISF reach on lower Potter Creek. Based on these water uses, hydrology is altered.

Data Collection and Analysis

A number of different sources of information were used to assess hydrology in lower Potter Creek. Each source will be presented in subsections for clarity.

USGS Potter Creek gages

There are two historic USGS streamflow gages on Potter Creek. The Potter Creek near Olathe, CO gage (USGS 9149910, 1979-1981) was located approximately 2,000 ft upstream from the proposed upper terminus at the confluence with Monitor Creek. The Potter Creek near

Columbine Pass gage (USGS 9149900, 1980-1981) was located 12 miles upstream from the proposed reach. Because both gages are located higher in the basin, they were not used further in this assessment of the lower Potter Creek hydrology.

CPW Potter Creek gage
CPW installs a temporary streamflow gage on Potter Creek annually to monitor spring flows in conjunction with research on spawning movements of native sucker species. This gage (termed the CPW Potter gage) is located about 600 ft upstream from the confluence with Roubideau Creek. The CPW Potter gage is operated seasonally, typically from early spring in March or April through June or early July when the spawning migration is completed, and flows drop. The gage has operated in most years from 2015 to 2022. However, streamflow was too low to develop a rating in 2018, no equipment was deployed in 2020 due to low flows, and equipment malfunctioned in 2021. This gage is not operated through late summer, fall, or winter and therefore does not record information from any flow events during those portions of the year. CWCB helped maintain the gage by making multiple streamflow measurements. Staff then used the available data to develop a rating curve to determine streamflow during the gaged portions of the years with data.

Climate Conditions
The CPW Potter Creek gage record period (2015-2022) was compared to a longer-term climate record for context. The nearest climate station with a relatively long record is at Columbine Pass (USS0008L02S, 1986 to 2022) located in the headwaters of Potter Creek, approximately 18 miles southwest from the proposed lower terminus. Figure 3 shows cumulative snow water equivalent (SWE) totals for 2015-2022 in comparison to the 30-year average (downloaded from the Colorado River Basin Forecast Center on 2/9/2023). Peak SWE in 2018 was the lowest on record, 2015, 2020 and 2021 were below average, 2016 was about average, and 2017, 2019, and 2022 were above average. This information demonstrates a range of precipitation in the area during the CPW Potter Creek gage record.

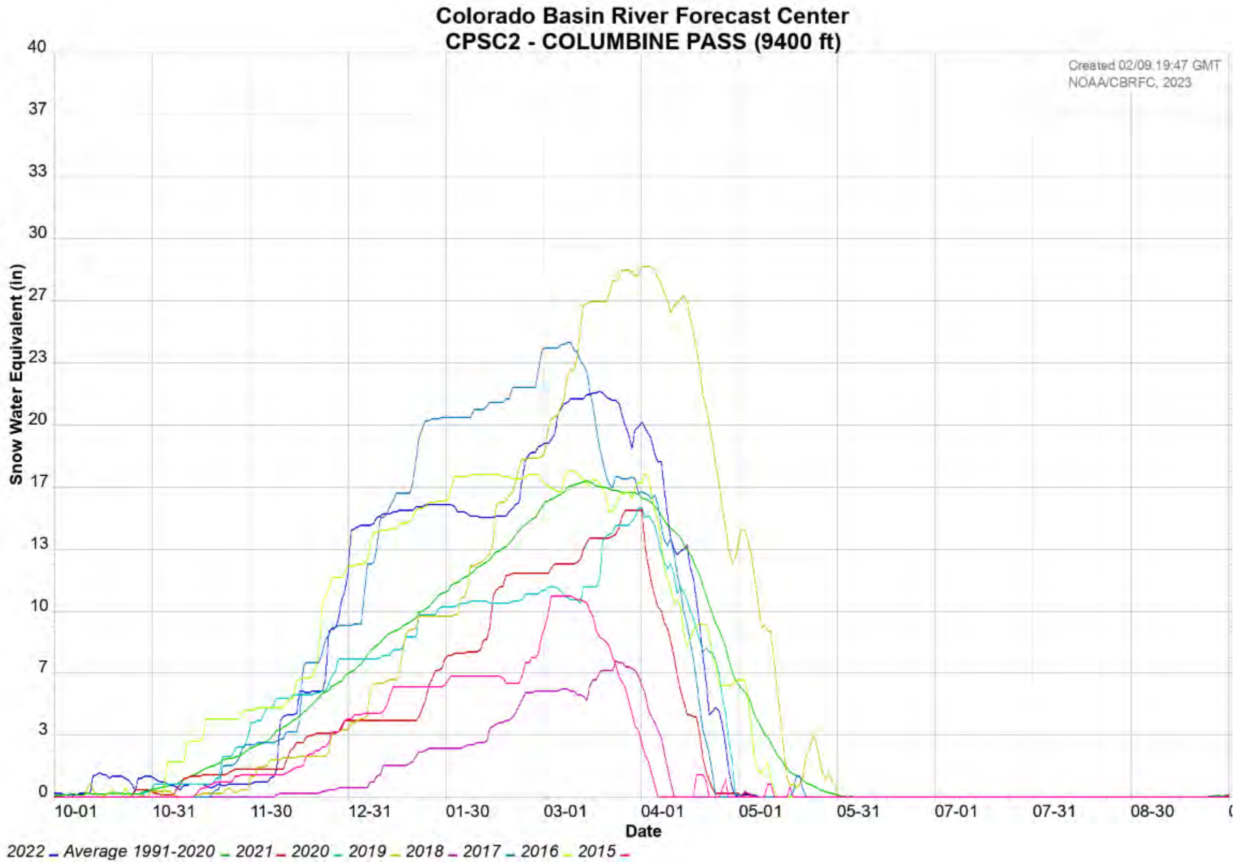


Figure 3. Cumulative SWE for 2015 to 2022 and average SWE from 1991 to 2020 downloaded from the Colorado River Basin Forecast Center on 2/9/2023. Source: NOAA Colorado Basin River Forecast Center

Staff also evaluated streamflow gages to better understand potential streamflow given that persistent low soil moisture in recent years has impacted how much snowfall becomes streamflow. The Dallas Creek gage and San Miguel gages (USGS 09147000 Dallas Creek near Ridgway and USGS 0917700 San Miguel River at Uravan) were selected because they were reasonably close to the Uncompahgre Plateau. The gages are not impacted by large reservoirs; however, they are in different basins and have significant water uses. Years with complete data (provisional or approved data, filling missing data in 2022 with the long-term average) from 1992 to 2022 was used to calculate annual water volumes and basic percentiles. Data from these gages show that 2019 was very wet (greater than 75th percentile); 2015 was wet to dry (greater than 50th percentile for the San Miguel and greater than the 75th percentile for Dallas Creek, 2016 and 2017 was wet or wettest (greater than the 50th percentile for the San Miguel River and greater than 75th percentile for Dallas Creek); 2018, 2020, 2021, and 2022 were in the driest category (less then 25th percentile). 2018 and 2020 were exceptionally dry with annual water volumes less than the 10th percentile. Therefore, the CPW Potter Creek gage data contains a range of year types, but many years in the record are likely to reflect dry or exceptionally dry conditions.

Based on the existing water uses practices in the basin, the streamflow measured at the CPW Potter Creek gage does not reflect natural hydrology. However, the impacts from these uses are recorded in the gage data. Based on this gage, hydrology in lower Potter Creek shows a range in streamflow between 2015 and 2022. The highest flows occurred in 2019. There were clear snowmelt runoff events in 2022, 2017, and 2016. Flows were lower in 2015 and very low in 2018 and 2020. There is no data for 2021 due to equipment malfunctions. Based on the CPW Potter Creek gage estimates, the riparian threshold of 225 cfs occurred several times as discussed below.

High-Flow Characteristics

The ISF recommendation is based on the importance of high-flow events that help to maintain the rare riparian community on Potter Creek. Based on the available information from the CPW gage, riparian flows would have been achieved four times between 2015 and 2022. These events lasted between approximately 39 and 64 days; in 2017 and 2019 the gage was discontinued before streamflow returned to the 2004 ISF levels (Table 2).

Table 2. Duration and maximum streamflow for high-flow events that reached bankfull thresholds in lower Potter Creek (2015-2022).

Start Date	End Date	Duration, days	Maximum flow, cfs	Data Source
4/16/2016	6/3/2016	48 days	263	CPW Potter Creek Gage
4/19/2017	6/7/2017	~48 days[1]	268	CPW Potter Creek Gage
4/28/2019	7/1/2019	~64 days[1]	324	CPW Potter Creek Gage
4/19/2022	5/29/2022	39 days	302	CPW Potter Creek Gage

[1]The end date for 2017 and 2019 is approximate because the gage was discontinued for the season before flows returned to the 2004 ISF level.

Although the CPW Potter Creek gage does not include data collected during later summer or fall, it is likely that monsoon events do occur in this system. These events have the potential to reach the riparian threshold. For example, the CWCB Monitor Creek gage, located on a tributary upstream, measured two high-flow events later in the summer of 2017 and 2019 (see the Monitor Creek March 2023 Executive Summary for more information). The event on Monitor Creek in 2017 was nearly 225 cfs and the event in 2019 was above the 225 cfs riparian threshold for lower Potter Creek.

The USGS StreamStats model estimates different peak flow statistics based on regional regression analysis (Table 3). These estimates provide information about the potential frequency of high-flow events, but the estimates may have high uncertainty in this area due to the lack of streamflow gages in the region that can be used to inform the models. Nevertheless, these estimates suggest that the riparian threshold of 225 cfs could occur at the frequency of about a 2-year peak flood event.

Table 3. StreamStats estimates of area-averaged high-flow events for lower Potter Creek.

Peak Flow Statistic	Estimated Flow, cfs
2 Year Peak Flood	296
5 Year Peak Flood	548
10 Year Peak Flood	756
25 Year Peak Flood	1,100
100 Year Peak Flood	1,650

Historical High-Flow Event Estimates

AECOM also surveyed the location of large piles of woody debris deposited by previous very infrequent high-flow events on the floodplain of the modeled stream site. The HEC-RAS model was used to estimate the flow necessary to reach the locations of the debris piles. This modeling work estimated that a flow of 1,050 cfs would reach the minimum elevation of the debris and a flow of 2,030 cfs would reach the high elevation of the debris. The observation of large piles of debris on the floodplain demonstrates that very high-flow events do occur and that these events can inundate large portions of the floodplain. The StreamStats peak flow statistics estimate that an event capable of reaching the lower elevation flood debris could occur on a 25-year frequency.

Water Availability Summary

The USGS and CPW Potter Creek gages, the AECOM high-flow estimates from flood debris, and StreamStats estimates of peak flow events provide an estimate of the range of streamflow conditions on lower Potter Creek. These data demonstrate that a high-flow event above the bankfull threshold of 225 cfs have occurred during spring runoff, but do not happen each year. In addition, it is likely that rain events later in the summer also reach the riparian threshold. Staff has concluded that water is available for ISF appropriation as structured.

MATERIAL INJURY

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

ADDITIONAL INFORMATION

Citations

AECOM, 2021, Cottonwood, Monitor, and Potter Creek's survey and hydraulics. Memo to CWCB.

Bureau of Land Management, 2020, Record of decision and approved resource management plan for Uncompahgre Field Office, 2020.

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

Colorado Natural Heritage Program, Rocky Mountain lower montane-foothills riparian woodland and shrubland. https://cnhp.colostate.edu/projects/ecological-systems-of-colorado/details/?elementID=365200

Cooper D.J., Merritt, D.M., Anderson, D.C. and Chimner, R.A, 1999, Factors controlling the establishment of Fremont cottonwood seedlings on the Upper Green River, USA. Regulated Rivers: Research and Management, 15:419-440.

Damm, M., and J. Stevens, 2000, Assessment of riparian vegetation and wildlife habitat structure: North Fork of the Gunnison tributaries and lower Gunnison tributaries. Colorado Natural Heritage Program.

Mahoney, J.M. and S.B. Rood, 1998, Streamflow requirements for cottonwood seedling recruitment- an integrative model. Wetlands, 18; 634-645.

Scott, M.L., Auble, G.T., and Friedman, J.M.,1997, Flood dependency of cottonwood establishment along the Missouri River, Montana, USA. Ecological Applications, 7:677-690.

Somers, P. and L. Floyd-Hanna, 1996, Wetlands and riparian habitats, and rivers. In Blair, R., ed. pp. 175-192. The western San Juan Mountains: their geology, ecology, and human history. University Press of Colorado, Niwot, CO.

Stephens, T., D. Culver, J. Zoern, and P. Lyon, 1999, A natural heritage assessment of wetlands and riparian areas in Uncompahgre River basin: Eastern Montrose and Ouray Counties Volume II. Colorado Natural Heritage Program.

Thompson, K.G., and Z.E. Hooley-Underwood, 2019, Present distribution of three Colorado River basin native non-game fishes, and their use of tributaries. Technical publication No. 52, Colorado Parks and Wildlife Aquatic Research Section.

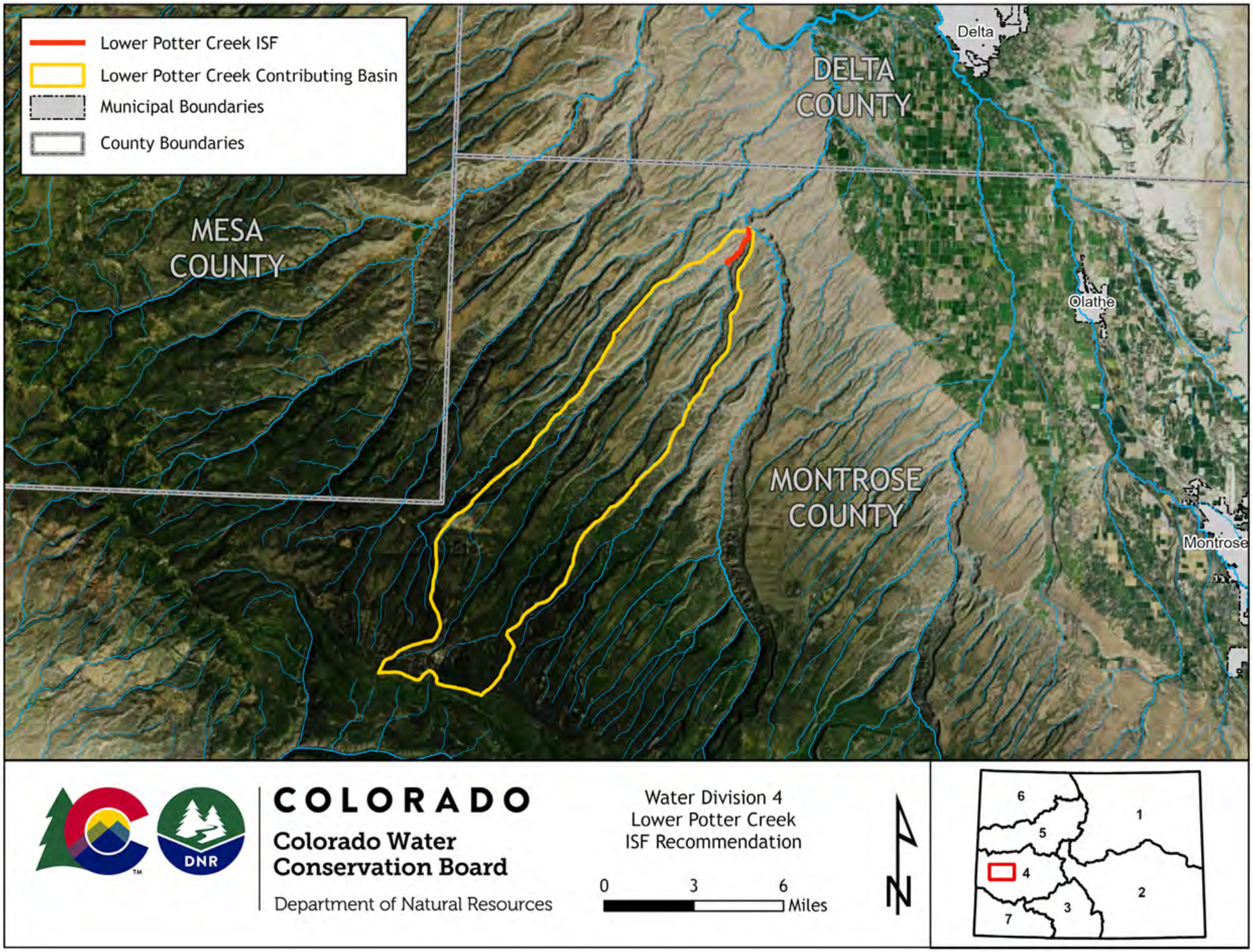
Utah Department of Natural Resources, Division of Wildlife Resources, 2006, Range-wide conservation agreement and strategy for Roundtail Chub *Gila robusta*, Bluehead Sucker *Catostomus discobolus*, and Flannelmouth Sucker *Catostomus latipinnis*.

Metadata Descriptions

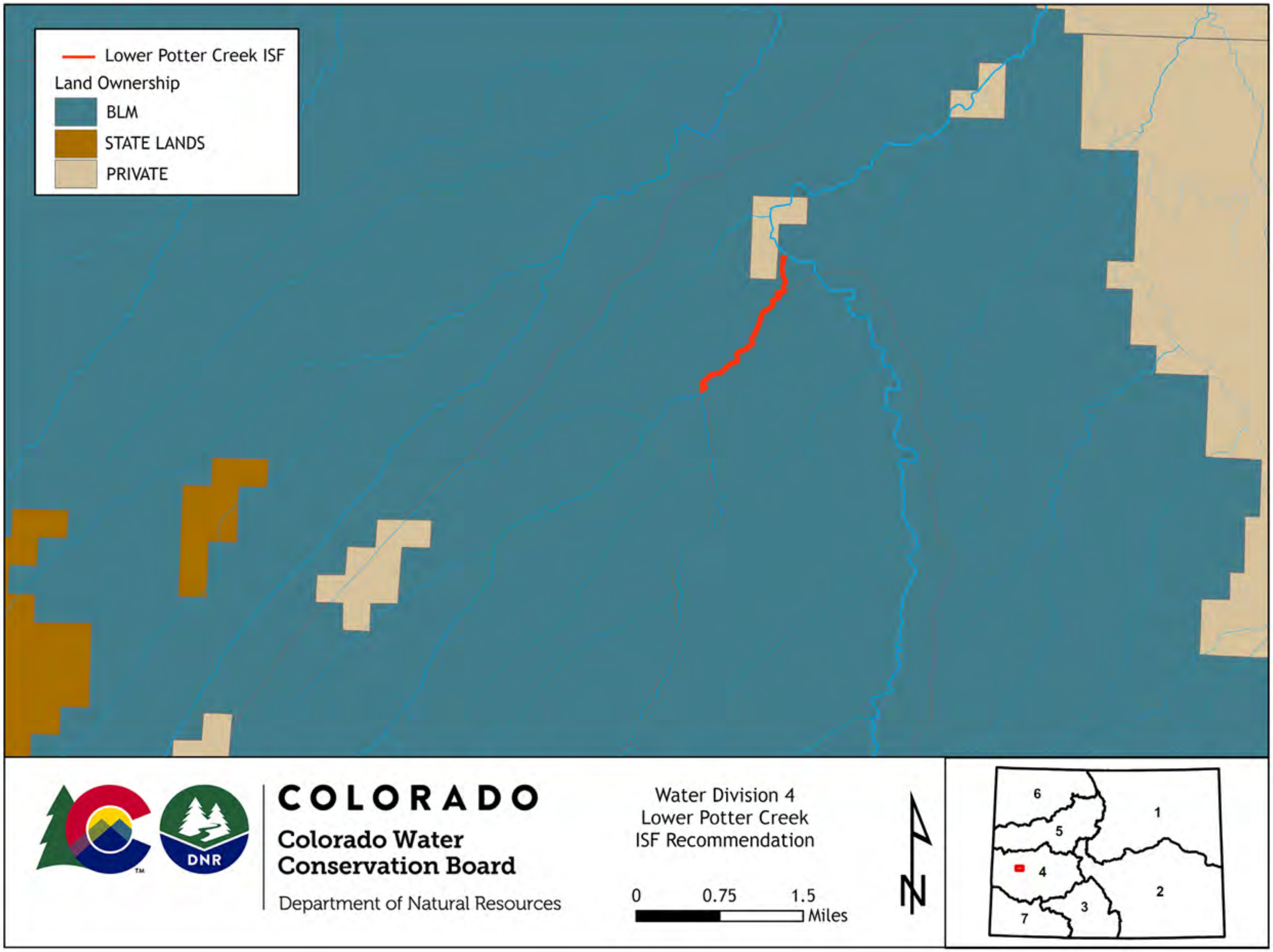
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

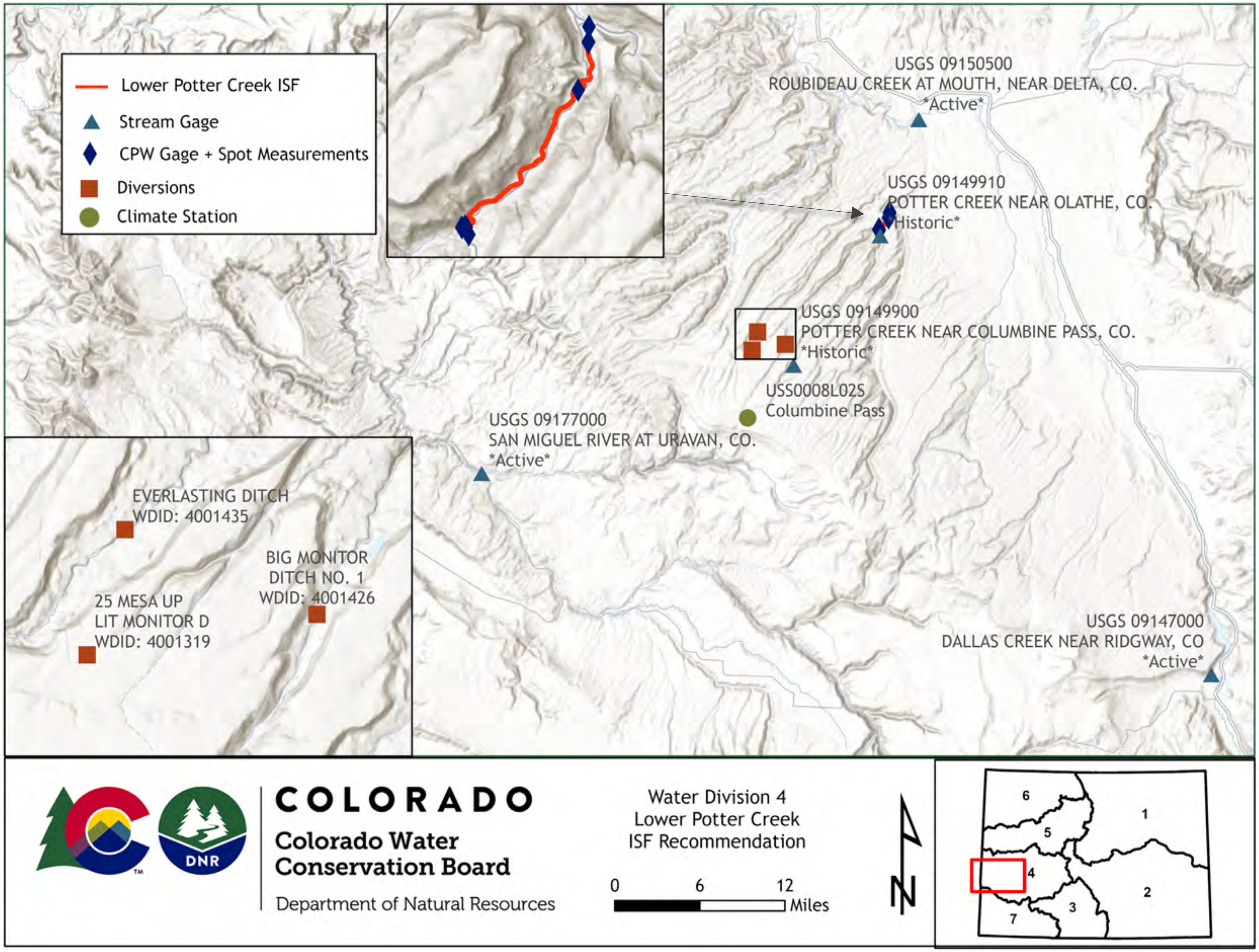
VICINITY MAP



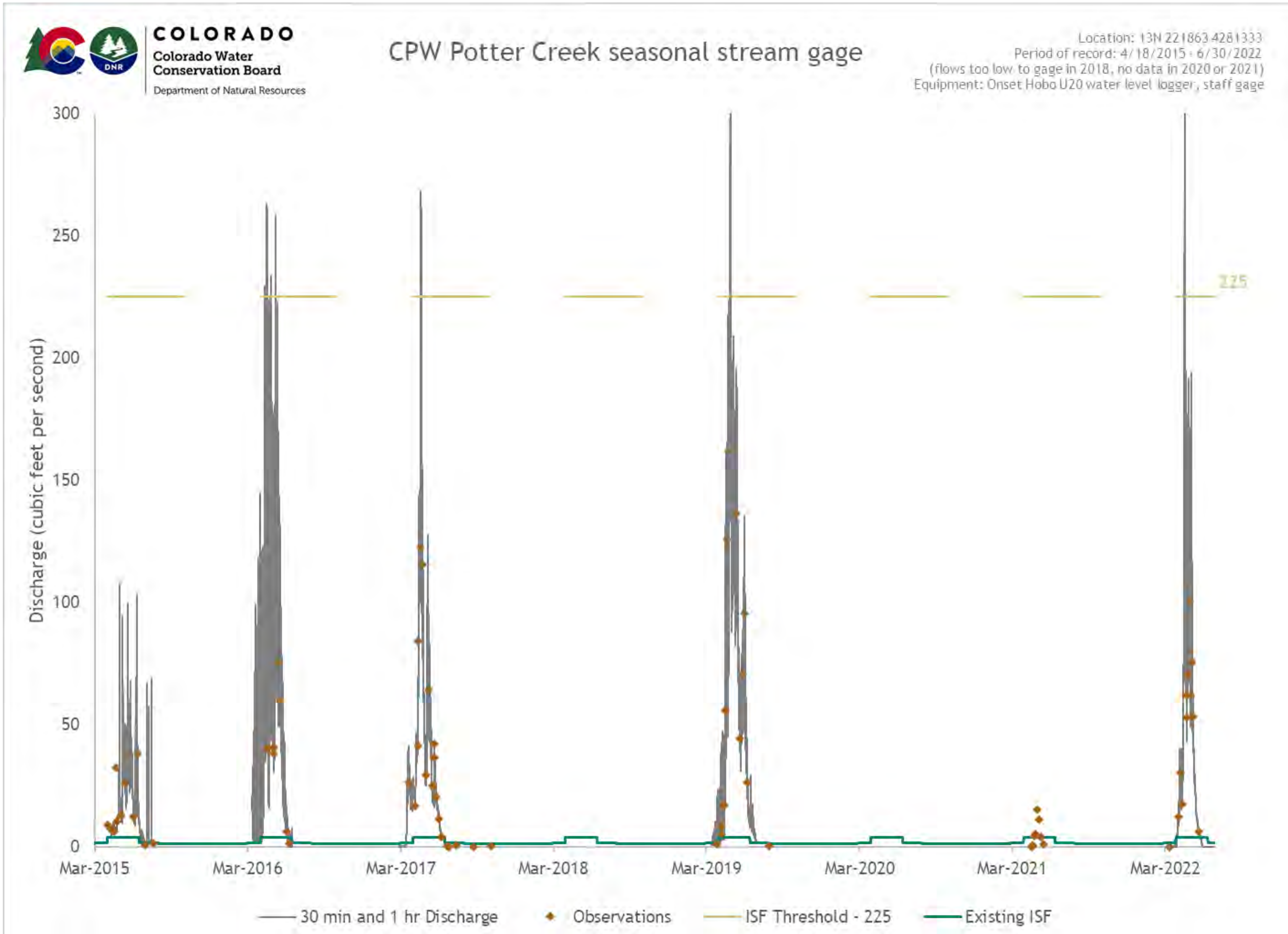
LAND OWNERSHIP MAP



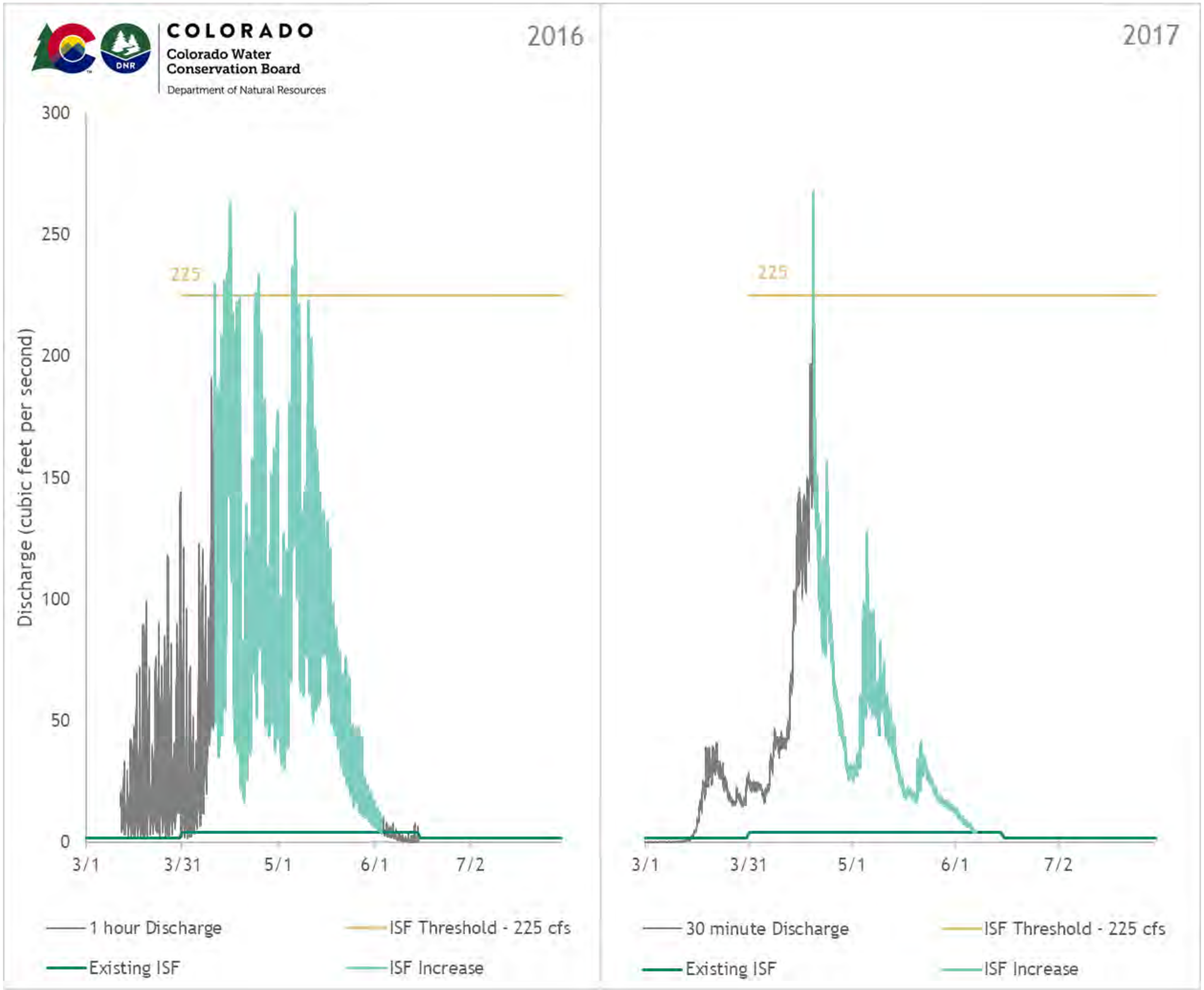
HYDROLOGIC FEATURES MAP



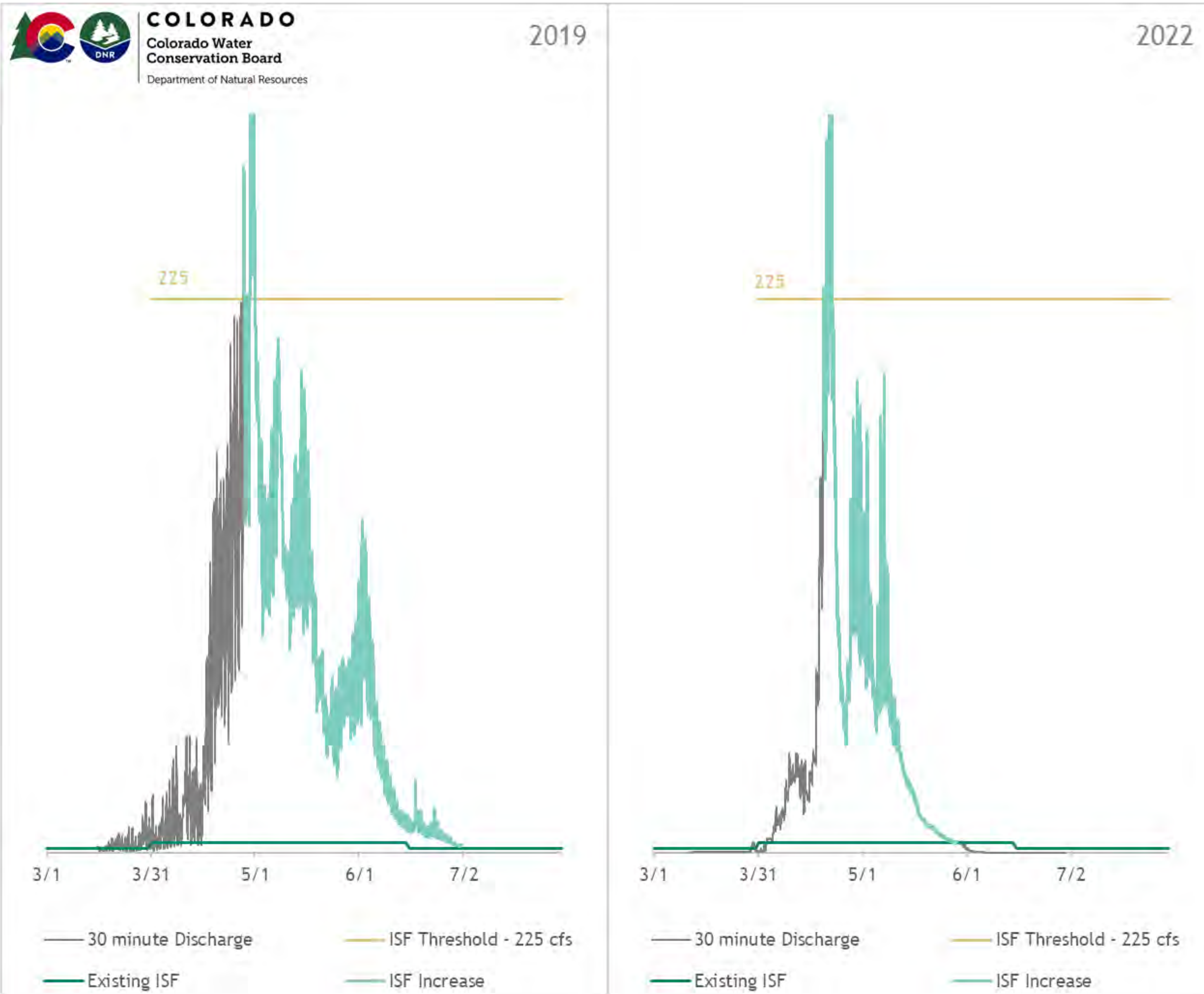
COMPLETE HYDROGRAPH



DETAILED HYDROGRAPH



DETAILED HYDROGRAPH



United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Department of Interior
Bureau of Land Management
Colorado State Office
Denver Federal Center, Building 40
Lakewood, Colorado 80215
www.blm.gov/colorado

In Reply Refer To:
7250 (CO-932)

Mr. Rob Viehl
Colorado Water Conservation Board
1313 Sherman Street, Room 721
Denver, Colorado 80203

Dear Mr. Viehl:

The Bureau of Land Management (BLM) is writing this letter to formally communicate its recommendation for an increase to the instream flow water right on Cottonwood Creek, located in Water Division 4. Cottonwood Creek is tributary to Roubideau Creek approximately four miles west of the City of Delta. This recommendation covers the portion of Cottonwood Creek that runs from the headgate of the Hawkins Ditch to the confluence with Roubideau Creek. For the 23.3-mile reach, 86% is located on federal lands, 7% is located on state lands, and the remaining 7% is privately owned.

This recommendation is a response to a request from the Colorado Water Conservation Board (CWCB). The CWCB requested that BLM identify a method to protect water-dependent values on Cottonwood Creek that may help build an alternative to formal designation of Cottonwood Creek into the National Wild and Scenic Rivers System. In the Record of Decision and Final Resource Management Plan for Dominguez-Escalante National Conservation Area, BLM determined that Cottonwood Creek is suitable for Wild and Scenic River designation. BLM's suitability determination specifically noted that the current lack of flow protection for globally significant riparian values was a significant factor driving BLM's suitability determination. BLM believes that the land use protections associated with a BLM suitability determination, combined with an instream flow water right appropriated by the CWCB to protect water-dependent values, will provide long-term protection for Cottonwood Creek.

There are two key scientific concepts driving this recommendation. The first is that establishment and reproduction of these riparian communities is highly dependent on periodic high flow events. This recommendation is structured so that instream flow protection is triggered when a high flow event begins, and protection continues until the high flow event recedes to base flow levels. The second scientific concept is that protection of base flows provides essential habitat for fish communities, and they also maintain the alluvial aquifer where the roots of riparian communities draw water. This recommendation acknowledges that there is an existing instream flow water right on Cottonwood Creek designed to protect base flows, and it relies upon that base flow protection to maintain alluvial aquifers that are critical for supporting riparian communities.

Even with these two forms of instream flow protection, this recommendation still leaves substantial water available for appropriation. When flows are above the protected base flow levels, but below the flow rate that triggers high flow protection, water can be appropriated for human use. In addition, when the creek leaves the Uncompahgre Plateau and enters the valley floor, flows will not be subject to protection and will be available for appropriation.

BLM's detailed instream flow recommendation, along with biological information and hydrologic investigations that support it, are set forth in a comprehensive report enclosed with this letter.

If you have any questions regarding our instream flow recommendation, please contact Roy Smith at 303-239-3940.

Sincerely,

Digitally signed by ALAN BITTNER
Date: 2023.02.28 08:20:45 -07'00'

Deputy State Director
Resources

Enclosure – Cottonwood Creek Instream Flow Report

Cc:
Stephanie Connolly, Southwest DO
Suzanne Copping, Uncompahgre FO
Jedd Sondergard, Uncompahgre FO

BLM Instream Flow Recommendation

Cottonwood Creek, Uncompahgre Plateau
Water Division 4

Instream Flow Recommendation Report Table of Contents

INTRODUCTION

Cottonwood Creek is located within the larger Roubideau Creek watershed, one of the most ecologically intact watersheds on the eastern side of the Uncompahgre Plateau. Cottonwood Creek originates at an elevation of approximately 9,000 feet near Columbine Pass and passes through the montane conifer and pinyon-juniper woodland ecological zones as it descends to an elevation of 5,000 feet at its confluence with Roubideau Creek.

The Cottonwood Creek watershed has experienced only limited development because there are only a few privately owned parcels within the watershed and water used to irrigate these private parcels is diverted from Cottonwood Creek and from neighboring Monitor Creek. While these diversions are only a small fraction of the average flow during snowmelt runoff, they can cause the creek to be dried up below the diversions during the July to September period. The riparian community on Cottonwood Creek reflects this hydrology, in that natural high flow events which support the riparian community still occur. However, low base flows during July-September limit the riparian community, in terms of distance and elevation from the active channel. Overall, the relatively intact high flow event regime on Cottonwood Creek supports healthy, intact riparian communities along the creek, but the last 20 years of drought have reduced the lateral extent of the riparian community.

There are no major barriers to native fish passage between Cottonwood Creek and the Gunnison River, which is unusual for streams on the eastern side of the Uncompahgre Plateau. The hydrology described above also supports abundant habitat for spawning and rearing by native fishes, including flannelmouth sucker, bluehead sucker, and roundtail chub, which are BLM sensitive species and species that are also the subject of a multi-state conservation agreement designed to prevent a listing of the species under the Endangered Species Act. The native fishes spend much of their life cycle in the Gunnison River but can be found in high numbers in Cottonwood Creek during the snowmelt runoff period.

The purpose of this recommendation is to protect the full array of Cottonwood Creek's ecological functions with instream flow water rights. The recommended instream flow water right is specifically structured to protect a component of the hydrologic regime – high flows -- that is critical for the persistence of riparian communities. Another critical component of the flow regime – base flows -- is partially protected by an existing seasonal instream flow water right from April 1 to June 15. Together, the two water rights assist in protecting the flow-dependent ecological functions in Cottonwood Creek while acknowledging that the hydrology of the creek has been somewhat altered by existing diversions.

This report covers the portion of Cottonwood Creek that runs from the headgate of the Hawkins Ditch to the confluence with Roubideau Creek. Eighty-six percent of the 23.3-mile reach is located on federal lands, while 7% is located on state lands, and the remaining 7% is privately owned.

BACKGROUND INFORMATION

BLM commenced an intensive study and review of Cottonwood Creek's management in 2010, as part of a general land use plan revision for lands managed by BLM's Uncompahgre Field Office. The intensive review of Cottonwood Creek by BLM was mandated by the National Wild and Scenic Rivers Act of 1968. The Act specifies that all federal land use plan revisions must analyze whether streams that pass through federal lands are "eligible" for designation into the National Wild and Scenic Rivers System.

An "eligibility" analysis identifies whether a stream supports one or more "outstandingly remarkable values" also referred to as "ORVs." An ORV is defined as a river-related value that is unique, rare, or exemplary, when compared to the other streams in the region of comparison, which in this case is the Colorado Plateau and southern Rocky Mountains eco-regions. An eligibility analysis also requires BLM to identify whether a stream is "free-flowing," which means that the stream does not have any on-channel water storage facilities.

When BLM conducted its review of Cottonwood Creek, it found that Cottonwood Creek is free-flowing and possesses ORVs. BLM relied upon information supplied by the Colorado Natural Heritage Program (CNHP), which has identified riparian communities along Cottonwood Creek that are globally vulnerable. CNHP also determined that these riparian communities are in good condition. The CNHP findings qualified as an "ORV" for BLM's eligibility study because BLM's Wild and Scenic River's Manual 6400 specifies the following criteria for a botanical or vegetation ORV:

> The area within the river corridor contains riparian communities that are ranked critically imperiled by state-based natural heritage programs. Alternatively, the river contains exemplary examples, in terms of health, resilience, species diversity, and age diversity, of more common riparian communities.

After completing the eligibility study of Cottonwood Creek, BLM also completed a separate "suitability" study, as required by the BLM Wild and Scenic Rivers Manual 6400. A "suitability" study analyzes 13 factors, including social, political, economic, and land management issues, to make a determination as to whether an "eligible" stream would make a good addition to the National Wild and Scenic Rivers System (NWSRS). Overall, a suitability study is designed to identify what management approach will work best to protect and enhance the identified ORVs. The study requires BLM to analyze what protection can be accomplished under BLM's land use and planning authorities, and to identify where those authorities cannot provide full protection to the ORVs.

BLM's draft suitability study was completed as part of a draft Resource Management Plan for the Dominguez-Escalante National Conservation Area, which was created by Congress in 2009. BLM's draft suitability analysis concluded that Cottonwood Creek is suitable for designation into the NWSRS. BLM reached this conclusion because while BLM can very effectively protect Cottonwood Creek's riparian communities from the land management perspective, BLM lacks authority to protect stream flows that are necessary for the continued persistence of those communities. BLM noted that if the stream were designated into the NWSRS, the designation would provide BLM with authority to claim a federal reserved water right for protecting the ORVs.

BLM issued its draft suitability report in 2013. After reviewing the draft, the CWCB sent a letter to BLM requesting that it work with the CWCB to develop a flow protection approach that would serve as an alternative to a federal reserved water right, thereby reducing the need for federal Wild and Scenic River designation.

In its final suitability report, BLM noted that a Gunnison River Basin stakeholder group was formed for the express purpose of providing recommendations to the BLM concerning Wild and Scenic River determinations. The suitability report noted that the stakeholder group did not reach consensus, with some stakeholders recommending a "suitable" determination, while other stakeholders recommending a "not suitable" determination. However, there was unanimity among the stakeholders that BLM should work closely with the CWCB to protect the flows necessary to support the vegetation ORV.

BLM's Final Suitability Report was formally adopted in 2017 with a BLM Record of Decision (ROD) on the Resource Management Plan for the Dominguez-Escalante National Conservation Area. The ROD sets the stage for BLM to formally cooperate with CWCB on comprehensive flow protection. BLM believes that the land use protections associated with the recently completed suitability determination, combined with an instream flow water right to protect water-dependent values, will provide long-term protection for Cottonwood Creek.

Willows sprouting in a high flow event zone along Cottonwood Creek.

References:

Bureau of Land Management. Final Wild and Scenic River Eligibility Report for The Uncompahgre Planning Area, 2010.

Bureau of Land Management. Record of Decision and Approved Resource Management Plan for Dominguez-Escalante National Conservation Area, 2017.

U.S. Environmental Protection Agency Ecoregion Map at https://www.epa.gov/eco-research/level-iii-and-iv-ecoregions-continental-united-states

BIOLOGICAL SUMMARY

Colorado Natural Heritage Program (CNHP) Methodology

When formulating this recommendation for an instream flow water right to protect riparian species and communities, BLM relied heavily upon information collected by CNHP, as well as subsequent field visits by BLM staff. CNHP is a nonprofit organization and is a sponsored program of the Warner College of Natural Resources at Colorado State University. CNHP is also a member of the NatureServe Network, an international network of partners that use the same scientific methodology to enable scientists to monitor the status of species and natural plant communities from state, national, and global perspectives.

To determine the conservation status of species within Colorado, CNHP gathers information on plants, animals, and natural plant communities throughout the state, also called “elements” of biodiversity. When CNHP completes a site-specific inventory and verifies the presence of an individual species or community, the verified location is called an “element occurrence.” Each element occurrence is ranked on a scale of A-D (excellent to poor) based on condition, size, and landscape context.

Using known information from element occurrences, each element of biodiversity (plant or animal species, or natural plant community) is assigned a rank that indicates its relative degree of imperilment on a five-point scale (for example, 1 = extremely rare/imperiled, 5 = abundant/secure). The primary criterion for ranking elements is the number of occurrences (in other words, the number of known distinct localities or populations). Element imperilment ranks are assigned both in terms of the element's degree of imperilment within Colorado (its State-rank or S-rank) and the element's imperilment over its entire range (its Global-rank or G-rank). Taken together, these two ranks indicate the degree of imperilment of an element. A complete description of each of the Natural Heritage ranks is provided below.

G/S1	**Critically imperiled**-at very high risk of extinction due to extreme rarity (often 5 or fewer occurrences) in the world/statewide, very steep declines, or other factors.
G/S2	**Imperiled-** at high risk of extinction or elimination globally/statewide because of rarity (6 to 20 occurrences, or 1,000 to 3,000 individuals) due to very restricted range, very few populations, steep declines, or other factors.
G/S3	**Vulnerable-**at moderate risk of extinction or elimination through its range or found locally in a restricted range (21 to 100 occurrences, or 3,000 to 10,000 individuals).
G/S4	**Apparently secure** globally/statewide, though it may be quite rare in parts of its range, especially at the periphery. Usually more than 100 occurrences and 10,000 individuals.
G/S5	**Secure-**common; widespread and abundant globally/statewide, though it may be quite rare in parts of its range, especially at the periphery.

Riparian Communities Supported by Cottonwood Creek

CNHP surveys revealed that Cottonwood Creek supports numerous occurrences of healthy, intact riparian plant communities that fall within the Rocky Mountain Lower Montane-Foothills Riparian Woodland and Shrubland Ecological System. Examples of the communities found along Cottonwood Creek and their imperilment ranks include:

- Narrowleaf Cottonwood / Skunkbush Sumac (Populus angustifolia/Rhus trilobata) Riparian Woodland (GS/S3, A-Excellent Condition)

- Extensive acreage of other riparian communities and species that are not globally imperiled. These occurrences are noted to be in very good condition and include species such as red osier dogwood, thin leaf alder, strap leaf willow, and coyote willow.

The global imperilment rank for the Narrowleaf Cottonwood / Skunkbush Sumac riparian community is globally vulnerable and state vulnerable. Imperilment for most riparian communities within the Rocky Mountain Lower Montane Riparian and Woodland Ecological System is caused by vegetation alteration as the surrounding landscape is developed and roads, homes, or agriculture fields directly infringe on floodplain zones; hydrologic alteration caused by dams and diversions; and invasive species introduction. These riparian systems have also been impacted by the loss of beaver. Throughout Colorado, intact examples of Lower Montane Riparian Woodland and Shrubland riparian communities are relatively rare.

The occurrences of these natural plant communities along Cottonwood Creek received an “A” ranking for excellent estimated long-term viability when they were originally surveyed by CNHP in the 1990s. An “A” ranking means that the local occurrence is in excellent condition and has an excellent chance at long-term persistence, provided that the community is not threatened by changes to land use and/or changes to the stream flows that support the community. More recent visits by BLM confirm that the communities are still viable, and reproduction of the primary species still occurs.

Even though Narrowleaf Cottonwood and Skunkbush Sumac are widely distributed throughout the western United States, they are seldom found growing in the same habitat because of their different habitat needs. BLM concluded that the reason these species form a distinct riparian community along Cottonwood Creek is related to hydrology and soils. The creek provides short-term flood conditions and moist alluvial soils after high flow events for cottonwood establishment. After seasonal high flow events, alluvial groundwater levels supported by the creek’s base flow are sufficiently high to support established cottonwood in areas immediately adjacent to the creek. However, while conditions within the riparian zone support cottonwood species, the sandstone-based soils along Cottonwood Creek are also very well drained, which allows the riparian zone to support species that do not tolerate high soil moisture for long periods of time.

The disturbances created by short-term high flow events favor sprouting by Skunkbush Sumac and Narrowleaf Cottonwood. Once short-term high flow events recede, the soils in the Cottonwood Creek floodplain are sufficiently well drained that Skunkbush Sumac can thrive, since its rooting depth is less than cottonwood root depths.

CNHP has designated the Cottonwood Creek watershed as a Potential Conservation Area (PCA) because of the importance of the riparian community. Potential Conservation Areas are identified by CNHP as landscapes that possess numerous elements of biological diversity within a concentrated area, making them candidates for protection if land and water management objectives include preservation of biological diversity. The Cottonwood Creek Road PCA is ranked as having very high biodiversity significance (B2, on a scale of B1-B5) because of both the intact riparian zones and several occurrences of rare upland plant species.

References:

Colorado Natural Heritage Program. Biodiversity Information Management System (also known as Biotics Database).

Colorado Natural Heritage Program. Cottonwood Creek Road Level 4 Potential Conservation Area Report. https://cnhp.colostate.edu/download/documents/pca/L4_PCA-Cottonwood%20Creek_4-24-2022.pdf

Colorado Natural Heritage Program. Rocky Mountain Lower Montane-Foothills Riparian Woodland and Shrubland. https://cnhp.colostate.edu/projects/ecological-systems-of-colorado/details/?elementID=365200

BLM Objectives for Managing Vulnerable Riparian Communities

CNHP has determined the riparian communities on Cottonwood Creek are rare and vulnerable at the global and state level. In addition, CNHP has noted that Cottonwood Creek is largely ecologically intact with some hydrologic alteration, which has resulted in riparian communities that are in good condition. For these reasons, BLM determined that the riparian communities along Cottonwood Creek met the threshold for an “outstandingly remarkable value,” (ORV) as defined by the Wild and Scenic Rivers Act.

BLM concurs with CNHP that preservation of globally significant riparian communities is important. BLM believes there are four primary reasons why protecting globally significant riparian communities is important:

- The existence of a set of species that forms a riparian community proves that its combination of species is stable and can thrive within the physical constraints of that environment. These constraints include soil type, flow regimes, slope, channel morphology, broad climate factors, micro-climates. In other words, that combination of species has proven its resiliency over time.

- Resilient communities are better able to withstand environmental stresses and catastrophic events, including floods, drought, fire, climate change, and disease.

- Resilient communities have a superior ability to provide environmental services. These services include stabilization of stream banks, storage of water in stable stream banks, filtration of pollution, stream shading, cycling of vegetative material, and cycling of nutrients. All of these services provide benefits for aquatic habitats, terrestrial wildlife, and humans.

- Resilient communities provide superior wildlife habitat, because specialist wildlife species have evolved to take advantage of the foraging, nesting, and brooding opportunities provided by those communities.

Overall, BLM concludes that while the individual species of Narrowleaf Cottonwood and Skunkbush Sumac are common in Colorado, the combination of these two species occupying the same habitat is rare. BLM believes that comprehensive protection is warranted because this community is uniquely adapted to thrive in conditions on the Uncompahgre Plateau, which includes stress from catastrophic events. If protected, this community will continue to be resilient and stable, and continue to provide the environmental services that adjacent human communities expect, such as providing wildlife habitat, high quality water supplies, and erosion control/mitigation.

Description of Species Within the Riparian Communities

The following section provides descriptions of each of the primary species that compose the globally significant riparian community. These descriptions include brief summaries of the habitat, as well as processes and hydrologic conditions that are necessary for successful reproduction and propagation.

Narrowleaf Cottonwood and Fremont Cottonwood

Narrowleaf Cottonwood (Populus angustifolia) and Fremont Cottonwood (Populus deltoides) are members of the willow family that can grow up to 80 feet in height. These species occupy the overstory in many riparian zones in Colorado that are located from 4,000 to 7,000 feet in elevation. Cottonwoods often grow in densely packed clusters forming "galleries" over the underlying riparian vegetation. Narrowleaf Cottonwood has lance-shaped leaves, while Fremont Cottonwood has triangular-shaped leaves with scalloped edges.

Mature Narrowleaf Cottonwood trees at the outer edge of the riparian zone on Cottonwood Creek.

Cottonwoods aggressively reproduce, making them ideal species for stabilizing soils and substrate in riparian zones. Narrowleaf Cottonwood and Fremont Cottonwood trees reproduce through three methods, and all methods are water dependent. Seeds are generally viable for a period of only two days, and the seeds require wet alluvium in full sunlight to germinate. Clonal reproduction by sprouting from roots occurs only when exposed roots are covered by wet sediments. New cottonwoods may also sprout from branch fragments if the branch fragments become lodged in wet alluvium with full sunlight. Steep gradients, coarse streambed materials and constrained channels promote clonal reproduction.

Overall, establishment and recruitment of new cottonwoods is dependent upon high flow events that establish bare, moist soil surfaces, combined with weather patterns that minimize soil moisture depletions. These events occur on average from every five to ten years. (Baker,1990; Rood, et al, 1997; Mahoney, J.M. and Rood,1998). Recruitment of new cottonwoods typically occurs when the soil water table does not decline more than 2.5 centimeters per day. Once established, cottonwood communities are highly dependent upon flows that maintain water levels in alluvial aquifers.

Skunkbush Sumac

Skunkbush Sumac is a deciduous, flowering shrub, averaging four feet in height. Like cottonwood, it reproduces by seed and root sprouts, but the dominant form of reproduction is by sprouting. Sprouting occurs most frequently in response to large disturbance events, such as floods. Skunkbush Sumac prefers well-drained soils and will not tolerate long-duration high flow events or a high water table for long durations.

Skunkbush Sumac

References:

Baker, W.L. (1990) Climatic and hydrologic effects on the regeneration of Populus angustifolia James along the Animas River, Colorado. Journal of Biogeography. 17-59-73.

Mahoney, J.M. & Rood, S.B. (1998). Streamflow requirements for cottonwood seedling recruitment- an integrative model. Wetlands, 18; 634-645.

Natural Resources Conservation Service - Plant Guides and Fact Sheets. https://plants.usda.gov/java/factSheet

Oregon State University Extension Service. Cottonwood Establishment, Survival, and Stand Characteristics. Publication EM 8800, March 2002.

Rood, S.B. et al. (1997). Canyonlands cottonwoods: Mortality of Fremont Cottonwoods in the Matheson Wetlands Preserve along the Colorado River at Moab, Utah. Report prepared for The Nature Conservancy, Moab, Utah, USA.

Scott, M.L., Auble, G.T., and Friedman, J.M. (1997) Flood dependency of cottonwood establishment along the Missouri River, Montana, USA. Ecological Applications, 7:677-690.

INSTREAM FLOW RATE QUANTIFICATION – STUDY METHODS

BLM facilitated three phases of study to develop this instream flow recommendation. The first phase provided "proof of concept" for the proposed instream flow protection approach, which is designed to protect high flow events. The second phase verified that scientific procedures commonly used to analyze stream channels and floodplains can readily be applied to the high-gradient stream channels and high-roughness floodplains on the Uncompahgre Plateau. The third phase was designed to quantify specific flow rates that should be protected.

- **Phase 1 -** A literature review identified the hydrologic attributes necessary to support the globally rare riparian communities.

- **Phase 2 -** Preliminary on-site studies determined that it is possible to identify bankfull flow rates and flow rates associated with high flow events that inundate all or part of the floodplain. These studies identified the general magnitude of high flow events and suitable portions of the creek for intensive modeling, but they were not used to formulate the final instream flow recommendations.

  Phase 2a -BLM implemented a cross-section analysis of a single cross section utilizing a model called WinXSPRO to develop a preliminary estimate of the flow rate at which bankfull conditions are achieved and inundation of the floodplain begins.

  Phase 2b - BLM also developed a preliminary estimation of peak flood discharge utilizing the U.S. Geological Survey Slope Area Computation Program.

- **Phase 3 -** A comprehensive study over a reach of the stream was conducted using the Hydrologic Engineering Center River Analysis System (HEC-RAS) developed by the U.S. Army Corps of Engineers. This study incorporated multiple cross sections to analyze stream geometry and it also incorporated elevation surveys of the floodplain to establish floodplain topography. The bankfull flow rates reflected in BLM's recommendation rely upon this study because it considered a range of different channel cross section configurations and developed an average flow rate at which bankfull conditions are reached.

Phase 1 - Scientific Literature Review

BLM conducted a review of the scientific literature to identify the flow regime needed to support the Rocky Mountain Lower Montane-Foothills Riparian Woodland and Shrubland Ecological System, including the specific communities present on Cottonwood Creek. Applicable research was narrowed to studies conducted in arid environments in the intermountain west, and includes some studies conducted within Colorado or within Utah very close to the Colorado border. The key findings from this literature review are as follows:

1. Riparian vegetation in dry regions is influenced by low-flow and high-flow components of the surface water regime, and by changing groundwater levels over time. High flow events influence vegetation along channels and floodplains by increasing water availability in riparian soils and by creating disturbances where new individuals can establish. The depth to groundwater and rate of groundwater decline after high flow events directly influences survival of riparian species.

2. Key hydrograph components for cottonwood establishment include timing and magnitude of peak discharge, the rate of decline of the recession limb, and the magnitude of base flows.

3. Woody riparian vegetation is commonly dependent on alluvial groundwater. A decline in water table relative to the condition in which roots developed may strand cottonwood and willow roots where they cannot obtain sufficient moisture.

No research was located that specifically analyzed linkages between flow regimes and Skunkbush Sumac, but substantial research has been completed on the overall requirements of riparian shrub species in arid environments. Those studies conclude that disturbances created by infrequent high flow events promote riparian shrub establishment and persistence. Botanical descriptions of Skunkbush Sumac also note that disturbance is an important part of its life history.

When the principles identified in scientific literature are applied to Cottonwood Creek, BLM concludes that the riparian communities on Cottonwood Creek are a direct response to high flow events. These events occur in association with seasonal snowmelt runoff in the April to June period and with monsoonal thunderstorms in the July to September period. These high flow events also erode the sandstone geology of the Uncompahgre Plateau, transporting and depositing significant sediment, providing fresh surfaces and nutrients for riparian establishment. These periodic disturbances and sediment deposit events provide a dynamic environment for continued change and rejuvenation of the riparian community.

BLM concludes that the riparian communities are also a direct response to base flow conditions that can occur during summer, fall, and winter. Base flows maintain water levels in the alluvial aquifer, which supports both deep-rooted cottonwoods and willows, which require constant access to groundwater to persist.

The following is a summary of the findings from BLM’s literature search:

<u>Establishment of Riparian Seedlings</u>

- Establishment of cottonwood seedlings is generally restricted to bare, moist sites protected from intense physical disturbance. (Scott, Auble, & Freidman, 1997).

- Bottomland trees and shrubs, including species of cottonwood, poplar, and willow, require bare, moist surfaces protected from large disturbance for successful establishment. (Scott, Friedman, and Auble, 1996).

- High flow events can produce tree establishment by creating bare, moist deposits high enough above the channel bed to minimize future flow- or ice-related disturbance. (Scott, Auble, & Freidman, 1997).

- Sediment deposition, either from main stem or tributary high flow events, is particularly important for tree establishment where channel movement is constrained by a narrow valley. The trees establish on the resulting elevated alluvial deposits. (Scott, Auble, & Freidman, 1997).

- Exposed portions of the bed are ideal sites for establishment of vegetation, including cottonwood. This vegetation promotes deposition of fine sediment and increases resistance to erosion, thus stabilizing the channel to a narrower width. (Scott, Auble, & Freidman, 1997).

- Deposition of additional fine-textured soils behind newly established cottonwoods allows additional seedlings to establish. (Cooper, Merritt, Andersen, and Chimner, 1999)

<u>Recruitment of Riparian Seedlings</u>

- Cottonwood recruitment is constrained to bare areas that contain fine-textured alluvial soils, saturated by high flow events, to provide the soil moisture necessary for seedling survival. Fine-textured soil provide enhance survival due to their higher water-holding capacity. (Cooper, Merritt, Andersen, and Chimner, 1999)

- Along the Animas River, establishment of Narrowleaf Cottonwood occurs about once every ten years, when peak snowmelt flows coincide with cool, wet weather. Establishment is also restricted to a few weeks when the seeds are viable. (Baker, 1990)

- Key hydrograph components for cottonwood establishment include timing and magnitude of high flow peaks, the rate of decline of the recession limb, and the magnitude of base flows. (Shaffroth, Auble, Stromberg, and Patten, 1998).

- Cottonwood establishment and recruitment typically occurs during high flow events with a frequency of once every ten years on the Colorado River near Moab, Utah. (Rood, et al, 1997)

- Studies have consistently suggested that cottonwood recruitment is associated with 1 in 5 to 1 in 10-year high flow events. (Mahoney & Rood, 1998)

- Bottomland tree seedlings, including willows, poplars, and cottonwoods, will tolerate burial, and can sprout from roots or stems. (Scott, Friedman, and Auble, 1996).

Riparian Dependency Upon Alluvial Groundwater Tables

- Woody riparian vegetation is commonly dependent on alluvial groundwater. A decline in water table relative to the condition in which roots developed may strand cottonwood and willow roots where they cannot obtain sufficient moisture. (Shaffroth, Stromberg, and Patten, 2000).

- Cottonwood seedlings typically require four years to grow roots to the depth of the late summer groundwater table. (Cooper, Merritt, Andersen, and Chimner, 1999)

- During the first growing season, bottomland tree seedlings are capable of extending tap roots as deep as one meter. (Scott, Friedman, and Auble, 1996). Typically, cottonwood, poplar, and willow seedlings cannot survive water table declines more rapid than 2.5 centimeters per day. This rate typically occurs on the descending limb of the hydrograph, toward the end of the snowmelt runoff period. (Mahoney and Rood, 1998)

- Cottonwood seedlings survive based on rapid establishment of a tap root, combined with capillary fringe action in the soil above the groundwater table. Depending on soil type, the capillary fringe can extend from 5 to 130 centimeters above the groundwater table. (Mahoney & Rood, 1998).

- Water tables in alluvial soils that are less than 1.5 meters from ground surface are required for successful seedling establishment of woody riparian plants. Species in the poplar and willow families require shallow water tables. Water table declines can lead to plant mortality. (Shaffroth, Stromberg, and Patten, 2000).

Relationship between riparian vigor/abundance/diversity and stream flows

- Riparian vegetation in dry regions is influenced by low-flow and high-flow components of the surface and groundwater flow regimes. High flows influence vegetation along channels and floodplains by increasing water availability and by creating disturbance. Depth, magnitude, and rate of groundwater decline influences riparian vegetation in the floodplain. (J.C. Stromberg, Beauchamp, Dixon, Lite, and Paradzick, 2007)

- The riparian water table is the primary water source for many riparian trees. (Stromberg, 1993)

- Stream discharge (mean annual flow volume and median flow volume) is correlated with riparian tree growth, vigor, and abundance. Riparian tree diversity is correlated with flood flows. (Stromberg, 1993)

- Riparian trees on small streams are the most sensitive to reductions in stream flow volume, in terms of vigor and abundance. (Stromberg, 1993)

Relationship Between Hydrologic Variability and Riparian Community Health

- The width of riparian communities along stream channels is heavily dependent on flow variability. Systematic reductions in flow variability reduces the width of riparian zones that are dependent upon moderate or infrequent inundation frequency. Lower flow variability will result in transition from riparian vegetation to upland vegetation at the edges of a riparian zone. (Auble, Scott, and Friedman, 2005)

- Hydrologic variability that influences the width of riparian zones includes high flow frequency, high flow duration, high flow height, and shear stress associated with high flow events. (Auble, Scott, and Friedman, 2005)

References:

Auble, G. T., Scott, M.L., and Friedman, J. M. (2005). Use of Individualistic Streamflow-Vegetation Relations Along the Fremont River, Utah, USA To Assess Impacts of Flow Alteration of Wetland and Riparian Areas. Wetlands, 25: 143-145.

Baker, W.L. (1990) Climatic and hydrologic effects on the regeneration of Populus angustifolia James along the Animas River, Colorado. Journal of Biogeography. 17-59-73.

Cooper D.J., Merritt, D.M., Anderson, D.C. & Chimner, R.A. (1999). Factors controlling the establishment of Fremont cottonwood seedlings on the Upper Green River, USA. Regulated Rivers: Research and Management, 15:419-440.

Mahoney, J.M. & Rood, S.B. (1998). Streamflow requirements for cottonwood seedling recruitment- an integrative model. Wetlands, 18; 634-645.

Scott, M.L., Auble, G.T., and Friedman, J.M. (1997) Flood dependency of cottonwood establishment along the Missouri River, Montana, USA. Ecological Applications, 7:677-690.

Scott, M.L., Friedman, J.M., and Auble, G.T. (1996) Fluvial process and the establishment of bottomland trees. Geomorphology 14: 327-339.

Shaffroth P.B., Auble G.T., Stromberg J.C., and Patten D.T.. (1998). Establishment of woody vegetation in relation to annual patterns of streamflow, Bill Williams River, AZ. Wetlands, 18, 577-590.

Shaffroth, P.B., Stromberg, J.C. and Patten, D.T. (2000). Woody riparian vegetation response to different alluvial water table regimes. Western North American Naturalist, 60:66-76.

Stromberg, J.C. (1993). Instream Flow Models for Mixed Deciduous Riparian Vegetation Within a Semiarid Region. Regulated Rivers: Research and Management, 8:225-235.

Stromberg, J.C., Beauchamp, V.B., Dixon, M.D., Lite, S.J., and Paradzick, C. (2007) Importance of low-flow and high-flow characteristics to restoration of riparian vegetation along rivers in the arid southwestern United States. Freshwater Biology (2007) 52, 651-679.

Rood, S.B. et al. (1997). Canyonlands cottonwoods: Mortality of Fremont Cottonwoods in the Matheson Wetlands Preserve along the Colorado River at Moab, Utah. Report prepared for The Nature Conservancy, Moab, Utah, USA.

Phase 2a – Initial Channel Cross Section Analysis Using WinXSPRO

The literature review identified that high flow events are a key component of the hydrologic regime that supports BLM's targeted riparian communities. BLM concluded that to identify the general magnitude of flow rates necessary to create high flow conditions, an analytical tool capable of analyzing flows at bankfull condition and higher was necessary. For this task, BLM selected WinXSPRO, a software package designed to analyze stream cross sections for geometric and hydraulic parameters.

BLM personnel conducted a reconnaissance site visit of Cottonwood Creek to identify a cross section that would be representative of typical channel morphology on the creek. At the chosen location, a monumented cross section was established, and the channel was surveyed during low flow conditions to document exact channel shape. Bankfull flow elevation was determined at the cross section, using multiple field indicators, including topographic breaks in bank slope, scour lines, changes in vegetation, depositional features, and size of material on the channel surface.

BLM personnel returned to the site multiple times to collect discharge measurements and water surface elevations at various flow rates. Data collected from the field visit during the highest flow rate (flow rate closest to bankfull elevation) was run through the WinXSPRO modeling software to estimate the flow rate needed to achieve bankfull flow. The preliminary results from this effort demonstrated that bankfull flows could be identified and modeled in this stream system.

Phase 2b - Initial Estimation of Peak Flood Discharge - U.S.G.S. Slope Area Computation Program (SACGUI)

The BLM also developed a model to estimate the streamflow of high flow events that deposited large piles of woody debris on the floodplain of Cottonwood Creek. To do this, BLM selected the USGS Slope Area Computation Graphical User Interface (SACGUI). This method is widely used by the USGS throughout the United States to calculate flood discharge when stream gage data is not available or after flood events have receded.

BLM survey teams established a cadastral survey benchmark and then used a Trimble GPS unit to collect data on high water marks, cross sections, channel geometry, and benchmarks. High water marks were estimated by vegetation and debris piles deposited from past flooding. Channel and floodplain roughness were also determined in the field as part of the process.

The modeling effort resulted in an initial estimate of the magnitude of flood discharge. The results of his phase were not used to develop final instream flow recommendations. The results were used to identify portions of the creek that would be suitable for more intensive modeling.

Phase 3 - Comprehensive Analysis Using HEC-RAS To Quantify Bankfull Flow Rate and Floodplain Inundation Flow Rate

HEC-RAS is widely used throughout the United States for hydraulic modeling of flood flows. HEC-RAS can be used to determine the depth and extent of inundation in floodplains and stream channels at various flow rates. HEC-RAS has significant advantages over simpler analytical techniques such as WinXSPRO because multiple cross sections can be entered to analyze channel geometry and overbank topography over a representative reach in the stream of interest. With this data, HEC-RAS can perform more advanced hydraulic calculations than approaches that rely on a single cross section. HEC-RAS is also capable of producing maps that illustrate the portions of the channel and floodplain that are inundated at various flow rates.

BLM worked closely with staff from the CWCB and AECOM to design and implement the HEC-RAS modeling. In April 2021, this team identified a portion of Cottonwood Creek reach that would be appropriate for HEC-RAS modeling purposes, based on the criteria that the modeling location is representative of the stream channel, and that the floodplain supports the riparian communities of interest to the BLM. The team also jointly identified on-the-ground indicators for the modeling effort, including the physical location on the stream banks for bankfull flow, the outermost locations of the floodplain, and the locations of debris piles dropped by previous flood events.

AECOM used the on-site survey information to develop a model for the selected reach of Cottonwood Creek. AECOM determined the Manning's "n" values (roughness factor for the stream channel and floodplain) that should be used in the modeling effort, based on channel characteristics. AECOM's final modeling results identified the discharge rates necessary to meet the bankfull indicators identified in the field, as well as the discharge necessary to deposit to the debris piles identified in the field. Please refer to the modeling memo and figures from AECOM to the CWCB dated June 9, 2021.

BLM INSTREAM FLOW RECOMMENDATION

Existing Instream Flow Water Right

Based upon a previous recommendation from BLM, the CWCB appropriated an instream flow water right on Cottonwood Creek in 2006 to protect the native fish community and macroinvertebrates supported by Cottonwood Creek. The upper terminus for the existing instream flow water right is at the Hawkins Ditch headgate and the lower terminus is the confluence of Cottonwood Creek with Roubideau Creek. The existing appropriation protects 3.6 cfs from April 1 to June 15. The existing appropriation is not year-round because diversions by senior water rights have the capability to dry up the creek during base flow conditions after the snowmelt runoff period is complete.

Riparian Flow Recommendation

BLM recommends an increase to the existing instream flow water right for the purpose of protecting a component of the natural environment that is not now fully protected – riparian species and intact riparian plant communities. Protecting bankfull flows and the receding limb of the hydrograph that occurs after these flows will provide the conditions necessary for riparian species to reproduce and for seedlings to establish, processes which are critical for sustaining riparian communities along Cottonwood Creek.

BLM recognizes that because of natural hydrologic variation, the frequency and timing of meeting the recommended flow rates is highly variable. Sufficient water to provide high flows may not be available in all years or even for several years in a row. However, BLM believes that infrequently available high flow events, combined with the existing ISF water right, are essential for protecting the processes that create and sustain the riparian community in Cottonwood Creek.

BLM recommends protection of the following flow rates:

> When the flow rate reaches 183.0 cubic feet per second (bankfull flow), all flow in the creek should be protected until the flow rate recedes to 3.6 cfs, which is the flow rate associated with the existing ISF right from April 1 to June 15. If the threshold of 183.0 cfs is met outside of the April 1 to June 15 period associated with the current CWCB water right, then flows should also be protected as they recede down to a 3.6 cfs flow rate.
>
> BLM recommends that the proposed water right be in effect only during the April 1 to September 30 period, if the flow rate threshold is met. This time frame corresponds to the portion of the year when the riparian community is actively growing and reproducing, and when a very high percentage of overbank flows occur due to snowmelt runoff events and monsoonal thunderstorm events. During years in which streamflow does not reach the proposed threshold, this instream flow water right for high flow events would not be

in effect.

Administration of Recommended Instream Flow Water Right

Active administration of the proposed instream flow water right will not be needed unless new junior water rights are established on the stream. When that occurs, a stream gage station would be needed to administer this instream flow water right. The gage would need to be closely monitored to determine if the threshold flow was reached, which would activate the proposed instream flow water right. Daily monitoring will be required because flows tend to increase rapidly at the start of bankfull event and decrease rapidly toward the end of a bankfull event.

A fictional example of how the existing instream flow water right would work with the recommended increase is set forth below:

> *In early May, Cottonwood Creek is flowing at 35 cfs due to snowmelt runoff from an above average snowpack. 3.6 cubic feet per second of this 35 cfs is protected under the existing instream flow water right. Then temperatures spike during a heat wave in May, and snowmelt flows increase very rapidly. Once the flow rate reaches the threshold of 183.0 cubic feet per second, then all flow in the creek is protected from water diversions by junior appropriators.*
>
> *After the snowmelt high flow event peaks at 300 cfs, it then slowly starts to recede as the heat wave subsides and temperatures return to normal ranges. All flow is protected until the flow rate recedes to 3.6 cubic feet per second in early June, which is the existing instream flow rate. Once 3.6 cfs is measured, then the instream flow water right designed to protect high flows is no longer in effect and the stream is subject only to the existing instream flow water right.*

If new junior water rights are established upstream from a future stream gage installed by the CWCB, any diversions made by the junior water rights would have to be accounted for in the gage discharge reading when the instream flow water right is administered. This adjustment would be necessary because the new junior water rights would deplete stream flows and could prevent stream flow from reaching the threshold at which the new instream flow water right would be administered.

WATER AVAILABILITY

Uncompahgre Plateau Hydrology Overview

Streamflow on the Uncompahgre Plateau is characterized by a three-month period of high flows during the snowmelt runoff period in April through June, followed by a period characterized by low base flows from July through March. As the first step for an initial water availability analysis, BLM calculated the mean annual monthly distribution of flow on the Uncompahgre Plateau, using the annual hydrographs from gages that were operated for very short periods on Potter Creek, Spring Creek, and Hay Press Creek. These three creeks were used since they are unaltered representations of natural flow regimes on the Uncompahgre Plateau.

The analysis revealed that approximately 85% of the annual flow volume on Uncompahgre Plateau streams occurs during the April to June snowmelt runoff period. Although monsoonal weather patterns in July through September can produce very large high flow events, they are typically of short duration, so these events do not result in a high percentage of streamflow volume allocated to those months.

Although there is some streamflow gage data available for the Uncompahgre Plateau, most of this data set has been collected near the floor of the Uncompahgre Valley. The historical data set is severely impacts by diversions and irrigation use that occur in and around the valley floor. This situation makes it difficult to use historical flow data to estimate the natural flow regime for watersheds on the Uncompahgre Plateau, and it makes it very difficult to calculate the magnitude of high flow events. In response to this limited data set, BLM completed an estimate of high flow discharge by using the U.S. Geological Survey Slope Area Computation Program (SACGUI). This model estimate identified the general magnitude of discharge associated with high flow events, given the lack of usable data for streams on the Uncompahgre Plateau. Reliance upon modeling efforts is also warranted because of personnel safety and logistical concerns. Specifically, high flow events that serve as the basis of this recommendation are infrequent, typically exceed thresholds for conducting safe discharge measurements, and often make travel routes temporarily unusable.

BLM sought to evaluate the magnitude of very high flow events by modeling the discharge necessary to deposit debris piles that are found in the floodplain. BLM initially conducted this modeling using the USGS SACGUI program, but ultimately relied upon the more robust HECRAS model for the final high flow discharge estimates.

Water Rights

BLM is aware of the following ditches upstream from the proposed instream reach:

North Fork Ditch – 13.0 cfs

BLM is aware of the following ditches within the proposed instream flow reach:

Everlasting Ditch – 27.0 cfs
Hawkins Ditch – 31.0 cfs
Pug White Ditch – 10.0 cfs
Horton Davis Ditch Enlargement – 6.0 cfs

Even though these ditches can divert substantial flow from Cottonwood Creek, the magnitude of diversions is not sufficiently large to eliminate high flow events, nor are they large enough to eliminate the natural hydrologic variability in the creek.

Finally, BLM is aware that the Davis Brothers Ditch Extension, which is decreed to divert 10 cfs from Dry Fork Escalante Creek, irrigates lands within the Cottonwood Creek watershed.

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
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Bureau of Land Management
Colorado State Office
Denver Federal Center, Building 40
Lakewood, Colorado 80215
www.blm.gov/colorado

In Reply Refer To:
7250 (CO-932)

Mr. Rob Viehl
Colorado Water Conservation Board
1313 Sherman Street, Room 721
Denver, Colorado 80203

Dear Mr. Viehl:

The Bureau of Land Management (BLM) is writing this letter to formally communicate its recommendation for an increase to the instream flow water right on Monitor Creek near Delta, located in Water Division 4. Monitor Creek is tributary to Potter Creek approximately eight miles southwest of the City of Delta. This recommendation covers the portion of Monitor Creek that runs from the confluence with Little Monitor Creek to the confluence with Potter Creek. The entire reach is owned and managed by BLM.

This recommendation is a response to a request from the Colorado Water Conservation Board (CWCB). The CWCB requested that BLM identify a method to protect water-dependent values on Monitor Creek that may help build an alternative to formal designation of Monitor Creek into the National Wild and Scenic Rivers System. In the Record of Decision and Final Resource Management Plan for the Uncompahgre Field Office, BLM determined that Monitor Creek is suitable for Wild and Scenic River designation. BLM's suitability determination specifically noted that the current lack of flow protection for globally significant riparian values was a significant factor driving BLM's suitability determination. BLM believes that the land use protections associated with a BLM suitability determination, combined with an instream flow water right appropriated by the CWCB to protect water-dependent values, will provide long-term protection for Monitor Creek.

There are two key scientific concepts driving this recommendation. The first is that establishment and reproduction of these riparian communities is highly dependent on periodic high flow events. This recommendation is structured so that instream flow protection is triggered when a high flow event begins, and protection continues until the high flow event recedes to base flow levels. The second scientific concept is that protection of base flows provides essential habitat for fish communities, and they also maintain the alluvial aquifer where the roots of riparian communities draw water. This recommendation acknowledges that there is a pending instream flow appropriation on Monitor Creek designed to protect base flows, and it relies upon that base flow protection to maintain alluvial aquifers that are critical for supporting riparian communities.

Even with these two forms of instream flow protection, this recommendation still leaves substantial water available for appropriation. When flows are above the protected base flow levels, but below the flow rate that triggers high flow protection, water can be appropriated for human use. In addition, when the creek leaves the Uncompahgre Plateau and enters the valley floor, flows will not be subject to protection and will be available for appropriation.

BLM's detailed instream flow recommendation, along with biological information and hydrologic investigations that support it, are set forth in a comprehensive report enclosed with this letter.

If you have any questions regarding our instream flow recommendation, please contact Roy Smith at 303-239-3940.

Sincerely,

Digitally signed by ALAN BITTNER
Date: 2023.02.28 08:22:28 -07'00'

Deputy State Director
Resources

Enclosure – Monitor Creek Instream Flow Report

Cc:
Stephanie Connolly, Southwest DO
Suzanne Copping, Uncompahgre FO
Jedd Sondergard, Uncompahgre FO

BLM Instream Flow Recommendation

Monitor Creek, Uncompahgre Plateau
Water Division 4

Instream Flow Recommendation Report Table of Contents

INTRODUCTION

Monitor Creek is located within the larger Roubideau Creek watershed, one of the most ecologically intact watersheds on the eastern side of the Uncompahgre Plateau. Monitor Creek originates at an elevation of approximately 9,000 feet near Columbine Pass and passes through the montane conifer and pinyon-juniper woodland ecological zones as it descends to an elevation of approximately 6,250 feet at its confluence with Potter Creek.

The Monitor Creek watershed is ecologically intact because there is very little development within the watershed, and the naturally variable flow regime has been only slightly altered. The healthy, intact riparian community on Monitor Creek reflects this hydrology, in that natural high flow events which support the riparian community still occur. In the headwaters of the Monitor Creek watershed, there is a small amount of acreage that is irrigated with water imported from Cottonwood Creek. In years when these lands are irrigated, there may be a small return flow contribution from the irrigated lands to Monitor Creek.

There are no major barriers to native fish passage between Monitor Creek and the Gunnison River, which is unusual for streams on the eastern side of the Uncompahgre Plateau. The hydrology described above also supports abundant habitat for spawning and rearing by native fishes, including Flannelmouth Sucker, Bluehead Sucker, and Roundtail Chub, which are BLM sensitive species and species that are also subject to a multi-state conservation agreement designed to prevent a listing of the species under the Endangered Species Act. The native fishes spend much of their life cycle in the Gunnison River but can be found in high numbers in Monitor Creek during the snowmelt runoff period.

The purpose of this recommendation is to protect the full array of Monitor Creek's ecological functions with instream flow water rights. The recommended instream flow water right is specifically structured to protect a component of the hydrologic regime – high flows -- that is critical for the persistence of riparian communities. Another critical component of the flow regime will be partially protected by an instream flow water right from April 1 to June 30 for which the CWCB formed its intent to appropriate at its January 2023 board meeting. Together, the two water rights will assist in protecting the flow-dependent ecological functions in Monitor Creek while acknowledging that the hydrology of the creek has been somewhat altered.

This report covers the portion of Monitor Creek that runs from the confluence of Big Monitor Creek and Little Monitor Creek to the confluence with Potter Creek. This reach is 8.29 miles in length and is located entirely on public lands managed by BLM.

BACKGROUND INFORMATION

BLM commenced an intensive study and review of Monitor Creek's management in 2010, as part of a general land use plan revision for lands managed by BLM's Uncompahgre Field Office. The intensive review of Monitor Creek by BLM was mandated by the National Wild and Scenic Rivers Act of 1968. The Act specifies that all federal land use plan revisions must analyze whether streams that pass through federal lands are "eligible" for designation into the National Wild and Scenic Rivers System.

An "eligibility" analysis identifies whether a stream supports one more "outstandingly remarkable values" also referred to as "ORVs." An ORV is defined as a river-related value that is unique, rare, or exemplary, when compared to the other streams in the region of comparison, which in this case is the Colorado Plateau eco-region. An eligibility analysis also requires BLM to identify whether a stream is "free-flowing," which means that the stream does not have any on-channel water storage facilities.

When BLM conducted its review of Monitor Creek, it found that Monitor Creek is free-flowing and possesses ORVs. BLM relied upon information supplied by the Colorado Natural Heritage Program (CNHP), which has identified riparian communities along Monitor Creek that are in outstanding condition. The CNHP findings qualified as an "ORV" for BLM's eligibility study because BLM's Wild and Scenic River's Manual 6400 specifies the following criteria for a botanical or vegetation ORV:

> The area within the river corridor contains riparian communities that are ranked critically imperiled by state-based natural heritage programs. Alternatively, the river contains exemplary examples, in terms of health, resilience, species diversity, and age diversity, of more common riparian communities.

After completing the eligibility study of Monitor Creek, BLM also completed a separate "suitability" study, as required by the BLM Wild and Scenic Rivers Manual 6400. A "suitability" study analyzes 13 factors, including social, political, economic, and land management issues, to make a determination as to whether an "eligible" stream would make a good addition to the National Wild and Scenic Rivers System (NWSRS). Overall, a suitability study is designed to identify what management approach will work best to protect and enhance the identified ORVs. The study requires BLM to analyze what protection can be accomplished under BLM's land use and planning authorities, and to identify where those authorities cannot provide full protection for the ORVs.

BLM's draft suitability analysis concluded that Monitor Creek is suitable for designation into the NWSRS. BLM reached this conclusion because while BLM can very effectively protect Monitor Creek's riparian communities from the land management perspective, BLM lacks authority to protect stream flows that are necessary for the continued persistence of those communities. BLM noted that if the stream were designated into the NWSRS, the designation would provide BLM with authority to claim a federal reserved water right for protecting the ORVs.

BLM issued its draft suitability report in 2013. After reviewing the draft, the CWCB sent a letter to BLM requesting that it work with the CWCB to develop a flow protection approach that would serve as an alternative to a federal reserved water right, thereby reducing the need for federal Wild and Scenic River designation. In response to the CWCB request, BLM included the following language in its Final Suitability Report:

> *If scientific studies conclude that alternative forms of flow protection are in place and are sufficient to fully protect the flow related ORVs on Monitor Creek, the BLM will determine it is unnecessary to quantify, assert, or adjudicate a federal reserved water right for this segment if it is ultimately designated into the National Wild and Scenic River System.*

BLM's Final Suitability Report was formally adopted by a BLM Record of Decision (ROD) in April 2020. The ROD sets the stage for BLM to formally cooperate with CWCB on comprehensive flow protection. BLM believes that the land use protections associated with the recently completed suitability determination, combined with an instream flow water right to protect water-dependent values, will provide long-term protection for Monitor Creek.

Willows sprouting below Fremont Cottonwood along Monitor Creek.

References:

Bureau of Land Management. Final Wild and Scenic River Eligibility Report for The Uncompahgre Planning Area, 2010.

Bureau of Land Management. Record of Decision and Approved Resource Management Plan for Uncompahgre Field Office, 2020.

U.S. Environmental Protection Agency Ecoregion Map at: https://www.epa.gov/eco-research/level-iii-and-iv-ecoregions-continental-united-states.

BIOLOGICAL SUMMARY

Colorado Natural Heritage Program (CNHP) Methodology

When formulating this recommendation for an instream flow water right to protect riparian species and communities, BLM relied heavily upon information collected by CNHP, as well as subsequent visits by BLM staff. CNHP is a nonprofit organization and is a sponsored program of the Warner College of Natural Resources at Colorado State University. CNHP is also a member of the NatureServe Network, an international network of partners that use the same scientific methodology to enable scientists to monitor the status of species and natural plant communities from state, national, and global perspectives.

To determine the conservation status of species within Colorado, CNHP gathers information on plants, animals, and natural plant communities throughout the state, also called "elements" of biodiversity. When CNHP completes a site-specific inventory and verifies the presence of an individual species or community, the verified location is called an "element occurrence." Each element occurrence is ranked on a scale of A-D (excellent to poor) based on condition, size, and landscape context.

Using known information from element occurrences, each element of biodiversity (plant or animal species, or natural plant community) is assigned a rank that indicates its relative degree of imperilment on a five-point scale (for example, 1 = extremely rare/imperiled, 5 = abundant/secure). The primary criterion for ranking elements is the number of occurrences (in other words, the number of known distinct localities or populations). Element imperilment ranks are assigned both in terms of the element's degree of imperilment within Colorado (its State-rank or S-rank) and the element's imperilment over its entire range (its Global-rank or G-rank). Taken together, these two ranks indicate the degree of imperilment of an element. A complete description of each of the Natural Heritage ranks is provided below.

G/S1	**Critically imperiled**-at very high risk of extinction due to extreme rarity (often 5 or fewer occurrences) in the world/statewide, very steep declines, or other factors.
G/S2	**Imperiled-** at high risk of extinction or elimination globally/statewide because of rarity (6 to 20 occurrences, or 1,000 to 3,000 individuals) due to very restricted range, very few populations, steep declines, or other factors.
G/S3	**Vulnerable-**at moderate risk of extinction or elimination through its range or found locally in a restricted range (21 to 100 occurrences, or 3,000 to 10,000 individuals).
G/S4	**Apparently secure** globally/statewide, though it may be quite rare in parts of its range, especially at the periphery. Usually more than 100 occurrences and 10,000 individuals.
G/S5	**Secure-**common; widespread and abundant globally/statewide, though it may be quite rare in parts of its range, especially at the periphery.

Riparian Plant Communities and Ecosystems Supported by Monitor Creek

CNHP surveys have revealed that Monitor Creek supports numerous occurrences of healthy, intact riparian plant communities that fall within the Rocky Mountain Lower Montane-Foothills

Riparian Woodland and Shrubland Ecological System. Examples of the communities found along Monitor Creek and their imperilment ranks include:

- Narrowleaf Cottonwood / Red Osier Dogwood (Populus angustifolia / Cornus sericea) Riparian Woodland (Element rank = G4/S4, Element Occurrence rank on Monitor Creek = B, Good Condition)

- Coyote Willow (Salix exigua) / Mesic Graminoids Western Wet Shrubland (Element rank = G5/S5, Element Occurrence rank on Monitor Creek = A, Excellent Condition) Note: Mesic Graminoids are grass-like species.

The global and state imperilment ranks for these natural plant communities are either apparently secure (G4) or secure (G5). Imperilment for most riparian communities within the Rocky Mountain Lower Montane Riparian and Woodland Ecological System is caused by vegetation alteration as the surrounding landscape is developed and roads, homes, or agriculture fields directly infringe on floodplain zones; hydrologic alteration caused by dams and diversions; and invasive species introduction. These riparian systems have also been impacted by the loss of beaver. Throughout Colorado, intact examples of Lower Montane Riparian Woodland and Shrubland riparian communities are relatively rare.

BLM also notes that Potter Creek, to which Monitor Creek is a tributary, supports three riparian communities with globally vulnerable (G3) rankings and state rankings that are either vulnerable (S3) or state imperiled (S2):

- Narrowleaf Cottonwood / Strapleaf Willow / Silver Buffaloberry *(Populus angustifolia / Salix lifulfolia / Shepherdia argentea)* Riparian Forest (G3/S3, B – Good Condition)

- Narrowleaf Cottonwood / Skunkbush Sumac *(Populus angustifolia / Rhus trilobata)* Riparian Woodland (G3/S3, A – Excellent Condition)

- Narrowleaf Cottonwood - Douglas Fir *(Populus angustifolia - Pseudotsuga menziesii)* Riparian Woodland (G3/S2, B – Good Condition)

BLM believes that given similar hydrology and soils along the two creeks, it is very likely that these vulnerable riparian communities also exist in the lower reaches of Monitor Creek near the confluence with Potter Creek and that they may exist in higher elevation portions of Monitor Creek.

The occurrences of these natural plant communities along Potter Creek received either “A” or “B” ranking for excellent or good estimated long-term viability when they were originally surveyed by CNHP in the 1990s. An “A” ranking means that the local occurrence is in excellent condition and has an excellent chance at long-term persistence, provided that the community is not threatened by changes to land use and/or changes to the stream flows that support the community. A “B” ranking means that this localized occurrence is in good condition and has a good chance at long-term persistence, provided that the community is not threatened by changes to land use and/or changes to the stream flows that support the riparian community. More recent site visits by BLM confirm that the communities are still viable, and reproduction of the primary species still occurs.

Even though Narrowleaf Cottonwood and Red Osier Dogwood are distributed throughout the western United States, they are seldom found growing in the same habitat because of their different habitat needs. BLM concluded that the reason these species form distinct riparian communities along Monitor Creek is related to hydrology and soils. The creek provides short-term flood conditions and moist alluvial soils after flood events for cottonwood establishment. After seasonal flooding, alluvial groundwater levels supported by the creek's base flows are sufficiently high to support established cottonwoods. However, while conditions within the riparian zone support cottonwood species, the sandstone-based soils along Monitor Creek are very well drained, allowing the riparian zone to support species that do not tolerate high soil moisture for long periods of time.

The disturbances created by short-term flood events also favor sprouting by Red Osier Dogwood as well as cottonwood. Once short-term flood events recede, the soils in the Monitor Creek floodplain are sufficiently well drained that Red Osier Dogwood can thrive, since their rooting depths are less than cottonwood root depths.

CNHP has included Potter Creek within its Roubideau Creek Potential Conservation Area (PCA) because of the importance of the riparian community. Potential Conservation Areas are identified by CNHP as landscapes that possess numerous elements of biological diversity within a concentrated area, making them candidates for protection if land and water management objectives include preservation of biological diversity. The Roubideau Creek PCA is ranked as having very high biodiversity significance (B2, on a scale of B1-B5) because of both the intact riparian zones and several occurrences of rare upland plant species.

References:

Colorado Natural Heritage Program. Biodiversity Information Management System (also known as Biotics Database).

Colorado Natural Heritage Program. Roubideau Creek Level 4 Potential Conservation Area Report. https://cnhp.colostate.edu/download/documents/pca/L4_PCA-Roubideau%20Creek_4-24-2022.pdf

Colorado Natural Heritage Program. Rocky Mountain Lower Montane-Foothills Riparian Woodland and Shrubland. https://cnhp.colostate.edu/projects/ecological-systems-of-colorado/details/?elementID=365200

BLM Objectives for Managing Imperiled and Vulnerable Riparian Communities

CNHP has noted that Monitor Creek is ecologically intact and mostly unaltered, which has resulted in riparian communities that are in unusually good condition. For these reasons, BLM determined that the riparian communities along Monitor Creek met the threshold for an ORV as defined by the Wild and Scenic Rivers Act.

BLM concurs with CNHP that preservation of globally significant riparian communities is important. BLM believes there are four primary reasons why protecting globally significant riparian communities is important:

- The existence of a set of species that forms a riparian community proves that its combination of species is stable and can thrive within the physical constraints of that environment. These constraints include soil type, flow regimes, slope, channel morphology, broad climate factors, micro-climates. In other words, that combination of species has proven its resiliency over time.

- Resilient communities are better able to withstand environmental stresses and catastrophic events, including floods, drought, fire, climate change, and disease.

- Resilient communities have a superior ability to provide environmental services. These services include stabilization of stream banks, storage of water in stable stream banks, filtration of pollution, stream shading, cycling of vegetative material, and cycling of nutrients. All of these services provide benefits for aquatic habitats, terrestrial wildlife, and humans.

- Resilient communities provide superior wildlife habitat, because specialist wildlife species have evolved to take advantage of the foraging, nesting, brooding opportunities provided by those communities.

Overall, BLM concludes that while many of the individual species in these communities, including the Narrowleaf Cottonwood, Red Osier Dogwood, and Coyote Willow, are common, the communities along Monitor Creek are in exemplary condition. BLM believes that comprehensive protection is warranted because these communities are uniquely adapted to thrive in conditions on the Uncompahgre Plateau, which includes stress from catastrophic events. If protected, these communities will continue to be resilient and stable, and continue to provide the environmental services that adjacent human communities expect, such as providing wildlife habitat, high quality water supplies, and erosion control/mitigation.

Description of Species Within the Riparian Communities

The following section provides descriptions of each of the primary species that compose the riparian communities. These descriptions include brief summaries of the habitat, as well as processes and hydrologic conditions that are necessary for successful reproduction and propagation.

Narrowleaf Cottonwood and Fremont Cottonwood

Narrowleaf Cottonwood (Populus angustifolia) and Fremont Cottonwood (Populus deltoides) are members of the willow family that can grow up to 80 feet in height. These species occupy the overstory in many riparian zones in Colorado that are located from 4,000 to 7,000 feet in elevation. Cottonwoods often grow in densely packed clusters forming "galleries" over the underlying riparian vegetation. Narrowleaf Cottonwoods have lance-shaped leaves, while Fremont Cottonwood has triangular-shaped leaves with scalloped edges.

Fremont Cottonwood (large trees on left of photograph against canyon wall) and Narrowleaf Cottonwood (trees at right edge of photograph) along Monitor Creek.

Cottonwoods aggressively reproduce, making them ideal species for stabilizing soils and substrate in riparian zones. Narrowleaf Cottonwood and Fremont Cottonwood reproduce through three methods, and all methods are water dependent. Seeds are generally viable for a period of only two days, and the seeds require wet alluvium in full sunlight to germinate. Clonal reproduction by sprouting from roots occurs only when exposed roots are covered by wet sediments. New cottonwoods may also sprout from branch fragments if the branch fragments become lodged in wet alluvium with full sunlight. Steep gradients, coarse streambed materials and constrained channels promote clonal reproduction.

Overall, establishment and recruitment of new cottonwoods is dependent upon high flow events that establish bare, moist soil surfaces, combined with weather patterns that minimize soil moisture depletions. These events occur on average from every five to ten years. Recruitment of new cottonwoods typically occurs when the soil water table does not decline more than 2.5 centimeters per day. Once established, cottonwood communities are highly dependent upon flows that maintain water levels in alluvial aquifers.

Red Osier Dogwood

Red Osier Dogwood is a woody deciduous shrub that grows up to 20 feet tall, with bark and twigs that are bright green is spring and summer, turning to reddish-purple in the fall. The species requires soils that are saturated for part of the growing season, but it is not tolerant of long-term soil saturation. The species prefers wetland margins where soils are inundated in spring but completely dry by later summer. Reproduction can occur either from suckering or seed.

Red Osier Dogwood

Strapleaf Willow

Strapleaf Willow is a deciduous shrub that grows up to six feet in height. It can dominate lower terraces of floodplains and stabilized gravel bars. The species requires bare gravel or sand substrate with adequate moisture for seed germination and development. The species is highly resilient to hydrologic disturbances, such as high velocity floodwaters, sediment deposition, and fully saturated soils.

Strapleaf Willow

Silver Buffaloberry

Silver Buffaloberry is a deciduous, thorny, thicket-forming shrub that is drought-hardy. The plant grows from 3 to 20 feet high. It grows only on well-drained soils, but it will tolerate a variety of soil types. Reproduction is by seed, typically on sites that are disturbed and/or receive full sunlight.

Silver Buffaloberry

Skunkbush Sumac

Skunkbush Sumac is a deciduous, flowering shrub, averaging four feet in height. Like cottonwood, it reproduces by seed and root sprouts, but the dominant form of reproduction is by sprouting. Sprouting occurs most frequently in response to large disturbance events, such as floods. Skunkbush sumac prefers well-drained soils and will not tolerate long-duration flood events or a high water table for long durations.

Skunkbush Sumac

References:

Baker, W.L. (1990) Climatic and hydrologic effects on the regeneration of Populus angustifolia James along the Animas River, Colorado. Journal of Biogeography. 17-59-73.

Mahoney, J.M. & Rood, S.B. (1998). Streamflow requirements for cottonwood seedling recruitment- an integrative model. Wetlands, 18; 634-645.

Natural Resources Conservation Service - Plant Guides and Fact Sheets. https://plants.usda.gov/java/factSheet

Oregon State University Extension Service. Cottonwood Establishment, Survival, and Stand Characteristics. Publication EM 8800, March 2002.

Rood, S.B. et al. (1997). Canyonlands cottonwoods: Mortality of Fremont Cottonwoods in the Matheson Wetlands Preserve along the Colorado River at Moab, Utah. Report prepared for The Nature Conservancy, Moab, Utah, USA.

Scott, M.L., Auble, G.T., and Friedman, J.M. (1997) Flood dependency of cottonwood establishment along the Missouri River, Montana, USA. Ecological Applications, 7:677-690.

INSTREAM FLOW RATE QUANTIFICATION – STUDY METHODS

BLM facilitated three phases of study to develop this instream flow recommendation. The first phase provided "proof of concept" for the proposed instream flow protection approach, which is designed to protect high flow events. The second phase verified that scientific procedures commonly used to analyze stream channels and floodplains can readily be applied to the high-gradient stream channels and high-roughness floodplains on the Uncompahgre Plateau. The third phase was designed to quantify specific flow rates that should be protected.

- **Phase 1 -** A literature review identified the hydrologic attributes necessary to support the globally rare riparian communities.

- **Phase 2 -** Preliminary on-site studies determined that it is possible to identify bankfull flow rates and flow rates associated with high flow events that inundate all or part of the floodplain. These studies identified the general magnitude of high flow events and suitable portions of the creek for intensive modeling, but they were not used to formulate the final instream flow recommendations.

  Phase 2a -BLM implemented a cross-section analysis of a single cross section utilizing a model called WinXSPRO to develop a preliminary estimate of the flow rate at which bankfull conditions are achieved and inundation of the floodplain begins.

  Phase 2b - BLM also developed a preliminary estimation of peak flood discharge utilizing the U.S. Geological Survey Slope Area Computation Program.

- **Phase 3 -** A comprehensive study over a reach of the stream was conducted using the Hydrologic Engineering Center River Analysis System (HEC-RAS) developed by the U.S. Army Corps of Engineers. This study incorporated multiple cross sections to analyze stream geometry and it also incorporated elevation surveys of the floodplain to establish floodplain topography. The bankfull flow rates reflected in BLM's recommendation rely upon this study because it considered a range of different channel cross section configurations and developed an average flow rate at which bankfull conditions are reached.

Scientific Literature Review

BLM conducted a review of the scientific literature to identify the flow regime needed to support the Rocky Mountain Lower Montane-Foothills Riparian Woodland and Shrubland Ecological System, including the specific communities present on Monitor Creek. Applicable research was narrowed to studies conducted in arid environments in the intermountain west, and includes some studies conducted within Colorado or within Utah very close to the Colorado border. The key findings from this literature review are as follows:

1. Riparian vegetation in dry regions is influenced by low-flow and high-flow components of the surface water regime, and by changing groundwater levels over time. High flow events influence vegetation along channels and floodplains by increasing water availability in riparian soils and by creating disturbances where new individuals can establish. The depth to groundwater and rate of groundwater decline after high flow events directly influences survival of riparian species.

2. Key hydrograph components for cottonwood establishment include timing and magnitude of peak discharge, the rate of decline of the recession limb, and the magnitude of base flows.

3. Woody riparian vegetation is commonly dependent on alluvial groundwater. A decline in water table relative to the condition in which roots developed may strand cottonwood and willow roots where they cannot obtain sufficient moisture.

No research was located that specifically analyzed linkages between flow regimes and Red Osier Dogwood, Skunkbush Sumac, Silver Buffaloberry, or Coyote Willow, but substantial research has been completed on the overall requirements of riparian shrub species in arid environments. Those studies conclude that disturbances created by infrequent high flow events promote riparian shrub establishment and persistence. Botanical descriptions of Red Osier Dogwood, Skunkbush Sumac, Silver Buffaloberry and Coyote Willow also note that disturbance is an important part of their life history.

When the principles identified in scientific literature are applied to Monitor Creek, BLM concludes that the riparian communities on Monitor Creek are a direct response to high flow events. These events occur in association with seasonal snowmelt runoff in the April to June period and with monsoonal thunderstorms in the July to September period. These high flow events also erode the sandstone geology of the Uncompahgre Plateau, transporting and depositing significant sediment, providing fresh surfaces and nutrients for riparian establishment. These periodic disturbances and sediment deposit events provide a dynamic environment for continued change and rejuvenation of the riparian community.

BLM concludes that the riparian communities are also a direct response to base flow conditions that can occur during summer, fall, and winter. Base flows maintain water levels in the alluvial aquifer, which supports both deep-rooted cottonwoods and willows, which require constant access to groundwater to persist.

The following is a summary of the findings from BLM’s literature search:

Establishment of Riparian Seedlings

- Establishment of cottonwood seedlings is generally restricted to bare, moist sites protected from intense physical disturbance. (Scott, Auble, & Freidman, 1997).

- Bottomland trees and shrubs, including species of cottonwood, poplar, and willow, require bare, moist surfaces protected from large disturbance for successful establishment. (Scott, Friedman, and Auble, 1996).

- High flow events can produce tree establishment by creating bare, moist deposits high enough above the channel bed to minimize future flow- or ice-related disturbance. (Scott, Auble, & Freidman, 1997).

- Sediment deposition, either from main stem or tributary high flow events, is particularly important for tree establishment where channel movement is constrained by a narrow valley. The trees establish on the resulting elevated alluvial deposits. (Scott, Auble, & Freidman, 1997).

- Exposed portions of the bed are ideal sites for establishment of vegetation, including cottonwood. This vegetation promotes deposition of fine sediment and increases resistance to erosion, thus stabilizing the channel to a narrower width. (Scott, Auble, & Freidman, 1997).

- Deposition of additional fine-textured soils behind newly established cottonwoods allows additional seedlings to establish. (Cooper, Merritt, Andersen, and Chimner, 1999)

Recruitment of Riparian Seedlings

- Cottonwood recruitment is constrained to bare areas that contain fine-textured alluvial soils, saturated by high flow events, to provide the soil moisture necessary for seedling survival. Fine-textured soil provide enhance survival due to their higher water-holding capacity. (Cooper, Merritt, Andersen, and Chimner, 1999)

- Along the Animas River, establishment of Narrowleaf Cottonwood occurs about once every ten years, when peak snowmelt flows coincide with cool, wet weather. Establishment is also restricted to a few weeks when the seeds are viable. (Baker, 1990)

- Key hydrograph components for cottonwood establishment include timing and magnitude of high flow peaks, the rate of decline of the recession limb, and the magnitude of base flows. (Shaffroth, Auble, Stromberg, and Patten, 1998).

- Cottonwood establishment and recruitment typically occurs during floods with a frequency of once every 10 years on the Colorado River near Moab, Utah. (Rood, et al, 1997)

- Studies have consistently suggested that cottonwood recruitment is associated with 1 in 5 to 1 in 10 year high flow event. (Mahoney & Rood, 1998)

- Bottomland tree seedlings, including willows, poplars, and cottonwoods, will tolerate burial, and can sprout from roots or stems. (Scott, Friedman, and Auble, 1996).

<u>Riparian Dependency Upon Alluvial Groundwater Tables</u>

- Woody riparian vegetation is commonly dependent on alluvial groundwater. A decline in water table relative to the condition in which roots developed may strand cottonwood and willow roots where they cannot obtain sufficient moisture. (Shaffroth, Stromberg, and Patten, 2000).

- Cottonwood seedlings typically require four years to grow roots to the depth of the late summer groundwater table. (Cooper, Merritt, Andersen, and Chimner, 1999)

- During the first growing season, bottomland tree seedlings are capable of extending tap roots as deep as one meter. (Scott, Friedman, and Auble, 1996). Typically, cottonwood, poplar, and willow seedlings cannot survive water table declines more rapid than 2.5 centimeters per day. This rate typically occurs on the descending limb of the hydrograph, toward the end of the snowmelt runoff period. (Mahoney and Rood, 1998)

- Cottonwood seedlings survive based on rapid establishment of a tap root, combined with capillary fringe action in the soil above the groundwater table. Depending on soil type, the capillary fringe can extend from 5 to 130 centimeters above the groundwater table. (Mahoney & Rood, 1998).

- Water tables in alluvial soils that are less than 1.5 meters from ground surface are required for successful seeding establishment of woody riparian plants. Species in the poplar and willow families require shallow water tables. Water table declines can lead to plant mortality. (Shaffroth, Stromberg, and Patten, 2000).

<u>Relationship between Riparian Vigor/Abundance/Diversity and Stream Flows</u>

- Riparian vegetation in dry regions is influenced by low-flow and high-flow components of the surface and groundwater flow regimes. High flows influence vegetation along channels and floodplains by increasing water availability and by creating disturbance. Depth, magnitude, and rate of groundwater decline influences riparian vegetation in the floodplain. (J.C. Stromberg, Beauchamp, Dixon, Lite, and Paradzick, 2007)

- The riparian water table is the primary water source for many riparian trees. (Stromberg, 1993)

- Stream discharge (mean annual flow volume and median flow volume) is correlated with riparian tree growth, vigor, and abundance. Riparian tree diversity is correlated with flood flows. (Stromberg, 1993)

- Riparian trees on small streams are the most sensitive to reductions in stream flow volume, in terms of vigor and abundance. (Stromberg, 1993)

Relationship Between Hydrologic Variability and Riparian Community Health

- The width of riparian communities along stream channels is heavily dependent on flow variability. Systematic reductions in flow variability reduces the width of riparian zones that are dependent upon moderate or infrequent inundation frequency. Lower flow variability will result in transition from riparian vegetation to upland vegetation at the edges of a riparian zone. (Auble, Scott, and Friedman, 2005)

- Hydrologic variability that influences the width of riparian zones includes high flow frequency, high flow duration, high flow height, and shear stress associated with high flow events. (Auble, Scott, and Friedman, 2005)

References:

Auble, G. T., Scott, M. L., and Friedman, J. M. (2005). Use of Individualistic Streamflow-Vegetation Relations Along the Fremont River, Utah, USA To Assess Impacts of Flow Alteration of Wetland and Riparian Areas. Wetlands, 25:143-145.

Baker, W.L. (1990) Climatic and hydrologic effects on the regeneration of Populus angustifolia James along the Animas River, Colorado. Journal of Biogeography, 17-59-73.

Cooper D.J., Merritt, D.M., Anderson, D.C. & Chimner, R.A. (1999). Factors controlling the establishment of Fremont cottonwood seedlings on the Upper Green River, USA. Regulated Rivers: Research and Management, 15:419-440.

Mahoney, J.M. & Rood, S.B. (1998). Streamflow requirements for cottonwood seedling recruitment- an integrative model. Wetlands, 18; 634-645.

Scott, M.L., Auble, G.T., and Friedman, J.M. (1997) Flood dependency of cottonwood establishment along the Missouri River, Montana, USA. Ecological Applications, 7:677-690.

Scott, M.L., Friedman, J.M., and Auble, G.T. (1996) Fluvial process and the establishment of bottomland trees. Geomorphology, 14:327-339.

Shaffroth P.B., Auble G.T., Stromberg J.C., and Patten D.T. (1998). Establishment of woody vegetation in relation to annual patterns of streamflow, Bill Williams River, AZ. Wetlands, 18, 577-590.

Shaffroth, P.B., Stromberg, J.C., and Patten, D.T. (2000). Woody riparian vegetation response to different alluvial water table regimes. Western North American Naturalist, 60:66-76.

Stromberg, J.C. (1993). Instream Flow Models for Mixed Deciduous Riparian Vegetation Within a Semiarid Region. Regulated Rivers: Research and Management, 8:225-235.

Stromberg. J.C., Beauchamp, V.B., Dixon, M.D., Lite S. J., and Paradzick, C. (2007) Importance of low-flow and high-flow characteristics to restoration of riparian vegetation along rivers in the arid southwestern United States. Freshwater Biology (2007) 52, 651-679.

Rood, S.B. et al. (1997). Canyonlands cottonwoods: Mortality of Fremont Cottonwoods in the Matheson Wetlands Preserve along the Colorado River at Moab, Utah. Report prepared for The Nature Conservancy, Moab, Utah, USA.

Phase 2a – Initial Channel Cross Section Analysis Using WinXSPRO

The literature review identified that high flow events are a key component of the hydrologic regime that supports BLM's targeted riparian communities. BLM concluded that to identify the general magnitude of flow rates necessary to create high flow conditions, an analytical tool capable of analyzing flows at bankfull condition and higher was necessary. For this task, BLM selected WinXSPRO, a software package designed to analyze stream cross sections for geometric and hydraulic parameters.

BLM personnel conducted a reconnaissance site visit of Cottonwood Creek to identify a cross section that would be representative of typical channel morphology on the creek. At the chosen location, a monumented cross section was established, and the channel was surveyed during low flow conditions to document exact channel shape. Bankfull flow elevation was determined at the cross section, using multiple field indicators, including topographic breaks in bank slope, scour lines, changes in vegetation, depositional features, and size of material on the channel surface.

BLM personnel returned to the site multiple times to collect discharge measurements and water surface elevations at various flow rates. Data collected from the field visit during the highest flow rate (flow rate closest to bankfull elevation) was run through the WinXSPRO modeling software to estimate the flow rate needed to achieve bankfull flow. The preliminary results from this effort demonstrated that bankfull flows could be identified and modeled in this stream system.

Phase 2b - Initial Estimation of Peak Flood Discharge - U.S.G.S. Slope Area Computation Program (SACGUI)

The BLM also developed a model to estimate the streamflow of high flow events that deposited large piles of woody debris on the floodplain of Cottonwood Creek. To do this, BLM selected the USGS Slope Area Computation Graphical User Interface (SACGUI). This method is widely used by the USGS throughout the United States to calculate flood discharge when stream gage data is not available or after flood events have receded.

BLM survey teams established a cadastral survey benchmark and then used a Trimble GPS unit to collect data on high water marks, cross sections, channel geometry, and benchmarks. High water marks were estimated by vegetation and debris piles deposited from past flooding. Channel and floodplain roughness were also determined in the field as part of the process.

The modeling effort resulted in an initial estimate of the magnitude of flood discharge. The results of his phase were not used to develop final instream flow recommendations. The results were used to identify portions of the creek that would be suitable for more intensive modeling.

Phase 3 - Comprehensive Analysis Using HEC-RAS To Quantify Bankfull Flow Rate and Floodplain Inundation Flow Rate

HEC-RAS is widely used throughout the United States for hydraulic modeling of flood flows. HEC-RAS can be used to determine the depth and extent of inundation in floodplains and stream channels at various flow rates. HEC-RAS has significant advantages over simpler analytical techniques such as WinXSPRO because multiple cross sections can be entered to analyze channel geometry and overbank topography over a representative reach in the stream of interest. With this data, HEC-RAS can perform more advanced hydraulic calculations than approaches that rely on a single cross section. HEC-RAS is also capable of producing maps that illustrate the portions of the channel and floodplain that are inundated at various flow rates.

BLM worked closely with staff from the CWCB and AECOM to design and implement the HEC-RAS modeling. In April 2021, this team identified a portion of Monitor Creek reach that would be appropriate for HECRAS modeling purposes, based on the criteria that the modeling location is representative of the stream channel, and that the floodplain supports the riparian communities of interest to the BLM. The team also jointly identified on-the-ground indicators for the modeling effort, including the physical location on the stream banks for bankfull flow, the outermost locations of the floodplain, and the locations of debris piles dropped by previous flood events.

AECOM used the on-site survey information to develop a model for the selected reach of Monitor Creek. AECOM determined the Manning's "n" values (roughness factor for the stream channel and floodplain) that should be used in the modeling effort, based on channel characteristics. AECOM's final modeling results identified the discharge rates necessary to meet the bankfull indicators identified in the field, as well as the discharge necessary to deposit to the debris piles identified in the field. Please refer to the modeling memo and figures from AECOM to the CWCB dated June 9, 2021.

BLM INSTREAM FLOW RECOMMENDATION

Existing Instream Flow Appropriation

Based upon a previous recommendation from BLM, the CWCB formed its intent to appropriate an instream flow water right on Monitor Creek at its January 2023 board meeting. The objective for the previous appropriation was to protect the native fish community and macroinvertebrate community supported by Monitor Creek. The upper terminus for the recent base flow appropriation is at the confluence with Little Monitor Creek and the lower terminus is the confluence with Potter Creek. The recent appropriation protects 4.6 cfs from April 1 to May 31 and 3.6 cfs from June 1 to June 30. The existing appropriation is not year-round because water availability data collected by the CWCB showed that flows during the remainder of the year are too variable to meet the CWCB's water availability standards for base flow appropriations.

Riparian Flow Recommendation

BLM recommends an increase to the existing instream flow water right for the purpose of protecting a component of the natural environment that is not now fully protected – riparian species and intact riparian plant communities. Protecting high flows and the receding limb of the hydrograph that occurs after these flows will provide the conditions necessary for riparian species to reproduce and for seedlings to establish, processes which are critical for sustaining riparian communities along Monitor Creek.

BLM recognizes that because of natural hydrologic variation, the frequency and timing of meeting the recommended overbank flow rates is highly variable. Sufficient water to meet riparian flood flows may not be available in all years or even for several years in a row. However, BLM believes that infrequently available high flow events, combined with baseflow protection, are essential for protecting the processes that create and sustaining the riparian community in Monitor Creek.

BLM recommends protection of the following flow rates:

> When the flow rate reaches 111.0 cubic feet per second (bankfull flow), all flow in the creek should be protected until the flow rate recedes to the lowest flow rate associated with the existing base flow appropriation, which is the 3.6 cfs. If the threshold of 111.0 cfs is met outside of the April 1 to June 30 period associated with the recent CWCB base flow appropriation, then flows should also be protected as they recede down to a 3.6 cfs flow rate.
>
> BLM recommends that the proposed water right be in effect only during the April 1 to

September 30 period, if the flow rate threshold is met. This time frame corresponds to the portion of the year when the riparian community is actively growing and reproducing, and when a very high percentage of overbank flows occur due to snowmelt runoff events and monsoonal thunderstorm events. During years in which streamflow does not reach the proposed threshold, this instream flow water right for high flow events would not be in effect.

Administration of Recommended Instream Flow Water Rights

Active administration of the proposed instream flow water right will not be needed unless new junior water rights are established on the stream. When that occurs, a stream gage station would be needed to administer this instream flow water right. The gage would need to be closely monitored to determine if the threshold flow was reached, which would activate the proposed instream flow water right. Daily monitoring will be required because flows tend to increase rapidly at the start of bankfull event and decrease rapidly toward the end of a bankfull event.

A fictional example of how the base flow water right would work with the overbank flow water right is set forth below:

> *In early May, Monitor Creek is flowing at 35 cfs due to snowmelt runoff from an above average snowpack. 4.6 cubic feet per second of this 35 cfs is protected under the existing instream flow water right. Then temperatures spike during a heat wave in May, and snowmelt flows increase very rapidly. Once the flow rate reaches the threshold 111.0 cfs, then all flow in the creek is protected from water diversions by junior appropriators.*
>
> *After the snowmelt flood event peaks at 200 cfs, it then slowly starts to recede as the heat wave subsides and temperatures return to normal ranges. All flow is protected until the flow rate recedes to 3.6 cubic feet per second in early June, which is the base flow water right that applies at that time of year. Once 3.6 cfs is measured, then the instream flow water right designed to protect high flows is no longer in effect and the stream is subject only to the existing instream flow appropriation for base flows..*

If new junior water rights are established upstream from a future stream gage installed by the CWCB, any diversions made by the junior water rights would have to be accounted for in the gage discharge reading when the instream flow water right is administered. This adjustment would be necessary because the new junior water rights would deplete stream flows and could prevent stream flow from reaching the threshold at which the new instream flow water right would be administered.

WATER AVAILABILITY

Uncompahgre Plateau Hydrology Overview

Streamflow on the Uncompahgre Plateau is characterized by a three-month period of high flows during the snowmelt runoff period in April through June, followed by a period characterized by low base flows from July through March. As the first step for an initial water availability analysis, BLM calculated the mean annual monthly distribution of flow on the Uncompahgre Plateau, using the annual hydrographs from gages that were operated for very short periods on Potter Creek, Spring Creek, and Hay Press Creek. These three creeks were used since they are unaltered representations of natural flow regimes on the Uncompahgre Plateau.

The analysis revealed that approximately 85% of the annual flow volume on Uncompahgre Plateau streams occurs during the April to June snowmelt runoff period. Although monsoonal weather patterns in July through September can produce very large high flow events, they are typically of short duration, so these events do not result in a high percentage of streamflow volume allocated to those months.

Although there is some streamflow gage data available for the Uncompahgre Plateau, most of this data set has been collected near the floor of the Uncompahgre Valley. The historical data set is severely impacts by diversions and irrigation use that occur in and around the valley floor. This situation makes it difficult to use historical flow data to estimate the natural flow regime for watersheds on the Uncompahgre Plateau, and it makes it very difficult to calculate the magnitude of high flow events.

In response to this limited data set, BLM completed an estimate of high flow discharge by using the U.S. Geological Survey Slope Area Computation Program (SACGUI). This model estimate identified the general magnitude of discharge associated with high flow events, given the lack of usable data for streams on the Uncompahgre Plateau. Reliance upon modeling efforts is also warranted because of personnel safety and logistical concerns. Specifically, high flow events that serve as the basis of this recommendation are infrequent, typically exceed thresholds for conducting safe discharge measurements, and often make travel routes temporarily unusable.

BLM sought to evaluate the magnitude of very high flow events by modeling the discharge necessary to deposit debris piles that are found in the floodplain. BLM initially conducted this modeling using the USGS SACGUI program, but ultimately relied upon the more robust HECRAS model for the final high flow discharge estimates.

Water Rights

Even though several ditches divert water from Monitor Creek, the magnitude of diversions is not sufficiently large to eliminate high flow events, nor are they large enough to eliminate the natural hydrologic variability in the creek. BLM is not aware of any diversion within the recommended reach. BLM is aware of the following ditches upstream of the recommended reach:

Monitor Ditch – 1.0 cfs
25 Mesa Upper Little Monitor Ditch – 7.0 cfs
Dorr Spring No. 12 – 0.25 cfs
Big Monitor Ditch – 51.85 cfs
Little Monitor Ditch – 4.0 cfs
Noah White Ditch – 3.0 cfs

It also important to note that some water imports and exports from the Monitor Creek watershed. The Everlasting Ditch, decreed for 27 cfs, diverts water from Cottonwood Creek and irrigates lands in the upper Monitor Creek watershed. 25 Mesa Upper Little Monitor Ditch, which diverts water from Little Monitor Creek, irrigates lands in both the Monitor Creek watershed and the Cottonwood Creek watershed.

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
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Lakewood, Colorado 80215
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In Reply Refer To:
7250 (CO-932)

Mr. Rob Viehl
Colorado Water Conservation Board
1313 Sherman Street, Room 721
Denver, Colorado 80203

Dear Viehl:

The Bureau of Land Management (BLM) is writing this letter to formally communicate its recommendation for an increase to the instream flow water right on Potter Creek, located in Water Division 4. Potter Creek is tributary to Roubideau Creek approximately eight miles southwest of the City of Delta. This recommendation covers the portion of Potter Creek that runs from the U.S. Forest Service boundary to the confluence with Roubideau Creek. For purposes of this recommendation, the creek will be divided into two sections. The first reach is above the confluence with Monitor Creek, and the second reach is below the confluence with Monitor Creek. The first reach is 8.1 miles in length, and the second reach is 1.72 miles in length. Both reaches are located entirely on lands managed by BLM.

This recommendation is a response to a request from the Colorado Water Conservation Board (CWCB). The CWCB requested that BLM identify a method to protect water-dependent values on Potter Creek that may help build an alternative to formal designation of Potter Creek into the National Wild and Scenic Rivers System. In the Record of Decision and Final Resource Management Plan for BLM's Uncompahgre Field Office, BLM determined that Potter Creek is suitable for Wild and Scenic River designation. BLM's suitability determination specifically noted that the current lack of flow protection for globally significant riparian values was a significant factor driving BLM's suitability determination. BLM believes that the land use protections associated with a suitability determination, combined with an instream flow water right to protect water dependent values, will provide long-term protection for Potter Creek.

There are two key scientific concepts driving this recommendation. The first is that establishment and reproduction of these riparian communities is highly dependent on periodic high flow events. This recommendation is structured so that instream flow protection is triggered when a high flow event starts, and protection continues until the high flow event recedes to base flow levels. The second scientific concept is that protection of base flows provides essential habitat for fish communities, and they also maintain the alluvial aquifer where the roots of riparian communities draw water. This recommendation acknowledges that there is an existing instream flow water right on Potter Creek designed to protect base flows, and it relies upon that base flow protection to maintain alluvial aquifers that are critical for supporting riparian communities.

Even with these two forms of instream flow protection, this recommendation still leaves substantial water available for appropriation. When flows are above the protected base flow levels but below the flow rate that triggers high flow protection, water can be appropriated for human use. In addition, when the creek leaves the Uncompahgre Plateau and enters the valley floor, flows will not be subject to protection and will be available for appropriation.

BLM’s detailed instream flow recommendation, along with biological information and hydrologic investigations that support it, are set forth in a report enclosed with this letter.
If you have any questions regarding our instream flow recommendation, please contact Roy Smith at 303-239-3940.

Sincerely,

Digitally signed by ALAN BITTNER
Date: 2023.02.28 08:23:39 -07'00'

Deputy State Director
Resources

Enclosure – Potter Creek Instream Flow Report

Cc: Suzanne Copping, Uncompahgre FO
Jedd Sondergard, Uncompahgre FO
Stephanie Connolly, Southwest DO

BLM Instream Flow Recommendation

Potter Creek, Uncompahgre Plateau
Water Division 4

Instream Flow Recommendation Report Table of Contents

INTRODUCTION

Potter Creek is located within the larger Roubideau Creek watershed, one of the most ecologically intact watersheds on the eastern side of the Uncompahgre Plateau. Potter Creek originates at an elevation of approximately 9,000 feet near Columbine Pass and passes through the montane conifer and pinyon-juniper woodland ecological zones as it descends to an elevation of approximately 5,500 feet at its confluence with Roubideau Creek.

The Potter Creek watershed is ecologically intact because there is very little development within the watershed, and the naturally variable flow regime is largely unaltered. The riparian community on Potter Creek reflects this hydrology, in that natural high flow events which support the riparian community still occur. Overall, the intact high flow event regime on Potter Creek supports healthy, intact riparian communities along the creek.

In addition, there are no major barriers to native fish passage between Potter Creek and the Gunnison River, which is unusual for streams on the east side of the Uncompahgre Plateau. The hydrology described above also supports abundant habitat for spawning and rearing by native fishes, including flannelmouth sucker, bluehead sucker, and roundtail chub, which are BLM sensitive species and species that are also the subject of a multi-state conservation agreement designed to prevent a listing of the species under the Endangered Species Act. The native fishes spend much of their life cycle in the Gunnison River but can be found in high numbers in Potter Creek during the snowmelt runoff period.

The purpose of this recommendation is to protect the full array of Potter Creek’s ecological functions with instream flow water rights. The recommended instream flow water right is specifically structured to protect a component of the hydrologic regime – high flows -- that is critical for the persistence of riparian communities. Another critical component of the flow regime – base flows -- is partially protected by an existing, year-round instream flow water right appropriated by the CWCB in 2004. Together, the two water rights assist in protecting the flow-dependent ecological functions in Potter Creek.

This report covers the portion of Potter Creek that runs from the U.S. Forest Service boundary to the confluence with Roubideau Creek. For purposes of BLM’s instream flow recommendation, this report divides Potter Creek into two sections. The first reach is above the confluence with Monitor Creek, and the second reach is below the confluence with Monitor Creek. The first reach is 8.1 miles in length, and the second reach is 1.72 miles in length. Both reaches are located entirely on lands owned and managed by BLM.

BACKGROUND INFORMATION

BLM commenced an intensive study and review of Potter Creek's management in 2010, as part of a general land use plan revision for lands managed by the Uncompahgre Field Office. The intensive review of Potter Creek BLM was mandated by the National Wild and Scenic Rivers Act of 1968. The Act specifies that all federal land use plan revisions must analyze whether streams that pass through federal lands are "eligible" for designation into the National Wild and Scenic Rivers System.

An "eligibility" analysis identifies whether a stream supports one or more "outstandingly remarkable values" also referred to as "ORVs." An ORV is defined as a river-related value that is unique, rare, or exemplary, when compared to the other streams in the region of comparison, which in this case is the Colorado Plateau eco-region. An eligibility analysis also requires BLM to identify whether a stream is "free-flowing," which means that the stream does not have any on-channel water storage facilities.

When BLM conducted its review of Potter Creek, it found that Potter Creek is free-flowing and possesses ORVs. BLM relied upon information supplied by the Colorado Natural Heritage Program (CNHP), which has identified riparian communities along Potter Creek that are globally rare. CNHP also determined that these riparian communities are in very good condition. The CNHP findings qualified as an "ORV" for BLM's eligibility study because BLM's Wild and Scenic River's Manual 6400 specifies the following criteria for a botanical or vegetation ORV:

> The area within the river corridor contains riparian communities that are ranked critically imperiled by state-based natural heritage programs. Alternatively, the river contains exemplary examples, in terms of health, resilience, species diversity, and age diversity, of more common riparian communities.

After completing the eligibility study of Potter Creek, BLM also completed a separate "suitability" study, as required by the BLM Wild and Scenic Rivers Manual 6400. A "suitability" study analyzes 13 factors, including social, political, economic, and land management issues, to determine whether an "eligible" stream would make a good addition to the National Wild and Scenic Rivers System (NWSRS). Overall, a suitability study is designed to identify what management approach will work best to protect and enhance the identified ORVs. The study requires BLM to analyze what protection can be accomplished under BLM's land use and planning authorities, and to identify where those authorities cannot provide full protection to the ORV.

BLM's draft suitability analysis concluded that Potter Creek is suitable for designation into the NWSRS. BLM reached this conclusion because while BLM can very effectively protect Potter Creek's riparian communities from the land management perspective, BLM lacks authority to protect stream flows that are necessary for the continued persistence of those communities. BLM noted that if the stream were designated into the NWSRS, the designation would provide BLM with authority to claim a federal reserved water right for protecting the ORVs.

BLM issued its draft suitability report in 2013. After reviewing the draft, the CWCB sent a letter requesting that BLM work with the CWCB to develop a flow protection approach that would serve as an alternative to a federal reserved water right, thereby reducing the need for federal Wild and Scenic River designation. In response to the CWCB request, BLM included the following language in its Final Suitability Report:

> *If scientific studies conclude that alternative forms of flow protection are in place and are sufficient to fully protect the flow related ORVs on Potter Creek, the BLM will determine it is unnecessary to quantify, assert, or adjudicate a federal reserved water right for this segment if it is ultimately designated into the National Wild and Scenic River System.*

BLM's Final Suitability Report was formally adopted by a BLM Record of Decision (ROD) in April 2020. The ROD sets the stage for BLM to formally cooperate with CWCB on comprehensive flow protection. BLM believes that the land use protections associated with the recently completed suitability determination, combined with an instream flow water right to protect water-dependent values, will provide long-term protection for Potter Creek.

Narrowleaf Cottonwood and Fremont Cottonwood sprouting in an area previously disturbed by high flows along Potter Creek.

References:

Bureau of Land Management. Final Wild and Scenic River Eligibility Report For The Uncompahgre Planning Area, 2010.

Bureau of Land Management. Record of Decision and Approved Resource Management Plan for Uncompahgre Field Office, 2020.

Bureau of Land Management. Record of Decision and Approved Resource Management Plan for Dominguez – Escalante National Conservation Area, 2017.

U.S. Environmental Protection Agency Ecoregion Map at https://www.epa.gov/eco-research/level-iii-and-iv-ecoregions-continental-united-states

BIOLOGICAL SUMMARY

Colorado Natural Heritage Program (CNHP) Methodology

When formulating this recommendation for an instream flow water right to protect riparian species and communities, BLM relied heavily upon information collected by CNHP, as well as subsequent field visits by BLM staff. CNHP is a nonprofit organization and is a sponsored program of the Warner College of Natural Resources at Colorado State University. CNHP is also a member of the NatureServe Network, an international network of partners that use the same scientific methodology to enable scientists to monitor the status of species and natural plant communities from state, national, and global perspectives.

CNHP tracks and ranks Colorado's rare and imperiled species and habitats. In addition, CNHP provides information and expertise on these topics to promote the conservation of Colorado's valuable biological resources. These services are provided by a staff of professional botanists and biologists. CNHP frequently completes inventory and study efforts at the request of local, state, and federal government agencies.

To determine the conservation status of species within Colorado, CNHP gathers information on plants, animals, and natural plant communities throughout the state, also called "elements" of biodiversity. When CNHP completes a site-specific inventory and verifies the presence of an individual species or community, the verified location is called an "element occurrence." Each element occurrence is ranked on a scale of A-D (excellent to poor) based on condition, size, and landscape context.

Using known information from element occurrences, each element of biodiversity (plant or animal species, or natural plant community) is assigned a rank that indicates its relative degree of imperilment on a five-point scale (for example, 1 = extremely rare/imperiled, 5 = abundant/secure). The primary criterion for ranking elements is the number of occurrences (in other words, the number of known distinct localities or populations). Element imperilment ranks are assigned both in terms of the element's degree of imperilment within Colorado (its State-rank or S-rank) and the element's imperilment over its entire range (its Global-rank or G-rank). Taken together, these two ranks indicate the degree of imperilment of an element. A complete description of each of the Natural Heritage ranks is provided below.

G/S1	**Critically imperiled**-at very high risk of extinction due to extreme rarity (often 5 or fewer occurrences) in the world/statewide, very steep declines, or other factors.
G/S2	**Imperiled-** at high risk of extinction or elimination globally/statewide because of rarity (6 to 20 occurrences, or 1,000 to 3,000 individuals) due to very restricted range, very few populations, steep declines, or other factors.
G/S3	**Vulnerable-**at moderate risk of extinction or elimination through its range or found locally in a restricted range (21 to 100 occurrences, or 3,000 to 10,000 individuals).
G/S4	**Apparently secure** globally/statewide, though it may be quite rare in parts of its range, especially at the periphery. Usually more than 100 occurrences and 10,000 individuals.
G/S5	**Secure**-common; widespread and abundant globally/statewide, though it may be quite rare in parts of its range, especially at the periphery.

Riparian Communities Supported by Potter Creek

CNHP surveys have revealed that Potter Creek supports numerous occurrences of healthy, intact riparian plant communities that fall within the Rocky Mountain Lower Montane-Foothills Riparian Woodland and Shrubland Ecological System. Examples of the communities found along Potter Creek and their imperilment ranks include:

- Narrowleaf Cottonwood / Strapleaf Willow / Silver Buffaloberry *(Populus angustifolia / Salix lifulfolia / Shepherdia argentea)* Riparian Forest (G3/S3, B – good condition)

- Narrowleaf Cottonwood / Skunkbush Sumac *(Populus angustifolia / Rhus trilobata)* Riparian Woodland (G3/S3, A – excellent condition)

- Narrowleaf Cottonwood / Red Osier Dogwood *(Populus angustifolia / Cornus sericea)* Riparian Woodland (G4/S4, A – excellent condition)

- Narrowleaf Cottonwood - Douglas Fir *(Populus angustifolia - Pseudotsuga menziesii)* Riparian Woodland (G3/S2, B – good condition)

- Douglas Fir / Red Osier Dogwood *(Pseudotsuga menziesii / Cornus sericea)* Riparian Woodland (G4/S2, B – good condition)

The global imperilment ranks for these natural plant communities are either apparently secure (G4) or vulnerable (G3), but the state ranks are either vulnerable (S3) or imperiled (S2). Imperilment for most communities within the Rocky Mountain Lower Montane Riparian and Woodland Ecological System is often caused by vegetation alteration as the surrounding landscape is developed and roads, homes, or agriculture fields directly infringe on floodplain zones; hydrologic alteration caused by dams and diversions; and invasive species introduction. These systems have also been impacted by the loss of beaver. Throughout Colorado, intact examples of Lower Montane Riparian Woodland and Shrubland riparian communities are relatively rare.

The occurrences of these natural plant communities along Potter Creek received either “A” or

"B" ranking for excellent or good estimated long-term viability when they were originally surveyed by CNHP in the 1990s. An "A" ranking means that the local occurrence is in excellent condition and has an excellent chance at long-term persistence, provided that the community is not threatened by changes to land use and/or changes to the stream flows that support the community. A "B" ranking means that this localized occurrence is in good condition and has a good chance at long-term persistence, provided that the community is not threatened by changes to land use and/or changes to the stream flows that support the riparian community. More recent visits by BLM confirm that the communities are still viable, and reproduction of the primary species still occurs.

Even though Narrowleaf Cottonwood, Silver Buffaloberry, Skunkbush Sumac, and Red Osier Dogwood are widely distributed throughout the western United States, they are seldom found growing in the same habitat because of their different habitat needs. BLM concluded that the reason these species form distinct riparian communities along Potter Creek is related to hydrology and soils. The creek provides short-term flood conditions and moist alluvial soils after high flow events for cottonwood establishment. After seasonal high flow events, alluvial groundwater levels supported by the creek's base flows are sufficiently high to support established cottonwoods. However, while conditions within the riparian zone support cottonwood species, the sandstone-based soils along Potter Creek are also very well drained, which allows the riparian zone to also support species that do not tolerate high soil moisture for long periods of time. The disturbances created by short-term high flow events favor sprouting by Skunkbush Sumac, Silver Buffaloberry, and Narrowleaf Cottonwood. as well as cottonwood. Once short term high flow events recede, the soils in the Potter Creek floodplain are sufficiently well drained that Skunkbush Sumac and Silver Buffaloberry can thrive, since their rooting depths are less than cottonwood root depths.

CNHP has included Potter Creek within its Roubideau Creek Potential Conservation Area (PCA) because of the importance of the riparian community. Potential Conservation Areas are identified by CNHP as landscapes that possess numerous elements of biological diversity within a concentrated area, making them candidates for protection if land and water management objectives include preservation of biological diversity. The Roubideau Creek PCA is ranked as having very high biodiversity significance (B2, on a scale of B1-B5) because of both the intact riparian zones and several occurrences of rare upland plant species.

References:

Colorado Natural Heritage Program. Biodiversity Information Management System (also known as Biotics Database).

Colorado Natural Heritage Program. Roubideau Creek Level 4 Potential Conservation Area Report. https://cnhp.colostate.edu/download/documents/pca/L4_PCA-Roubideau%20Creek_4-24-2022.pdf

Colorado Natural Heritage Program. Rocky Mountain Lower Montane-Foothills Riparian Woodland and Shrubland. https://cnhp.colostate.edu/projects/ecological-systems-of-colorado/details/?elementID=365200

BLM Objectives for Managing Imperiled and Vulnerable Riparian Communities

CNHP has determined that the riparian communities on Potter Creek are vulnerable or imperiled at the state level. In addition, CNHP has noted that Potter Creek is ecologically intact and mostly unaltered, which has resulted in riparian communities that are in unusually good condition. For these reasons, BLM determined that the riparian communities along Potter Creek met the threshold for an ORV as defined by the Wild and Scenic Rivers Act.

BLM concurs with CNHP that preservation of globally significant riparian communities is important. BLM believes there are four primary reasons why protecting globally significant riparian communities is important:

- The existence of a set of species that forms a riparian community proves that its combination of species is stable and can thrive within the physical constraints of that environment. These constraints include soil type, flow regimes, slope, channel morphology, broad climate factors, micro-climates. In other words, that combination of species has proven its resiliency over time.

- Resilient communities are better able to withstand environmental stresses and catastrophic events, including floods, drought, fire, climate change, and disease.

- Resilient communities have a superior ability to provide environmental services. These services include stabilization of stream banks, storage of water in stable stream banks, filtration of pollution, stream shading, cycling of vegetative material, and cycling of nutrients. All of these services provide benefits for aquatic habitats, terrestrial wildlife, and humans.

- Resilient communities provide superior wildlife habitat, because specialist wildlife species have evolved to take advantage of the foraging, nesting, brooding opportunities provided by those communities.

Overall, BLM concludes that while many of the individual species in these communities are common, these combinations of species are rare. BLM believes that comprehensive protection is warranted because these communities are uniquely adapted to thrive in conditions on the Uncompahgre Plateau, which includes stress from catastrophic events. If protected, these communities will continue to be resilient and stable, and continue to provide the environmental services that adjacent human communities expect, such as providing wildlife habitat, high quality water supplies, and erosion control/mitigation.

Description of Species Within the Riparian Communities

The following section provides descriptions of each of the primary species that compose the riparian communities. These descriptions include brief summaries of the habitat, as well as processes and hydrologic conditions that are necessary for successful reproduction and propagation.

Narrowleaf Cottonwood and Fremont Cottonwood

Narrowleaf Cottonwood (Populus angustifolia) and Fremont Cottonwood (Populus deltoides) are members of the willow family that can grow up to 80 feet in height. These species occupy the overstory in many riparian zones in Colorado that are located from 4,000 to 7,000 feet in elevation. Cottonwoods often grow in densely packed clusters forming "galleries" over the underlying riparian vegetation. Narrowleaf Cottonwood has lance-shaped leaves, while Fremont Cottonwood has triangular-shaped leaves with scalloped edges.

Fremont Cottonwood (large trees on extreme right and extreme left of photograph) and Narrowleaf Cottonwood (narrower profile trees in middle of photograph) along Potter Creek.

Cottonwoods aggressively reproduce, making them ideal species for stabilizing soils and substrate in riparian zones. Narrowleaf Cottonwood and Fremont Cottonwood reproduce through three methods, and all methods are water dependent. Seeds are generally viable for a period of only two days, and the seeds require wet alluvium in full sunlight to germinate. Clonal reproduction by sprouting from roots occurs only when exposed roots are covered by wet sediments. New cottonwoods may also sprout from branch fragments if the branch fragments become lodged in wet alluvium with full sunlight. Steep gradients, coarse streambed materials and constrained channels promote clonal reproduction.

Overall, establishment and recruitment of new cottonwoods is dependent upon high flow events that establish bare, moist soil surfaces, combined with weather patterns that minimize soil moisture depletions. These events occur on average from every five to ten years. (Baker,1990; Rood, et al, 1997; Mahoney, J.M. and Rood,1998). Recruitment of new cottonwoods typically occurs when the soil water table does not decline more than 2.5 centimeters per day. Once established, cottonwood communities are highly dependent upon flows that maintain water levels in alluvial aquifers.

Strapleaf Willow

Strapleaf Willow is a deciduous shrub that grows up to six feet in height. It can dominate lower terraces of floodplains and stabilized gravel bars. The species requires bare gravel or sand substrate with adequate moisture for seed germination and development. The species is highly resilient against to hydrologic disturbances, such as high velocity floodwaters, sediment deposition, and fully saturated soils.

Strapleaf Willow

Silver Buffaloberry

Silver Buffaloberry is a deciduous, thorny, thicket-forming shrub that is drought-hardy. The plant grows from 3 to 20 feet high. It grows only on well-drained soils, but it will tolerate a variety of soil types. Reproduction is by seed, typically on sites that are disturbed and/or receive full sunlight.

Silver Buffaloberry

Skunkbush Sumac

Skunkbush Sumac is a deciduous, flowering shrub, averaging four feet in height. Like cottonwood, it reproduces by seed and root sprouts, but the dominant form of reproduction is by sprouting. Sprouting occurs most frequently in response to large disturbance events, such as floods. Skunkbush sumac prefers well-drained soils and will not tolerate long-duration flood events or a high water table for long durations.

Skunkbush Sumac

References:

Baker, W.L. (1990) Climatic and hydrologic effects on the regeneration of Populus angustifolia James along the Animas River, Colorado. Journal of Biogeography. 17-59-73.

Mahoney, J.M. & Rood, S.B. (1998). Streamflow requirements for cottonwood seedling recruitment- an integrative model. Wetlands, 18; 634-645.

Natural Resources Conservation Service - Plant Guides and Fact Sheets. https://plants.usda.gov/java/factSheet

Oregon State University Extension Service. Cottonwood Establishment, Survival, and Stand Characteristics. Publication EM 8800, March 2002.

Rood, S.B. et al. (1997). Canyonlands cottonwoods: Mortality of Fremont Cottonwoods in the Matheson Wetlands Preserve along the Colorado River at Moab, Utah. Report prepared for The Nature Conservancy, Moab, Utah, USA.

Scott, M.L., Auble, G.T., and Friedman, J.M. (1997) Flood dependency of cottonwood establishment along the Missouri River, Montana, USA. Ecological Applications, 7:677-690.

INSTREAM FLOW RATE QUANTIFICATION – STUDY METHODS

BLM facilitated three phases of study to develop this instream flow recommendation. The first phase provided "proof of concept" for the proposed instream flow protection approach, which is designed to protect high flow events. The second phase verified that scientific procedures commonly used to analyze stream channels and floodplains can readily be applied to the high-gradient stream channels and high-roughness floodplains on the Uncompahgre Plateau. The third phase was designed to quantify specific flow rates that should be protected.

- **Phase 1 -** A literature review identified the hydrologic attributes necessary to support the globally rare riparian communities.

- **Phase 2 -** Preliminary on-site studies determined that it is possible to identify bankfull flow rates and flow rates associated with high flow events that inundate all or part of the floodplain. These studies identified the general magnitude of high flow events and suitable portions of the creek for intensive modeling, but they were not used to formulate the final instream flow recommendations.

    Phase 2a -BLM implemented a cross-section analysis of a single cross section utilizing a model called WinXSPRO to develop a preliminary estimate of the flow rate at which bankfull conditions are achieved and inundation of the floodplain begins.

    Phase 2b - BLM also developed a preliminary estimation of peak flood discharge utilizing the U.S. Geological Survey Slope Area Computation Program.

- **Phase 3 -** A comprehensive study over a reach of the stream was conducted using the Hydrologic Engineering Center River Analysis System (HEC-RAS) developed by the U.S. Army Corps of Engineers. This study incorporated multiple cross sections to analyze stream geometry and it also incorporated elevation surveys of the floodplain to establish floodplain topography. The bankfull flow rates reflected in BLM's recommendation rely upon this study because it considered a range of different channel cross section configurations and developed an average flow rate at which bankfull conditions are reached.

Scientific Literature Review

BLM conducted a review of the scientific literature to identify the flow regime needed to support the Rocky Mountain Lower Montane-Foothills Riparian Woodland and Shrubland Ecological System, including the specific communities present on Potter Creek. Applicable research was narrowed to studies conducted in arid environments in the intermountain west, and includes some studies conducted within Colorado or within Utah very close to the Colorado border. The key findings from this literature review are as follows:

1. Riparian vegetation in dry regions is influenced by low-flow and high-flow components of the surface water regime, and by changing groundwater levels over time. High flow events influence vegetation along channels and floodplains by increasing water availability in riparian soils and by creating disturbances where new individuals can establish. The depth to groundwater and rate of groundwater decline after high flow events directly influences survival of riparian species.

2. Key hydrograph components for cottonwood establishment include timing and magnitude of peak discharge, the rate of decline of the recession limb, and the magnitude of base flows.

3. Woody riparian vegetation is commonly dependent on alluvial groundwater. A decline in water table relative to the condition in which roots developed may strand cottonwood and willow roots where they cannot obtain sufficient moisture.

Considerable research has been conducted on the hydrologic conditions necessary for establishment and persistence of cottonwood trees. Those studies conclude that persistence of cottonwood trees as part of a riparian community is highly dependent on infrequent high flow events. High flow events create disturbed area and sediment deposits where cottonwood can germinate. The research also concludes that slowly receding flow rates after the flood event are important for maintaining water levels in the alluvial aquifer, so that the roots of new seedlings can chase slowly receding groundwater levels in riparian soils.

No research was located that specifically analyzed linkages between flow regimes and Skunkbush Sumac, Silver Buffaloberry, Red Osier Dogwood, or Strapleaf Willow, but substantial research has been completed on the overall requirements of riparian shrub species in arid environments. Those studies conclude that disturbances created by infrequent high flow events promote riparian shrub establishment and persistence. Botanical descriptions of Skunkbush Sumac, Silver Buffaloberry and Strapleaf Willow also note that disturbance is an important part of their life history.

When the principles identified in scientific literature are applied to Potter Creek, BLM concludes that the riparian communities on Potter Creek are a direct response to high flow events. These events occur in association with seasonal snowmelt runoff in the April to June period and with monsoonal thunderstorms in the July to September period. These high flow events also erode the sandstone geology of the Uncompahgre Plateau, transporting and depositing significant sediment, providing fresh surfaces and nutrients for riparian establishment. These periodic disturbances and sediment deposit events provide a dynamic environment for continued change and rejuvenation of the riparian community.

BLM concludes that the riparian communities are also a direct response to base flow conditions that can occur during summer, fall, and winter. Base flows maintain water levels in the alluvial aquifer, which supports both deep-rooted cottonwoods and willows, which require constant access to groundwater to persist.

The following is a summary of the findings from BLM's literature search:

Establishment of Riparian Seedlings

- Establishment of cottonwood seedlings is generally restricted to bare, moist sites protected from intense physical disturbance. (Scott, Auble, & Freidman, 1997).
- Bottomland trees and shrubs, including species of cottonwood, poplar, and willow, require bare, moist surfaces protected from large disturbance for successful establishment. (Scott, Friedman, and Auble, 1996).
- High flow events can produce tree establishment by creating bare, moist deposits high enough above the channel bed to minimize future flow- or ice-related disturbance. (Scott, Auble, & Freidman, 1997).
- Sediment deposition, either from main stem or tributary high flow events, is particularly important for tree establishment where channel movement is constrained by a narrow valley. The trees establish on the resulting elevated alluvial deposits. (Scott, Auble, & Freidman, 1997).
- Exposed portions of the bed are ideal sites for establishment of vegetation, including cottonwood. This vegetation promotes deposition of fine sediment and increases resistance to erosion, thus stabilizing the channel to a narrower width. (Scott, Auble, & Freidman, 1997).
- Deposition of additional fine-textured soils behind newly established cottonwoods allows additional seedlings to establish. (Cooper, Merritt, Andersen, and Chimner, 1999).

Recruitment of Riparian Seedlings

- Cottonwood recruitment is constrained to bare areas that contain fine-textured alluvial soils, saturated by high flow events, to provide the soil moisture necessary for seedling survival. Fine-textured soil provide enhance survival due to their higher water-holding capacity. (Cooper, Merritt, Andersen, and Chimner, 1999).
- Along the Animas River, establishment of Narrowleaf Cottonwood occurs about once every ten years, when peak snowmelt flows coincide with cool, wet weather. Establishment is also restricted to a few weeks when the seeds are viable. (Baker, 1990).
- Key hydrograph components for cottonwood establishment include timing and magnitude of high flow peaks, the rate of decline of the recession limb, and the magnitude of base flows. (Shaffroth, Auble, Stromberg, and Patten, 1998).

- Cottonwood establishment and recruitment typically occurs during high flow events with a frequency of once every ten years on the Colorado River near Moab, Utah. (Rood, et al, 1997).

- Studies have consistently suggested that cottonwood recruitment is associated with 1 in 5 to 1 in 10 year high flow event. (Mahoney & Rood, 1998).

- Bottomland tree seedlings, including willows, poplars, and cottonwoods, will tolerate burial, and can sprout from roots or stems. (Scott, Friedman, and Auble, 1996).

Riparian Dependency Upon Alluvial Groundwater Tables

- Woody riparian vegetation is commonly dependent on alluvial groundwater. A decline in water table relative to the condition in which roots developed may strand cottonwood and willow roots where they cannot obtain sufficient moisture. (Shaffroth, Stromberg, and Patten, 2000).

- Cottonwood seedlings typically require four years to grow roots to the depth of the late summer groundwater table. (Cooper, Merritt, Andersen, and Chimner, 1999).

- During the first growing season, bottomland tree seedlings are capable of extending tap roots as deep as one meter. (Scott, Friedman, and Auble, 1996). Typically, cottonwood, poplar, and willow seedlings cannot survive water table declines more rapid than 2.5 centimeters per day. This rate typically occurs on the descending limb of the hydrograph, toward the end of the snowmelt runoff period. (Mahoney and Rood, 1998).

- Cottonwood seedlings survive based on rapid establishment of a tap root, combined with capillary fringe action in the soil above the groundwater table. Depending on soil type, the capillary fringe can extend from 5 to 130 centimeters above the groundwater table. (Mahoney & Rood, 1998).

- Water tables in alluvial soils that are less than 1.5 meters from ground surface are required for successful seeding establishment of woody riparian plants. Species in the poplar and willow families require shallow water tables. Water table declines can lead to plant mortality. (Shaffroth, Stromberg, and Patten, 2000).

Relationship between riparian vigor/abundance/diversity and stream flows

- Riparian vegetation in dry regions is influenced by low-flow and high-flow components of the surface and groundwater flow regimes. High flows influence vegetation along channels and floodplains by increasing water availability and by creating disturbance. Depth, magnitude, and rate of groundwater decline influences riparian vegetation in the floodplain. (J.C. Stromberg, Beauchamp, Dixon, Lite, and Paradzick, 2007).

- The riparian water table is the primary water source for many riparian trees. (Stromberg, 1993).

- Stream discharge (mean annual flow volume and median flow volume) is correlated with riparian tree growth, vigor, and abundance. Riparian tree diversity is correlated with flood flows. (Stromberg, 1993).

- Riparian trees on small streams are the most sensitive to reductions in stream flow volume, in terms of vigor and abundance. (Stromberg, 1993).

Relationship Between Hydrologic Variability and Riparian Community Health

- The width of riparian communities along stream channels is heavily dependent on flow variability. Systematic reductions in flow variability reduces the width of riparian zones that are dependent upon moderate or infrequent inundation frequency. Lower flow variability will result in transition from riparian vegetation to upland vegetation at the edges of a riparian zone. (Auble, Scott, and Friedman, 2005).

- Hydrologic variability that influences the width of riparian zones includes high flow frequency, high flow duration, high flow height, and shear stress associated with high flow events. (Auble, Scott, and Friedman, 2005).

References:

Auble, G. T., Scott, M.L., and Friedman, J. M. (2005). Use of Individualistic Streamflow-Vegetation Relations Along the Fremont River, Utah, USA To Assess Impacts of Flow Alteration of Wetland and Riparian Areas. Wetlands, 25: 143-145.

Baker, W.L. (1990) Climatic and hydrologic effects on the regeneration of Populus angustifolia James along the Animas River, Colorado. Journal of Biogeography. 17-59-73.

Cooper D.J., Merritt, D.M., Anderson, D.C. & Chimner, R.A. (1999). Factors controlling the establishment of Fremont cottonwood seedlings on the Upper Green River, USA. Regulated Rivers: Research and Management, 15:419-440.

Mahoney, J.M. & Rood, S.B. (1998). Streamflow requirements for cottonwood seedling recruitment- an integrative model. Wetlands, 18; 634-645.

Scott, M.L., Auble, G.T., and Friedman, J.M. (1997) Flood dependency of cottonwood establishment along the Missouri River, Montana, USA. Ecological Applications, 7:677-690.

Scott, M.L., Friedman, J.M., and Auble, G.T. (1996) Fluvial process and the establishment of bottomland trees. Geomorphology 14: 327-339.

Shaffroth P.B., Auble, G.T., Stromberg, J.C., and Patten. D.T. (1998). Establishment of woody vegetation in relation to annual patterns of streamflow, Bill Williams River, AZ. Wetlands, 18, 577-590.

Shaffroth, P.B., Stromberg, J.C. and Patten, D.T. (2000). Woody riparian vegetation response to different alluvial water table regimes. Western North American Naturalist, 60:66-76.

Stromberg, J.C. (1993). Instream Flow Models for Mixed Deciduous Riparian Vegetation Within a Semiarid Region. Regulated Rivers: Research and Management, 8:225-235.

Stromberg. J.C., Beauchamp, V.B. Dixon, M.D. Lite, S. J., and Paradzick, C. (2007) Importance of low-flow and high-flow characteristics to restoration of riparian vegetation along rivers in the arid southwestern United States. Freshwater Biology (2007) 52, 651-679.

Rood, S.B. et al. (1997). Canyonlands cottonwoods: Mortality of Fremont Cottonwoods in the Matheson Wetlands Preserve along the Colorado River at Moab, Utah. Report prepared for The Nature Conservancy, Moab, Utah, USA.

Phase 2a – Initial Channel Cross Section Analysis Using WinXSPRO

The literature review identified that high flow events are a key component of the hydrologic regime that supports BLM's targeted riparian communities. BLM concluded that to identify the general magnitude of flow rates necessary to create high flow conditions, an analytical tool capable of analyzing flows at bankfull condition and higher was necessary. For this task, BLM selected WinXSPRO, a software package designed to analyze stream cross sections for geometric and hydraulic parameters.

BLM personnel conducted a reconnaissance site visit of Potter Creek to identify a cross section that would be representative of typical channel morphology on the creek. At the chosen location, a monumented cross section was established, and the channel was surveyed during low flow conditions to document exact channel shape. Bankfull flow elevation was determined at the cross section, using multiple field indicators, including topographic breaks in bank slope, scour lines, changes in vegetation, depositional features, and size of material on the channel surface.

BLM personnel returned to the site multiple times to collect discharge measurements and water surface elevations at various flow rates. Data collected from the field visit during the highest flow rate (flow rate closest to bankfull elevation) was run through the WinXSPRO modeling software to estimate the flow rate needed to achieve bankfull flow. The preliminary results from this effort demonstrated that bankfull flows could be identified and modeled in this stream system.

Phase 2b - Initial Estimation of Peak Flood Discharge - U.S.G.S. Slope Area Computation Program (SACGUI)

The BLM also developed a model to estimate the streamflow of high flow events that deposited large piles of woody debris on the floodplain of Cottonwood Creek. To do this, BLM selected the USGS Slope Area Computation Graphical User Interface (SACGUI). This method is widely used by the USGS throughout the United States to calculate flood discharge when stream gage data is not available or after flood events have receded.

BLM survey teams established a cadastral survey benchmark and then used a Trimble GPS unit to collect data on high water marks, cross sections, channel geometry, and benchmarks. High water marks were estimated by vegetation and debris piles deposited from past flooding. Channel and floodplain roughness were also determined in the field as part of the process.

The modeling effort resulted in an initial estimate of the magnitude of flood discharge. The results of his phase were not used to develop final instream flow recommendations. The results were used to identify portions of the creek that would be suitable for more intensive modeling.

Phase 3 - Comprehensive Analysis Using HEC-RAS To Quantify Bankfull Flow Rate and Floodplain Inundation Flow Rate

HEC-RAS is widely used throughout the United States for hydraulic modeling of flood flows. HEC-RAS can be used to determine the depth and extent of inundation in floodplains and stream channels at various flow rates. HEC-RAS has significant advantages over simpler analytical techniques such as WinXSPRO because multiple cross sections can be entered to analyze channel geometry and overbank topography over a representative reach in the stream of interest. With this data, HEC-RAS can perform more advanced hydraulic calculations than approaches that rely on a single cross section. HEC-RAS is also capable of producing maps that illustrate the portions of the channel and floodplain that are inundated at various flow rates.

BLM worked closely with staff from the CWCB and AECOM to design and implement the HEC-RAS modeling. In April 2021, this team identified two reaches on Potter Creek that would be appropriate for HEC-RAS modeling purposes, based on the criteria that the modeling location is representative of the stream channel, and that the floodplain supports the riparian communities of interest to the BLM. The team also jointly identified on-the-ground indicators for the modeling effort, including the physical location on the stream banks for bankfull flow, the outermost locations of the floodplain, and the locations of debris piles dropped by previous flood events.

AECOM used the on-site survey information to develop a model for the selected reaches of Potter Creek. AECOM determined the Manning's "n" values (roughness factor for the stream channel and floodplain) that should be used in the modeling effort, based on channel characteristics. AECOM's final modeling results identified the discharge rates necessary to meet the bankfull indicators identified in the field, as well as the discharge necessary to deposit to the debris piles identified in the field. Please refer to the modeling memo and figures from AECOM to the CWCB dated June 9, 2021.

BLM INSTREAM FLOW RECOMMENDATION

Existing Instream Flow Water Right

Based upon a previous recommendation from BLM, the CWCB appropriated an instream flow water right on Potter Creek in 2004 to protect the native fish community and macroinvertebrates supported by Potter Creek. The upper terminus for the existing instream flow water right is at the BLM – U.S. Forest Service boundary and the lower terminus is the confluence of Potter Creek with Roubideau Creek. The existing appropriation was made in the following amounts:

1.8 cubic feet per second from March 1 to March 31
4.0 cubic feet per second from April 1 to June 15
1.8 cubic feet per second from June 16 to July 31
1.4 cubic feet per second from August 1 to February 29

Riparian Flow Recommendation

BLM recommends an increase to the existing instream flow water right for the purpose of protecting a component of the natural environment that is not now fully protected – riparian species and intact riparian plant communities. Protecting high flows and the receding limb of the hydrograph that occurs after these flows will provide the conditions necessary riparian species to reproduce and for seedlings to establish, processes which are critical for sustaining riparian communities along Potter Creek.

BLM recognizes that because of natural hydrologic variation, the frequency and timing of meeting the recommended flow rates are highly variable. Sufficient water to meet riparian flood flows may not be available in all years or even for several years in a row. However, BLM believes that infrequently available high flow events, combined with the existing ISF flows, are essential for protecting the processes that create and sustaining the riparian community in Potter Creek.

BLM recommends protection of the following flow rates:

BLM-USFS boundary to confluence with Monitor Creek

> When the flow rate reaches 177.0 cubic feet per second (bankfull flow), all flow in the creek should be protected until the flow rate recedes to the existing instream flow water right.

Confluence with Potter Creek to confluence with Roubideau Creek

When the flow rate reaches 225.0 cubic feet per second (bankfull flow), all flow in the creek should be protected until the flow rate recedes to the existing instream flow water right.

BLM recommends that the proposed water rights be in effect only during the April 1 to September 30 period, if the flow rate threshold is met. This time frame corresponds to the portion of the year when the riparian community is actively growing and reproducing, and when a very high percentage of overbank flows occur due to snowmelt runoff events and monsoonal thunderstorm events. During years in which streamflow does not reach the proposed threshold, this instream flow water right for high flow events would not be in effect.

Administration of Recommended Instream Flow Water Rights

Active administration of the proposed instream flow water right will not be needed unless new junior water rights are established on the stream. When that occurs, a stream gage station would be needed to administer this instream flow water right. The gage would need to be closely monitored to determine if the threshold flow was reached, which would activate the proposed instream flow water right. Daily monitoring will be required because flows tend to increase rapidly at the start of bankfull event and decrease rapidly toward the end of a bankfull event.

A fictional example of how the existing instream flow water right would work with the recommended increase is set forth below:

> *In early May, Potter Creek is flowing at 35 cfs due to snowmelt runoff from an above average snowpack. 4.0 cubic feet per second of this 35 cfs is protected under the existing instream flow water right. Then temperatures spike during a heat wave in May, and snowmelt flows increase very rapidly. Once the flow rate hits 177.0 cubic feet per second in the upper reach, or 225.0 cubic feet per second in the lower reach, then all flow in the creek is protected from water diversions by junior appropriators.*
>
> *After the snowmelt high flow event peaks at 300 cfs, it then slowly starts to recede as the heat wave subsides and temperatures return to normal ranges. All flow is protected until the flow rate recedes to 4.0 cubic feet per second in early June, which is the existing instream flow rate that applies at that time of year. Once 4.0 cfs is measured, then the riparian flood rate is no longer in effect and the stream is subject only to the existing instream flow water right.*

If new junior water rights are established upstream from a future stream gage installed by the CWCB, any diversions made by the junior water rights would have to be accounted for in the gage discharge reading when the instream flow water right is administered. This adjustment would be necessary because the new junior water rights would deplete stream flows and could prevent stream flow from reaching the threshold at which the new instream flow water right would be administered.

WATER AVAILABILITY

Uncompahgre Plateau Hydrology Overview

Streamflow on the Uncompahgre Plateau is characterized by a three-month period of high flows during the snowmelt runoff period in April through June, followed by a period characterized by low base flows from July through March. As the first step for an initial water availability analysis, BLM calculated the mean annual monthly distribution of flow on the Uncompahgre Plateau, using the annual hydrographs from gages that were operated for very short periods on Potter Creek, Spring Creek, and Hay Press Creek. These three creeks were used since they are unaltered representations of natural flow regimes on the Uncompahgre Plateau.

The analysis revealed that approximately 85% of the annual flow volume on Uncompahgre Plateau streams occurs during the April to June snowmelt runoff period. Although monsoonal weather patterns in July through September can produce very large high flow events, they are typically of short duration, so these events do not result in a high percentage of streamflow volume allocated to those months.

Although there is some streamflow gage data available for the Uncompahgre Plateau, most of this data set has been collected near the floor of the Uncompahgre Valley. The historical data set is severely impacted by diversions and irrigation use that occur in and around the valley floor. This situation makes it difficult to use historical flow data to estimate the natural flow regime for watersheds on the Uncompahgre Plateau, and it makes it very difficult to calculate the magnitude of high flow events. In response to this limited data set, BLM completed an estimate of high flow discharge by using the U.S. Geological Survey Slope Area Computation Program (SACGUI). This model estimate identified the general magnitude of discharge associated with high flow events, given the lack of usable data for streams on the Uncompahgre Plateau. Reliance upon modeling efforts is also warranted because of personnel safety and logistical concerns. Specifically, high flow events that serve as the basis of this recommendation are infrequent, typically exceed thresholds for conducting safe discharge measurements, and often make travel routes temporarily unusable.

BLM sought to evaluate the magnitude of very high flow events by modeling the discharge necessary to deposit debris piles that are found in the floodplain. BLM initially conducted this modeling using the USGS SACGUI program, but ultimately relied upon the more robust HECRAS model for the final high flow discharge estimates.

Water Rights

BLM is not aware of any ditches that divert flows from Potter Creek. A high percentage of the Potter Creek watershed is within a BLM Wilderness Study Area and within roadless areas on lands managed by the U.S. Forest Service.

To:	Brandy Logan, Water Resources Specialist		
From:	Rigel Rucker, AECOM Project Manager Isaac Allen, AECOM Deputy PM Griffin Cullen, AECOM Project Engineer		
Date:	June 9, 2021		
Project Title:	Cottonwood, Monitor and Potter Creek's Survey and Hydraulics	**Project Number:**	60654120

OVERVIEW

The purpose of this project was to collect survey information and develop hydraulic models for four sites in Montrose County, CO. The sites included locations on Cottonwood Creek, Monitor Creek, Potter Creek above the confluence of Monitor Creek (Potter Above), and Potter Creek below the confluence of Monitor Creek (Potter Below). This information was used to determine bank full flows and flood inundation flows.

APPROACH AND ASSUMPTIONS

Topographic Survey and Data Collection

In April 2021, AECOM conducted detailed survey on all 4 reaches. Survey data consisted of cross section elevations that established channel geometry and overbank topography as well as the top of the banks and the toe of the slope. In addition to the elevation data, AECOM surveyors identified locations of debris piles. AECOM surveyor also measured bankfull indicators that were identified by Colorado Water Conservation Board (CWCB) and Bureau of Land Management (BLM) staff.

Table 1. Summary of Survey Data

Reach	Number of Cross Sections	Number of Points	
		Bankfull	Debris
Cottonwood	8	13	14
Monitor	4	6	25
Potter Above	5	10	20
Potter Below	5	9	20
Total	**22**	**39**	**79**

Surveyors established horizontal and vertical control at each location. The datum used for collecting horizontal coordinates was "North American Datum of 1983 (NAD83) State Plane Colorado Central Zone 0502 US Survey Feet" and vertical coordinates were established using the "North American Vertical Datum of 1988 (NAVD88) with Geoid12B US Survey Feet.

Raw survey data and photos collected in the field are included in Attachment 1.

Development of Hydraulic Model

AECOM developed a hydraulic model for each of the 4 reaches using the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center's River Analysis System (HEC-RAS) Versions 5.0.7. An ArcGIS extension, HEC-GeoRAS version 10.2, aided in the development of model inputs and was used to map inundation boundaries. Cross section elevations were obtained from the survey data using HEC-GeoRAS within the compatible ArcMap version 10.5.1 GIS platform.

At each cross section, the bank stations were placed at the "Top of Bank" locations noted in the survey. Manning's" n" values were selected based on aerial imagery and photos collected during field survey. These values were carefully selected in accordance with Table 3-1 in the HEC-RAS 5.0.1 Reference Manual. All channel Manning's "n" values range between 0.035 - 0.055 to represent a main channel with gravels, cobbles, and a few boulders. Cottonwood is on the lower end of this range because the channel is mostly smaller cobbles and Potter Above is on the high end because the photos show mostly medium to large boulders. In the overbanks, the Manning's "n" values range from 0.05 – 0.07 to denote floodplains with light to medium brush with some trees. Potter Above has higher overbank values because the brush appears to be relatively dense and Monitor has lower Manning's "n" values because there is generally less brush. The table below summarizes the values used in this analysis.

Table 2. Manning's n values

Reach	Left Overbank	Channel	Right Overbank
Cottonwood	0.055 – 0.06	0.045	0.07
Monitor	0.05	0.05	0.07
Potter Above	0.06	0.055	0.07
Potter Below	0.065	0.04	0.055

Normal depth was used as the downstream boundary for each reach. The energy grade slope was approximated using the average channel bed slope, assuming that flow is uniform. This methodology was checked specifically at Monitor creek where the downstream cross section was defaulting to critical depth. Additional cross sections from LiDAR data were added downstream of the surveyed section. These sections decreased the water surface elevation at the most downstream cross section by 0.1 ft. This difference in water surface elevation would amount to a difference in 5 cfs for the Bankfull flow and 0 cfs for the Flood flow. This difference is accounted for in the range of discharge values reported in the result.

Using an iterative process, discharge values were entered into the Steady Flow Data option. The goal was to match the water surface elevations calculated in the hydraulic model to the minimum bankfull elevation and the minimum and maximum flood inundation elevation at each cross section. The bankfull elevations were denoted as "bankfull monsoon" in the field. The flood inundation target elevations were calculated at each cross section using the minimum and maximum surveyed point that noted "Debris." The difference between the water surface elevation and the bankfull or flood inundation elevation was averaged for each reach with a target of 0 difference and the smallest Root Mean Square Error (RMSE) possible. It should be noted that many of the profiles for each section default to critical depth. This is likely due to the steepness of the streambed for these surveyed reaches.

The final hydraulic models are included in Attachment 2.

RESULTS

The final discharge values can be seen below in Table 3. A more detailed breakdown of water surface elevation differences between surveyed target elevation and the calculated elevation can be found on each Exhibit in Attachment 3.

Table 3. Final Discharge Values

River	Bankfull (cfs)	Flood Discharge at Debris Locations	
		Min (cfs)	Max (cfs)
Cottonwood	183	974	1247
Monitor	111	1960	3885
Potter Above	177	310	753
Potter Below	225	1050	2030
Max RMSE	*0.64*	*1.03*	*1.16*

The flood inundation flows calculated were generally greater than the bankfull flows and exhibit a wide range of flows. This is likely due to the variability in elevation between the surveyed debris points. There are many different scenarios that could contribute to the surveyed debris points which results in a wider range of elevations and thus a wider range of discharge values.

Resulting water surface elevations were plotted against the surveyed elevations to determine the inundation boundaries for each scenario. These mapped boundaries are shown in the exhibits of Attachment 3. It should be noted that in multiple scenarios, the inundation boundaries do not match exactly with the surveyed location because the discharge values were calibrated to an elevation.

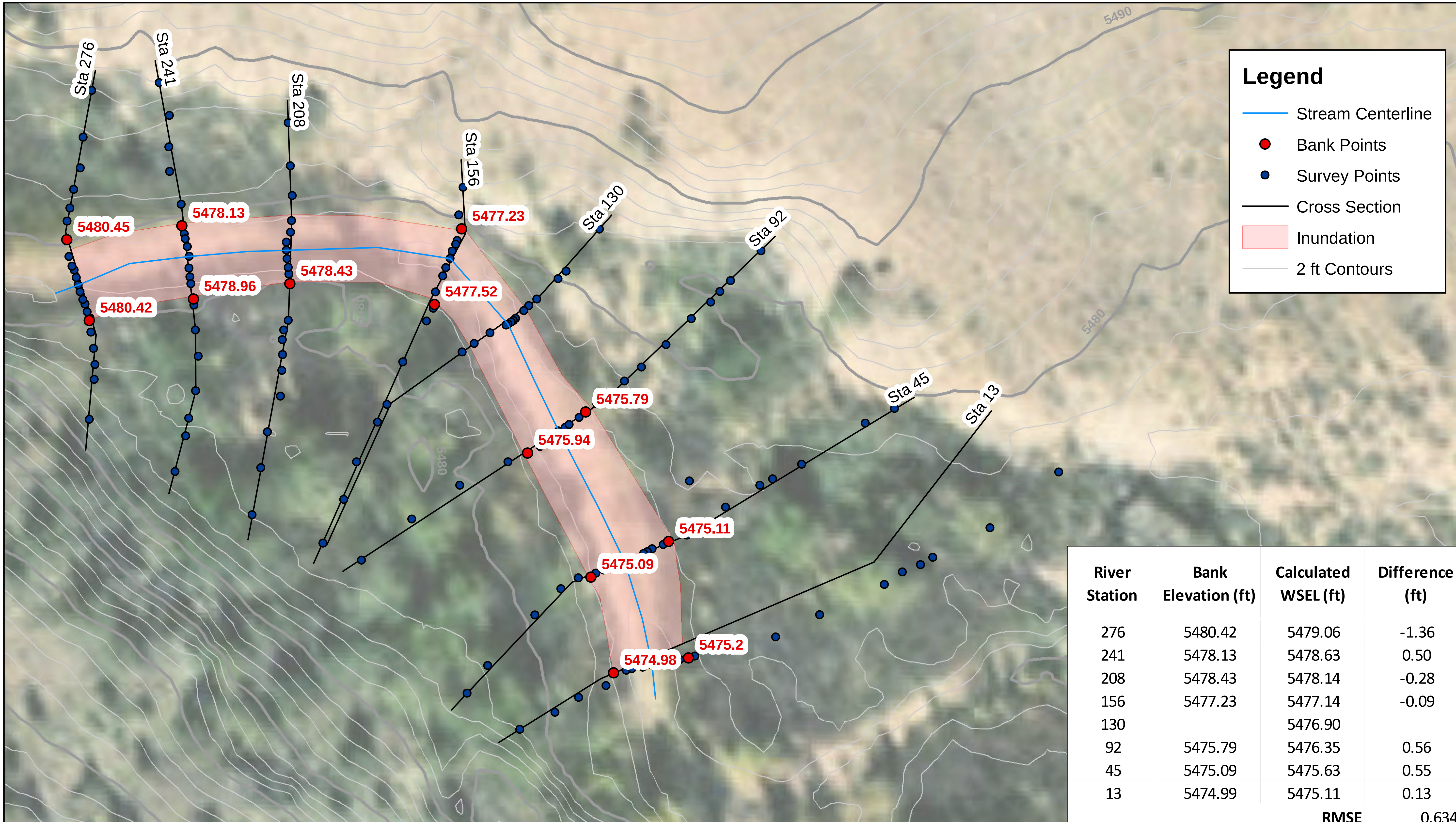
ATTACHMENTS

Attachment 1 – Survey data

Attachment 2 – Hydraulic Model

Attachment 3 - Exhibits

- **Exhibit 1 -** Cottonwood Creek –Bankfull Flow
- **Exhibit 2 -** Cottonwood Creek – Flood Inundation
- **Exhibit 3 -** Monitor Creek – Bankfull Flow
- **Exhibit 4 -** Monitor Creek – Flood Inundation
- **Exhibit 5 -** Potter Creek Above Monitor – Bankfull Flow
- **Exhibit 6 -** Potter Creek Above Monitor – Flood Inundation
- **Exhibit 7 -** Potter Creek Below Monitor – Bankfull Flow
- **Exhibit 8 -** Potter Creek Below Monitor – Flood Inundation



River Station	Bank Elevation (ft)	Calculated WSEL (ft)	Difference (ft)
276	5480.42	5479.06	-1.36
241	5478.13	5478.63	0.50
208	5478.43	5478.14	-0.28
156	5477.23	5477.14	-0.09
130		5476.90	
92	5475.79	5476.35	0.56
45	5475.09	5475.63	0.55
13	5474.99	5475.11	0.13
		RMSE	0.6344

Exhibit 1: Cottonwood Creek - Bankfull Flow

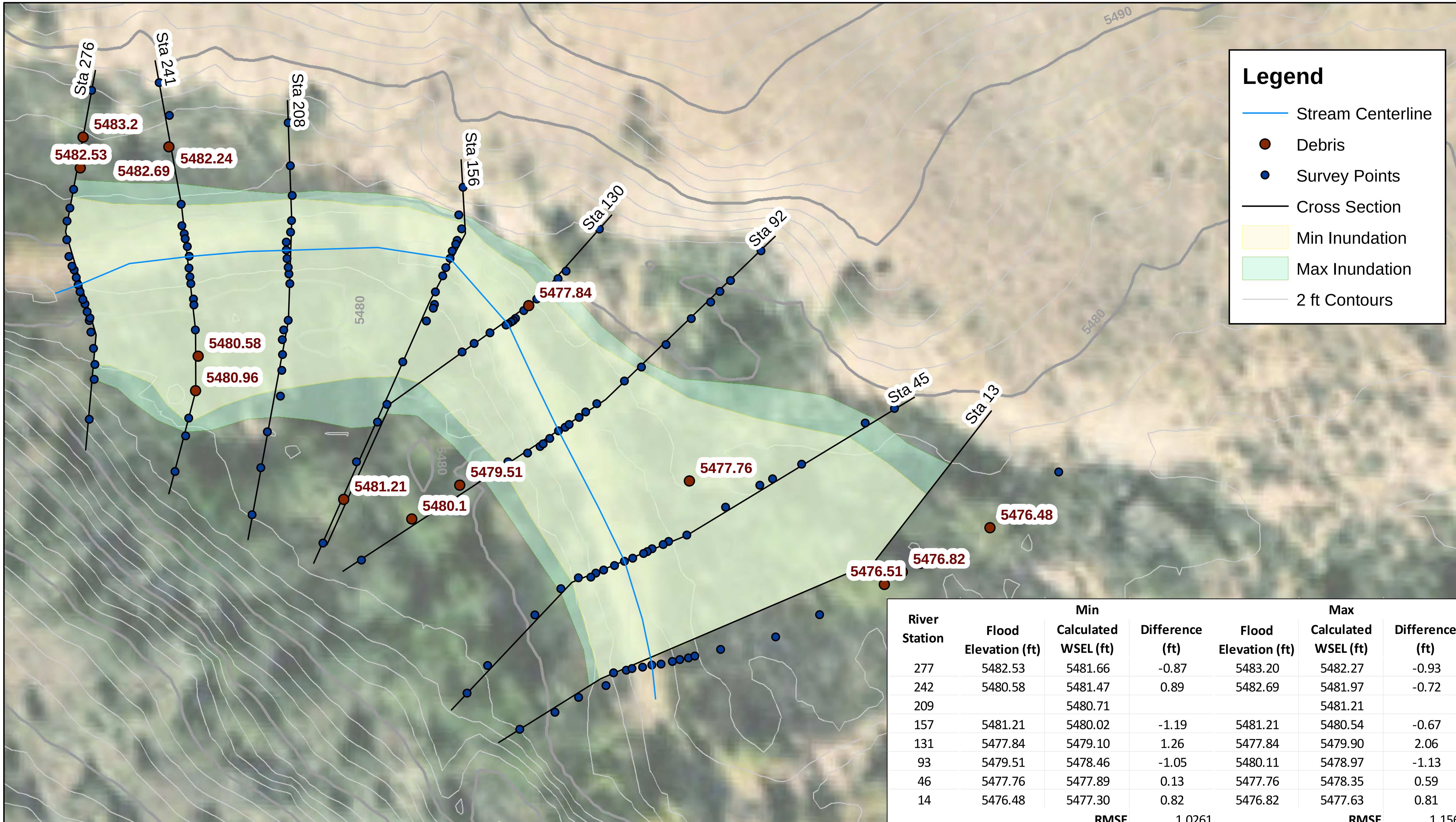
Discharge = 183 cfs

AECOM

N

0 15 30 Feet 1 inch = 30 feet

Please note that contours were included for reference only and were not directly utilized in the analysis.



River Station	Min Flood Elevation (ft)	Min Calculated WSEL (ft)	Min Difference (ft)	Max Flood Elevation (ft)	Max Calculated WSEL (ft)	Max Difference (ft)
277	5482.53	5481.66	-0.87	5483.20	5482.27	-0.93
242	5480.58	5481.47	0.89	5482.69	5481.97	-0.72
209		5480.71			5481.21	
157	5481.21	5480.02	-1.19	5481.21	5480.54	-0.67
131	5477.84	5479.10	1.26	5477.84	5479.90	2.06
93	5479.51	5478.46	-1.05	5480.11	5478.97	-1.13
46	5477.76	5477.89	0.13	5477.76	5478.35	0.59
14	5476.48	5477.30	0.82	5476.82	5477.63	0.81
		RMSE	1.0261		RMSE	1.1565

Exhibit 2: Cottonwood Creek - Flood Inundation

Discharge = 974 - 1247 cfs

N

0 15 30 Feet

1 inch = 30 feet

Please note that contours were included for reference only and were not directly utilized in the analysis.

River Station	Bank Elevation (ft)	Calculated WSEL (ft)	Difference (ft)
277	5430.78	5430.71	-0.07
241	5429.79	5430.13	0.34
214	5429.99	5429.76	-0.23
185	5429.21	5429.16	-0.05
135		5427.74	
96		5425.50	
55		5422.80	
12		5422.28	
		RMSE	0.2099

Exhibit 3: Monitor Creek - Bankfull Flow

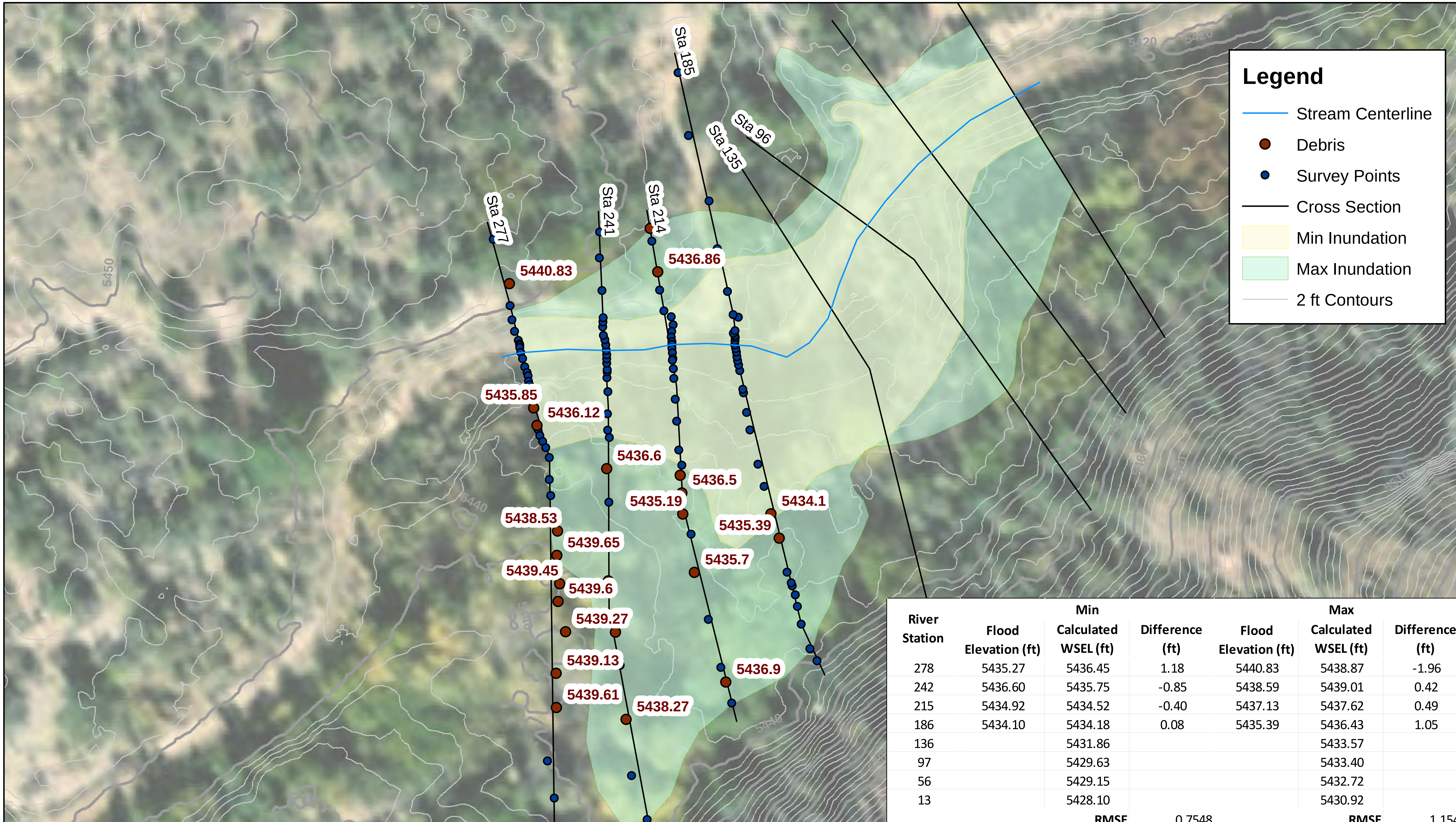
Discharge = 111 cfs

N

0 20 40 Feet

1 inch = 40 feet

Please note that contours were included for reference only and were not directly utilized in the analysis.



River Station	Min Flood Elevation (ft)	Min Calculated WSEL (ft)	Min Difference (ft)	Max Flood Elevation (ft)	Max Calculated WSEL (ft)	Max Difference (ft)
278	5435.27	5436.45	1.18	5440.83	5438.87	-1.96
242	5436.60	5435.75	-0.85	5438.59	5439.01	0.42
215	5434.92	5434.52	-0.40	5437.13	5437.62	0.49
186	5434.10	5434.18	0.08	5435.39	5436.43	1.05
136		5431.86			5433.57	
97		5429.63			5433.40	
56		5429.15			5432.72	
13		5428.10			5430.92	
		RMSE	0.7548		RMSE	1.1548

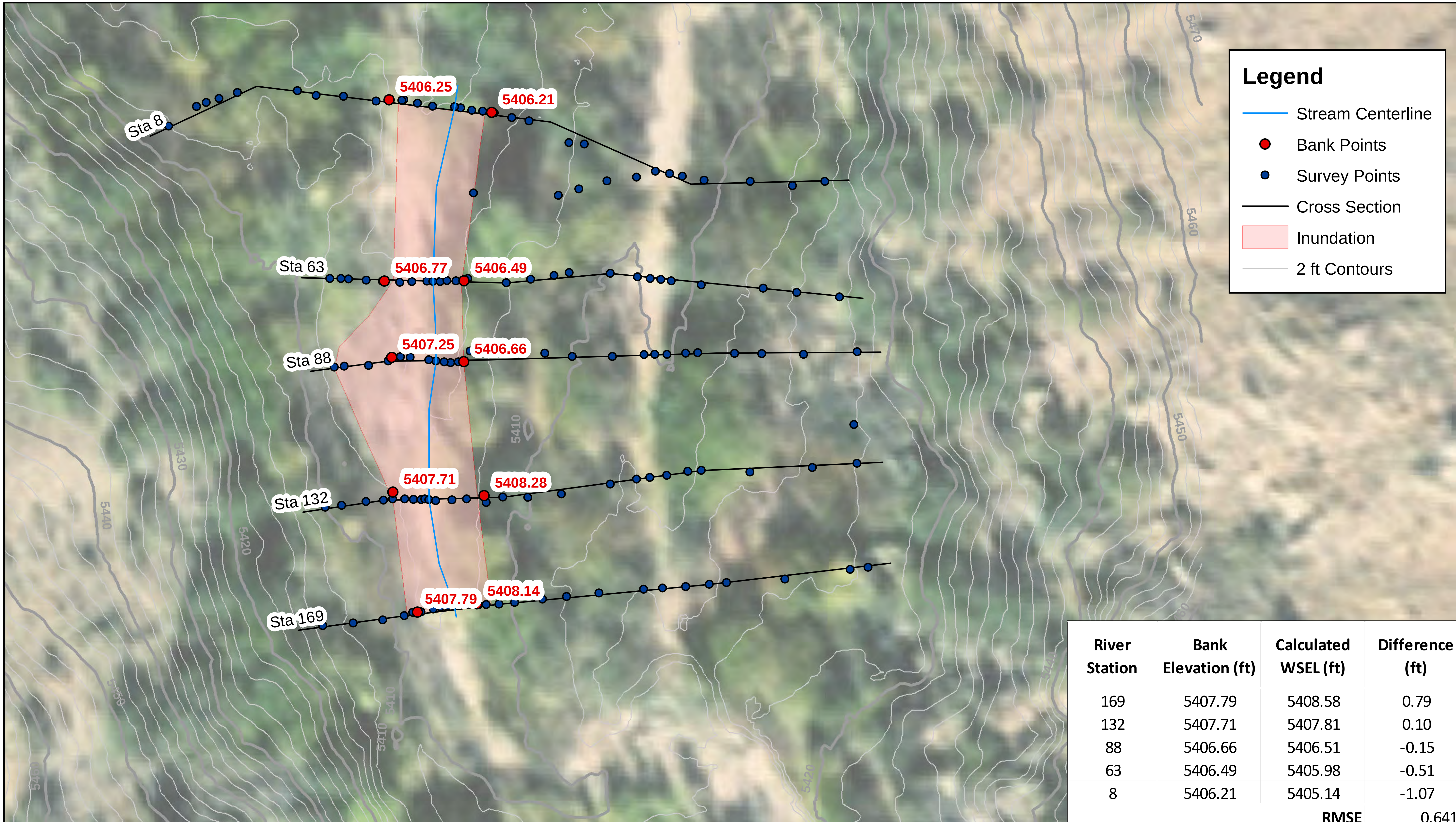
Exhibit 4: Monitor Creek - Flood Inundation

Discharge = 1960 - 3885 cfs

AECOM

N 0 20 40 Feet 1 inch = 40 feet

Please note that contours were included for reference only and were not directly utilized in the analysis.



River Station	Bank Elevation (ft)	Calculated WSEL (ft)	Difference (ft)
169	5407.79	5408.58	0.79
132	5407.71	5407.81	0.10
88	5406.66	5406.51	-0.15
63	5406.49	5405.98	-0.51
8	5406.21	5405.14	-1.07
		RMSE	0.6417

Exhibit 5: Potter Above - Bankfull Flow

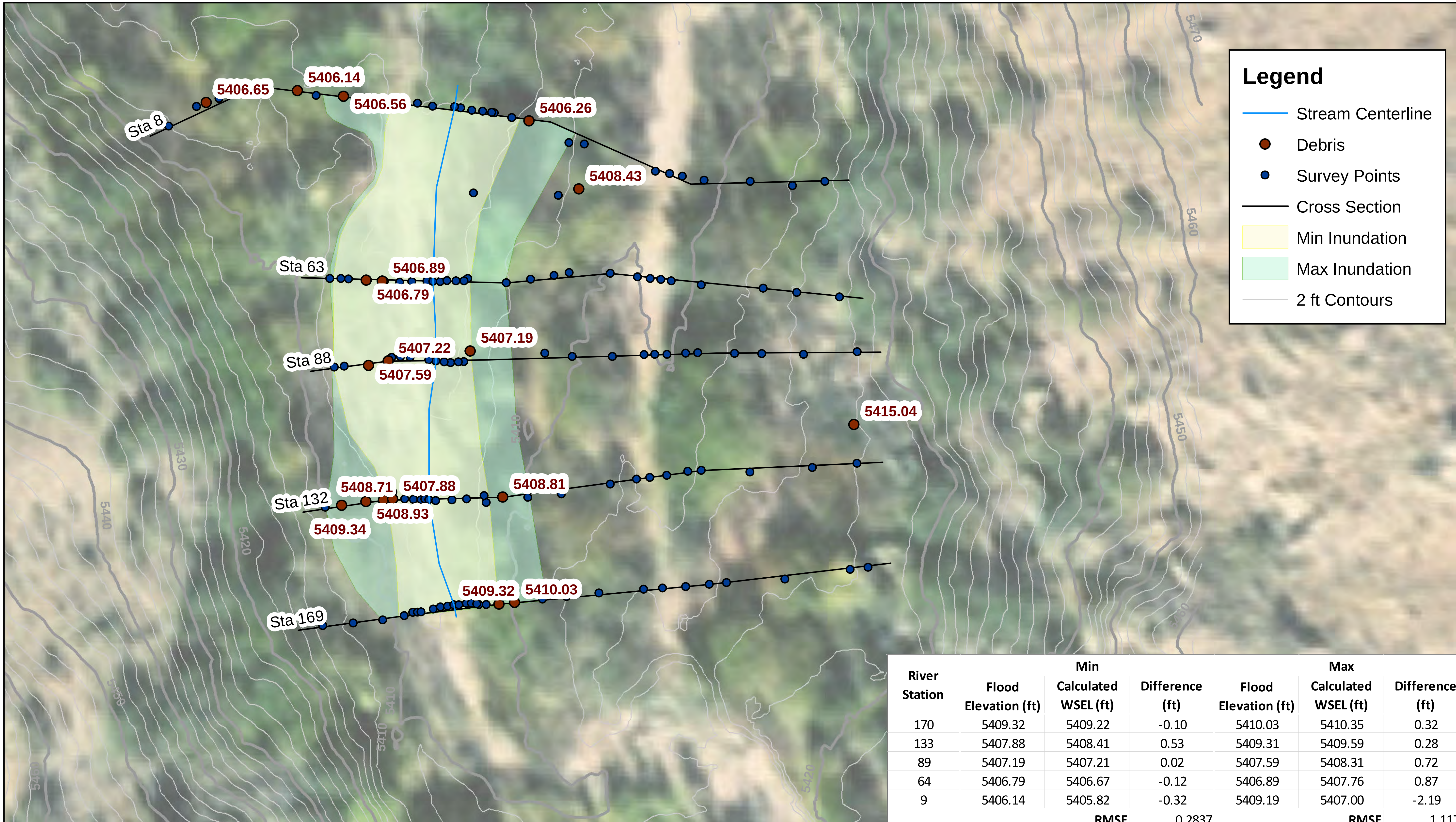
Discharge = 177 cfs

N

0 15 30 Feet

1 inch = 30 feet

Please note that contours were included for reference only and were not directly utilized in the analysis.



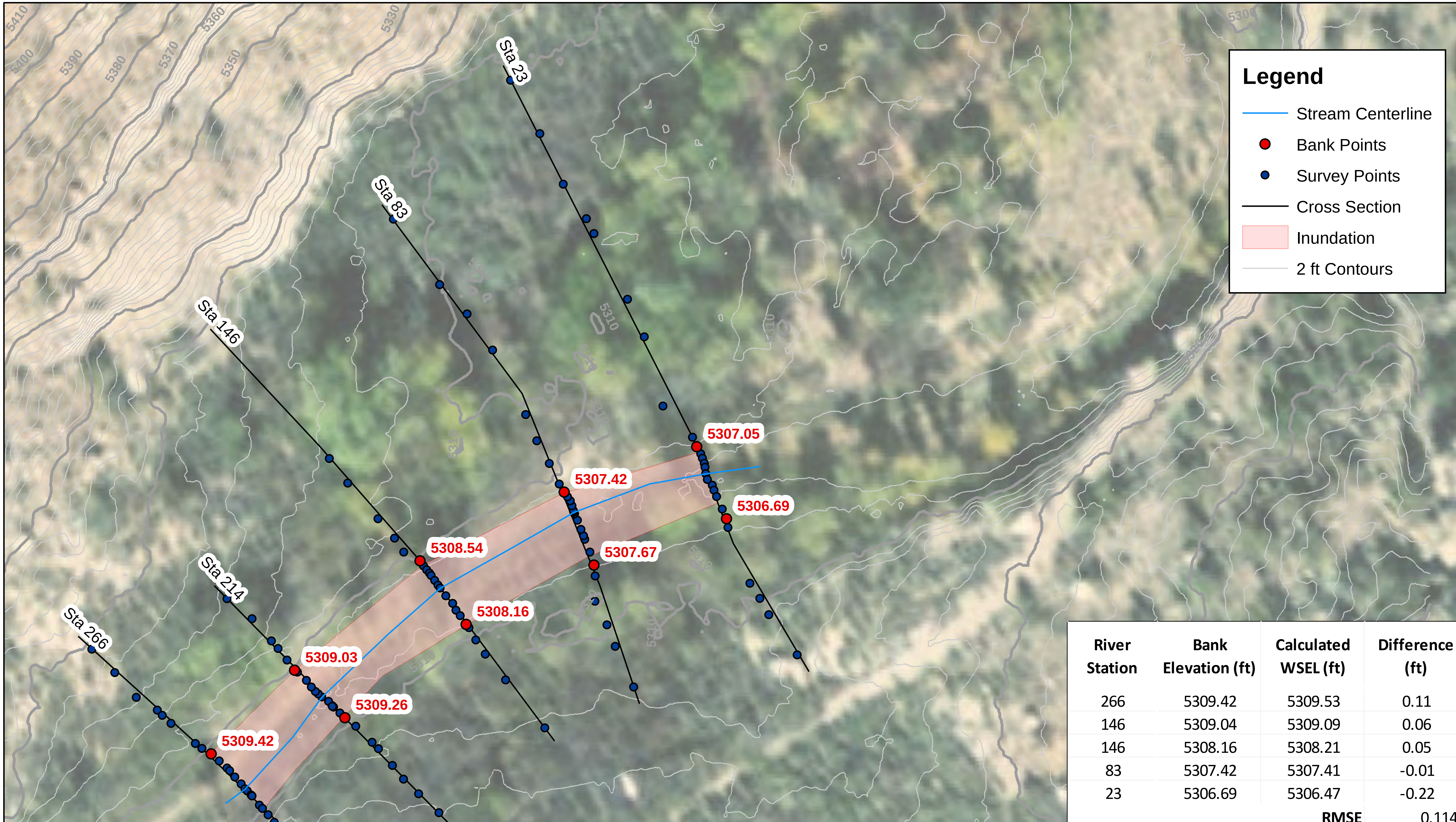
River Station	Flood Elevation (ft)	Min Calculated WSEL (ft)	Difference (ft)	Flood Elevation (ft)	Max Calculated WSEL (ft)	Difference (ft)
170	5409.32	5409.22	-0.10	5410.03	5410.35	0.32
133	5407.88	5408.41	0.53	5409.31	5409.59	0.28
89	5407.19	5407.21	0.02	5407.59	5408.31	0.72
64	5406.79	5406.67	-0.12	5406.89	5407.76	0.87
9	5406.14	5405.82	-0.32	5409.19	5407.00	-2.19
		RMSE	0.2837		RMSE	1.1174

Exhibit 6: Potter Above - Flood Inundation

Discharge = 310 - 753 cfs

AECOM

Please note that contours were included for reference only and were not directly utilized in the analysis.

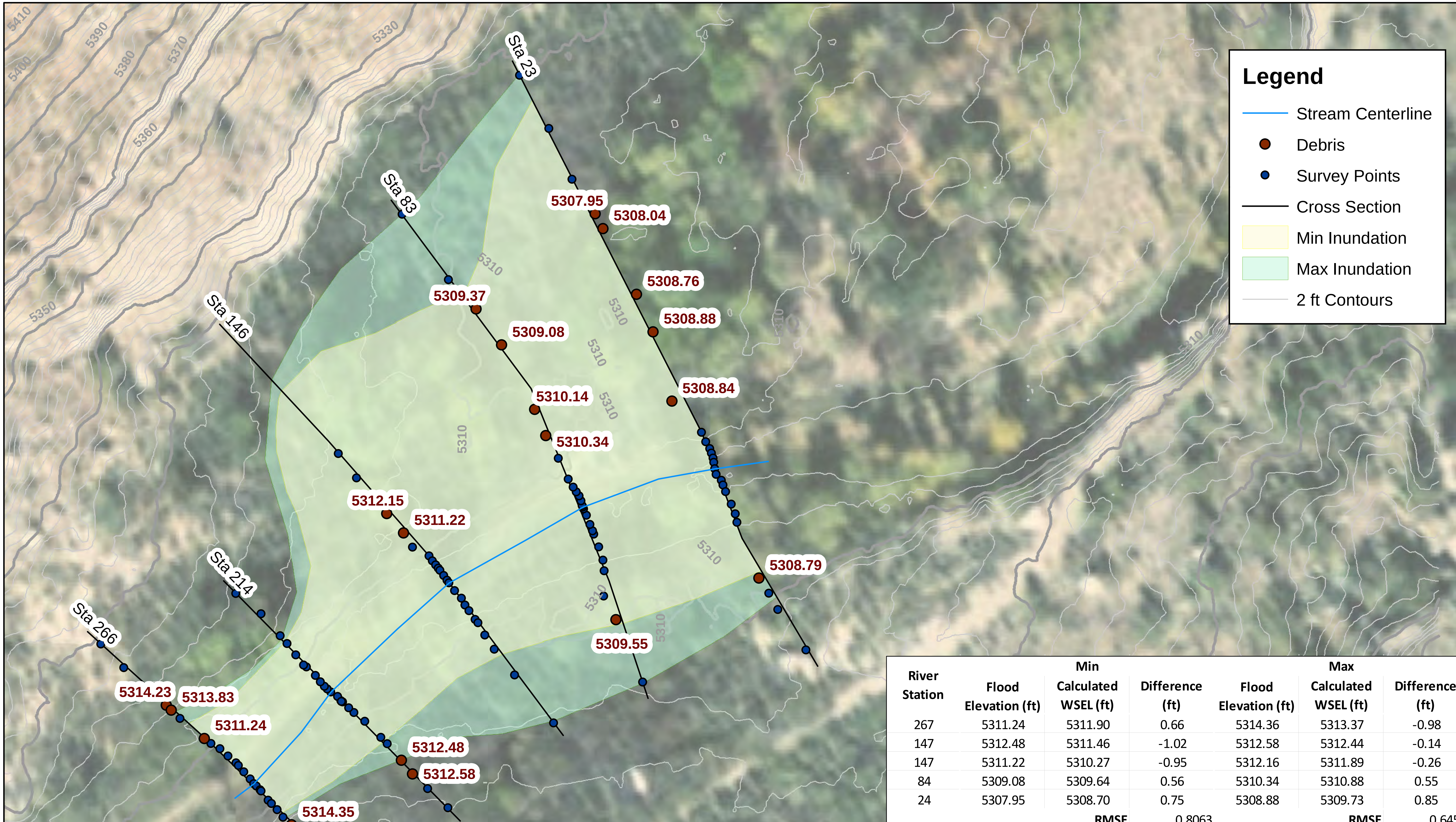


River Station	Bank Elevation (ft)	Calculated WSEL (ft)	Difference (ft)
266	5309.42	5309.53	0.11
146	5309.04	5309.09	0.06
146	5308.16	5308.21	0.05
83	5307.42	5307.41	-0.01
23	5306.69	5306.47	-0.22
		RMSE	0.1140

Exhibit 7: Potter Below - Bankfull Flow

Discharge = 225 cfs

Please note that contours were included for reference only and were not directly utilized in the analysis.



River Station	Flood Elevation (ft)	Min Calculated WSEL (ft)	Difference (ft)	Flood Elevation (ft)	Max Calculated WSEL (ft)	Difference (ft)
267	5311.24	5311.90	0.66	5314.36	5313.37	-0.98
147	5312.48	5311.46	-1.02	5312.58	5312.44	-0.14
147	5311.22	5310.27	-0.95	5312.16	5311.89	-0.26
84	5309.08	5309.64	0.56	5310.34	5310.88	0.55
24	5307.95	5308.70	0.75	5308.88	5309.73	0.85
		RMSE	0.8063		RMSE	0.6456

Exhibit 8: Potter Below - Flood Inundation

Discharge = 1050 - 2030 cfs

AECOM

Please note that contours were included for reference only and were not directly utilized in the analysis.

FINAL DRAFT

Colorado Water Conservation Board

Delta Area Water Development Allowance

Roubideau Creek, photo by Raquel Flinker, Colorado River District

February 2023

Prepared by

SGM

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FINAL DRAFT

Delta Area Water Development Allowance

COLORADO WATER CONSERVATION BOARD

Prepared By

Amanda Webb

Reviewed By

Jordan Dimick, PE

SGM Project 2022-160.004

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1.0 Introduction

The Colorado Water Conservation Board (CWCB) is considering an instream flow (ISF) appropriation that protects all available flow for a portion of the year when threshold streamflow conditions are met, minus a development allowance, within Cottonwood, Monitor, and Potter Creeks. These creeks are located approximately five miles west of Delta, Colorado. The proposed ISFs would only be in effect if bank full conditions are met, to allow flooding conditions to occur in the riparian zone, during the months of April through September. These flooding events may not occur every year, and when they do, may only last for a few days or weeks. Since 2000, Colorado has generally experienced an extended drought, and while in some years these basins have seen greater than normal streamflows, the riparian corridor adjacent to streams have been negatively impacted by low streamflow during drought periods.

Within each creek basin, there are private landowners whose properties are surrounded by large portions of public lands managed by the U.S. Forest Service (USFS), Bureau of Land Management (BLM), and Colorado Parks and Wildlife (CPW). The purpose of this project was to consider the ownership of lands, possible future water demands, the available water supplies, and then to establish a water development allowance (WDA) in each creek basin for private and federal/state water rights. The future demands identified in the WDA would thereby allow for the development of water rights for private uses and would allow the USFS, BLM, and CPW to support their management operations. Ultimately, the ISF appropriations would seek to permanently protect and preserve the natural environment in each of the aforementioned creeks.

1.1 Study Area

The study area is located along the northeastern portion of the Uncompahgre Plateau between Sawmill Mesa, Monitor Mesa, and 7N Mesa, and includes the basins of Cottonwood Creek, Monitor Creek, and Potter Creek (Study Area) (see Figure 1). These basins are tributary to Roubideau Creek, which is tributary to the Gunnison River and ultimately the Colorado River. The majority of these basins are located within Montrose County, approximately five miles west of Delta, Colorado; with small portions of the Cottonwood Creek Basin located within Delta County and Mesa County.

The Study Area creeks are perennial in nature. They are characterized by a relatively short duration, high-flow runoff driven by snowmelt during the spring to early summer followed by low baseflows in late fall and winter months. During portions of normal and dry years, some locations in the Study Area creeks can become dry in the lower reaches, which is generally understood to be associated with upstream diversions for irrigation within the Study Area.

1.2 Project Purpose and Goals

CWCB currently has decreed ISF water rights on Cottonwood and Potter Creeks to protect aquatic habitat. The BLM recommended a seasonal ISF on Monitor Creek to protect the native fish population. In addition, BLM recommended additional ISF water rights on all three streams to protect the riparian communities. This recommendation is structured to protect higher flow events that reach bank full or greater flow conditions between April 1 and September 30. The purpose of these recommended ISF rights would be to preserve and protect high flow events resulting in flow within the floodplain and riparian vegetation. These flows are critical for creating conditions necessary for riparian vegetation to become established and recharging of the shallow aquifers adjacent to the stream. These aquifers ultimately supply water to the pristine, intact, and rare riparian communities adjacent to Cottonwood, Monitor, and Potter Creeks. See Figure 2 for the location of each existing and recommended ISF on Cottonwood, Monitor, and Potter Creeks.

Currently, the existing ISF on Cottonwood Creek extends 23.29 miles from the headgate of the Hawkins Ditch at the upstream terminus to the confluence with Roubideau Creek at the downstream terminus. The existing ISF is for 3.6 cubic feet per second (cfs) from April 1 through June 15. On Potter Creek, the existing ISF extends 9.8 miles from the BLM – USFS boundary at the upstream terminus to the confluence with Roubideau Creek at the downstream terminus. Potter Creek's existing ISF is for 4.0 cfs from April 1 through June 15, 1.80 cfs from June 16 through July 31, 1.0 cfs from August 1 through February 29, and 1.80 cfs from March 1 through March 31.

The recommended seasonal ISF on Monitor Creek for aquatic habitat would extend 8.29 miles from the confluence with Little Monitor Creek at the upstream terminus to the confluence with Potter Creek at the downstream terminus. BLM completed a R2Cross evaluation and recommended 4.6 cfs from April 1 through May 31 and 3.6 cfs from June 1 to June 30. This recommendation will work similar to all other ISF appropriations.

This project is focused on the recommended ISFs to protect riparian vegetation for each creek. These riparian based ISFs do not identify a specific flow rate. Instead, the proposed ISF recommendation for each drainage is to protect all unappropriated flow when threshold flow rates (bank full conditions) occur between April 1 and September 30. These ISF protections would be in effect once the threshold flow occurred until flows return to the lower ISF flow rates or September 30, whichever happens first. If the threshold flows did not occur in a given year, the additional riparian ISF flow rates would not be in effect for that year.

The purpose of this report was to identify reasonable water uses that may occur within the Study Area in the future. The identified future uses would be included within a WDA for each drainage in the Study Area. The identified uses within the WDA would then be allowed to divert water from the creeks during times when the riparian based ISF was triggered to protect all unappropriated flows. The individual WDAs will allow for future water use on both private lands located within each basin and the development of water within publicly owned lands managed by USFS, BLM, and CPW. SGM evaluated the potential for future water development on privately owned parcels within the Study Area to estimate the future demands of each basin.

In addition to recommending the appropriation of new ISFs for these three creeks, the BLM has determined that a 14.41-mile segment of Cottonwood Creek on BLM land is suitable for Wild and Scenic River designation. Per Appendix O of the Dominguez – Escalante National Conservation Area Proposed Resource Management Plan and Final Environmental Impact Statement Report, "Designation of this segment would enhance current recreational uses along the segment by providing long-term protection of flows and the scenic landscapes adjacent to the creek." This document is included as Appendix A to this report.

In the June 2018 Final Wild and Scenic River Suitability Report for the BLM Uncompahgre Planning Area, the BLM determined that a 9.4-mile segment of Monitor Creek and a 9.8-mile segment of Potter Creek are suitable for Wild and Scenic River designations, both specifically classified as a Wild River. BLM's suitability evaluation of these two streams as Wild Rivers, if designated, would protect streamflow to mimic natural seasonal changes required to sustain a healthy riparian vegetation community. The BLM noted that protection of the riparian community could be achieved through Wild and Scenic River designation, or as an alternative approach, could be achieved by relying on a new CWCB ISF water right to protect the riparian community, combined with the land use protections afforded by the BLM's suitability determination. This document is included as Appendix B to this report.

2.0 Approach and Methodology

SGM completed the following analyses using the methodologies described in the following sections to estimate the potential for future new water development in the Study Area.

1. Delineated basin boundaries using the United States Geological Survey (USGS) StreamStats application (StreamStats), a USGS 10-meter digital elevation model (DEM), and a USGS topographic base map.
2. Collected and analyzed publicly available spatial data within each basin including ISF reaches and termini points, water right structures, Colorado Decision Support System (CDSS) 2020 delineated irrigated area, permitted and constructed wells, land ownership, stream gages, DEMs, hydrology, soil, topographic base map, and aerial imagery.
3. Identified the location of private and public lands within the individual basins. Calculated the total acreage, slope, and mean elevation of private lands in each basin.
4. Identified the location of decreed water rights structures and permitted and constructed wells in each basin.
5. Cross-referenced water rights with the December 2021 Final Revised Abandonment List of Water Rights in Water Division 4 and calculated the total volumes or flow rates of existing water rights.
6. Queried and defined soil characteristics of private land in each basin.
7. Identified existing irrigated areas and potentially irrigable lands.
8. Conducted a CDSS StateCU analysis of pasture grass using the Upper Gunnison High Altitude Coefficients to estimate pasture demands.
9. Estimated the water yield in the Study Area based on historical stream gage data and the BLM modified approach of the USGS regional streamflow equation for the Uncompahgre Plateau to constrain physical water supply.
10. Evaluated the potential and/or impacts of water exportation from Cottonwood, Monitor, and Potter Creek basins.
11. Conducted a telephone interview with District 41 water commissioner, Luke Reschke, regarding transbasin diversions between the Study Area basins.
12. Estimated future water demands and evaluated limitations based on the potential future use of private parcels, physical supply, topography, legal supply, potential irrigated area, and other developmental constraints to determine a future WDA.

2.1 Geographic Information Systems (GIS)

Project mapping was completed in the Study Area displaying Cottonwood Creek, Monitor Creek, and Potter Creek basins to their confluence with Roubideau Creek. Detailed water rights structures, land ownership, and potentially irrigable land maps were also prepared. Geographic Information Systems (GIS) spatial data were obtained from various publicly available sources, as shown in Table 1.

Table 1. GIS Data Sources	
Data Source	**GIS Layers and other information**
Montrose County	Property ownership
Delta County	Property ownership
Mesa County	Property ownership
DWR CDSS	Water rights structures, 2020 irrigated land, stream gages, ISF reaches and termini, permitted and/or constructed wells, climate stations, precipitation contours, livestock water tanks
United States Geological Survey	National Hydrography Dataset (NHD) (streams, rivers, canals, ditches), 10-meter Digital Elevation Model (DEM), topographic base map, StreamStats delineated basins
National Resource Conservation Service	Soil type and classes, irrigation capability
United States Forest Service	Grazing Allotments
United States Department of the Interior - Bureau of Land Management	Grazing Allotments
ESRI	County boundaries, towns, roads
Maxar	2018 and 2021 imagery

2.1.1 Basin Delineation

Basins were delineated using StreamStats and verified using a USGS topographic map and 10-meter DEM. Potter Creek was delineated into an upper and lower basin. The term Upper Potter Creek Basin refers to the basin upstream of Potter Creek's confluence with Monitor Creek, and the term Potter Creek Basin refers to the entire Potter Creek basin upstream of its confluence with Roubideau Creek. In effect, the Potter Creek Basin includes Monitor Creek Basin, Upper Potter Creek Basin, and the area below Potter Creek's confluence with Monitor Creek down to Roubideau Creek (see Figure 1). Further, general information for each basin was tabulated including the mean, minimum, and maximum basin elevations, total drainage area, estimated average annual precipitation, and estimated flow data provided by StreamStats. These data were cross-referenced using 10-meter DEMs, CDSS average annual precipitation contours from 1951 – 1980, and historical gage data provided to SGM by the CWCB. Mean, minimum, and maximum basin elevations and total drainage area for each basin are shown in Table 2, below.

Table 2. Basin Characteristics				
Basin	**Max. Elevation (FAMSL)**	**Min. Elevation (FAMSL)**	**Mean Elevation (FAMSL)**	**Area (Acres)**
Cottonwood Creek	9,370	4,921	7,214	29,952
Monitor Creek	9,370	7,711	5,349	19,264
Upper Potter Creek	9,337	7,659	5,348	16,448
Potter Creek (1)	9,370	7,646	5,202	36,480

Notes:
FAMSL = Feet above mean sea level
(1) – Includes Monitor Creek Basin, Upper Potter Creek Basin, and area below Potter Creek's confluence with Monitor Creek

Using the USGS StreamStats tool, SGM estimated the mean annual precipitation for Cottonwood, Monitor, Upper Potter, and Potter Creek basins to be 16.09-inches (in), 19.1-in, 19.32-in, and 18.99-in, respectively. SGM cross-referenced these data with the CDSS average annual precipitation contours (1951-1980) and found that precipitation is variable depending upon elevation within each basin and ranges between 16 – 20 inches at the headwaters of the basins to 8 inches at the mouth of Cottonwood Creek, where it enters Roubideau Creek (see Figure 3).

2.1.2 Existing ISF Reaches

ISF reaches and termini points were downloaded from the CDSS HydroBase database (HydroBase) and are shown in Figures 2 and Figures 4 through 7. The CWCB has the following decreed ISF water rights:

- Cottonwood Creek:
  - 3.6 cfs from April 1 through June 15
- Potter Creek:
  - 4.0 cfs from April 1 through June 15.
  - 1.80 cfs from June 16 through July 31.
  - 1.0 cfs from August 1 through February 29.
  - 1.80 cfs from March 1 through March 31.

The Cottonwood Creek ISF has an appropriation date of 1/25/2006 (Case No. 06CW166) and extends 23.29 miles from the headgate of Hawkins Ditch at the upstream terminus to the confluence with Roubideau Creek at the downstream terminus. The Potter Creek ISF has an appropriation date of 1/28/2004 (Case No. 04CW161) and extends 9.8 miles from the BLM – USFS boundary at the upstream terminus to the confluence with Roubideau Creek at the downstream terminus.

2.1.3 Water Rights and Structures

Spatial information regarding water rights structures and exempt wells were downloaded from the CDSS HydroBase. Data were exported to ArcGIS and clipped to the Study Area basins. Most of the permitted and exempt wells do not have a decreed water right. Information regarding water rights appropriations and water uses were collected from HydroBase and tabulated for each basin. Decreed water rights were cross-referenced with the December 2021 Final Revised Abandonment List of Water Rights in Water Division 4 (Final 2021 Abandonment List). A total of 9.0 cubic feet per second (cfs) was included on the 2021 Abandonment List for the Everlasting Ditch and a total of 10.0 cfs was included on the 2021 Abandonment List for the Hawkins Ditch. During 2022, the owners of these water rights protested the abandonments, so the total absolute decreed amount was not reduced for the tabulation shown on Figure 4. In 2022, the Division Engineer did not find the owner of the Long Park Ditch conditional water rights had completed adequate diligence; therefore, those rights were cancelled. Therefore, the Long Park Ditch water rights were not considered in this study. See Figures 2 and Figures 4 through 7 for water rights maps, summary decreed water rights tables, and permitted well tables.

Cottonwood Creek Basin water rights structures, shown in Figure 4, consist of ditches, springs, stock ponds, and reservoirs. The decreed reservoirs were characterized as stock ponds if their decreed storage amount was less than or equal to 1.0 acre-foot (AF). Twelve out of the 28 ponds and reservoirs were characterized as reservoirs, with the remaining 16 characterized as stock ponds. Most diversions within the Cottonwood Creek Basin are decreed for fire protection, stock-watering, and/or federal reserved uses. Other uses include irrigation, domestic, storage, wildlife, and/or recreational uses. One permitted well (Permit No. 19-GX) exists within this basin, which is a geoexchange system loop field and is considered non-consumptive.

Monitor Creek Basin water rights structures, shown in Figure 5, consist of ditches, a pipeline, springs, wells, stock ponds, and reservoirs. The decreed reservoirs were characterized as stock ponds if their decreed storage amount was less than or equal to 1.0 AF. Six out of the 34 ponds and reservoirs were characterized as reservoirs, with the remaining 28 characterized as stock ponds. Most diversions in the Monitor Creek Basin are decreed for irrigation, domestic, fire-protection, stock-watering, and/or federal reserved uses. Other uses include storage and wildlife uses. Seven constructed wells exist in this basin and one permit has been issued for a future well. See the Division of Water Resources (DWR) wells table in Figure 5 for their location and permit number.

Upper Potter Creek Basin (above the confluence with Monitor Creek) water rights structures, shown in Figure 6, consist of springs, ponds, and reservoirs. Two out of the 18 ponds and reservoirs were characterized as reservoirs, with the remaining 16 characterized as stock ponds. Most diversions in the Upper Potter Creek Basin are decreed for fire protection, stock-watering, and federal reserved uses. Other uses include domestic, storage, and/or wildlife uses. One permitted well (Permit No. 19-GX) exists within this basin, which is a geoexchange system loop field and is considered non-consumptive.

Figure 7 shows Monitor Creek Basin water rights, Upper Potter Creek Basin water rights, and includes the Potter Creek Basin segment below the confluence of Monitor and Potter Creeks, collectively referred to as Potter Creek Basin. For detailed water rights tabulation, refer to Figures 5 and 6.

It is important to note that the Study Area is remote, and the equipment used to measure diversions does not record real-time diversions. Rather, DWR staff make periodic visits to record the diversion at a given point in time. Therefore, the available diversion records for the water rights in the Study Area may not fully represent the actual diversions which occur. For instance, many of the absolute decreed water rights do not have records where they have diverted their full decreed amount. While diversion records indicate that several of the senior ditches have not diverted their full water right, owners of those water rights could improve their existing infrastructure to fully divert and use the physically and legally available supply for the irrigation of additional lands under those ditches. These decreed water rights are senior to any future ISF appropriation. Additionally, there is only one conditional water right in Cottonwood Creek Basin (Table Rock Reservoir) which could be made absolute in the future.

2.1.4 Livestock Water Tanks

Livestock water tanks were queried using the online CDSS Map Viewer. According to the Colorado Revised Statute Sections 35-49-101 to 35-49-116, livestock water tanks may exist on waterways that are normally dry and may not exceed 10 AF of capacity. They cannot be used for irrigation purposes and are only used for stock watering purposes. Approximately nine livestock water tanks exist in Cottonwood Creek Basin, six in Monitor Creek Basin, and three in Potter Creek Basin. Private landowners and the BLM utilize the existing livestock water tanks. Livestock water tanks are considered exempt and do not require a water right.

2.1.5 Land Ownership

Private parcel boundaries, ownership information, and land use codes for each parcel within the study area were accessed from the Montrose, Delta, and Mesa Counties' Assessor's Offices online databases. Parcels of interest included private land parcels that intersect Cottonwood, Monitor, or Potter Creek basins' boundaries, or that are completely within those basins' boundaries. The total private land ownership in acres and as a percent of each basin is shown in Table 3, below. See Figure 8 for detailed land ownership and parcel acreage information.

Table 3. Basin Areas and Land Ownership

Basin	Total Area (acres)	Private Property (1) (acres)	Private Property Percent of Basin	Public Land (2) (acres)
Cottonwood Creek	29,952	3,285.7	11.0%	BLM: 15,505 CPW: 2,175 USFS: 9,583
Monitor Creek	19,264	2,474.1	12.8%	BLM: 6,920 USFS: 10,008
Upper Potter Creek	16,448	4.4	0.02%	BLM: 6,013 USFS: 10,415
Potter Creek (3)	36,480	2,631.0	7.2%	BLM: 13,684(4) USFS: 20,423

Notes:

(1) Acreage represents the total acreage of parcels, including portions that extend outside of the basin boundary

(2) Acreage represents public land within the basin boundary.

(3) Includes Monitor Creek Basin, Upper Potter Creek Basin, and area below Potter Creek's confluence with Monitor Creek.

(4) Includes Monitor Creek Basin and Upper Potter Creek Basin area plus 751 acres of BLM land below confluence with Monitor Creek.

2.1.6 Existing Irrigated Area

The HydroBase includes current (as of 2020) delineated irrigated areas within each basin, which were downloaded and are shown in Figure 9. As of 2020, CDSS delineated 182.4 acres of irrigated land in the Cottonwood Creek Basin and 184.7 acres of irrigated land in the Monitor Creek Basin. Based upon the HydroBase shapefile information, the irrigated acreage in the Study Area is categorized as grass pasture and primarily flood irrigated. No irrigated lands were delineated in the Upper Potter Creek Basin nor below its confluence with Monitor Creek.

2.1.7 Soil Types

Soil data were downloaded from the National Resource Conservation Service (NRCS) Web Soil Survey. Soil types on private land are shown in Figure 9. Various soil types exist in the private lands within the Study Area. Each soil type was analyzed for its NRCS Irrigated Soil Capability Class (Soil Class). The Soil Class defines each soil's potential to be irrigated. A summary of soil type and Soil Class is included in Table 4, below. Please note that soil types that comprised less than 1% of total private irrigated acreage were not included in Table 4. A description of each Soil Class is provided in Section 3.1.9 and Table 5-A. Due to the wide range of slopes identified for each NRCS listed soil type, SGM refined each soil's irrigation potential using slope data as described in the next section (2.1.8), and shown in Table 5-B.

Table 4. Private Land Soil Types

Map Unit Symbol	Soil Type	% Of Private Land	Irrigated Soil Capability Class
13	Chilson-Delson, moderately deep-Beenom families complex, 1-20% slopes	7.69%	Class 6, Class 7
16	Delson, moderately deep-Sharrott families complex, 1-15% slopes	1.69%	Class 6
24	Kubler-Delson-Cerro families complex, 3-15% slopes	3.39%	Class 6, Class 7
29	Supervisor-Cebone families complex, 1-15% slopes	14.52%	Class 6
49	Lazear-Rock outcrop complex, 3-30% slopes	1.49%	Class 6
67	Rock outcrop	2.13%	Class 8
73	Shavano-Leazear complex, 3-12% slopes	3.87%	Class 6
75	Torriorthents-Rock outcrop, sandstone, complex	3.31%	Class 7
76	Torriorthents-Rock outcrop, shale, complex	2.29%	Class 7
262	Arabrab-Evpark-Parkelei complex, 3-20% slopes	36.97%	Class 6, Class 8
B31	Barx-Lazear, very flaggy-Rock outcrop complex, 3-35% slopes	2.14%	Class 6
R3	Lazear, extremely flaggy-Rock outcrop-Wellsbasin, extremely stony complex, 20-75% slopes	7.57%	Class 8
X31M	Walknolls-Rock outcrop complex, 20-60% slopes	4.01%	Class 7

X61	Moento-Beje, extremely stony complex, 10-35% slopes	4.83%	Class 7
Total		**95.90%**	

Notes:

- Soil Units that comprised <1.0% of total acreage not shown on the table or map
- Total private land acreage = 5,916.7 acres
- The remaining 4.1% of private acreage is characterized by other soil types that comprise <1% each of overall private land acreage. The remaining soil types all have an irrigation class of 4.

2.1.8 Irrigated Soil Potential Classification

To assess the potential to irrigate lands within private land parcels, SGM calculated the slope throughout the study area using a USGS 10-meter DEM and weighted the results with NRCS Non-Irrigated Soil Capability Class data accessed from the Soil Data Viewer 6.2 ArcGIS add-in analyst tool. SGM assigned score values to each Soil Class and each slope range, as shown in Tables 5-A and 5-B, respectively. Class 4 soils received a score of 2, Class 6 soils received a score of 1, and Class 7 and Class 8 soils received a score of 0 (see Table 5-A). Similarly, slopes of less than 8-percent received a score of 2, slopes between 8 and 10-percent received score of 1, and slopes greater than 10-percent received a score of 0 (see Table 5-B).

Table 5-A. Irrigation Potential Classification Scoring System (NRCS Soil Class)

NRCS Soil Class[1]	Score Value	Irrigation Potential
Class 4 – soils have very severe limitations that reduce the choice of plants or require very careful management, or both.	2	Irrigable
Class 6 – soils have severe limitations that make them generally unsuitable for cultivation and that restrict their use mainly to pasture, rangeland, forestland, or wildlife habitat.	1	Marginally Irrigable
Class 7 – soils have very severe limitations that make them unsuitable for cultivation and that restrict their use mainly to grazing, forestland, or wildlife habitat.	0	Not Irrigable
Class 8 – soils and miscellaneous areas have limitations that preclude commercial plant production and that restrict their use to recreational purposes, wildlife habitat, basin, or aesthetic purposes.	0	Not Irrigable

Notes:

(1) NRCS Soil Class data gathered from Soil Data Viewer 6.2 ArcGIS add-in analyst tool.

Table 5-B. Irrigation Potential Classification Scoring System (Slope Range)

Slope Range	Score Value	Irrigation Potential
0-8%	2	Irrigable
8-10%	1	Marginally Irrigable
>10%	0	Not Irrigable

After defining a score value for each Soil Class and slope range, weighted scores were assessed using the ArcGIS Raster Times tool. The Raster Times tool multiplied the score values assigned to the Soil Class and slope range of a pixel, as described in Tables 5-A and 5-B, into weighted values that incorporated each attribute. For instance, a portion of private property with slopes less than 2% (value of 2) and Class 6 soils (value of 1) would receive an overall score of 2 (Score of 2 x Score of 1 = Weighted Score of 2). The greatest possible weighted score that can be assigned would be a numeric score of 4, if the Soil Class was assigned a value of 2 and the slope was assigned a score of 2 (2 x 2 = 4). If a pixel had slopes greater than 10% or Class 7 or 8 soils, the weighted score was assigned a 0, meaning the area is not suitable for irrigation. The weighted slope and NRCS Soil Class values are shown in Table 6.

Table 6. Weighted Irrigation Capability Values and Descriptions

Weighted Score Value (1)	Irrigation Potential
2 or 4	Irrigable - slope range is favorable for irrigation and soils are able to sustain choice crops with careful management.
1	Marginally irrigable – slope range is not favorable, and soils may sustain choice crops with careful management.
0	Not Irrigable – slope range is unable to irrigate, and soils are not suitable to sustain crops.

Notes:

(1) Weighted score value was calculated for each pixel by multiplying the Non-Irrigated Soil Capability Class (Table 5-A) with the slope range (Table 5-B).

The proximity of irrigable and marginally irrigable lands within private parcels to CDSS mapped canals/ditches were analyzed within a quarter mile (1,320 feet) buffer to assess the physical ability to divert and deliver irrigation supplies to potential lands for future irrigation (see Figures 10 and 11). Total acres of future potentially irrigable lands within the quarter-mile buffer were calculated in ArcGIS. Lands that fell outside of the delineated basins and lands delineated by CDSS as being currently irrigated were not considered. Based upon the conditions listed in Tables 5-A, 5-B, and 6, a total of 2,248 acres of private land were classified as irrigable, 173 acres of private land were considered marginally irrigable, and 2,241 acres were considered not irrigable (see Figure 10). These values do not include the limited area within the single 4-acre private parcel in Upper Potter Creek Basin, as future irrigation is unlikely due to the limited water rights and water supply in this area of the basin.

After discussions with the BLM and CWCB staff, it was determined that the estimate of potentially irrigable soils within the Study Area was much greater than what could practically be irrigated given the overall elevation of the Study Area and the extremely limited water supply available in the upper portion of each basin. Therefore, SGM examined aerial photography near the existing irrigated areas and within the irrigable and potentially irrigable areas delineated in the weighted classification of irrigated soils. Much of the irrigated area that was deemed suitable was heavily wooded or had dense vegetation. Thus, irrigation would require significant efforts by landowners to remove vast amounts of forest prior to irrigation. Therefore, SGM outlined potentially irrigable area polygons that appeared most reasonable to be irrigated in the future by assessing vegetation cover, soil irrigation capabilities, proximity to existing ditches, and waterways that could potentially be diverted in the future with the construction of new canals or storage ponds (see Figure 11). A total of 420.6 acres of potential future irrigated land was delineated after analyzing aerial imagery and the irrigation potential of soils, which includes the sum of soils that are classified as irrigable and marginally irrigable, as described above and in Table 6. Specifically, 68.8 acres of irrigated lands were delineated in the Cottonwood Creek Basin and 351.8 acres were delineated in the Monitor Creek Basin (see Table 7). For clarification, the values listed in Table 7 do not include land that is currently irrigated, as denoted by the 2020 CDSS irrigated area shapefile.

SGM did not delineate any future potential irrigated land in the Upper Potter Creek Basin, due to the limited amount of private land and lack of existing ditches with decreed uses for irrigation purposes.

Table 7. Potential Future Irrigated Area by Basin

Basin	**SGM Delineated Future Irrigated Area** *(Weighted Score of 2 or 4)* **(Acres)**	**SGM Delineated Future Marginally Irrigated Area** *(Weighted Score <2)* **(Acres)**	**Basin Total Future Irrigated Area (Acres)**
Cottonwood	62.5	6.3	**68.8**
Monitor	287.2	64.6	**351.8**
Upper Potter	0	0	**0**

Note:
No irrigable lands on private property were identified in Upper Potter Basin nor Potter Creek below its confluence with Monitor Creek.

From a water rights perspective, it is important to consider that many of the senior ditches within Cottonwood Creek Basin have decreed water rights that allow for the irrigation of many more acres than are currently being irrigated. While diversion records indicate that several of the senior ditches have not diverted their full water right, owners of those water rights could improve their existing infrastructure to fully divert and use the physically and legally available supply for the irrigation of additional lands under those ditches. Again, these decreed water rights are senior to any new riparian based ISF appropriation.

2.1.9 Grazing Allotments

Grazing allotments on BLM managed lands were provided by the BLM. USFS grazing allotments were downloaded from the USFS Geospatial Data Discovery ArcGIS Hub. Additional grazing and animal unit month (AUM) data were provided by the USFS for their grazing allotments. All USFS and BLM allotments are active within the Study Area basins. The BLM allotments support cattle grazing and the USFS allotments support cattle and horse grazing. The AUM value for each allotment is provided in Table 8 below and shown in Figure 12.

Table 8. Grazing Allotment Animal Unit per Month (AUM)	
Allotment	**AUM**
USFS Active Grazing Allotments (Cattle & Horse)	
25 Mesa C&H	**2,893**
Boyden/Monitor C&H	**5,612**
Dry Fork C&H	**3,140**
BLM Active Grazing Allotments (Cattle)	
Joker	**46**
Lee Bench	**41**
Sawmill Mesa	**618**
Twenty-Five Mesa North	**644**
White Ranch	**10**
Winter	**774**
Total	**13,779**

2.2 Basin Yield Analysis

2.2.1 Historical Gages

To our knowledge, no long-term gaging efforts have been conducted on the creeks within the Study Area. Two historical gages exist on Potter Creek: Potter Creek near Columbine Pass, CO (POTCOLCO) and Potter Creek near Olathe, CO (POTOLACO). These historical gages have recorded data from 1980 and 1981, and 1979 through 1981, respectively. No historical gages exist on Cottonwood Creek.

For the purpose of this project, CWCB has completed temporary gaging of all three creeks over the past seven years. SGM received the available temporary gage data from CWCB within the Study Area for the following periods.

- Potter Creek data were available from 4/8/2015 through 7/1/2019.
- Monitor Creek data were available from 6/8/2017 through 6/30/2020 and from 4/1/2021 through 9/14/2021.
- Cottonwood Creek data were available from 5/12/2015 through 5/14/2020.

These data were analyzed and tabulated into monthly gaged volumes as shown in Appendix C. It is important to consider that the gaged records represent the available streamflows after the historical diversions by upstream decreed water users, exempt users (i.e., exempt livestock uses), and resulting return flows, and do not represent the total water available within each watershed. Finally, SGM considered a nearby gage station with a period of record that extended from 1938 through present to determine years with wet, dry, and average hydrology to correlate the historical gage data within the Study Area as years with wet, dry, or average hydrology. For the purpose of this project, the closest gage with a sufficiently long period of record was the Uncompahgre River at Delta, CO (Station ID: UNCDELCO). The entire Uncompahgre River at Delta period of record was used to determine normal, wet, and dry years, given the limited duration of stream gaging in the Study Area (see Appendix D).

2.2.2 StreamStats

SGM considered the USGS StreamStats Monthly Flow Statistics Flow Report, which estimated each basin's yield (see Appendix E for StreamStats Reports). The StreamStats estimated total basin yield for the Cottonwood Creek, Monitor Creek, Upper Potter Creek, and Potter Creek basins are shown in Table 9. The mean annual yield of each basin is dependent upon mean basin elevation and total area of each basin.

Table 9. StreamStats Estimated Basin Yield (AF)

Basin	Mean Annual Yield (AF)
Cottonwood Creek	2,876
Monitor Creek	3,058
Upper Potter Creek	2,741
Potter Creek (1)	5,688

Notes:
(1) – Includes Monitor Creek Basin, Upper Potter Creek Basin, and area below Potter Creek's confluence with Monitor Creek

Based on the historical streamflow gaging records, SGM believes that the StreamStats basin yield is too low and does not represent historical yields. While StreamStats can provide useful estimates of streamflow characteristics, the mismatch between StreamStats and historical data indicated that an alternative basin yield methodology was necessary for this project.

2.2.3 Elevation-adjusted Basin Yield Analysis

Due to the limited available gage data and potentially underestimated yield provided by StreamStats, SGM employed a methodology to estimate the available flow within each creek. SGM's methodology can be described as an elevation-adjusted basin yield analysis that considers historical stream gaging records for nearby streams with similar characteristics (area, slope, and aspect) to extrapolate basin yields for ungauged streams. Specific for this project, SGM considered the following historical gage records:

- Spring Creek near Montrose, CO (1977 – 1981) (Station ID: 09149420)
- Roubideau Creek Mouth near Delta, CO (1939 – 2010) (Station ID: 09150500)
- Dry Creek at Bergonia Rd, near Delta, CO (1996 – 1998) (Station ID: 09149480)
- Escalante Creek (1977 – 1989) (Station ID: 09151500)

SGM used Streamstats to calculate the basin tributary to each of the historical gages and utilized the mean basin elevation and calculated basin area of each basin in the Study Area. These calculations were cross-checked by using a USGS 10-meter DEM clipped to each basin's perimeter. SGM then calculated the historical monthly and annual gaged volumes for the historical stream gages and picked a year within that record that corresponded to a normal year within the Uncompahgre River at Delta's gaged records. For each historical gaged basin, the normal annual gaged volume was then divided by the total acreage of the basin tributary to the historical gage location. A linear regression equation was then developed between the four historical gages to estimate the relationship between the average yield per acre and the mean elevation of the basin (see Appendix F). The resulting elevation-adjusted basin yield equation developed for this project was:

Basin Yield = (0.00081 * (Mean Basin Elevation)) – 5.42925

For the developed linear regression equation, the R^2 value (correlation factor) was equal to 0.84. The closer the correlation factor is to 1.0, the more correlated the compared data are to each other. The calculated R^2 value of 0.84 indicates the relationship between elevation and yield is significant (well correlated) and therefore reasonable to use to estimate the average annual yield of the Study Area basins. See Table 10 for calculated elevation adjusted basin yields of the Study Area basins.

Table 10. Elevation-adjusted Basin Yield (AF)

Basin	Drainage Area (acres)	Mean Basin Elevation (FAMSL)	Mean Annual Yield (AF)
Cottonwood Creek	29,952	7,213	12,379
Monitor Creek	19,264	7,710	15,717
Upper Potter Creek	16,448	7,658	12,736
Potter Creek (1)	36,480	7,645	27,842

Notes:
(1) – Includes Monitor Creek Basin, Upper Potter Creek Basin, and area below Potter Creek's confluence with Monitor Creek

Appendix F shows the summary tables and figures for this analysis, as well as the historical gage records considered.

It is important to note that the estimated mean annual yields, shown in Table 10, represent the entire natural flow within the basin and do not account for water rights and subsequent diversions. SGM reviewed historical diversion records but understands that the available diversion records are based on periodic inspections of remote flumes, and while representative of diversion rates, do not accurately account for total diversions. In accounting for the recorded diversions, we believe that the elevation-adjusted basin yield analysis over-estimates the annual yields in Cottonwood, Monitor, and Potter creeks, but the volumes are more representative than the StreamStats estimates considering the recent CWCB gaged streamflow in the Study Area. Due to the over-estimation of this method, SGM relied on a regional equation developed by the USGS and utilized by the BLM, as discussed below in Section 2.2.4.

2.2.4 Uncompahgre Plateau and Glade Park Annual Hydrograph Estimation

BLM staff provided SGM with a hydrologic analysis of the Uncompahgre Plateau using historic gage data (see Appendix G). The BLM noted that most available streamflow gage data is "severely impacted by diversions and irrigation use." Therefore, it is "difficult to estimate the natural flow regime for the basins on the [Uncompahgre] Plateau." The BLM relied upon a regional equation, developed by the USGS, to estimate the annual flow characteristics of the Uncompahgre Plateau. The regional equation used in their report is provided below:

$$Q_{ann} = 9.7 \times 10^{-2}(A^{0.888})(E_b^{1.74})(1.98)(365)$$

Q_{ann} = mean annual volume in acre-feet
A = drainage area in square miles
E_b = (mean basin elevation – 5,000) / 1,000

The BLM considered nearby gages in their study including:

- Spring Creek near Beaver Hill (1978 – 1980)
- Potter Creek near Olathe, CO (1980)
- Hay Press Creek above Fruita Reservoir #3 (1984 – 1987)
- Escalante Creek near Delta, CO (1977 – 1988)
- Tabeguache Creek near Nucla, CO (1947 – 1952)

The BLM concluded that the comparison between actual gaged volumes and estimated volumes using the regional equation developed by the USGS provided a reasonably accurate estimate of the total annual flow volume. Therefore, SGM utilized the BLM's modified approach of the USGS regional equation to calculate the annual basin yields for the Study Area basins. The calculated mean annual volumes of each basin are provided in Table 11.

Table 11. BLM Study of Estimated Mean Annual Basin Yield (AF)

Basin	Drainage Area (mi²)	Mean Basin Elevation (FAMSL)	(Mean Basin Elevation – 5,000 FT) / 1000 FT	Mean Annual Yield (AF)
Cottonwood Creek	46.8	7,213	2.213	8,495.2
Monitor Creek	30.1	7,710	2.710	8,167.0
Upper Potter Creek	25.7	7,658	2.658	6,862.4
Potter Creek (1)	57.0	7,645	2.645	13,802.8

Notes:
(1) – Includes Monitor Creek Basin, Upper Potter Creek Basin, and area below Potter Creek's confluence with Monitor Creek

It is important to note that the estimated mean annual yields shown in Table 11 represent the entire natural flow within the basin and do not account for water rights and subsequent diversions. SGM considered the historical diversion records and believe the USGS regional equation methodology is generally representative of the basin yields for the Study Area because it most closely resembles recent CWCB gaged streamflow for the Study Area creeks after considering historical diversions; therefore, this methodology was relied upon for the subsequent analyses in developing the WDA for each watershed.

2.2.5 Estimated Physical Water Supply

In order to estimate the monthly streamflow volumes in Cottonwood, Monitor, and Potter Creeks, SGM considered the USGS developed regional equation used by the BLM in their hydrologic analysis of the Uncompahgre Plateau (Appendix G). The BLM calculated a mean annual monthly distribution using the annual hydrographs from the historical Potter Creek, Spring Creek, and Hay Press Creek gage records. These creeks were used because they best represent the natural flow regime of the Plateau. SGM relied upon the BLM monthly distribution percentages and calculated the mean monthly flows of each creek in the Study Area (see Table 12). Based on the BLM's monthly distribution percentages, the normal peak flow would occur in May. SGM notes that based on the historical and recent CWCB streamflow gage records, the peak runoff can occur in May, but oftentimes occurs in April. The timing of runoff is dependent upon the snowpack, spring storms, and warming spring temperatures. Although the monthly distribution model reasonably estimates flows within each creek, SGM notes that the actual monthly streamflow volumes and timing of peak runoff vary greatly from year-to-year.

Table 12. Monthly Distribution of Flows													
Watershed		Cottonwood			Monitor			Upper Potter			Potter		
Annual Basin Yield (AF)		8,495.2			8,167.0			6,862.4			13,802.8		
Month	% of Flow	AF/Month	AF/Day	Mean Monthly Flow (cfs)	AF/Month	AF/Day	Mean Monthly Flow (cfs)	AF/Month	AF/Day	Mean Monthly Flow (cfs)	AF/Month	AF/Day	Mean Monthly Flow (cfs)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Jan	0.32%	27.18	0.88	0.44	26.13	0.84	0.43	21.96	0.71	0.36	44.17	1.42	0.72
Feb	0.65%	55.22	1.97	0.99	53.09	1.90	0.96	44.61	1.59	0.80	89.72	3.20	1.62
Mar	1.00%	84.95	2.74	1.38	81.67	2.63	1.33	68.62	2.21	1.12	138.03	4.45	2.24
Apr	14.70%	1,248.79	41.63	20.99	1,200.55	40.02	20.18	1,008.77	33.63	16.95	2,029.01	67.63	34.10
May	55.41%	4,707.19	151.84	76.55	4,525.33	145.98	73.60	3,802.46	122.66	61.84	7,648.13	246.71	124.38
Jun	24.61%	2,090.67	69.69	35.13	2,009.90	67.00	33.78	1,688.84	56.29	28.38	3,396.87	113.23	57.09
Jul	1.30%	110.44	3.56	1.80	106.17	3.42	1.73	89.21	2.88	1.45	179.44	5.79	2.92
Aug	0.50%	42.48	1.37	0.69	40.84	1.32	0.66	34.31	1.11	0.56	69.01	2.23	1.12
Sep	0.40%	33.98	1.13	0.57	32.67	1.09	0.55	27.45	0.91	0.46	55.21	1.84	0.93
Oct	0.39%	33.13	1.07	0.54	31.85	1.03	0.52	26.76	0.86	0.44	53.83	1.74	0.88
Nov	0.37%	31.43	1.05	0.53	30.22	1.01	0.51	25.39	0.85	0.43	51.07	1.70	0.86
Dec	0.35%	29.73	0.96	0.48	28.58	0.92	0.46	24.02	0.77	0.39	48.31	1.56	0.79
	Average			11.68			11.22			9.43			18.97

Notes:

(1) Month

(2) BLM monthly distribution percentages using annual hydrographs from the historical Potter Creek, Spring Creek, and Hay Press Creek gage records.

(3) Annual Basin Yield multiplied by BLM monthly distribution percentage (Column 2)

(4) Column 3 divided by days per month

(5) Column 4 converted to cfs (Column 4/1.9835)

(6) Annual Basin Yield multiplied by BLM monthly distribution percentage (Column 2)

(7) Column 6 divided by days per month

(8) Column 7 converted to cfs (Column 7/1.9835)

(9) Annual Basin Yield multiplied by BLM monthly distribution percentage (Column 2)

(10) Column 9 divided by days per month

(11) Column 10 converted to cfs (Column 10/1.9835)

(12) Annual Basin Yield multiplied by BLM monthly distribution percentage (Column 2)

(13) Column 12 divided by days per month

(14) Column 13 converted to cfs (Column 13/1.9835)

2.3 Interview with District 41 Commissioner – Luke Reschke

To verify our understanding of the historical streamflow and water rights administration in the Study Area, SGM completed a phone interview with the Division 4, District 41 Water Commissioner, Luke Reschke. More specifically, SGM wanted to understand the extent to which diversions from one watershed in the Study Area are delivered (or can be delivered) to an adjacent watershed. This operation would be considered a transbasin diversion. Mr. Reschke informed SGM that limited transbasin diversions occur within the Study Area. In summary:

- The 25 Mesa Upper Little Monitor Ditch diverts water from Little Monitor Creek and delivers water into Bullfrog Reservoir within the Cottonwood Creek Basin (see Figures 4 and 5 for structure locations).
- The Davis Brothers Ditch diverts water from the Dry Fork of Escalante Creek and delivers the supply into the Cottonwood Creek Basin through the North Fork Ditch (see Figure 4 for the location of the North Fork Ditch).
- Mr. Reschke was not able to recall any structures that directly diverted water out of Cottonwood Creek Basin.
- At the time of the interview, Mr. Reschke indicated that the Long Park Ditch Nos.1 through 5 conditional water rights could divert from Cottonwood Creek and are conditionally decreed to irrigate land in the Monitor Creek Basin in the future. As previously mentioned, in September 2022 the Long Park Ditch system water rights were cancelled by the court; therefore, any future transbasin irrigation from Cottonwood Basin to Monitor Basin would require a new water right.

Mr. Reschke indicated that within the Cottonwood Creek Basin, the Hawkins Ditch and Everlasting Ditch are senior water rights that are capable of diverting the majority of streamflow within Cottonwood Creek. Mr. Reschke indicated that the overall irrigation season within these basins is short due to the quick runoff and limited supply availability. Given the remote location of the Study Area, the administration of water rights in Cottonwood, Monitor, and Potter creeks are generally limited to periodic field visits to verify diversion rates. Finally, Mr. Reschke has often observed downstream reaches of the Study Area creeks running dry during late fall and winter months. We understand these dry conditions are a result of the predominant drought conditions that have generally persisted in Colorado from 2000 through the present. While there have been a few normal and wet years since 2000, the number of dry years along with continued irrigation diversions have resulted in extremely dry conditions in the lower portions of the Study Area creeks. These observations further corroborate our understanding of the limited amount of water supply and the relatively short duration of runoff. Therefore, additional ISF water rights in the Study Area would help to protect and preserve high flow flood events to benefit the riparian vegetation.

3.0 Water Demand Estimation and Development Scenarios

SGM worked with stakeholders to determine viable future scenarios that may occur in the Study Area. These future scenarios and respective water uses would require additional water rights to secure a future water supply. Conceptually, the future diversions and uses would be allowed under each specific basin's WDA. Stakeholders identified three conceptual water development scenarios. First, landowners could seek to adjudicate new junior surface diversion water rights for supplemental irrigation. Second, the current parcels could be subdivided into 35-acre parcels, which would increase domestic demands, while maintaining irrigation on a portion of the subdivided parcels. Finally, the current parcels could be subdivided into 5-acre parcels, which would significantly increase domestic demands, while maintaining irrigation on a portion of the subdivided parcels

In order to determine what the future water demands would be for each scenario, SGM evaluated the current water demands and developed representative unit water demands for the specific types of water uses that may occur in the future.

3.1 Unit Water Demand Estimation

In order to estimate the future WDAs for each basin within the Study Area, SGM considered the existing and potential future water uses within the basins to estimate reasonable water demands for this project. Future water uses included irrigating additional private land, future grazing on public lands, and subdividing private land parcels for future small-scale farms that would rely on new water supplies and junior water rights. These analyses are discussed below.

3.1.1 State CU Analysis

To estimate the potential water demands of the irrigated areas on private parcels within the Study Area, SGM conducted a Climate Station Scenario analysis in the CDSS StateCU program. The average monthly irrigation water requirement (IWR) for pasture grass was calculated using the Upper Gunnison High Altitude (UGHA) crop coefficient from 1992 through 2021. SGM relied upon nearby climate station data to complete the analysis. Precipitation data were gathered from the Montrose No. 2 NOAA Climate Station (USC00055722) between 1992 and 2021 and temperature data were gathered from the Cottonwood Basin Colorado NOAA Climate Station (USR0000CCOT) between 1992 and 2021. Temperature data were orthographically adjusted based on the elevation at a rate of 3.6° Fahrenheit (F) per thousand feet. Precipitation data were orthographically adjusted based on the CDSS average annual precipitation contours from 1951 through 1980. See Figure 3 for precipitation ranges and locations of climate stations used in the analysis.

The average elevations of the existing and potential future irrigated areas were calculated using a USGS 10-meter DEM. SGM created two scenarios to calculate an irrigation water requirement for pasture grass, shown in Table 13. Scenario 1 estimated the IWR for irrigated lands at approximately 7,000 FAMSL to be 2.3 AF/acre. Scenario 2 estimated the IWR for irrigated lands at approximately 8,400 FAMSL to be 2.0 AF/acre. All of the existing irrigated areas and potential future irrigated areas exist at or near these elevations.

Table 13. Average Monthly Irrigation Water Requirement for Grass Pasture		
Month	**Scenario 1 - 7,000'**	**Scenario 2 - 8,400'**
	Acre-feet/acre	**Acre-feet/acre**
January	0.000	0.000
February	0.000	0.000
March	0.000	0.000
April	0.043	0.045
May	0.492	0.403
June	0.562	0.509
July	0.492	0.440
August	0.388	0.340
September	0.312	0.265
October	0.000	0.000
November	0.000	0.000
December	0.000	0.000
Total	**2.289**	**2.003**

General Notes:

- Values generated using a Climate Station Scenario analysis in StateCU (Interface Version 7.1.2, FORTRAN Version 13.1)
- Irrigation Water Requirement as calculated by StateCU for 1.0 acre of pasture grass. Analysis used Upper Gunnison High Altitude (UGHA) crop coefficient.
- Precipitation based on the Montrose No 2 NOAA Climate Station (USC00055722) between 1992 and 2021. Temperature based on the Cottonwood Basin Colorado NOAA Climate Station (USR0000CCOT) between 1992 and 2021.
- Temperature data were orthographically adjusted based on the elevation at a rate of 3.6° F per thousand feet.

Column Notes:

- Scenario 1:
  - Analysis assumes fields are located at an elevation of 7,000 FAMSL and latitude of 38.55° N.
  - Precipitation data were orthographically adjusted by a factor of 1.55.
- Scenario 2:
  - Analysis assumes fields are located at an elevation of 8,400 FAMSL and latitude of 38.50° N.
  - Precipitation data were orthographically adjusted by a factor of 1.55.

3.1.2 Stock Water and Grazing Demand

To estimate the current grazing water demands with the Study Area, SGM analyzed the USFS and BLM grazing allotment data on federal lands. Nearly all of the public lands within the Study Area are under active grazing allotments. For the BLM grazing allotments, SGM estimated current water demands for grazing based on AUM values and a typical livestock demand per day, which considers the equivalent amount of vegetation consumed by a calf-cow combination. For the USFS grazing allotments, SGM estimated current water demands for grazing based on the number of animals (cattle and horses) within each allotment, the grazing period, and a typical livestock demand per day. SGM reviewed the available literature and determined a reasonable water demand for an open range cow-calf pair to be 34.2 gallons per day (gpd).

The current range of water demands per allotment are provided in Tables 14a and 14b. The spatial extent of each allotment does not match basin boundaries and some of the allotments extend outside the Study Area boundary. Therefore, it is difficult to estimate the exact grazing demand within each basin. Conservatively, the overall grazing demand for each allotment was used. Across all of the grazing allotments near the Study Area, the estimated stock water demand was estimated to be 34.95 AF (6.72 AF for BLM and 28.2 for USFS) (see Tables 14a and 14b).

We understand the BLM grazing allotments are close to their maximum achievable grazing density, and therefore BLM does not anticipate needing a significant increase in the amount of stock water demands in the future. The USFS do not currently have any proposed ranged improvements; however, water developments could occur in the future based on needs.

Based on conversations with the BLM and USFS staff, those agencies believe that a future total water supply demand estimate of 2.0 AF per year per basin is adequate for each of the BLM and USFS various future water demands and uses. For planning purposes, the BLM and USFS future water developments may include spring development and exempt stock uses that could potentially occur in the future, such as livestock watering tanks.

Table 14a. USFS Annual Stock Water and Grazing Demands

Allotment	Cattle		Horses		Unit Grazing Demand			Total Grazing Demand	
	No. of Cattle	No. of Grazing Days	No. of Horses	No. of Grazing Days	Livestock Water Demand (gpd)	Annual Cattle Grazing Demand (gal/yr)	Annual Horse Grazing Demand (gal/yr)	Total Grazing Demand (gal/yr)	Total Grazing Demand (AF)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
USFS Active Grazing Allotments (Cattle & Horse)									
25 Mesa C&H	481	137	4	148	34.2	2,253,677	20,246	2,273,924	7.0
Boyden/Monitor C&H	936	137	14	137		4,385,534	65,596	4,451,130	13.7
Dry Fork C&H	522	137	6	142		2,445,779	29,138	2,474,917	7.6
					Total	**9,084,991**	**114,980**	**9,199,971**	**28.2**

Notes:

(1) Grazing allotment name

(2) Number of permitted cattle within grazing allotment. Assumes Cow/Calf pair.

(3) No. of days of active grazing allowed in permit

(4) Number of permitted horses within grazing allotment.

(5) No. of days of active grazing allowed in permit

(6) Typical water demand for cow/calf pair per day

(7) Column 2 * Column 3 * Column 6

(8) Column 4 * Column 5 * Column 6

(9) Sum of Columns 7 + 8

(10) Column 9 converted to acre-feet (325,851 gallons in one acre-foot)

Table 14b. BLM Stock Water and Grazing Demands				
Allotment	Animal Unit Month (AUM)	Livestock Water Demand (gpd)	Daily Livestock Water Demand (gpd)	Annual Livestock Water Demand (AF)*
(1)	(2)	(3)	(4)	(5)
BLM Active Grazing Allotments (Cattle)				
Joker	46	34.2	1,573.2	0.14
Lee Bench	41		1,402.2	0.13
Sawmill Mesa	618		21,135.6	1.95
Twenty-Five Mesa North	644		22,024.8	2.03
White Ranch	10		342.0	0.03
Winter	774		26,470.8	2.44
		Total	**374,686**	**6.72**

Notes:

(1) Grazing allotment name

(2) Number of permitted AUMs in grazing allotment

(3) Average gallons used per day per cow/calf pair

(4) Column 2 * Column 3

(5) Column 4 * 30 days / 325851

3.1.3 Subdivision and Small-Scale Farm Demand

Colorado law allows parcels of 35.0 acres or larger to obtain an exempt well permit with a total diversion amount of 3.0 AF/year, which typically allows for a domestic supply for up to 3 residences, irrigation of 1 acre, and allows for stock water usage. Under Colorado's Revised Statute (C.R.S.), exempt wells do not currently need a decreed water right, so long as the uses and annual volumetric restrictions comply with the general permit requirements. Therefore, any future subdivision and development of parcels 35.0 acres or larger could be completed without a decreed water right. However, if the exempt well statute were to go away in the future, new water rights would need to be obtained for subdivided parcels. To conservatively account for the new water demands associated with the subdivision of larger parcels, SGM calculated the maximum demands that would be incurred under the exempt well statute. In the future, should the exempt well statute be removed from Colorado law, new junior water rights (or a decreed augmentation plan) would be required to provide a legal water supply for domestic, irrigation, and stock water uses of 35.0-acre parcels. These potential future demands and modeled assumptions are discussed in detail in Sections 3.2.2 and 3.2.3.

3.2 Water Development Scenarios

For the purpose of determining the future WDA for each basin, SGM worked with the stakeholders to determine various development scenarios that could likely be realized in the future and would require additional water supplies to be developed. Based upon the information gathered, stakeholder input, and the analyses completed for this project, SGM considered three potential water demand scenarios that could occur within these basins in the future. The scenarios are generally independent of one another and could not fully occur concurrently; but portions of each scenario could occur simultaneously. Since we are not able to determine what development will occur in the future and the realized water demand associated with future development, if any, it is prudent to identify and select the maximum future water demand from all three scenarios for the future WDA in each basin. Accordingly, the maximum future water demand scenario for each specific basin was considered for the future water development allowance, as shown in Section 5.1, 5.2, 5.3, and 5.4, for all identified types of water use.

3.2.1 Scenario A: Continued Irrigation and Potential Future Irrigation

Scenario A considers the amount of additional water that would need to be developed if additional portions of private properties were irrigated. Under Scenario A, SGM considered the amount of existing decreed water rights within a basin that could continue to irrigate existing lands and, in addition, irrigate any future lands. Many ditches have decrees that allow for the irrigation of more land than they are currently irrigating. In addition, this scenario models any future water right that would need to be obtained to irrigate lands that would not be covered under an existing water right.

For this scenario, SGM analyzed proximity to existing waterways and ditches, potential future irrigable lands, and assessed current irrigated area and existing decreed water rights.

3.2.1.1 Cottonwood Creek Basin

In Cottonwood Creek Basin, the North Fork Ditch, Everlasting Ditch, Hawkins Ditch, and Pug White Ditch lie upstream of all private land within the basin. The Horton and Davis Seep Ditch is near the upstream portion of the private land as well. Per the USGS National Hydrology Dataset, these ditches extend into the private parcels in the central portion of the basin. Additionally, the 2020 CDSS irrigated area shapefile indicates that these ditches are used to irrigate approximately 183.2 acres of land within the central portion of the basin. SGM reviewed these ditches' decrees and found that collectively they are decreed for the irrigation of over 2,700 acres. The existing ditches in Cottonwood Creek Basin are decreed to divert 87 cfs, of which 67 cfs is decreed for irrigation uses.

SGM reviewed the extent of the potentially irrigated area, as discussed in Section 2.1.8, and found that much of these areas are heavily wooded; therefore, after further analysis, SGM reduced the total amount of potentially irrigable land within the Cottonwood Creek Basin to 68.8 acres. Given these lands' proximity to the decreed water rights and irrigated lands, SGM generally believes that 48.8 acres of land could be irrigated by current absolute water rights in the central portion of the basin with the construction of new infrastructure, and 20.0 acres would require junior water rights with the construction of new infrastructure near the furthest downstream portion of the basin.

As stated above, a total of 20.0 acres would require new junior water rights. These lands lie at an elevation of approximately 7,000 FAMSL. Using an IWR of 2.3 AF/acre, flood irrigation efficiency of 50-percent, and ditch loss of 15-percent, SGM calculated additional demands of 107.7 AF of water (see Table 15). In SGM's experience, a flood efficiency of 50% and ditch efficiency of 85% are reasonable planning values for water supply limited areas, such as the Study Area. In addition, construction of future surface water irrigation systems would be completed using modern mechanical equipment and construction practices. If desired, landowners could construct more efficient irrigation systems by lining ditches and storage ponds, and using gated irrigation pipe, or by piping the whole irrigation system for a highly efficient pressurized irrigation system.

Since, increased water efficiency cannot be guaranteed, SGM relied on a flood efficiency of 50% and ditch efficiency of 85%.

To determine a representative diversion rate for new irrigation water rights on Cottonwood Creek, SGM estimated the average daily diversion demand (which includes ditch loss and irrigation inefficiencies) during the peak irrigation demand month (June). For Cottonwood Creek, the maximum average daily demand to irrigate an additional 20.0 acres of land would be 0.44 cfs. To account for the limited duration of time that the water supply is physically available in Cottonwood Creek during the runoff, SGM anticipates that future irrigation demands would be best met through the combination of new surface water rights and storage facilities. SGM believes it would be reasonable to allow the maximum monthly diversion rate shown in Table 15 into future storage facilities anytime the water was physically and legally available in Cottonwood Creek.

Table 15								
Cottonwood Creek Basin								
Month	Days	Future Irrigation at 7,000 FAMSL (acres)	Demand per Acre at 7,000 FAMSL (AF/acre)	Irrigation Demand (AF)	Ditch Efficiency (%)	Irrigation Efficiency (%)	Irrigation Diversion Demand (AF)	Daily Diversion Demand (cfs)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
January	31	20.0	-	-			-	-
February	28	20.0	-	-			-	-
March	31	20.0	-	-			-	-
April	30	20.0	0.04	0.9	0.85	0.50	2.02	0.03
May	31	20.0	0.49	9.8	0.85	0.50	23.15	0.38
June	30	20.0	0.56	11.2	0.85	0.50	26.45	0.44
July	31	20.0	0.49	9.8	0.85	0.50	23.15	0.38
August	31	20.0	0.39	7.8	0.85	0.50	18.26	0.30
September	30	20.0	0.31	6.2	0.85	0.50	14.68	0.25
October	31	20.0	-	-			-	-
November	30	20.0	-	-			-	-
December	31	20.0	-	-			-	-
Total	**365**		**2.29**	**45.78**			**107.72**	

Notes:

AF = acre-feet; cfs = cubic feet per second

Highlighted value indicates month with maximum diversion rate

Column Notes:

(1) Month

(2) Number of Days in Month

(3) Potential future irrigated area in Cottonwood Creek Basin that lies at approximately 7,000 FAMSL

(4) Average monthly irrigation water requirement (AF/acre) for grass pasture at 7,000 feet above mean sea level and latitude of 38.55° N. Calculated using a Climate Station Scenario analysis in StateCU (Interface Version 7.1.2, FORTRAN Version 13.1). Analysis used Upper Gunnison High Altitude (UGHA) crop coefficient. Precipitation data based on the Montrose No. 2 NOAA Climate Station (USC00055722) between 1992 and 2021. Temperature based on the Cottonwood Basin Colorado NOAA Climate Station (USR0000CCOT) between 1992 and 2021. Temperature data were orthographically adjusted basin on the

(5) Column 3 x Column 4

(6) Assumed ditch transit to be 85% efficient

(7) Assumed flood irrigation efficiency of 50%

(8) Column 5 divided by Column 6 divided by Column 7

(9) Column 8 divided by no. of days in month divided by 1.9835 (conversion factor from AF to cfs)

3.2.1.2 Monitor Creek Basin

In Monitor Creek Basin, no ditches exist upstream of the private parcels located near the headwaters of the basin. However, several water ways tributary to Monitor Creek exist near, or within, these private parcels. In order to irrigate the private parcels in the headwaters of Monitor Creek, new junior water rights would need to be filed and infrastructure would need to be constructed.

The 2020 CDSS irrigated area shapefile denotes that there are currently 184 acres of land being irrigated within Monitor Creek Basin. SGM reviewed the Monitor Creek Basin ditches' decrees and found that the ditches are decreed to irrigate over 900 acres combined. The existing ditches in Monitor Creek Basin are decreed to divert 71.9 cfs for irrigation and other uses. SGM reviewed future potentially irrigated areas, as discussed in Section 2.1.8, and after further analysis found that some of these areas are heavily wooded; therefore, SGM believes 351.8 acres are potentially irrigable in the future. Some of these lands are either upstream of any existing water rights or are not in the vicinity of existing water rights, therefore, SGM believes 328.5 acres of these lands would likely require new junior water rights. The remaining 23.3 acres of potentially irrigable land are near existing irrigated lands and could be irrigated by senior water rights.

As stated above, a total of 328.5 acres would require new water rights. 112.1 acres lie at an elevation of approximately 7,000 FAMSL. Using an IWR of 2.3 AF/acre, flood irrigation efficiency of 50-percent, and ditch loss of 15-percent, SGM calculated additional demands of 603.8 AF of water for the 112.1 acres of land. In addition, 216.4 acres of the future potential irrigated area lies at approximately 8,400 FAMSL. Using an IWR of 2.0 AF/acre, a flood irrigation efficiency of 50-percent, and a 15-percent ditch loss, SGM calculated future irrigation demands to be 1,019.4 AF. The sum of these demands totals 1,623.1 AF of new water demand (see Table 16). SGM analyzed the physical supply for these areas and determined that there is an available supply during normal and wet years to irrigate additional lands, discussed later in this report in Section 4.2.

To determine a representative diversion rate for new irrigation water rights on Monitor Creek, SGM estimated the average daily diversion demand (which includes ditch loss and irrigation inefficiencies) during the peak irrigation demand month (June). For Monitor Creek, the maximum average daily demand to irrigate an additional 328.5 acres of land would collectively be 6.8 cfs. To account for the limited duration of time that the water supply is physically available in Monitor Creek during the runoff, SGM anticipates that future irrigation demands would be best met through the combination of new surface water rights and storage facilities. SGM believes it would be reasonable to allow the maximum monthly diversion rate shown in Table 16 into future storage facilities anytime the water was physically and legally available in Monitor Creek.

Table 16															
Monitor Creek Basin															
Month	Days	Future Irrigation at 7,000 FAMSL (acres)	Demand per Acre at 7,000 FAMSL (AF/acre)	Irrigation Demand (AF)	Ditch Efficiency (%)	Irrigation Efficiency (%)	Irrigation Diversion Demand (AF)	Future Irrigation at 8,400 FAMSL (acres)	Demand per Acre at 8,400 FAMSL (AF/acre)	Irrigation Demand (AF)	Ditch Efficiency (%)	Irrigation Efficiency (%)	Irrigation Diversion Demand (AF)	Total Irrigation Diversion Demand (AF)	Daily Diversion Demand (cfs)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
January	31	112.1	-	-			-	216.4	-	-			-	-	-
February	28	112.1	-	-			-	216.4	-	-			-	-	-
March	31	112.1	-	-			-	216.4	-	-			-	-	-
April	30	112.1	0.04	4.8	0.85	0.50	11.34	216.4	0.05	9.7	0.85	0.50	22.91	34.3	0.58
May	31	112.1	0.49	55.2	0.85	0.50	129.77	216.4	0.40	87.2	0.85	0.50	205.20	335.0	5.45
June	30	112.1	0.56	63.0	0.85	0.50	148.24	216.4	0.51	110.1	0.85	0.50	259.17	407.4	6.85
July	31	112.1	0.49	55.2	0.85	0.50	129.77	216.4	0.44	95.2	0.85	0.50	224.04	353.8	5.75
August	31	112.1	0.39	43.5	0.85	0.50	102.34	216.4	0.34	73.6	0.85	0.50	173.12	275.5	4.48
September	30	112.1	0.31	35.0	0.85	0.50	82.29	216.4	0.27	57.3	0.85	0.50	134.93	217.2	3.65
October	31	112.1	-	-			-	216.4	-	-			-	-	-
November	30	112.1	-	-			-	216.4	-	-			-	-	-
December	31	112.1	-	-			-	216.40	-	-			-	-	-
Total	365		2.29	256.60			603.76		2.00	433.23			1,019.37	1,623.13	

Notes:

AF = acre-feet; cfs = cubic feet per second

Highlighted value indicates month with maximum diversion rate

Column Notes:

(1) Month

(2) Number of Days in Month

(3) Potential future irrigated area in Monitor Creek Basin that lies at approximately 7,000 FAMSL

(4) Average monthly irrigation water requirement (AF/acre) for grass pasture at 7,000 feet above mean sea level and latitude of 38.55° N. Calculated using a Climate Station Scenario analysis in StateCU (Interface Version 7.1.2, FORTRAN Version 13.1). Analysis used Upper Gunnison High Altitude (UGHA) crop coefficient. Precipitation data based on the Montrose No. 2 NOAA Climate Station (USC00055722) between 1992 and 2021. Temperature based on the Cottonwood Basin Colorado NOAA Climate Station (USR0000CCOT) between 1992 and 2021. Temperature data were orthographically adjusted basin on the elevation at a rate of 3.6° F per thousand feet. Precipitation data were orthographically adjusted by a factor of 1.55.

(5) Column 3 x Column 4

(6) Assumed ditch transit to be 85% efficient

(7) Assumed flood irrigation efficiency of 50%

(8) Column 5 divided by Column 6 divided by Column 7

(9) Potential future irrigated area in Monitor Creek Basin that lies at approximately 8,400 FAMSL, near the headwaters of Little Monitor Creek

(10) Average monthly irrigation water requirement (AF/acre) for grass pasture at 8,400 feet above mean sea level and latitude of 38.50° N. Calculated using a Climate Station Scenario analysis in StateCU (Interface Version 7.1.2, FORTRAN Version 13.1). Analysis used Upper Gunnison High Altitude (UGHA) crop coefficient. Precipitation data based on the Montrose No. 2 NOAA Climate Station (USC00055722) between 1992 and 2021. Temperature based on the Cottonwood Basin Colorado NOAA Climate Station (USR0000CCOT) between 1992 and 2021. Temperature data were orthographically adjusted basin on the elevation at a rate of 3.6° F per thousand feet. Precipitation data were orthographically adjusted by a factor of 1.55.

(11) Column 9 x Column 10

(12) Assumed ditch transit to be 85% efficient

(13) Assumed flood irrigation efficiency of 50%

(14) Column 11 divided by Column 12 divided by Column 13

(15) Column 8 + Column 14

(16) Column 15 divided by no. of days in month divided by 1.9835 (conversion factor from AF to cfs)

3.2.1.3 **Potter Creek Basin**

There is no irrigation currently occurring in Upper Potter Creek Basin nor below its confluence with Monitor Creek. In addition, no diversion ditches exist within the basin. Due to the very limited amount of private land (4 acres in Upper Potter Creek Basin and 157 acres below confluence with Monitor Creek), lack of suitable soils and slopes, and lack of ditches, SGM did not delineate any potential irrigated land in the Upper Potter Creek Basin nor downstream from Potter Creek's confluence with Monitor Creek. Therefore, there are no future irrigation demands for Potter Creek Basin under Scenario A.

3.2.2 Scenario B: Subdivision of 35.0-Acre Parcels for Small-scale Farms

While exempt well permits can currently be issued for parcels that are at least 35.0 acres without a decreed water right, SGM considered the amount of junior water rights (or decreed augmentation plans) that would be required for the subdivision of land if the exempt well permit statute were revoked under Scenario B. For the purpose of this analysis, SGM assumed a demand comparable to that allowed under an exempt well permit (3.0 AF/year) for the future subdivision of private property into 35.0-acre parcels.

To estimate the future water demands that could be realized in the Study Area for the future subdivision of larger parcels into 35.0-acre small-scale farms, SGM analyzed the number of private parcels over 35.0-acres and estimated the maximum number of 35.0-acre parcels that they could be subdivided into. Of the existing private parcels in the Study Area, a total of 87, 35.0-acre parcels could be created in the Cottonwood Creek Basin, 61, 35.0-acre parcels could be created in the Monitor Creek Basin, and 4, 35.0-acre parcels could be created in the Potter Creek Basin below the confluence with Monitor Creek.

For planning purposes, an indoor use daily demand of 195 gpd per single-family residence was considered for this scenario. SGM assumed each 35.0-acre parcel would have three single-family residences, which equates to an annual indoor demand of approximately 0.66 AF/year. SGM assumed a stock water demand of 10 animals, which would have an average daily demand of 32.4 gpd, totaling 324 gpd, for an annual demand of 0.36 AF/year. The annual stock water demand (0.36 AF/year) and indoor demand (0.66 AF/year) totals 1.02 AF/year per 35.0-acre parcel. This leaves a remaining 1.98 AF/year available of the 3.0 AF/year allowed for irrigation demands. Using a calculated irrigation demand of 2.29 AF/acre, as listed in Table 13, each 35.0-acre parcel would be able to irrigate approximately 0.85 acres of land. To be conservative, SGM increased 0.85 acres of land to 1.0 acres, which would increase the overall water demand on the stream systems. Absent an exempt well statute, landowners would likely rely on groundwater supply for domestic and stock water uses and would seek to divert water for irrigation use through a surface diversion for irrigation of 1.0 acre. Currently the exempt well statute allows for the irrigation of 1 acre. A new surface diversion water right would need to account for ditch losses and irrigation inefficiencies. After accounting for an 85% ditch efficiency and 50% irrigation efficiency, each 35.0-acre parcel would have a stream diversion demand of approximately 5.39 AF/year to irrigate 1 acre of land (see Table 17a). This would result in an average daily diversion rate of 0.023 cfs per 35.0-acre parcel for the maximum irrigation demand month of June.

In practice the future surface diversions would occur primarily during runoff and would need to capture the total irrigation demand plus anticipated losses. Runoff also coincides with when the riparian based ISFs are most likely to be in effect. Therefore, SGM assumed that the highest monthly demand diversion rate could be diverted and captured in storage.

SGM assumed that the senior decreed water rights that are currently used for irrigation could continue to be used for irrigation in the same areas, regardless of if the parcels had been subdivided into 35.0-acre parcels. While unlikely that a future developer would sever senior water rights historically used to irrigate parcels of land once those same parcels were subdivided into 35.0-acre ranches, it would increase the WDA for each basin to assume that future residential development would require completely new water rights. Therefore, to be conservative, SGM excluded these senior water rights as being available for future irrigation on future 35.0-acre parcels in the Cottonwood Creek Basin and Monitor Creek Basin. Based on the number of 35.0-acre parcels that could be created in each basin, the maximum diversion demand occurs in June and equates to 2.06 cfs in Cottonwood Basin, 1.44 cfs in Monitor Creek Basin, and 1.54 cfs in Potter Creek Basin (see Table 17b).

Assuming a maximum water demand of 6.40 AF/year for domestic, stock water, and irrigation uses per 35.0-acre parcel, the resultant future potential future subdivision water demand would be approximately 557.2 AF in the Cottonwood Creek Basin, 390.6 AF in the Monitor Creek Basin, 416.3 AF in Potter Creek Basin (see Table 17b). Only one private parcel existed in the Upper Potter Creek Basin and was less than 35.0-acres; therefore, no new 35.0-acres parcel development would be able to occur.

Table 17a																
Month	Days	Houses per 35-acre Parcel	Demand Per House (gpd)	Monthly Domestic Demand (AF)	Livestock Units	Demand per Animal (gpd)	Monthly Livestock Demand (AF)	Irrigated Area (acres)	Demand per Acre (AF/acre)	Irrigation demand (AF)	Ditch Efficiency (%)	Irrigation Efficiency (%)	Irrigation Diversion Demand (AF)	Total Well Demand (AF)	Total Surface Diversion Demand (AF)	Total Monthly Demand per 35-acre Parcel (AF)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
January	31	3	195	0.06	10	32.4	0.03	1	0.00	0.00			0.00	0.09	0.00	**0.09**
February	28	3	195	0.05	10	32.4	0.03	1	0.00	0.00			0.00	0.08	0.00	**0.08**
March	31	3	195	0.06	10	32.4	0.03	1	0.00	0.00			0.00	0.09	0.00	**0.09**
April	30	3	195	0.05	10	32.4	0.03	1	0.04	0.04	85%	50%	0.10	0.08	0.10	**0.18**
May	31	3	195	0.06	10	32.4	0.03	1	0.49	0.49	85%	50%	1.16	0.09	1.16	**1.24**
June	30	3	195	0.05	10	32.4	0.03	1	0.56	0.56	85%	50%	1.32	0.08	1.32	**1.41**
July	31	3	195	0.06	10	32.4	0.03	1	0.49	0.49	85%	50%	1.16	0.09	1.16	**1.24**
August	31	3	195	0.06	10	32.4	0.03	1	0.39	0.39	85%	50%	0.91	0.09	0.91	**1.00**
September	30	3	195	0.05	10	32.4	0.03	1	0.31	0.31	85%	50%	0.73	0.08	0.73	**0.82**
October	31	3	195	0.06	10	32.4	0.03	1	0.00	0.00			0.00	0.09	0.00	**0.09**
November	30	3	195	0.05	10	32.4	0.03	1	0.00	0.00			0.00	0.08	0.00	**0.08**
December	31	3	195	0.06	10	32.4	0.03	1	0.00	0.00			0.00	0.09	0.00	**0.09**
Total	**365**			**0.66**			**0.36**			**2.29**			**5.39**	**1.02**	**5.39**	**6.40**

Notes:

gpd: gallons per day; AF = acre-feet

Column Notes:

(1) Month

(2) Number of Days in Month

(3) Number of houses assumed for 35-acre parcel

(4) Standard assumped indoor demand of 195 gpd

(5) (Column 2 x Column 3 x Column 4)/325,851 - [1 AF = 325,851 gallons]

(6) Number of livestock animals per 35-acre parcel assumed

(7) Assumed average demand of 32.4 gpd per animal

(8) (Column 2 x Column 6 x Column 7)/325,851

(9) Assumed irrigated acreage per 35-acre parcel

(10) Average monthly irrigation water requirement (AF/acre) for grass pasture at 7,000 feet above mean sea level and latitude of 38.55° N. Calculated using a Climate Station Scenario analysis in StateCU (Interface Version 7.1.2, FORTRAN Version 13.1). Analysis used Upper Gunnison High Altitude (UGHA) crop coefficient. Precipitation data based on the Montrose No. 2 NOAA Climate Station (USC00055722) between 1992 and 2021. Temperature based on the Cottonwood Basin Colorado NOAA Climate Station (USR0000CCOT) between 1992 and 2021. Temperature data were orthographically adjusted basin on the elevation at a rate of 3.6° F per thousand feet. Precipitation data were orthographically adjusted by a factor of 1.55.

(11) Column 9 x Column 10

(12) Assumed ditch transit to be 85% efficient

(13) Assumed flood irrigation efficiency of 50%

(14) Column 11 divided by Column 12 divided by Column 13

(15) Assumes domestic and livestock demands are met by a well (Column 5 + 8)

(16) Assumes irrigation demands are met by a future surface diversion (Column 14)

(17) Sum of Columns 5 + 8 + 14

Table 17b										
Basin		**Cottonwood**			**Monitor**			**Potter (Combined Monitor and Potter)**		
Month	**Days**	**No. of 35-acre Parcels**	**Total Demand (AF)**	**Average Daily Diversion Rate (cfs)**	**No. of 35-acre Parcels**	**Total Demand (AF)**	**Average Daily Diversion Rate (cfs)**	**No. of 35-acre Parcels**	**Total Demand (AF)**	**Average Daily Diversion Rate (cfs)**
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**
January	31	87	7.5	0.12	61	5.3	0.09	65	5.6	0.09
February	28	87	6.8	0.12	61	4.8	0.09	65	5.1	0.09
March	31	87	7.5	0.12	61	5.3	0.09	65	5.6	0.09
April	30	87	16.1	0.27	61	11.3	0.19	65	12.0	0.20
May	31	87	108.2	1.76	61	75.9	1.23	65	80.9	1.32
June	30	87	122.3	2.06	61	85.8	1.44	65	91.4	1.54
July	31	87	108.2	1.76	61	75.9	1.23	65	80.9	1.32
August	31	87	86.9	1.41	61	61.0	0.99	65	65.0	1.06
September	30	87	71.1	1.20	61	49.9	0.84	65	53.2	0.89
October	31	87	7.5	0.12	61	5.3	0.09	65	5.6	0.09
November	30	87	7.3	0.12	61	5.1	0.09	65	5.4	0.09
December	31	87	7.5	0.12	61	5.3	0.09	65	5.6	0.09
Total	**365**		**557.2**		**390.6**			**416.3**		

Notes:

AF = acre-feet; cfs = cubic feet per second

Highlighted value indicates month with maximum diversion rate

Column Notes:

(1) Month

(2) Number of Days in Month

(3) Number of 35-acre parcels that could potentially be subdivided from existing private parcels in Cottonwood Basin and require new junior water rights to irrigate 1.0-

(4) Column 3 x total monthly demand factor per 35-acre parcel (see Column 17, Table 16a)

(5) (Column 4/Column 2)/1.9835 - [1.935 AF/day = 1 cfs)

(6) Number of 35-acre parcels that could potentially be subdivided from existing private parcels in Monitor Basin and require new junior water rights to irrigate 1.0 acre

(7) Column 6 x total monthly demand factor per 35-acre parcel (see Column 17, Table 16a)

(8) (Column 7/Column 2)/1.9835

(9) Number of 35-acre parcels that could potentially be subdivided from existing private parcels in Potter Basin and require new junior water rights to irrigate 1.0-acre(s) (Includes Sum of Monitor Basin and Upper Potter Basin). All future subdivided 35.0-acre parcels are located in Potter Creek Basin below its confluence with Monitor Creek. No potential 35-acre parcels exist within Potter Creek above its confluence with Monitor Creek.

(10) Column 9 x total monthly demand factor per 35-acre parcel (see Column 17, Table 16a)

(11) (Column 10/Column 2)/1.9835

3.2.3 Scenario C: Subdivision of 5.0-Acre Parcels for Small-scale Farms

Scenario C is similar to Scenario B in that SGM considered the diversion demand associated with the development of private land if each parcel were subdivided into 5.0-acre plots of land for small-scale farms.

To estimate the future water demand that could be realized in the Study Area for the future subdivision of larger parcels into 5.0-acre small-scale farms, SGM analyzed the number of private parcels over 5.0-acres and estimated the maximum number of 5.0-acre parcels that could be subdivided. Of the existing private parcels in the Study Area, a total of 649, 5.0-acre parcels could be created in the Cottonwood Creek Basin, 481, 5.0-acre parcels could be created in the Monitor Creek Basin, 1, 5.0-acre parcel could be created in Upper Monitor Creek Basin, and 31, 5.0-acre parcels could be created in the Potter Creek Basin below the confluence with Monitor Creek.

Similar to Scenario B, an indoor daily use demand of 195 gpd for each single-family residence was considered for this scenario. SGM assumed each 5.0-acre parcel would only have one single-family residence, which would equate to a water demand of 0.22 AF/year. SGM assumed a stock water demand for 5 animal units using an average daily demand of 32.4 gpd per animal, totaling 162 gpd, or 0.18 AF/year. SGM assumed a maximum of 2,000 square feet (0.046 acres) of irrigation would occur on each 5.0-acre parcel, which equates to 0.11 AF/year. Given the subdivision of land into smaller parcels and limited irrigation, SGM assumed that all demands for a 5.0-acre parcel could be met by a well. Therefore, a sprinkler irrigation efficiency of 85% was used, which resulted in an irrigation diversion demand of 0.12 AF/year per 5.0-acre parcel. The total combined annual diversion demand would therefore be 0.52 AF/year (see Table 18a).

Assuming this maximum water demand of 0.52 AF/year per 5.0-acre parcel, the potential future water demand would be approximately 339.8 AF in the Cottonwood Creek Basin, 251.8 AF in the Monitor Creek Basin, 0.5 AF in Upper Potter Creek Basin, and 268.6 AF in the Potter Creek Basin (combined Monitor and Potter Creeks) (see Table 18b). Only one private parcel existed in the Upper Potter Creek Basin and was less than 5.0-acres; however, SGM accounted for future development on this parcel.

Given that the potential water supply for future 5.0-acre small-scale farms would come from individual wells, which would have delayed depletions to Cottonwood, Monitor, and Potter Creeks, SGM considered the entire annual demand for the future development may need to be augmented to protect the existing vested water rights, including CWCB's ISFs in Cottonwood Creek and Monitor Creek. While a basin-wide augmentation plan could be difficult to implement, for the purpose of this project, SGM recommends considering the maximum demand that could be realized through the development of larger parcels into smaller 5.0-acre small-scale farms (Table 18b).

Similar to Scenario B, SGM excluded the use of any decreed senior water rights as being available for future irrigation on future 5.0 acre parcels in the Cottonwood Creek, Monitor Creek, and Potter Creek basins.

Table 18a															
Month	Days	Houses per 5-acre Parcel	Demand Per House (gpd)	Monthly Domestic Demand (AF)	Livestock Units	Demand per Animal (gpd)	Monthly Livestock Demand (AF)	Irrigated Area (acres)	Demand per Acre (AF/acre)	Irrigation demand (AF)	Sprinkler Efficiency (%)	Irrigation Diversion Demand (AF)	Total Well Demand (AF)	Total Surface Diversion Demand (AF)	Total Demand per 5-acre Parcel (AF)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
January	31	1	195	0.02	5	32.4	0.02	0.05	0.00	0.00		0.00	0.03	0.00	**0.03**
February	28	1	195	0.02	5	32.4	0.01	0.05	0.00	0.00		0.00	0.03	0.00	**0.03**
March	31	1	195	0.02	5	32.4	0.02	0.05	0.00	0.00		0.00	0.03	0.00	**0.03**
April	30	1	195	0.02	5	32.4	0.01	0.05	0.04	0.00	85%	0.00	0.03	0.00	**0.04**
May	31	1	195	0.02	5	32.4	0.02	0.05	0.49	0.02	85%	0.03	0.03	0.03	**0.06**
June	30	1	195	0.02	5	32.4	0.01	0.05	0.56	0.03	85%	0.03	0.03	0.03	**0.06**
July	31	1	195	0.02	5	32.4	0.02	0.05	0.49	0.02	85%	0.03	0.03	0.03	**0.06**
August	31	1	195	0.02	5	32.4	0.02	0.05	0.39	0.02	85%	0.02	0.03	0.02	**0.05**
September	30	1	195	0.02	5	32.4	0.01	0.05	0.31	0.01	85%	0.02	0.03	0.02	**0.05**
October	31	1	195	0.02	5	32.4	0.02	0.05	0.00	0.00		0.00	0.03	0.00	**0.03**
November	30	1	195	0.02	5	32.4	0.01	0.05	0.00	0.00		0.00	0.03	0.00	**0.03**
December	31	1	195	0.02	5	32.4	0.02	0.05	0.00	0.00		0.00	0.03	0.00	**0.03**
Total	**365**			**0.22**			**0.18**			**0.11**		**0.12**	**0.40**	**0.12**	**0.52**

Notes:

gpd: gallons per day; AF = acre-feet

Column Notes:

(1) Month

(2) Number of Days in Month

(3) Number of houses assumed for 5-acre parcel

(4) Standard assumped indoor demand of 195 gpd

(5) (Column 2 x Column 3 x Column 4)/325,851 - [1 AF = 325,851 gallons]

(6) Number of livestock animals per 5-acre parcel

(7) Assumed average demand of 32.4 gpd per animal

(8) (Column 2 x Column 6 x Column 7)/325,851

(9) Assumed irrigated acreage per 5-acre parcel to be 2,000 square-feet

(10) Average monthly irrigation water requirement (AF/acre) for grass pasture at 7,000 feet above mean sea level and latitude of 38.55° N. Calculated using a Climate Station Scenario analysis in StateCU (Interface Version 7.1.2, FORTRAN Version 13.1). Analysis used Upper Gunnison High Altitude (UGHA) crop coefficient. Precipitation data based on the Montrose No. 2 NOAA Climate Station (USC00055722) between 1992 and 2021. Temperature based on the Cottonwood Basin Colorado NOAA Climate Station (USR0000CCOT) between 1992 and 2021. Temperature data were orthographically adjusted basin on the elevation at a rate of 3.6° F per thousand feet. Precipitation data were orthographically adjusted by a factor of 1.55.

(11) Column 9 x Column 10

(12) Assumed sprinkler efficiency of 85%

(13) Column 11 / Column 12

(14) Assumes domestic and livestock demands are met by a well (Column 5 + 8)

(15) Assumes irrigation demands are met by a future surface diversion (Column 13)

(17) Sum of Columns 5 + 8 + 13

Table 18b													
Basin		Cottonwood			Monitor			Upper Potter			Potter (Combined Monitor and Potter)		
Month	Days	No. of 5 acre Parcels	Total Demand (AF)	Average Daily Diversion Rate (cfs)	No. of 5 acre Parcels	Total Demand (AF)	Average Daily Diversion Rate (cfs)	No. of 5 acre Parcels	Total Demand (AF)	Average Daily Diversion Rate (cfs)	No. of 5 acre Parcels	Total Demand (AF)	Average Daily Diversion Rate (cfs)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
January	31	649	22.0	0.36	481	16.3	0.27	1	0.0	0.001	513	17.4	0.28
February	28	649	19.9	0.36	481	14.8	0.27	1	0.0	0.001	513	15.7	0.28
March	31	649	22.0	0.36	481	16.3	0.27	1	0.0	0.001	513	17.4	0.28
April	30	649	22.8	0.38	481	16.9	0.28	1	0.0	0.001	513	18.1	0.30
May	31	649	39.3	0.64	481	29.1	0.47	1	0.1	0.001	513	31.1	0.51
June	30	649	41.0	0.69	481	30.4	0.51	1	0.1	0.001	513	32.4	0.55
July	31	649	39.3	0.64	481	29.1	0.47	1	0.1	0.001	513	31.1	0.51
August	31	649	35.6	0.58	481	26.4	0.43	1	0.1	0.001	513	28.2	0.46
September	30	649	32.3	0.54	481	23.9	0.40	1	0.0	0.001	513	25.5	0.43
October	31	649	22.0	0.36	481	16.3	0.27	1	0.0	0.001	513	17.4	0.28
November	30	649	21.3	0.36	481	15.8	0.27	1	0.0	0.001	513	16.9	0.28
December	31	649	22.0	0.36	481	16.3	0.27	1	0.0	0.001	513	17.4	0.28
Total	**365**		**339.8**			**251.8**			**0.5**			**268.6**	

Notes:

AF = acre-feet; cfs = cubic feet per second

Highlighted value indicates month with maximum diversion rate

Column Notes:

(1) Month

(2) Number of Days in Month

(3) Number of 5-acre parcels that could potentially be subdivided from existing private parcels in Cottonwood Basin

(4) Column 3 x total monthly demand factor per 5-acre parcel (see Column 16, Table 17a)

(5) (Column 4/Column 2)/1.9835 - [1.935 AF/day = 1 cfs)

(6) Number of 5-acre parcels that could potentially be subdivided from existing private parcels in Monitor Basin

(7) Column 6 x total monthly demand factor per 5-acre parcel (see Column 16, Table 17a)

(8) (Column 7/Column 2)/1.9835

(9) Number of 5-acre parcels that could potentially be subdivided from existing private parcels in Upper Potter Creek Basin only.

(10) Column 9 x total monthly demand factor per 5-acre parcel (see Column 16, Table 17a)

(11) (Column 10/Column 2)/1.9835

(12) Number of 5-acre parcels that could potentially be subdivided from existing private parcels in Potter Basin. (Includes Sum of Monitor Basin and Upper Potter Basin)

(13) Column 12 x total monthly demand factor per 5-acre parcel (see Column 16, Table 17a)

(14) (Column 13/Column 2)/1.9835

3.2.4 Scenario Overview by Basin

Table 19, below, summarizes the total future demand per basin in each scenario. The highlighted value in yellow indicates the maximum demand in each basin.

Table 19. Scenario Demands Overview

Scenario / Basin	Cottonwood		Monitor		Potter (Combined Monitor and Potter)	
	(AF)	(cfs)	(AF)	(cfs)	(AF)	(cfs)
A [(1)]	107.72	0.44	1623.13	6.85	1623.13	6.85
B [(2)]	557.16	2.06	390.65	1.44	416.27	1.54
C [(3)]	339.77	0.69	251.82	0.51	268.57	0.55

Notes:

(1) Scenario A considers future irrigation demands for potentially future irrigable areas. See section 3.2.1 for more information.

(2) Scenario B assumes domestic, stock, and irrigation demands per subdivision into 35-acre parcels. See Section 3.2.2 for more information.

(3) Scenario C assumes domestic, stock, and irrigation demands per subdivision into 5-acre parcels. See Section 3.2.3 for more information.

Highlighted value indicated maximum future demand in respective Basin.

4.0 Constraints on Future Water Development

Many factors may limit the ability to develop future water rights within the three Study Area basins, including the suitability of native soils for irrigation based on soil condition and slope, the timing and availability of the physical water supply, and the legal availability of water. These factors are discussed in detail below.

4.1 Irrigated Soil Potential

The irrigated soil potential was discussed in Sections 2.1.7 and 2.1.8, which was based on the irrigation class of the soils in combination with slopes of the private parcels. A total of 68.8 acres of future irrigable lands were delineated in the Cottonwood Creek Basin and 351.8 acres were delineated in the Monitor Creek Basin. After further review, SGM believes that the 48.8 acres of future irrigable lands in Cottonwood Creek Basin could be met by senior water rights. Similarly, 23.3 acres of future irrigable lands in Monitor Creek Basin could be met by senior water rights. SGM notes that irrigation in Monitor Creek Basin could possibly be increased if future ditches were constructed on federally managed lands; however, given the remote location and the BLM's determination that these stream segments are eligible for a Wild and Scenic designation, which would allow for only minor development, we do not believe it would be likely that parties who wish to construct ditches would be able to obtain a right-of-way grant from the BLM for that purpose. Therefore, SGM only considered the irrigation of private lands near existing waterways and ditches through private parcels.

4.2 Physical Supply

The three Study Area basins are reliant on snowmelt runoff and summer rainstorms for the majority of their physical water supply. These drainages have a relatively short runoff period and the physical availability of supplies to irrigate land and/or store for subsequent irrigation is typically limited to a three-to-four-month period between early spring and early summer. Further, it would require a significant amount of effort to construct ditches upstream of potentially irrigable lands. Most of the delineated potential future irrigated land in the Monitor Creek Basin resides at approximately 8,400 FAMSL, near the headwaters of Little Monitor and Monitor creeks. This area would have a short growing season due to its elevation and a very limited window of spring runoff, given its proximity to the Basin's headwaters. Based on the data shown in Tables 12 and 13, the physical supply (both timing and amount) in the headwaters would be the limiting factor. Given the relatively short runoff duration and high streamflow rates, it is reasonable to assume that future irrigators would consider storing their diversions when the water was physically available to better manage their water application to meet the crops' irrigation water requirement in subsequent months. Future decrees could be obtained for small catchments that would have non-jurisdictional embankments constructed to allow for the storage of irrigation supplies. While evaporation and/or seepage would occur on these ponds, SGM believes the calculated future irrigation diversion demands are adequate to allow for storage prior to application.

Further downstream, there is potential to irrigate new lands, however, senior rights would convey the majority of streamflow in dry and normal years. There is potential for there to be physical supply during wet years. As noted by the District 41 Water Commissioner, the creeks in the Study Area can become dry in some locations in downstream reaches or have very low baseflow during late fall and winter months.

Based on the estimated future irrigated area of 328.5 acres in Monitor Creek Basin and the calculated IWR for pasture grass at 7,000 feet and 8,400 feet, as discussed in Section 2.2.1, SGM assumed a 50-percent flood irrigation efficiency and a 15-percent ditch loss for a calculated maximum daily diversion demand of 6.8 cfs, as shown in Table 15.

SGM delineated a 5.45 square-mile subbasin within the headwater area of Monitor Creek Basin, where a majority of the potential future irrigated area lie, to estimate the available physical supply in the upper portion of the basin. Using the USGS regional equation (see Section 2.2.4), SGM found that approximately 2,882.7 AF would be available in a normal year. However, as shown in Table 12, approximately 55.41% of the annual supply is generally estimated to flow in May. For this delineated 5.45 square-mile subbasin, that would equate to 1,597.3 AF, at an average daily flow of 25.98 cfs. Assuming a maximum diversion rate of 6.8 cfs, the available supply could reasonably irrigate a maximum area of 328.5 acres. Therefore, SGM believes that enough water is physically available during high flow for all of the delineated future irrigated areas within the upper portion of the Monitor Creek Basin. Given this analysis, SGM believes there is also an adequate physical water supply in the lower portions of Monitor Creek Basin for the future irrigated areas.

It is also important to consider that many of the existing water rights that are decreed for irrigation are currently irrigating less acreages than listed in their original decrees. Therefore, SGM understands that owners of existing decreed water rights could improve their diversion structures to increase the amount of diversions up to their decreed diversion rates. This could result in the senior water rights holders in this area placing a call on the river, which would reduce the amount of water legally available to future junior irrigation water rights filed in the Monitor Creek Basin.

4.3 Legal Supply

Given the number of water rights in the Cottonwood and Monitor basins, SGM anticipates that junior water rights would only be legally entitled to divert supplies during the peak of runoff in some normal years and in wet years. The legal availability of water rights would be greatly diminished during dry years and some normal years. SGM was unable to find any historical administrative calls using the CDSS HydroBase, and the District 41 Water Commissioner confirmed that water rights are generally not administered within the Study Area. Further, the existing CWCB ISF water rights on Cottonwood and Potter creeks, when administered, would be senior to future water rights filing in the Study Area and would limit the ability of upstream structures to divert native streamflow. Currently, most of the water rights on Cottonwood Creek are senior to the CWCB ISF on Cottonwood Creek, with the exception of Hawkins Spring No.1, Hawkins Spring No. 3, and Jones Spring No. 2, which have a total decreed flow rate of 0.0132 cfs (see Figure 4). All water rights that divert on Monitor Creek and Potter Creek are senior to the existing CWCB ISF on Potter Creek. If future water development were to occur, their operations may be limited by the existing ISF water rights in these drainages.

5.0 Findings

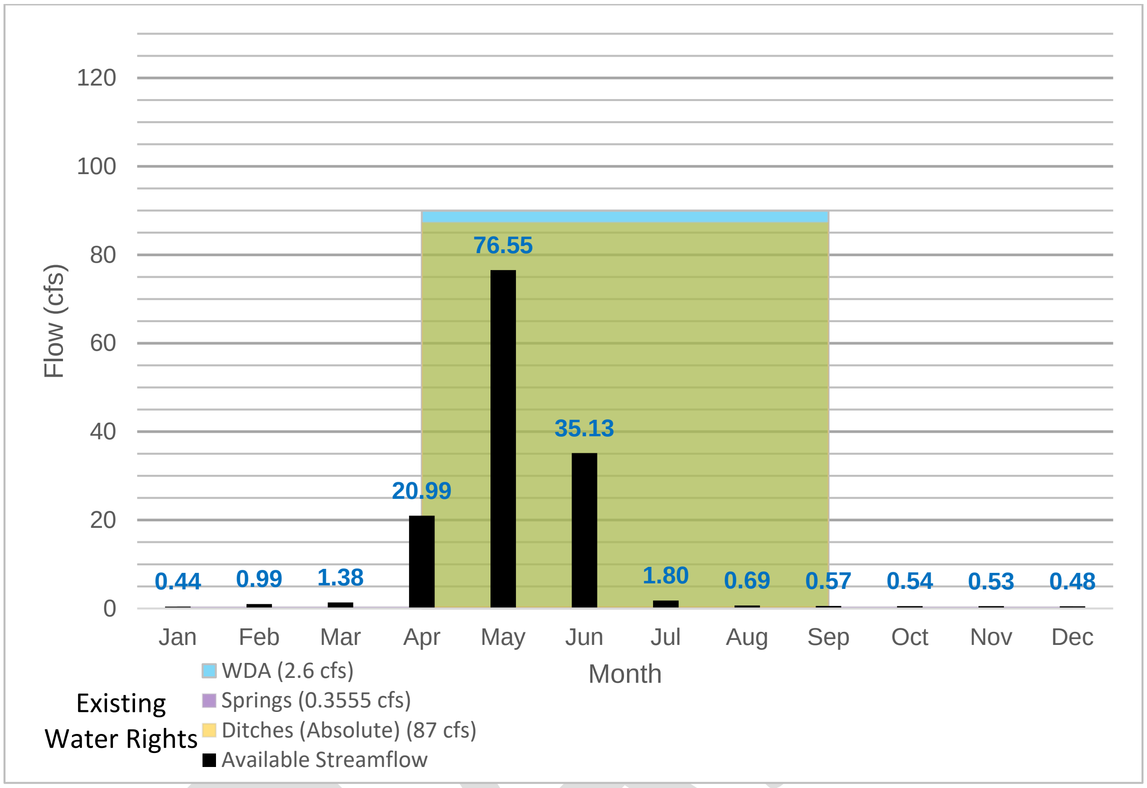
Based on our analysis, SGM has developed the following conclusions for the Study Area basins.

5.1 Cottonwood Creek Basin

5.1.1 Water Availability

Using the BLM modified USGS regional equation to calculate the basin yield of Cottonwood Creek Basin, SGM calculated an average basin yield of 8,495.2 AF/year. Using the monthly distribution factors, SGM calculated the monthly volume and flows for Cottonwood Creek Basin, as shown in Figure 13. It is important to note that the BLM modified USGS regional equation estimates peak flows occurring in May. However, SGM notes that based on the historical and recent CWCB streamflow gage records, the peak runoff can occur in May, but oftentimes occurs in April. Additionally, Figure 13 is overlaid with existing decreed water rights in Cottonwood Creek Basin, as shown by the shaded areas. The aggregated decreed water rights often exceed the available streamflow calculated from the USGS regional equation. However, SGM notes that the values shown in Figure 13 represent an estimate of the average monthly streamflow and are not representative of the maximum daily streamflow rates. Further, the physical availability of water in some tributaries or stream segments may not allow for decreed water rights to achieve their absolute rates each year.

Figure 13 – Cottonwood Creek Basin Mean Monthly Flow Distribution



5.1.2 Existing Water Rights and Associated Water Demands

SGM tabulated the absolute water rights, existing irrigated area, exempt wells, exempt livestock watering tanks, and grazing allotments within Cottonwood Creek Basin and estimated the current water demands. SGM did not consider changes of water rights nor possible restrictions for water uses outside of irrigation months, as the proposed riparian based ISF on Cottonwood Creek would only be in effect from April through September.

- SGM calculated the existing absolute water rights diversions to be: 791.6 AF for reservoirs and stock ponds, 87.0 cfs for ditches, and 0.3555 cfs for springs.
- A total of 183.2 acres of irrigated area lie within Cottonwood Creek Basin. Using an IWR of 2.3 for lands at approximately 7,000 FAMSL and an irrigation efficiency of 50-percent for flood irrigation, SGM calculated an irrigation demand of 842.7 AF to irrigate existing lands. Including a 15-percent ditch loss, the diversion demand would be 991.4 AF.
- The conditional water rights in the Cottonwood Creek Basin total 62.0 AF for reservoirs.
- One exempt, non-consumptive geoexchange well exists within Cottonwood Creek Basin.
- The grazing allotments are difficult to estimate demand per basin due to the extent of the grazing allotment boundaries extending outside the basin boundaries. It is

estimated that existing grazing demands total 34.95 AF for all basins within the Study Area.

- 9 livestock water tanks exist within Cottonwood Creek Basin. In order to have an exempt livestock use, the volume of the storage vessel must be less than 10 AF each, and the actual demand would be commensurate with the amount of stock water and grazing demand 34.95 AF for the entire Study Area).

5.1.3 Future Water Development Allowance

SGM calculated the future Cottonwood Creek Basin water demands by using the future water demand scenario that would require the most diversions. For Cottonwood Creek Basin, the largest water development allowance would occur if all private parcels were subdivided into 35.0-acre parcels (see Scenario B in Section 3.2.2). In addition to the development of 35.0-acre parcels, SGM included demands for the management of USFS, BLM, and CPW lands.

- Under the assumption that the exempt well statute would no longer be available, SGM assumed that each 35.0-acre parcel would have a total demand of 6.40 AF/year. SGM calculated a potential future demand of 87 subdivided parcels. This equates to a maximum annual demand of 557.2 AF/year with a maximum diversion rate of 2.06 cfs.
- Based on the discussions with BLM and USFS staff, SGM understands that each agency estimated a total future potential demand of 2.0 AF per year. Additionally, the BLM and USFS have requested a maximum diversion rate of 0.22 cfs each.
- Based on the discussions with CPW staff, SGM understands the CPW estimated total future potential demand to be 1.0 AF for future porous log structures, which would be used to support native fisheries. CPW staff have requested a maximum diversion rate of 0.1 cfs to fill and offset evaporation from the porous log structures.
- The Cottonwood Creek water development allowance will be allocated for future water right development under the following uses:
    - Storage
    - Recreation
    - Wildlife
    - Stock watering
    - Irrigation
    - Fire-protection
    - Domestic
    - Piscatorial

Accordingly, the Cottonwood Creek WDA was developed as shown in Table 20.

Table 20. Cottonwood Creek Water Development Allowance			
WDA Uses	**Annual Amount (AF)**	**Diversion Amount (cfs)**	**Uses**
Water Use on Private Parcels (1)	557.2	2.06	Irrigation, domestic, stock watering, recreation, wildlife, piscatorial, fire-protection, and storage
BLM	2.0	0.22	
USFS	2.0	0.22	
CPW	1.0	0.1	
Total	**562.2**	**2.6**	

Notes:

(1) Assumes a total new water demand associated with residential, livestock, and irrigation for 87, 35-acre parcels. Only 65 of those parcels would require new irrigation water supply.

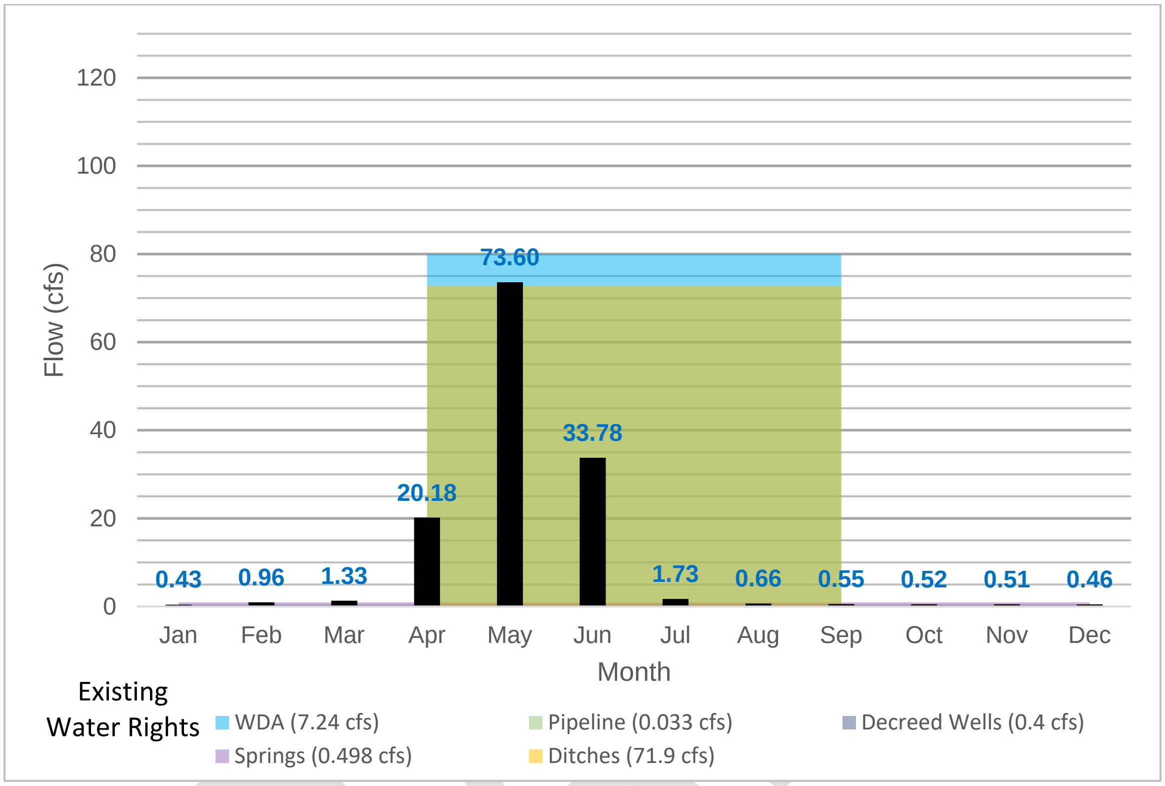
When the riparian based ISF is in effect, all senior uses and all future uses that occurred under the WDA would be allowed to continue. The remaining water within Cottonwood Creek would be protected as part of the riparian based ISF.

5.2 Monitor Creek Basin

5.2.1 Water Availability

Using the BLM modified USGS regional equation to calculate the basin yield of Monitor Creek Basin, SGM calculated an average basin yield of 8,167.0 AF/year. Using the monthly distribution factors, SGM calculated the monthly volume and flows for Monitor Creek Basin. See Figure 14. It is important to note that the BLM modified USGS regional equation estimates peak flows occurring in May, however, SGM notes that based on the historical and recent CWCB streamflow gage records, the peak runoff can occur in May, but oftentimes occurs in April. Additionally, Figure 14 is overlaid with existing decreed water rights in Monitor Creek Basin, as shown by the shaded areas. The aggregated decreed water rights often exceed the available streamflow calculated from the USGS regional equation. However, SGM notes that the values shown in Figure 14 represent an estimate of the average monthly streamflow and are not representative of the maximum daily streamflow rates. Further, the physical availability of water in some tributaries or stream segments may not allow for decreed water rights to achieve their absolute rates each year.

Figure 14 – Monitor Creek Basin Mean Monthly Flow Distribution



5.2.2 Existing Water Demands

SGM included absolute water rights, existing irrigated area, exempt wells, exempt livestock watering tanks, and grazing allotments in current water demand calculations. SGM did not consider changes of water rights nor possible restrictions for water uses outside of irrigation months, as the proposed Monitor Creek riparian based ISF would only be in effect from April through September.

- Using data gathered from the CDSS HydroBase, SGM calculated the existing absolute water rights diversions to be 452.5 AF for reservoirs and stock ponds, 71.9 cfs for ditches, 0.4 cfs for decreed wells, and 0.498 cfs for springs.
- A total of 184.0 acres of irrigated area lie within Monitor Creek Basin. Using an IWR of 2.3 for lands at approximately 7,000 FAMSL and an irrigation efficiency of 50% for flood irrigation, SGM calculates a demand of 846.4 AF required to irrigate. Including a 15-percent ditch loss, the diversion demand would be 995.8 AF.
- Seven constructed exempt wells exist within Monitor Creek Basin. Assuming a maximum of 3 AF per exempt well, 21 AF of water is allocated for exempt well demands.
- The grazing allotments are difficult to estimate demand per basin due to the extent of the grazing allotment boundaries extending outside the basin boundaries. It is estimated that existing grazing demands total 34.95 AF for all basins within the Study Area.

- 6 livestock water tanks exist within Monitor Creek Basin. In order to have an exempt livestock use, the volume of the storage vessel must be less than 10 AF each, and the actual demand would be commensurate with the amount of stock water and grazing demand (34.95 AF for the entire Study Area).

5.2.3 Future Water Development Allowance

SGM calculated the future Monitor Creek Basin water demands by using the future water demand scenario that would require the most diversions. For Monitor Creek Basin, the largest water development allowance would occur if new water rights were filed to irrigate approximately 328.5 acres of additional lands (see Scenario A in Section 3.2.1). In addition to future irrigation demand, SGM included demands for the management of USFS, BLM, and CPW lands.

- One permitted exempt well application has been filed within Monitor Creek Basin. Assuming a maximum of 3 AF per exempt well, SGM calculated a total demand of 3 AF for this one permitted exempt well.
- SGM delineated an estimated future irrigated area in Monitor Creek Basin to be 351.8 acres. Approximately 328.5 acres of this would require a new water right. 26.4 acres lies at an elevation of 8,400 FAMSL. Using an IWR of 2.0 AF/acre, flood irrigation efficiency of 50-percent, and ditch loss efficiency of 15-percent, SGM calculated additional demands of 1,019.4 AF of water. In addition, 112.1 acres of the future potential irrigated area lie at approximately 7,000 FAMSL. Using an IWR of 2.3 AF/acre, a flood irrigation efficiency of 50-percent, and a 15-percent ditch loss, SGM calculated future irrigation demands to be 603.8 AF. The sum of these demands totals 1,623.1 AF of new water demand. SGM analyzed physical supply for these areas and determined that there is an available supply during normal and wet years to irrigate additional lands.
- Based on the discussions with BLM and USFS staff, SGM understands that each agency estimated a total future potential demand of 2.0 AF per year. Additionally, the BLM and USFS have requested a maximum diversion rate of 0.22 cfs each.
- The Monitor Creek water development allowance will be allocated for future water right development under the following uses:
  - Irrigation
  - Storage
  - Recreation
  - Wildlife
  - Fire-protection
  - Domestic
  - Stock

Accordingly, the Monitor Creek WDA was developed as shown in Table 21. Please note, SGM did not include any exempt uses in the WDA calculations as the exempt uses would not require a future water rights application. Should the exempt well permit statute be revoked and the private parcels within Monitor Creek subdivided and developed, the overall demand of the subdivision under Scenarios B and C would be less than the identified potential irrigation water demand developed for Scenario A. Should the private parcels in Monitor Creek be subdivided, the need for large supplemental irrigation water rights would be diminished.

Table 21. Monitor Creek Water Development Allowance

WDA Uses	Annual Amount (AF)	Diversion Amount (cfs)	Uses
Future Irrigation	1,623.1	6.85	Irrigation, domestic, stock watering, recreation, wildlife, fire-protection, and storage
BLM	2.0	0.22	
USFS	2.0	0.22	
Total	**1,627.1**	**7.29**	

Notes:

(1) The total amount for irrigation includes a 15-percent ditch loss and overall irrigation efficiency of 50-percent. This total volume could also be stored in relatively small irrigation ponds throughout the runoff to help extend the water availability to meet the irrigation water requirement. No additional storage amount was allocated above the total diversion demand.

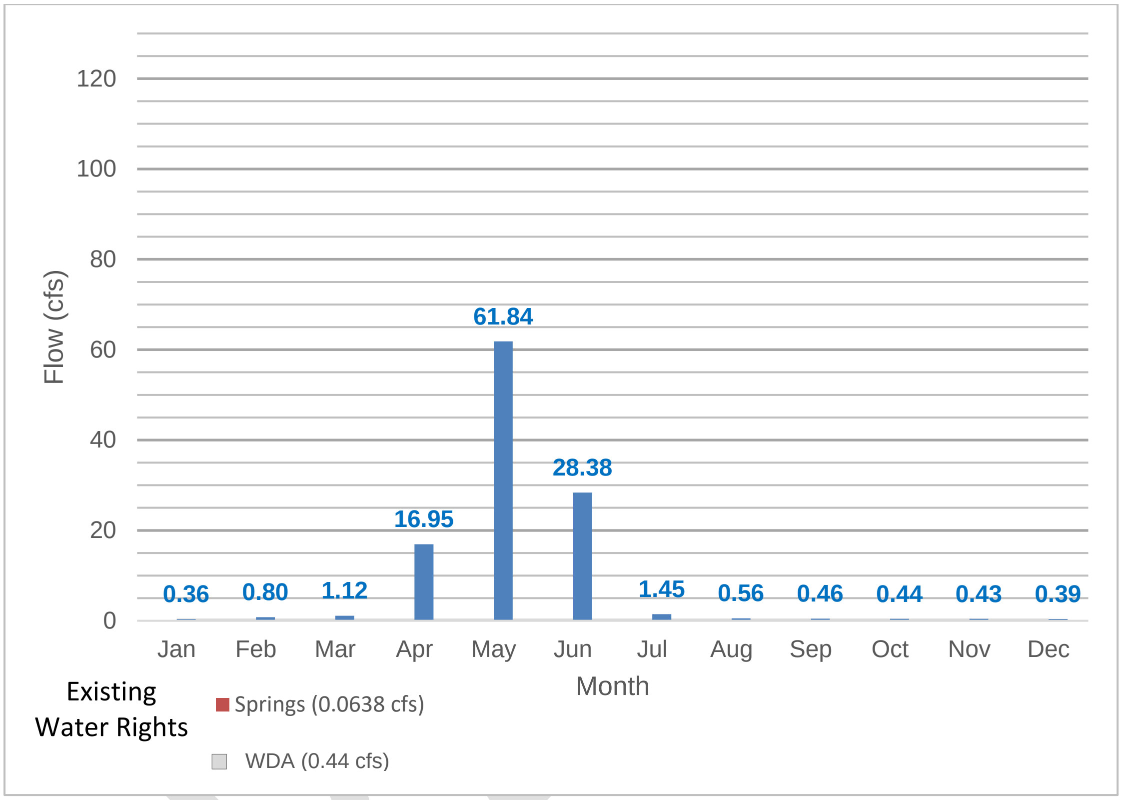
When the riparian based ISF is in effect, all senior uses and all future uses that occurred under the WDA would be allowed to continue. The remaining water within Monitor Creek would be protected as part of the riparian based ISF.

5.3 Upper Potter Creek Basin

5.3.1 Water Availability

Using the BLM modified USGS regional equation to calculate the basin yield of Upper Potter Creek Basin, SGM calculated an average basin yield of 6,862.4 AF/year. Using the monthly distribution factors, SGM calculated the monthly volume and flows for Upper Potter Creek Basin. See Figure 15. It is important to note that the BLM modified USGS regional equation estimates peak flows occurring in May, however, SGM notes that based on the historical and recent CWCB streamflow gage records, the peak runoff can occur in May, but oftentimes occurs in April. Similar to Figures 13 and 14, Figure 15 shows the existing decreed water rights in Upper Potter Creek Basin. However, the magnitude of the diversion rates is much smaller than the estimated monthly mean streamflows, so they are not readily visible in Figure 15.

Figure 15 – Upper Potter Creek Basin Mean Monthly Flow Distribution



5.3.2 Existing Water Demands

SGM included absolute water rights, exempt wells, exempt livestock watering tanks, and grazing allotments in current water demand calculations.

- Using data gathered from the CDSS HydroBase, SGM calculated the existing absolute water rights diversions to be 9.8 AF for reservoirs and stock ponds and 0.0638 cfs for springs.
- One exempt, non-consumptive geoexchange well exists within Upper Potter Creek Basin.
- The grazing allotments are difficult to estimate demand per basin due to the extent of the grazing allotment boundaries extending outside the basin boundaries. It is estimated that existing grazing demands total 34.95 AF for all basins within the Study Area.
- 3 livestock water tanks exist within Potter Creek Basin. In order to have an exempt livestock use, the volume of the storage vessel must be less than 10 AF each, and the actual demand would be commensurate with the amount of stock water and grazing demand (34.95 AF for the entire Study Area).

5.3.3 Future Potential Water Demands and Water Development Allowance

SGM calculated the future Upper Potter Creek Basin water demands by using the future water demand scenario that would require the most diversions. For Upper Potter Creek Basin, the largest water development allowance would occur if the one existing private parcel would have future domestic, stock water, and irrigation demands as described in Scenario C (see Section 3.2.3). In addition to the development of one 5.0-acre parcel, SGM included demands for the management of USFS, BLM, and CPW lands. SGM did not consider changes of water rights for this analysis.

- Based on the discussions with BLM and USFS staff, SGM understands that each agency estimated a total future potential demand of 2.0 AF per year. Additionally, the BLM and USFS have requested a maximum diversion rate of 0.22 cfs each.
- The Upper Potter Creek water development allowance will be allocated for future water right development under the following uses:
    - o Irrigation
    - o Storage
    - o Recreation
    - o Wildlife
    - o Fire-protection
    - o Domestic
    - o Stock watering

Accordingly, the upper Potter Creek WDA was developed as shown in Table 22.

Table 22. Upper Potter Creek Water Development Allowance

WDA Uses	Annual Amount (AF)	Diversion Amount (cfs)	Uses
Water Use on Private Parcels (1)	0.5	0.001	Irrigation, storage, recreation, wildlife, fire-protection, domestic, and stock
BLM	2.0	0.22	
USFS	2.0	0.22	
Total	**4.5**	**0.441**	

Notes:
(1) – Assumes a total new water demand associated with residential, livestock, and irrigation for one, 5-acre parcels.

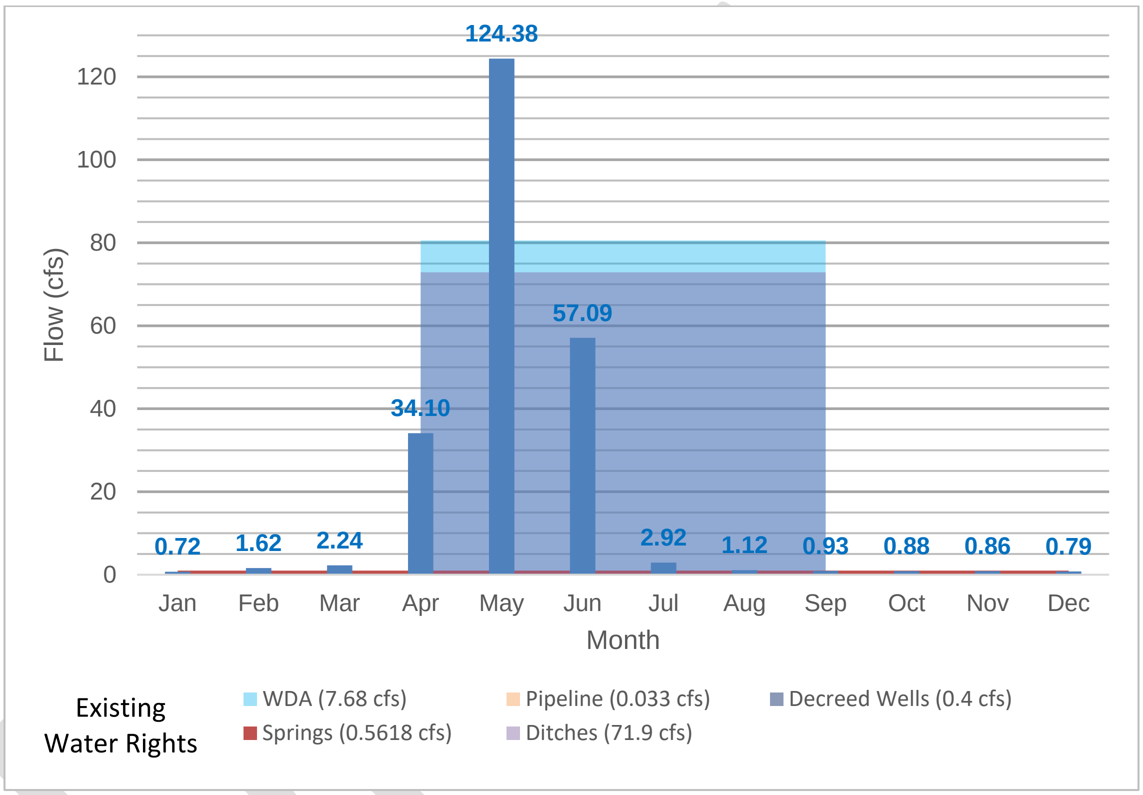
When the riparian based ISF is in effect, all senior uses and all future uses that occurred under the WDA would be allowed to continue. The remaining water within Upper Potter Creek would be protected as part of the riparian based ISF..

5.4 Potter Creek Basin

5.4.1 Water Availability

Using the BLM modified USGS regional equation to calculate the basin yield of Potter Creek Basin, SGM calculated an average basin yield of 6,862.4 AF/year. Using the monthly distribution factors, SGM calculated the monthly volume and flows for Potter Creek Basin. See Figure 16. The aggregated decreed water rights often exceed the available streamflow calculated from the USGS regional equation in some months. However, SGM notes that the values shown in Figure 16 represent an estimate of the average monthly streamflow and are not representative of the maximum daily streamflow rates. Further, the physical availability of water in some tributaries or stream segments may not allow for decreed water rights to achieve their absolute rates each year.

Figure 16 – Potter Creek Basin Mean Monthly Flow Distribution



5.4.2 Existing Water Demands

Refer to Sections 5.2.2 and 5.3.2 for existing water demands of Monitor Creek Basin and Upper Potter Creek Basin.

5.4.3 Future Potential Water Demands and Water Development Allowance

SGM calculated the future Potter Creek Basin water demands by using the future water demand scenario that would require the most diversions. For Potter Creek Basin, the largest water development allowance would occur if new water rights were filed to irrigate approximately 328.5 acres of additional lands in Monitor Creek Basin (see Scenario A in Section 3.2.1). Refer to Sections 5.2.3 and 5.3.3 for future potential water demands of Monitor Creek Basin and Upper Potter Creek Basin.

Accordingly, the Potter Creek WDA was developed as shown in Table 23. Please note, SGM did not include any exempt uses in the WDA calculations as the exempt uses would not require a future water rights application.

Table 23. Potter Creek Water Development Allowance			
WDA Uses	**Annual Amount**	**Diversion Amount**	**Uses**
	(AF)	**(cfs)**	
Irrigation [1]	1,623.1	6.85	Irrigation, domestic, stock watering, recreation, wildlife, fire-protection, and storage
BLM	4.0	0.44	
USFS	4.0	0.44	
Total	**1,631.1**	**7.73**	

Notes:

(1) The total amount for irrigation includes a 15-percent ditch loss and overall irrigation efficiency of 50-percent. This total volume could also be stored in relatively small irrigation ponds throughout the runoff to help extend the water availability to meet the irrigation water requirement. No additional storage amount was allocated above the total diversion demand.

Based upon the information reviewed, methodologies described, and work completed SGM believes the WDA values tabulated in Tables 20 through 23 are reasonable for the described uses. Further, based upon the remote location of the private properties, surrounding public lands, limited infrastructure, and availability of streamflow throughout the irrigation season for Cottonwood, Monitor, and Potter basins, we believe that water development in the future will be very limited. Finally, based on the available gage data and analyses completed, we believe there is water physically and legally available to support a future ISF water right appropriation as sought by the CWCB.

6.0 References

The following documents and information were relied upon and/or considered in the preparation of this water development allowance report.

DATA

Colorado Water Conservation Board. (2015 – 2020). Cottonwood Creek temporary stream gage measurements.

Colorado Water Conservation Board. (2017 – 2021). Monitor Creek temporary stream gage measurements

Colorado Water Conservation Board. (2015 – 2019). Potter Creek temporary stream gage measurements

DIVERSION RECORDS

Colorado Division of Water Resources, Colorado Decision Support Systems HydroBase. (Retrieved March 2022). *Daily Diversion Records.*

PERSONAL COMMUNICATIONS

Flinker, R., Colorado River District, personal communication, February, April, and May 2022.

Logan, B. and Viehl, R., Colorado Water Conservation Board, personal communication, February, April, and May 2022.

Reschke, L., Division 3, District 41 Water Commissioner, personal communication, April 2022.

Smith, R. E and Sondergard, J. B., Bureau of Land Management, personal communication. February, April, and May 2022.

REPORTS AND OTHER DOCUMENTS

Protest to Final Abandonment List (Case No. 22CW13) in Delta County, Colorado, Division 4, Water District 40. *Everlasting Ditch*. (June 2022).

Order to Dismiss and Cancellation of Water Right (Case No. 21CW3040) in Montrose County, Colorado, Division 4. *Long Park Ditch.* (September 2022).

United States Department of Agriculture Natural Resources Conservation Service. (March 2022). Custom Soil Resources Report for Paonia Area, Colorado, Parts of Delta, Gunnison, and Montrose Counties; Ridgway Area, Colorado, Parts of Delta, Gunnison, Montrose and Ouray Counties; and Uncompahgre National Forest Area, Colorado, Parts of Mesa, Montrose, Ouray, and San Miguel Counties.

United States Geological Survey (USGS). (March 2022). Cottonwood Creek StreamStats Report.

United States Geological Survey (USGS). (March, 2022). Monitor Creek StreamStats Report.

United States Geological Survey (USGS). (March 2022). Potter Creek Below Confluence StreamStats Report.

United States Geological Survey (USGS). (March, 2022). Potter Creek StreamStats Report.

SHAPEFILES

Bureau of Land Management (BLM) (May 2022) *Grazing Allotments* (shapefile) Retrieved from personal email communication with Sondergard, J. B.

Bureau of Land Management (BLM) Navigator Geospatial Data. (December 2021). *PLSS Township/Range and Sections* (shapefiles). Retrieved from https://data.doi.gov/dataset?organization=bureau-of-land-management

Colorado Division of Water Resources: Colorado Decision Support Systems. (March 2022). *Structures with water rights, climate stations, surface water gages, 2020 irrigated lands, instream flow reaches, permitted wells, and average precipitation contours* (shapefiles). Retrieved from https://cdss.colorado.gov/gis-data/gis-data-by-category

Delta County, Colorado GIS Department. (January 2022). *Delta County Parcels* (shapefile). Retrieved from https://www.deltacounty.com/DocumentCenter/Index/243

Environmental Systems Research Institute (ESRI). (March 2022). *County Boundaries, Towns, and North American Detailed Streets* (shapefiles). Retrieved from https://hub.arcgis.com/search

Mesa County, Colorado GIS Department. (July 2021). *Tax Parcels* (shapefile). Retrieved from https://opendata.mesacounty.us/pages/property

Montrose County, Colorado GIS Department (February 2022). *Parcels* (shapefile). Retrieved from https://www.montrosecounty.net/406/Downloadable-Data

United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) Web Soil Survey (WSS). (March 2022). *Soils* (shapefile). Retrieved from https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

United States Forest Service (USFS) (May 2022) *Range: Allotment* (ESRI geodatabase). Retrieved from https://data-usfs.hub.arcgis.com/

United Stated Geological Survey (USGS) StreamStats web application. (March 2022). *Drainage Basins* (shapefile). Retrieved from https://streamstats.usgs.gov/ss/

United Stated Geological Survey (USGS) StreamStats web application. (April 2021). *National Hydrology Dataset* (shapefile). Retrieved from https://apps.nationalmap.gov/downloader/

United Stated Geological Survey (USGS). (1980). *100K Topographic Basemap* (.tif file) Retrieved from: https://ngmdb.usgs.gov/topoview/viewer/#4/40.01/-100.06

United Stated Geological Survey (USGS) *10-meter Digital Elevation Model (DEM).* Retrieved from https://apps.nationalmap.gov/downloader/

AERIAL IMAGERY

Maxar Imagery (August 5, 2021) Imagery

SOFTWARE/TOOLS

Colorado Division of Water Resources: Colorado Decision Support Systems. (April 2022). Map Viewer web application. Retrieved from https://maps.dnrgis.state.co.us/dwr/Index.html?viewer=mapviewer

Colorado Division of Water Resources. StateCU (software). GUI Version 7.1.2. Model Version 13.10

United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) Web Soil Survey (WSS) application. (March 2022).

United States Geological Survey (USGS) StreamStats web application. (March and May 2022).

DECREES

Cottonwood Creek

- W2524
- W2523
- CA5873
- CA4808
- CA3503
- CA2563
- CA2030

Monitor Creek

- CA5873
- CA3503
- CA2563
- 96CW0150

Attachment I

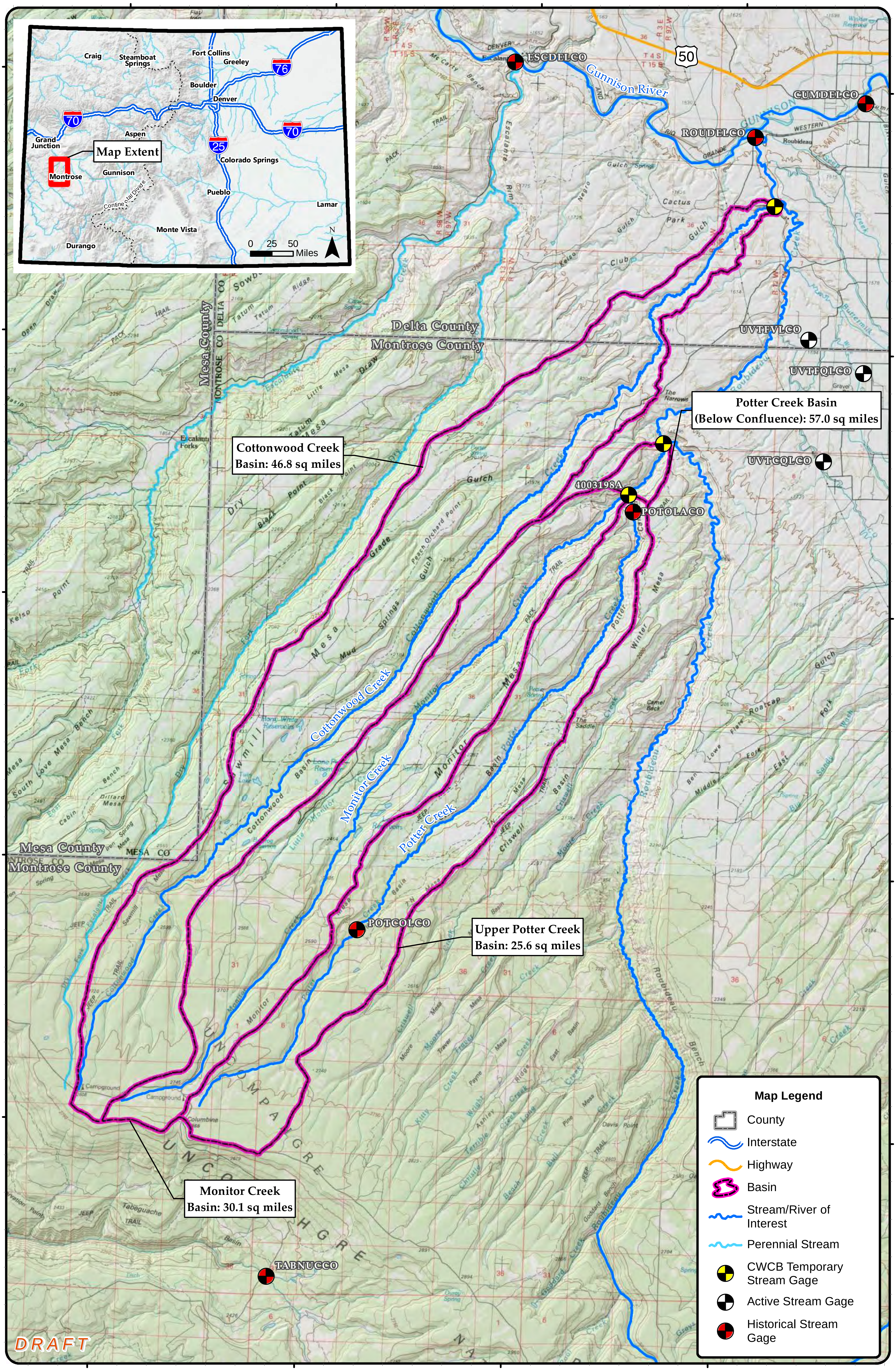


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Figure 1
Vicinity Map
CWCB

Date:6/23/2022 | Job No. 2022-160 | Map by: ANW | Checked by: NJD | Scale: 1:120,000

Data Sources: USGS StreamStats (Watersheds), USGS (Topo Basemap, NHD Streams, Stream Gages), ESRI (Counties & Roads)

File: P:\Project Files\2022-160-CWCB Delta Area Water Dev Allowance\01 Delta\H-Dwgs\GIS\MXDs\Fig1.VicinityMap.mxd

The information displayed above is intended for general planning purposes. Refer to legal documentation/data sources for descriptions/locations.

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1 inch = 10,000 feet

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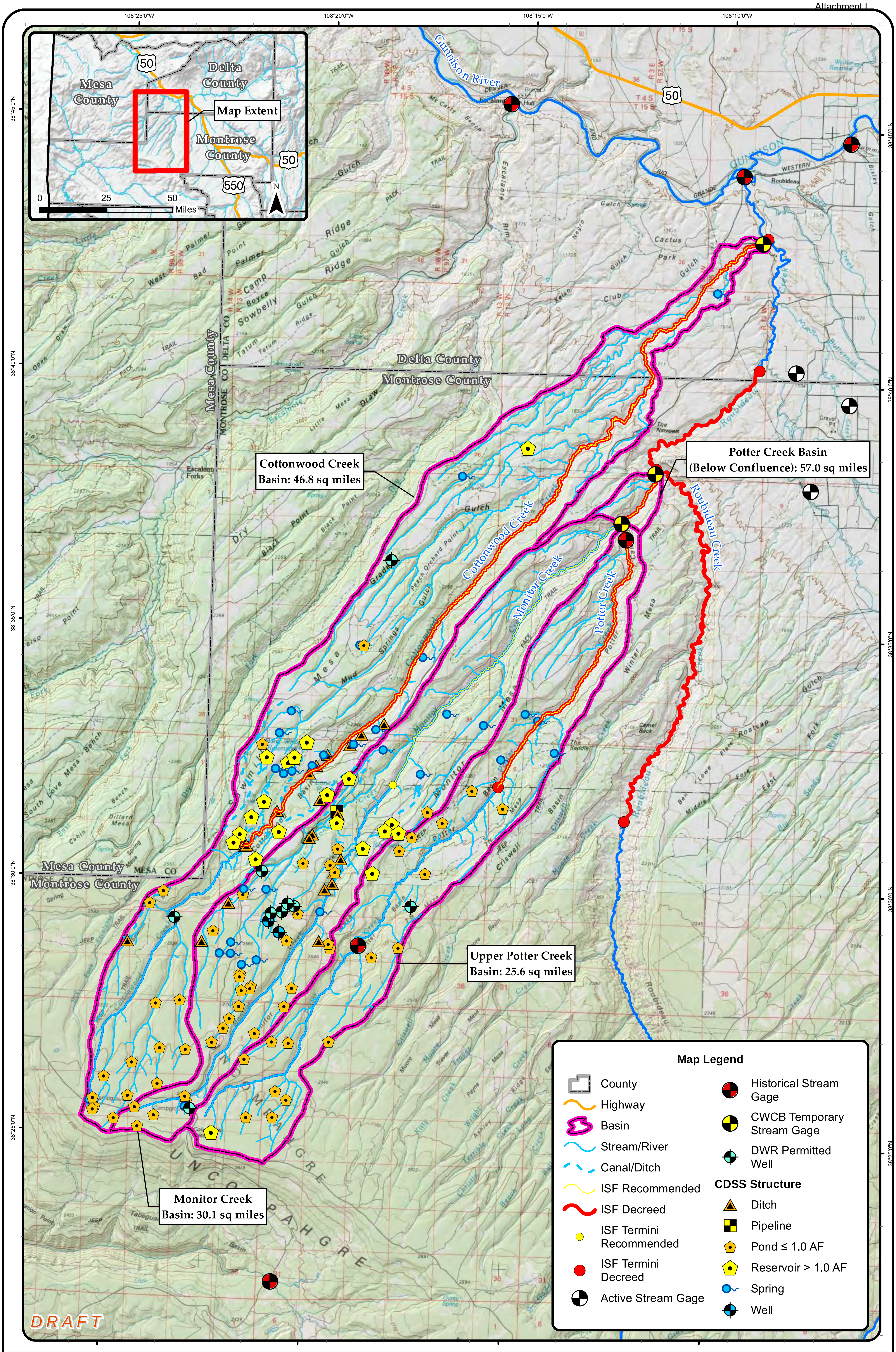

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Figure 2
Basins Overview
CWCB

Date:6/23/2022 | Job No. 2022-160 | Map by: SJB | Checked by: NJD | Scale: 1:120,000

Data Sources: DWR CDSS (Structures & ISF), USGS StreamStats (Watersheds), DWR (Permitted Wells), USGS (NHD Streams/Rivers & Canals/Ditches, Stream Gages, Topo Basemap), ESRI (Counties & Highways)

File: P:\Project Files\2022-160-CWCB Delta Area Water Dev Allowance\01 Delta\H-Dwgs\GIS\MXDs\Fig2.WatershedsOverview.mxd

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1 inch = 10,000 feet

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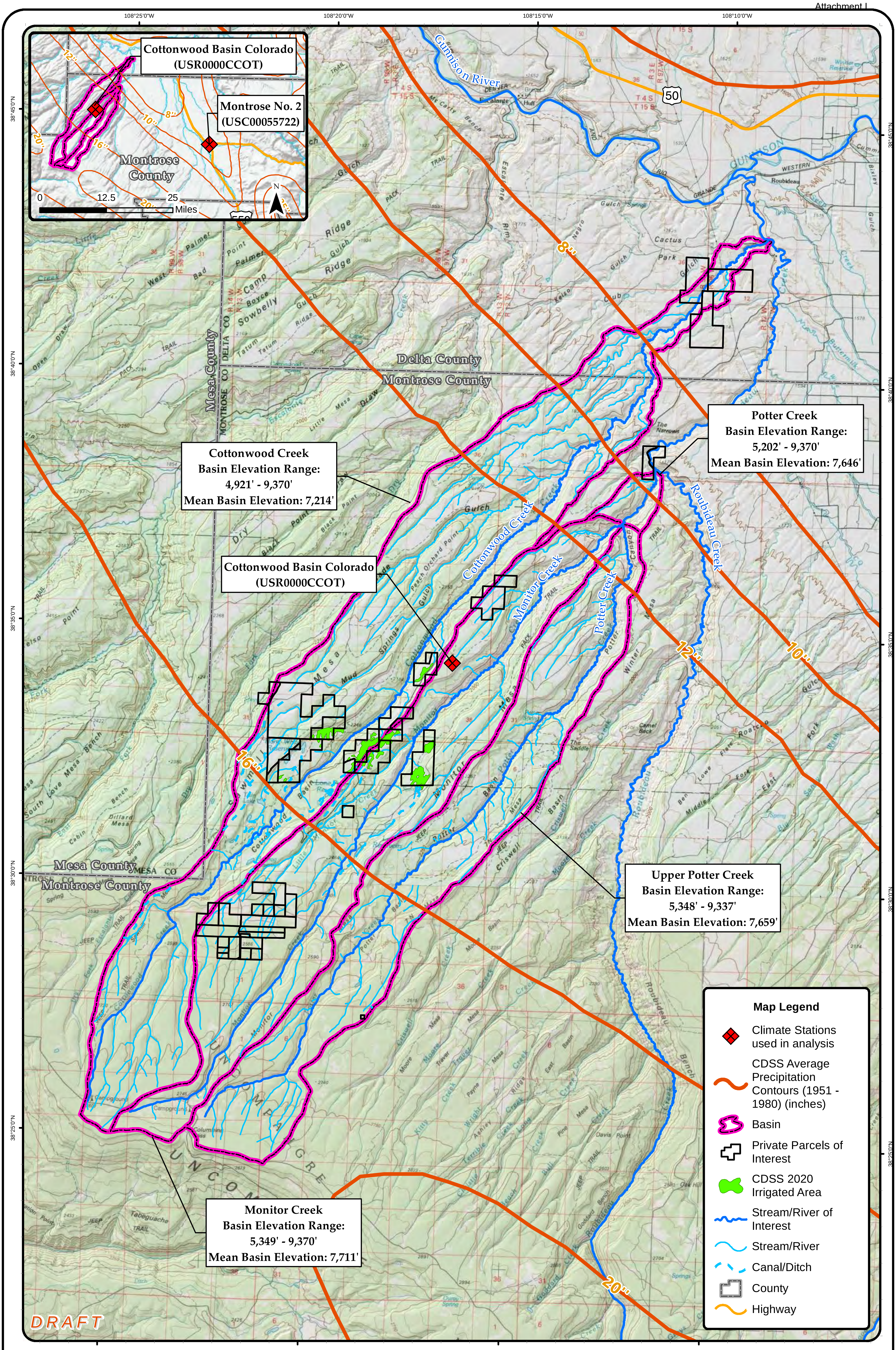

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Figure 3
Average Precipitation
CWCB

Date:6/23/2022 | Job No. 2022-160 | Map by: ANW | Checked by: NJD | Scale: 1:120,000

Data Sources: DWR CDSS (Structures & ISF), USGS StreamStats (Watersheds), DWR (Permitted Wells), USGS (NHD Streams/Rivers & Canals/Ditches, Stream Gages, Topo Basemap), ESRI (Counties & Highways)

File: P:\Project Files\2022-160-CWCB Delta Area Water Dev Allowance\01 Delta\H-Dwgs\GIS\MXDs\Fig3.AveragePrecipitation.mxd

The information displayed above is intended for general planning purposes. Refer to legal documentation/data sources for descriptions/locations.

0 10,000 20,000 Feet
1 inch = 10,000 feet
N

Attachment I

Cottonwood Creek Ponds and Reservoirs

Label	Name	Absolute (AF)	Conditional (AF)
CR-1	ERN TRAIL R	0.5	-
CR-2	NO 3 ON TOP	0.5	-
CR-3	U CWOOD 1	0.1	-
CR-4	SMOKEHOUSE	0.1	-
CR-5	U CWOOD 2	0.1	-
CR-6	SMOKEHOUSE 2	0.1	-
CR-7	25 MESA 6	0.1	-
CR-8	SMOKEHOUSE 1	0.1	-
CR-9	25 MESA 18	0.1	-
CR-10	WH SAWMILL	0.1	-
CR-11	25 MESA 19	0.1	-
CR-12	25 MESA 20	0.1	-
CR-13	BEAR PEN 2	0.1	-
CR-14	BEAR PEN 1	0.1	-
CR-15	BULL FROG RESERVOIR	140	-
CR-16	PINE TRAIL RESERVOIR	65	-
CR-17	CASTLE ROCK RESERVOIR	33	-
CR-18	BEAVER RESERVOIR	20	-
CR-19	ROUND PARK RESERVOIR	85	-
CR-20	TWIN LAKE RESERVOIR	156	-
CR-21	LONE PINE RESERVOIR	10	-
CR-22	FENCELINE R	1.3	-
CR-23	BOUNDARY RES	0.2	-
CR-24	HARRY WHITE RESERVOIR NO. 1	86	-
CR-25	TABLE ROCK RESERVOIR	20	62
CR-26	HARRY WHITE RESERVOIR NO. 2	171	-
CR-27	CLAY POND	0.1	-
CR-28	STONE BASIN RESERVOIR	1.8	-
	Total	791.6	62

Cottonwood Creek Springs

Label	Name	Absolute (cfs)
CS-1	SMOKEHOUS CG	0.001
CS-2	JONES SPRING NO. 2	0.0044
CS-3	HAWKINS SPRING NO. 1	0.0044
CS-4	HAWKINS SPRING NO. 3	0.0044
CS-5	COTTON SPRING NO. 2	0.05
CS-6	COTTON SPRING NO. 1	0.05
CS-7	EARL D WHITE SPRING NO. 1	0.033
CS-8	DOZER SPRING	0.02
CS-9	BEAR SPRING	0.02
CS-10	EARL D WHITE SPRING NO. 2	0.033
CS-11	CLAY SPRING	0.033
CS-12	CANTY SPRINGS	0.05
CS-13	PORTER SPRING	0.0223
CS-14	WYATT SPRING NO. 1	0.03
	Total	0.3555

Cottonwood Creek DWR Wells

Label	Permit No.	Status
DWR-C1	19-GX	NA

Cottonwood Creek Ditches

Label	Name	Absolute (cfs)	Decreed Acreage (acres)
CD-1	NORTH FORK DITCH	13	120 acres (CA2563) & 1,200 acres (CA4808)
CD-2	EVERLASTING DITCH	27	190 acres (CA2030) & 840 acres (CA5873)
CD-3	HAWKINS DITCH	31	300 acres (CA3503)
CD-4	PUG WHITE DITCH	10	135 (CA5873)
CD-5	HORTON DAVIS SEP D ENLT	6	NA
	Total	87	2,785

Notes:

67 cfs of the total 87 cfs may be used for irrigation uses

Partial water rights on 2020 Abandonment List; however abandonment is currently being protested. Total water right shown in Table. Total of 9 cfs may potentially be abandoned from Everlasting Ditch and 10 cfs may potentially be abandoned from Hawkins Ditch.

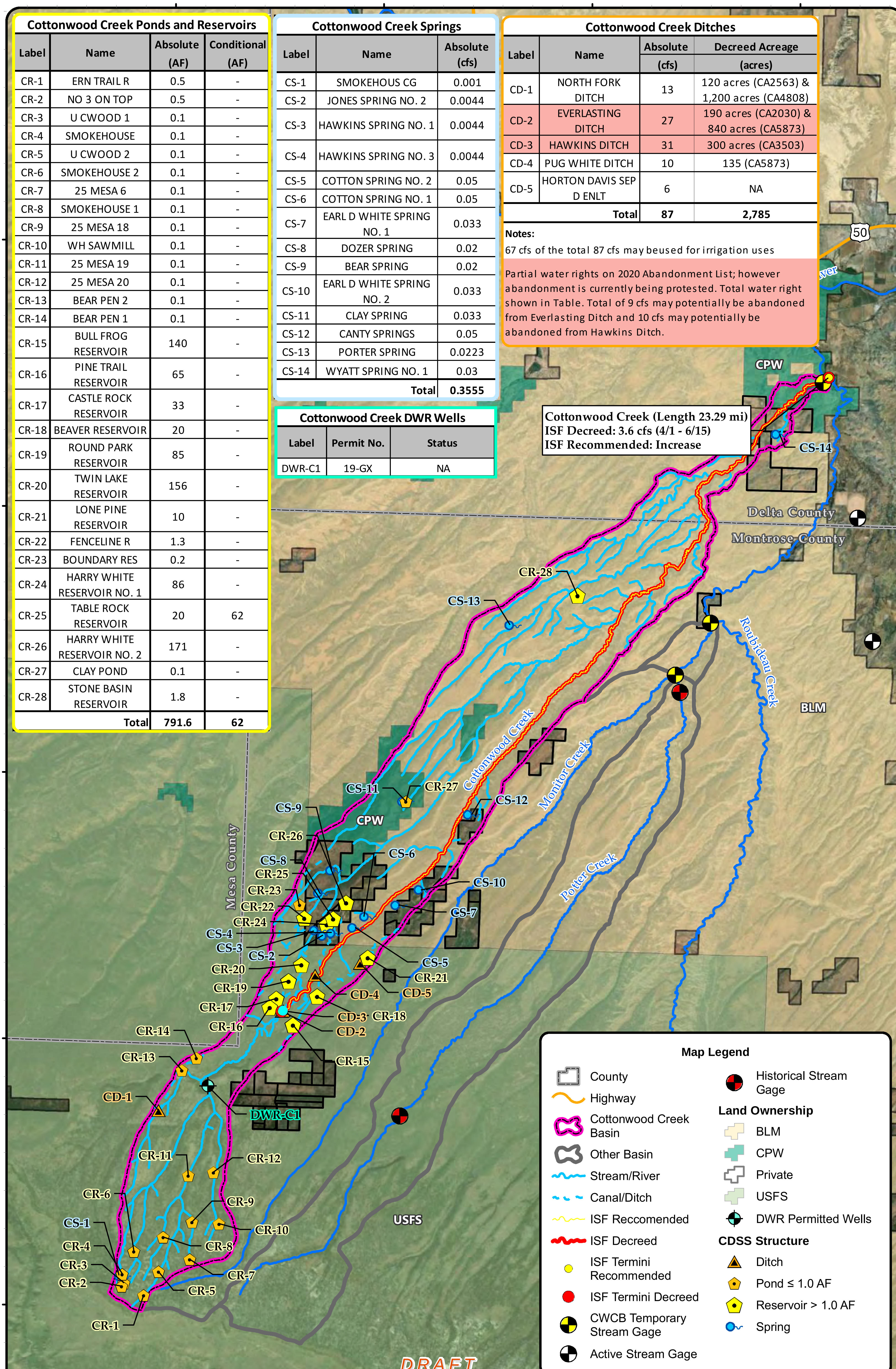

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Figure 4
Cottonwood Creek Water Rights
CWCB

Date: 1/6/2023 | Job No. 2022-160 | Map by: SJB | Checked by: NJD | Scale: 1:120,000

Data Sources: CDSS (Structures, ISF) USGS StreamStats (Watersheds), DWR (Permitted Wells), USGS (NHD Streams/Rivers, Stream Gages), ESRI (Counties & Roads), Maxar 2018 & 2021 Imagery

File: P:\Project Files\2022-160-CWCB Delta Area Water Dev Allowance\01 Delta\H-Dwgs\GIS\MXDs\2022-12-

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0 10,000 20,000 Feet
1 inch = 10,000 feet
N

Attachment I

Monitor Creek Ponds and Reservoirs

Label	Name	Absolute (AF)
MR-1	JUG RES	0.1
MR-2	U CWOOD 3	0.1
MR-3	U CWOOD 4	0.1
MR-4	ROAD 2	0.1
MR-5	COLUMBINE R	0.1
MR-6	FLAT ROCK R	0.1
MR-7	25 MESA 9	0.8
MR-8	KNOLL LOCK R	1
MR-9	25 MESA 10	0.4
MR-10	25 MESA 11	0.3
MR-11	PARK LICK RS	0.9
MR-12	HARRINGTON	0.2
MR-13	41 2 RES	0.1
MR-14	MCKEE RES	0.1
MR-15	MILTS RES	0.1
MR-16	ANGEL RES	0.1
MR-17	SPRUCE SPR	0.2
MR-18	25 MESA RES NO 1 *	0.5
MR-19	25 MESA 14	0.5
MR-20	WILLOW BU 2	0.1
MR-21	WILLOW BU 1	0.7
MR-22	BUFFS RES	0.2
MR-23	CCC SPR	0.1
MR-24	W BILLIE JO	0.1
MR-25	HORSESHOE	0.1
MR-26	E BILLIE JO	0.1
MR-27	25 MESA R	0.1
MR-28	BIG MONITOR RESERVOIR NO. 1	93
MR-29	LITTLE MONITOR RES NO 1	130
MR-30	MIDDLE RESERVOIR	52
MR-31	BIG GULCH 1	1.9
MR-32	BIG MONITOR RESERVOIR NO. 2	127.5
MR-33	BIG GULCH 2	0.8
MR-34	LITTLE MONITOR RES NO 2 **	40
	Total	452.5

Notes:
* - Inactive structure which phycially exists
** - Historical structure which no longer exis

Monitor Creek Ditches

Label	Name	Absolute (cfs)
MD-1	MONITOR DITCH	1
MD-2	25 MESA UP LIT MONITOR D	7
MD-3	DORR SPRING NO 12	0.25
MD-4	BIG MONITOR DITCH NO. 1	51.85
MD-5	DAD S DESIRE DITCH **	3.3
MD-6	LITTLE MONITOR DITCH	4
MD-7	JOKER RESERVOIR DITCH **	1.5
MD-8	NOAH R WHITE DITCH	3
	Total	71.9

Notes:
** - Historical structure which no longer exis

Monitor Creek Pipelines

Label	Name	Absolute (cfs)
MP-1	HI RANCH SPRING PIPELINE	0.033

Monitor Creek Stream Gage

Label	Name
MG-1	Monitor Creek Above Potter Creek Confluence

Monitor Creek Springs

Label	Name	Absolute (cfs)
MS-1	COLUMBINE CG	0.001
MS-2	MURRAY SPRING PIPELINE	0.033
MS-3	DORR SPRING NO 8	0.02
MS-4	DORR SPRING NO 9	0.01
MS-5	HELGELAND SPRING AND PIPELINE	0.002
MS-6	DORR SPRING NO 10	0.01
MS-7	25 MESA SWPL	0.05
MS-8	DICKERSON SPRINGS	0.033
MS-9	DORR SPRING NO 11	0.25
MS-10	PATHFINDER SPRING	0.033
MS-11	N R WHITE SPRING	0.033
MS-12	LEE BENCH SPRING	0.001
MS-13	LONG GULCH SPRING NO 1	0.022
	Total	0.498

Monitor Creek Decreed Wells

Label	Name	Absolute (cfs)
M1	ANGEL SPRING WELL NO 1	0.1
M2	ANGEL SPRING WELL NO 2	0.1
M3	ANGEL SPRING WELL NO 3	0.1
M4	ANGEL SPRING WELL NO 4	0.1
	Total	0.4

Monitor Creek DWR Wells

Label	Permit No.	Status
DWR-M1	188705	Well Constructed
DWR-M2	126329	Permit Issued
DWR-M3	129528	Well Constructed
DWR-M4	129528	Well Constructed
DWR-M5	244517	Well Constructed
DWR-M6	130765	Well Constructed
DWR-M7	130765	Well Constructed
DWR-M8	246580	Well Constructed

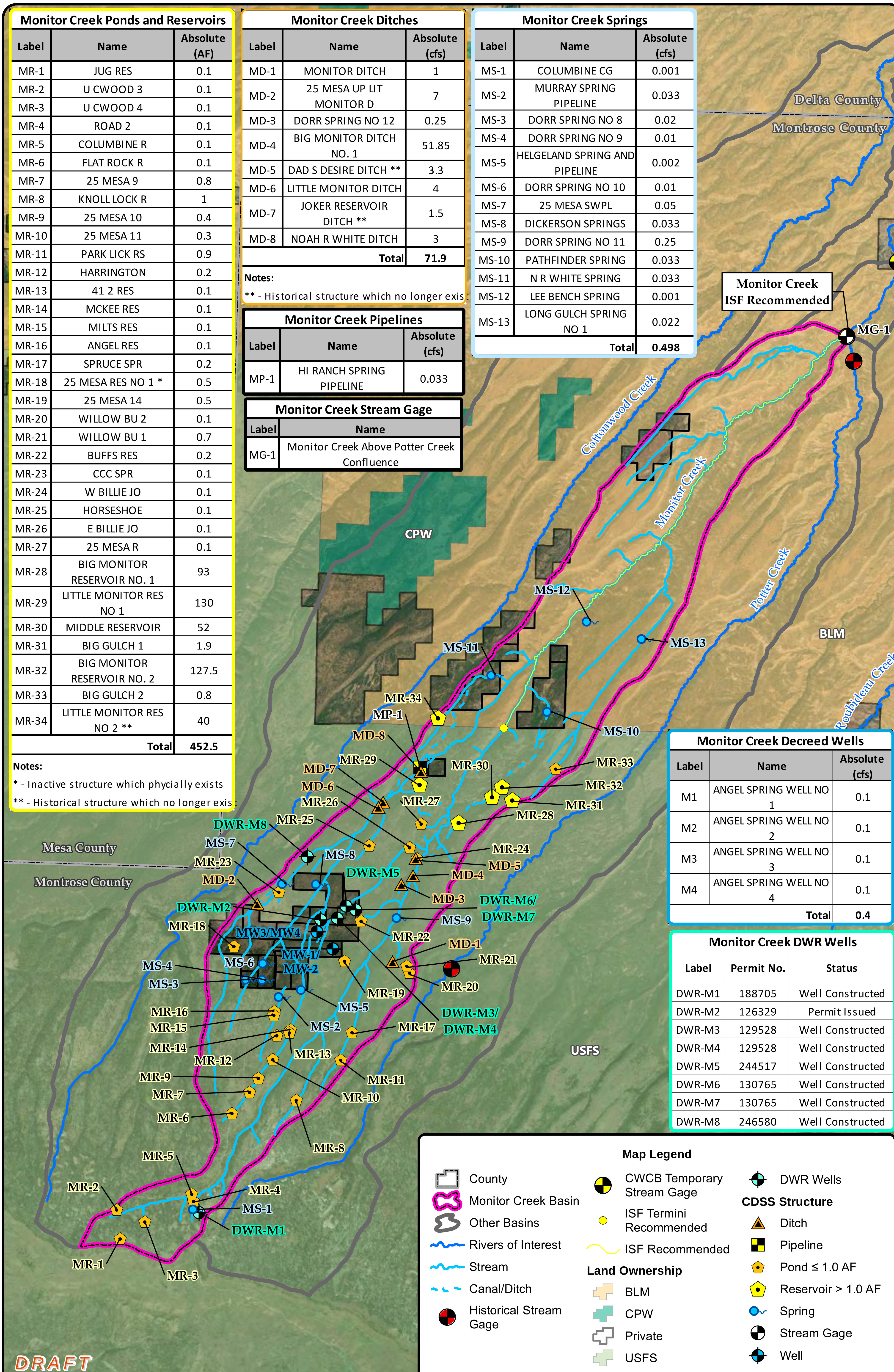

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Figure 5
Monitor Creek Water Rights
CWCB

Date:5/27/2022 | Job No. 2022-160 | Map by: ANW | Checked by: NJD | Scale: 1:84,000

Data Sources: CDSS (Structures & ISF), USGS StreamStats (Watersheds), DWR (Permitted Wells), USGS (NHD Streams/Rivers & Canal/Ditch, Stream Gage), ESRI (Counties), 2018 & 2021 Maxar Imagery

File: P:\Project Files\2022-160-CWCB Delta Area Water Dev Allowance\01 Delta\H-Dwgs\GIS\MXDs\Fig5.MonitorCreekWaterRights.mxd

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0 7,000 14,000 Feet
1 inch = 7,000 feet
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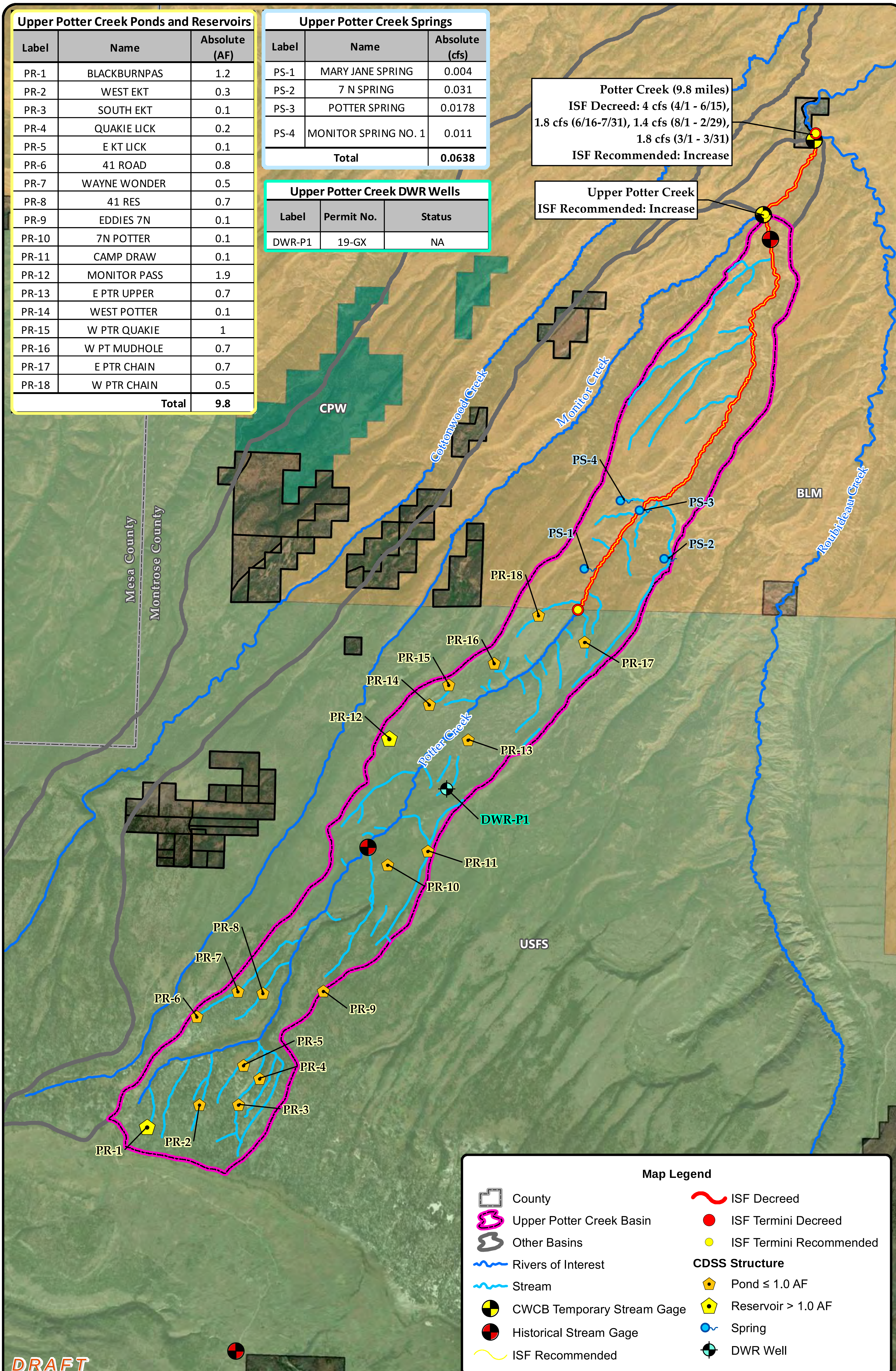

Upper Potter Creek Ponds and Reservoirs

Label	Name	Absolute (AF)
PR-1	BLACKBURNPAS	1.2
PR-2	WEST EKT	0.3
PR-3	SOUTH EKT	0.1
PR-4	QUAKIE LICK	0.2
PR-5	E KT LICK	0.1
PR-6	41 ROAD	0.8
PR-7	WAYNE WONDER	0.5
PR-8	41 RES	0.7
PR-9	EDDIES 7N	0.1
PR-10	7N POTTER	0.1
PR-11	CAMP DRAW	0.1
PR-12	MONITOR PASS	1.9
PR-13	E PTR UPPER	0.7
PR-14	WEST POTTER	0.1
PR-15	W PTR QUAKIE	1
PR-16	W PT MUDHOLE	0.7
PR-17	E PTR CHAIN	0.7
PR-18	W PTR CHAIN	0.5
	Total	9.8

Upper Potter Creek Springs

Label	Name	Absolute (cfs)
PS-1	MARY JANE SPRING	0.004
PS-2	7 N SPRING	0.031
PS-3	POTTER SPRING	0.0178
PS-4	MONITOR SPRING NO. 1	0.011
	Total	0.0638

Upper Potter Creek DWR Wells

Label	Permit No.	Status
DWR-P1	19-GX	NA

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Figure 6
Upper Potter Creek Water Rights
CWCB

Date:6/23/2022 | Job No. 2022-160 | Map by: ANW | Checked by: NJD | Scale: 1:84,000

Data Sources: DWR CDSS (Structures & ISF), USGS StreamStats (Watersheds), DWR (Permitted Wells), USGS (NHD Streams/Rivers, Stream Gage), ESRI (Counties), Maxar 2018 & 2021 Imagery

File: P:\Project Files\2022-160-CWCB Delta Area Water Dev Allowance\01 Delta\H-Dwgs\GIS\MXDs\Fig6.PotterCreekAbvWaterRights.mxd

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1 inch = 7,000 feet
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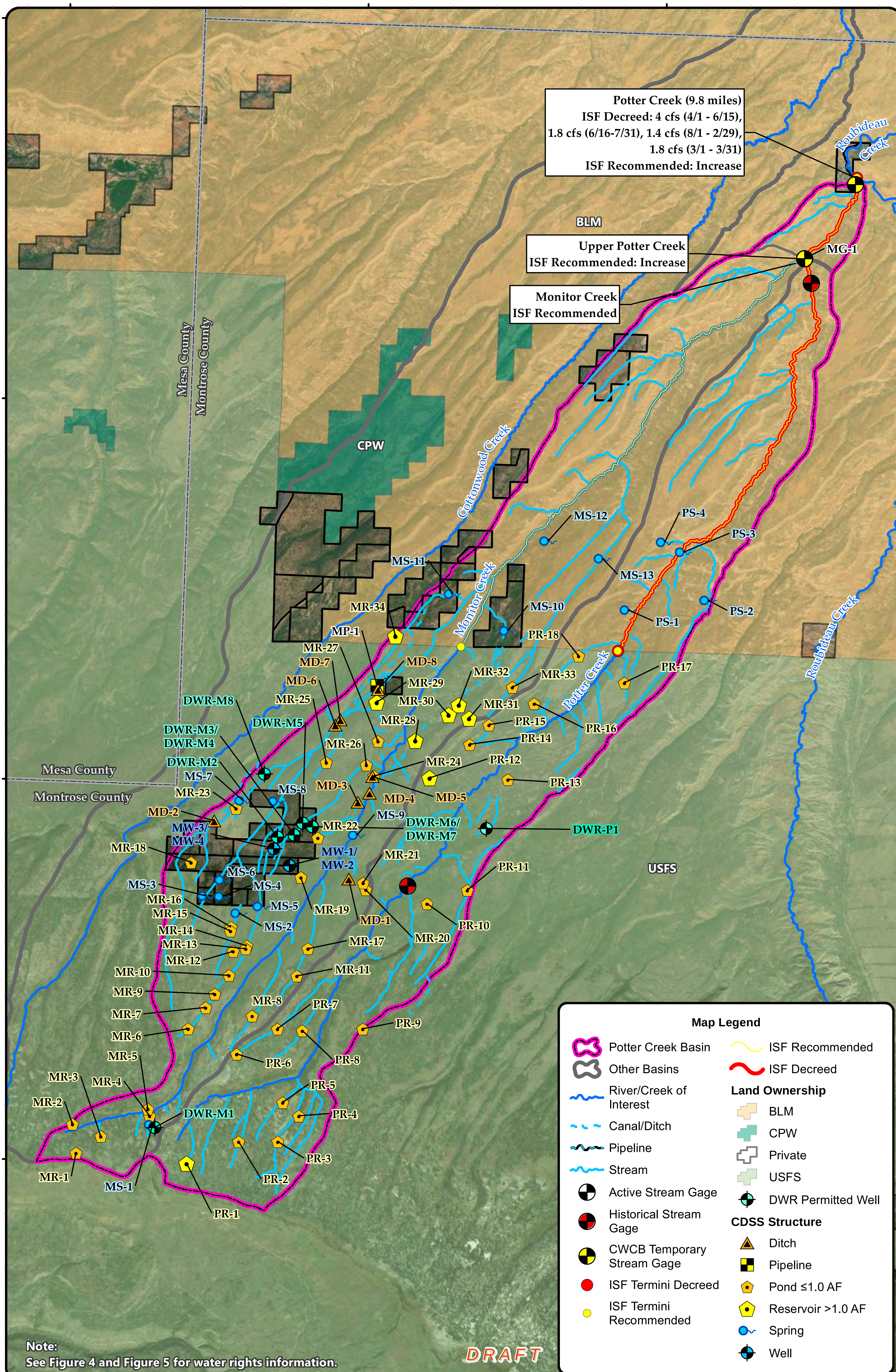

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Figure 7
Potter Creek (Below Monitor Confluence) Water Rights
CWCB

Date:6/23/2022	Job No. 2022-160	Map by: SJB	Checked by: NJD	Scale: 1:84,000

Data Sources: CDSS (Structures & ISF), USGS StreamStats (Watersheds), DWR (Permitted Wells), USGS (NHD Streams/Rivers & Canals/Ditches, Stream Gages), ESRI (Counties), Maxar 2021 & 2018 Imagery

File: P:\Project Files\2022-160-CWCB Delta Area Water Dev Allowance\01 Delta\H-Dwgs\GIS\MXDs\Fig7.PotterBlwWaterRights.mxd

The information displayed above is intended for general planning purposes. Refer to legal documentation/data sources for descriptions/locations.

0 7,000 14,000 Feet

1 inch = 7,000 feet

N

Attachment I

Private Parcels of Interest

Label	Owner	Area (Ac)[1]
	Montrose County	
MCP-1	CAMP LLC	120.01
MCP-2	CAMP LLC	155.15
MCP-3	CAMP LLC	121.51
MCP-4	BOYD JIMMIE D et al.*	40.17
MCP-5	MARKLEY BARBARA S	19.98
MCP-6	DAVIS JILL RENEE	19.92
MCP-7	BOYD JIMMIE D et al.*	78.07
MCP-8	FLETCHER MATTHEW D JR & ROGERS TYLER R	0.55
MCP-9	BARRIENTOS LETA LYNN	37.57
MCP-10	BARRIENTOS LETA LYNN	77.79
MCP-11	BARRIENTOS LETA LYNN	39.62
MCP-12	CAMPBELL JEROME K	9.8
MCP-13	ANGEL CAROL D	71.21
MCP-14	ANGEL CAROL D	79.37
MCP-15	ANGEL CAROL D	196.65
MCP-16	HELGELAND FAMILY IRREVOCABLE TRUST	41.15
MCP-17	ADAM MARVIN E & ADAM MARGARET E	39.83
MCP-18	POWER ELI AND POWER ABIGAIL	40.94
MCP-19	POWER ELI AND POWER ABIGAIL	81.27
MCP-20	DICKERSON RICHARD G	159.37
MCP-21	UNGERER MAX H & ABBOTT GINA L	40.72
MCP-22	KNK LAND & CATTLE LLC	71.69
MCP-23	KNK LAND & CATTLE LLC	309.7
MCP-24	KNK LAND & CATTLE LLC	202.87
MCP-25	KNK LAND & CATTLE LLC	161.38
MCP-26	KNK LAND & CATTLE LLC	864.46
MCP-27	DILLON DOUGLAS	80.24
MCP-28	KNK LAND & CATTLE LLC	44.78
MCP-29	LAZY HX LLC	211.13
MCP-30	LAZY HX LLC	203.57
MCP-31	LAZY HX LLC	84.14
MCP-32	LAZY HX LLC	33.03
MCP-33	FINNEGAN KENNETH & FINNEGAN KATHLEEN A	132.63
MCP-34	GRAZIANO JAMES MICHAEL & GRAZIANO LYNN CAROL REV TRUST	311.07
MCP-35	GRAZIANO JAMES MICHAEL & GRAZIANO LYNN CAROL REV TRUST	39.54
MCP-36	FINNEGAN KENNETH & FINNEGAN KATHLEEN A	146.35
MCP-37	BYERS JEANELLE E	17.712
MCP-38	MANCUSO MARK	239.35
MCP-39	MANCUSO MARK D	80.63
MCP-40	VANDERPLAATS GREGORY M, et al.	156.95
MCP-41	BOYD LARRY R & WANDA K	4.41
	Delta County	
DCP-1	BUTTERMILK LAND COMPANY LLC	403.74
DCP-2	GORE RANCHES LLC	327.23
DCP-3	GORE RANCHES LLC	319.32
	Total	5,916.58

Notes: *1) Represents total parcel acres including area outside of watershed boundary.*

Public Lands by Watershed

Watershed	Owner	Area (Ac)[1]
Cottonwood Creek	Bureau of Land Management	15,505
	Colorado Parks and Wildlife	2,175
	U.S Forest Service	9,583
	Total	**27,263**
Monitor Creek	Bureau of Land Management	6,920
	U.S Forest Service	10,008
	Total	**16,928**
Upper Potter Creek	Bureau of Land Management	6,013
	U.S Forest Service	10,415
	Total	**16,428**
Potter Creek[2]	Bureau of Land Management	751
	Total	**751**

Notes: *1) Area of public lands within watershed boundary, 2) Area not included in Monitor or Upper Potter Creek watersheds.*

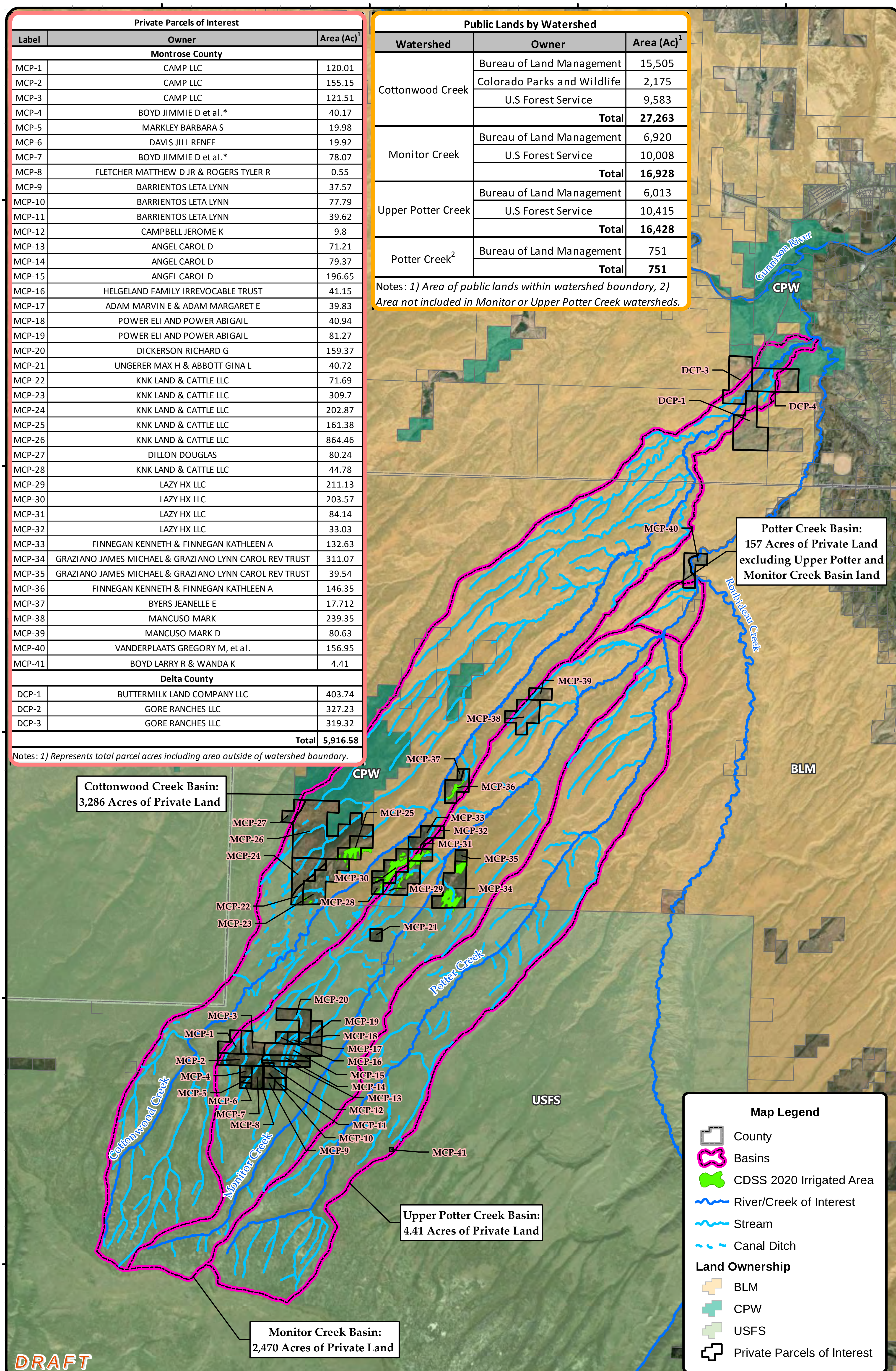

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Figure 8
Land Ownership
CWCB

Date:6/23/2022 | Job No. 2022-160 | Map by: SJB | Checked by: NJD | Scale: 1:120,000

Data Sources: USGS StreamStats (Watersheds), USGS (NHD Streams/Rivers & Canals/Ditches), ESRI (Counties), Maxar 2021 & 2018 Imagery, Montrose County GIS, Delta County GIS

File: P:\Project Files\2022-160-CWCB Delta Area Water Dev Allowance\01 Delta\H-Dwgs\GIS\MXDs\Fig8.LandOwnership.mxd

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1 inch = 10,000 feet

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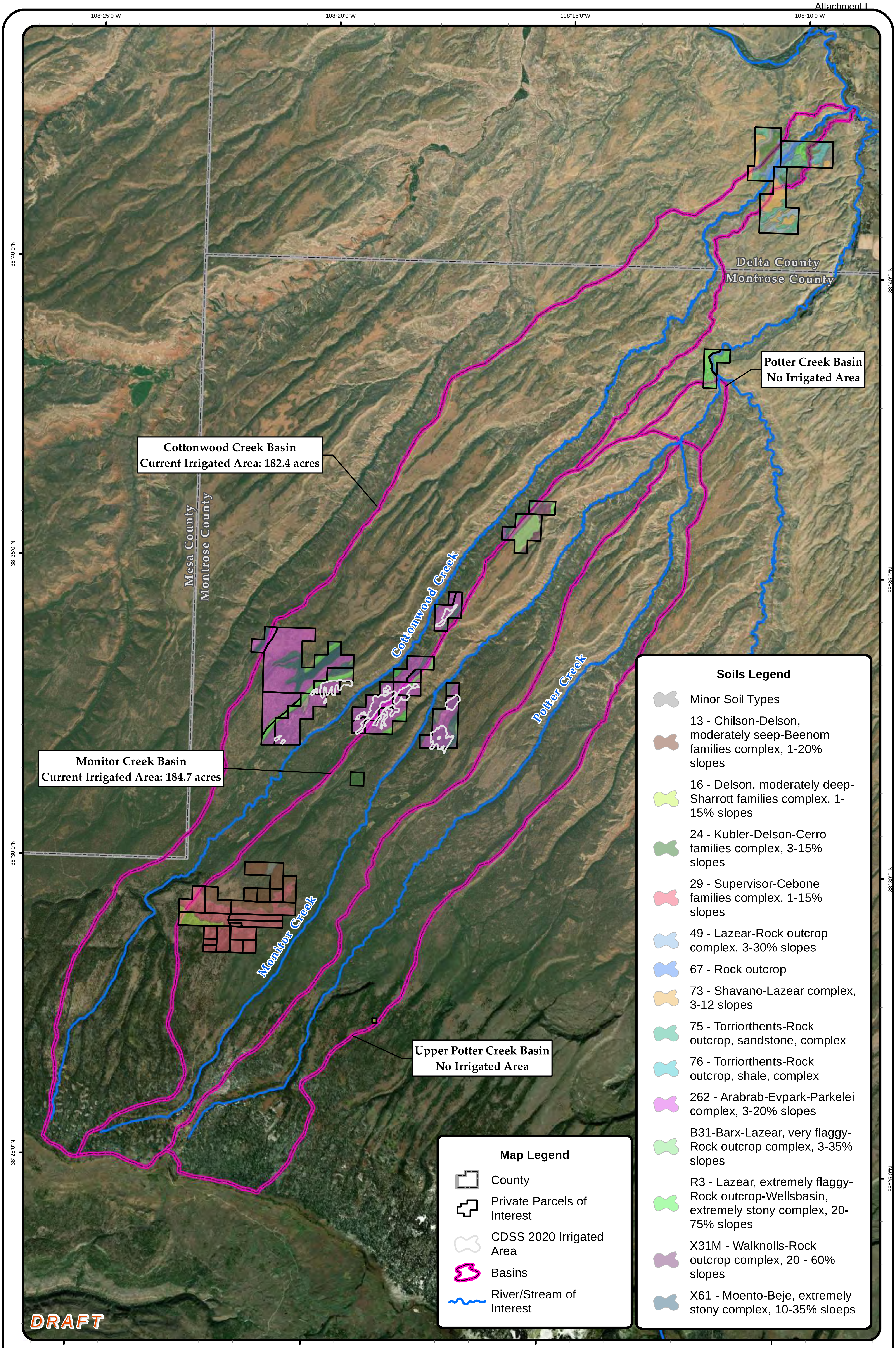
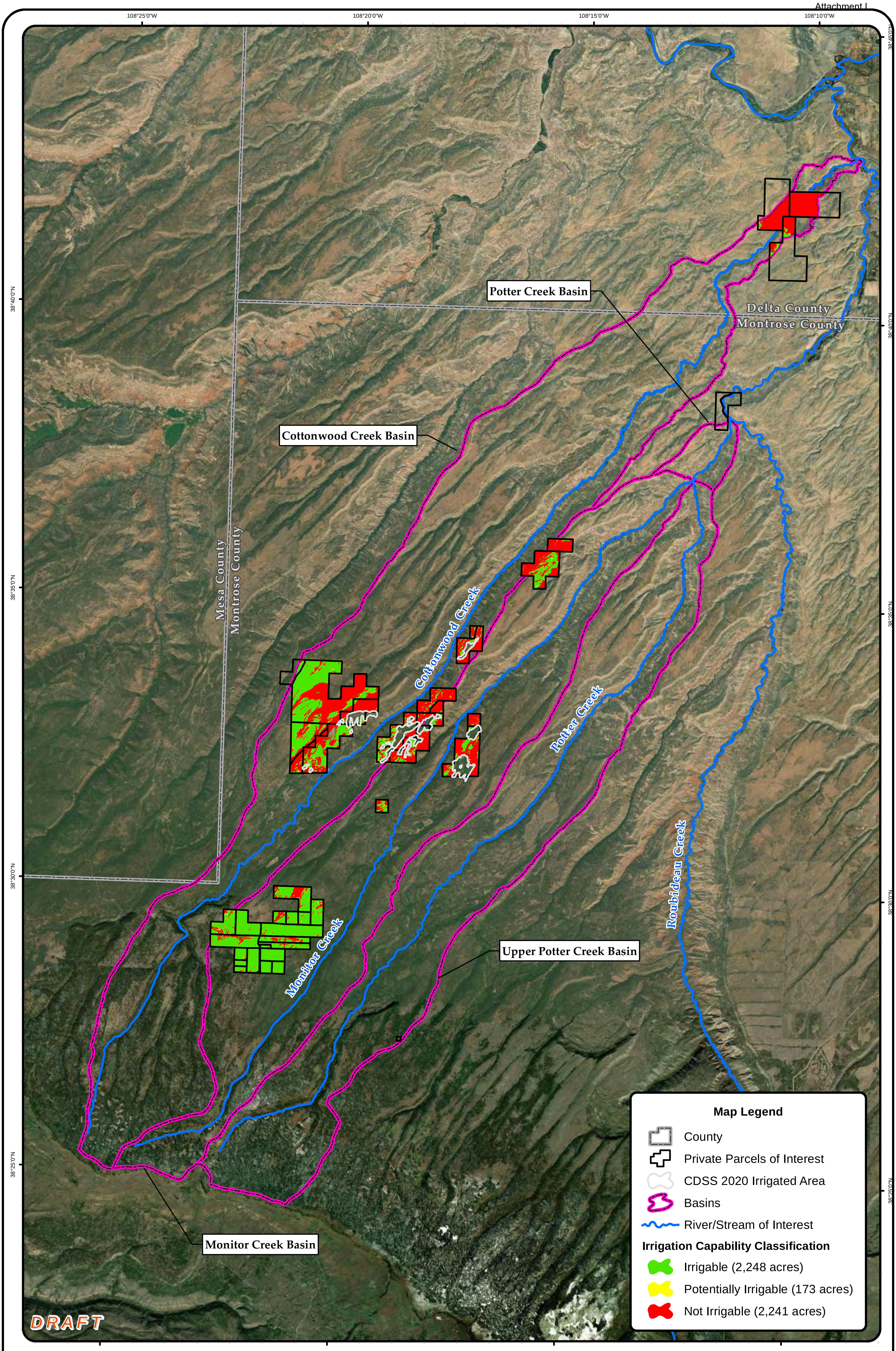


SGM 555 RiverGate Ln, Suite B4-82 Durango, CO 81301 970.385.2340 www.sgm-inc.com	Figure 9 **Soil Type and Irrigated Area** CWCB	Date:5/27/2022 · Job No. 2022-160 · Map by: ANW · Checked by: NJD · Scale: 1:102,000 Data Sources: USGS StreamStats (Watersheds), USGS (NHD Streams/Rivers), NRCS WebSoil Survey (Soils). Montrose County GIS (Parcels), Delta County GIS (Parcels) File: P:\Project Files\2022-160-CWCB Delta Area Water Dev Allowance\01 Delta\H-Dwgs\GIS\MXDs\Fig9.SoilsMap.mxd The information displayed above is intended for general planning purposes. Refer to legal documentation/data sources for descriptions/locations.	0 · 8,500 · 17,000 Feet 1 inch = 8,500 feet	N



SGM 555 RiverGate Ln, Suite B4-82 Durango, CO 81301 970.385.2340 www.sgm-inc.com	Figure 10 **Irrigated Soil Capability** CWCB	Date:1/23/2023 Job No. 2022-160 Map by: SJB Checked by: NJD Scale: 1:106,000 Data Sources: USGS StreamStats (Watersheds), USGS (NHD Streams/Rivers), NRCS WebSoil Survey (Soils). Montrose County GIS (Parcels), Delta County GIS (Parcels) File: I:\Durango\2022-160-CWCB Delta Area Water Dev Allowance\01 Delta\H-Dwgs\GIS\MXDs\Fig10.PotentialIrrigatedArea.mxd The information displayed above is intended for general planning purposes. Refer to legal documentation/data sources for descriptions/locations.	0 8,500 17,000 Feet 1 inch = 8,833 feet N

Irrigated Area Summary

Basin	CDSS 2020 Irrigated Area (Acres)	SGM Delineated Potential Future Irrigated Area (Acres)
Cottonwood	183.2	68.8
Monitor	184.0	351.8
Potter	0	0

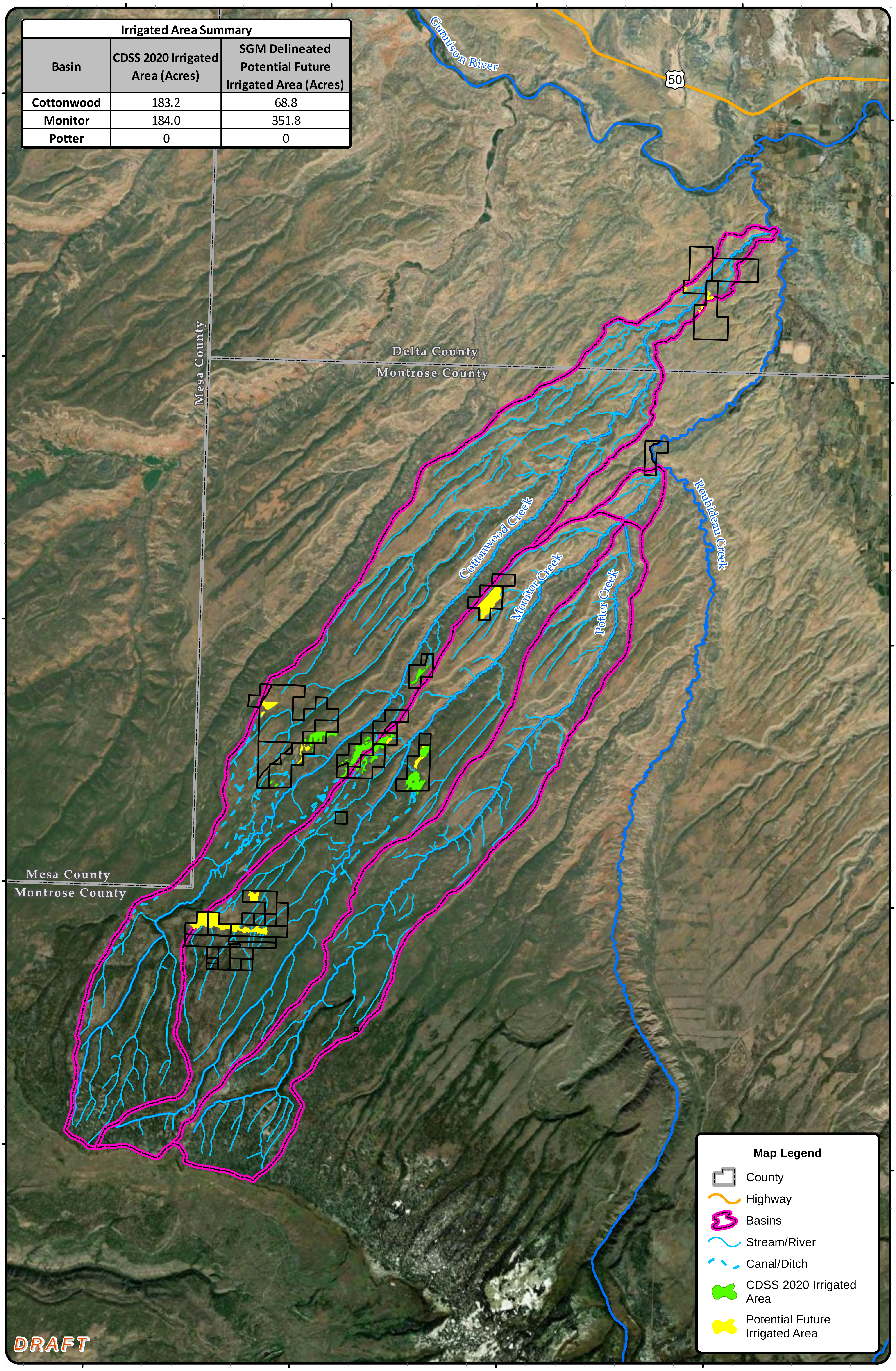


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Figure 11
Future Development
CWCB

Date:2/15/2023 | Job No. 2022-160 | Map by: ANW | Checked by: NJD | Scale: 1:120,000

Data Sources: DWR CDSS (Structures & ISF), USGS StreamStats (Watersheds), DWR (Permitted Wells), USGS (NHD Streams/Rivers & Canals/Ditches, Stream Gages, Topo Basemap), ESRI (Counties & Highways)

File: I:\Durango\2022-160-CWCB Delta Area Water Dev Allowance\01 Delta\H-Dwgs\GIS\MXDs\Fig11.FutureDevelopment.mxd

The information displayed above is intended for general planning purposes. Refer to legal documentation/data sources for descriptions/locations.

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1 inch = 10,000 feet
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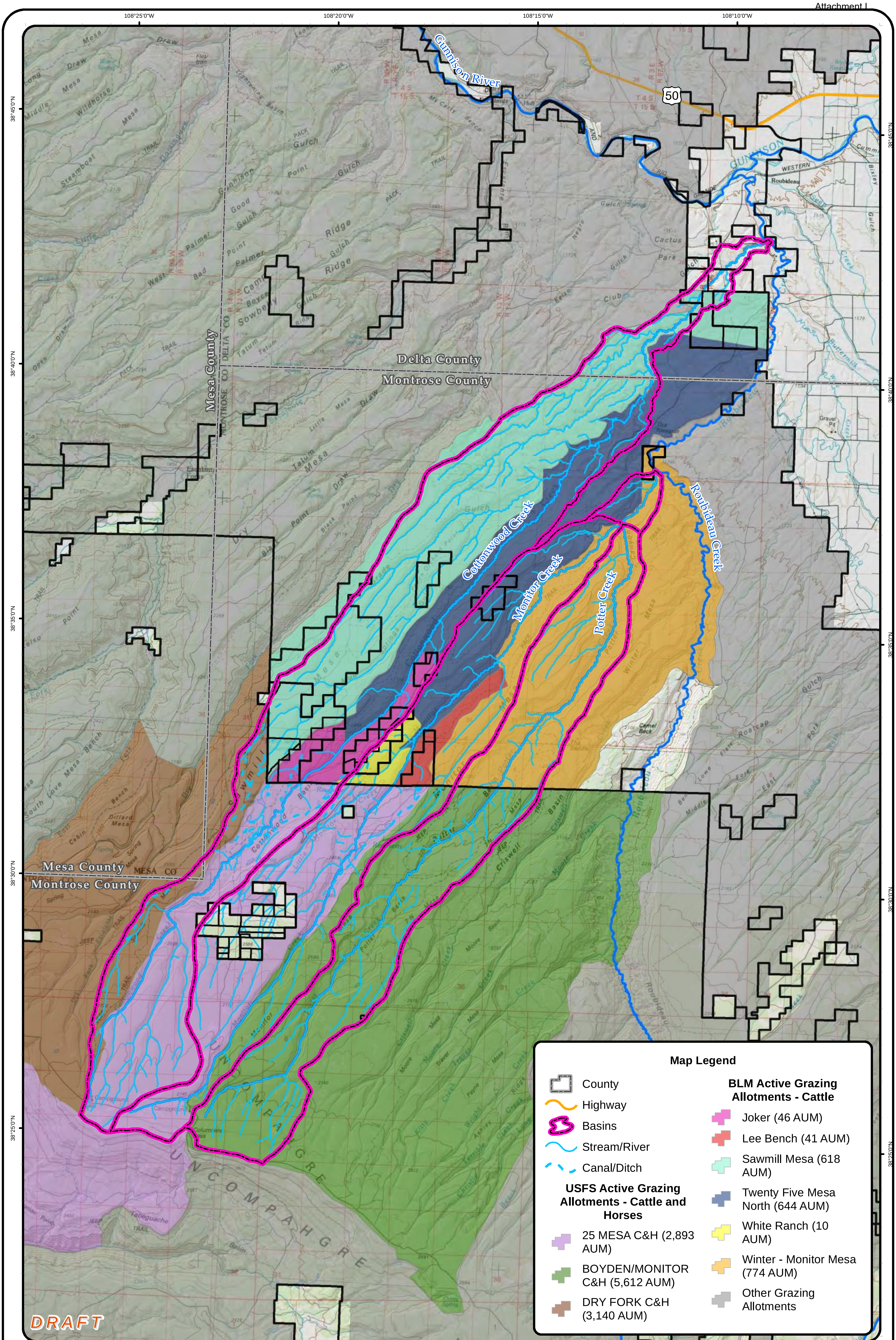

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Figure 12
Grazing Allotments
CWCB

Date: 2/16/2023 | Job No. 2022-160 | Map by: ANW | Checked by: NJD | Scale: 1:120,000

Data Sources: DWR CDSS (Structures & ISF), USGS StreamStats (Watersheds), DWR (Permitted Wells), USGS (NHD Streams/Rivers & Canals/Ditches, Stream Gages, Topo Basemap), ESRI (Counties & Highways)

File: I:\Durango\2022-160-CWCB Delta Area Water Dev Allowance\01 Delta\H-Dwgs\GIS\MXDs\Fig12.GrazingAllotments.mxd

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0 10,000 20,000 Feet

1 inch = 10,000 feet

N

Western Resource Advocates.

CONTACT

303.444.1188
info@westernresources.org
WesternResourceAdvocates.org

February 22, 2023

Board of Directors, Colorado Water Conservation Board
Colorado Department of Natural Resources
1313 Sherman Street, Room 718
Denver, CO 80203

Support for ISF Recommendations on Cottonwood Creek, Monitor Creek, and Potter Creek, Water Division 4

Dear Board Members:

Western Resource Advocates (WRA) strongly supports the Colorado Water Conservation Board (CWCB) staff's instream flow (ISF) recommendations on Cottonwood Creek, Monitor Creek, and Potter Creek ("three creeks") in Water Division 4 to protect the riparian vegetation communities present that are deemed Outstandingly Remarkable Values (ORVs). In 2022, we were involved in obtaining Outstanding Waters (OW) designation to protect water quality in Potter Creek and Monitor Creek. The proposed ISFs, combined with existing baseflow ISFs on Cottonwood and Potter Creeks and the pending baseflow ISF on Monitor Creek, will provide flow protection for these ORVs – as well as the native fishes that rely heavily on the three creeks for spawning and rearing habitat.

The purpose of these ISF recommendations is to protect the full array of the three creeks' ecological functions with ISF water rights. The recommended ISFs are specifically structured to protect a component of the hydrologic regime – bankfull flow – that is critical for the persistence of the high value ORV riparian communities. This is consistent with the CWCB Board's recognition of the need to appropriate higher flows to protect certain riparian communities. The existing and pending baseflow ISFs are structured to support aquatic habitat and species. Together bankfull and baseflow ISF rates will protect the full range of flow-dependent ecological functions in these creeks.

To help WRA understand the importance of the proposed ISFs to the three creek's riparian communities, we hired Dr. David Cooper, a riparian and wetland ecohydrologist. Dr. Cooper has 43 years of experience in scientific research, land and water management, ecosystem restoration and education. He is a senior research scientist (emeritus) in the Department of Forest and Rangeland Stewardship at Colorado State University in Fort Collins where he works to understand the hydrologic regimes needed to support riparian and wetland ecosystems. Dr. Cooper has extensive experience working in western Colorado

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Santa Fe • NM 87501

550 W. Musser
Suite G
Carson City • NV 89703

307 West 200 South
Suite 2000
Salt Lake City • UT 84101

having completed multi-year research programs on the Yampa and Green River systems, San Miguel, Dolores, Colorado, and many other rivers. These projects have focused on the flows needed to allow establishment and survival of key plant species and the physiological characteristics of key groups of species such as cottonwoods and willows. Dr. Cooper has published more than 150 papers in scientific journals, and several books and manuals on these topics, and has trained a generation of riparian and wetland scientists at CSU.

Dr. Cooper conducted sites visits in September 2021 and October 2022, reviewed existing data and reports, and documented his findings in the attached reports. Dr. Cooper found the proposed instream flow rates are appropriate, serve a variety of functions, and are crucial to the establishment, maintenance and persistence of cottonwoods and many other species in the riparian zone.

We commend your staff for their work and urge the Board to declare the CWCB's intent to appropriate the proposed ISFs for Cottonwood Creek, Monitor Creek and Upper and Lower Potter Creek. WRA is committed to supporting these ISFs throughout the appropriation process and will be available to provide testimony, as will Dr. Cooper.

Sincerely,

Bart Miller, Director Healthy Rivers Program
Western Resource Advocates

Laura Belanger, Sr. Water Resources Engineer & Policy Advisor
Western Resource Advocates

Cc: Rob Viehl, Section Chief, CWCB Stream and Lake Protection Section

Attachments:

- Importance of High Flow Events for Sustaining Riparian Vegetation, Assessment of BLM's Instream Flow Recommendation Monitor Creek, Uncompahgre Plateau Water Division 4 by David J. Cooper, PhD for Western Resource Advocates
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Importance of High Flow Events for Riparian Vegetation

Assessment of BLM's Instream Flow Recommendation Cottonwood Creek, Uncompahgre Plateau Water Division 4

Undertaken on behalf of Western Resource Advocates

David J. Cooper, PhD, Department of Forest and Rangeland Stewardship,
Colorado State University, Fort Collins, CO 80523

My Qualifications

I am a riparian and wetland ecohydrologist with 43 years of experience in scientific research, land and water management, ecosystem restoration and education. I am a senior research scientist (emeritus) in the Department of Forest and Rangeland Stewardship at Colorado State University in Fort Collins. I work to understand the hydrologic regimes needed to support riparian and wetland ecosystems. I have conducted more than 300 research projects on streams and wetlands in western Colorado, western states, and in Canada, Alaska, Peru, Bolivia, China, Poland, Slovakia and many other regions. I have extensive experience working in western Colorado having completed multi-year research programs on the Yampa and Green, San Miguel, Dolores, Colorado and many other rivers. These projects have focused on the flows needed to allow establishment and survival of key plant species and communities, and the physiological characteristics of key species such as cottonwoods and willows. I work extensively on the effects of water management, water diversions, ditches, irrigation, ground water pumping and large mainstem dams on riparian and wetland ecosystems. I work closely with federal, state, and local governments that manage land and water, as well as non-profit and for profit companies to meet their goals of managing and restoring riparian and wetland ecosystems. I have published more than 150 papers in scientific journals, and several books and manuals on these topics, and at CSU trained a generation of riparian and wetland scientists.

Summary

My assessment supports the claimed instream flow, including seasonal bankfull flows when the flow rate reaches 183 cfs for Cottonwood Creek until it recedes to the existing instream flow water right. This flow is needed to trigger reproduction of riparian plants and support the riparian communities.

INTRODUCTION

Critical Importance of Bankfull and Higher Flows

River systems, alluvial floodplains and their riparian vegetation are the product of a complex set of river flows, sediment reworking and ecological processes. Streams and their floodplains are modified almost annually by variable flows that erode beds, banks and floodplains, deposit sediment and create complex landforms that provide a wide range of habitats for aquatic and terrestrial organisms. Typically, there is a balance between erosion and deposition within the river corridor that provides constant but changing habitats. Occasionally very high flows erode entire sections of floodplains and it takes years to decades to repopulate disturbed areas with riparian plants and build landforms (Friedman, Osterkamp, Lewis 1996). Most of the hydrologic processes that influence channel and floodplain landforms, and their vegetation in Colorado, occur during high flow periods, particularly spring snowmelt events and summer thunderstorms (Braatne et al. 1996).

Stream flows provide habitat within channels and recharge ground water under the riparian zone (Cooper, Chimner, Merritt 2002). This alluvial ground water, typically called hyporheic water, is essential to the survival of riparian plants (Stanford and Ward 1993). Most riparian plants are phreatophytes (phreato = the phreatic surface or water table, and phyte = plant, meaning plants that root to the water table) and depend on the acquisition of relatively shallow ground water, within 8-12 feet of the ground surface, to survive the extreme heat and high atmospheric water demand that drives evapotranspiration during the summer (Cooper & Merritt 2012). Runoff from watersheds provides water for downstream areas and their hyporheic zone that allows tall and dense vegetation to grow that would not exist if it depended exclusively on soil moisture recharged by direct precipitation. The abundance of water and vegetation makes riparian zones the most important habitat for plant and animal species in arid and semi-arid regions throughout the world. Colorado's riparian areas support almost 40% of all the plant species in Colorado, many migratory birds and rare plants and plant communities (Cooper, Chimner, Merritt 2012). Trees can also shade streams and maintain cooler water temperatures for fish and other aquatic species.

The importance of snowmelt and monsoon rains for producing high flows

Streams that drain western Colorado's Uncompahgre Plateau have highly variable flows. Rapid snowmelt on the Plateau in April or May can produce flows that fill or exceed the capacity of their channels. These high flows can overtop stream banks, flood the riparian zone, and importantly have the power to reshape streams and their riparian areas through time. Similar high flows can be generated by runoff from strong monsoon precipitation events in mid to late summer. High flows during both seasons can produce similarly important effects on the stream corridor, including landform erosion and deposition, and wetting floodplain soils. But there are also important differences. Spring snowmelt driven flows occur prior to the growing season and create bare and wet substrates just prior to the time plants become active. This can create important opportunities for plant establishment that year. Monsoon driven flows typically occur from mid-July through September, during the heat of the summer and can recharge floodplain soils and ground water providing important support for phreatophytes. The disturbance created by monsoon driven floods can create bare areas that persist for many years allowing plant establishment even in years without bankfull flows. These late summer flows also create disturbances that benefit clonally reproducing species (clones are asexually produced individuals, such as root sprouts from a mother plant, see figure 3).

The flow-generated disturbance regime is essential for the long-term functioning of riparian ecosystems. In the assessment of instream flow needs for Cottonwood Creek, BLM correctly focuses its recommendation on protecting bankfull and higher flows that maintain stream and riparian area functioning (BLM 2022), and the flows needed to fill and overtop banks are well calculated by AECOM (2021).

Riparian Plant Establishment and Survival

Two species of cottonwood trees are the largest and most important plants that form riparian forests in western Colorado. In low elevation areas of the Colorado Plateau Fremont cottonwood (*Populus fremontii*) is dominant, while at higher elevations narrow leaf cottonwood (*Populus angustifolia*) is dominant. Both species occur along Cottonwood Creek and are dependent on high flow events for the establishment of new individuals.

Fremont cottonwood is deciduous, meaning it drops its leaves in winter, and dioecious, meaning male and female plants occur. Both sexes produce flowering catkins each spring, typically in April through May, when snowmelt dominated streams are peaking (Cooper Chimner Merritt 2012). Male catkins produce pollen that fertilizes the female flowers that can form seeds. When the seed is ripe the catkin's capsules open and seeds, covered with long white "cottony" hairs are dispersed by the wind. Cottonwoods are named for these cottony seeds. Unlike most seed from woody plants, cottonwood seeds are not dormant, have very little food stored for their embryos and live for only a few days. If a seed lands on bare and wet mineral sediment, it takes in water and begins to grow almost immediately. The germinant forms a root that penetrates the sediment to obtain water and two leaves pre-formed in the seed, called cotyledons, emerge to begin photosynthesizing and allowing the seedlings to rapidly grow (Mahoney and Rood 1998). However, most seeds land on dry ground, desiccate and die. Only a tiny fraction of seeds land on the needed bare and wet mineral soil created by high flow disturbance regimes, and suitable habitat for germination may only occur in years when high flows and seed release occur simultaneously. The critical link for seedling establishment is high flow generated stream dynamics that create suitable bare and wet habitat for seed germination and seedling growth (Cooper, Andersen, Chimner 2003; Scott, Friedman, Auble, 1996; Scott, Auble, Friedman 1997).

Cottonwood seedlings can grow fast, and their taproot can reach up to 2-3 feet deep in the first season. Within this rooting zone water must remain abundant to sustain growth and survival (Cooper, Merritt, Andersen, Chimner 1999). Seedlings in locations where the water table drops far below the ground typically die. Survival requires seedling roots to remain in contact with the riparian water table (Segelquist et al. 1998), or its capillary fringe, or be in fine grained soil that holds sufficient water to support seedlings (Cooper Merritt Chimner 1999). This hyporheic and soil water cannot be recharged by direct precipitation alone, it must be recharged by stream flows and a perennial shallow water table.

The survival of cottonwood seedlings and saplings is tenuous and highly dependent on water availability. Fremont cottonwood, and the closely related plains cottonwood, are the most sensitive tree species in North America to drought induced mortality (Tyree et al. 1994). The trees have a large canopy of broad leaves with high evapotranspiration (ET) rates in the hot, windy and low humidity summer environment of western Colorado. Supplying water for ET requires a substantial flow of sap from roots to the canopy each day. Soil water moves into the tree roots and up to the leaves through xylem vessels. Transpiration on the leaf surface creates tension as liquid water is converted to water vapor, and this tension pulls water up through the vessels from the roots to the canopy. Cottonwood vessels are large in diameter and have pores on their sides that can allow air to enter when tension on the xylem water column is very high. When tension in the xylem is very high, the chain of water moving in some vessels up the tree breaks, and an air bubble may form blocking water flow. If this happens in enough vessels it can limit water delivery to portions or all of the canopy creating severe water stress for leaves, branches and entire trees. To reduce water stress, plants close their stomates, the pores on leaves that allow carbon dioxide (CO_2) to enter the leaves, that the plants use to create food. However, by closing their stomates the plants stop food production and can starve to death.

Research on Colorado streams has shown that when the water table, and the soil wetted by capillary action, is below the reach of tree roots for more than two weeks during the growing season individual leaves, twigs, whole branches and even whole trees can die (Cooper, D'Amico, Scott 2003). Cottonwood trees commonly have dead branches as a legacy of water stress from past drought events. Some scientists consider the dying, or shedding, of leaves and branches an adaptation that allows trees to reduce their water needs during severe drought and improves the tree's probability of survival (Rood, Patiño, Coombs, Tyree 2000). But dieback of the canopy is an important indicator of insufficient water availability for trees.

Narrow leaf cottonwood has many similarities and some key differences to Fremont cottonwood (Baker 1990; Braatne, Rood, Heilman 1996). This species occurs at higher elevations than Fremont cottonwood, although their ranges overlap, as they do along Cottonwood Creek. Narrow leaf cottonwood seed production, timing of dispersal, germination and seedling establishment requirements are similar to Fremont cottonwood. However, Fremont cottonwood reproduces only from seed, while narrow leaf cottonwood can reproduce from seed or suckering from roots (Rose & Cooper 2016). Narrow leaf cottonwood produces an extensive system of very shallow lateral roots. When flood erosion exposes and abrades these roots, buds are activated that stimulate shoot formation at that point on the root, and each shoot can form a tree. This flexibility superbly adapts narrow leaf cottonwood to highly dynamic environments such as high gradient streams and floodplains, like Cottonwood Creek. Suckers can form where flood disturbance affects any area underlain by existing root systems. Suckers can remain connected to and supported by the mother plant that provides it with a constant source of water. If a subsequent flood severs the lateral root that connected plants, independent clones are formed that are genetically identical, but disconnected. Most of the narrow leaf cottonwoods I saw on Cottonwood Creek appear to be produced by suckering, indicating that high energy floods have perpetuated the formation of suckers that maintain the structure of the riparian forest.

Importance of Bankfull and Higher Flows for Cottonwood Creek

I visited Cottonwood Creek on 16 September 2021 and again on 4 October 2022. During my first visit I analyzed the reach used by BLM to determine the flows needed to over top the bank, and walked about a mile upstream to understand the channel and riparian zone structure and vegetation composition. I made observations of the plant species present, evidence of high flow elevation and mode of reproduction of the trees and shrubs present. I revisited the site in 2022 to see the influence of a year with more abundant monsoon season rains. On this second visit I walked upstream and downstream from the site I visited in 2021 for about a mile in each direction. My opinions about Cottonwood Creek are based on my observations made during these two site visits. This report should be considered final unless additional data become available. It's vital to understand that 2021 and 2022 are in a period of extreme drought in the southwestern US. While Cottonwood Creek was dry, there was available ground water at some depth that allowed many phreatophyte trees and shrubs to persist.

The importance of high flows for Fremont and narrow leaf cottonwood establishment is critical. These species evolved under the environmental pressures of flow variance, a natural disturbance regime and stream dynamics. High flows that rework channels and floodplains are vital to create bare and wet sediment required for seed germination, and the growth and survival of cottonwood seedlings on Cottonwood Creek. Without the disturbance regime created by large flows, seedling and sucker establishment could not occur. High flows create habitat that may allow seedlings and sucker establishment the year of the flood, or for many years after the channel reworking flows because the bare sediment will persist for many years.

It's important to understand that runoff from hillslopes following rain events, groundwater flow from hillsides, or direct rain or snowmelt on riparian areas, does not provide sustained soil water sufficient to support the growth of cottonwood seedlings, saplings or trees, or other native riparian plant species. Steep gradient streams, like Cottonwood Creek, experience high velocity flows that flush out fine-grained sediment creating channels and floodplains composed largely of coarse textured sediment with little water holding capacity. Because the floodplains are dominated by tree and shrub species that require an abundance of available water all summer, they need water inputs from the watershed to maintain a shallow ground water level, within 9-13 feet of the soil surface.

The Colorado Parks and Wildlife (CPW) established a temporary stream flow gage on Cottonwood Creek and provided draft stream flow data for 2015-2022. CWCB contracted with AECOM to develop a hydraulic model using HEC-RAS for Cottonwood Creek to provide a baseline for quantifying flow needed for bankfull flow in Cottonwood Creek in the analyzed reach (AECOM 2021). 183 cfs was determined to be the flow needed to create bankfull flow. A review of the discharge data provided by CWCB indicated that bankfull or higher flows occurred several times over the 2016 to 2022 period.

Bankfull flows will create the fluvial dynamics needed for the maintenance and persistence of cottonwoods, willows, narrow leaf alder and red osier dogwood that also rely on high flows for reproduction. BLM's proposal to protect all flood flows from April through September makes sense because these high flows are critical to the regeneration of landforms, create habitat for seedlings and sprouts, and recharge the alluvial aquifer (Freidman and Lee 1996; Cooper Andersen Chimner 2003).

Figure 1. Cottonwood Creek channel and adjacent tall narrow leaf cottonwood trees and short asexual sprouts along the channel margin. The channel is largely cobble and the floodplain surfaces supporting riparian vegetation are 3-6 feet above the channel. This photo taken in September 2021 when the channel was dry. Dead branches and drying leaves indicate severe water stress and leaf and stem dieback in the cottonwoods.

Figure 2. Cottonwood Creek channel in the lower left side of the photo. The riparian area on river right supports narrow leaf cottonwood resprouts. The two tallest trees are Fremont cottonwood.

Figure 3. Two narrow leaf cottonwoods connected by a lateral root that was exposed by flood waters. These two trees and likely many others in the area are clones.

Figure 4. Short (3-9 feet tall) narrow leaf cottonwoods on the left side of the channel are clones created by root sprouts. Skunkbrush sumac is widespread on the floodplain.

THE ROLE OF INSTREAM FLOW IN SUPPORTING RIPARIAN COMMUNITIES ON COTTONWOOD CREEK

The persistence of high flow events, and the mid elevation location of Cottonwood Creek allows the persistence of a wide range of riparian trees, shrubs and herbs and produces several outstandingly remarkable values (ORVs) due to the unique combination of biota present. High natural biodiversity is supported, for example the narrow leaf cottonwood / skunkbrush sumac (*Populus angustifolia/Rhus trilobata*) riparian woodland community type identified by the Colorado Natural Heritage Inventory (CNHP) as rare in Colorado. This community is characterized by narrow leaf cottonwood and skunkbrush sumac. The co-occurrence of these species indicates environmental conditions that rarely occur in Colorado and are worthy of protection. The rarity is due to the persistence of the periodic high flow events in this watershed that created suitable habitat for these two species that rarely co-occur, as well as good populations of other important riparian species such as red osier dogwood, thin leaf alder, strap leaf willow, and coyote willow. These species all have life history characteristics that tie them to dynamic floodplains. For example, red osier dogwood and coyote willow reproduce mostly via clonal spread, similar to narrow leaf cottonwood. These species form a tall forest on the floodplain, with an understory of shrubs that creates a multi layered vegetation type that is highly suitable for migratory birds.

The dynamic flows of Cottonwood Creek creates a disturbance regime that allow many clonally reproducing species to persist. Alder and strap leaf willow reproduce from seed similarly to cottonwoods, and small populations of these species occur along Cottonwood Creek. Also striking is the near lack of the exotic invasive species tamarisk/salt cedar (*Tamarix* species and hybrids), and Russian olive (*Elaeagnus angustifolia*), and we know that these exotic species are limited in the shade of taller riparian plants (DeWine & Cooper 2010) such as cottonwood. Maintaining healthy riparian communities is essential for supporting populations of native animals including migratory birds, small mammals, and native fishes that seasonally occupy Cottonwood Creek.

The geomorphic processes that support key riparian species, and the ORV's they produce, is clearly tied to high flow events of bankfull and higher stage. Critical factors to consider for the long-term management of Cottonwood Creek's ORV's are:

- High flow events that exceed 183 cfs, fill the channel, overtop the banks in many areas and create suitable bare and moist habitats for cottonwood and other riparian plants. Seedling establishment and sucker formation must occur regularly because many individuals are removed in subsequent high flows, and mortality due to drought and herbivory can be very high.
- AECOM's analysis identifies the flow needed to overtop the banks. Allowing all flows of this magnitude and higher to flow down Cottonwood Creek's channel is vital for the persistence of the riparian vegetation and its ORVs.
- High flows that occur just prior to the timing of cottonwood seed dispersal, typically in May and early June are vital for reproduction by seed. Normal snowmelt driven floods occur during this time and are suitable for creating these maintenance flows.
- The slow decline in flow on the descending limb of the spring snowmelt peak is important for maintaining soil saturation that helps support establishing seedlings and existing plants.
- Perennial surface flow, and/or shallow ground water flow is needed to support riparian water tables within 8-15 feet of the ground surface that trees require during the summer.
- An existing instream flow water right of 3.6 cfs exists, and should provide summer baseflow if this instream flow occurs.

I recommend that BLM continue to monitor the condition of Cottonwood Creek's riparian communities and their responses to recent and future flows. During my site analysis in September 2021, I noted cottonwood tree dieback, likely due to the ground water being deeper than 8-12 feet in the summer. During my visit in 2022 dieback was apparent (Figures 6 and 7). There was no baseflow in Cottonwood Creek in any of the reaches I visited in either year. This could be due to the persistent drought of the 21st century, or human water management in the headwaters. Fremont and narrow leaf cottonwood are the most sensitive tree species in North America to drought induced dieback and mortality. The maintenance of available ground water within the trees rooting zone is critical for limiting leaf and branch dieback or whole tree death. Maintaining periodic stream flow and a perennial water table within the reach of tree roots during the summer throughout the Cottonwood Creek watershed is critical for the persistence of these communities and their ORV's (Schook et al. 2020a,b, 2021). BLM's report identifies several water rights in the upper reaches of Cottonwood Creek that can remove water from the creek. Working with private interests to develop a water management plan to support the ORVs of the creek would benefit these riparian communities.

Figure 5. Dead cottonwoods on the floodplain of Cottonwood Creek, 2022.

Figure 6. Overview of Cottonwood Creek looking west illustrates the extent of cottonwood dieback (gray colored stems) through the reach investigated.

LITERATURE CITED

AECOM. 2021. Cottonwood, Monitor and Potter Creek's Survey and Hydraulics. Unpublished report to Colorado Conservation Board.

Baker, W.L. 1990. Climatic and hydrologic effects on the regeneration of *Populus angustifolia* James along the Animas River, Colorado. Journal of Biogeography. 17-59-73.

Braatne, J.H., Rood, S.B., and Heilman, P.E. 1996. Life history, ecology, and conservation of riparian cottonwoods in North America. 1n Biology of Populus and its implications for management and conservation. Part I, Chapter 3. Edited Dy R.F. Stettler, H.D. Bradshaw, Jr., P.E. Heilman, and T.M. Hinckley. NRC Research Press, National Research Council of Canada, Ottawa, ON, Canada. pp. 57-85.

BLM. 2022. BLM instream flow recommendation, Cottonwood Creek, Uncompahgre Plateau, Water Division 4.

Cooper, D.J., D.C. Andersen, R.A. Chimner. 2003. Multiple pathways for woody plant establishment on floodplains at local to regional scales. Journal of Ecology 91:182-196.

Cooper, David J. and David M. Merritt. 2012. Assessing the water needs of riparian and wetland vegetation in the western U.S. USDA Forest Service, Rocky Mountain Research Station, General Technical Report RMRS-GTR-282

Cooper, D.J., D.M. Merritt, D.A. Andersen and R. Chimner. 1999. Factors controlling Fremont cottonwood seedling establishment on the upper Green River, Colorado and Utah. *Regulated Rivers: Research and Management* 15: 419-440.

Cooper, D.J., D. D'Amico and M.L. Scott. 2003. Physiological and morphological response patterns of *Populus deltoides* to alluvial groundwater pumping. *Environmental Management* 31:215-226.

Cooper, D.J., R. Chimner, D. Merritt. 2012. Western Mountain Wetlands. Chapter 22, In: Wetland Habitats of North America: Ecology and Conservation Concerns. Edited by: Darold P. Batzer and Andrew H. Baldwin, University of California Press. Pages 313-328.

DeWine, J. and D.J. Cooper. 2010. Habitat Overlap and Facilitation in Tamarisk and Box elder Stands: Implications for Tamarisk Control Using Native Plants. *Restoration Ecology* 18: 349-358.

Friedman, J. M., W. R. Osterkamp, W.M Lewis. 1996. Channel narrowing and vegetation development following a Great Plains Flood. Ecology 77: 2167-2181.

Freidman, J. M. and V.J. Lee. 2002. Extreme floods, channel change, and riparian forests along ephemeral streams. Ecological monographs 72: 409-425.

Mahoney, J.M. & Rood, S.B. (1998). Streamflow requirements for cottonwood seedling recruitment- an integrative model. Wetlands, 18; 634-645.

Rood, S.B., S. Patiño, K. Coombs, M.T. Tyree. 2000. Branch sacrifice: cavitation-associated drought adaptation of riparian cottonwoods. Trees 14: 248-257.

Rose, J. R. and D. J. Cooper. 2016. The influence of floods and herbivory on cottonwood establishment and growth in a multi-herbivore system. *Ecohydrology* DOI 10.1002/eco/1768.

Schook, D., J. Friedman, J. Hoover, S. Rice, R. Thaxton, D. J. Cooper. 2021. Riparian forest productivity decline initiated by streamflow diversion then amplified by atmospheric drought 40 years later. *Ecohydrology*, in press.

Schook, D., J. Friedman, C. Stricker, A Csank, D. J. Cooper. 2020a. Short- and long-term response of riparian cottonwoods (*Populus* spp.) to flow diversion: analysis of stable carbon isotopes and tree-ring widths. *Science of the Total Environment* https://doi.org/10.1016/j.scitotenv.2020.139523

Schook, D. M., D. J. Cooper, J. M. Friedman, S. E. Rice, J. D. Hoover, and R. D. Thaxton. 2020b. Effects of flow diversion on Snake Creek and its riparian cottonwood forest, Great Basin National Park. Natural Resource Report NPS/GRBA/NRR—2020/2104. National Park Service, Fort Collins, Colorado.

Scott, M.L., Auble, G.T., and Friedman, J.M. (1997) Flood dependency of cottonwood establishment along the Missouri River, Montana, USA. Ecological Applications, 7:677-690.

Scott, M.L., Friedman, J.M., and Auble, G.T. (1996) Fluvial process and the establishment of bottomland trees. Geomorphology 14: 327-339.

Stanford, J. and J.V. Ward. 1993. An ecosystem perspective of alluvial rivers: connectivity and the hyporheic corridor. Journal of the North American Benthological Society:12: 48-60.

Tyree, M.T., K. Kolb, S. Rood, S. Patiño. 1994. Vulnerability to drought-induced cavitation of riparian cottonwoods in Alberta: a possible factor in the decline of the ecosystem? Tree Physiology 14: 455-466.

Importance of High Flow Events for Sustaining Riparian Vegetation

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Assessment of BLM's Instream Flow Recommendation Monitor Creek, Uncompahgre Plateau Water Division 4

Undertaken on behalf of Western Resource Advocates

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Summary

My assessment supports the claimed instream flow, including seasonal bankfull flows when the flow rate reaches 111 cfs for Monitor Creek until it recedes to the existing instream flow water right. This flow is needed to trigger reproduction of riparian plants including narrow leaf cottonwood, red osier dogwood, and coyote willow that form the dominant riparian communities along the creek.

INTRODUCTION

Critical Importance of Bankfull and Higher Flows

River systems, alluvial floodplains and their riparian vegetation are the product of a complex set of river flows, sediment reworking and ecological processes. Streams and their floodplains are modified almost annually by variable flows that erode beds, banks and floodplains, deposit sediment and create complex landforms that provide a wide range of habitats for aquatic and terrestrial organisms. Typically, there is a balance between erosion and deposition within the river corridor that provides constant but changing habitats. Occasionally very high flows erode entire sections of floodplains and it takes years to decades to repopulate disturbed areas with riparian plants and build landforms (Friedman, Osterkamp, Lewis 1996). Most of the hydrologic processes that influence channel and floodplain landforms, and their vegetation in Colorado, occur during high flow periods, particularly spring snowmelt events and summer thunderstorms (Braatne et al. 1996).

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Streams that drain western Colorado's Uncompahgre Plateau have highly variable flows. Rapid snowmelt on the Plateau in April or May can produce flows that fill or exceed the capacity of their channels. These high flows can overtop stream banks, flood the riparian zone, and importantly have the power to reshape streams and their riparian areas through time. Similar high flows can be generated by runoff from strong monsoon precipitation events in mid to late summer. High flows during both seasons can produce similarly important effects on the stream corridor, including landform erosion and deposition, and wetting floodplain soils. But there are also important differences. Spring snowmelt driven flows occur prior to the growing season and create bare and wet substrates just prior to the time plants become active. This can create important opportunities for plant establishment that year. Monsoon driven flows typically occur from mid-July through September, during the heat of the summer and can recharge floodplain soils and ground water providing important support for phreatophytes. The disturbance created by monsoon driven floods can create bare areas that persist for many years allowing plant establishment even in years without bankfull flows. These late summer flows also create disturbances that benefit clonally reproducing species (clones are asexually produced individuals, such as root sprouts from a mother plant, see figure 3).

The flow-generated disturbance regime is essential for the long-term functioning of riparian ecosystems. In the assessment of instream flow needs for Monitor Creek, BLM correctly focuses its recommendation on protecting bankfull and higher flows that maintain stream and riparian area functioning (BLM 2022), and the flows needed to fill and overtop banks were calculated by AECOM (2021) as 111 cfs. Flow monitoring by CWCB illustrates that surface flow was present for more that a relatively short period of time only occurred in 2019 and 2022, and in both years bankfull or higher flows occurred (Figure 1). The years 2020 and 2021 had little to no flow and 2017 and 2018 had limited flow.

Riparian Plant Establishment and Survival

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Cottonwood seedlings can grow fast, and their taproot can reach up to 2-3 feet deep in the first season. Within this rooting zone water must remain abundant to sustain growth and survival (Cooper, Merritt, Andersen, Chimner 1999). Seedlings in locations where the water table drops far below the ground typically die. Survival requires seedling roots to remain in contact with the riparian water table (Segelquist et al. 1998), or its capillary fringe, or be in fine grained soil that holds sufficient water to support seedlings (Cooper Merritt Chimner 1999). This hyporheic and soil water cannot be recharged by direct precipitation alone, it must be recharged by stream flows and a perennial shallow water table.

The survival of cottonwood seedlings and saplings is tenuous and highly dependent on water availability. Fremont cottonwood, and the closely related plains cottonwood, are the most sensitive tree species in North America to drought induced mortality (Tyree et al. 1994). The trees have a large canopy of broad leaves with high evapotranspiration (ET) rates in the hot, windy and low humidity summer environment of western Colorado. Supplying water for ET requires a substantial flow of sap from roots to the canopy each day. Soil water moves into the tree roots and up to the leaves through xylem vessels. Transpiration on the leaf surface creates tension as liquid water is converted to water vapor, and this tension pulls water up through the vessels from the roots to the canopy. Cottonwood vessels are large in diameter and have pores on their sides that can allow air to enter when tension on the xylem water column is very high. When tension in the xylem is very high, the chain of water moving in some vessels up the tree breaks, and an air bubble may form blocking water flow. If this happens in enough vessels it can limit water delivery to portions or all of the canopy creating severe water stress for leaves, branches and entire trees. To reduce water stress, plants close their stomates, the pores on leaves that allow carbon dioxide (CO_2) to enter the leaves, that the plants use to create food. However, by closing their stomates the plants stop food production and can starve to death.

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Narrow leaf cottonwood has many similarities and some key differences to Fremont cottonwood (Baker 1990; Braatne, Rood, Heilman 1996). This species occurs at higher elevations than Fremont cottonwood, although their ranges overlap, as they do along Monitor Creek. Narrow leaf cottonwood seed production, timing of dispersal, germination and seedling establishment requirements are similar to Fremont cottonwood. However, Fremont cottonwood reproduces only from seed, while narrow leaf cottonwood can reproduce from seed or suckering from roots (Rose & Cooper 2016). Narrow leaf cottonwood produces an extensive system of very shallow lateral roots. When flood erosion exposes and abrades these roots, buds are activated that stimulate shoot formation at that point on the root, and each shoot can form a tree. This flexibility superbly adapts narrow leaf cottonwood to highly dynamic environments such as high gradient streams and floodplains, like Monitor Creek. Suckers can form where flood disturbance affects any area underlain by existing root systems. Suckers can remain connected to and supported by the mother plant that provides it with a constant source of water. If a subsequent flood severs the lateral root that connected plants, independent clones are formed that are genetically identical, but disconnected. Most of the n leaf cottonwoods I saw on Monitor Creek appear to be produced by suckering, indicating that high energy floods have perpetuated the formation of suckers that maintain the structure of the riparian forest.

Importance of High Flow Events for Monitor Creek

I visited Monitor Creek on 17 September 2021, and again on 4 October 2022. During my first visit I analyzed the reach used by BLM to determine the flows needed to over top the bank, and walked about a mile upstream to understand the channel and riparian zone structure and vegetation composition. I made observations of the plant species present, evidence of high flow elevation and mode of reproduction of the trees and shrubs present. I revisited the site in 2022 to see site conditions in a year with more abundant monsoon season rains. On this second visit I walked upstream and downstream from the site I visited in 2021 for about at least 1/2 mile in each direction. My opinions about Monitor Creek are based on my observations made during these two site visits. This report should be considered final unless additional data become available. It's vital to understand that 2021 and 2022 are in a period of extreme drought in the southwestern US. Monitor Creek was flowing during both visits and available ground water allowed the phreatophyte trees and shrubs to persist.

The importance of flood flows for Fremont and narrow leaf cottonwood is critical to understand. These species evolved under the environmental pressures of flow variance, a natural disturbance regime and stream dynamics. High flows that rework channels and floodplains are vital to create bare and wet sediment required for seed germination, and the growth and survival of cottonwood seedlings on Monitor Creek. Without the disturbance regime created by large flows, seedling and sucker establishment would not occur. Flood flows create habitat that may lead to seedlings and sprout establishment the year of the flood, or for many years after the channel reworking flows because the bare sediment will persist for many years. In the photos provided in this report Figure 4 shows how clonal reproduction occurs, and Figure 6 shows an abundance of young seedlings and saplings of cottonwood and willows on a bare sediment bar along Monitor Creek.

It's important to understand that runoff from hillslopes following rain events, direct rain or snowmelt on riparian areas, and ground water flow from hillsides do not provide sustained soil water sufficient to support the growth of cottonwood seedlings and saplings or other native riparian plant species. Steep gradient riparian areas, like Monitor Creek, experience high velocity flows that flush out fine-grained sediment creating channels and floodplains composed largely of coarse textured sediment that has little water holding capacity (See Figure 3). Because the floodplains are dominated by tree and shrub species that require an abundance of available water all summer, they need stable water inputs from the watershed to maintain a shallow ground water level and soil water. The stable water inputs are provided by high flows during snowmelt and monsoon rain events, and surface water flow during the summer supports what appears to be a perennially high water table sufficient to support seedling establishment and persistence.

Calculations provided by AECOM (2021) provide an important baseline for quantifying the flow needed to overtop the banks of Monitor Creek in the reach analyzed. 111 cfs was determined to be the flow needed to create bankfull flow. A review of the discharge data provided by CWCB indicated that bankfull or higher flows occurred several times over the 2016 to 2022 period.

Other species, such as willows, narrow leaf alder and red osier dogwood also rely on these high flows for reproduction. BLM's proposal to protect all flood flows from April through September makes sense because such flows are critical to potential for regeneration of landforms, create habitat for seedlings and sprouts, and recharge the alluvial aquifer (Freidman and Lee 1996; Cooper Andersen Chimner 2003).

Figure 1. Monitor Creek channel and tall cottonwood trees in background. The channel had flowing water throughout most of the visited reach in September 2021 even during the severe drought. Trees did not have yellowed leaves, or abundant dead branches and few dead trees were present. The left side of the channel in this reach is dominated by the exotic yellow sweet clover, but it does not prevent native species from establishing.

Figure 2. Monitor Creek has a well-developed cobble channel with riparian forests of diverse cottonwood age classes and willow and cottonwood seedlings and saplings.

Figure 3. Two narrow leaf cottonwoods on Cottonwood Creek connected by a lateral root that was exposed by flood waters. This photo is to show this important process.

Figure 4. Straight reach of Monitor Creek, with three square bulrush (*Schoenoplectus pungens*) a typical wetland plant, lining the bank on the right side of the channel indicating the presence of perennially saturated soil.

Figure 5. In the foreground on bare and wet mineral soil are abundant current year and 2nd year seedlings of narrow leaf and Fremont cottonwood along Monitor Creek. This indicates that suitable conditions for establishment have occurred in recent years. Also present is sandbar/coyote willow on the channel margins.

THE ROLE OF INSTREAM FLOW IN SUPPORTING RIPARIAN COMMUNITIES ON MONITOR CREEK

The persistence of a natural flood regime, and the mid elevation location of Monitor Creek allows the persistence of a wide range of riparian trees, shrubs and herbs and produces several outstandingly remarkable values (ORVs) including uncommon and rare plant communities, plant diversity and fish and bird habitat. High natural biodiversity is supported, for example good examples of the following communities are found in the study area:

- Narrow leaf cottonwood / red osier dogwood *(Populus angustifolia / Cornus sericea)* Riparian Woodland (G4/S4, A)

- Coyote willow (*Salix exigua*) / Mesic Graminoids Western Wet Shrubland (Element rank = G5/S5, A)

Rankings by the Colorado Natural Heritage Inventory (CNHP) indicate that these communities are either globally secure-common (G5) or secure (G4), and state secure (S4), state common (S5). They are characterized by the typically high elevation narrow leaf cottonwood and red osier dogwood, and the lower elevation riparian species coyote willow. The co-occurrence of these species indicates environmental conditions that rarely occur and are worthy of protection. The rarity is due to the persistence of the natural high flows in this watershed that creates suitable habitat for these species that rarely co-occur, as well as good populations of other important riparian species. These species all have life history characteristics that tie them to dynamic floodplains.

The narrow leaf cottonwood / red osier dogwood community creates a tall canopy with a dense understory of shrubs that stabilize channel margins and provide good habitat for birds. The condition of these communities was excellent on Monitor Creek due to the perennial ground water availability. The trees had full canopies indicating adequate ground water was available for the woody plants during the summer. The two dominant species are characteristic of high energy gravel bottom streams and rivers and reproduce mainly asexually from root sprouts or in the case of dogwood, from stems bring buried and rooting allowing the plant to spread. The Coyote willow / mesic graminoid community is also common along the creek, and is typically on the lowest portions of the floodplain where it is wettest (Figure 6).

I saw no individuals of the exotic invasive species tamarisk/salt cedar (*Tamarix* species and hybrids), and Russian olive (*Elaeagnus angustifolia*) along Monitor Creek. We know that these exotic species can be limited by the shade of taller riparian plants (DeWine & Cooper 2010) such as cottonwood. Maintaining these healthy riparian communities is essential for limiting the invasion of these exotic plants, and for supporting populations of native animals including migratory birds, small mammals, and native fishes that seasonally occupy Monitor Creek.

Monitor Creek has existing upstream water rights that can divert flow up to 63.65 cfs from the Creek. Much of this water appears to be stored in high elevation reservoirs to irrigate pastures. The diversions do not appear to limit snowmelt and monsoon driven high flows or baseflows.

The geomorphic processes that support key riparian species, and the ORV's they produce, is clearly tied to high flow events. Critical factors to consider for the long-term management of Monitor Creek's ORV's are:

- Flows large enough to fill the channel, overtop the banks in many areas and create suitable bare and moist habitats for cottonwood and other riparian plant, seedlings and sucker formation must occur regularly. The high flows also create a disturbance regime necessary for the reproduction of clonal species such as narrow leaf cottonwood, sand bar willow and red osier dogwood.
- AECOM (2021) identified the flow needed to overtop the banks for the reach above Monitor Creek's confluence with Potter Creek as 111 cfs. Allowing all flows of this magnitude and higher to flow down Monitor Creek is vital for the persistence of the riparian vegetation and its ORVs.

- High flows that occur just prior to the timing of cottonwood seed dispersal, typically in May and early June are vital for sexual reproduction. Normal snowmelt driven floods occur during this time and are suitable for creating these maintenance flows.
- The slow decline in flow on the descending limb of the spring snowmelt peak is important for maintaining soil saturation that helps support establishing seedlings and existing plants.
- Perennial flow in at least some sections of Monitor Creek is needed to allow the recharge and support of riparian water tables within 8-15 feet of the ground surface that trees rely on during the summer.
- An existing instream flow water right of 4 cfs exists, and should provide summer baseflow if this instream flow occurs.
- An analysis of upstream water diversions and return flows would be helpful to understand current flows, flow limitations and any return flows or flow augmentation into Monitor Creek.

Monitor Creek's riparian communities are in excellent condition, among the best of any I have seen in the Uncompahgre Plateau region as indicated by the few dead trees and few dead branches in the dominant riparian trees and shrubs. I recommend that BLM continue to monitor the condition of these communities and their responses to recent and future flows. The maintenance of available ground water within the trees rooting zone is critical for limiting future leaf and branch dieback or whole tree death. Maintaining the perennial water table within reach of the trees during the summer throughout the Monitor Creek watershed is critical for the persistence of these ecosystems and their ORV's (Schook et al. 2020a,b, 2021).

LITERATURE CITED

AECOM. 2021. Cottonwood, Monitor and Potter Creek's Survey and Hydraulics. Unpublished report to Colorado Conservation Board.

Baker, W.L. 1990. Climatic and hydrologic effects on the regeneration of *Populus angustifolia* James along the Animas River, Colorado. Journal of Biogeography. 17-59-73.

Braatne, J.H., Rood, S.B., and Heilman, P.E. 1996. Life history, ecology, and conservation of riparian cottonwoods in North America. 1n Biology of Populus and its implications for management and conservation. Part I, Chapter 3. Edited Dy R.F. Stettler, H.D. Bradshaw, Jr., P.E. Heilman, and T.M. Hinckley. NRC Research Press, National Research Council of Canada, Ottawa, ON, Canada. pp. 57-85.

BLM. 2022. BLM instream flow recommendation, Cottonwood Creek, Uncompahgre Plateau, Water Division 4.

Cooper, D.J., D.C. Andersen, R.A. Chimner. 2003. Multiple pathways for woody plant establishment on floodplains at local to regional scales. Journal of Ecology 91:182-196.

Cooper, David J. and David M. Merritt. 2012. Assessing the water needs of riparian and wetland vegetation in the western U.S. USDA Forest Service, Rocky Mountain Research Station, General Technical Report RMRS-GTR-282

Cooper, D.J., D.M. Merritt, D.A. Andersen and R. Chimner. 1999. Factors controlling Fremont cottonwood seedling establishment on the upper Green River, Colorado and Utah. *Regulated Rivers: Research and Management* 15: 419-440.

Cooper, D.J., D. D'Amico and M.L. Scott. 2003. Physiological and morphological response patterns of *Populus deltoides* to alluvial groundwater pumping. *Environmental Management* 31:215-226.

Cooper**,** D.J., R. Chimner, D. Merritt. 2012. Western Mountain Wetlands. Chapter 22, In: Wetland Habitats of North America: Ecology and Conservation Concerns. Edited by: Darold P. Batzer and Andrew H. Baldwin, University of California Press. Pages 313-328.

DeWine, J. and D.J. Cooper. 2010. Habitat Overlap and Facilitation in Tamarisk and Box elder Stands: Implications for Tamarisk Control Using Native Plants. *Restoration Ecology* 18: 349-358.

Friedman, J. M., W. R. Osterkamp, W.M Lewis. 1996. Channel narrowing and vegetation development following a Great Plains Flood. Ecology 77: 2167-2181.

Freidman, J. M. and V.J. Lee. 2002. Extreme floods, channel change, and riparian forests along ephemeral streams. Ecological monographs 72: 409-425.

Mahoney, J.M. & Rood, S.B. (1998). Streamflow requirements for cottonwood seedling recruitment- an integrative model. Wetlands, 18; 634-645.

Rood, S.B., S. Patiño, K. Coombs, M.T. Tyree. 2000. Branch sacrifice: cavitation-associated drought adaptation of riparian cottonwoods. Trees 14: 248-257.

Rose, J. R. and D. J. Cooper. 2016. The influence of floods and herbivory on cottonwood establishment and growth in a multi-herbivore system. *Ecohydrology* DOI 10.1002/eco/1768.

Schook, D., J. Friedman, J. Hoover, S. Rice, R. Thaxton, D. J. Cooper. 2021. Riparian forest productivity decline initiated by streamflow diversion then amplified by atmospheric drought 40 years later. *Ecohydrology*, in press.

Schook, D., J. Friedman, C. Stricker, A Csank, D. J. Cooper. 2020a. Short- and long-term response of riparian cottonwoods (*Populus* spp.) to flow diversion: analysis of stable carbon isotopes and tree-ring widths. *Science of the Total Environment* https://doi.org/10.1016/j.scitotenv.2020.139523

Schook, D. M., D. J. Cooper, J. M. Friedman, S. E. Rice, J. D. Hoover, and R. D. Thaxton. 2020b. Effects of flow diversion on Snake Creek and its riparian cottonwood forest, Great Basin National Park. Natural Resource Report NPS/GRBA/NRR—2020/2104. National Park Service, Fort Collins, Colorado.

Scott, M.L., Auble, G.T., and Friedman, J.M. (1997) Flood dependency of cottonwood establishment along the Missouri River, Montana, USA. Ecological Applications, 7:677-690.

Scott, M.L., Friedman, J.M., and Auble, G.T. (1996) Fluvial process and the establishment of bottomland trees. Geomorphology 14: 327-339.

Stanford, J. and J.V. Ward. 1993. An ecosystem perspective of alluvial rivers: connectivity and the hyporheic corridor. Journal of the North American Benthological Society:12: 48-60.

Tyree, M.T., K. Kolb, S. Rood, S. Patiño. 1994. Vulnerability to drought-induced cavitation of riparian cottonwoods in Alberta: a possible factor in the decline of the ecosystem? Tree Physiology 14: 455-466.

Importance of High Flow Events for Sustaining Riparian Vegetation

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Assessment of BLM's Instream Flow Recommendation Potter Creek, Uncompahgre Plateau Water Division 4

Undertaken on behalf of Western Resource Advocates

David J. Cooper, PhD, Department of Forest and Rangeland Stewardship, Colorado State University, Fort Collins, CO 80523

My Qualifications

I am a riparian and wetland ecohydrologist with 43 years of experience in scientific research, land and water management, ecosystem restoration and education. I am a senior research scientist (emeritus) in the Department of Forest and Rangeland Stewardship at Colorado State University in Fort Collins. I work to understand the hydrologic regimes needed to support riparian and wetland ecosystems. I have conducted more than 300 research projects on streams and wetlands in western Colorado, western states, and in Canada, Alaska, Peru, Bolivia, China, Poland, Slovakia and many other regions. I have extensive experience working in western Colorado having completed multi-year research programs on the Yampa and Green, San Miguel, Dolores, Colorado and many other rivers. These projects have focused on the flows needed to allow establishment and survival of key plant species and communities, and the physiological characteristics of key species such as cottonwoods and willows. I work extensively on the effects of water management, water diversions, ditches, irrigation, ground water pumping and large mainstem dams on riparian and wetland ecosystems. I work closely with federal, state, and local governments that manage land and water, as well as non-profit and for profit companies to meet their goals of managing and restoring riparian and wetland ecosystems. I have published more than 150 papers in scientific journals, and several books and manuals on these topics, and at CSU trained a generation of riparian and wetland scientists.

Summary

My assessment supports the claimed instream flow, including seasonal bankfull flows when the flow rate reaches 177 cfs until it recedes to the existing instream flow water right for Potter Creek above its confluence with Monitor Creek, and when the flow rate reaches 225 cfs until it recedes to the existing instream flow water right below the confluence with Roubideau Creek.

INTRODUCTION

Critical Importance of Bankfull and Higher Flows

River systems, alluvial floodplains and their riparian vegetation are the product of a complex set of river flows, sediment reworking and ecological processes. Streams and their floodplains are modified almost annually by variable flows that erode beds, banks and floodplains, deposit sediment and create complex landforms that provide a wide range of habitats for aquatic and terrestrial organisms. Typically, there is a balance between erosion and deposition within the river corridor that provides constant but changing habitats. Occasionally very high flows erode entire sections of floodplains and it takes years to decades to repopulate disturbed areas with riparian plants and build landforms (Friedman, Osterkamp, Lewis 1996). Most of the hydrologic processes that influence channel and floodplain landforms, and their vegetation in Colorado, occur during high flow periods, particularly spring snowmelt events and summer thunderstorms (Braatne et al. 1996).

Stream flows provide habitat within channels and recharge ground water under the riparian zone (Cooper, Chimner, Merritt 2002). This alluvial ground water, typically called hyporheic water, is essential to the survival of riparian plants (Stanford and Ward 1993). Most riparian plants are phreatophytes (phreato = the phreatic surface or water table, and phyte = plant, meaning plants that root to the water table) and depend on the acquisition of relatively shallow ground water, within 8-12 feet of the ground surface, to survive the extreme heat and high atmospheric water demand that drives evapotranspiration during the summer (Cooper & Merritt 2012). Runoff from watersheds provides water for downstream areas and their hyporheic zone that allows tall and dense vegetation to grow that would not exist if it depended exclusively on soil moisture recharged by direct precipitation. The abundance of water and vegetation makes riparian zones the most important habitat for plant and animal species in arid and semi-arid regions throughout the world. Colorado's riparian areas support almost 40% of all the plant species in Colorado, many migratory birds and rare plants and plant communities (Cooper, Chimner, Merritt 2012). Trees can also shade streams and maintain cooler water temperatures for fish and other aquatic species.

The importance of snowmelt and monsoon rains for producing high flows

Streams that drain western Colorado's Uncompahgre Plateau have highly variable flows. Rapid snowmelt on the Plateau in April or May can produce flows that fill or exceed the capacity of their channels. These high flows can overtop stream banks, flood the riparian zone, and importantly have the power to reshape streams and their riparian areas through time. Similar high flows can be generated by runoff from strong monsoon precipitation events in mid to late summer. High flows during both seasons can produce similarly important effects on the stream corridor, including landform erosion and deposition, and wetting floodplain soils. But there are also important differences. Spring snowmelt driven flows occur prior to the growing season and create bare and wet substrates just prior to the time plants become active. This can create important opportunities for plant establishment that year. Monsoon driven flows typically occur from mid-July through September, during the heat of the summer and can recharge floodplain soils and ground water providing important support for phreatophytes. The disturbance created by monsoon driven floods can create bare areas that persist for many years allowing plant establishment even in years without high flow events. Late summer flows also create disturbances that benefit clonally reproducing species (clones are asexually produced individuals, such as root sprouts from a mother plant, see figure 3).

The flow-generated disturbance regime is essential for the long-term functioning of riparian ecosystems. In the assessment of instream flow needs for Potter Creek, BLM correctly focuses its recommendation on protecting bankfull and higher flows that maintain stream and riparian area functioning (BLM 2022), and the flows needed to fill and overtop banks are well calculated by AECOM (2021).

Riparian Plant Establishment and Survival

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I visited Potter Creek on 17 September 2021, and again on 4 October 2022. During my first visit I analyzed the reach used by BLM to determine the flows needed to over top the bank, and walked about a mile upstream to understand the channel and riparian zone structure and vegetation composition. I made observations of the plant species present, evidence of high flow elevation and mode of reproduction of the trees and shrubs present. I revisited the site in 2022 to see the conditions during a year with more abundant monsoon season rains. On this second visit I walked upstream and downstream from the site I visited in 2021 for about at least 1/2 mile in each direction. My opinions about Potter Creek are based on my observations made during these two site visits. This report should be considered final unless additional data become available. It's vital to understand that 2021 and 2022 are in a period of extreme drought in the southwestern US. Potter Creek was flowing during both visits and available ground water allowed the phreatophytic trees and shrubs to persist.

The importance of high flows events for Fremont and narrow leaf cottonwood is critical to understand. These species evolved under the environmental pressures of flow variance, a natural disturbance regime and stream dynamics. High flows that rework channels and floodplains are vital to create bare and wet sediment required for seed germination, and the growth and survival of cottonwood seedlings on Potter Creek. Without the disturbance regime created by large flows, seedling and sucker establishment would not occur. High flows create habitat that may lead to seedlings and sprout establishment the year of the flood, or for many years after the channel reworking flows because the bare sediment will persist for many years. High flow events were measured at a temporary gauge on Potter Creek. Flows for several weeks also occurred in 2015 and 2022. These flows allowed the establishment of cottonwood, willow and other species to reproduce along Potter Creek (Figure 2).

Runoff from hillslopes following rain events, direct rain or snowmelt on riparian areas, and ground water flow from hillsides do not provide sustained soil water sufficient to support the growth of cottonwood seedlings and saplings or other native riparian plant species along Potter Creek. Steep gradient streams experience high velocity flows that flush out fine-grained sediment creating channels and floodplains composed largely of coarse textured sediment with little water holding capacity (Figure 2). Because the floodplains are dominated by tree and shrub species that require an abundance of available water all summer, they need stable water inputs from the watershed to maintain a shallow ground water level and soil water. The stable water inputs are provided by high flows during snowmelt and monsoon rain events, and surface water flow during the summer supports what appears to be a perennially high water table sufficient to support seedling establishment and persistence.

Calculations provided by AECOM (2021) provide an important baseline for quantifying the flow needed to create bankfull flows on Potter Creek in the reach analyzed. 177 cfs in the reach above the confluence with Monitor Creek, and 225 cfs in the reach below its confluence with Monitor Creek, was determined to be the flow needed to create bankfull flow. A review of the discharge data provided by CWCB indicated that bankfull or higher flows occurred several times over the 2016 to 2022 period.

Other species, such as willows, narrow leaf alder and red osier dogwood also rely on these high flows for reproduction. BLM's proposal to protect all flood flows from April through September makes sense because these high flows are critical to the regeneration of landforms, creation of habitat for seedlings and sprouts, and recharging the alluvial aquifer (Freidman and Lee 1996; Cooper Andersen Chimner 2003).

Figure 2. Potter Creek channel and tall narrow leaf cottonwood trees. Channel is largely cobble and the riparian surfaces are 3-6 feet above the channel. This photo taken in September 2021 was during a period of extreme drought when the channel was dry but available soil water allowed trees to survive this extreme period. Most trees are in good condition with full canopies and few dead branches, but a few dead trees are seen. Young cottonwood and willow seedlings and saplings occur on the right side of the channel.

Figure 3. Potter Creek has a well-developed cobble channel with riparian forests of diverse cottonwood and willow size and age classes on both sides of the channel. Most of the trees have healthy canopies indicating little water stress or branch shedding, although a few, such as the cottonwood seen on the top left, had ongoing canopy dieback.

Figure 4. Two narrow leaf cottonwoods on Cottonwood Creek, connected by a lateral root that was exposed by flood waters, illustrates this important process.

Figure 5. Pole sized (10-20 feet tall) narrow leaf and Fremont cottonwoods along Potter Creek indicate that conditions suitable for establishment have occurred in recent decades.

Figure 6. Multiple age and size classes of narrow leaf and Fremont cottonwood along Potter Creek indicate that suitable conditions for establishment have occurred in recent years.

THE ROLE OF INSTREAM FLOW IN SUPPORTING RIPARIAN COMMUNITIES ON POTTER CREEK

The persistence of a natural flood regime, and the mid elevation location of Potter Creek allows the persistence of a wide range of riparian trees, shrubs and herbs and produces several outstandingly remarkable values (ORVs) including plant diversity and fish and bird habitat. High natural biodiversity is supported, for example good examples of the following uncommon or rare plant communities are found in the study area:

- Narrow leaf cottonwood / strapleaf willow / silver buffaloberry *(Populus angustifolia / Salix ligulifolia / Shepherdia argentea)* Riparian Forest (G3/S3, B)
- Narrow leaf cottonwood / skunkbush sumac *(Populus angustifolia / Rhus trilobata)* Riparian Woodland (G3/S3, A)
- Narrow leaf cottonwood / red osier dogwood *(Populus angustifolia / Cornus sericea)* Riparian Woodland (G4/S4, A)
- Narrow leaf cottonwood - Douglas Fir *(Populus angustifolia - Pseudotsuga menziesii)* Riparian Woodland (G3/S2, B)
- Douglas Fir / red osier dogwood *(Pseudotsuga menziesii / Cornus sericea)* Riparian Woodland (G4/S2, B)

Rankings by the Colorado Natural Heritage Inventory (CNHP) indicate that these communities are either globally secure (G4) or globally vulnerable (G3), and state secure (S4), state vulnerable (S3) or state imperiled (S2). These communities are characterized by the typically higher elevation narrow leaf cottonwood, Douglas fir and red osier dogwood, and the lower elevation riparian species skunkbrush sumac, strapleaf willow and silverberry. The co-occurrence of these species indicates environmental conditions that rarely occur and are worthy of protection. The rarity is due to the persistence of the natural high flows in this watershed that creates suitable habitat for these species that rarely co-occur, as well as good populations of other important riparian species. These species all have life history characteristics that tie them to dynamic floodplains. All of these communities have tall canopies, with a diverse understory of shrubs. The species and communities are in good condition as indicated by the full canopies of the trees without an abundance of dead trees, or trees with largely dead canopies. The shrubs all have multiple stems and also appear in excellent condition.

It is striking that the exotic invasive species tamarisk/salt cedar (*Tamarix* species and hybrids), and Russian olive (*Elaeagnus angustifolia*), are almost entirely absent from Potter Creek. We know that these exotic species can be kept in check by the shade of taller riparian plants (DeWine & Cooper 2010) such as cottonwood. Maintaining these healthy riparian communities is essential for limiting the invasion of these exotic plants, and supporting populations of native animals including migratory birds, small mammals, and native fishes that seasonally occupy Potter Creek.

Potter Creek appears not to have existing upstream water rights that divert flow from the Creek. Therefore, it is one of the few streams in Colorado with a natural flow regime. These conditions will allow snowmelt driven and monsoon driven flood flows to move down Potter Creek, as well as baseflows, protected by an instream flow right. Below Potter Creek's confluence with Monitor Creek, much of Potter Creek has perennial flow due to contributions from Monitor

Creek. This reach supports small fishes in the summer, and an abundance of wetland plants such as "three square" (*Schoenoplectus pungens*) and even cattails (*Typha latifolia*).

The geomorphic processes that support key riparian species, and the ORV's they produce, is clearly tied to high flow events. Critical factors to consider for the long-term management of Potter Creek's ORV's are:

- Flows large enough to fill the channel, overtop the banks in many areas and create suitable bare and moist habitats for cottonwood and other riparian plant seedlings and sucker formation must occur regularly.
- AECOM's analysis identifies the flow needed to overtop the banks for the reach above Potter Creek's confluence with Monitor Creek (177 cfs), and below the confluence (225 cfs). Allowing all flows of this magnitude and higher to flow down Potter Creek is vital for the persistence of the riparian vegetation and its ORVs.
- High flows that occur just prior to the timing of cottonwood seed dispersal, typically in May and early June are vital for sexual reproduction. Normal snowmelt driven floods occur during this time and are suitable for creating these maintenance flows.
- The slow decline in flow on the descending limb of the spring snowmelt peak is important for maintaining soil saturation that helps support establishing seedlings and existing plants.
- Perennial flow down Potter Creek is needed to allow the riparian water table to persist within 8-12 feet of the ground surface, that is essential for cottonwood and other woody plants in the study reach during the summer.
- An existing instream flow water right of 4 cfs exists, and should provide summer baseflow if this instream flow occurs.

Potter Creek's riparian communities are in excellent condition, among the best of any I have seen in the Uncompahgre Plateau region. There is a wide range of plant sizes and ages, indicating regular and persistent reproduction and the plants have full canopies with well-developed understories. I recommend that BLM continue to monitor the condition of these communities and their responses to recent and future flows. The maintenance of available ground water within the trees rooting zone is critical for limiting future leaf and branch dieback or whole tree death, and tree reproduction. Maintaining the perennial water table within reach of the trees during the summer throughout the Potter Creek watershed is critical for the persistence of these ecosystems and their ORV's (Schook et al. 2020a,b, 2021).

LITERATURE CITED

AECOM. 2021. Cottonwood, Monitor and Potter Creek's Survey and Hydraulics. Unpublished report to Colorado Conservation Board.

Baker, W.L. 1990. Climatic and hydrologic effects on the regeneration of *Populus angustifolia* James along the Animas River, Colorado. Journal of Biogeography. 17-59-73.

Braatne, J.H., Rood, S.B., and Heilman, P.E. 1996. Life history, ecology, and conservation of riparian cottonwoods in North America. 1n Biology of Populus and its implications for management and conservation. Part I, Chapter 3. Edited Dy R.F. Stettler, H.D. Bradshaw,

Jr., P.E. Heilman, and T.M. Hinckley. NRC Research Press, National Research Council of Canada, Ottawa, ON, Canada. pp. 57-85.
BLM. 2022. BLM instream flow recommendation, Cottonwood Creek, Uncompahgre Plateau, Water Division 4.
Cooper, D.J., D.C. Andersen, R.A. Chimner. 2003. Multiple pathways for woody plant establishment on floodplains at local to regional scales. Journal of Ecology 91:182-196.
Cooper, David J. and David M. Merritt. 2012. Assessing the water needs of riparian and wetland vegetation in the western U.S. USDA Forest Service, Rocky Mountain Research Station, General Technical Report RMRS-GTR-282
Cooper, D.J., D.M. Merritt, D.A. Andersen and R. Chimner. 1999. Factors controlling Fremont cottonwood seedling establishment on the upper Green River, Colorado and Utah. *Regulated Rivers: Research and Management* 15: 419-440.
Cooper, D.J., D. D'Amico and M.L. Scott. 2003. Physiological and morphological response patterns of *Populus deltoides* to alluvial groundwater pumping. *Environmental Management* 31:215-226.
Cooper, D.J., R. Chimner, D. Merritt. 2012. Western Mountain Wetlands. Chapter 22, In: Wetland Habitats of North America: Ecology and Conservation Concerns. Edited by: Darold P. Batzer and Andrew H. Baldwin, University of California Press. Pages 313-328.
DeWine, J. and D.J. Cooper. 2010. Habitat Overlap and Facilitation in Tamarisk and Box elder Stands: Implications for Tamarisk Control Using Native Plants. *Restoration Ecology* 18: 349-358.
Friedman, J. M., W. R. Osterkamp, W.M Lewis. 1996. Channel narrowing and vegetation development following a Great Plains Flood. Ecology 77: 2167-2181.
Freidman, J. M. and V.J. Lee. 2002. Extreme floods, channel change, and riparian forests along ephemeral streams. Ecological monographs 72: 409-425.
Mahoney, J.M. & Rood, S.B. (1998). Streamflow requirements for cottonwood seedling recruitment- an integrative model. Wetlands, 18; 634-645.
Rood, S.B., S. Patiño, K. Coombs, M.T. Tyree. 2000. Branch sacrifice: cavitation-associated drought adaptation of riparian cottonwoods. Trees 14: 248-257.
Rose, J. R. and D. J. Cooper. 2016. The influence of floods and herbivory on cottonwood establishment and growth in a multi-herbivore system. *Ecohydrology* DOI 10.1002/eco/1768.
Schook, D., J. Friedman, J. Hoover, S. Rice, R. Thaxton, D. J. Cooper. 2021. Riparian forest productivity decline initiated by streamflow diversion then amplified by atmospheric drought 40 years later. *Ecohydrology*, in press.
Schook, D., J. Friedman, C. Stricker, A Csank, D. J. Cooper. 2020a. Short- and long-term response of riparian cottonwoods (*Populus* spp.) to flow diversion: analysis of stable carbon isotopes and tree-ring widths. *Science of the Total Environment* https://doi.org/10.1016/j.scitotenv.2020.139523
Schook, D. M., D. J. Cooper, J. M. Friedman, S. E. Rice, J. D. Hoover, and R. D. Thaxton. 2020b. Effects of flow diversion on Snake Creek and its riparian cottonwood forest, Great Basin National Park. Natural Resource Report NPS/GRBA/NRR—2020/2104. National Park Service, Fort Collins, Colorado.
Scott, M.L., Auble, G.T., and Friedman, J.M. (1997) Flood dependency of cottonwood establishment along the Missouri River, Montana, USA. Ecological Applications, 7:677-690.

Scott, M.L., Friedman, J.M., and Auble, G.T. (1996) Fluvial process and the establishment of bottomland trees. Geomorphology 14: 327-339.

Stanford, J. and J.V. Ward. 1993. An ecosystem perspective of alluvial rivers: connectivity and the hyporheic corridor. Journal of the North American Benthological Society:12: 48-60.

Tyree, M.T., K. Kolb, S. Rood, S. Patiño. 1994. Vulnerability to drought-induced cavitation of riparian cottonwoods in Alberta: a possible factor in the decline of the ecosystem? Tree Physiology 14: 455-466.

AMERICAN RIVERS

January 30, 2023

Rob Viehl
Instream Flow Program
Colorado Water Conservation Board
1313 Sherman St.
Denver, C0 80203

Dear Mr. Viehl:

The American Rivers Southwest Program would like to express our support for instream flow rights for Monitor, Potter and Cottonwood Creeks. These creeks are all located within the larger Roubideau Creek watershed, one of the most ecologically intact watersheds on the eastern side of the Uncompahgre Plateau.

The Bureau of Land Management determined that portions of Cottonwood Creek, Monitor Creek, and Potter Creek are suitable for Wild and Scenic River designation based on riparian vegetation communities deemed Outstandingly Remarkable Values (ORVs). In addition, American Rivers participated in a successful effort to obtain Outstanding Waters designation to protect water quality in Potter Creek and Roubideau Creek, based on the presence of indicator fish and vegetation species, as well as attainment of stringent water quality metrics. We support using the ISF Program to provide flow protection for these important values.

The American Rivers Southwest Region Program seeks to drive solutions for rivers and communities' ability to heal and thrive in the face of climate change and human impacts. We believe using the ISF program to protect flows in Monitor, Potter and Cottonwood Creeks will help protect the resilience of this important ecosystem.

Thank you for your consideration.

Sincerely,

Hannah Holm
Associate Director for Policy, Southwest Region
115 N 5th Street, #410
Grand Junction, CO 81501

COLORADO
Parks and Wildlife
Department of Natural Resources

Water Resources Section – Aquatic, Terrestrial, and Natural Resources Branch

March 3, 2023

Rob Viehl, Section Chief
Colorado Water Conservation Board (CWCB)
Stream and Lake Protection Section
1313 Sherman Street, 7th Floor
Denver, CO 80203

Re: Letter of Support for Instream Flow Recommendations on Cottonwood, Monitor, and Potter Creeks in Water Division 4

Dear Mr. Viehl:

Colorado Parks and Wildlife (CPW) is submitting this letter in support of the Bureau of Land Management (BLM) recommendations for instream flow (ISF) appropriations on Cottonwood, Monitor, and Potter Creeks, in Water Division 4. Cottonwood, Monitor, and Potter Creeks are tributaries of Roubideau Creek on the northeastern side of the Uncompahgre Plateau near the town of Delta. The riparian corridors of the three creeks support globally rare and vulnerable riparian communities, and the BLM is recommending an additional riparian ISF recommendation to protect high-flow events and the receding limb of the hydrograph. Although these streams have some baseflow protection through established and pending ISF rights held by the Colorado Water Conservation Board (CWCB), they currently lack flow protection for high-flow events which are critical for the establishment of seedlings and maintenance of the riparian communities. The BLM's riparian ISF recommendations are structured to only be in effect when flows are sufficiently high to meet or exceed the streams' bankfull thresholds. At other times, the existing seasonal ISF rights would continue to provide in-stream benefits. In total, the water rights will support conditions necessary to sustain these rare riparian communities and will also benefit native Colorado River warm-water fish species.

CPW believes that the BLM's recommendations are appropriate and necessary to support both globally rare riparian plant communities and native warm-water fishes. High flow events cue spawning migrations for juvenile and adult warm-water fish, and influence wood and sediment recruitment in the stream which are key contributors to the habitat forming geomorphic processes that support healthy spawning beds and refugia for resident fish populations. CPW is a fish and wildlife management agency, a landowner and a water user on Cottonwood and Roubideau Creeks at CPW's Escalante State Wildlife Area (SWA) Lower

Roubideau Tract. In these roles, CPW believes the CWCB and BLM's approach to flow protection is reasonable and protects water users, including CPW, with a reasonable future development allowance that would remain senior to the proposed ISF appropriation. Development allowances were based on discussions with water rights stakeholders, including CPW[1]. The ISF recommendations are structured to protect potential future water rights developments in the watershed while supporting the ecologically unique attributes of the three creeks.

Background

Cottonwood, Monitor, and Potter Creeks support healthy, intact riparian corridors which include narrowleaf cottonwood and skunkbush sumac, a riparian plant combination considered globally rare and vulnerable by the Colorado Natural Heritage Program (CNHP). The creeks' riparian areas also support diverse communities of other plant species, including silver buffaloberry, Fremont cottonwood, red osier dogwood, thin leaf alder, strap leaf willow, and coyote willow. While many of these species are widely distributed, they are rarely found growing in the same location, making many of these communities rare and vulnerable. Riparian plant communities are in high quality condition throughout the proposed ISF reaches. Cottonwood, Monitor, and Potter Creeks were identified as suitable for a Wild and Scenic Rivers designation because of these exemplary riparian traits considered "outstandingly remarkable values," or ORV's. These drainages are located within federally protected areas. Their headwaters start in the Uncompahgre National Forest. Lower Cottonwood Creek flows within the Dominguez-Escalante National Conservation Area, and Monitor and Potter Creeks are located within BLM lands near the Camel Back Wilderness Study Area. The BLM believes that land use protections, paired with a state-established ISF water right, will provide necessary long-term protection for Cottonwood, Monitor, and Potter Creeks, in place of a Wild and Scenic Rivers designation and federal reserved water right.

Native Fish Species in Cottonwood, Monitor, and Potter Creeks

Of particular interest to CPW, Roubideau Creek and its tributaries, Cottonwood, Monitor, and Potter, support Flannelmouth Sucker (*Catostomus latipinnis*), Bluehead Sucker (*C. discobolus*), and Roundtail Chub (*Gila robusta*), an assemblage of native Colorado River Basin fishes often referred to as the "three-species." All three-species are listed in the Colorado State Wildlife Action Plan as a Tier 1 Species of Greatest Conservation Need, or "species which are truly of highest conservation priority in the state." The three-species are exhibiting a downward trend and collectively occupy less than half of their native range in the Colorado River Basin overall. Contributing factors include hydrologic alteration, lack of connectivity, and competition and hybridization with non-native species. CPW is signatory, along with multiple tribes, states and federal agencies, to the Range-Wide Conservation Agreement and

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[1]CPW's requested development allowance in Cottonwood Creek is 1 AF and 0.1 cfs for a variety of potential future uses including storage, recreation, wildlife, fire-protection, domestic, and stock (SGM Delta Area Water Development Allowance for the CWCB, 2/17/23).

Conservation Strategy (UDWR 2006[2]) for the three-species. The goal of the Conservation Agreement is to ensure the persistence of populations of each of the three-species throughout their respective ranges. CPW seeks to reduce the imperiled status of these species across their historic range in Colorado in order to protect the species and to reduce the risk of a federal listing as threatened or endangered under the Endangered Species Act.

CPW researchers and aquatic biologists have dedicated significant resources to researching annual movement patterns and spawning tributary selection by three-species in the lower Gunnison Basin. Native fish tagged with passive integrated transponders ("PIT-tags") are monitored by CPW researchers. PIT-tag data reveals heavy use of Roubideau Creek and its tributaries by adult three-species during spring runoff and its receding limb. Extensive sampling conducted by CPW in the Roubideau Creek watershed between 2014 through 2022 shows large numbers of adult fish using these tributaries in the spring to spawn, as well as fall occupancy by young-of-year and juvenile native fish. Data from this research effort points to the importance of Roubideau Creek tributary habitats for the life histories of the three-species fishes. It is evident from work conducted in Cottonwood Creek that some important tributaries are ephemeral or intermittent. Cottonwood Creek only flows reliably during spring snowmelt, yet CPW has observed thousands of spawning adult three-species fishes using that tributary during runoff periods in 2014 through 2017 (Hooley-Underwood et al. 2019[3]). Expert opinion from numerous sampling events in Potter and Monitor Creeks also suggests high usage by adults for their spawning migrations.

Further research was conducted on these important tributaries to assess the viability of limiting the threat of hybridization with non-native suckers by managing their spawning run. CPW researchers installed and maintained a channel-spanning exclusionary weir on Cottonwood Creek from 2015 through 2017 and at the mouth of Roubideau Creek from 2020 through 2022. The purpose of these structures are to exclude non-native suckers during the spawning migration, thereby limiting hybridization with native sucker species. As part of this research, CPW found that upwards of 25,000 fish use the Roubideau Creek drainage to spawn annually, with thousands of fish using tributaries such as Cottonwood and Potter Creeks where where passive interrogation arrays (PIA's) were installed to detect PIT-tagged fish. Individual fish have very high annual spawning tributary fidelity in the system, with up to almost 80% of individuals returning to the drainage to spawn multiple years in a row (Hooley-Underwood, personal communication). This research highlights the importance of Roubideau Creek and its tributaries because of their influence on the persistence of the three-species in the entire Gunnison Basin. CPW has and will continue to dedicate significant resources to monitoring three-species movements and researching novel concepts to protect important spawning runs, such as Roubideau Creek and its tributaries, from threats. Instream flow protection is a complementary action to these research and monitoring efforts.

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[2] Utah Division of Wildlife Resources (UDWR). 2006. Range-wide conservation agreement and strategy for Roundtail Chub, Bluehead Sucker, and Flannelmouth Sucker. Publication Number 06-18. Prepared for Colorado River Fish and Wildlife Council. Utah Department of Natural Resources, Division of Wildlife Resources, Salt Lake City, Utah.

[3] Thompson, K. G., and Z. E. Hooley-Underwood. 2019. Present Distribution of Three Colorado River Basin Native Non-game Fishes, and Their Use of Tributary Streams. Colorado Parks and Wildlife Technical Publication 52.

Instream Flow Recommendation Structure and Benefits

The BLM is proposing additional ISF appropriations on Cottonwood, Monitor, and Potter Creeks that would offer high-flow protection in addition to the existing decreed and pending baseflow ISF rights held by the CWCB. The proposed ISF appropriations will come into effect once a bankfull threshold is met and would remain in effect until flows have receded back to the decreed or pending baseflow ISF rates. Bankfull thresholds vary for the four proposed ISF segments. This high-flow protection will only occur if the bankfull threshold is achieved between April 1 and September 30.

The BLM's recommendation is targeted to support riparian plant communities, but protecting high-flow events will also provide significant benefits to multiple life stages of native three-species. High-flows during snowmelt runoff provides phenological cues to aquatic species, including spawning mature fish and emergent aquatic invertebrates. A gradual recessional flow after the peak supports incubating eggs, as well as larvae development and hatching, as drastic streamflow reductions during this period can dewater eggs. Additionally, this flow component helps maintain habitat availability, specifically margin habitat which supports growth and maturation of larvae and young-of-the-year fish. A natural recessional flow enables adult fish to emigrate into larger river systems before they become stranded. High-flow events support multiple life stages of fish, as well as facilitating sediment transport, channel shaping, and recruitment of woody debris and organic materials, which are crucial for maintaining aquatic habitat over the long-term.

Conclusion

Research shows Cottonwood, Monitor, and Potter Creeks are critical spawning tributaries used by native fish during the spring high-flow period and receding limb. These are important tributaries in Colorado that influence the persistence of three-species in the greater Gunnison and Colorado River Basins. Additionally, the ORV's identified by the BLM on Cottonwood, Monitor, and Potter Creeks are unique ecological traits which warrant special consideration for ISF protection. The BLM and CWCB's approach is based on the best available science and factors in an allowance for reasonable water rights development in the basins in the future. CPW offers our support of the ISF recommendations on Cottonwood, Monitor, and Potter Creek which will support rare riparian plant assemblages and in turn benefit spawning migratory three-species and resident fish populations in the creeks. CPW will be available at the March CWCB meeting to answer any questions about the benefits this recommendation will provide to native warm-water species.

Sincerely,

Katie Birch — Digitally signed by Katie Birch Date: 2023.03.03 08:56:07 -07'00'

Katie Birch
CPW Instream Flow Program Coordinator

cc: Sralla, Unterreiner, Alves, Harris

Audubon | ROCKIES

320 East Vine Drive, Suite 312
Fort Collins, CO 80524

970.416.6931
rockies.audubon.org

Directors, Colorado Water Conservation Board
Colorado Department of Natural Resources
1313 Sherman Street, Room 718
Denver, CO 80203

February 24, 2023

RE: Support for Division 4 Proposed Uncompahgre Plateau Instream Flows

Dear Directors:

Audubon Rockies, a regional office of the National Audubon Society, expresses our support for the Lower Gunnison 2023 Instream Flow Recommendations for Cottonwood Creek, Monitor Creek, and Potter Creek in Water Division 4.

Audubon Rockies supports these instream flow recommendations to protect the full array of the ecological function of the three creeks. The Bureau of Land Management determined that portions of Cottonwood Creek, Monitor Creek, and Potter Creek contain riparian vegetation communities deemed Outstandingly Remarkable Values (ORVs). The recommended instream flows are specifically structured to protect the peak flow period for overbank flows critical for sustaining riparian corridor vegetation communities. These diversity-rich riparian corridor ecosystems provide essential ecological services such as influencing environmental processes, acting as habitats for terrestrial and aquatic biota, and supporting services and functions that benefit the surrounding community. Hence the sustainability of such river corridor ecosystems is highly significant.

Components of the recommended instream flow water rights encompass base and overbank flow. They will assist in protecting the full range of flow-dependent ecological functions in these creek corridors. Monitor, Potter, and Cottonwood Creeks are all located within the larger Roubideau Creek watershed, one of the most ecologically intact watersheds on the eastern side of the Uncompahgre Plateau.

Healthy watersheds provide diverse critical habitats for birds. As evidenced in the attached maps, the following identified three focal species are known to occupy this region. Please see maps for specific habitat ranges surrounding the three creeks. The Southwestern Willow Flycatcher, a federally listed endangered species, is known for controlling insect populations around wetlands, waterways, and nests in riparian habitats. The Peregrine Falcon relies heavily on rivers and riparian corridor for nesting and food supply. Lastly, with a widespread dependency on the watershed, Brown-capped Rosy-finches live on glaciers in the summer and in the canyons carved by rivers and streams in the winter.

Birds are sensitive indicators of environmental and watershed health. Given their dependence on different habitats, birds can detect changes in watersheds, including water quality and forest health. Improving the ecological function of the three creeks can secure healthy habitats for birds and wildlife, in addition to the health of our natural resources and environment.

Thank you for your consideration.

Sincerely,

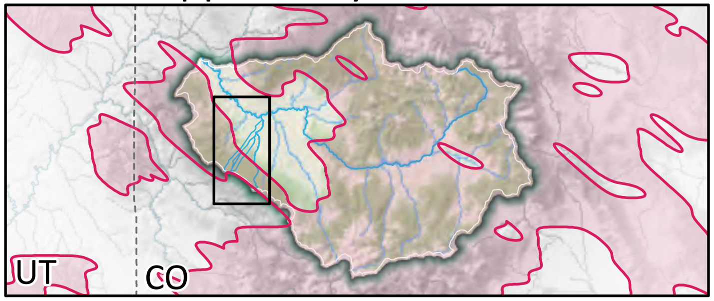
Abby Burk, Western Rivers Regional Program Manager

Samantha Grant, Western Rivers Senior Coordinator

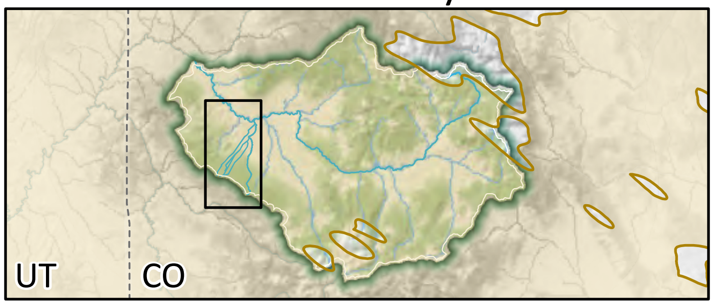
Avian habitat range in Gunnison River Basin, CO

Audubon

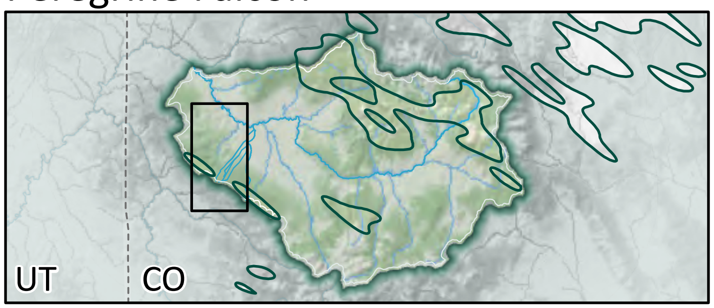
Brown-capped Rosy-Finch



Southwestern Willow Flycatcher



Peregrine Falcon



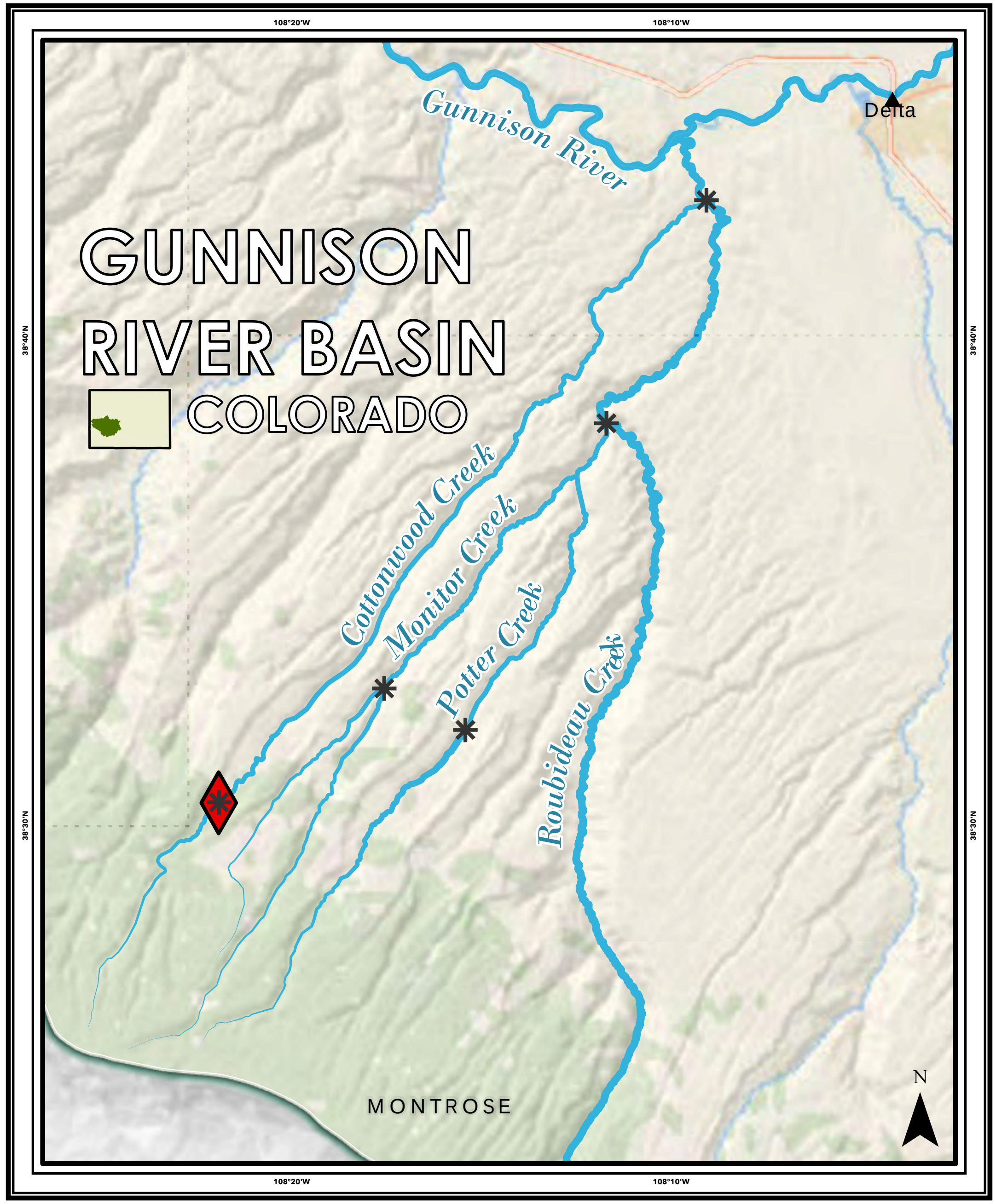
0 30 60 120 Miles

Streams and Rivers

Hawkins Ditch

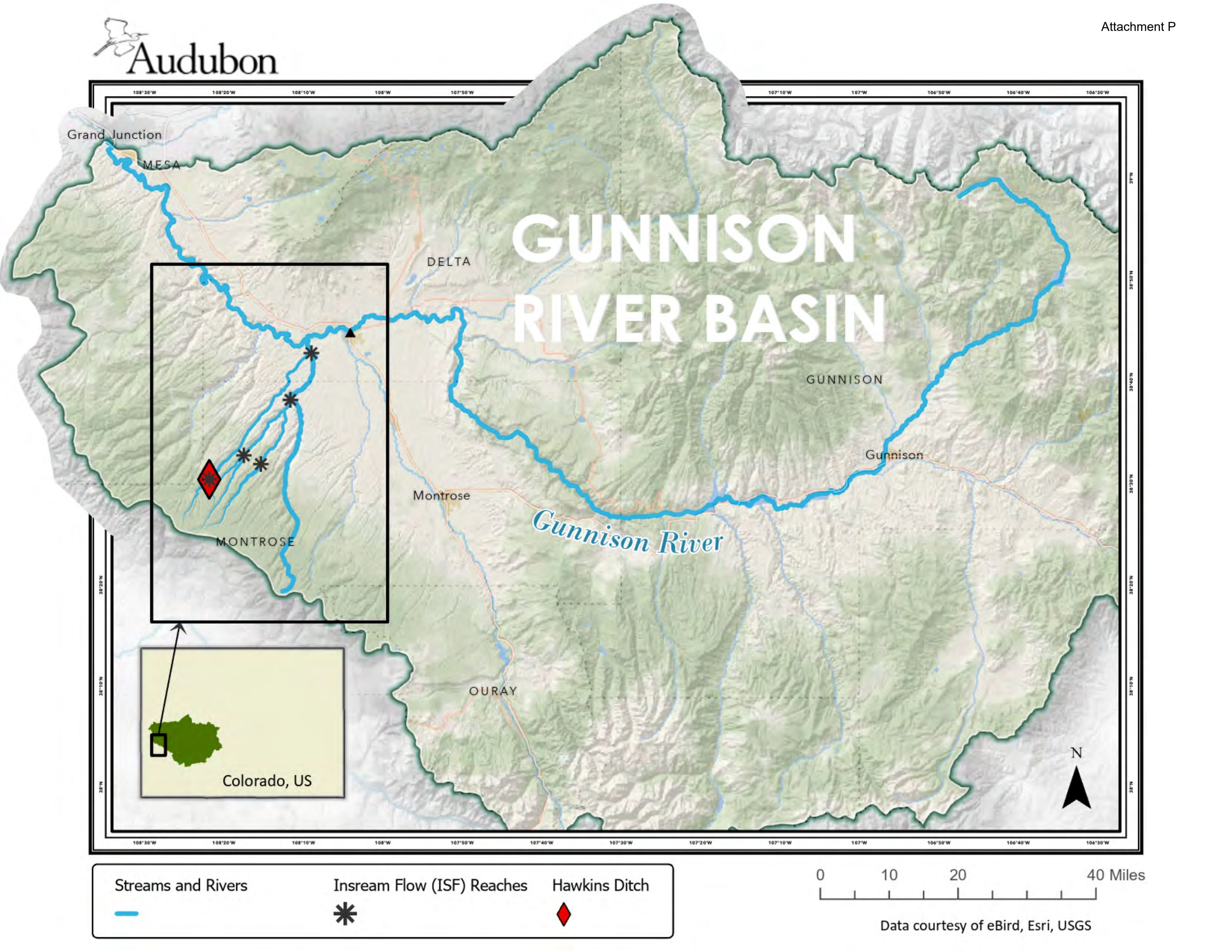
Insream Flow (ISF) Reaches

US State Boundaries



0 2.75 5.5 11 Miles

Data courtesy of eBird, Esri, USGS


Audubon
Grand Junction
MESA
DELTA
GUNNISON RIVER BASIN
GUNNISON
Gunnison
Montrose
Gunnison River
MONTROSE
OURAY
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Streams and Rivers
Insream Flow (ISF) Reaches
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40 Miles
Data courtesy of eBird, Esri, USGS