FINAL REPORT

Yampa Basin Alternative Agricultural Water Transfer Methods Study

March 2014

The Nature Conservancy
Protecting nature. Preserving life.™

TROUT UNLIMITED

CDM Smith

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Acronyms

AF	acre-feet
AFY	acre-feet per year
ATM	alternative agricultural water transfer methods
CDSS	Colorado Decision Support System
cfs	cubic feet per second
CPW	Colorado Parks and Wildlife
CSU	Colorado State University
CU	consumptive use
CWCB	Colorado Water Conservation Board
CWT	Colorado Water Trust
DWR	Division of Water Resources
GIS	geographical information system
ISFs	instream flows
IWR	irrigation water requirements
IWSA	Interruptible Water Supply Agreement
M&I	municipal and industrial
NRCE	Natural Resources Consulting Engineers
SEO	State Engineers Office
SWSI	Statewide Water Supply Initiative
SWSP	Substitute Water Supply Plan
TNC	The Nature Conservancy
TU	Trout Unlimited
USGS	U.S. Geological Survey
WFET	Watershed Flow Evaluation Tool
WY	Water Year

Executive Summary

Historically, transfer of irrigation water to other purposes has been implemented by permanently drying up irrigated fields and permanently moving that water to another purpose. This has been typically done by municipal water utilities that purchase agricultural water rights or shares in a ditch company and then change the consumptive use (CU) water from those water rights to municipal and industrial (M&I) uses. There are also a few examples of transfers from agriculture to environmental purposes such as adjudicated instream flow (ISF) water rights. Under some circumstances, these permanent transfers have an undesirable impact on communities and local economies. To reduce these impacts, the Colorado Water Conservation Board (CWCB) has funded several studies to identify alternative agricultural water transfer methods (ATMs) that provide agricultural water for other purposes on a temporary basis while in the long run keeping rural farmlands irrigated and producing crops.

As recipients of an ATM grant from the CWCB, The Nature Conservancy (TNC), Trout Unlimited (TU), and the Community Agriculture Alliance, with technical support from CDM Smith, evaluated potential voluntary alternative transfer methods that may allow agricultural water to be used to meet both irrigation shortages and environmental needs without permanently drying up currently irrigated land. The ideal scenario to accomplish the goal of relieving irrigation shortages while meeting environmental needs would consist of a lease of water from a willing upstream irrigator, delivery of that water through a stream reach that has an identified environmental need for higher flows, and then delivery of that water to a downstream irrigator whose agricultural water right is short. TNC and TU intend to bring financial resources to the Yampa Basin to implement one or more ATM transactions upon completion of the technical analysis.

This study—and any transactions that follow from it—was based on two key principles:

1. Any transactions would involve only willing participants, and
2. Water transfers would be temporary.

Irrigation shortages considered were identified during the Agricultural Water Needs Study completed for the Basin Roundtable in 2010[1] (although the methods used in the report to calculate shortages were not identical to the approach used in the Agricultural Water Needs Study). Environmental needs considered were (a) CWCB-held ISF water rights that have historically not been satisfied, (b) moderate and high risk locations identified in the Watershed Flow Evaluation Tool study[2], and (c) other stream reach locations identified by local biologists as being at times acutely short of flows needed to sustain fish.

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[1] CDM Smith. 2010. Yampa/White/Green Basin Roundtable Agricultural Water Needs Study.

[2] CDM Smith. 2012. Yampa-White Basin Roundtable Watershed Flow Evaluation Tool Study.

The specific objectives of the project were to:

1. Identify locations in the Yampa Basin where potential ATM transactions could help to meet nonconsumptive needs and agricultural shortages.
2. Identify the types of ATM transactions that are most suitable for meeting multiple purposes.
3. Conduct outreach to water rights owners, governmental entities and other interested parties to
   i) share the premise of the study, and
   ii) seek feedback for informing our understanding of potential ATM transactions.
4. Produce a final report describing potential ATM transactions, and
5. If willing participants are found, begin working toward implementation of a pilot ATM transaction.

During implementation of this project, TNC and TU communicated with the agricultural community and treated personal information about water rights with respect.

Progress on the project was presented multiple times to the Yampa-White-Green Basin Roundtable, at times to the entire Roundtable, and at times through the Ag Subcommittee of the Basin Roundtable. Also, throughout this project TNC and TU sought guidance from an agricultural advisory committee consisting of the Community Agricultural Alliance, Colorado State University Extension, and the Routt County Conservation District.

This study necessarily used detailed information about water rights (diversions, shortages, CU, etc.). Though all information was obtained from publicly available sources, this report illustrates the analysis and findings without presenting data and information that would put a strong light on any one private water right.

Lessons Learned

- The ideal scenario described above (upstream lessor, delivery to a downstream short irrigator, meeting environmental needs in between) is challenging to put together because of the mismatches in timing of water availability and shortages as well as challenges around water rights administration. This is particularly true when considering only potential lessors who are "water long," i.e., potential lessors whose water rights are fully satisfied in most years. Considering "water short" irrigators as potential lessors opens up more possibilities. A less complicated scenario may exist where a CWCB ISF water right is the recipient of leased water. While beneficial to the lessor and the environment, this less complicated scenario is less desirable because it does not meet the ideal of serving both irrigation shortages and environmental needs. In such a case, even if there is not an identified agricultural water *shortage* to use the water after the CWCB instream use, the additional water in the river should improve water availability and delivery for downstream diverters.

- There are limitations to what can be done with existing, publically available data and tools. For example, although StateMod is a useful tool for determining supply availability and diversion shortages, it is dependent on key assumptions built into the model as well as data from HydroBase. In many instances, HydroBase incompletely captures actual irrigation practices, irrigator interactions, and other special circumstances that may have a substantial effect on the feasibility of agricultural transfer methods. Ultimately, direct on-the-ground information and analysis for specific potential transactions is required.

- Shepherding leased water past headgates for delivery to a downstream irrigator while meeting environmental needs along the way remains a challenge for multiple reasons, including:
  - Water leased from upstream can be protected for delivery to a downstream user only if the downstream water right is short at the same time that the upstream leased water is available. Also, there are numerous other factors that determine whether or not water can be protected past headgates, including relative seniority of the lessor's water right to intervening headgates, the ability to call an upstream water right, the amount of streamflow in the reach, and the condition of intervening diversion structures.
  - An adjudicated CWCB ISF water right can be used to protect streamflow for the environment, but these rights are often the most junior rights on a stream. The CWCB can use leased water to: (1) supplement existing ISF water rights that are not being met; (2) add water to existing ISF water rights above their decreed amount to improve the natural environment (but only as authorized by a water court decree); and (3) to preserve and in some cases improve the natural environment on a stream reach where no decreed ISF water right currently exists, but only as authorized by a water court decree. Many variables influence whether such leases can provide benefits to the environment, with the primary variable being whether the leased water is available at times when needed by the natural environment, such as in late summer to increase flows and decrease water temperature.
  - To determine return flow obligations, a detailed analysis for a particular transaction is needed, detail that is beyond the scope of this study. Though we have not completed detailed return flow analyses for any potential transactions identified in this study, the limited amount of available storage capacity in the Yampa Basin could mean that there are few options for managing return flows using existing infrastructure.
- Leasing to meet both agricultural and environmental shortages simultaneously will benefit from collaboration among water users on a stream. Legal innovations may also be needed in order to achieve the desired outcome of simultaneously meeting environmental needs and irrigation shortages. Even if it is difficult to fill in agricultural and environmental shortages simultaneously through a single transaction, there should be more plentiful opportunities to benefit environmental or agricultural water shortages through separate transactions.

Recommendations

- Work with individual water right owners who have expressed interest in temporary leasing for the environment. During this study, we heard clear interest in leasing from some individuals stemming from a desire to:
  - Increase options for deriving economic benefit from their water right,
  - Put their water right to a recognized use while dealing with short-term issues that prevent water use in any given year, such as needed maintenance, and
  - Benefit the environment.

- Continue to create technical and legal innovations that increase the options of water right owners while protecting other water users from injury. Specific current efforts that, if supported, could greatly advance ATM goals include:
  - "Water efficiency savings" legislation that would allow for instream protection of irrigation water saved through efficiency improvements.
  - "Flexible market" legislation that would reduce the costs and increase the options for an irrigator to temporarily transfer water to another beneficial use—including ISF—without risk of abandonment.
  - A West Slope or Upper Colorado River Basin water bank, the primary intent of which is to mitigate risk of a Colorado River compact call. Among the benefits that would accrue from a water bank would be (a) increasing options for irrigators to derive economic benefit from their water rights, and (b) providing additional ISF using water deliveries from willing lessors to the bank. The Water Bank Working Group, made up of the Colorado River Water Conservation District, Denver Water, TNC, and others, has expressed a keen interest in temporary leasing along the lines of what is described in this report.

In summary, this study identified several locations where ATMs meeting needs of both the environment and consumptive uses could be implemented, while also illustrating challenges that, if surmounted, could expand the number of leasing transactions that meets the needs for flexibility and increased mutual benefit among consumptive and nonconsumptive interests. There are also hopeful signs in the interest expressed across these sectors and in technical and policy innovations being pursued across Colorado. With the right set of collaborative efforts along with technical and legal tools, the type of leasing arrangement studied in this project could offer substantial benefit to both irrigators and the environment.

Section 1

Introduction

In 2012, the Colorado Water Conservation Board (CWCB) awarded a grant to The Nature Conservancy (TNC) to identify potential projects and methods that could be used to meet both nonconsumptive and consumptive needs in the Yampa River Basin. This effort leveraged existing studies funded by CWCB (e.g., the Yampa-White Basin needs assessments) to identify the most favorable candidate locations for implementing alternative agricultural water transfer methods (ATM) projects to meet nonconsumptive and consumptive needs. The main targeted needs of this project were environmental attributes and agricultural shortages. The project examined available water rights and a variety of ATM mechanisms to identify the best candidates possible for ATM projects.

This technical report describes the analytical methods employed for the Yampa ATM study and provides a general summary of findings. Contents of the report are as follows:

- **Section 1** provides a summary of CWCB's Agricultural Water Transfer Methods Grant Program, an overview of the Yampa ATM study, including project partners, project objectives, and study area.
- **Section 2** describes types of ATMs that may be implemented in the Yampa Basin as well as the legal mechanisms available to facilitate that implementation.
- **Section 3** describes analytical methods used in the study, including data sources and target scenarios.
- **Section 4** documents the four levels of screening analysis that were performed to identify and refine potential candidate reaches for implementation of ATMs in the Yampa Basin.
- **Section 5** summarizes potential water administration issues related to ATM implementation in the Yampa Basin.
- **Section 6** summarizes project conclusions and provides recommended next steps.
- **Section 7** provides a list of cited references.

1.1 CWCB Alternative Agricultural Water Transfer Methods Grant Program

The Statewide Water Supply Initiative (SWSI) 2010 (CWCB 2011a) estimated that by 2050, the State of Colorado may lose 500,000 to 700,000 acres of currently irrigated farmland. These losses are predicted due to a number of reasons, including urbanization, inadequate augmentation water supplies for out-of-priority well pumping, enrollment of lands in conservation programs, declining aquifers, and compact compliance. Additional irrigated acres are anticipated to be lost due to planned agricultural-to-municipal water transfers and transfers to meet the future water supply gap.

Historically, as described by CWCB (2012) in the ATM Grant Program Summary and Status Update technical memorandum, agricultural-to-municipal water transfers have been implemented through a process commonly referred to as "buy-and-dry" or traditional agricultural transfers. In such transfers, a water provider—such as a municipal water utility—typically purchases agricultural water rights or shares in a ditch company, and the use of CU water from those water rights is changed in water court to allow municipal and industrial (M&I) uses. The formerly irrigated farmland must be permanently dried up and re-vegetated using native plant species (to prevent erosion and growth of noxious weeds) or converted to dryland farming practices. In cases where the parcels are located near a rural/urban interface, the land may be developed and urbanized. It is in this manner that large tracts of Colorado's historically irrigated lands have been lost and will continue to be lost in the future.

In order to reduce the burden on irrigated farmland and agriculture-dependent economies associated with traditional buy-and-dry transfers of agricultural water to municipal use, recent years have seen increased efforts to identify ATMs. In general, these ATMs are techniques that seek to provide agricultural water for M&I use on an as-needed basis while keeping rural farmlands irrigated and producing crops.

Senate Bill 07-22 authorized the CWCB to develop a grant program to facilitate the development and implementation of ATMs in the state. Since its inception in 2007, the CWCB's Alternative Agricultural Water Transfer Methods Grant Program has awarded nearly $3 million to municipal water providers, ditch companies, conservancy and conservation districts, university research teams, nonprofit organizations, and other entities to pursue ATMs.

1.2 Yampa Basin ATM Study

In 2012, CWCB's Alternative Agricultural Water Transfers Grant Program awarded $132,000 to TNC to build upon concepts that emerged from the previous round of ATM grants and other related studies. The following sections identify the project proponents and partners, project objectives, and project study area.

1.2.1 Project Partners

TNC and its partner Trout Unlimited (TU) were the primary proponents of the Yampa Basin ATM project. Additional guidance was provided by an agriculture outreach committee consisting of representatives from the Colorado State University (CSU)/Routt County Extension, the Community Agriculture Alliance, and the Routt County Conservation District. Representatives of these organizations are as follows:

- TNC – Geoff Blakeslee and John Sanderson
- TU – Brian Hodge and Drew Peternell
- CSU/Routt County Extension – Todd Hagenbuch
- Community Agriculture Alliance – Marsha Daughenbaugh
- Routt County Conservation District – Jackie Brown

Consultant CDM Smith contracted with TNC to perform the technical analyses for the Yampa ATM study. The project team also met with, and received guidance from, Water Division 6 Division Engineer Erin Light, Water Commissioners for the five Water Districts in the project study area, Linda Bassi and Jeff Baessler of CWCB's Stream & Lake Protection Section, and staff of the Colorado Water Trust (CWT). The project team also shared progress on a few occasions with the Yampa-White Basin Roundtable and its Agricultural Subcommittee.

1.2.2 Project Goals and Objectives

The overarching goal of this study was to understand opportunities and limitation for lessors and lessees to work together in willing-participant transactions to simultaneously meet multiple needs for water. A corollary goal was to find opportunities for water users and habitat conservationists to work together on mutually beneficial projects. Good communication from those executing this project and the ranching community is essential for the success of this effort, and the technical analysis was at times slowed by our recognition that this communication had not yet been sufficiently thorough. TNC, TU, and their partners have worked and will continue to work through the Agriculture Subcommittee of the Yampa-White-Green Basin Roundtable to improve understanding of the needs of the ranching community, and to keep that community apprised of our activities. It is the intention of the habitat conservation community to bring financial resources to the Yampa Basin to implement an ATM pilot project upon completion of the technical analysis now being conducted.

Following are the study objectives for this project:

1. Identify locations in the Yampa Basin where ATMs could help to meet nonconsumptive needs and agricultural shortages.
2. Analyze ATM transactions that might be used to meet multiple needs in specific candidate locations.
3. Identify which ATM mechanisms are most suitable for meeting multiple purposes in each candidate location.
4. Conduct outreach to water rights owners, governmental entities, and other interests to gage, and develop, interest in ATM transactions.
5. Produce a final report describing in detail the most favorable ATM transactions and describing the next steps for implementing each of those transactions.
6. Begin working toward implementation of ATM transactions recommended in the final report.

The Yampa Basin ATM project may yield valuable information that is transferable to other basins, including the technical aspects of ATM assessment and implementation as well as insights regarding outreach to local communities in efforts to encourage irrigators to willingly participate in such programs. This project may also prove useful in identifying possible water rights to be used in a West Slope water bank should that concept become a reality. The project also seeks to expand the scope of ATMs to the benefit of both consumptive and nonconsumptive uses.

1.2.3 Study Area

As shown in **Figure 1**, the Yampa River Basin is situated in the northwestern corner of Colorado, bordering both Wyoming and Utah. The drainage covers 6,780 square miles and contains the majority of Routt and Moffatt Counties. The Yampa River Basin is part of Water Division 6, along with the North Platte Basin and the White River Basin, and it is subdivided into multiple administrative Water Districts.

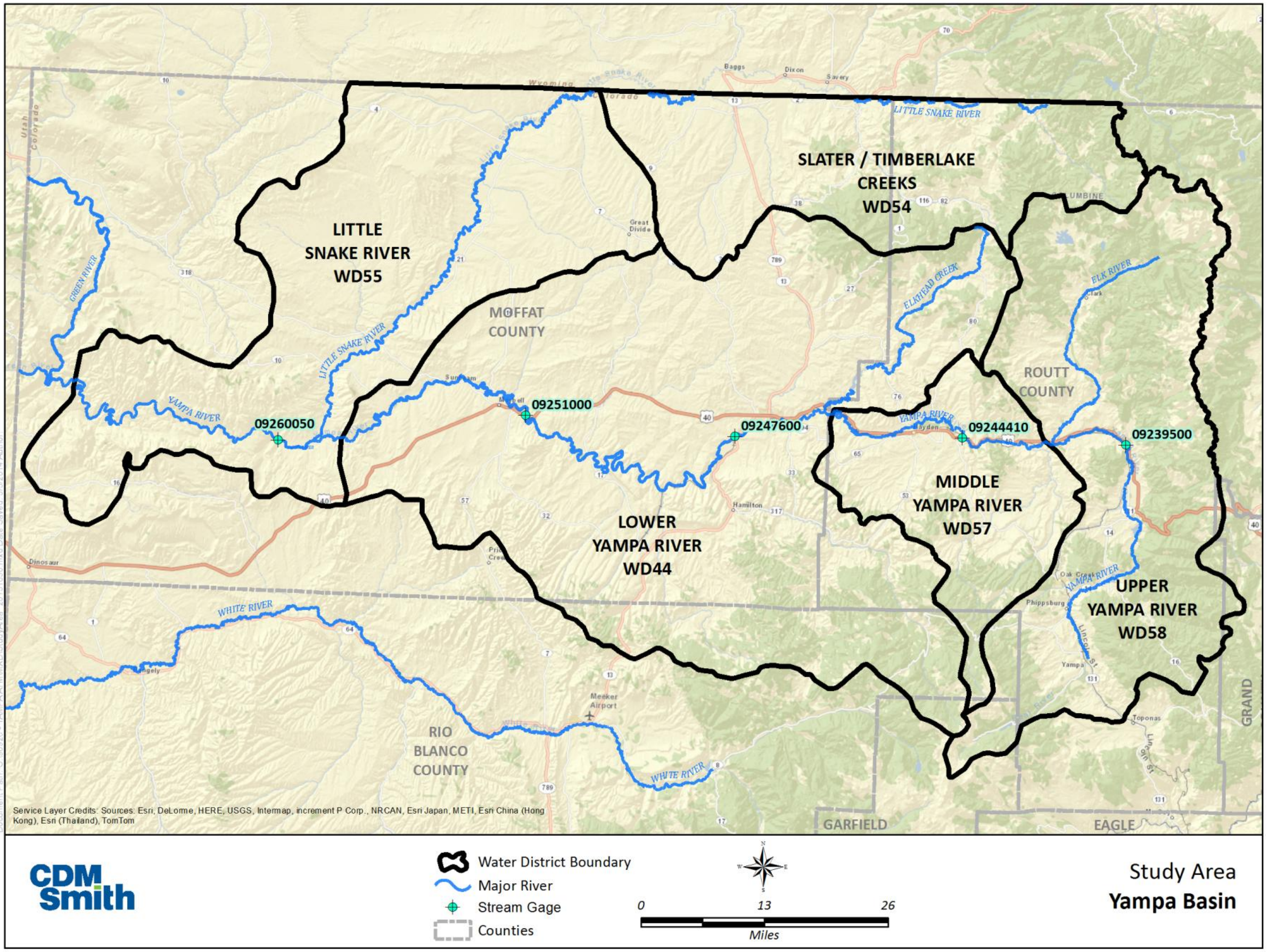

Figure 1. Yampa Basin Study Area

The study area for the Yampa ATM project included five Water Districts that cover the following hydrologic basins:

- Water District 44 – Lower Yampa River
- Water District 54 – Slater/Timberlake Creeks
- Water District 55 – Little Snake River
- Water District 57 – Middle Yampa River
- Water District 58 – Upper Yampa River

SWSI 2010 (CWCB 2011a) characterizes Yampa Basin as having a majority of demand contributed by agricultural irrigators (235,000 ace-feet per year [AFY] of irrigation water requirements (IWR) for the combined Yampa-White Basin), and a comparatively small M&I demand (12,000 AFY for the combined Yampa-White Basin). Streamflows in the Yampa Basin are provided primarily from snow melt runoff and are characterized by high spring and early summer flows and low late summer and fall flows. This effect is most apparent in the small upper tributary streams. These streamflows tend to affect irrigation practices as ranchers will divert their full water right early in the growing season and oftentimes do not have a full supply in the later season. Major mainstem streamflow gages are also shown in **Figure 1**; historical streamflows are summarized in **Table 1** below.

Table 1. Average Annual Flow at Major Yampa River Mainstem Streamflow Gages

Gage	Gage ID	Average Flow (cfs)	Period of Record	Drainage Area (mi^2)
Yampa River at Steamboat Springs, CO	09239500	512	1904-2013	567
Yampa River Below Diversion, Near Hayden, CO	09244410	1,117	1965-1986	1,430
Yampa River Below Craig, CO	09247600	1,270	1984-2013	2,128
Yampa River Near Maybell, CO	09251000	1,561	1916-2013	3,383
Yampa River at Deerlodge Park, CO	09260050	2,153	1982-2013	7,931

SWSI 2010 (CWCB 2011a) estimated then-current irrigated lands in the Yampa Basin at 119,000 acres. As a result of anticipated losses to urbanization and agriculture-to-municipal transfers to meet the M&I gap, it was estimated that by 2050, irrigated lands in the Yampa Basin would be reduced to a range of 53,000 to 115,000 acres. SWSI 2010 also considered the possibility that new irrigated lands may be added in parts of the Yampa Basin. Irrigated agriculture in the Yampa Basin consists mainly of ranches growing hay for their cattle herds, which are cow-calf operations requiring hay for winter feed. During years with water shortages, ranchers may have to buy hay to supplement their hay supply or in extended droughts, reduce herd sizes. The main crops in the basin are pasture grass and alfalfa with pasture grass amounting to 93.6 percent and alfalfa totaling 6.0 percent of the irrigated area in 2005 (Natural Resources Consulting Engineers [NRCE] 2012). Nearly all of the lands are flood irrigated with some limited sprinkler irrigation.

Most pasture grass is harvested only once during the growing season and irrigation after cutting is done by some ranchers to provide water to grow grass for grazing when the cattle are brought down from the high country pasture for the winter season. Due to the significant agricultural uses and the presence of important environmental resources, the Yampa Basin provided a unique opportunity to determine the effectiveness of ATMs to provide water for environmental and instream purposes. In addition, ATMs may be a means of minimizing the future losses of irrigated lands anticipated by SWSI 2010 over the next 40 years.

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Section 2

ATM Practices and Legal Mechanisms

There are two major requirements to make water available to another user through implementation of an ATM: (1) a change in on-farm practices to reduce consumptive use (CU), and (2) a legal mechanism to transfer that water to another user on a temporary or permanent basis. These topics are explored in the following sections.

2.1 Types of ATMs

CWCB (2011b) described a variety of ATM practices that were to be considered by projects funded through the ATM grant program; relevant sections of that report are included in Appendix A. As described in Section 1.2.3, hay meadows dominate irrigated agriculture in the Yampa Basin; thus, given the environment and primary irrigation practices of the Yampa Basin, not all types of ATMs would be viable.

The following are possible means of altering existing irrigation practices to reduce CU and make water available for the implementation of ATM transactions in the Yampa Basin:

- Full-season fallowing
  - *Full-season fallowing* would include forgoing irrigation of certain fields or tracts for an entire season. Full-season fallowing would be performed on a rotational basis so that pasture grass or alfalfa would not die off.
- Reduce Crop Irrigation Consumptive Use
  - *Split-season irrigation* is an agreement where irrigation is terminated prior to the end of the historical irrigation season and the saved CU is leased to another irrigator or to the CWCB for an instream flow (ISF) water right.
  - Split season irrigation is a type of *deficit irrigation*, when an irrigator intentionally provides the crop with less than the crop's irrigation water requirement, thereby reducing CU. Lindenmayer et al. (2011) addressed both split-season and full-season irrigation on alfalfa, and they concluded that split-season irrigation is the more effective way to reduce CU. The Colorado Water Bank Feasibility Study – Phase 2 (MWH 2013) found that potential exists for using deficit irrigation under some circumstances, that split-season irrigation is the most feasible type of deficit irrigation on the West Slope, and that economic and technical challenges may inhibit use of full-season deficit irrigation.
  - *Changing crop types* to a crop with a lower CU may also affect the amount of irrigation water required to fulfill crop irrigation requirements. In this case, the difference between historical crop CU and the new crop CU could be transferred downstream to another use. This may be difficult to implement on some areas with pasture grass since shallow water tables and saturated soils may make it difficult to grow other crops with lower CU such as wheat or barley. This type of reduction in CU would require water court approval and while possible, it may not be achievable under a temporary action such a lease or loan.

2.2 Potential for ATMs in the Yampa-White Basin to Contribute to the West Slope Water Bank

The Colorado River Water Conservation District[3] is spearheading an effort to create a Water Bank on Colorado's West Slope that would serve to avoid or mitigate a Lee Ferry deficit under the 1922 Colorado River Compact. Through the proposed Water Bank, agricultural water users could voluntarily participate in an ATM such as rotational fallowing or split-season irrigation (as described above on a temporary basis as part of a larger effort to avoid, reduce, or mitigate a Lee Ferry deficit). Rotational fallowing and split-season irrigation could avoid permanent dry-up and help keep agriculture and its associated infrastructure intact. Any water users who choose to participate would be paid for participating in an ATM by a junior water user who needs to be protected. Junior users may include Front Range cities, water uses for health and safety, power plants, and high-value perennial crops such as vineyards and orchards.

Partners in the Water Bank study are the Southwestern Water Conservation District, the Front Range Water Council, TNC, and the CWCB. There is also a group of advisors helping with the study, including irrigators, tribes, and the Bureau of Reclamation. The Water Bank study is investigating feasibility by looking at:

- Supply and demand
- On-farm feasibility
- Regional economic and environmental impacts

In Phase 2A, the Water Bank working group examined the supply side of the water bank in greater detail by evaluating the feasibility of the water bank in a representative set of eight irrigation systems. The irrigation system in the Yampa Basin that was examined was the Ekhart Ditch on the upper Elk River.

The Yampa ATM project team has reviewed the Water Bank Phase 1 and Phase 2 reports (MWH 2012; 2013), and based on those reports a plausible West Slope Water Bank scenario for the Yampa-White Basin is described below.

Two basic points that were considered in developing this scenario are:

- Although pre-1922 (pre-compact) would not be curtailed in the event of a Lee Ferry deficit and all post-compact rights are potentially subject to curtailment, compact water banking is not necessarily limited to banking the CU from pre-compact rights only, because it may be possible to accumulate credits—including post-compact CU—in Lake Powell or other Colorado River Storage Project units to avoid compact calls.

- One of the findings in the Phase 1 and 2 reports is that CU reductions from the rotational and split-season schemes will vary considerably by crop types and elevation.

[3] For more information on the Water Bank, or to obtain a copy of the Phase 1 and Phase 2 reports, contact Dan Birch at the Colorado River Water Conservation District (dbirch@crwcd.org) or Aaron Derwingson at The Nature Conservancy (aderwingson@tnc.org).

Information in the Phase 1 and Phase 2 reports makes it possible to estimate CU that could potentially be fallowed using an ATM and subsequently delivered to the state line, less some transit loss, for water banking. The estimates are based on the following information:

- Table 10 from the Phase 1 report shows the total supply limited consumption by irrigation in the Yampa-White as: 149,393 acre-feet (AF) with 139,765 AF in grass pasture and 8,957 AF in alfalfa. The elevation tables in Appendix A to the Phase 1 report indicate that approximately 77 percent of the irrigated pasture is below 7,000 feet.
- The Phase 1 report provides an example (page 10) that for irrigated grass and alfalfa hay crops around 5,000 feet, 45 percent of the CU can be saved if the irrigation season is split and no irrigation occurs after July 1. As elevation increases, however, there are fewer cuttings. In the highest elevation farms and ranches, no "split season" fallowing can occur if only a single cutting is possible—only full-season fallowing. The estimated savings for the Yampa-White is reduced to 15 percent, due to the limited pasture below 5,000 feet.

CU for potential Water Bank delivery is derived from two sources: split-season irrigation and full season rotational fallowing. Potential annual CU savings derived from each of these sources under a Water Bank scenario may be calculated as follows:

- Full season, rotational fallowing—If 10 percent of all grass pasture and alfalfa is fully fallowed on a rotating basis, 14,939 AF of CU could be saved.
- Split-season irrigation—15 percent savings for fallowing of irrigated pasture below 7,000 feet that is not affected by full season rotational fallowing = 15,529 AF [(149,393 AF – 14,939 AF) * 77% * 15%]

Total potential Yampa-White Basin Water Bank deliveries before transit loss: 14,939 AF + 15,529 AF = 30,468 AF.

Theoretically, this Water Bank could provide a downstream delivery point for any voluntary fallowing of irrigation CU in the Yampa Basin, but the operational mechanisms for this Water Bank have yet to be developed. ATMs would need to be broadly applied and the funding secured for both direct and indirect compensation. A number of difficult questions also remain unresolved about when water banking operations should be triggered and at what level. The studies to date have focused on the supply potentials.

2.3 Legal Mechanisms for ATM Implementation

Section 2.1 described the most appropriate ATMs for addressing consumptive and nonconsumptive water needs in the Yampa Basin. A related activity is to identify the legal mechanisms that exist in Colorado Revised Statutes that would allow various ATMs to operate in accordance with statutes and regulations. There are four potential methods for an ATM to operate on a temporary basis that can provide water for consumptive and nonconsumptive water needs depending on the specific goal to be achieved. They are as follows:

1. Loan of water between two agricultural water users as allowed under CRS 37-83-105 (1).
2. Loan of water to the CWCB for ISF pursuant to a decreed ISF water right as allowed in CRS 37-83-105 (2).

3. Operation under an Interruptible Water Supply Agreement (IWSA) pursuant to CRS 37-92-309 and the State Engineer's Regulations 2CCR 402-15.

4. Operation under a Substitute Water Supply Plan (SWSP) pursuant to CRS 37-92-308 (5).

The use of these four methods would allow an ATM to be approved by the State Engineer[4], which would provide water for consumptive and nonconsumptive needs. The following sections review the various mechanisms available and identify various requirements for each mechanism.

2.3.1 Loan of Water between Two Agricultural Water Users: CRS 37-83-105 (1)

The "loan statute" was originally approved by the Legislature in 1899 and was for loans between agricultural water users. The Supreme Court in two cases in 1907 interpreted the statute so as to ensure that the water rights of other water users would not be injured by the loan. With this interpretation, the use of the loan statute has been limited in its application since most water users wishing to loan his/her water right wanted to do so in a manner to not limit their crop production. The most common loan request under the 1899 statute was to have the senior water right owner irrigate the crops under his/her lands and then allow a junior water right owner to irrigate his/her lands and then rotate the water back to the senior water right. This can result in an expanded use of the senior water right and injury to other water rights

The loan statute was amended in 2003 by the Legislature in response to various efforts to use the statute in the drought of 2002 that were found to not be in accordance with the statute; i.e., a loan from a water right in the Aspen area to Glenwood Springs to achieve ISF benefits for trout habitat in the intervening reach or for loans between agricultural water users that had the potential to cause injury to other water users as described in the above paragraph. The amended statute has criteria for the State and Division Engineer to follow in considering approval of a loan CRS 37-83 105 (2) (b). It also has public notice provisions so that other water users have the opportunity to comment on the potential injury to their water rights if within a 15-day comment period. The loan to another agricultural water user cannot exceed 180 days during one calendar year.

The use of this section of the loan statute could be used to allow an upstream senior water right owner to restrict the irrigation use of the water on his/her land and allow the water to flow downstream to a junior water right. The reach of the stream between the water rights would have enhanced flows by at least the amount of the CU and possibly an additional amount associated with the return flows that reached the stream in the same irrigation season. The return flow could be diverted by intervening water rights. However, if there are no intervening diverters, the reach could be benefitted by both the CU and the return flow lagged back to the stream. The Division Engineer may require that lagged groundwater return flows be maintained through the use of a recharge pond located on the upstream lands. If there is an intervening water right that is senior to the downstream water right that could divert the water then potentially only the CU component of the senior loaning water right could be protected to the downstream receiving water right. In identifying candidate locations for ATMs under this statute, the contractor will identify those that do not have intervening water rights with more senior priorities than the water right being loaned. The use of this statute will require that the

[4] An ATM for the lease or rotation of an irrigation water right to improve ISFs can also be allowed under CRS 37-92-102(3). However, this statute requires approval by the CWCB and then the water court. This report only addresses ATMs that are approved by the State Engineer.

upstream senior water right forgo all or a portion of the CU of the water right to prevent any expanded use and injury to other water rights.

2.3.2 Loan of Water to the CWCB for Instream Flow Purposes: CRS 37-83-105 (2)

The section of the "loan statute" was added in 2003 to allow senior water rights to be used through a loan to the CWCB for the purpose of enhancing the decreed ISF water rights of the CWCB that are not being satisfied. The application of this loan is expected more often in drought years when the stream flows are below average. The CWCB prior to accepting the loan must compile sufficient information to allow the State Engineer to determine that such loan does not injure existing decreed water rights; CRS 37-83-105 (2) (a) (I). The exercise of this loan is limited to 120 days per year and is further limited to a maximum of 3 years in a 10-year period. The 10-year period is for one time only and cannot be renewed for a second 10-year period. Subsection (2) (b) contains several criteria that the request for approval of the loan must contain in order to be considered by the Division Engineer who is the approving authority.

The use of this section of the loan statute could be used to allow an upstream senior water right owner to restrict the irrigation use of the water so that some of the water associated with the exercise of the water right could flow down to the ISF water right not being satisfied and thereby enhancing the stream flow for the benefit of the environment and fish habitat. The amount of water available depends on whether there are intervening water rights that are senior to the loaning water right. These water rights could divert the return flow component of the water right that reached the stream. The Division Engineer could protect the CU component of the irrigation water rights down to the reach where the ISF water right is located unless the intervening senior to the water right being loaned has the ability to take all of the water in the stream, if so then the water cannot be protected.

This section of the loan statute was used in 2012 for several loans being implemented by the CWT who solicited water from water users who were willing to loan their water to the CWCB with compensation from the Trust. There were four loans approved under the CWT program in 2012, including a loan on the Yampa River from the Upper Yampa Water Conservancy District using Stagecoach Reservoir, for Willow Creek and the Colorado River by Aspen Shorefox LLC near Granby using a direct flow water right, for a loan from Coyote River LLC on Deep Creek using a direct flow water right, and for a loan from the Winter Park Ranch Water & Sanitation District for the St. Louis Creek and Fraser River using direct flow water rights. In addition, the Colorado Parks and Wildlife (CPW) loaned water to the CWCB from Big Beaver Reservoir to enhance the flows on Big Beaver Creek and the White River.

In 2013, two loans were approved with one being the CWT loan on the Yampa River from the Upper Yampa Water Conservancy using Stagecoach Reservoir and a loan with the CWT and Western Rivers Conservancy for a direct flow right on the Cimarron River in the Gunnison Basin.

These loan applications and State Engineers Office (SEO) approvals are on the CWCB website under the Environment tab on the home page then clicking on the Instream Flow program and then the Completed Transactions tab.

2.3.3 Use of an Interruptible Water Supply Agreement to Enhance Instream Flows: CRS 37-92-309

This statute was enacted in 2003 in response to the drought of 2002 and provides a temporary procedure to allow a water right to be used for a different purpose or in a different location. The IWSA was established primarily to allow a change-in-use of a senior water right to municipal use in a drought. However, it can also be used to allow a senior water right to be moved to another use downstream of a reach needing enhanced stream flows. The senior water right could be transferred to a municipal water right or agricultural water right and provide instream benefits in the intervening reach.

The IWSA statute limits the operation of the temporary change in use to 3 years in a 10-year period. The statute was amended in 2013 in HB13-1030 by allowing up to two subsequent approvals of the same IWSA. Thus the same IWSA could operate over a 30-year period. However, there are some terms imposed on any subsequent approval that must be satisfied before the State Engineer can approve it, such as not transferring water over the Continental Divide and that the use of multiple IWSAs do not provide a primary source of supply. The State Engineer is authorized to approve and administer IWSAs that permit a temporary change in the point of diversion, location of use, and type of use of an absolute water right without the need for obtaining a change in use from the Water Court.

The applicant must give public notice of the request for approval of an IWSA using the notification list established for approval of substitute water supply plans as described in CRS 37-92-308 (6). The application must be accompanied by a detailed written report prepared by a professional engineer or other professional that evaluates the historical CU, return flows, and the potential for material injury to other water rights. The public has 30 days from the date the notice is published to provide comments to the State Engineer about the potential for injury to vested water rights and terms and conditions that should be imposed upon the IWSA so that it will not cause injury to a party's water right.

The State Engineer may approve the IWSA without conducting a hearing and must find that the operation and administration of the IWSA will not cause injury to other water rights. The State Engineer may impose such terms and conditions as are necessary to prevent injury to other water rights and that a plan is in place to prevent erosion and blowing of soils and to prevent the growth of noxious weeds. A fee established by the State Engineer must accompany the application. The fee was established in rules promulgated by the State Engineer for approval of IWSAs in 2006 and the rules are published on the website for the State Engineer at http://water.state.co.us/ under the documents and forms tab. The fee is currently $2,857 and is adjusted annually for inflation.

The IWSA statute can be used to allow a temporary change in use of a senior water right that could be used to provide water for consumptive and nonconsumptive uses. The historical CU of the senior water right could be delivered to a downstream water right and protected from diversion by intervening water rights by the Division Engineer who must administer the IWSA. This water could increase streamflow in the reach between the upstream senior water right and the downstream receiving water right. If a water bank is established for mitigating or preventing a curtailment demand from the lower basin states pursuant to the Colorado River Compact and the provisions of the Upper Colorado River Compact, then the lower delivery point for an IWSA on the Yampa River could be one established by the water bank and not a downstream water right.

The IWSA may also allow for other forms of an ATM rather than just temporary dry up of a senior water right. The IWSA could support a form of rotational fallowing under a ditch system where the dry-up acres are rotated each year so that the dry up is for only one year for a specific irrigated area. It could also be used through a plan that continues to irrigate a specific area for part of the season under a split-season irrigation plan. The difference between the historical CU and the reduced CU (conserved CU) is the amount of water that could be made available for delivery to a downstream water right.

This concept including deficit irrigation has not been implemented through an IWSA but has been studied under the CWCB's grant program for ATMs that included research on the Lower South Platte River by the Parker Water and Sanitation District and CSU. The CWCB published a final report on the ATM Grant Program in May of 2011 and is available on the CWCB website, http://cwcb.state.co.us/, under the Loans and Grants tab.

2.3.4 Use of a Substitute Water Supply Plan Approved Under CRS 37-92-308 (5) to Enhance Instream Flows

This statute was enacted in 2002 in response to an interpretation of the statues by the Colorado Supreme Court in Empire Lodge Homeowners Association v. Moyer, 39 P.3d 1139 (Colo 2001) This decision restricted the State Engineer's authority to approve a substitute water supply plan as interpreted in CRS 37-80-120 by various State Engineers from 1970 to 2002. The substitute water supply plan as described in CRS 37-80-120 (2) allows individuals and private or public entities to provide a substituted water supply to a senior water right and allow the provider of the substituted supply to divert water under a junior water right at another location. For example, the approval of the substitute water supply plans for groundwater augmentation organizations allowed out-of-priority pumping in the South Platter River from 1970 to 2002 since substituted water was provided to senior surface water rights and junior wells were allowed to operate.

The Legislature clarified the State Engineer's authority to approve an SWSP in this new legislation in CRS 37-92-308. Section 308 (5) provides for approval of a SWSP for a period not to exceed 5 years in time with approval each year by the State Engineer upon re-application. This section cannot be used more than once for a water right. This type of SWSP does not require that a water court application for a change in use be pending as is the case for 308 (4). The use of 308 (5) to allow a dry year lease of water between the Rocky Ford Highline Canal and the City of Aurora in the Arkansas River Basin was approved by the State Engineer in 2004 and 2005 to provide water to Aurora to assist with its water supply shortages resulting from the serious drought in the early 2000s, especially 2002. The key requirement in order to allow the use of 308 (5) is that there will be no depletions resulting from the water use plan or change in use that extend beyond 5 years. To meet this requirement, the SWSP must either have a limited depletion period less than 5 years or maintain historical return flows while changing the use of the historical CU to a different use and new location. Once the water is returned to the canal system and irrigation is resumed, the historical return flows will continue and the stream system sees no change in return flows. To ensure that return flows are maintained will usually require that recharge basins are used to place a portion of the diversions associated with the return flows in them so as to replicate the historical return flows.

The applicant must give notice of the request for approval of the SWSP using the SWSP notification list for the water division in which the proposed plan is located and proof of such notice is filed with the State Engineer. The State Engineer must give the owners of water rights 30 days after the date of notice to file comments on the SWSP. The State Engineer in order to approve the plan must find that the plan will replace all out-of-priority depletions in time, location, and amount and will otherwise prevent injury to other water rights and decreed conditional water rights and will not impair compliance with any interstate compact.

The use of a SWSP as described in this section could allow an upstream senior water right to be changed in use and all or a portion of the historical CU delivered to a downstream user such as a junior irrigation right that has insufficient supply, or another use that is in need of a more reliable supply. The intervening reach of the stream will benefit by the historical CU being left in the stream and delivered to the downstream location. The historical CU can be protected from diversion by other water rights provided they are not senior to the water right providing the substitute supply. If they are senior and can take all of the water in the stream at their diversion, then the water cannot be fully protected. This dry-up of a stream does not occur very often in the Yampa River Basin.

Section 3

Data Sources and Methods of Analysis

The major focus of this project was on a technical analysis of potential lessors and lessees, and the contributions a temporary water transfer could make toward improving streamflow for the environment. The analysis was initiated by selecting 23 potential candidate stream reaches using agricultural shortages identified in the agricultural water needs study (CDM Smith 2010) and environmental shortages identified in the Watershed Flow Evaluation Tool (CDM Smith 2012). *The locations of these potential candidates are not presented in this report out of consideration to the water right owners.* The analysis then proceeded through four levels of screening to determine the feasibility of leasing in each of the potential candidate reaches. In each level the analysis became more detailed and sophisticated, and after each level of analysis, the set of potential candidate reaches was narrowed. A general overview of the data sources and methods used to select candidate reaches and conduct the analysis is presented below. Refinements to methods and data sources are described in Section 4 as they occurred during the iterative screening process.

3.1 Data Sources

Various sources of data were used to determine the location and feasibility of ATMs throughout the basin. The sources and data types used are detailed below.

3.1.1 Colorado Decision Support System

The Colorado Decision Support System (CDSS) was the source of both hydrologic modeling and geographic information system (GIS) data used for the Yampa ATM study. Various GIS data available from the CDSS website and used for this study includes the following:

- Diversion locations
- Irrigated acreage coverages
- Canal locations
- Contours
- Municipal boarders
- Stream alignments and water bodies

StateMod was the basis of modeling for the Yampa ATM study. StateMod is a surface water allocation model maintained as part of the CDSS. StateMod models were developed for various basins throughout Colorado and are continually maintained and improved by the CWCB and the Colorado Division of Water Resources (DWR). The 2009 release of the Yampa StateMod Surface Water allocation model was downloaded from the CDSS website[5]. Baseline and historical output files from this version of the model were used for the Yampa ATM study analyses related to irrigation shortages, diversions, streamflows, and return flows. More information on the modeling process for the Yampa Basin can be found in the Yampa Surface Water Model User Manual (AECOM 2009).

[5] http://cdss.state.co.us/basins/Pages/YampaWhite.aspx

3.1.1.1 Application of the Baseline Model for Yampa ATM Analyses

The StateMod baseline model uses defined operations and demands and historical naturalized streamflows to create a model that represents current conditions (i.e., present-day operations, infrastructure, and demands) superimposed on historical hydrology. As the name suggests, the baseline model provides a foundation on which to build hypothetical scenarios or future model runs. The baseline model attempts to meet all crop IWR regardless of past irrigation practices, and thus, the baseline model represents preferred ditch operations under current conditions.

StateMod uses available streamflow, water rights, and historical crop patterns for the modeled structures to estimate agricultural shortages that are reported directly by the model. The baseline model was initially used in the Yampa ATM candidate reach screening to determine locations with irrigation water shortages due to water supply limitations. Because the baseline model attempts to fulfill the IWR at each ditch, a modeled agricultural shortage (as a percentage of IWR) under the baseline scenario is indicative of a shortage due to lack of physical or legal water availability. This was useful in selecting the preliminary candidate reaches defined in Section 4.1 because, in contrast to the historical model described below, the baseline model scenario is less prone to showing agricultural shortages that result from historical irrigation practices.

For example, the historical model may show a shortage if there is a nonzero IWR in a month in which no historical diversions occurred as a result of operator decisions. If there was water physically and legally available, the baseline model would divert that water to meet as much of the IWR as possible, and would therefore exhibit a lower percent shortage. This helped to effectively isolate those locations (i.e., potential water lessees) not able to meet crop water requirements due to a lack of available water supplies.

3.1.1.2 Application of the Historical Model for Yampa ATM Analyses

While the baseline model output facilitated a first cut at potential candidate reach screening by identifying those reaches in which making additional water available could help to meet agricultural water shortages, it was recognized that only historically consumed water (rather than preferred potential consumption) was the actual limiting factor on the amount of CU that could be transferred downstream. Thus the StateMod historical model was used for further screening analysis involving the identification of potential water lessors.

The historical model is typically used for calibration purposes and used to recreate historical conditions using explicitly defined historical operations. In the model development process, demands and reservoir releases are set to their historical values. This is effective to test if modeled flows match historically observed flows by U.S. Geological Survey (USGS) gages. Initial calibration steps are performed by fine-tuning return flow locations and baseflow calculation assumptions. Additionally, the historical model was used to identify data errors such as misplaced gages, incorrect operations, etc. Simulated diversions, streamflows, and reservoir contents are compared back to their historical values and calibrated to minimize deviations. The final CDSS historical model for the Yampa Basin offers the best representation of historical operations available.

In the Yampa Basin, a primary challenge in determining where ATMs would be most effective was that the irrigation practices do not always follow consumptive crop irrigation requirements, i.e., diversions did not historically take place even though consumptive crop irrigation requirements existed and water was physically and legally available. Documentation from diversion records occasionally exists; however, it seldom provides detailed insight regarding operational irrigation practices. The result is that in the historical model, crop IWR is sometimes shorted because of irrigation practices, not because of water availability. Ultimately, the only way to gain confirmation of irrigation practices would be to talk directly to the water commissioners or the irrigator.

As described above, the baseline model was primarily used to filter those reaches having agricultural shortages due to water availability. Successive levels of candidate reach screening generally analyzed data based on the historical model run, including estimates of historical CU that could be transferred from an agricultural water user (potential lessor) to another consumptive or nonconsumptive beneficial water use (potential lessee), historical diversions by both potential lessors and potential lessees, historical streamflows and associated shortages in decreed ISF reaches, and reaches in which environmental flows would benefit trout and/or warmwater fish. Agricultural shortages associated with ditches and canals that could be potential lessors were also evaluated and reported based on the historical model data in order to be consistent throughout the screening analyses.

The differences between baseline and historical agricultural shortages can be seen on the two sets of maps included in Appendix B, with some locations in the historical data showing greater shortages (as a percent of IWR) than the baseline scenario. Again, this is because the historical data shows the outcome of irrigator decisions to not divert and apply available water to meet crop needs, whereas the baseline scenario data uses available water to meet crop demands regardless of historical practices.

3.1.2 Yampa-White-Green Agricultural Water Needs Assessment Study

In 2010, the Yampa-White Agricultural Water Needs Assessment Study was completed. The 2004 version of the Yampa and White models were used as the basis of modeling. Various modifications were made to better capture what the Yampa Basin Roundtable observes in the basin. The most relevant modification to the model was breaking aggregated nodes[6] into diversions on the modeled stream (combined into "A" aggregates) or tributary to the modeled stream (combined into "B" aggregates). The "B" aggregates were limited to their historical diversions to simulate the water that was historically available at their respective headgates, instead of allowing the "B" aggregates to divert water from the mainstem of the river. Dividing aggregated structures in this manner adds a layer of detail that determines whether structures on the mainstem or on tributaries to the mainstem are short with a higher level of accuracy. Further information on this methodology is detailed in the Yampa/White/Green Basin Roundtable Agricultural Water Needs Study (CDM Smith 2010). **Figure 2** below is an example of how agricultural shortages were illustrated in the agricultural water needs assessment. Note that this figure includes Water Districts 43 and 56, which were included in the agricultural needs study but were not included in the present Yampa ATM study.

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[6] Aggregated diversions are groups of diversions too small to be modeled explicitly. To limit the number diversions shown explicitly in the model, CDSS selected diversions with total diversion rights less than a threshold of 4.5 cfs to be aggregated into a single diversion. All diversions between baseflow nodes are grouped and located just upstream of the downstream baseflow node. Although this overestimates the physical flow available to the aggregate diversions, it accurately models the depletions from the river.

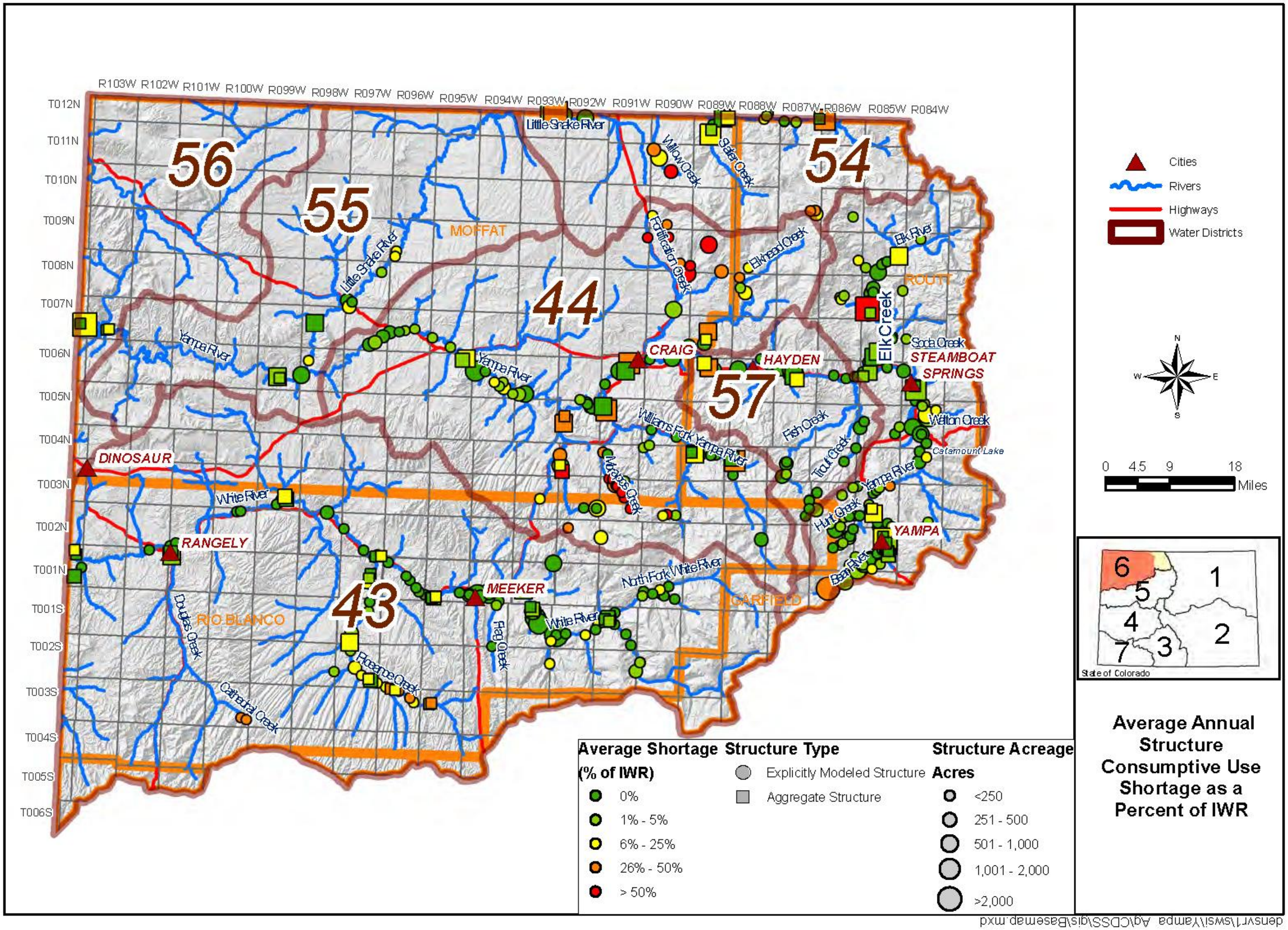

Figure 2. Example Illustration of Agricultural Shortages (from Figure 1-8 in CDM Smith 2010)

3.1.3 Yampa-White Watershed Flow Evaluation Tool

The Yampa-White Basin Roundtable Watershed Flow Evaluation Tool (WFET) Study was a study that determined nonconsumptive environmental flow needs. Through this study metrics were developed to determine the relative risk to important environmental attributes due to the status of streamflow. The needs identified in the WFET report for trout and warmwater fish were used in the Yampa ATM study to indicate intervening nonconsumptive needs, i.e., a WFET location would be situated between the upstream diversion (potential lessor) and downstream water user (potential lessee) and would incidentally benefit from the ATM. Further information can be found in the Yampa-White Basin Roundtable Watershed Flow Evaluation Tool Study Report (CDM Smith 2012).

3.1.3.1 Trout Flow-Ecology Relationship

As described by CDM Smith (2012), the trout flow-ecology relationship is based on summer flows (average for August to September) and is expressed as a percent of natural mean annual flow using the following equation:

$$\frac{(\text{Mean August } Q_{\text{Existing}} + \text{Mean September } Q_{\text{Current}}) \div 2}{\text{Mean Annual } Q_{\text{natural}}} \times 100$$

where:

Q = flow (cubic feet per second [cfs]).

The lower the percentage of average August and September flows, the higher the risk of a particular location. Risk is expressed through the ratings developed by Binns and Eiserman (1979) shown in **Table 2**. Ratings 3 and 4 are considered acceptable for maintaining trout. The effectiveness of ATMs on the trout flow-ecology relationship locations was assessed in terms of the potential to increase August and September flows, and, especially, to move from a 0, 1, or 2 rating to a 3 or 4 rating.

Table 2. Categorical Rating of Low-Flow Suitability for Trout (Cutthroat, Brook, Brown, and Rainbow), from Binns and Eiserman (1979)

Rating	Summer Low Flow[1] (% of Mean Annual Flow)	Description
0 (worst)	< 10%	Inadequate to support trout
1	10-15%	Potential for trout support is sporadic
2	16-25%	May severely limit trout stock every few years
3	26-55%	Low flow may occasionally limit trout numbers
4 (best)	>55%	Low flow may very seldom limit trout.

[1] Summer flows (average for August to mid-September) are expressed as percentage of mean annual flow.

3.1.3.2 Warmwater Fish Flow-Ecology Relationship

The flow-ecology metric presented by CDM Smith (2012) for native bluehead sucker and flannelmouth sucker (warmwater fish) is represented by the following equation:

$$\%\ \text{maximum native sucker potential biomass} = 0.1025 \times (30\text{– day min flow}^{0.3021})$$

where "30-day minimum flow" is a running mean calculated over the summer-autumn flow period (July 1 to November 30) for each year, then averaged over the study period. In this manner, biomass is estimated for both natural conditions and current flow conditions. This relationship is shown graphically in **Figure 3**.

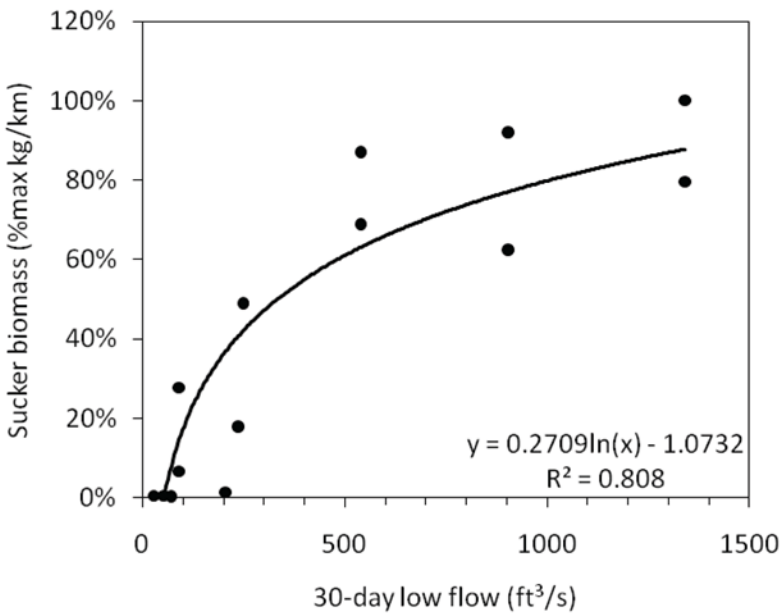

Figure 3. The Relationship between Sucker Biomass and Low Flow

Percent reduction in biomass is then calculated as:

$$\% \text{ reduction in potential biomass} = \frac{(\text{natural} - \text{current})}{\text{natural}} \times 100)$$

The effectiveness of ATMs on the warmwater fish was assessed in terms of increases in late growing season and winter month flows and by the potential for a lease of water to lower the percent reduction in potential biomass.

3.1.4 CWCB Instream Flow Program

A GIS shapefile of all ISF water right reaches with decreed flow rates was obtained from CWCB's Stream & Lake Protection Section. **Figure 4** shows the CWCB ISFs in the Yampa River Basin. These ISF water right segments may both be an intervening beneficiary of an ATM or it may alternatively act as the lessee in the agreements described in Section 2.2.2.

According to staff of CWCB's Stream & Lake Protection Section, any and all available means are used to estimate flows along reaches included, but not limited to, USGS and Colorado DWR gages, the CWCB automated alert system for monitoring low flows, field spot measurements, and public word of mouth (i.e., concerned citizens). Typically, the only method that division engineers accept for making calls is USGS/DWR gages.

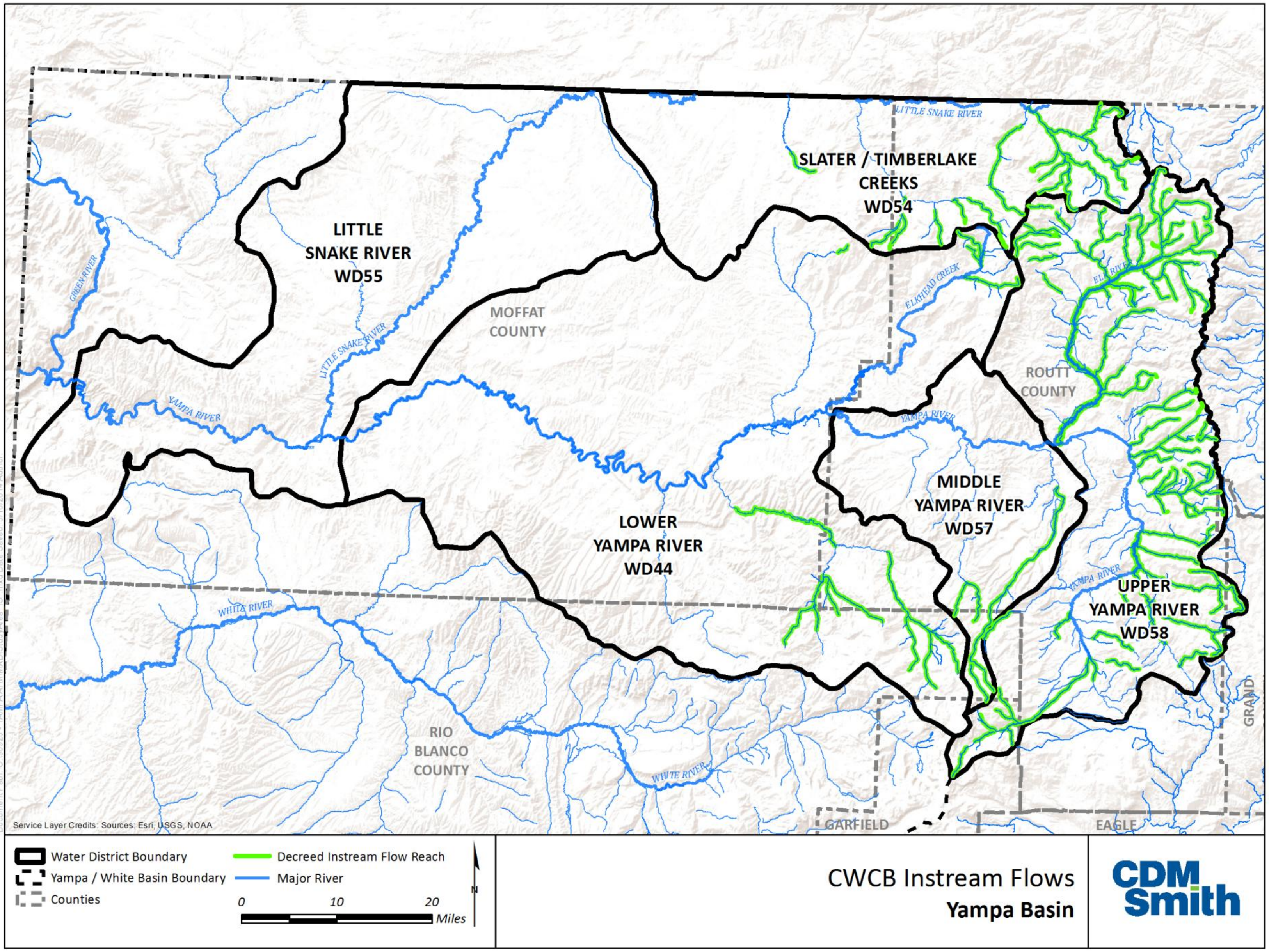

Figure 4. CWCB Instream Flows in the Yampa River Basin

3.1.5 Colorado River Cutthroat Trout Reaches

The Colorado River cutthroat trout conservation team, which coordinates a multi-state, interagency conservation strategy for the cutthroat trout, have designated certain stream reaches as important for the long-term survival of imperiled Colorado River cutthroat trout. Although the Colorado River cutthroat trout reaches by themselves are not decreed ISF water rights, they are another type of nonconsumptive use that was initially studied as an intervening use between a lessor and lessee. A shapefile of Colorado River cutthroat trout reaches was obtained from the Wyoming Game and Fish Department, which houses the data from the conservation team. **Figure 5** shows the Colorado River cutthroat trout reaches in the Yampa Basin.

3.1.6 HydroBase

HydroBase is a database maintained by CWCB and DWR that contains various data relating to water rights and water use throughout Colorado. Data extracted from HydroBase included:

- Data used within the StateMod modeling effort
- Water rights priorities and flow rates
- Historical diversions
- Irrigated acreages
- Owner contact information

HydroBase serves as a repository for the most up-to-date information available for diversions in Colorado. It is especially useful since diversion and water rights data is available for all diversions, not just diversions over a certain size as described in Section 3.1.2. Results from the StateMod analysis could be further examined using diversion data for unmodeled diversions using historical diversion and water rights data. This resolution of data allowed this study to accurately extract and analyze data for structures as small as 1 cfs diversions.

3.2 Properties of Potential Candidate Reaches

Generally, potential candidate stream reaches for an ATM that meets the intent of this project include:

- A downstream agricultural diversion node with a modeled shortage,
- An upstream agricultural diversion that does not have modeled shortages (or has minimal shortages), and
- An identified environmental need for fisheries between the upstream and downstream diversions.

Alternately, a potential candidate reach may have a CWCB ISF water right and an upstream agricultural diversion that has minimal or no modeled shortages. An example of how agricultural shortages and environmental needs appeared using data from existing studies is shown in **Figure 6**. A similar figure for each water district is included in Appendix B.

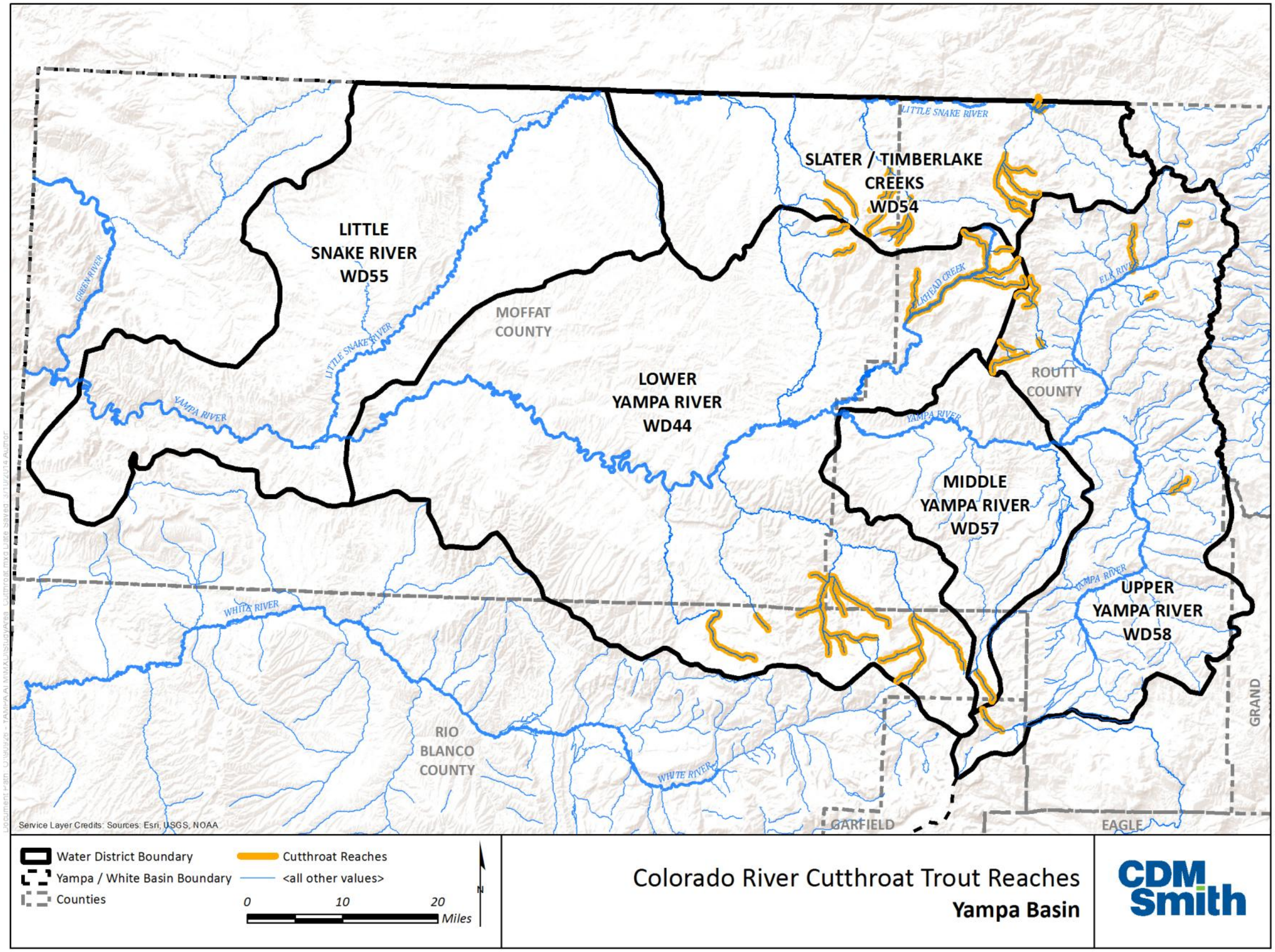

Figure 5. Colorado River Cutthroat Trout Reaches in the Yampa River Basin

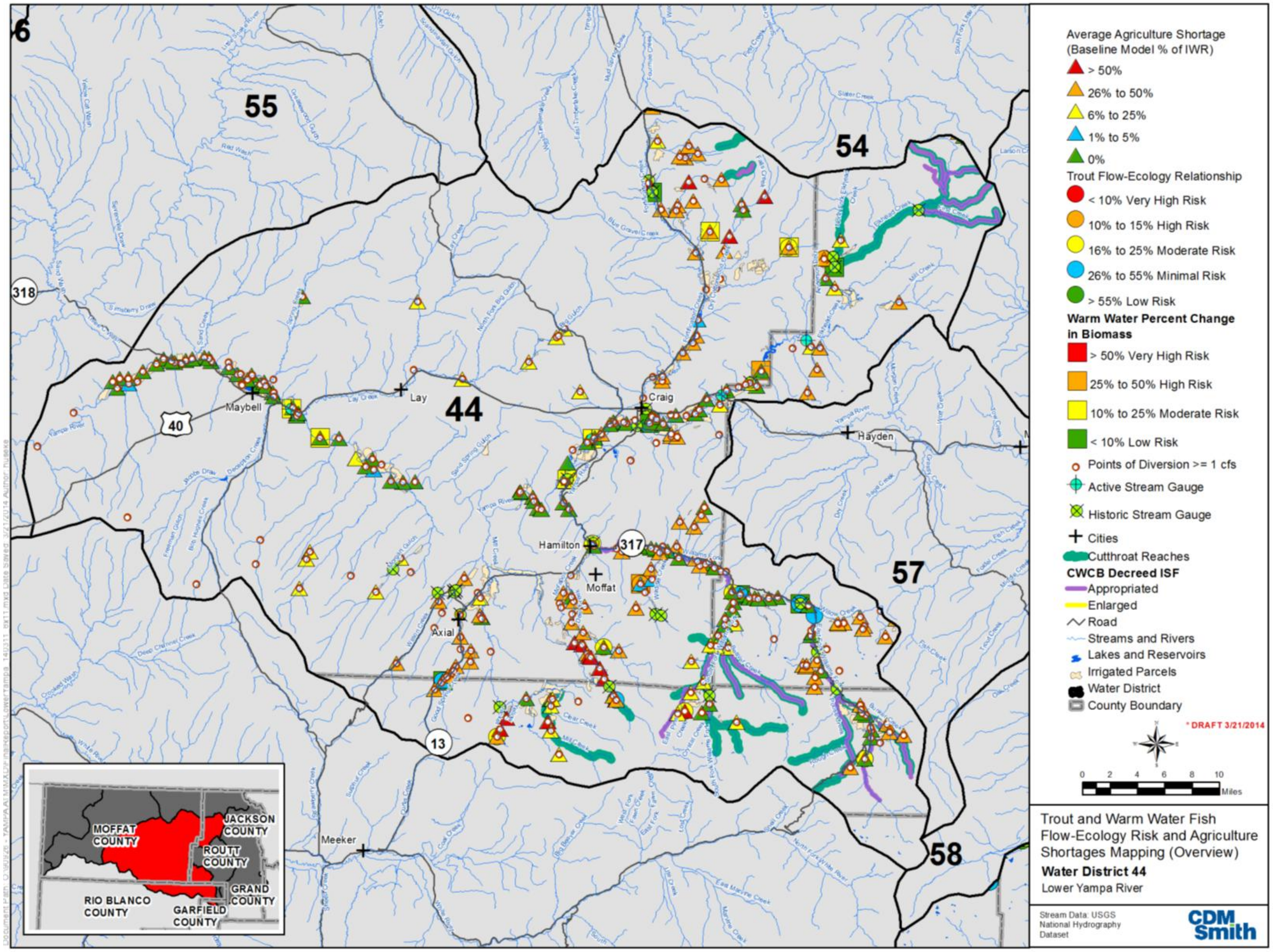

Figure 6. Illustration of Mapped Agricultural Shortages and Environmental Needs Data, Water District 44

The main factors (with varying levels of importance) that determine the feasibility of a given candidate reach are as follows:

- Is there a downstream agricultural diversion with a shortage?
  - Is that diversion part of an aggregated modeling node, and if yes, is that node part of the mainstem reach or a tributary reach?
- What upstream diversions may be potential lessors?
  - Is the upstream diversion part of an aggregated modeling node on the mainstem or a tributary?
- What is the magnitude of shortages for intervening ISF water rights?
- Is the average annual transferable CU at the upstream structure larger than the average annual consumptive IWR shortage downstream? Could the transferable CU from multiple upstream diversions be combined to meet the downstream shortage if needed?
- Does the timing of the upstream water diversion and use match the timing of the downstream user's water need?

All of these factors and others that arose as the screening analysis progressed were taken into consideration during the various levels of potential candidate reach screening, documented in Section 4.

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Section 4

Screening of Potential Candidate Reaches

This section describes the four successive levels of potential candidate reach screening completed for the Yampa ATM study, progressing from basinwide and water district mapping of relevant data (e.g., agricultural shortages and flow-ecology relationships for aquatic species) through the development of specific example ATM transactions. The analyses performed for each screening level are summarized below, along with a general overview of results, observations, and conclusions.

4.1 Level 1 Screening (April 2012 - October 2012)

Data were compiled to identify potential candidate reaches for ATM transactions. The dataset included agricultural shortages (from StateMod) and flow-ecology relationships for trout and warmwater fish (from the WFET study). A copy of the CDSS Yampa StateMod model (2009 release, see Section 3.1.1.1) was modified to split the aggregates into modeled stream ("A") aggregates and tributary ("B") aggregates (see Section 3.1.2). As described in Section 3.1.1.1, the baseline model scenario, which uses physically and legally available water to meet crop demands regardless of historical irrigation practices, was used to initially identify irrigation shortages.

Nodes corresponding to the average annual agricultural shortage and flow-ecology relationship data points were plotted on a set of preliminary maps for each of the five Water Districts in the Yampa ATM study area. Recommendations were provided to eliminate shortage nodes for agricultural diversions less than 1 cfs, revise various trout and warmwater fish nodes, and add Colorado River cutthroat trout streams to the maps. **Figure 7** shows the mapped categories of average agricultural shortage[7], trout flow-ecology relationship, and percent change in biomass for warmwater fish[8] based on the source data described in Sections 3.1.1 through 3.1.3. The colors, from green to red, indicate best to worst status for the given resource. This colors and symbols are used on maps in Appendix B that show status for these resources by water district under baseline and historical models.

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[7] For more detail on agricultural shortages, see CDM Smith (2010). Yampa/White/Green Basin Roundtable Agricultural Water Needs Study.

[8] For more detail on the trout flow-ecology relationship and the change in biomass for warmwater fish, see CDM Smith (2012). Yampa-White Basin Roundtable Watershed Flow Evaluation Tool Study.

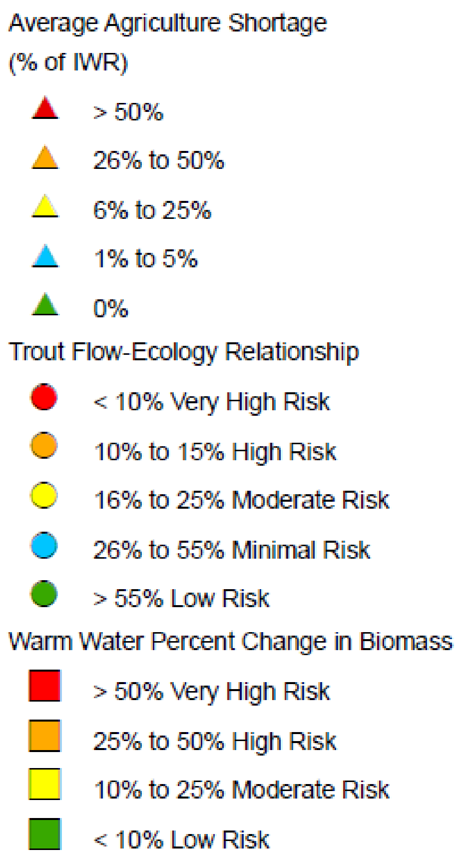

Figure 7. Properties of Mapped Nodes for Agricultural Shortages and Flow-Ecology Relationships for Fish

Based on recommendations from TNC and TU, a revised set of basin maps was developed. A database and shapefile of Colorado River cutthroat trout reaches was acquired (see Section 3.1.5) and incorporated. Initial attempts were made to identify potential candidate reaches by visual inspection of the maps, specifically to locate those reaches meeting these ideal candidate criteria around which the best potential ATM project could be built:

1. A trout or warmwater node exists that is *not* green or blue (not low risk).
2. There is a green (fulfilled) irrigation diversion upstream.
3. There is a red or orange (water short) irrigation diversion downstream.
4. No intervening diverters between source, environmental segment, and destination.

Reaches meeting these criteria would satisfy the Yampa ATM project objectives of meeting both consumptive and environmental needs.

Concurrently, research of the legal mechanisms for temporary implementation of ATMs and water leases was initiated. Preliminary identification of potential candidate reaches based on the criteria specified above found fewer than anticipated opportunities. Based on the investigation of legal mechanisms, it was found that water could be temporarily leased to the CWCB for the benefit of decreed ISF water right reaches. Shapefiles of the appropriated, donated, and enlarged ISF water right reaches were obtained from CWCB's Stream & Lake Protection Section and added to the Water District maps. With the inclusion of leases to ISF water rights, a total of 23 potential candidate reaches were identified. Candidate reaches were defined as those places where an ATM transaction could most have the potential to be effective, with an ideal situation defined as meeting both environmental and agricultural needs.

Following identification of these 23 potential candidate reaches, additional GIS work was performed to refine the reach boundaries and to map the individual mainstem and tributary agricultural diversions included in the aggregate agricultural shortage nodes (see Section 3.1.2). Properties of the nodes within each potential candidate reach were cataloged to facilitate further screening analyses, as follows:

- Properties of diversions greater than 1 cfs, including identification numbers, structure names, water source, geographic coordinates, decreed flow rates, corresponding map nodes, etc.
- Identification of diversion structures that are part of a StateMod agricultural shortage aggregate
- Properties of agricultural shortage nodes
- Irrigated parcel data, including corresponding diversion structure, crop type(s), irrigation type(s), and area
- Properties of trout and warmwater fish flow-ecology nodes
- Properties of CWCB ISF water right reaches
- Properties of Colorado cutthroat trout reaches

At the conclusion of the Level 1 screening, the project team met with the Water Division 6 Division Engineer and Water Commissioners to discuss the Yampa ATM project and to seek guidance regarding the potential for successful implementation of ATM projects in the five Water Districts of the study area. Input received during this meeting helped to shape the subsequent phases of the project. Feedback during this meeting also reminded us how important it was to respect the privacy of individual water right owners.

4.2 Level 2 Screening (December 2012 - March 2013)

The 23 potential candidate reaches identified in Level 1 screening were carried forward for Level 2 screening, described below. During Level 2 screening, candidates were evaluated based on criteria established in the detailed technical work plan, which is included in Appendix A. This work plan was guided by the progress to that point in the study, feedback from the Division Engineer and Water Commissioners, and further direction provided by TNC and TU. The work plan included descriptions of planned analysis of agricultural diversions, IWR, CU, return flows, streamflows, and other parameters.

4.2.1 Study Period for Technical Analyses

As described in the technical work plan, a study period encompassing Water Years (WY) 1980-2005 was selected for the detailed technical analyses. Reasons given for selecting these years were as follows:

- WY 1980 was selected as the start of the study period because historical data from the recent past is expected to be more complete and more reliable than data from earlier years.
- At the time of the analysis, the latest version of the StateMod project flows through September 2005.
- Historical data recorded during this period will be more reflective of current water usage and irrigation practices in the Yampa Basin.

4.2.2 Enhanced Screening Criteria for use in Technical Analyses

There are a number of factors that could result in the elimination of a potential candidate reach identified in the Level 1 screening from becoming a viable candidate for ATM implementation in the Yampa Basin, including the following:

1. Downstream agricultural shortages (potential lessees) are:
    a. Part of an aggregate node that is collectively water short based on the assumptions and analytical methods used in StateMod, but the individual structure is found to not be water short after evaluation of historical diversions, irrigated acreage, and a pro-rata share of the aggregate shortage.
    b. Not on the main stream of the potential candidate reach (methods using exchanges up a tributary are assumed to be impractical and infeasible).
2. There is an identified environmental need, yet no CWCB ISF water right and no other downstream lessees exist. Potential lessors may only lease to downstream water uses (consumptive or environmental) with existing decreed water rights. Leases for nondecreed uses—for example, locations with designated fish flow-ecology relationships—are not feasible.
3. Upstream (potential lessor) supplies are:
    a. Not great enough in magnitude to meet downstream consumptive or environmental water needs.
    b. Not available at the same time as downstream consumptive or environmental water needs.

4.2.3 Additional Methods for Technical Analyses and Advanced Screening

For Level 2 and more advanced candidate reach screening, a much more detailed database and data processing tool was developed. In addition, expanded StateMod scenarios were utilized, methods were developed for estimating CU at agricultural shortage nodes originally part of StateMod aggregates, and means of performing best-fit feasibility analyses were developed. These topics are described in the following sections.

4.2.3.1 Database and Data Processing Tool Development

Data from StateMod is output in various formats, each of which summarizes different types of data. StateMod's outputs are comprehensive as there are many inputs for water rights allocation modeling. The list of outputs is extensive; the following are the modeling inputs and outputs (from both the baseline and historical model) used for the Yampa ATM study:

- IWR
- Demands/Historical Diversions
- Irrigated Acreage
- Water Rights
- Simulated Streamflows
- Consumptive Use and Headgate Shortages

To develop a full picture of the StateMod outputs and how the data may aide in determining viable ATM candidates, a tool was developed to extract the data from the StateMod output and assemble a series of easily accessible graphs and charts. As the screening process was established, the tool evolved through iterations to look at the data in different ways.

The first tool was developed in January 2013, and was used to show a time series of diversions, headgate demands, IWR, shortages, and simulated flows for any diversion in the model. This tool was used for the first part of the level 2 screening. In subsequent screening iterations through August 2013, the database was expanded to display data for ISF water right reaches and WFET fishery node risk levels. The accuracy of the data from this point on was also improved by using the complete set of historical data available from the StateMod and HydroBase.

In the final version of the tool, the following charts were included:

- Detailed Diversion Data Time Series (Diversions, Demands, IWR, Headgate Shortages, CU Shortages, Simulated Streamflows)

- Average Monthly Diversion Data (Diversions, Demands, IWR, Headgate Shortages, CU Shortages, Simulated Streamflows)

- ISF Time Series of simulated flows, ISF water right decreed streamflow rates, and ISF water right shortages.

- ISF Monthly Averages of simulated flows, ISF water right decreed streamflow rates, and ISF water right shortages.

- A diversion overlay chart that allowed a comparison of monthly average consumptive use of lessor and monthly average consumptive use shortages of lessees

4.2.3.2 Expanded use of StateMod Output

Level 2 screening further used StateMod (both historical and baseline) data to determine the feasibility of an ATM within each reach. Through an iterative process, it was determined to be advantageous to look at both the baseline model and historical model. As discussed in Section 3.1.1.1, there are benefits to using the baseline or historical models. A baseline model (results shown in the previous section) shows the water use and availability if water irrigators aim to fulfill 100 percent of their IWR (as determined by the Blaney-Criddle method[9]), physical and legal water availability permitting. Historical irrigation practices in the Yampa Basin deviate from this idealized scenario and range from irrigating high volumes in the wet part of the season to not irrigating during the dry part of the season (even though Blaney-Criddle estimates IWR through the end of the irrigation season).

4.2.3.3 Estimating Consumptive Use and Shortages at Aggregated Modeling Nodes

For lessors, the CU portion of their diversions could potentially be made available for leasing. The recorded historical data from HydroBase includes historical diversions and acreage. As part of the modeling process, IWR is calculated by StateCU using historical weather and irrigated crops (area and type). Due to limitations within the model, some agricultural nodes are aggregated together. This results in a lack of modeled data for the individual nodes including CU, consumptive IWR shortage, and headgate shortages.

Different calculation methods were used to estimate annual and monthly CU shortages for structures that are part of aggregated agricultural nodes in StateMod. To disaggregate IWR for any aggregated diversion for the purpose of estimating *annual* IWR and related shortages for individual nodes included in an aggregate node, IWR was estimated using the following equation:

$$Diversion\ IWR = \frac{Diversion\ Irrigated\ Acrage}{Aggregate\ Irrigated\ Acreage} \times Aggregate\ IWR$$

Using the estimated IWR and historical diversions, it was assumed that if the historical diversions at max flood irrigation efficiency (54 percent) are greater than the IWR, then there are no shortages. The following equation was used:

$$Consumptive\ Use\ Shortage = Max\ \ Diversion\ IWR - Max\ Efficiency \times Historical\ Diversion, 0$$

These calculations were performed on an annual average basis for each aggregate node. This method was used to take advantage of all available data (in some diversions, there are very few diversion records). If historical diversion data was not available over the period of record, this may result in an unreliable estimation, which is noted in the following sections.

To calculate CU shortages for disaggregated diversions on a *monthly* basis, historical aggregate CUs were partitioned out by ratio of acreage. Although this should intuitively yield the same results on an annual basis (i.e., by summing the monthly results), CU shortages may vary widely depending on the method used. The annual average CU shortages are dependent on each individual disaggregated diversion, i.e., if an aggregate structure is water short, but historically one of the diversions within that structure diverts adequate water to meet its demand, that disaggregated diversion would be short on a monthly basis, and not short on an annual basis. Differences between the graphs in the following sections and what is shown in other supporting analysis spreadsheets are due to these two methodologies being used. It should be taken into consideration that neither method is more accurate than the other and that the only way to validate any of these results is to verify irrigation shortages with the owners and operators of these ditches.

[9] Blaney-Criddle method is the calculation methodology used in StateCU to determine the IWR. IWR is calculated as a function of crop type, crop acreage, temperature, and precipitation. Details on the Blaney-Criddle Method can be found in the StateCU documentation (Colorado Water Conservation Board 2008).

4.2.3.4 Feasibility Analysis

A qualitative best-fit analysis was performed on the feasibility of implementing a lease agreement for each potential candidate reach. This analysis was based on the quantified magnitude of downstream agricultural irrigation shortages, upstream magnitude of diversions/CU, and the presence of intervening environmental uses (ISF water right reaches, critical reaches for trout and warmwater fish locations, cutthroat trout reaches, etc.). Quantitative data analyses for nodes in the potential candidate reaches were performed using historical records and StateMod data for the period 1980-2005.

4.2.4 Findings of Preliminary Technical Analyses

Detailed technical analyses were performed for each of the 23 potential candidate reaches based on the January 2013 technical analysis work plan (see Appendix A) and enhanced methods and screening criteria described in the preceding sections. Most of the analyses were based on the StateMod historical model. Diversion structures in each of the 23 potential candidate reaches were classified as potential lessors (location to implement ATM to make water available for leasing) and/or lessees (beneficiary of leased water, e.g., a water-short irrigation ditch or ISF reach) based on adequate or surplus availability or shortage of irrigation water. As noted at the beginning of this report, all data and information used for these analyses was obtained from publicly-funded or publicly-available sources such as the CDSS hydrologic models and HydroBase database of historical streamflows, diversions, and other information. Identification of a ditch as a potential lessor or lessee for the purposes of this study does not in any way imply a willingness of the ditch and/or water rights owners to participate in an ATM and water leasing program.

The purpose of presenting this information herein is to provide a meaningful quantitative assessment of structures and candidate reaches that may satisfy the Yampa ATM study objectives as defined by the project proponents. The primary goal was to identify those locations at which ATMs may be implemented to make water available to meet both consumptive and environmental needs in the Yampa Basin. The results of technical analyses performed for the Level 2 screening are summarized for each reach and structure in Appendix C, and for each reach in Table 3 below. *Out of respect for the privacy of individual water right holders, specific river reaches and diversions are not identified in this report.* For many of the reaches with ISF water rights as potential lessees, the shortage associated with the ISF water right was not yet calculated at this stage of the analysis and therefore appears as "N/A" in.

Table 3. Summary of Results for Preliminary Technical Analyses for Level 2 Screening

Candidate Reach[1]	Potential Lessors			Potential Lessees		Potential Environmental Beneficiaries	
	#	Range of Diversions (AFY)	Range of CU (AFY)	#	Range of Shortage (AFY)	#	Description
Potential water leasing between agricultural users							
4	6	1,117-3,186	229-694	1	170	1	Endangered Fish Species Target Flows
5	2	283-640	NA-31	3	N/A-290	2	Warmwater (moderate risk), Endangered Fish Species Target Flows
6	2	243-311	41-122	1	38	2	Warmwater (moderate risk), Trout (high risk)
8	6	734-2,041	102-550	1	42	1	Warmwater (high risk)
10	2	3,652-5,785	754-1,349	4	N/A-181	2	Trout (moderate risk), Warmwater (moderate risk)
22	8	133-2,614	12-526	1	39	1	Trout (high risk)
Potential water leasing from agricultural user(s) to ISF water right							
1	5	134-3,776	50-618	1	N/A	1	Trout (moderate risk)
2	3	174-407	41-95	1	N/A	3	Trout (2-moderate risk), Trout (high risk)
3	7	147-1,208	74-326	1	N/A	3	Trout (2-moderate risk), Warmwater (moderate risk)
11	1	298	N/A	1	N/A	0	N/A
12	1	721	165	2	N/A	0	N/A
13	12	189-2,837	9-889	1	N/A	0	N/A
15	1	195	47	1	N/A	2	Trout (moderate risk), Warmwater (high risk)
17	2	71-217	13-Dec	1	N/A	0	N/A
19	20	up to 2,400	N/A	1	N/A[2]	0	N/A
20	19	N/A	N/A	1	N/A[3]	0	N/A
21	1	90	43	1	N/A	1	Trout (moderate risk)
23	4	165-1,159	45-425	1	2,600	1	Trout (moderate risk)

[1] Candidate Reaches 7, 9, 14, 16, 18 were deemed infeasible due to absence of potential lessors or potential lessees or both.
[2] ISF 19-A is short every month of the year on average, but is most short in May-September (~450 AFM)
[3] ISF 20-A is typically short by 50-180 AFM for each month except April-June.

4.2.5 Outcomes of Level 2 Screening

The Level 1 screening was based on mapping of relevant node data and visual inspection to identify preliminary candidate reaches. Closer inspection of data revealed a few instances in which the water source of an agricultural node that was visually perceived to be a potential lessor or potential lessee was actually on a different stream (e.g., on a tributary instead of the main stream of a candidate reach). In other cases, a node mapped as an agricultural shortage and initially perceived as a potential lessee was determined to be part of a StateMod aggregate and did not exhibit a shortage individually. Thus, of the 23 potential candidate reaches analyzed in the Level 2 screening, four reaches (Reaches 7, 14, 16, and 18) were immediately eliminated due to an absence of potential lessors or lessees. Reach 9, a potential agriculture-to-ISF water right leasing opportunity, was also eliminated because the ISF water right was shown to have a modeled shortage only one time since 1980.

During Level 2 screening, six of 23 potential candidate reaches were identified as potentially feasible opportunities for ATM implementation and leasing between agricultural water users (ag-to-ag leases). Each of these reaches would also produce environmental benefits for trout, warmwater fish, or the endangered species target flows. The viability of each ag-to-ag leasing opportunity is subject to field verification of modeled CU shortages, especially for those ditches that are part of aggregate StateMod nodes and for which CU shortages could at best be roughly estimated.

Twelve of 23 candidate reaches were identified as potentially feasible opportunities for implementing ATMs and leasing water to satisfy streamflow shortages in stream reaches with decreed ISF water rights. As shown in Table 2, four of these potential candidate reaches would rely on only one potential lessor to contribute water for the improvement of streamflows under the ISF water right. Three reaches have 12 or more potential lessors to benefit a single ISF water right. Only 6 of the 12 potential ag-to-ISF options would also produce environmental benefits for moderate- and high risk locations for trout or warmwater fish, or for the endangered species target flows.

Combining feasible agriculture-to-agriculture leases and feasible agriculture-to-ISF leases, a total of 18 of the original 23 candidate reaches were considered feasible at the end of Level 2 screening. TNC and TU consulted on these 18 reaches with the agricultural outreach committee. Based on the direct knowledge of the committee members, 12 of the 18 remaining candidate reaches were eliminated from consideration, leaving six candidate reaches to be considered in Level 3 screening.

4.3 Level 3 Screening (March 2013 - May 2013)

For Level 3 screening, the six remaining reaches were:

1. Reach 1
2. Reach 6
3. Reach 10 (with the lower terminus extended further downstream)
4. Reach 12 (combined with Reach 13)
5. Reach 20
6. Reach 22 (with the lower terminus extended further downstream)

4.3.1 Analyses Performed during the Level 3 Screening Period

Following the completion of technical analyses for the Level 2 screening, several other relevant issues were investigated by the consultant, driven by inquiries from TNC and TU, and summarized as follows:

- Possible water administration issues in the remaining potential candidate reaches were identified and researched.
- Historical calls in the Yampa Basin over the 1980-2012 period were reviewed using HydroBase data. Most calls in the Yampa Basin occurred on small tributaries, and none were identified that would have affected the potential candidate reaches for the Yampa ATM study.
- The consultant met with representatives of the Colorado Water Trust to discuss their experiences and lessons learned from the temporary water leases successfully implemented to improve streamflows through the "Request for Water 2012" program. The consultant also reviewed the applications and engineering reports associated with those leases to better understand the extent of technical analysis required for SEO approval and successful implementation of temporary water leases.
- Elkhead Reservoir is managed in part to improve stream flows in the Yampa River that is designated as endangered species critical habitat, from Elkhead Creek to the Green River. Although it shows as a "donated ISF" in the CWCB database, this not a typical instream flow.

Rather, this water right for a pool of water in Elkhead Reservoir (5,000 acre feet committed in all years; 2,000 additional acre feet available for annual lease) to be released to improve flows in critical habitat. These releases are protected (that is, administered past headgates). This right is not, however, and instream flow right with priority that can "call" more junior water rights. The conditional water right associated with the environmental pool in Elkhead Reservoir is owned by the Colorado River Water Conservation District, and will be conveyed to the CWCB upon perfection of portion of the storage enlargement water rights for instream use for the benefit of the endangered fish. The consultant inquired with the Water Division 6 Division Engineer and CWCB's Stream & Lake Protection Section to determine whether water made available through the loan of consumptive use to the CWCB could be used to improve the reliability of the instream use already decreed for releases from the enlargement of Elkhead Reservoir. Based on additional legal advice, it was concluded that the reliability of this donated but decreed instream use could not be improved through a loan to the CWCB because it is not a decreed instream flow water right. It may be possible to use an IWSA or a SWSP to provide water for the endangered fish in the designated reach. The analysis of using these ATMs to improve the flows for endangered fish recovery is nonetheless included in this report and TNC is reserving its legal judgment on the feasibility of ATMs to supply water to critical habitat.

The database developed during Level 2 screening continued to be used, but the output was compiled into a more user-friendly spreadsheet for Level 3 screening. The refined potential candidate reach screening spreadsheet included the following:

- Master diversion inventory, which summarizes the properties of all potential lessor and lessee diversions or ISF water rights in the remaining six potential candidate reaches:
  - Candidate Reach
  - Structure ID
  - Structure Name
  - Water Source
  - Potential Lessor or Potential Lessee
  - Adjudication dates, appropriation dates, administration numbers, and decreed flow rates for the most senior water right associated with each diversion structure or ISF water right
  - Total number of water rights and total decreed flow rate associated with each diversion structure or ISF water right
  - Publicly-available owner information as published in HydroBase for each diversion
  - Irrigated acreage
  - Crop types
  - Historical average annual diversions, average annual IWR, and average annual CU shortage from StateMod.
  - Historical annual average CU shortage, calculated as the difference between IWR and CU.
  - System efficiency, calculated as CU divided by diversions.

- For each potential candidate reach, the following data was summarized for WY 1980-2005:
  - Monthly CU estimates for potential lessors
  - Monthly shortage estimates for potential lessees
  - Plots of this data on an average monthly basis, as illustrated in **Figure 8** below
  - Spells plots illustrating the timing of shortages for ISF water rights

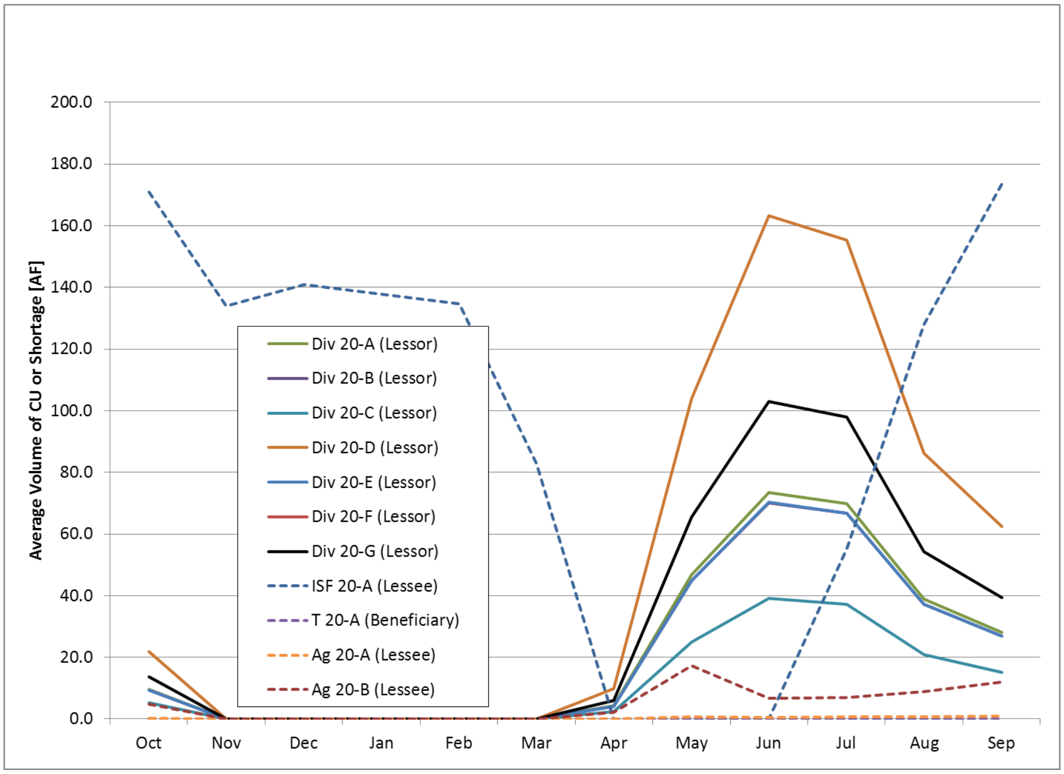

Figure 8. Example Plot of Average Historical CU (lessors) and Shortages (lessees), Irrigation Year 1980-2005, from Level 3 Screening Analysis

The spells plots are set up as a grid with months on the horizontal or x-axis and years (WY 1980-2005) on the vertical or y-axis. The "spells" are the shaded periods during which shortages are estimated to have occurred, as illustrated in **Figure 9** below.

Shortages to an ISF water right presume full administration and that the ISF water right has been called up to its decreed amount. If an upstream lessor is in priority, then the estimated amount of the transferable CU water can be administered to relieve any remaining shortage to the ISF water right.

Red indicates months when actual flows are less than the decreed ISF rate. Spreadsheets detailing the amount of shortage were not included in this report because they also contained detailed information about private water rights.

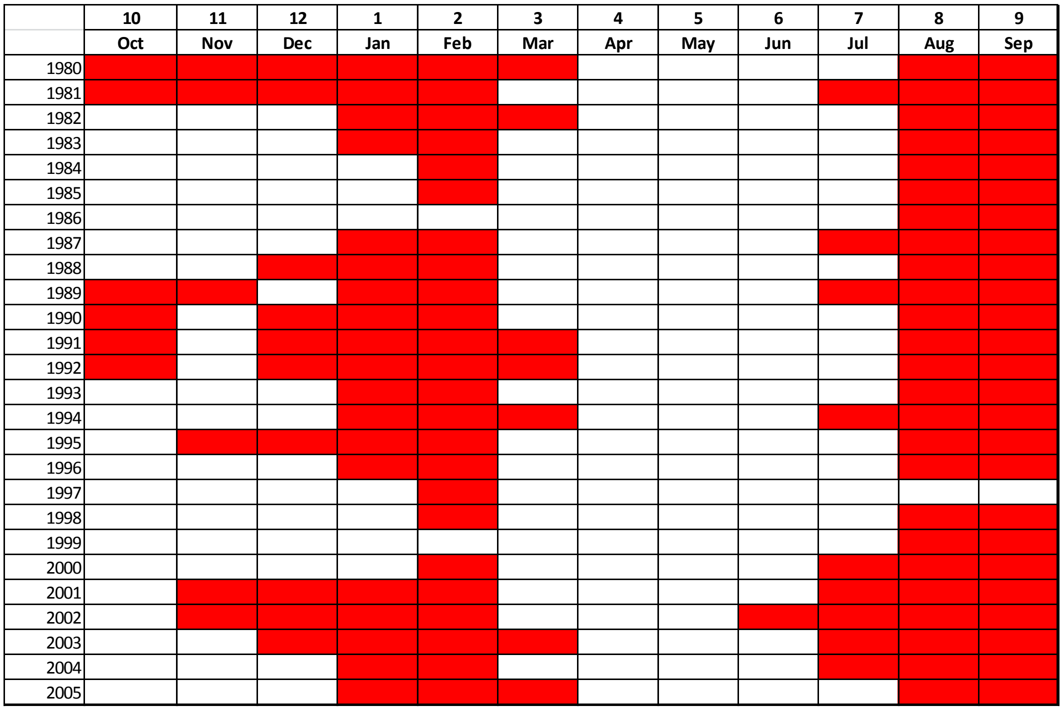

Figure 9. Example Plot of ISF Shortage Spells, from Level 3 Screening Analysis (Red indicates months when actual flows are less than the decreed ISF rate)

4.3.2 Results of Level 3 Screening Analyses

Level 3 screening provided an in-depth look at the remaining six potential candidate reaches, including comparison of the historical CU of potential lessor ditches to the historical CU or streamflow shortages of the potential lessee ditches and the ISF water right reaches.

Values of estimated historical CU and/or shortage are annual averages based on WY 1980-2005. These are feasibility-level estimates that are not of the same level of detail that would be required for an application to the SEO for a leasing transaction.

In general, potential lessors are in the upstream part of a candidate reach and the potential lessees are in the downstream part of a candidate reach. Agricultural diversions with historical shortages in the middle of some of the longer reaches could potentially go either way depending on the interests and needs of those irrigators.

Additional technical findings of the Level 3 screening analysis are summarized below in **Table 4**. Appendix D includes a spreadsheet with more detailed Level 3 screening results.

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Table 4. Summary of Results for Level 3 Screening Analysis

Candidate Reach[1]	Potential Lessors			Potential ISF Lessees		Potential Agricultural Lessees	
	#	Range of Historical Diversions (AFY)	Range of Historical CU (AFY)	Present (Y/N?)	Range of Historical Shortage (AFY)	#	Range of Historical Shortage (AFY)
Potential water leasing between agricultural users							
6	6	206-1,360	41-323	N	N/A	2	38-41
10	12	43-7,179	23-1,533	N	N/A	7	95-424
22	6	133-2,614	26-465	Y	2,595f	4	20-424
Potential water leasing from agricultural user(s) to ISF water right							
1	5	134-3,776	50-618	Y	1,218	0	N/A
12	7	419-2,837	132-889	Y	173-27,130	3	3-139
20	7	240-751	122-335	Y	1,158	2	N/A-59

The following is a summary of important notes and observations from Level 3 screening of the remaining six potential candidate reaches.

- Reach 1
  - Historical CU for agricultural diversions that were part of StateMod aggregates was estimated based on a ratio of individual structure irrigated acreage (if available) to total aggregate irrigated acreage, multiplied by the total aggregate CU. If the individual structure irrigated acreage was not available, the CU could not be estimated for the structure (Structure Div 1-E, for example). Only one potential lessor (Structure Div 1-A) is not part of a StateMod aggregate.
  - All five potential lessors in this reach irrigate grass pasture.
  - Conceptually, this appears to be a very good example of where split season irrigation, stopping in late June or early July, could really provide some benefit to the ISF reach in July-September. There is not enough transferable historical CU that could be leased to eliminate the full shortage (1,218 AFY), and the available CU declines during those months, but some contribution to streamflow would seem to be better than none. Structure Div 1-A would be the ideal candidate because it has the largest volume of historical CU (618 AFY).
- Reach 6
  - Structure Div 6-G is an example that demonstrates some of the analytical complications of agricultural diversions that are part of a StateMod aggregate. On the preliminary maps based on StateMod historical data, this diversion was shown to have a historical shortage of 6 to 25 percent. However, data analysis found no shortage for the individual diversion. This difference is due to the mapping assigning shortage range based on the aggregate as a whole, whereas the database estimates IWR based on the ratio of irrigated acreage (if available) for a structure to the irrigated acreage for the aggregate as a whole.
- Reach 10
  - Crops grown by the potential lessors in this reach are primarily grass pasture and alfalfa.

  - Water cannot be leased directly to the critical habitat for the endangered fish because there is no instream flow water right for this reach. There is only the water in Elkhead Reservoir that can be released and protected to augment flows in critical habitat. However, an IWSA or other agreement may be possible to augment water released from Elkhead Reservoir for the endangered fish. In addition to several potential agricultural lessees downstream, leased water may benefit streamflows through this reach, particularly in August and September.
  - Agricultural shortages for structures that are part of StateMod aggregates should be field verified.

- Reach 12
  - Leasing transferable CU from agricultural water users in this reach could help improve streamflows through the ISF water right reach and could help minimize the risk of a call for the ISF water right.
- Reach 20
  - Leasing water to improve flows through the ISF water right reach is the most practical implementation option in Reach 20, assuming leasable CU is available at the same time as the ISF water right shortage.
- Reach 22
  - It would be valuable to assess the feasibility (including determining operational and/or administrative constraints) of leasing early season water upstream and storing to meet late season agricultural or ISF water right shortages.

4.4 Level 4 Screening (June 2013 - August 2013)

Additional recommendations for refinement of potential candidate reaches and guidance for next steps in the analysis emerged from a May 2013 meeting between TNC, TU, and the agriculture outreach committee. Further screening was required to determine the most feasible candidate reaches to bring to the Level 4 screening step. The primary sources of information are StateMod and the CDSS HydroBase, similar to previous levels of screening of the larger set of potential candidate reaches. Additional analysis required information outside of StateMod to determine the feasibility of the remaining potential candidate reaches, including data that was utilized to expand the project team's understanding of the key individual structures to determine the feasibility of the remaining reaches.

4.4.1 Potential Candidate Reaches and Shortlisted Lessors/Lessees Analyzed in Level 4 Screening

Following a review of Level 3 screening results by TNC and TU, four remaining candidate reaches were selected to be analyzed in Level 4 screening. These included two reaches which showed potential for transfers between agricultural users (Reach 6 and Reach 10) and two reaches which showed potential for agriculture-to-ISF water right transfers (Reach 1 and Reach 12). Reach 10 was extended farther downstream to capture more potential water-short agricultural lessees. Reach 12 was contracted to its original extent, eliminating some potential lessees downstream, but retaining potentially viable agricultural lessor(s) to provide water to CWCB to benefit an ISF water right.

Through discussion with TNC, it was determined that these were the most feasible reaches remaining in which the desired project objectives could be met. Furthermore, TNC identified a short-list of the key structures to research further to determine direct lessor/lessee relationships. Reach 20 and Reach 22 were eliminated from further analysis in the Level 4 screening.

4.4.2 Analyses Performed for Level 4 Screening

For each of the remaining four candidate reaches, a brief description of the known configuration and properties of the key ditches was developed. To determine the timing and magnitude of potential lessor CU and potential lessee CU shortage, as well as any environmental use shortages, (i.e., ISF water right shortages, warmwater fish-flow ecology shortages, and trout flow-ecology shortages), graphs of the average monthly and average dry monthly CU and environmental shortages were developed. Spells plots were created that illustrate the timing of monthly shortages for ISF water rights (using decreed rates) and other environmental reaches (using WFET risk equations) over the Water Years (WY) 1980-2005 period. Return flow analyses were also performed as part of the Level 4 screening; these are documented in Section 5 in the context of potential water administration issues.

4.4.3 Hydrologic Classification of Years in the Study Period

CU and CU shortages were both characterized by average conditions and dry conditions. Average conditions consider the entire 26-year period of record (WY 1980-2005) used for this study. Dry years were determined by ranking the naturalized flows input to StateMod at the following three streamflow gages in the Yampa River basin:

- 09249750 Williams Fork at Mouth, near Hamilton, CO
- 09247600 Yampa River below Craig, CO
- 09253000 Little Snake River near Slater, CO

These gages do not necessarily correspond to any particular potential candidate reach. Dry years were assumed to be those with annual naturalized flows below the 25th percentile. From the WY 1980-2005 study period, each gage had 7 dry years, of which 5 years were common to all three gages. The dry-year analyses were therefore based on WY 1981, 1992, 1994, 2002, and 2004. The spreadsheet used to identify dry years for this analysis is included in Appendix A.

4.4.4 Findings of Level 4 Screening Analyses

The following sections summarize the findings of the technical analyses performed for the Level 4 screening.

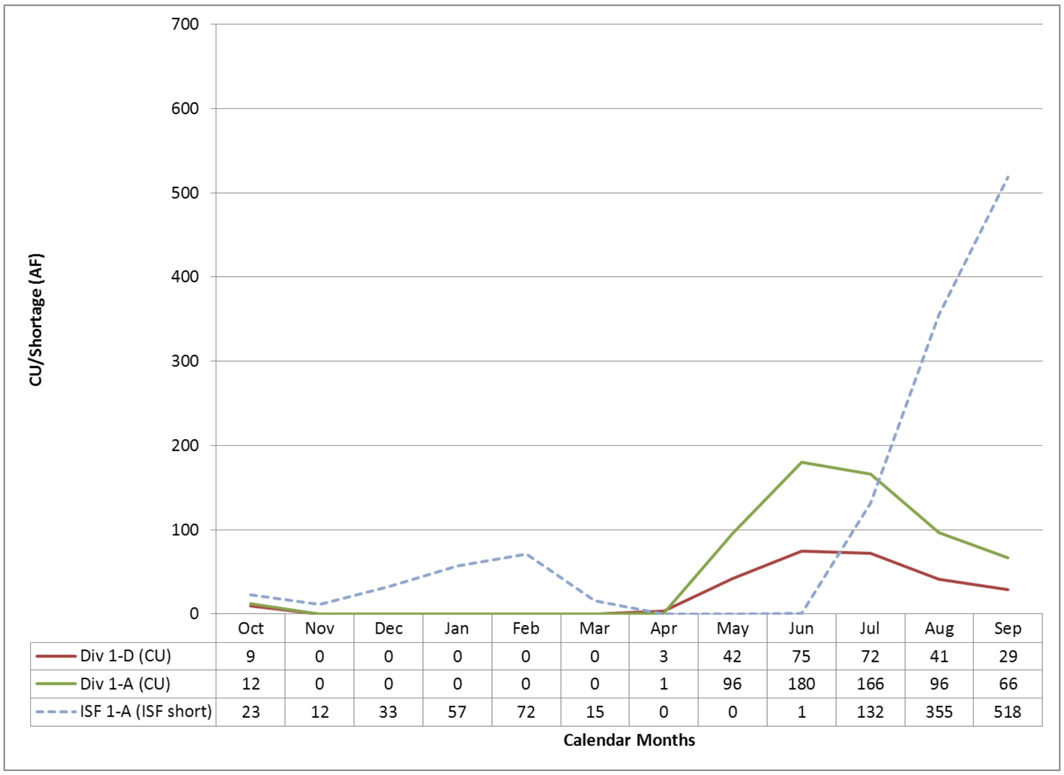
4.4.4.1 Level 4 Screening Example 1: Agriculture-to-ISF Transfer (Reach 1)

The two structures identified by TNC as potential lessors in this reach are Div 1-D and Div 1-A. The objective of ATM implementation in Reach 1 would be leasing water from one or both of these diversions to the CWCB to provide water to meet streamflow shortages under ISF 1-A. According to a summary from the agricultural advisor meeting with TNC, there are relatively few diversions to be administered and TNC has a relationship with some of the water users in this reach.

As shown in **Figure 10** (annual average) and **Figure 11** (dry years) below, the ISF water right (ISF 1-A) typically experiences its largest shortages between July and September. However, the spells plot in **Figure 12** indicates that ISF water right shortages are observed in most months of the year. Based on StateMod output data, Div 1-A and Div 1-D consume about 850 AF of water over the irrigation season, thus being a potential candidate to improve flows downstream of these diversions. Although the magnitude of CU from Div 1-A and Div 1-D are not enough to eliminate ISF water right shortages, ISF water right shortages could be reduced between July and September by about 300 AF on average.

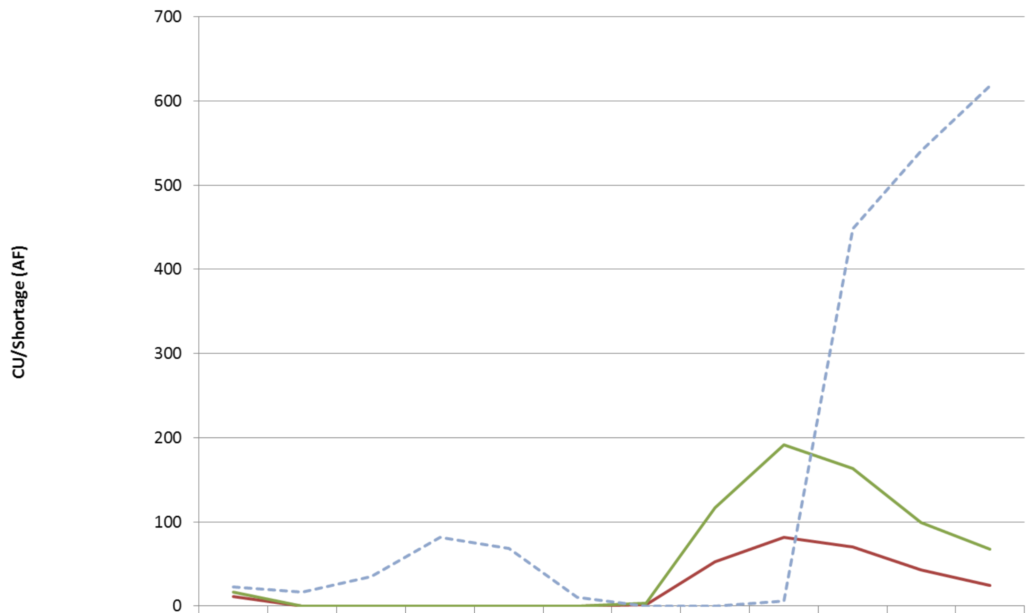
The timing of available CU water from the potential lessor ditches and ISF water right shortages match up, thus making this a feasible ATM reach to partially improve flows for the ISF water right (ISF 1-A). Discussions with the water commissioners and/or ditch owners/irrigated are needed to confirm the viability of leasing from Div 1-A and/or Div 1-D. In addition, StateMod CU estimates would need to be verified to assess the feasibility of leasing water to the ISF water right.

Figure 10 and **Figure 11** show that Div 1-A and Div 1-D could partially meet ISF water right shortages without any retiming. However, even with re-timing, ISF water rights shortages cannot be fully met by leases from these two ditches.



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Div 1-D (CU)	9	0	0	0	0	0	3	42	75	72	41	29
Div 1-A (CU)	12	0	0	0	0	0	1	96	180	166	96	66
ISF 1-A (ISF short)	23	12	33	57	72	15	0	0	1	132	355	518

Figure 10. Reach 1 Average Historical CU (lessors) and Shortages (lessees), WY 1980-2005



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Div 1-D (CU)	12	0	0	0	0	0	1	52	81	70	43	25
Div 1-A (CU)	17	0	0	0	0	0	3	117	191	164	99	68
ISF 1-A (ISF short)	23	17	35	82	69	11	0	0	6	448	541	618

Calendar Months

Figure 11. Reach 1 Average Historical CU (lessors) and Shortages (lessees), Dry Years

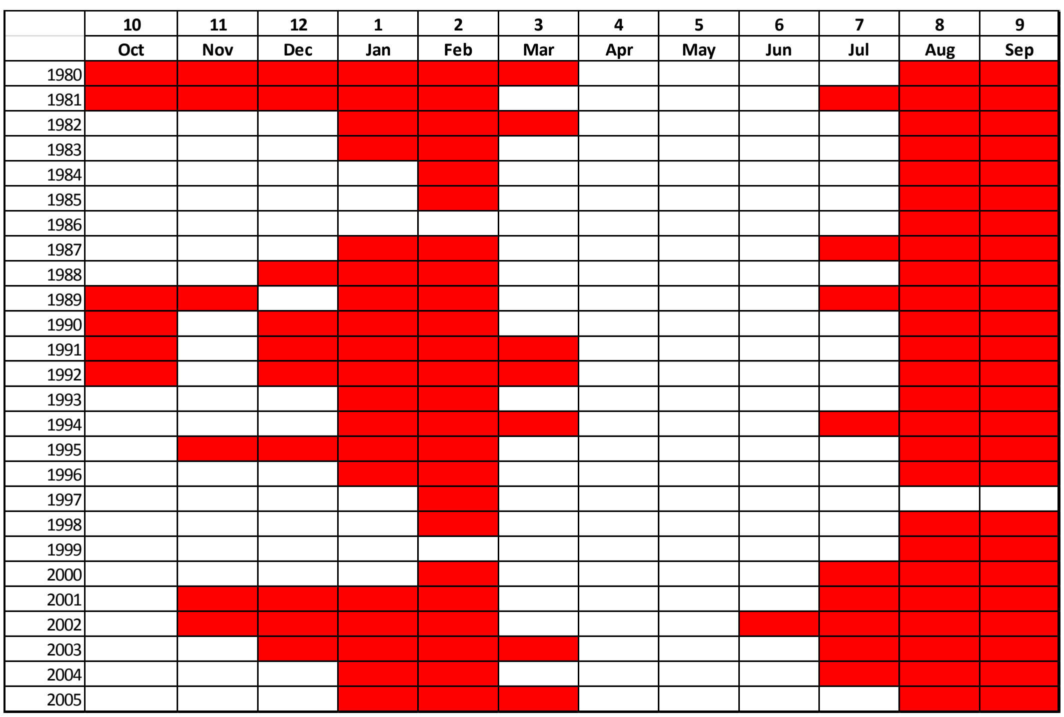
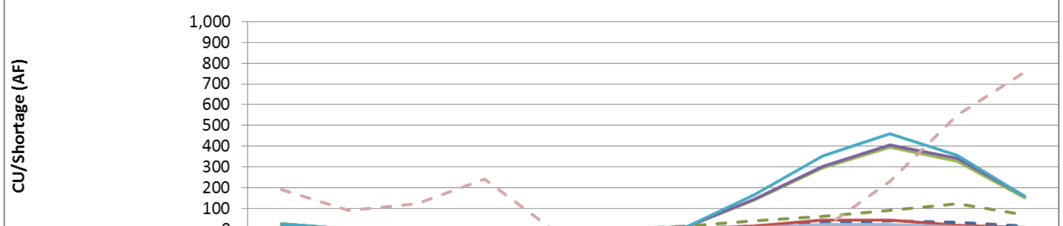


Figure 12. Shortage Spells for ISF water right (ISF 1-A) in Reach 1
(Red indicates months when actual flows are less than the decreed ISF rate)

A similar process of data analysis and generation of illustrative figures was followed for the second agriculture-to-ISF candidate reach (Reach 12). Likewise, a detailed assessment was performed to identify potential hurdles to implementation and to identify specific questions to be discussed with the Water Commissioners, Division Engineer, water rights owners, and irrigators.

4.4.4.2 Level 4 Screening Example 2: Agriculture-to-Agriculture Transfer (Reach 10)

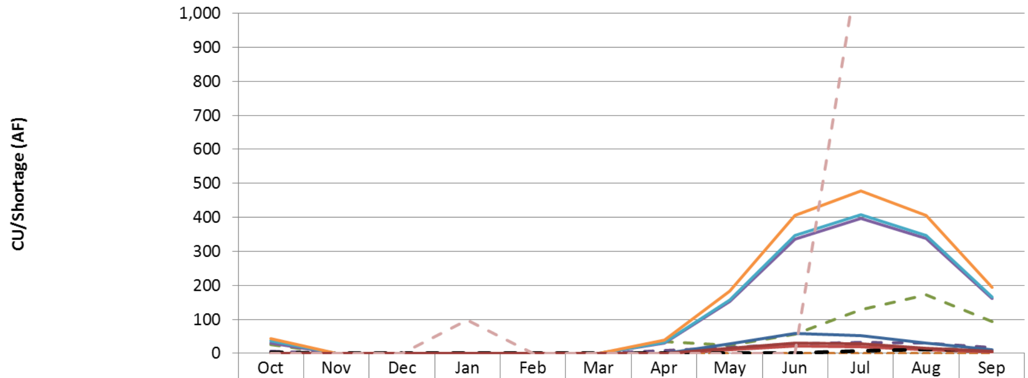
Reach 10 is configured similarly to the way that ideal ATM reaches were envisioned for this study, i.e., large water-long diversions with senior water rights upstream, smaller water short diversions downstream, and environmental needs that could be met between the two diversions. **Figure 13** and **Figure 14** below illustrate the magnitude and timing of estimated CU and shortages for the short-listed ditches in Reach 10 based on WY 1980-2005 data from StateMod. Estimated shortages at trout and warmwater fish flow-ecology nodes in Reach 10 are also shown in **Figure 14** and **Figure 15**. Note, however, that these environmental shortages from the WFET study do not have decreed uses or associated water rights, and therefore these locations cannot function as lessees in an ATM implementation and flows cannot be formally protected. Rather, these locations or reaches can only be regarded as beneficiaries of a lease between an upstream agricultural water user and a downstream agricultural or ISF water right shortage. **Figure 15** is an example spells plot showing months of shortage for the environmental flows for endangered fish species.



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Ag 10-H (CU Short)	17	0	0	0	0	0	17	43	63	92	124	69
Ag 10-I (CU Short)	5	0	0	0	0	0	5	17	30	40	35	17
T 10-A (Beneficiary)	0	0	0	0	0	0	0	0	0	0	0	0
WW 10-A (Beneficiary)	0	0	0	0	0	0	0	0	0	0	0	0
Div 10-K (CU)	0	0	0	0	0	0	0	7	18	17	8	3
Ag 10-C (CU Short)	3	0	0	0	0	0	1	9	8	15	20	12
Div 10-I (CU Short)	1	0	0	0	0	0	0	17	45	44	21	7
Div 10-A (CU)	26	0	0	0	0	0	13	140	295	395	327	154
Div 10-E (CU)	28	0	0	0	0	0	14	146	304	407	343	159
Div 10-D (CU)	28	0	0	0	0	0	13	165	353	461	355	158
Div 10-L (CU)	0	0	0	0	0	0	0	9	24	23	11	4
EFS 10-A (Beneficiary)	193	91	122	242	0	0	0	0	0	229	551	759

Calendar Months

Figure 13. Reach 10 Average Historical CU (lessors) and Shortages (lessees or environmental flow beneficiaries), WY 1980-2005



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Ag 10-H (CU Short)	25	0	0	0	0	0	35	25	57	128	171	94
Ag 10-I (CU Short)	7	0	0	0	0	0	9	18	27	32	31	17
T 10-A (Beneficiary)	0	0	0	0	0	0	0	0	0	0	0	0
WW 10-A (Beneficiary)	0	0	0	0	0	0	0	0	0	0	0	0
Div 10-K (CU)	0	0	0	0	0	0	0	11	23	20	12	5
Ag 10-C (CU Short)	4	0	0	0	0	0	2	0	0	7	11	9
Div 10-I (CU Short)	0	0	0	0	0	0	0	27	58	52	30	12
Div 10-A (CU)	30	0	0	0	0	0	30	153	337	397	337	162
Div 10-E (CU)	38	0	0	0	0	0	33	157	346	408	347	166
Div 10-D (CU)	44	0	0	0	0	0	39	184	405	478	406	194
Div 10-L (CU)	0	0	0	0	0	0	0	15	31	28	16	6
EFS 10-A (Beneficiary)	0	0	0	98	0	0	0	0	0	1191	1801	2791

Calendar Months

Figure 14. Reach 10 Average Historical CU (lessors) and Shortages (lessees or environmental flow beneficiaries), Dry Years

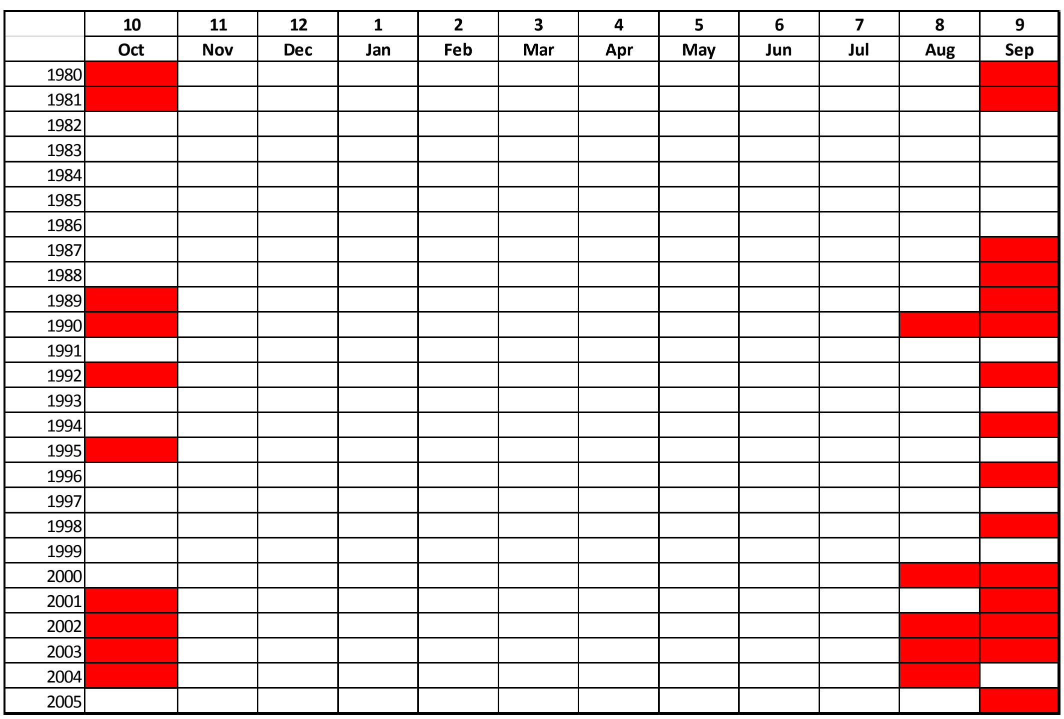


Figure 15. Example Shortage Spells for Environmental Flows for Endangered Fish Species (Red indicates months when actual flows are less than target flows for endangered fish)

Agricultural diversion structures Div 10-A, Div 10-D, and Div 10-E are located near the upstream end of the reach and collectively consume an average of nearly 4,300 AFY during the irrigation season. Any one of these three ditches could meet the majority of the average CU shortages for the identified potential lessors downstream.

Two diversions, located in the geographic middle of Reach 10, were short-listed as both potential lessors and potential lessees: Div 10-I/Ag 10-C and Div 10-J/Ag 10-B (see Table D-3 in Appendix D). As lessees, together they are 50-180 AFY short on average annually, depending on the method of analysis (annual versus monthly, as discussed above).

On the downstream portion of the reach, there are two potential lessees: Ditch Ag 10-I and Ditch Ag 10-H. The combined estimated average annual shortage is approximately 600 AFY. **Figure 13** and **Figure 14** show that the timing and magnitude of potential lessors is great enough to eliminate these shortages without any retiming

Unlike the appropriated ISF water right in Reach 1, the decreed water for the endangered fish critical habitat is a storage right in Elkhead Reservoir that can be released and protected to augment flow in critical habitat. Based on consultation with the Water Division 6 Engineer's office and CWCB's Stream & Lake Protection Section, however, it was determined that the nature of this water right precludes a lease under CRS 37-82-105(2) and that improvements to flow conditions in this reach (EFS 10-A) must be incidental from other leases, e.g., a lease from Div 10-E to Ag 10-H or Ag 10-I. Such incidental increases in flow in EFS 10-A would only be observed between the upstream end of the reach and the lessee. The Yampa ATM team does not yet have enough information or formal legal judgment to draw any conclusions on these points for this report.

A similar process of data analysis and generation of illustrative figures was followed for the second agriculture-to-agriculture candidate reach (Reach 6). Likewise, a detailed assessment was performed to identify potential hurdles to implementation and to identify specific questions to be discussed with the Water Commissioners, Division Engineer, water rights owners, and irrigators.

Section 5

Potential Administrative Issues for Potential Candidate Reaches

The consultant reviewed the potential candidate reaches and used the diversion inventory and output database spreadsheet tools developed for the study to look at potential lessor ditches in greater detail. These data sources are powerful tools that will allow TNC and TU to focus on specific reaches that have the most potential to improve streamflow. In most cases, there are intervening senior water rights that may impact the ability to deliver to a downstream leasing ditch or an ISF water right reach. What is not able to be determined from the databases are the actual water rights administration and irrigation practices in a specific candidate reach.

The purpose of this section is to provide insight regarding water rights administration issues that may affect the implementation of potential ATMs and water leasing projects in the Yampa River Basin. The issues addressed in the following sections were identified by TNC and TU in March 2013. For further information on the administration of potential water leasing scenarios, consultations with the Water Division 6 Division Engineer and the Yampa River Basin Water Commissioners are recommended. These issues are applicable to ATMs based on temporary approvals of the change of the lessor water right and full administration of the lessee and other water rights while the temporary approval is in effect. Other considerations may apply for rotating consumptive use between upstream and downstream users under a change of water rights and determination of transferable consumptive use decreed in water court. Any water released from storage as part of a temporary ATM can be protected from diversion in the intervening reach by the Division Engineer.

5.1 Upstream and Downstream Water Rights are Junior to Intervening Water Rights

This situation can occur and the feasibility of a temporary ATM depends on the local condition on the specific stream. If the intervening water rights have been historically satisfied and have not placed a call, then it is most likely that the historical CU being delivered to a downstream water right would be able to be passed by the headgates to the downstream junior because the diversion that resulted in the CU being transferred would not be called out. If the intervening senior(s) have taken the entire stream flow, i.e., dried up the stream during the irrigation season, and the diversion records reflect this or the local water commissioner confirms this, then the ability to pass the CU is not possible. If the intervening water right owner has not placed a call to satisfy his/her water right but has dried up the stream, then it is likely that they would attempt to divert any CU water in the stream and technically can place a call if needed to allow the diversion. This most likely would have occurred on a tributary stream and not on the Yampa or Elk Rivers where a call has not been placed to date and most likely has not experienced any dry up points. Full administration is presumed when modeling shortages in StateMod, however, so that calls by intervening seniors that would limit shepherding of temporary leases water can be identified.

5.2 Upstream Senior Water Right with Intervening Water Rights Senior to Downstream Leasing Water Right

This situation also can occur and the feasibility of a temporary ATM may depend on local conditions on the specific stream. If the intervening water rights have been historically satisfied and not placed a call or dried up the stream, it is again likely that the CU water could be passed to the downstream junior leasing water right. Even if the intervening senior water rights have dried up the stream, they are still junior to the upstream lessor and it should be theoretically possible to deliver the CU water to the downstream water right provided the intervening water diversions have the ability to pass flow at the headgate. If the senior diverters do not have adjustable headgates or the ability to turn water back to the stream through a waste gate, then the Division Engineer may have to order the installation of proper headgates to pass the CU water downstream. Previously, the Division 6 Engineer has ordered the installation of appropriate headgates on the Yampa River to allow delivery of Elkhead Reservoir releases to the downstream terminus of the Endangered Fish reach.

5.3 Other Considerations

The consultant reviewed the potential candidate reaches and used the spreadsheet and database tools developed for this study to look at potential lessor ditches in greater detail. These data sources are powerful tools that will allow potential users of this process to focus on specific reaches that have the most potential to improve streamflow. In most cases, there are intervening senior water rights that may impact the ability to deliver to a downstream leasing ditch or an ISF water right reach. StateMod can provide an initial assessment of full administration of lessor, intervening and lessee water rights. This assessment should then be adjusted to the extent that full administration in StateMod does not reflect actual water rights administration and irrigation practices in a specific candidate reach.

For example, for a candidate in one of the reaches is situated high in the reach and has a good diversion record including late season diversions with a fairly large irrigated area (392 acres). This diverter has a lot of good attributes including not being water short except in 1980. The local water administration practices become very important and a discussion with the local water commissioner would be very helpful in understanding if CU from an ATM under this ditch would be deliverable to the lower end of the ISF water right in this reach.

Candidate Reach 20 was reviewed to evaluate whether an ATM or multiple ATMs could produce additional late season water to improve the water available to the CWCB for the local ISF water right. The diversion inventory spreadsheet was used to identify larger ditches that have senior water rights, and the Output Database file was used to look at the diversion history of these ditches. A Ditch with 270 irrigated acres and another with 157 irrigated acres on one tributary have historical diversions in August and September that if incorporated in an ATM may provide some additional late season flows for the ISF water right. There is a ditch on another tributary with 585 irrigated acres and very senior water rights also has diversions in August to October in good runoff years and could be included in an ATM or a multiple ATM to provide later season flows to the ISF water right on the main stream of Reach 10. A discussion with the current and/or former Water Commissioner(s) would provide better information on the late season streamflow and irrigation practices.

Candidate Reach 10 was also evaluated using the tools described above. There is a senior water right at the upper end of the reach with a pattern of diversions into the late summer months of August and September. It has an irrigated area of 748 acres and has consumed on average of 758 AFY. There are water short ditches shown on the map for this reach that may be potential lessees. One ditch has a modeled CU shortage of about 180 AFY. The historic diversions are much less (about 43 AFY), and the reason for this needs to be determined. If the owners have not actively irrigated the 120 irrigated acres, then a lease to them may not be practical.

The critical habitat for endangered fish on the lower Yampa River was evaluated as a potential lessee based on the fact that water stored in Elkhead Reservoir is released to augment flows in the critical habitat. As discussed previously, the consultant inquired with the CWCB's Stream & Lake Protection Section to determine the legal nature of this water right. CWCB discussed this issue with the Division 6 Engineer, who discussed it with the Attorney General's staff and concluded that this is not a feasible option because the water right in question is a storage right in Elkhead Reservoir that is released and protected to augment flow in critical habitat. This right is not a decreed ISF and the loan statute, CRS 37-83-105 (2) requires that the loan be to a decreed ISF water right. An IWSA or a SWSP may provide a mechanism for further augmenting flows in the critical habitat, but this possibility was not conclusively determined.

Candidate Reach 12 was evaluated for the potential lease to an ISF water right. There is a senior water right at the upper end of the reach that irrigates around 54 acres and has a recent pattern of diversions of year round use. This water right has a CU of around 165 AFY and has a senior right for 3.8 cfs. There are no intervening water rights and would be a potential candidate reach to consider in more detail.

Each candidate reach can be evaluated and prioritized in the manner described above in the five examples. For each reach, there most likely will be specific questions about late season streamflow, irrigation practices, and water rights administration policies that will need to be resolved by meeting with the local water commissioner.

5.4 Return Flows

Maintenance of historical return flows (magnitude and timing), how they would be affected by temporary leasing and additionally what return flow obligation would have to be met were evaluated. This analysis was performed as part of the Level 4 screening.

In StateMod return flows are calculated by applying a delay table to the remainder of water not consumed by crop irrigation. The StateMod assigns a delay pattern to each structure individually based on use, proximity to the stream, and trans-basin diverters. Generally most structures use delay pattern 1, which are for diversions relatively close to a live stream, and return flows accrue at the next downstream node. In this study all short-listed diversions fit into this category. **Table 5** shows the delay pattern (note that the sum of percentage of flows returned is 97 percent to account for a 3-percent incidental loss).

Table 5. StateMod Return Flow Delay Pattern

Months Delayed	0	1	2	3	4	5	6	7	8
Percentage of Flows Returned	75.6	11.3	3.2	2.2	1.6	1.2	0.8	0.6	0.5

Figure 16 and **Figure 17** show the diversions and StateMod estimated return flows on an average monthly basis for the potential lessors the Yampa ATM candidate reaches summarized under Level 4 screening in Section 4 (Reach 1 and Reach 10). Similar analyses and figures were generated for Reach 6 and Reach 12, which were also evaluated in the Level 4 screening.

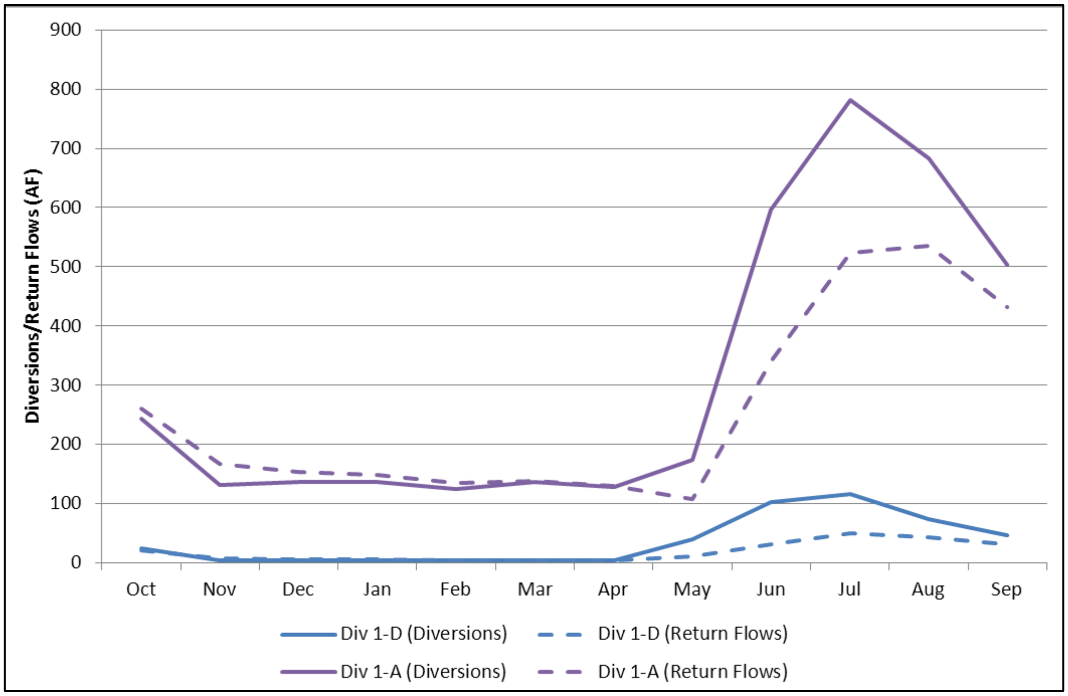


Figure 16. Diversions and Estimated Return Flows for Potential Lessors in Reach 1

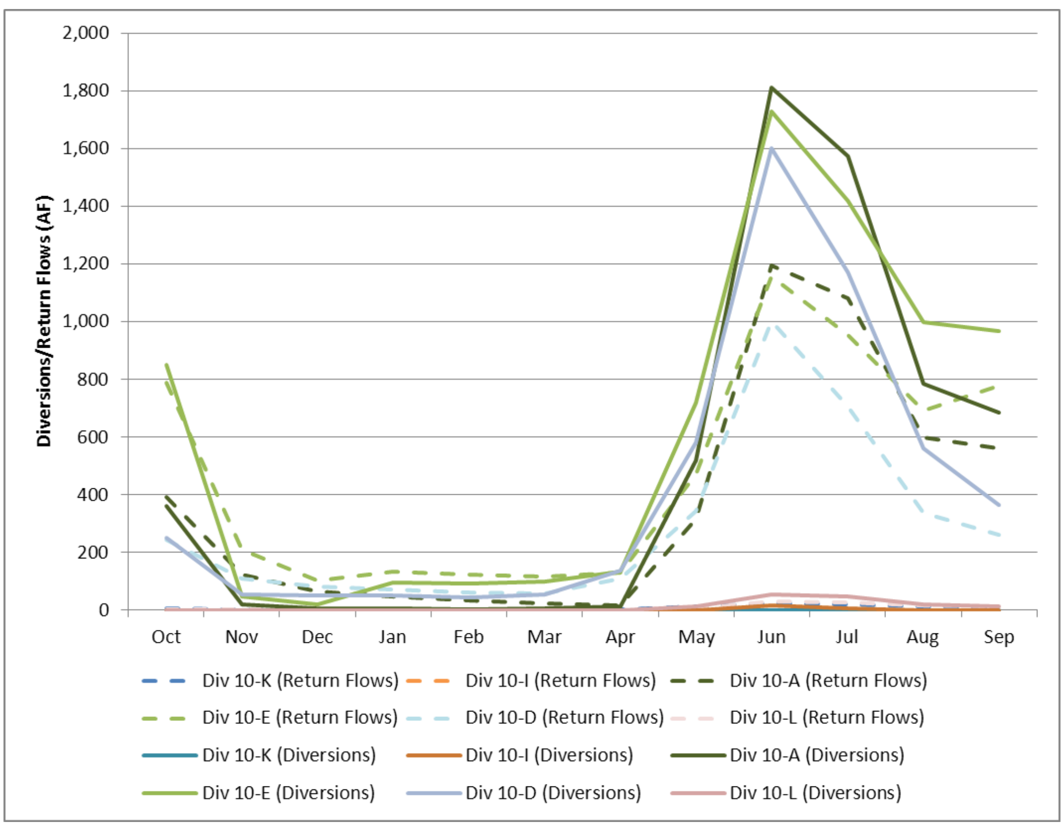


Figure 17. Diversions and Estimated Return Flows for Potential Lessors in Reach 10

Section 6

Conclusions and Recommendations

The objective of the Yampa ATM study was to identify river and stream reaches in five Water Districts of the Yampa River Basin in which ATMs could be feasibly implemented to meet both consumptive and nonconsumptive water needs. Ideal candidate reaches, as specified by project proponent TNC and its partners, would involve the following scenario:

- Upstream agricultural water user with full or surplus irrigation supplies and transferable CU water
- Downstream agricultural water user with an irrigation CU shortage (consumptive need)
- A need for water in the reach between to improve flows for trout (including Colorado cutthroat trout) or warmwater fish (nonconsumptive need)

6.1 Conclusions of Feasibility-Level Technical and Administrative Analyses

Upon initial review of maps developed for this study, a relatively small number of reaches satisfied the ideal scenario described above. Concurrent investigation of legal mechanisms for implementing temporary water leases found that the CWCB's ISF program could serve as recipient of leased water. As a result, the potential candidate reaches were expanded to include CWCB ISF water right reaches as downstream, nonconsumptive end users of water leased in conjunction with ATM implementation.

Level 1 screening was based primarily on GIS analyses and identified 23 potential candidate reaches. Three subsequent levels of screening reduced the number of potential candidate reaches to four. At each successive level, more detailed technical analyses and investigations of potential lessors and potential lessees were performed, including further GIS work, analysis of StateMod and HydroBase data, and consultations with the Water Division 6 Division Engineer, Water Commissioners, and the CWCB Stream & Lake Protection section. At each level of screening, summary documentation was provided to TNC and TU. Those entities then coordinated with the local agriculture outreach committee and provided further feedback and direction for the study. The remaining four potential candidate reaches represent two each of the ATM/water leasing options presented in this study:

- **Option 1**: ATM implementation and water lease from agricultural user to agricultural user (Reach 6 and Reach 10)
- **Option 2**: ATM implementation and water lease from agricultural user to the CWCB for enhancing an ISF water right (Reach 1 and Reach 12)

The findings of the analyses described in this report were instructive and informative, but were not without limitations. The study was heavily dependent on existing data from multiple publicly-available sources. Although StateMod is an excellent tool to determine supply availability and diversion shortages using historical diversion and streamflow record data, StateMod calculates supply availability using available data from HydroBase. While using HydroBase, StateMod tries to determine a set of assumptions and patterns to allow it to implicitly determine water supply availability. That means StateMod exclusively relies on data available in HydroBase and makes the assumption that HydroBase provides a full picture of the operations in the basin. Subsequently, irrigation practices, irrigator interactions, and other special circumstances cannot be considered within the model, but may have a substantial effect on the feasibility of agricultural transfer methods.

Ultimately, the analyses conducted for the Yampa ATM study were limited by reliance on GIS mapping and computer analyses of model and gage data without an ongoing direct outreach program engaging potentially affected water users. There are still many unresolved questions for the remaining four potential candidate reaches that may affect the viability of those reaches for ATM implementation. For example, it is not necessarily known if StateMod estimates of CU shortages for the supposed water-short agricultural end users are accurate; this is due to analytical shortcomings of aggregate nodes in StateMod, reliance on 20-year old irrigated acreage data, and other factors. There are many unknowns for the potential lessors as well regarding modeled estimates of transferable CU and return flows, along with questions about recent uses of those ditches based on comments in the HydroBase structure summaries. Agricultural market forces must also be considered in a region that is primarily irrigating hay meadows to feed local cattle herds. For these reasons, continued outreach to the water commissioner(s) and the individual irrigators may be able to close the gap between modeling data and on-the-ground irrigation practices.

6.2 Technical and Administrative Factors for Further Consideration in Next Steps

None of the conclusions stated above is meant to suggest that the project objectives were not met. On the contrary, the project was successful in completing feasibility-level analyses that identified potential candidate reaches in which ATMs may be implemented to meet consumptive (agricultural shortage) and nonconsumptive (ISF water right and fishery) needs. TNC and TU intend to continue pursuit of a successful ATM pilot project in the Yampa Basin. Whether a pilot project will derive from one of the four remaining candidate reaches from this study is to be determined. Next steps will be guided by interaction with the Division Engineer and Water Commissioners and direct outreach with the potentially-affected water users. While many of these factors have been given consideration in this study, the list below summarizes the factors that will need to be considered in greater depth in order to successfully implement a Yampa ATM pilot project.

- **Statement of need**. A concern was noted by the Division Engineer related to a temporary lease of reservoir water implemented in 2012 to supply a shortage in an ISF water right. Specifically, leased reservoir water intended to be delivered to a water user below an ISF water right reach cannot be protected for delivery to the water user if there is already enough water in the river to meet the downstream user's decree. As a general rule, Division 6 will only shepherd leased water if a downstream headgate shortage exists and the downstream user would not have been able to exercise its priority to call the lessor or other water rights to satisfy that shortage. Such administration is assumed when modeling and analyzing estimated shortages.

- **Protection of instream water.** CU water can be protected from lessor to lessee (in accordance with prior appropriations). Water associated with the return flows can be protected down to the historical point of return so as to avoid causing injury to water users that relied on the return flows

- **Return flow obligations.** The obligation is dependent upon the expected lag between time of diversion and time of return. A detailed analysis will be required to determine (a) lag time and (b) historical point of return. If lag time is short (e.g., 1-2 days), there may be no need to lag return flows and the water can be bypassed at the headgate for delivery to the river at the appropriate location of historical return flows. If lag time is long (e.g., 1 month), the lessor will be responsible for preventing injury to downstream users by maintaining the timing of return flows.

- **Transit Loss.** Transit loss should be factored in on a site-specific basis.

- **Protection of lessor water rights.** In accordance with state statutes, a lessor engaged in a State Engineer-approved transfer will be protected against abandonment and loss of CU credits.

- **Transfers between agricultural water users.** Lessor priority date is key for temporary transfers. If the lessor is senior, intervening headgates could not satisfy their rights by calling the upstream lessor and the CU water will be shepherded downstream. A senior, intervening headgate has the right to take CU water if the intervening headgate could have called out the lessor water right. The senior would be required to place a call to do so. To place a call, an irrigator must (a) be able to sweep the river, (b) have a headgate, and (c) have a functioning measurement device. This flags two other issues: (1) if there's more water in the river as a result of an agricultural transfer, a senior may take it and (2) if a senior places a call, the river will be dried up below that point of diversion. Moreover, if intervening headgates, senior or junior, lack a headgate and measurement device, they will be shut off to meet the requirements of the lease. Full administration is modeled in StateMod, so that any calls by intervening seniors that would limit shepherding of transferred water or increase de-watering below any intervening senior prior to the transfer, can be identified.

- **Transfers from agricultural users to CWCB ISF water rights.** To administer an agriculture-to-ISF water right transfer, Division 6 will need some evidence that the ISF water right has been shorted and access to one or more flow measurement devices. Before shutting users off to meet an ISF water right, the Division Engineer would first check for measuring devices, headgates, beneficial use, and adherence to rights. Noncompliant irrigators would be shut down to satisfy the ISF water right. As described in Section 4.3.1, modeled shortages to an ISF water right assume full administration and that the ISF water right has been called up to its decreed amount. If an upstream lessor is in priority, then the estimated amount of the transferable CU water can be administered to relieve any remaining shortage to the ISF water right.

In conjunction with consideration of these factors, successful implementation of a Yampa ATM pilot project will require more detailed engineering analyses than those completed for screening purposes in this feasibility-level study. Approval from the SEO will be required to execute any temporary lease agreement. Coordination with the CWCB will be necessary if the proposed pilot project involves leasing from an agricultural water user to the CWCB for an ISF water right reach. Based on the analyses presented herein, it appears that opportunities may exist in the Yampa Basin for the implementation of ATMs to meet both consumptive and nonconsumptive needs.

6.3 Recommendations

The following are recommended actions for continued pursuit of ATM pilot projects in the Yampa River Basin.

- Work with individual water right owners who have expressed interest in temporary leasing for the environment. During this study, we heard clear interest in leasing from some individuals stemming from a desire to:
  - Increase options for deriving economic benefit from their water right,
  - Put their water right to a recognized use while dealing with short-term issues that prevent water use in any given year, such as needed maintenance, and
  - Benefit the environment.
- Continue to create technical and legal innovations that increase the options of water right owners while protecting other water users from injury. Specific current efforts that, if supported, could greatly advance ATM goals include:
  - "Water efficiency savings" legislation that would allow for instream protection of irrigation water saved through efficiency improvements.
  - "Flexible market" legislation that would reduce the costs and increase the options for an irrigator to temporarily transfer water to another beneficial use—including instream flow—without risk of abandonment.
  - A West Slope or Upper Colorado River Basin water bank, the primary intent of which is to mitigate risk of a Colorado River compact call. Among the benefits that would accrue from a water bank would be (a) increasing options for irrigators to derive economic benefit from their water rights, and (b) providing additional ISF using water deliveries from willing lessors to the bank. The Water Bank Working Group, made up of the Colorado River Water Conservation District, Denver Water, TNC, and others, has expressed a keen interest in temporary leasing along the lines of what is described in this report.
- Execute ATMs as described in this report to better understand opportunities, limitations, and how West Slope ATMS can be beneficial to all parties involved.

In summary, this study identified several locations where ATMs meeting needs of both the environment and consumptive uses could be implemented, while also illustrating challenges that, if surmounted, could expand the number of leasing transactions that meets the needs for flexibility and increased mutual benefit among consumptive and nonconsumptive interests. There are also hopeful signs in the interest expressed across these sectors and in technical and policy innovations being pursued across Colorado. With the right set of collaborative efforts along with technical and legal tools, the type of leasing arrangement studied in this project could offer substantial benefit to both irrigators and the environment.

Section 7

References

AECOM. 2009. Yampa River Basin Water Resources Planning Model User's Manual. Denver: CWCB.

Binns, N. A. and F. M. Eiserman. 1979. Quantification of Fluvial Trout Habitat in Wyoming. *Transactions of the American Fisheries Society*. 108(3):215-228.

CDM Smith (formerly CDM). 2010. Yampa/White/Green Basin Roundtable Agricultural Water Needs Study.

CDM Smith. 2012. Yampa-White Basin Roundtable Watershed Flow Evaluation Tool Study.

CWCB (Colorado Water Conservation Board). 2008. StateCU Documentation*.* Denver: CWCB.

CWCB. 2011a. Statewide Water Supply Initiative 2010. Final Report. January.

CWCB. 2011b. Alternative Agricultural Water Transfer Methods Grant Program Summary. Final Report. May.

CWCB. 2012. Technical Memorandum: Alternative Agricultural Water Transfer Methods Grant Program Summary and Status Update. November.

Lindenmayer, R. B., N. C. Hansen, J. Brummer and J. G. Pritchett. 2011. Deficit Irrigation of Alfalfa for Water-Savings in the Great Plains and Intermountain West: A Review and Analysis of the Literature. *Agron. J.* **103**(1): 45-50.

MWH. 2012. Colorado River Water Bank Feasibility Study, Phase 1. Final Draft Report. Prepared for Colorado River Water Conservation District.

MWH. 2013. Colorado River Water Bank Feasibility Study, Phase 2. Final Draft Report. Prepared for Colorado River Water Conservation District.

Natural Resources Consulting Engineers, Inc. 2012. Colorado River Compact Colorado Water Bank Feasibility Study Water Supply Technical Memorandum. February 8.

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Appendix A

Yampa ATM Documentation

- Descriptions of ATMs excerpted from the Alternative Agricultural Water Transfer Methods Grant Program Summary report (Colorado Water Conservation Board, May 2011)
- Yampa ATM project status update from The Nature Conservancy to the Colorado Water Conservation Board (November 2012)
- Technical work plan for Yampa ATM screening analyses (January 2013)
- Analysis of wet, average, and dry years in the Yampa Basin.

2.1 Alternative Agricultural Transfer Methods

Traditional agricultural water transfers have been and will continue to be an important part of water providers' plans for meeting their future water demand as long as there are farmers and ranchers willing to sell their water rights. Realizing this, there is a concern that some water transfers may have negative third-party effects such as impacts to the agricultural supply, service, and processing sectors that are fundamental to agriculture-based rural economies. It is also understood that there are other factors contributing to the reduction of farming and ranching in Colorado. For example, CWCB (2011c), in its assessment of 2050 irrigated acres, took into account the following factors in addition to agricultural to municipal water transfers:

- Urbanization of existing irrigated lands
- Water management decisions
- Demographic factors
- Biofuels production
- Climate change
- Farm programs
- Subdivision of agricultural lands and lifestyle farms
- Yield and productivity
- Open space and conservation easements
- Economics of agriculture

To better understand and to help address this trend, the CWCB investigated alternatives to traditional purchase and transfer of water from irrigated lands to new uses in the *Statewide Water Supply Initiative—Phase 2 Report* (CWCB 2007). This report examined trends in irrigated acreage, dynamics leading to agricultural transfers, economic and social consideration, and a discussion of five alternative methods to permanent transfers of water rights for M&I purposes. As the SWSI 2 report states, "The goal of the alternative transfer is to minimize the impact on the local economy, provide other funding sources to the agricultural user, and optimize both the agricultural and nonagricultural benefits of the remaining lands." Listed below are the ATMs identified and discussed in the report:

- Interruptible Supply Agreements (ISAs)
- Rotational fallowing (short- and long-term)
- Water banks
- Reduced crop CU
- Purchase and lease-back

While some of these alternative methods have been implemented in Colorado to a limited extent, traditional water transfers continue to dominate the market in Colorado. As stated in the SWSI 2 report (CWCB 2007), "It is not the intent to interfere with or criticize traditional transfers of agricultural waters since these are a property right and…are needed to meet the [2050] M&I water needs. It is the intent, however, to illustrate how and when alternatives to traditional agricultural transfers may present benefits to not only the parties to the transfer, but other third party beneficiaries."

Furthermore, "[w]hile any transfer method is likely to reduce agricultural production (yield or number of irrigated acres), exploration and implementation of alternative transfer methods may lessen the effect of the transfer within a defined geographic location and may help sustain agriculture by providing additional revenue sources to the agricultural user" (CWCB 2007). Clearly, as municipal water demands continue to increase, irrigators will continue to see an increased interest in their water rights from cities. Moreover, as the demand for a limited amount of water increases, it will be necessary for all water users to optimize the use of a limited resource.

Historically, cities have often relied upon temporary watering restrictions on residential landscaping to reduce demands and provide for emergency reserves in case of continued drought. Through the implementation of ATMs, the irrigators may begin to view their water rights as another "crop" to be marketed and cities may begin to view the cornfields as "reservoirs" holding much-needed water supplies in times of shortage. While possible, most municipal and domestic water providers will probably not be interested in selling taps for homes that rely on a 20-, 30-, or 40-year water lease agreement that could potentially not be renewed (recognizing that permanence may be achieved through methods such as ISAs, transferring a portion of a water right, etc.). Even with the potential for renewal of long-term lease arrangements, water providers have concerns regarding the uncertainty of the long-term lease costs. More likely, alternative methods that are temporary in nature such as rotational fallowing and water banking may be best applied to drought mitigation, drought recovery, an emergency supply, and long-term conjunctive use (i.e., the integrated management of surface water and groundwater supplies). Possibly most important, revenues generated through the various agreements between irrigators and cities can provide much needed capital to invest back into the farm or irrigation systems. Some of the key benefits derived from ATMs include:

- Relationships between irrigators and municipalities—water sharing
- Provides irrigators with needed capital to upgrade farm or irrigation system equipment or infrastructure
- Provides irrigators with a temporary increased income that may be used for payment of debts or increased disposable income
- Helps to optimize the use of a limited water resource
- Sustain rural agricultural communities and economies
- Preserve productive agriculture open spaces
- Provide for greater food security
- Provides wildlife habitat

Descriptions of these ATM concepts identified above, adapted from the SWSI 2 report and other documents, are presented in the following sections.

2.1.1 Interruptible Supply Agreements

ISAs may consist of temporary, long-term, or permanent arrangements in which agricultural water is transferred for other purposes in other locations while irrigation is temporarily suspended. Exercising an ISA is typically triggered on an as-needed basis and could include dry-year needs, drought recovery needs, and even wet-year needs. An ISA would include limitations as to the frequency in which the supply could be exercised throughout the term of the agreement. Current law (Section 37-75-309 CRS) allows the State Engineer to administratively approve temporary ISAs as long as they are not triggered more than three times in a 10-year period. A longer term ISA that could involve more frequent interruption of the agricultural use would require water court approval. The terms of such an ISA are within the parties' discretion, as is the schedule of payments that might reflect frequency or repetition of exercise of the option.

A Colorado example of this type of ATM is the ISA between the City of Aurora and the Rocky Ford Highline Canal, which was first carried out in 2004 and again in 2005 as a Substitute Water Supply Plan. To effectuate the ISA two contracts were implemented. First, a contact with the ditch company providing for the company's support of the lease as well as improvements to the facilities of the company for the benefit of both lessors and non-leasing farmers. Second, individual contracts with each leasing farmer were developed. In 2004, the lease water was used for drought recovery of Aurora's water supply, and in 2005 the lease was shared with Colorado Springs Utilities to supplement both cities' water supply recoveries. In 2008, Aurora and the Rocky Ford High Line Canal Company executed a 10-year renewable leasing agreement by which Aurora will make payments to the canal company in lease and non-lease years and the canal company will support future leasing to Aurora.

2.1.2 Rotational Fallowing

The rotational fallowing concept consists of a type of interruptible agricultural transfer arrangement involving several agricultural parties and one or more M&I, environmental, or recreational users. For example, as a means to provide additional water to meet new demands or to replace the existing yield of nonrenewable groundwater supplies (a potential future need considered for the South Metro and northern El Paso County areas in the 2010 gap analysis update), each agricultural participant would agree not to irrigate a certain percentage of their land for certain years or each year of the term of the agreement that could relate to the number of agricultural users or the irrigated area participating in the rotational fallowing program. Rotational fallowing arrangements are probably best suited for drought and drought recovery, as well as conjunctive use with groundwater to firm existing M&I supplies, but might also be used to provide a base water supply for new/replacement demands. Most likely, if the yield from a rotational fallowing arrangement was used to provide water to a new and growing demand, a long-term, renewable, or even a perpetual agreement would be essential.

At this time, examples of successful rotational fallowing programs include a long-term agreement between the Metropolitan Water District (MWD) and the Palo Verde Irrigation District (PVID) in southern California, in which PVID growers fallow between 7 and 35 percent of their land annually with multiple growing seasons, yielding 25,000 AF to 111,000 AF to MWD each year (CWCB 2007). In Colorado, engineering and economic studies have been underway since 2006 to facilitate the development of the Super Ditch Company rotational land fallowing-water leasing program in the Lower Arkansas Valley. This program is discussed in greater detail later in this report.

2.1.3 Water Banks

In addition to interruptible supply contracts and rotational land fallowing (i.e., rotational crop management contracts), a water bank was authorized by the Colorado legislature in 2003. Water banks have had varying degrees of success in the Western U.S. and have been applied to stored surface water, direct delivery water (i.e., run-of-the-river), and stored groundwater. In general, water banks act as a legal mechanism to transfer water from water rights owners that may not need water in a given year (lessor) and water users having an annual or short-term demand (lessee) versus a long-term supply need.

Water banks may operate in a variety of ways. Important operational considerations include:

- **Model Type:** Water banks may operate as a deposit/withdrawal model or as a clearinghouse model. In the first, anyone qualified may "deposit" and the bank subsequently manages "withdrawals." This may involve a commitment to keep water available for some length of time or until withdrawn. In the second model type, the institution functions as a broker that helps transferors and transferees find each other, usually imposing standard forms, information and assurance requirements, and rules.

- **Funding:** The bank may act with its own funding and with its own specific objectives in mind, or act solely as a service provider (i.e., impartial to any water transaction).

- **Pricing:** The bank may set prices at pre-defined levels, allow prices to float subject to a known index or market condition, or the parties may negotiate a price.

- **Arrangement Duration:** A transaction time between water "moving" among a transferor and a transferee can be short, as with banks that wheel direct flow waters, to indefinitely long, as may be the case for groundwater based banks.

A pilot water bank was established in the Arkansas Basin of Colorado in 2003, but had little or no usage. As described by CWCB (2007), "The lack of usage may be related to the restrictions placed on the type of water (only stored) and no demand due to lack of infrastructure to deliver to source of demand and restrictions on the market (only in basin uses)." Despite the limited usage of the pilot water bank, subsequent legislation allowed for the creation of water banks in any of the state's river basins.

No other formal water banks have been successfully established in Colorado as of 2010, but currently the Colorado River Water Conservation District, the Southwestern Water Conservation District, The Nature Conservancy, and several Front Range water providers that divert water from the West Slope are working with CWCB staff to explore how a water bank could help Colorado prevent and/or address and respond to a Colorado River Compact curtailment and its effects on Colorado water users. The proposed water bank seeks to provide a means for pre-compact (i.e., pre-1922) water rights to be used to allow critical post-compact water uses to continue under a compact curtailment order. Specifically, certain lands that are irrigated by pre-compact water rights would be temporarily fallowed, and these water rights would be used to offset depletions associated with critical post-compact water uses.

2.1.4 Reduced Crop Consumptive Use

In a report developed by the CWCB, the Colorado Water Institute, and CDM, the Colorado Agricultural Water Alliance (CAWA [2008]) explains the distinction between changes in agricultural irrigation practices that can and cannot yield water that is transferable to other uses:

> Under current laws and customs, opportunities for producing significant amounts of transferable water for municipal and industrial (M&I) uses through agricultural conservation measures are constrained by certain physical, legal, and economic factors. To understand these limitations, it is essential to separate the concepts of irrigation efficiency and [agricultural] water conservation. Under current Colorado laws and practices, water saved through irrigation efficiency measures, such as upgrading from flood irrigation to sprinklers or water salvaged through removing phreatophytes, cannot be transferred to other uses or used to expand irrigated acres [beyond those acres allowable in the water right decree]. In [the CAWA report], **[agricultural] water conservation** refers to practices that reduce historical consumptive use, while irrigation efficiency refers to practices that decrease nonconsumptive losses such as runoff or deep percolation of irrigation water.
>
> When considering the potential for agricultural water conservation, it is important to understand the distinctions between saved and salvaged water, as opposed to water that is made available by reducing the consumptive use from irrigated crops. Much of the debate over water conservation indicates that imprecise use of terminology creates confusion and often obscures the real policy considerations. Improvements in irrigation efficiency do not necessarily result in an increase in water available for other uses in Colorado. Saved and salvaged water, as currently construed in Colorado, do not include the concept of water potentially conserved through the reduction of crop consumptive use.
>
> A new term, *Conserved Consumptive Use Water*, is proposed to describe water that is part of the consumptive use of a water right that is removed from an irrigated cropping system. The transfer of this water, while possible under Colorado water law, has not yet been tested in water court or codified by the legislature. [Several of the projects funded by the CWCB are furthering the research and practicality of these transfers.]

In addition, the CAWA (2008) report identifies the following scenarios for generating conserved consumptive use water:

1. Irrigated acres are decreased,
2. Crop selection is changed from a summer crop to a cool season crop,
3. Crop selection is changed to one with a shorter growing season,
4. Deficit irrigation is practiced, applying some amount less than full or historical evapotranspiration over the growing season, or

5. Evaporative losses from the field surface are reduced as a result of conservation tillage, mulching, and or drip irrigation that are a component of the evapotranspiration from applied irrigation water.

The preceding list is consistent with SWSI 2, which considered two potential "methods that reduce CU by reducing the amount or yield of crops planted and irrigated. It is this reduced crop CU, not the reduction in gross diversions (e.g., changes from flood irrigation to sprinkler irrigation, etc.) that can be potentially transferred to a new use" (CWCB 2007). A key benefit of these alternative irrigation and/or cropping methods is that presumably all the irrigated land is maintained at some level of agricultural production throughout the lifetime of the transfer.

It is possible that changes in irrigation application methods and/or timing of irrigation can result in a reduction of CU as compared to historical CU on the same agricultural parcel. As defined by Hansen et al. (2010), limited irrigation (aka "deficit irrigation") refers to "the application of less water than required to meet the full water demand of the crop, with an emphasis on applying the limited water during critical crop growth stages to optimize the beneficial effects of the water." A reduction in per acre CU from either method potentially could be transferred to an alternative "off-farm" use (i.e., M&I, environmental, recreational).

The second approach to reducing crop CU involves changing the historical crop type (perpetually or for a limited term) from crops having relatively high annual CU to crops having lower CU requirements. **Table 1** below provides estimates of annual CU rates for a variety of crops at a number of locations across the Front Range and Eastern Plains of Colorado.

Table 1. Estimated Season Crop Water Requirements (Consumptive Use) in Eastern Colorado (inches/season)[1]

	Alfalfa	Sugar Beets	Grass Hay/ Pasture	Corn, Grain	Sorghum, Grain	Dry Beans	Wheat, Winter	Soybeans	Spring Grains
South Platte Basin									
Byers	32.1	—	27.5	—	20.5	—	16.4	—	12.5
Greeley	31.6	29.3	26.6	—	19.5	18.4	16.4	—	—
Longmont	30.9	25.5	26.2	21.7	—	15.8	18.5	—	11.4
Sterling	35.2	30.0	28.0	—	—	—	12.5	—	14.3
Republican Basin									
Burlington	35.6	30.0	31.1	26.0	21.5	19.2	19.0	—	—
Cheyenne Wells	36.1	30.4	31.7	25.8	—	—	18.6	—	—
Holyoke	35.2	29.9	—	25.4	—	18.7	—	16.4	15.2
Wray	35.2	30.0	30.9	25.4	16.1	18.8	—	10.4	15.2

Table 1. Estimated Season Crop Water Requirements (Consumptive Use) in Eastern Colorado (inches/season)[1] (cont.)

	Alfalfa	Sugar Beets	Grass Hay/ Pasture	Corn, Grain	Sorghum, Grain	Dry Beans	Wheat, Winter	Soybeans	Spring Grains
Arkansas Basin									
Colorado Springs	30.0	—	26.0	20.5	16.0	—	14.1	—	—
Holly	39.3	34.8	34.7	29.4	25.2	—	19.7	—	—
Lamar	39.1	34.3	34.2	26.8	22.6	—	19.3	—	11.8
Rocky Ford	37.8	32.7	32.9	27.7	—	—	—	—	14.2
Springfield	37.4	32.3	32.6	26.7	22.7	18.8	18.6	—	10.4
Trinidad	33.3	—	28.1	21.3	—	—	16.1	—	—
Average	**34.9**	**30.8**	**30.0**	**25.2**	**20.5**	**18.3**	**17.2**	**13.4**	**13.1**

[1] Sources: CAWA (2008), Table 4-2 (Holyoke only); Schneekloth and Andales (2009), Table 1 (all others)

According to Hansen et al. (2010), "Corn and alfalfa are the dominant crops produced under irrigation in Colorado, representing about 80 percent of the irrigated acres." Based on the data presented in Table 1, these two crops have average seasonal CU requirements across the Front Range and Eastern Plains of 34.9 inches and 25.2 inches, respectively. While the individual location data shows that savings will vary from place-to-place, it is evident that planting and irrigating alternate crops such as dry beans or winter wheat could lead to significant savings of crop CU water.

A Colorado example of reduced crop CU is the Aurora Continued Farming Program in the lower Arkansas Valley. This is a pilot program started in 2004 and an example of a method in which agricultural land may be kept in viable production following an agricultural transfer. Under this program Aurora invested in high efficiency (drip systems or sprinklers) irrigation technology for the farm lands enrolled in the program and provides 0.5 AF per acre per year of augmentation water to keep these lands in production. Findings to date include:

- In Aurora's Rocky Ford II transfer, Aurora realized a 1.76 AF per acre CU yield from the water rights. By dedicating 0.5 AF per acre to the continued farming, Aurora was still able to transfer to municipal uses 1.26 AF per acre of water.
- The irrigators have changed farming practices and grow low consumptive crop types (melons and onions) compared to the high consumptive crops historically grown (corn and alfalfa).
- Depending on the chosen crop, the irrigators have supplemented the 0.5 AF per acre of augmentation water with other available water sources, but there appears to be a substantial water savings overall.
- Through the use of the drip irrigation systems, the crops are provided with amount of water needed at the time it is needed; the fertilizer is applied with the irrigation water. This has translated into healthier and more productive plants with larger and more uniform crop yields.
- Water quality improvements. Traditional furrow irrigation has high return flows that may be high in salinity and other pollutants. Through the use of these highly efficient irrigation systems the return flows are reduced along with the accompanying contaminants.

As demonstrated by the Aurora example, a hybrid system of low CU crops coupled with limited irrigation (intentional under-irrigation) methods could further leverage the possibilities of this type of ATM. Transfers from this alternative would likely provide a fixed per annum water yield that could provide a supply necessary to increase an M&I user's firm annual yield.

An important consideration with this type of cropping approach to CU reduction is that there must be a market for the lower CU crops in order for the associated water transfer to truly benefit all of the involved parties. These concepts are being investigated further as part of the Lower South Platte Irrigation Research and Demonstration Project (LSPIRDP), a partnership between the Parker Water and Sanitation District (PWSD) and Colorado State University (CSU). Such transfers may pose some fundamental legal issues regarding the nature and extent of irrigation water rights. Additional information about this effort is provided later in this report.

2.1.5 Purchase and Leaseback

The final alternative considered in the SWSI 2 report as a means to provide additional M&I, environmental, and recreational water supplies is Purchase by End User with Leaseback under Defined Conditions and is perhaps the most common means presently used within Colorado. A purchase and leaseback arrangement, while commonly implemented for a fixed term of 5 to 10 years or annually as excess supplies are available, can be a permanent agreement where the municipal, environmental, or recreational interest purchases agricultural water rights with the agreement that the new owner will lease back water to the farmer (or ditch system) under specified and pre-determined hydrologic circumstances. For example, a municipality may be limited to making a call on this new supply only during dry years or when there is a compact call in place. The farmer may lease the water during hydrologically average and wet years.

Purchase and leaseback arrangements can be viewed as a more permanent variation of ISAs that provide more certainty to the purchaser. If the new owner of the water right begins using the water for "new" and growing demands (versus just for firming pre-existing supplies), a purchase and lease-back arrangement could eventually result in the permanent dry-up of irrigable lands or regions and in this case could be characterized as a "soft landing" transition period when moving from irrigated to non-irrigated farmland. Annual leases by M&I providers of previously purchased irrigation rights take place in both the South Platte and Arkansas River Basins. Examples include the following:

- Arkansas Basin
  - Pueblo Board of Water Works (PBWW) and the Bessemer Irrigating Ditch Company (Bessemer Ditch). PBWW has purchased over 5,440 shares in the Bessemer Ditch and has offered the sellers a long-term lease of the shares through 2029. Over 98 percent of the shares purchased are being leased back to the sellers.
  - PBWW annual excess water supply leasing program.
  - Aurora and Rocky Ford High Line, Holbrook Canal.

- Colorado Springs Utilities and Colorado Canal. Colorado Springs Utilities markets surplus water back to Colorado Canal as well as augmentation plans, effectively creating a two-way market.

- Tri State Generation and Transmission Association and Amity Canal.

- Multiple excess municipal water supply leases with Division of Wildlife (DOW) and State Parks.

- South Platte Basin

  - City of Thornton and Water Supply and Storage Company (WSSC).

  - City of Fort Collins and North Poudre Irrigation Company (NPIC).

Section 6 – References

CAWA (Colorado Agricultural Water Alliance). 2008. Meeting Colorado's Future Water Supply Needs: Opportunities and Challenges Associated with Potential Agricultural Water Conservation Measures.

CWCB (Colorado Water Conservation Board). 2007. Statewide Water Supply Initiative – Phase 2. Final Report, Section 3 – Alternative Agricultural Water Transfer Methods to Traditional Purchase and Transfer. November 2007. Prepared by Camp Dresser & McKee Inc.

CWCB. 2011c. Statewide Water Supply Initiative 2010, Final Report, Appendix I—Technical Memorandum State of Colorado Current and 2050 Agricultural Demands. Prepared by Camp Dresser & McKee, Inc., AECOM, and Harvey Economics.

Hansen, N., J. Pritchett, T. Holtzer, J. Brummer, M. Stephens, J. Schneekloth, B. Bosley, A. Helm, D. Westfall, and J.R. Herman. 2010. Progress Report of the Lower South Platte Irrigation Research and Demonstration Project and Final Report for the Parker Water and Sanitation District Water Supply Reserve Account Grant. January 2010.

Schneekloth, J., and A. Andales. 2009. Seasonal Water Needs and Opportunities for Limited Irrigation for Colorado Crops. Crop Series No. 4.718. Colorado State University Extension.

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MEMORANDUM

TO: Todd Doherty
FROM: John Sanderson, TNC
Doug Robotham, TNC
Seth Turner, CDM Smith
Hal Simpson, CDM Smith
DATE: October 5, 2012
RE: Update on Yampa ATM project and related Water Bank analysis

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The Nature Conservancy and its partners at Trout Unlimited and CDM Smith are pleased to provide this interim report on progress on the project "Use of ATMs to meet nonconsumptive and consumptive needs in the Yampa Basin." A related effort being pursued in the Yampa Basin—assessment of fallowing potential and other water saving tools in relation to a Water Bank—is also reported on below.

The intention of this project is to enhance relationships between irrigators and habitat conservationists by meeting the needs of water-short rights with leased water while simultaneously improving instream flows in key reaches. Good communication from those executing this project and the ranching community is essential for success of this effort, and the technical analysis has been somewhat slowed by our recognition that this communication had not yet been sufficiently thorough. We have worked and will continue to work through the Ag Subcommittee of the Basin Roundtable to improve our understanding of the needs of the ranching community, and to keep that community apprised of our activities. It is the intention of the habitat conservation community to bring financial resources to the Yampa Basin to implement an ATM pilot project upon completion of the technical analysis now being conducted.

We recently met with the District Engineer and the Water Commissioners in Division 6 to apprise them of our work. We learned much about specific issues that may be challenges in implementing an ATM, and we will continue to work with this staff to ensure that we are paying attention to all relevant details.

The ATM project scope as described in the Alternative Agricultural Water Transfer Methods Competitive Grant Program application contains six tasks. Progress on each of those tasks is described below.

1) Identify Location and Timing of Non-Consumptive and Consumptive Needs

We have identified several potential locations where water-short irrigation rights could possibly be met by leasing water on a temporary basis from an upstream water-long right, while improving water-short instream flows along the way. Additional locations for ATM implementation were identified based on potential opportunities for temporary leases of water to satisfy CWCB instream flows (ISFs). These locations were identified using the following sources of data:

- Irrigated lands from CDSS, which were reviewed during the Yampa-White Ag Study
- Water-short agricultural areas based on existing studies
- Environmental needs based on existing information from sources such as the Non-consumptive Needs Assessment, Watershed Flow Evaluation Tool, and Trout Unlimited's Conservation Success Index
- ISF mapping based on shapefiles obtained from CWCB.

Having identified potential locations where we might do an ATM transaction, we now intend to reach out to the ranching community to seek individuals who may be interested in working on a pilot transaction.

2) Analyze Possible ATM Transactions

Possible on-field approaches making consumptive use water available for lease include:

- full-season fallowing, likely on a rotational basis,
- reduced crop consumptive use (deficit or split-season irrigation), or
- crop type changes

Legal mechanism through which CU could be leased include:

- Loan of water between two agricultural (Ag) water users as allowed under CRS 37-83-105 (1).
- Loan of water to the CWCB for instream flows pursuant to a decreed instream flow water right as allowed in CRS 37-83-105 (2).
- Operation under an Interruptible Water Supply Agreement (IWSA) pursuant to CRS 37-92-309 and the State Engineer's Regulations 2CCR 402-15.
- Operation under a Substitute Water Supply plan (SWSP) pursuant to CRS 37-92-308 (5).

In addition to existing legal mechanisms under which an ATM could be operated, we will also explore—in collaboration with the Water Bank working group—the possibility of operating under a Water Bank agreement.

Having identified locations where water-short and water-long irrigation rights can be connected in a way that also benefits the instream flows, we intend to prepare an inventory of the water rights associated with identified potential locations. Once the inventory is complete, we will analyze the timing and amounts of water that would be made available through application of an ATM to these water rights. Other factors to be considered include exchange potential, return flow obligations, and infrastructure capacity. We will also analyze potential environmental improvement based on the amount of lease water that may be available, as well as potential impacts on late season flows.

3) Identify the Best ATM for Implementation in each Location

The best location for an ATM will be, first and foremost, a location where a water-long right owner and a water-short right owner in a potential location want to work with us to conduct a willing buyer-willing seller transaction. This location must also take account of the timing and location of water available through the ATM and the timing and location of the non-consumptive and consumptive need.

4) Conduct Outreach to Water Rights Owners, Governmental Entities, and Other Interested Parties

Since the beginning of this project we have conducted outreach to the Community Ag Alliance, Colorado State University Extension, CSU researchers, and water interests in the Yampa Basin, including the Basin Roundtable, to provide information about the study and receive feedback. This outreach will continue as the project progresses. Later, information from the preceding tasks will be used to identify specific landowners, water rights holders, and other interested parties to contact and work with to develop interest in specific ATM transactions to meet multiple-purpose needs.

5) Prepare a Report to Describe the Most Favorable ATMs and Identify Next Steps to Implementation

Anticipated completion of this project is May 30, 2013. Once complete, the project partners will work to facilitate implementation of the recommended ATMs that can best meet both non-consumptive and consumptive needs in the Yampa Basin.

6) Begin implementation of recommended ATM transactions

Implementation is anticipated in 2013 at the earliest. In addition to the water transaction, implementation will have to include a thorough study of changes in crop productivity and savings of consumptive use.

Water Bank

What we are learning through this ATM project is highly relevant to the Water Bank study being spearheaded by the Colorado River Water Conservation District. The water bank concept is that the water supply made available by fallowing irrigated land high in the Yampa river basin (through an ATM) would be deposited in this water bank by delivering it to any number of locations lower in the Yampa basin that exhibited high instream flow risks rather than an in-basin irrigation shortage. The water bank working group is interested in investigating a whole system in the Yampa Basin because flexibility in fallowing over time increases with multiple water users. We have been in regular contact with the water bank working group to determine how our respective projects can best complement each other.

The candidate system in the Yampa basin being considered for phase 2 of the water bank study is the Ekhart Ditch on the upper Elk River. Because it is a fairly small irrigation system of about 250 acres, the candidate system for the next phase of analysis may be expanded to include several nearby systems along the upper Elk River so that more wide spread rotational or split season fallowing can be assessed. The assessment of fallowing potentials at candidate irrigation systems for phase 2 of the water bank study including the system on the upper Elk River should be complete by the end of October 2012 with a phase 2 report due at the end of November 2012.

The following is the proposed work plan for Yampa ATM technical analysis to be completed by CDM Smith.

- 23 potential candidate reaches were identified through work between May and October 2012. These potential candidate reaches will be the basis for further analyses to be completed as described below. Identified potential candidate reaches were generally one of two types:
    1. Downstream shortage associated with agricultural consumptive need, potential lessors with adequate water supply at upper end of the reach, and a trout or warm water fishery shortage (nonconsumptive) between.
    2. CWCB instream flow (ISF), possibly with a fishery shortage, and one or more upstream diverters as potential lessor.
- General steps for the technical analysis were proposed in December 2012. These steps, as follows, will be elaborated upon throughout this document:
    1. Data analysis of water short ditches first to understand as much as possible about the magnitude and timing of these shortages along with any other appropriate data in HydroBase and the StateMod Model.
    2. Then look at upstream users for potential lessors.
    3. Then look at return flow issues associated with potential lessors.
- Use study period Water Years (WY) 1980-2005 for detailed streamflow and diversion data analyses.
    - WY 1980 was selected as the start of the study period because historical data from the more recent past is expected to be more complete and more reliable than data from earlier years.
    - The end of the study period (September 2005) was based on end of simulation for latest version of the CDSS model.
    - In addition, historical data recorded during this period will be more reflective of current water usage and irrigation practices in the Yampa Basin.
    - Note that the data from the Yampa agricultural water demands study that was used for screening of potential candidate reaches was based on WY 1950-2005, but that data was used for initial screening and identification of potential candidate reaches; we are now initiating more detailed technical analyses.

<u>Additional revisions and refinements to candidate reach maps</u>

- Use aerial photography to improve visual understanding of how a ranch is irrigated and maintained.
    - Create a second set of the candidate reach maps using aerial photography (mostly likely Bing Maps, which has ~1 m resolution and layer files that can be readily used in GIS) as the base map, overlay same river reaches, nodes, etc., as existing maps.
    - Make the irrigated parcels transparent over the aerial photos. Also confirm the date of the most recent field verification of the irrigated parcels data (e.g., 1993 or 2005?)
- Add shapefile of stream gages to existing potential candidate reach maps to identify which potential candidate reaches have nearby gaging that would be indicative of

streamflow in the potential candidate reach (ideally on the main stream through a reach, not on a tributary).

STEP 1A: Evaluate the timing and magnitude of agricultural consumptive use (CU) shortages

For potential candidate reaches with downstream agricultural CU shortage(s), identified through analysis completed in May-October 2012, evaluate the timing and amounts of historical diversions, CU, and shortage, as follows:

- Visually screen existing maps to identify those shortage nodes diverting from the main stream in a potential candidate reach.
- Confirm visual analysis by retrieving water rights information for all agricultural shortage nodes (in a given potential candidate reach) from HydroBase. This information should identify the water source for each right. Verify main stream versus tributary and focus subsequent steps on main stream shortages. (We want to avoid the scenario of leasing water to flow downstream, and then exchange up a tributary to a lessee's point of diversion.)
- Obtain historical diversion records (monthly and daily) from HydroBase and/or StateMod (HydroBase historical diversions are used in StateMod, however, any missing data was filled using StateDMI). Historical diversions in HydroBase are based on the records maintained by the State Engineer's Office, which are the best available source of data for this analysis.
- Evaluate historical diversion pattern over WY 1980-2005 first using monthly data. If a more refined analysis is required for a particular location, the daily data will be used as well.
- For the selected shortage locations, also evaluate the estimates of Water Supply Limited (WSL) CU from StateCU as well as the estimated volume and percentage of CU shortage estimated in StateMod.

STEP 1B: Evaluate streamflow in the potential candidate reaches

Historical streamflow data will be analyzed based on historical gage records or StateMod estimates, as follows:

- For potential candidate reaches with an agricultural shortage as the (consumptive) downstream end user
    - If streamflow data is available from a gage near to a potential candidate reach, obtain the historical records from HydroBase and summarize statistics on a monthly/daily basis over WY 1980-2005.
    - If historical streamflow gage data is not available, streamflow estimates at StateMod node locations represent the best available source of streamflow data for the scope and scale of this analysis. (Note that streamflow in StateMod is calculated at every node, but to maintain a mass balance, gains for reaches between any two gages are entirely realized at the downstream node. For this reason, the accuracy of flow estimates is greatest just downstream of a gage.)

  - Compare the results of this streamflow analysis to the results of the diversion and CU analyses to see if there are correlations between the timing and volume of streamflows and the timing and magnitude of agricultural shortages.
- For potential candidate reaches with leasing to CWCB ISF as the potential (non-consumptive) downstream user
  - Whether instream flows are being met is typically measured by the nearest upstream gage.
  - CWCB ISF website reports that 70 streamflow gage stations are used to monitor ISFs. We have requested the list of these gages to determine if any are related to the ISFs identified in potential candidate reaches for Yampa ATM.
  - If a particular ISF does not have an upstream gage record, we can evaluate StateMod streamflow estimates for the nearest upstream node.
  - We have downloaded the Water Division 6 ISF tabulation, which can be used with existing data to verify the timing and amounts of ISF minimum flows.
  - Together, these data sources will be used to determine the timing and amount of streamflow available relative to the requirements of the ISF decrees.

STEP 2A. Evaluate the timing and magnitude of CU available from potential upstream lessors

Once we have evaluated the amount and timing of agricultural diversions and streamflows, we can analyze potential lessors at the upper end of a potential candidate reach.

- Potential candidate reaches may have only one potential upstream lessor (common for ISF reaches) or many (common in areas with concentrated agricultural production).
- The timing and magnitude of agricultural shortages or ISF shortfalls from Steps 1A/1B will help establish a threshold to help identify the most productive potential lessors.
- Based on careful review of existing maps as well as amounts of diversions and irrigated land and other factors, we propose to analyze potential lessors for a given potential candidate reach. Relevant factors for lessor selection include the following:
  - Geographic location relative to the irrigation shortage node (preferably on the same main channel, although a lessor could potentially be on an upstream tributary).
  - Magnitude and timing of historical diversions by the potential lessor (diversion data from HydroBase for WY 1980-2005).
  - Estimates of CU for the potential lessor, from StateCU
- Objective will be to evaluate how timing and amount of potential lessor diversions (and hence, water availability) compares to timing and amount of shortage diversions and streamflows.

STEP 2B. Assess the contribution of leased water to meeting non-consumptive demands (ISF or fisheries)

Based on the preceding analyses of streamflows and potential yield from leasing transferable CU, CDM Smith proposes to calculate estimates of the amount and timing of increased flows in reaches selected with the goal of improving streamflows to meet ISF criteria or meet fisheries needs.

STEP 3: Return flow analysis

Return flow analysis will be an important component of any ATM implementation. The analyses in Steps 1 and 2 will result in a refined list of potential lessors and lessees for completing one or more ATM transactions in the Yampa River basin.

Meeting with the Division 6 Division Engineer and/or Water Commissioners may be a necessary pre-cursor to any technical analysis of return flows. The objective of this meeting would be to clarify legal obligations for the maintenance of return flows in any of the final potential candidate reaches. Maintenance of return flows from lessors may require construction of recharge basins or other storage to release water at the appropriate time and in the appropriate amount to avoid injury to other water users.

The steps to the technical analysis of return flows will be refined once the other steps are complete, but the following considerations are acknowledged:

- In the Yampa Basin, return flows from large early season diversions bolster late season flows. Return flows of lessors needs to be analyzed to study the effect of foregoing their diversions. Although leasing CU water to a downstream diversion would have the immediate effect of increasing flow along the reach, it might have the detrimental effect of decreasing late season flows if return flows are not properly maintained.
- Estimates of return flows can be derived from StateMod data.
- Unless an agricultural user has a tailwater ditch with a point return location to the river, many agricultural return flows are diffuse, non-point returns. StateMod is designed such that estimated return flows accrue to the next downstream node, unless specific information is available for return flows from a particular diversion structure.
- Model includes return flow lag tables that identify a pattern that each structures return flows enter the stream. These lag tables were refined through the model calibration process such that flows at streamflow gages match well to historical records.
- Calculate return flows as difference between diversions and CU, minus 3 percent for incidental losses.

Available data from existing resources

- From HydroBase
    1. decreed amount and water source associated with water right
    2. historical diversions (monthly and daily)
    3. irrigated acreage and crop type(s)type of crops
    4. diversion data for individual structures that are aggregated in CDSS model.
- From CDSS models
    1. monthly WSL CU (from State CU)
    2. monthly shortage (from StateMod)
    3. monthly diversion (historical, from StateMod)

Other analytical issues

A suggestion was made that irrigators at risk of abandonment may make good potential lessors. The CDM Smith technical team advises as follows:

- The abandonment list (Water Division 6, Revised Abandonment List, December 19, 2011) contains water rights recommended for abandonment following review in 2010. There was a period through June 30, 2012 to file a protest with the water court and request a judicial review of the abandonment. If no protest was filed, then the abandonment stands.
- For 2020, the Division Engineer will review diversion records to see if there is 10 years of no use, and if so, will place the water right on the initial abandonment list at that time.
- The water court handles abandonment of conditional water rights that do not show diligence every 6 years.
- At this time in the review cycle, it is unlikely that potential abandonment will be helpful in identifying potential lessors for implementation of ATMs in the Yampa Basin.

It has also been discussed that absentee ranch owners who are no longer producing hay crops or managing commercial cattle herds may be good candidates for leasing water. It will be difficult to identify who these land- and water rights owners are and whether they are irrigating with any diligence without engaging the water commissioners or others with on-the-ground knowledge of the area.

WIFOHACO.09249750.WILLIAMS FORK AT MOUTH, NEAR HAMILTON, CO.

Wet / Avg / Dry Year	Annual Naturalized Flow [AF]
1984	337033
1985	271278
1983	249390
1997	242723
1998	237822
1986	228592
1982	216609
1996	215466
1995	208845
1980	198696
1993	198204
2005	177933
1999	163283
2003	158469
1988	155255
1991	147156
1987	141248
2001	120775
2000	119565
1989	115229
2004	114132
1992	112527
1981	102485
1990	100019
1994	89582
2002	76113
25th Percentile =	**116313**
75th Percentile =	**216323.25**

YAMCRACO.09247600.YAMPA RIVER BELOW CRAIG, CO.

Wet / Avg / Dry Year	Annual Naturalized Flow [AF]
1984	1837129
1997	1515740
1986	1500194
1985	1433314
1983	1386225
1995	1371544
1998	1333794
1996	1313598
1993	1266048
1982	1264814
2005	1182113
1980	1177975
1999	1090756
2003	1013041
2000	958730
1991	925702
1988	906169
2001	818353
1987	734723
2004	730391
1994	698839
1990	693737
1989	683589
1992	625269
1981	601818
2002	443902
25th Percentile =	**731474**
75th Percentile =	**1328745**

LSRSLACO.09253000.LITTLE SNAKE RIVER NEAR SLATER, CO

Wet / Avg / Dry Year	Annual Naturalized Flow [AF]
1984	312862
1983	290308
1997	252015
1982	243331
1986	230429
1996	226312
1985	225590
1998	225340
1993	218226
1999	217446
1995	205323
2005	201969
1980	190817
1988	154287
2000	152071
2003	134268
1991	130125
1990	125021
1989	121353
1994	119388
1981	114668
2001	107848
1987	104814
2004	104016
1992	99172
2002	80028
25th Percentile =	**119879.25**
75th Percentile =	**225527.5**

Appendix B

Maps of Yampa Basin Environmental Attributes and Agricultural Shortages (Baseline and Historical Scenarios)

- Yampa River basin overview
- Water District 44 - Lower Yampa River
- Water District 54 - Slater/Timberlake Creeks
- Water District 55 - Little Snake River
- Water District 57 - Middle Yampa River
- Water District 58 - Upper Yampa River

Average Agriculture Shortage (Baseline Model % of IWR)
- > 50%
- 26% to 50%
- 6% to 25%
- 1% to 5%
- 0%

Trout Flow-Ecology Relationship
- < 10% Very High Risk
- 10% to 15% High Risk
- 16% to 25% Moderate Risk
- 26% to 55% Minimal Risk
- > 55% Low Risk

Warm Water Percent Change in Biomass
- > 50% Very High Risk
- 25% to 50% High Risk
- 10% to 25% Moderate Risk
- < 10% Low Risk
- Points of Diversion >= 1 cfs
- Cities

- Active Stream Gauge
- Historic Stream Gauge
- Cutthroat Reaches

CWCB Decreed ISF
- Appropriated
- Enlarged

Stream Data: USGS National Hydrography Dataset

- Road
- Streams and Rivers
- Lakes and Reservoirs
- Irrigated Parcels
- County Boundary

N S E W

0 4 8 12 16 Miles

Trout and Warm Water Fish Flow-Ecology Risk and Agriculture Shortages Mapping (Overview)

Yampa Basin

CDM Smith

* DRAFT 3/21/2014

Average Agriculture Shortage (Historic Model % of IWR)

- > 50%
- 26% to 50%
- 6% to 25%
- 1% to 5%
- 0%

Trout Flow-Ecology Relationship

- < 10% Very High Risk
- 10% to 15% High Risk
- 16% to 25% Moderate Risk
- 26% to 55% Minimal Risk
- > 55% Low Risk

Warm Water Percent Change in Biomass

- > 50% Very High Risk
- 25% to 50% High Risk
- 10% to 25% Moderate Risk
- < 10% Low Risk
- Points of Diversion >= 1 cfs
- Cities

- Active Stream Gauge
- Historic Stream Gauge
- Cutthroat Reaches

CWCB Decreed ISF

- Appropriated
- Enlarged

Stream Data: USGS National Hydrography Dataset

- Road
- Streams and Rivers
- Lakes and Reservoirs
- Irrigated Parcels
- County Boundary

N S E W

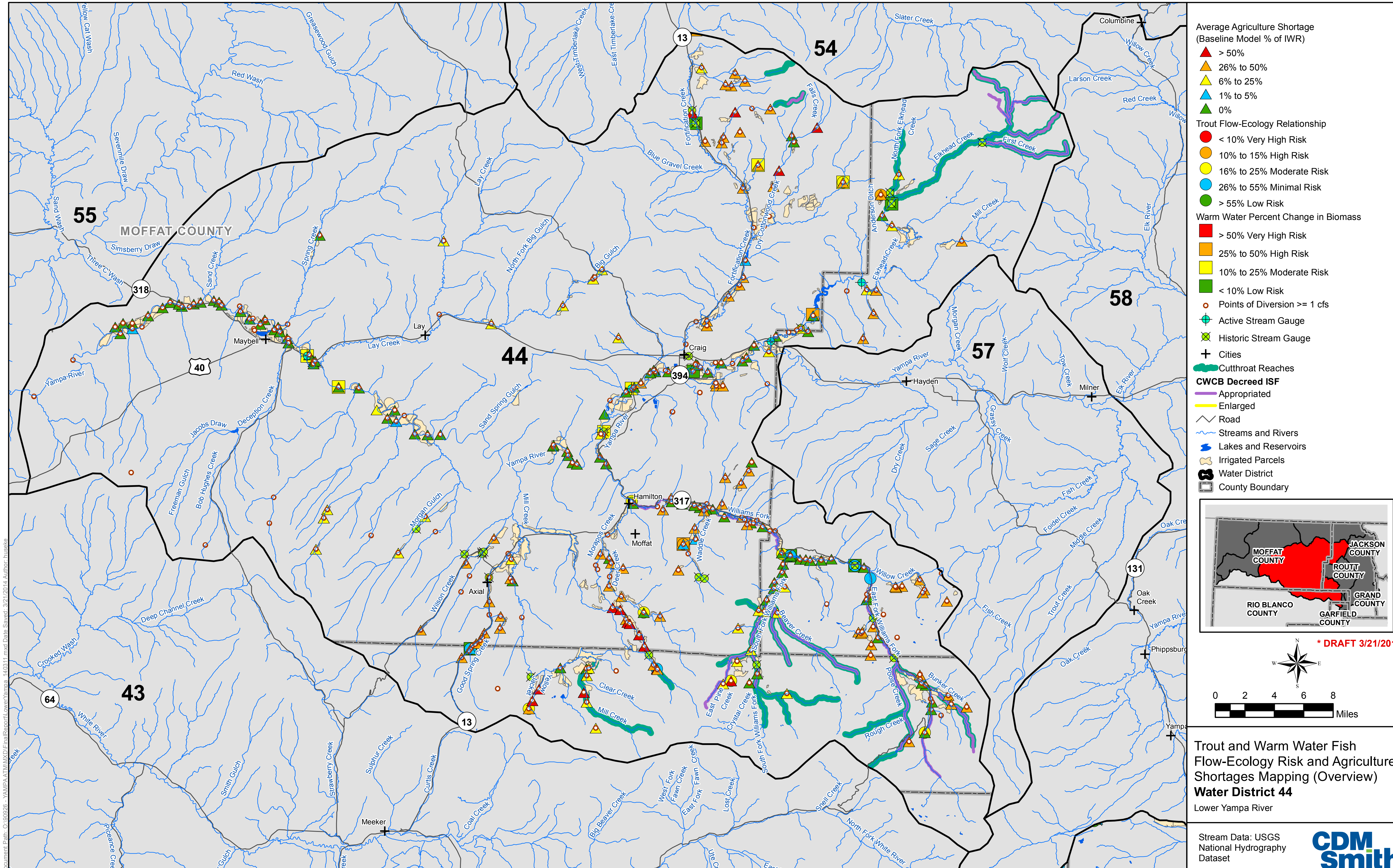
0 4 8 12 16 Miles

Trout and Warm Water Fish Flow-Ecology Risk and Agriculture Shortages Mapping (Overview)

Yampa Basin

CDM Smith

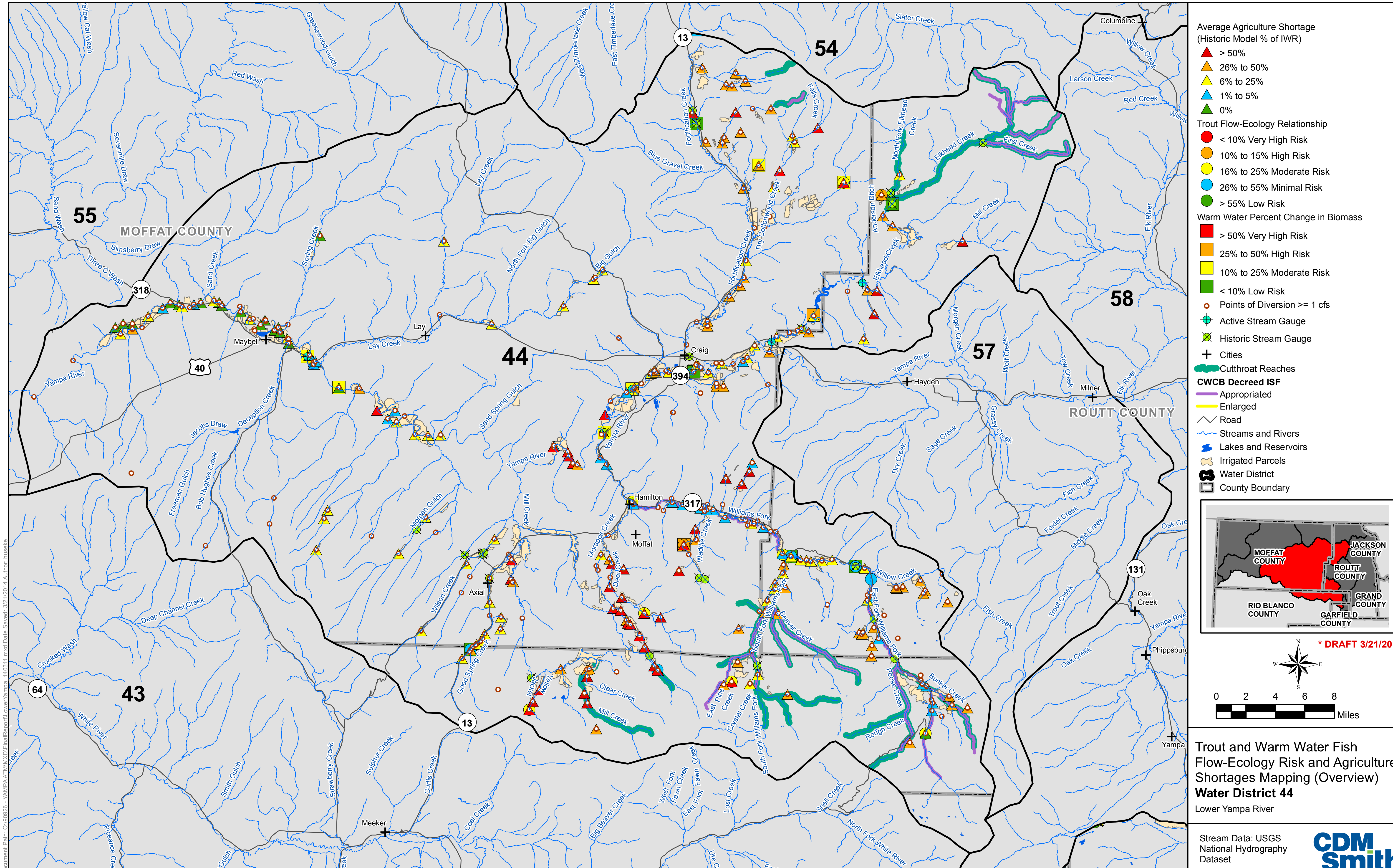
*** DRAFT 3/21/2014**



Trout and Warm Water Fish Flow-Ecology Risk and Agriculture Shortages Mapping (Overview)

Water District 44

Lower Yampa River



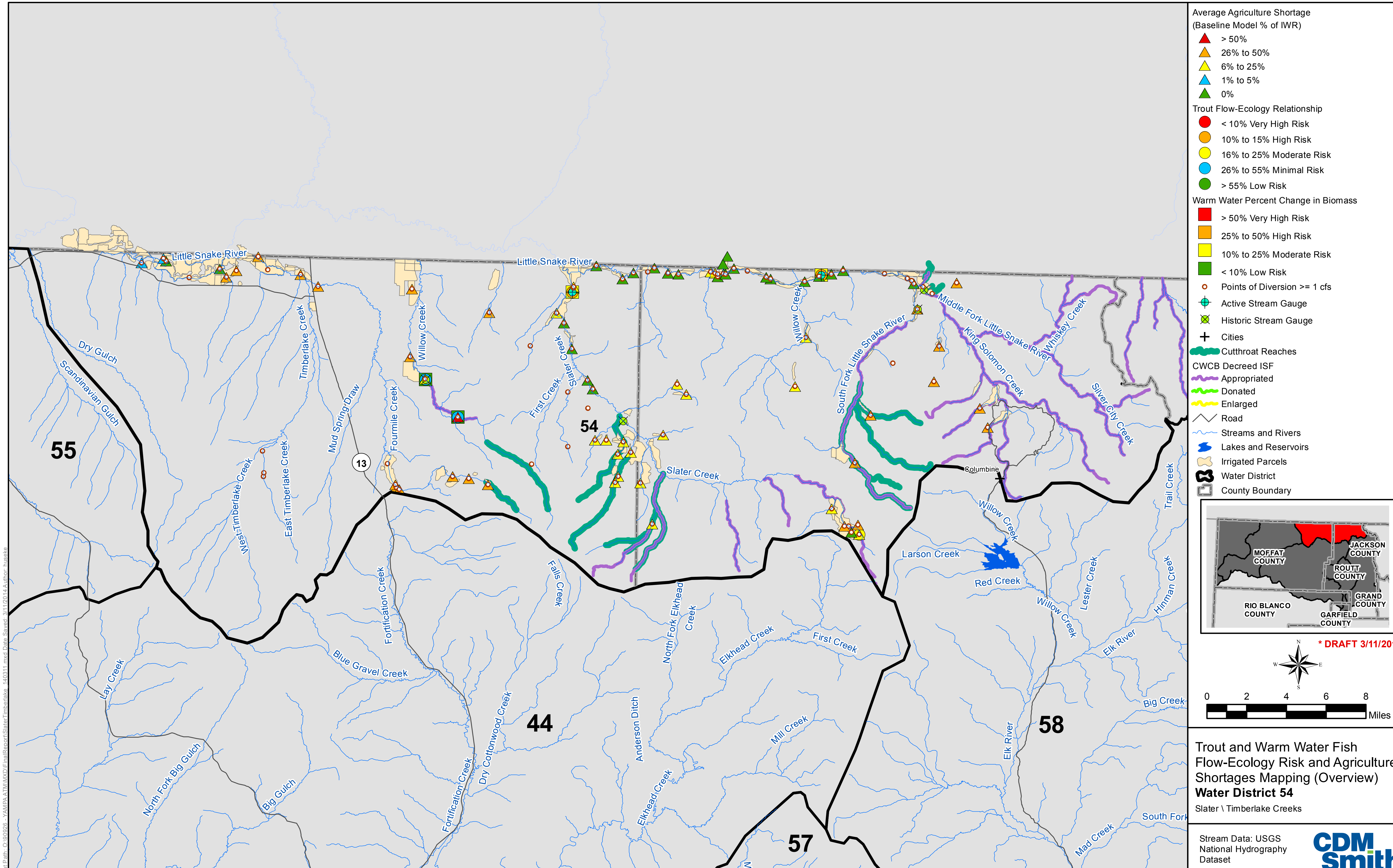
Trout and Warm Water Fish Flow-Ecology Risk and Agriculture Shortages Mapping (Overview)

Water District 44

Lower Yampa River

Stream Data: USGS National Hydrography Dataset

CDM Smith



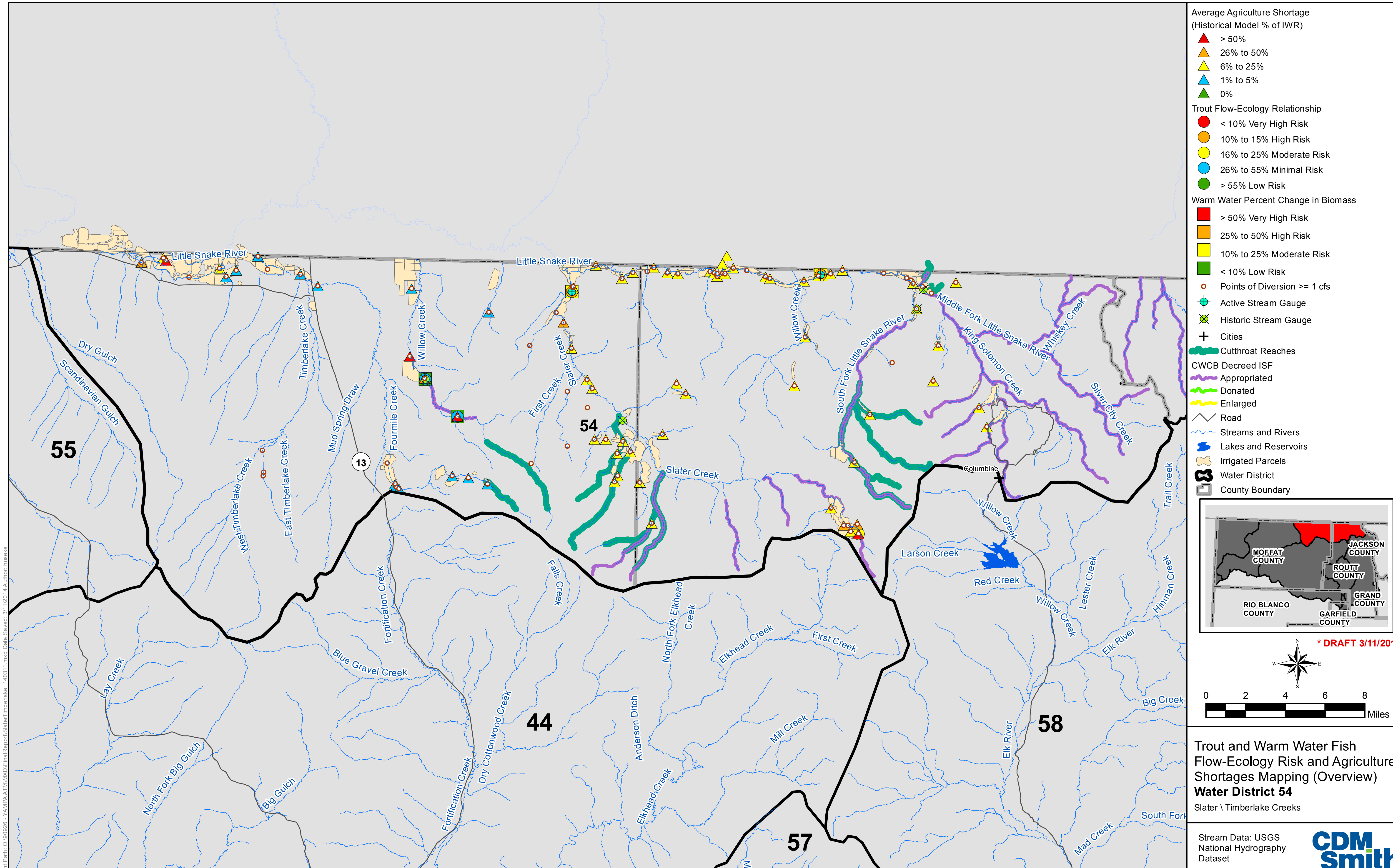
Trout and Warm Water Fish Flow-Ecology Risk and Agriculture Shortages Mapping (Overview)

Water District 54

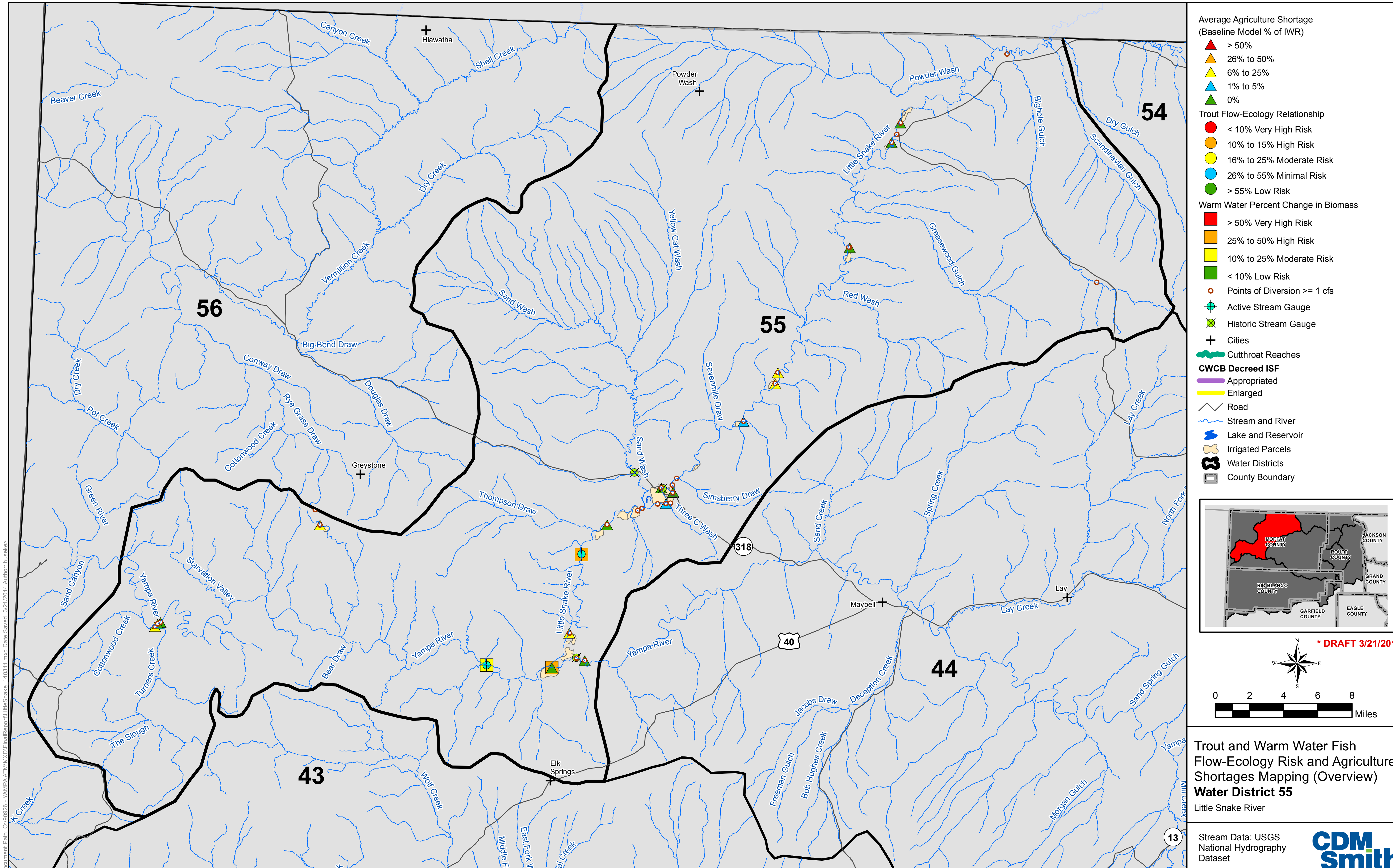
Slater \ Timberlake Creeks

Stream Data: USGS National Hydrography Dataset

CDM Smith



Average Agriculture Shortage
(Historical Model % of IWR)
> 50%
26% to 50%
6% to 25%
1% to 5%
0%
Trout Flow-Ecology Relationship
< 10% Very High Risk
10% to 15% High Risk
16% to 25% Moderate Risk
26% to 55% Minimal Risk
> 55% Low Risk
Warm Water Percent Change in Biomass
> 50% Very High Risk
25% to 50% High Risk
10% to 25% Moderate Risk
< 10% Low Risk
Points of Diversion >= 1 cfs
Active Stream Gauge
Historic Stream Gauge
Cities
Cutthroat Reaches
CWCB Decreed ISF
Appropriated
Donated
Enlarged
Road
Streams and Rivers
Lakes and Reservoirs
Irrigated Parcels
Water District
County Boundary
MOFFAT COUNTY
JACKSON COUNTY
ROUTT COUNTY
RIO BLANCO COUNTY
GRAND COUNTY
GARFIELD COUNTY
* DRAFT 3/11/2014
0 2 4 6 8
Miles
Trout and Warm Water Fish Flow-Ecology Risk and Agriculture Shortages Mapping (Overview)
Water District 54
Slater \ Timberlake Creeks
Stream Data: USGS National Hydrography Dataset
CDM Smith
54
55
44
58
57
13
Little Snake River
Middle Fork Little Snake River
South Fork Little Snake River
King Solomon Creek
Whiskey Creek
Silver City Creek
Slater Creek
First Creek
Willow Creek
Timberlake Creek
East Timberlake Creek
West Timberlake Creek
Mud Spring Draw
Fourmile Creek
Dry Gulch
Scandinavian Gulch
Columbine
Larson Creek
Red Creek
Trail Creek
Lester Creek
Hinman Creek
Elk River
Big Creek
South Fork
Mad Creek
Falls Creek
Fortification Creek
North Fork Elkhead Creek
Elkhead Creek
Blue Gravel Creek
Lay Creek
North Fork Big Gulch
Big Gulch
Dry Cottonwood Creek
Anderson Ditch
Mill Creek



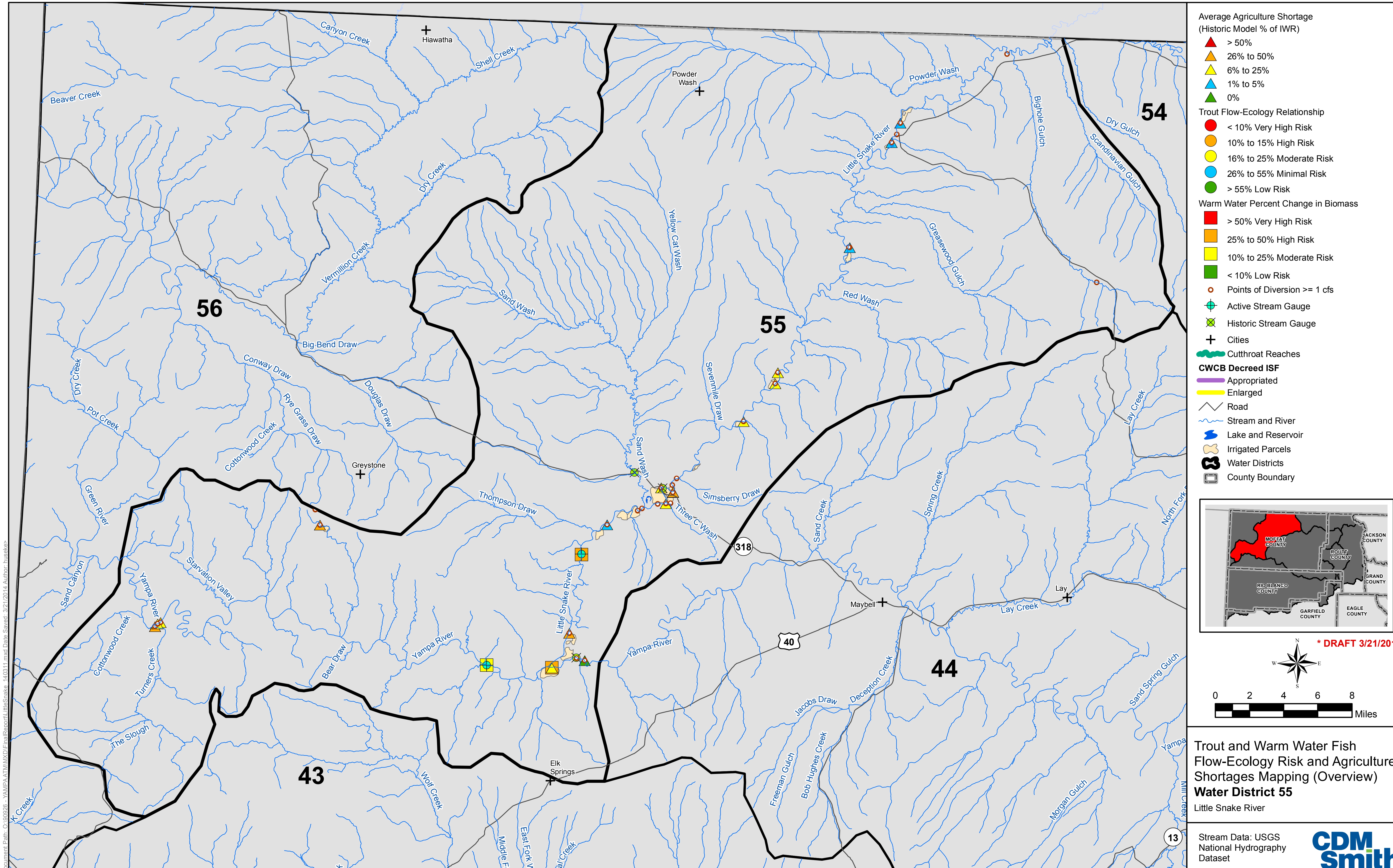
Trout and Warm Water Fish Flow-Ecology Risk and Agriculture Shortages Mapping (Overview)

Water District 55

Little Snake River

Stream Data: USGS National Hydrography Dataset

CDM Smith


Average Agriculture Shortage
(Historic Model % of IWR)
> 50%
26% to 50%
6% to 25%
1% to 5%
0%
Trout Flow-Ecology Relationship
< 10% Very High Risk
10% to 15% High Risk
16% to 25% Moderate Risk
26% to 55% Minimal Risk
> 55% Low Risk
Warm Water Percent Change in Biomass
> 50% Very High Risk
25% to 50% High Risk
10% to 25% Moderate Risk
< 10% Low Risk
Points of Diversion >= 1 cfs
Active Stream Gauge
Historic Stream Gauge
Cities
Cutthroat Reaches
CWCB Decreed ISF
Appropriated
Enlarged
Road
Stream and River
Lake and Reservoir
Irrigated Parcels
Water Districts
County Boundary
MOFFAT COUNTY
ROUTT COUNTY
JACKSON COUNTY
GRAND COUNTY
RIO BLANCO COUNTY
GARFIELD COUNTY
EAGLE COUNTY
* DRAFT 3/21/2014
0 2 4 6 8
Miles
Trout and Warm Water Fish
Flow-Ecology Risk and Agriculture
Shortages Mapping (Overview)
Water District 55
Little Snake River
Stream Data: USGS
National Hydrography
Dataset
CDM Smith
54
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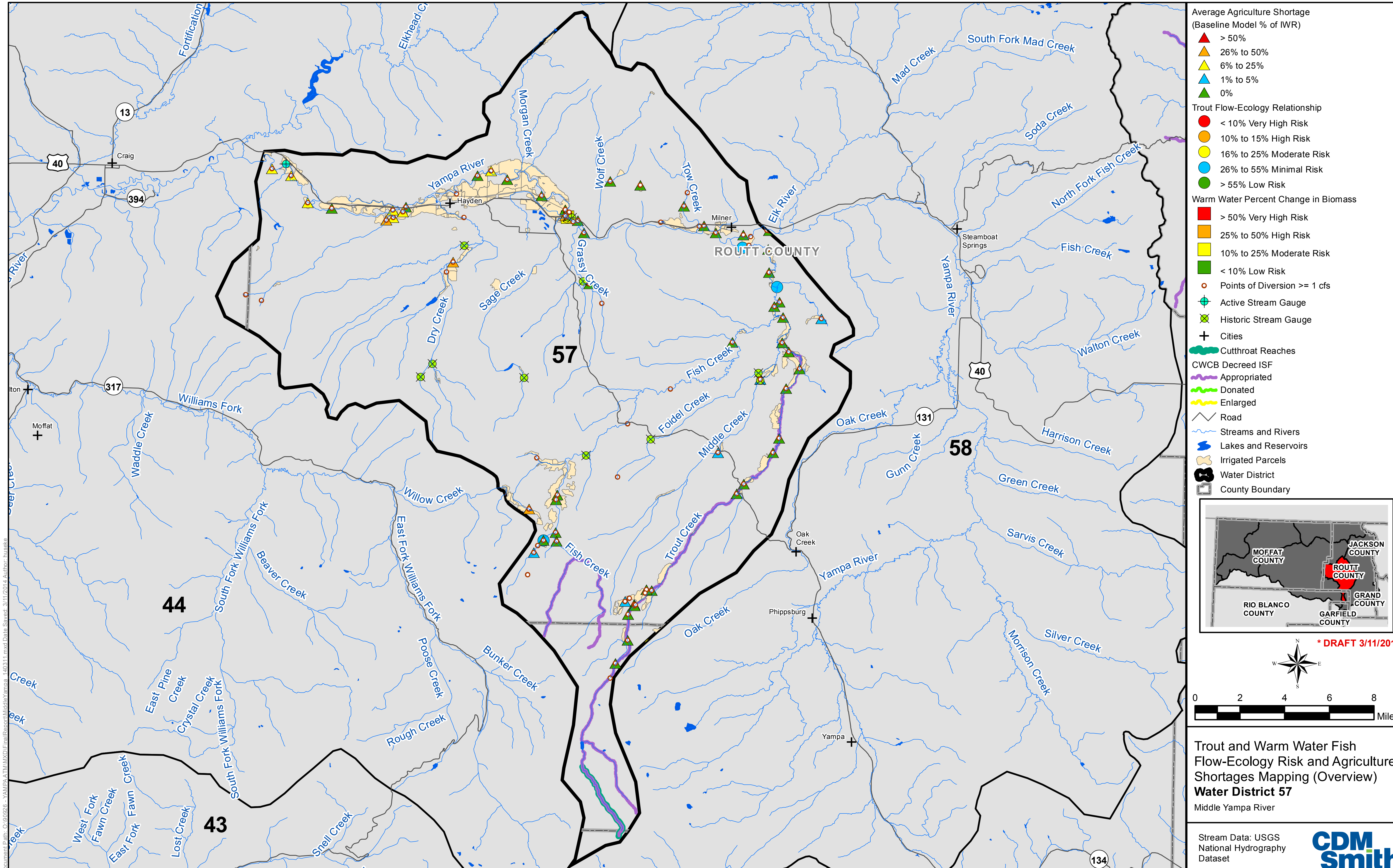
56
43
44
Hiawatha
Powder Wash
Greystone
Maybell
Lay
Elk Springs
Canyon Creek
Shell Creek
Beaver Creek
Powder Wash
Little Snake River
Bighole Gulch
Dry Gulch
Scandinavian Gulch
Dry Creek
Vermillion Creek
Yellow Cat Wash
Greasewood Gulch
Red Wash
Sand Wash
Big Bend Draw
Conway Draw
Douglas Draw
Rye Grass Draw
Pot Creek
Cottonwood Creek
Sevenmile Draw
Simsberry Draw
Three C Wash
Thompson Draw
Green River
Starvation Valley
Sand Canyon
Yampa River
Turners Creek
Bear Draw
Sand Creek
Spring Creek
Lay Creek
North Fork
Jacobs Draw
Deception Creek
Sand Spring Gulch
The Slough
Wolf Creek
Freeman Gulch
Bob Hughes Creek
Morgan Gulch
Middle Fork
East Fork
Mill Creek
318
40
13



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6% to 25%
1% to 5%
0%
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Active Stream Gauge
Historic Stream Gauge
Cities
Cutthroat Reaches
CWCB Decreed ISF
Appropriated
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Enlarged
Road
Streams and Rivers
Lakes and Reservoirs
Irrigated Parcels
Water District
County Boundary
MOFFAT COUNTY
JACKSON COUNTY
ROUTT COUNTY
RIO BLANCO COUNTY
GRAND COUNTY
GARFIELD COUNTY
* DRAFT 3/11/2014
0 2 4 6 8
Miles
Trout and Warm Water Fish
Flow-Ecology Risk and Agriculture
Shortages Mapping (Overview)
Water District 57
Middle Yampa River
Stream Data: USGS
National Hydrography
Dataset
CDM Smith
57
58
44
43
ROUTT COUNTY
Craig
Hayden
Milner
Steamboat Springs
Oak Creek
Phippsburg
Yampa
Moffat
Yampa River
Elk River
Fortification
Elkhead C
Morgan Creek
Wolf Creek
Tow Creek
Grassy Creek
Sage Creek
Dry Creek
Fish Creek
Foidel Creek
Middle Creek
Trout Creek
Oak Creek
Williams Fork
Waddle Creek
Willow Creek
South Fork Williams Fork
Beaver Creek
East Fork Williams Fork
Poose Creek
Bunker Creek
Rough Creek
East Pine Creek
Crystal Creek
West Fork Fawn Creek
East Fork Fawn Creek
Lost Creek
Snell Creek
South Fork Mad Creek
Mad Creek
Soda Creek
North Fork Fish Creek
Walton Creek
Harrison Creek
Gunn Creek
Green Creek
Sarvis Creek
Silver Creek
Morrison Creek
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394
317
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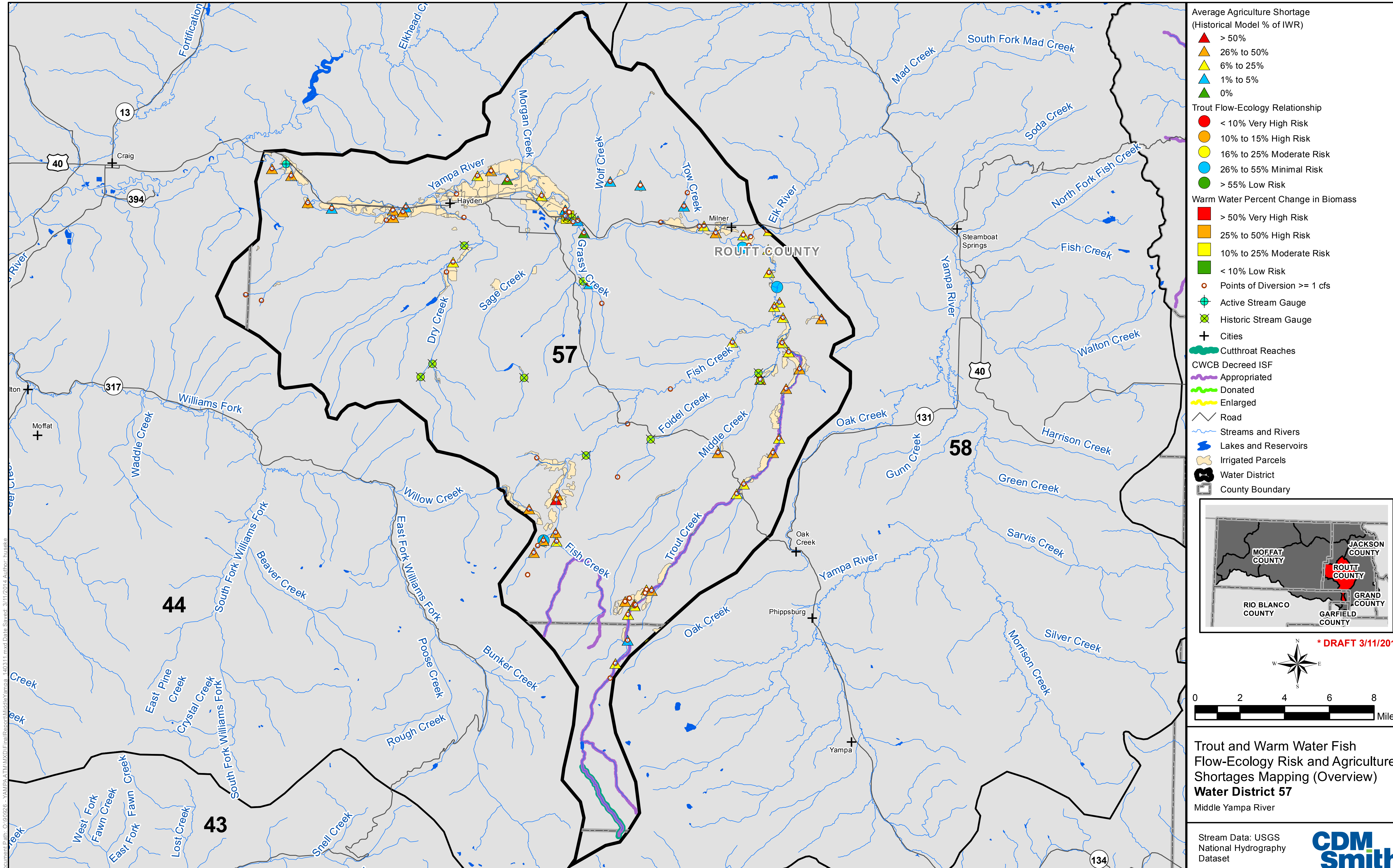
134


Average Agriculture Shortage
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26% to 50%
6% to 25%
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Points of Diversion >= 1 cfs
Active Stream Gauge
Historic Stream Gauge
Cities
Cutthroat Reaches
CWCB Decreed ISF
Appropriated
Donated
Enlarged
Road
Streams and Rivers
Lakes and Reservoirs
Irrigated Parcels
Water District
County Boundary
MOFFAT COUNTY
JACKSON COUNTY
ROUTT COUNTY
RIO BLANCO COUNTY
GRAND COUNTY
GARFIELD COUNTY
* DRAFT 3/11/2014
0 2 4 6 8
Miles
Trout and Warm Water Fish Flow-Ecology Risk and Agriculture Shortages Mapping (Overview)
Water District 57
Middle Yampa River
Stream Data: USGS National Hydrography Dataset
CDM Smith
57
58
44
43
ROUTT COUNTY
Craig
Hayden
Milner
Steamboat Springs
Oak Creek
Phippsburg
Yampa
Moffat
Yampa River
Elk River
Morgan Creek
Wolf Creek
Tow Creek
Grassy Creek
Sage Creek
Dry Creek
Fish Creek
Foidel Creek
Middle Creek
Trout Creek
Oak Creek
Williams Fork
Willow Creek
Beaver Creek
East Fork Williams Fork
South Fork Williams Fork
Bunker Creek
Poose Creek
Rough Creek
Waddle Creek
Elkhead Creek
Fortification Creek
Mad Creek
South Fork Mad Creek
Soda Creek
North Fork Fish Creek
Walton Creek
Harrison Creek
Gunn Creek
Green Creek
Sarvis Creek
Silver Creek
Morrison Creek
East Pine Creek
Crystal Creek
Lost Creek
Snell Creek
West Fork Fawn Creek
East Fork Fawn Creek
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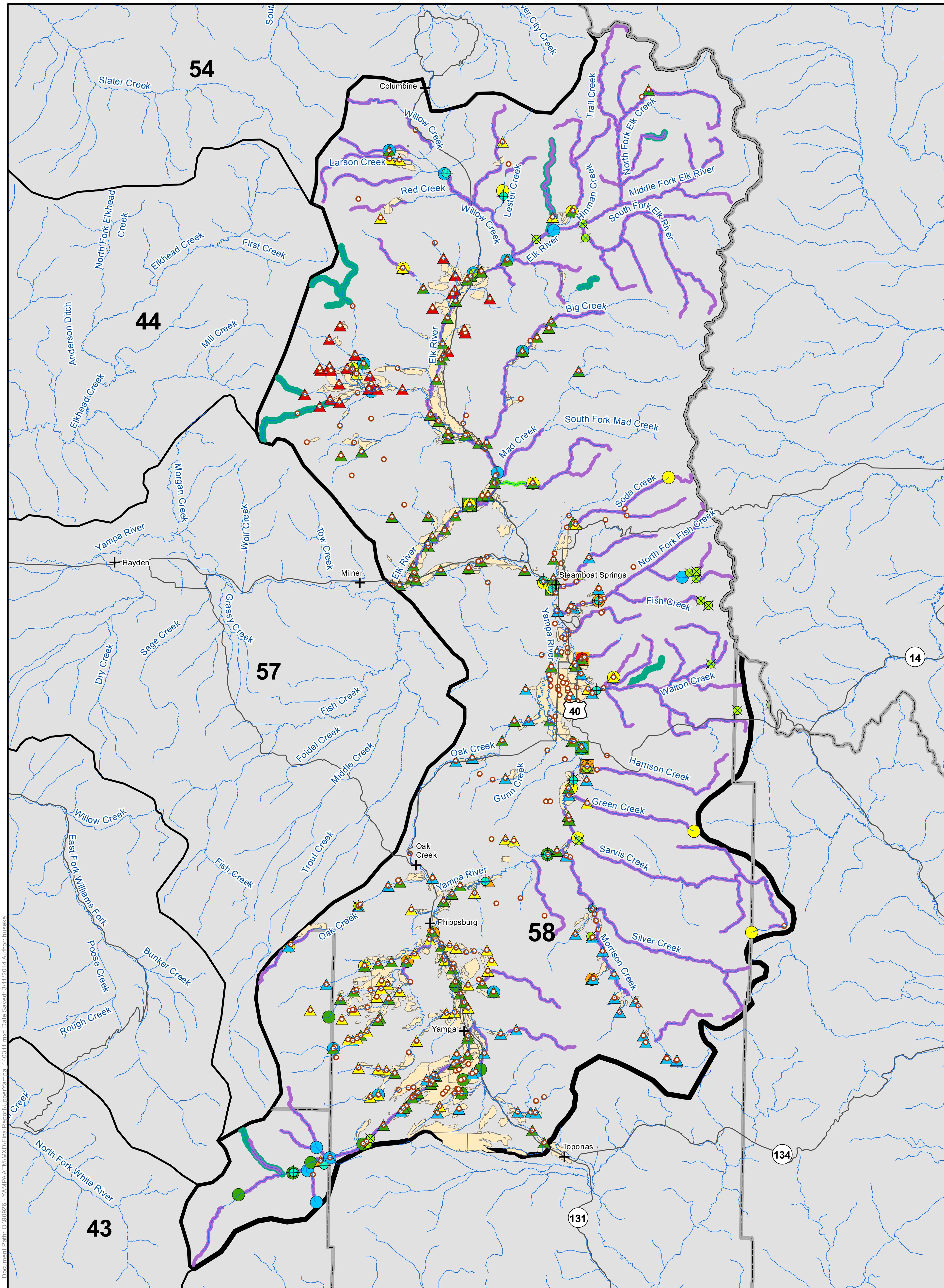

Average Agriculture Shortage (Baseline Model % of IWR)
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Trout Flow-Ecology Relationship
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- < 10% Low Risk
- Points of Diversion >= 1 cfs
- Active Stream Gauge
- Historic Stream Gauge
- Cities

Cutthroat Reaches

CWCB Decreed ISF
- Appropriated
- Donated
- Enlarged
- Road
- Streams and Rivers
- Lakes and Reservoirs
- Irrigated Parcels
- Water District
- County Boundary

MOFFAT COUNTY
JACKSON COUNTY
ROUTT COUNTY
GRAND COUNTY
RIO BLANCO COUNTY
GARFIELD COUNTY

0 2 4 6 8 Miles

Trout and Warm Water Fish Flow-Ecology Risk and Agriculture Shortages Mapping (Overview)

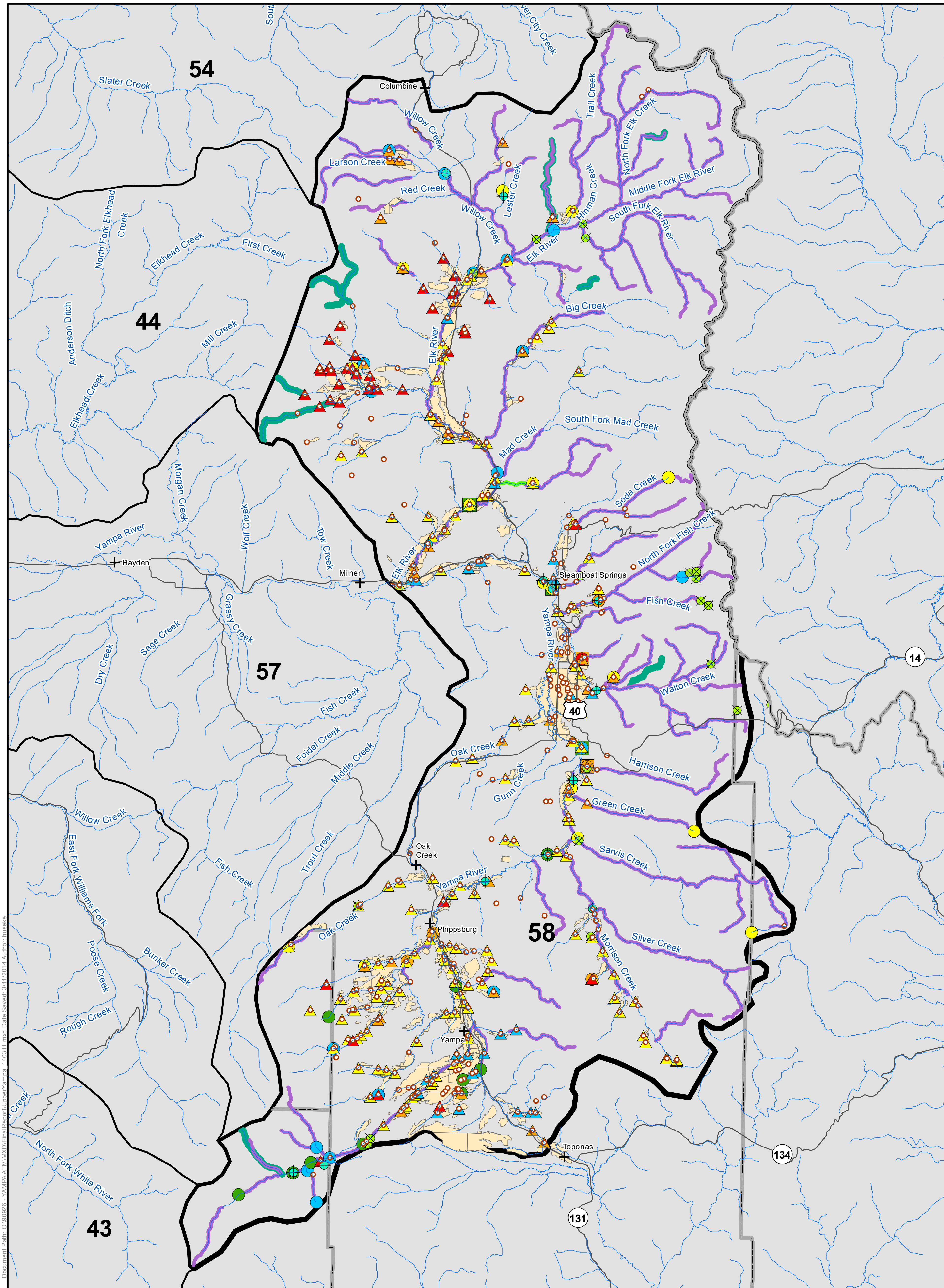
Water District 58

Upper Yampa River

* DRAFT 3/11/2014

Stream Data: USGS National Hydrography Dataset

CDM Smith



Average Agriculture Shortage (Historical Model % of IWR)
- > 50%
- 26% to 50%
- 6% to 25%
- 1% to 5%
- 0%

Trout Flow-Ecology Relationship
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- 10% to 15% High Risk
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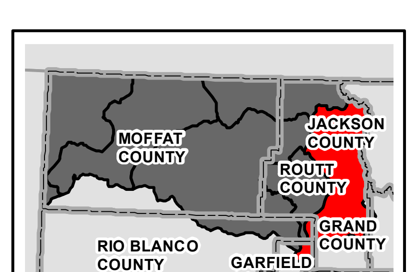
- Points of Diversion >= 1 cfs
- Active Stream Gauge
- Historic Stream Gauge
- Cities

Cutthroat Reaches

CWCB Decreed ISF
- Appropriated
- Donated
- Enlarged
- Road
- Streams and Rivers
- Lakes and Reservoirs
- Irrigated Parcels
- Water District
- County Boundary



0 2 4 6 8 Miles

Trout and Warm Water Fish Flow-Ecology Risk and Agriculture Shortages Mapping (Overview)

Water District 58

Upper Yampa River

* DRAFT 3/11/2014

Stream Data: USGS National Hydrography Dataset

CDM Smith

Appendix C

Level 2 Screening Summaries by Reach

Structure ID Key

Potential Lessors

Div = Diversion (agricultural)

Potential Lessees

Ag = Agricultural shortage
ISF = Instream Flow water right

Potential Beneficiaries

T = Trout Flow-Ecology Node
WW = Warm Water Fish Flow-Ecology Node
EFS = Endangered Fish Species

Table C-1. Level 2 Screening Summary for Candidate Reach 1 (Ag-to-ISF)						
Potential Lessors			Potential Lessees		Potential Environmental Beneficiaries	
ID	Avg. Diversion [AFY]	Avg. CU [AFY]	ID	Avg. Shortage [AFY]	ID	Description
Div 1-A	3,776	618	ISF 1-A	N/A	T 1-A	Moderate Risk
Div 1-B	212	50				
Div 1-C	134	73				
Div 1-D	433	233				
Div 1-E	432	N/A				

Table C-2. Level 2 Screening Summary for Candidate Reach 2 (Ag-to-ISF)						
Potential Lessors			Potential Lessees		Potential Environmental Beneficiaries	
ID	Avg. Diversion [AFY]	Avg. CU [AFY]	ID	Avg. Shortage [AFY]	ID	Description
Div 2-A	358	41	ISF 2-A	N/A	T 2-A	Moderate Risk
Div 2-B	174	94			T 2-B	Moderate Risk
Div 2-C	407	95			T 2-C	High Risk

Table C-3. Level 2 Screening Summary for Candidate Reach 3 (Ag-to-ISF)						
Potential Lessors			Potential Lessees		Potential Environmental Beneficiaries	
ID	Avg. Diversion [AFY]	Avg. CU [AFY]	ID	Avg. Shortage [AFY]	ID	Description
Div 3-A	1,208	326	ISF 3-A	N/A	T 3-A	Moderate Risk
Div 3-B	729	78			T 3-B	Moderate Risk
Div 3-C	147	N/A			WW 3-A	Moderate Risk
Div 3-D	158	N/A				
Div 3-E	676	74				
Div 3-F	869	260				
Div 3-G	438	150				

Table C-4. Level 2 Screening Summary for Candidate Reach 4 (Ag-to-Ag)						
Potential Lessors			Potential Lessees		Potential Environmental Beneficiaries	
ID	Avg. Diversion [AFY]	Avg. CU [AFY]	ID	Avg. Shortage [AFY]	ID	Description
Div 4-A	3,186	650	Ag 4-A	170	EFS 4-A	Endangered Fish Species Target Flows
Div 4-B	1,117	395				
Div 4-C	1,231	229				
Div 4-D	1,750	694				
Div 4-E	1,303	229				
Div 4-F	1,962	304				

Table C-5. Level 2 Screening Summary for Candidate Reach 5 (Ag-to-Ag)						
Potential Lessors			Potential Lessees		Potential Environmental Beneficiaries	
ID	Avg. Diversion [AFY]	Avg. CU [AFY]	ID	Avg. Shortage [AFY]	ID	Description
Div 5-A	640	N/A	Ag 5-A	N/A	WW 5-A	Moderate Risk
Div 5-B	283	31	Ag 5-B	N/A	EFS 5-A	Endangered Fish Species Target Flows
			Ag 5-C	290		

Table C-6. Level 2 Screening Summary for Candidate Reach 6 (Ag-to-Ag)						
Potential Lessors			Potential Lessees		Potential Environmental Beneficiaries	
ID	Avg. Diversion [AFY]	Avg. CU [AFY]	ID	Avg. Shortage [AFY]	ID	Description
Div 6-A	311	122	Ag 6-A	38	WW 5-A	Moderate Risk
Div 6-B	243	41			T 5-A	High Risk

Table C-7. Level 2 Screening Summary for Candidate Reach 7 (Infeasible, no lessees)						
Potential Lessors			Potential Lessees		Potential Environmental Beneficiaries	
ID	Avg. Diversion [AFY]	Avg. CU [AFY]	ID	Avg. Shortage [AFY]	ID	Description
Div 7-A	358	N/A			WW 7-A	Moderate Risk
Div 7-B	752	285			T 7-A	High Risk

Table C-8. Level 2 Screening Summary for Candidate Reach 8 (Ag-to-Ag)						
Potential Lessors			Potential Lessees		Potential Environmental Beneficiaries	
ID	Avg. Diversion [AFY]	Avg. CU [AFY]	ID	Avg. Shortage [AFY]	ID	Description
Div 8-A	734	102	Ag 8-A	42	WW 8-A	High Risk
Div 8-B	934	122				
Div 8-C	745	150				
Div 8-D	2,041	550				
Div 8-E	1,552	485				
Div 8-F	1,003	189				

Table C-9. Level 2 Screening Summary for Candidate Reach 9 (Ag-to-ISF)						
Potential Lessors			Potential Lessees		Potential Environmental Beneficiaries	
ID	Avg. Diversion [AFY]	Avg. CU [AFY]	ID	Avg. Shortage [AFY]	ID	Description
Div 9-A	54	29	ISF 9-A	N/A		
Div 9-B	213	28				
Div 9-C	191	103				
Div 9-D	258	68				
Div 9-E	797	399				
Div 9-F	272	147				
Div 9-G	904	337				

Table C-10. Level 2 Screening Summary for Candidate Reach 10 (Ag-to-Ag)						
Potential Lessors			Potential Lessees		Potential Environmental Beneficiaries	
ID	Avg. Diversion [AFY]	Avg. CU [AFY]	ID	Avg. Shortage [AFY]	ID	Description
Div 10-A	5,785	1,349	Ag 10-A	N/A	T 10-A	Moderate Risk
Div 10-B	3,652	754	Ag 10-B	N/A	WW 10-A	Moderate Risk
			Ag 10-C	181		
			Ag 10-D	N/A		

Table C-11. Level 2 Screening Summary for Candidate Reach 11 (Ag-to-ISF)						
Potential Lessors			Potential Lessees		Potential Environmental Beneficiaries	
ID	Avg. Diversion [AFY]	Avg. CU [AFY]	ID	Avg. Shortage [AFY]	ID	Description
11-A	298	N/A	ISF 11-A	N/A		

Table C-12. Level 2 Screening Summary for Candidate Reach 12 (Ag-to-ISF)						
Potential Lessors			Potential Lessees		Potential Environmental Beneficiaries	
ID	Avg. Diversion [AFY]	Avg. CU [AFY]	ID	Avg. Shortage [AFY]	ID	Description
Div 12-A	721	165	ISF 12-A	N/A		
			ISF 12-B	N/A		

Table C-13. Level 2 Screening Summary for Candidate Reach 13 (Ag-to-ISF)						
Potential Lessors			Potential Lessees		Potential Environmental Beneficiaries	
ID	Avg. Diversion [AFY]	Avg. CU [AFY]	ID	Avg. Shortage [AFY]	ID	Description
Div 13-A	668	132	ISF 13-A	N/A		
Div 13-B	878	185				
Div 13-C	587	305				
Div 13-D	212	22				
Div 13-E	2,693	776				
Div 13-F	419	199				
Div 13-G	2,837	889				
Div 13-H	189	12				
Div 13-I	591	276				
Div 13-J	791	286				
Div 13-K	226	9				
Div 13-L	445	76				

Table C-14. Level 2 Screening Summary for Candidate Reach 14						
Potential Lessors			Potential Lessees		Potential Environmental Beneficiaries	
ID	Avg. Diversion [AFY]	Avg. CU [AFY]	ID	Avg. Shortage [AFY]	ID	Description
N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table C-15. Level 2 Screening Summary for Candidate Reach 15 (Ag-to-ISF)						
Potential Lessors			**Potential Lessees**		**Potential Environmental Beneficiaries**	
ID	**Avg. Diversion [AFY]**	**Avg. CU [AFY]**	**ID**	**Avg. Shortage [AFY]**	**ID**	**Description**
Div 15-A	195	47	ISF 15-A	N/A	T 15-A	Moderate Risk
					WW 15-A	High Risk

Table C-16. Level 2 Screening Summary for Candidate Reach 16 (Infeasible, no potential lessors)						
Potential Lessors			Potential Lessees		Potential Environmental Beneficiaries	
ID	Avg. Diversion [AFY]	Avg. CU [AFY]	ID	Avg. Shortage [AFY]	ID	Description
N/A	N/A	N/A	ISF 16-A	N/A	N/A	N/A

Table C-17. Level 2 Screening Summary for Candidate Reach 17 (Ag-to-ISF)						
Potential Lessors			Potential Lessees		Potential Environmental Beneficiaries	
ID	Avg. Diversion [AFY]	Avg. CU [AFY]	ID	Avg. Shortage [AFY]	ID	Description
Div 17-A	217	13	ISF 17-A	N/A		
Div 17-B	71	12				

Table C-18. Level 2 Screening Summary for Candidate Reach 18 (Infeasible, no potential lessees)						
Potential Lessors			**Potential Lessees**		**Potential Environmental Beneficiaries**	
ID	**Avg. Diversion [AFY]**	**Avg. CU [AFY]**	**ID**	**Avg. Shortage [AFY]**	**ID**	**Description**
Div 18-A	269	125			T 18-A	High Risk
Div 18-B	N/A	N/A				

Table C-19. Level 2 Screening Summary for Candidate Reach 19 (Ag-to-ISF)						
Potential Lessors			Potential Lessees		Potential Environmental Beneficiaries	
ID	Avg. Diversion [AFY]	Avg. CU [AFY]	ID	Avg. Shortage [AFY]	ID	Description
Div 19-A	up to 2,400	N/A	ISF 19-A	N/A[1]		
Div 19-B	up to 2,400	N/A				
Div 19-C	up to 2,400	N/A				
…	…	N/A				
Div 19-T	up to 2,400	N/A				

[1] ISF 19-A is short every month of the year on average, but is most short in May-September (~450 AFM)

Table C-20. Level 2 Screening Summary for Candidate Reach 20 (Ag-to-ISF)						
Potential Lessors			Potential Lessees		Potential Environmental Beneficiaries	
ID	Avg. Diversion [AFY]	Avg. CU [AFY]	ID	Avg. Shortage [AFY]	ID	Description
Div 20-A	N/A	N/A	ISF 20-A	N/A[1]	T 20-A	High Risk
Div 20-B	N/A	N/A				
Div 20-C	N/A	N/A				
…	N/A	N/A				
Div 20-S	N/A	N/A				

[1] ISF 20-A is typically short by 50-180 AFM for each month except April-June.

Table C-21. Level 2 Screening Summary for Candidate Reach 21 (Ag-to-ISF)						
Potential Lessors			Potential Lessees		Potential Environmental Beneficiaries	
ID	Avg. Diversion [AFY]	Avg. CU [AFY]	ID	Avg. Shortage [AFY]	ID	Description
Div 21-A	90	43	ISF 21-A	N/A	T 21-A	Moderate Risk

Table C-22. Level 2 Screening Summary for Candidate Reach 22 (Ag-to-Ag)						
Potential Lessors			Potential Lessees		Potential Environmental Beneficiaries	
ID	Avg. Diversion [AFY]	Avg. CU [AFY]	ID	Avg. Shortage [AFY]	ID	Description
Div 22-A	156	24	Ag 22-A	39	T 22-A	High Risk
Div 22-B	990	262				
Div 22-C	520	216				
Div 22-D	171	12				
Div 22-E	242	26				
Div 22-F	2,614	465				
Div 22-G	1,583	526				
Div 22-H	133	72				

Table C-23. Level 2 Screening Summary for Candidate Reach 23 (Ag-to-ISF)						
Potential Lessors			Potential Lessees		Potential Environmental Beneficiaries	
ID	Avg. Diversion [AFY]	Avg. CU [AFY]	ID	Avg. Shortage [AFY]	ID	Description
Div 23-A	175	65	ISF 23-A	2,600	T 23-A	Moderate Risk
Div 23-B	165	45				
Div 23-C	1,159	425				
Div 23-D	315	94				

Appendix D

Level 3 Screening Summaries by Reach

Structure ID Key

Potential Lessors

Div = Diversion (agricultural)

Potential Lessees

Ag = Agricultural shortage

ISF = Instream Flow water right

Potential Beneficiaries

T = Trout Flow-Ecology Node

WW = Warm Water Fish Flow-Ecology Node

Table D-1. Level 3 Screening Summary for Candidate Reach 1 (Ag-to-ISF)

Potential Lessors		Potential Lessees	
ID	**Historical CU (AFY)**	**ID**	**Historical Shortage (AFY)**
Div 1-A	618	ISF 1-A	1,218
Div 1-B	50		
Div 1-C	73		
Div 1-D	234		
Div 1-E	N/A		

Table D-2. Level 3 Screening Summary for Candidate Reach 6 (Ag-to-Ag)

Potential Lessors		Potential Lessees	
ID	Historical CU (AFY)	ID	Historical Shortage (AFY)
Div 6-A	122	Ag 6-A	38
Div 6-B	41	Ag 6-B[1]	41
Div 6-C	155		
Div 6-E	323		
Div 6-F[1]	300		
Div 6-G	44		

[1] Div 6-G and Ag 6-B are the same structure, which could serve as a potential lessor or potential lessee because of its mid-reach location.

Table D-3. Level 3 Screening Summary for Candidate Reach 10 (Ag-to-Ag)

Potential Lessors		Potential Lessees	
ID	**Historical CU (AFY)**	**ID**	**Historical Shortage (AFY)**
Div 10-A	1,349	Ag 10-B[2]	N/A
Div 10-B	754	Ag 10-C[1]	181
Div 10-C	360	Ag 10-E	137
Div 10-D	1,533	Ag 10-F	135
Div 10-E	1,399	Ag 10-G	95
Div 10-F	69	Ag 10-H	424
Div 10-G	899	Ag 10-I	N/A
Div 10-H	513		
Div 10-I[1]	23		
Div 10-J[2]	N/A		
Div 10-K	79		
Div 10-L	108		

[1] Div 10-I and Ag 10-C are the same structure, which could serve as a potential lessor or potential lessee because of its mid-reach location.

[2] Div 10-J and Ag 10-B are the same structure, which could serve as a potential lessor or potential lessee because of its mid-reach location.

Table D-4. Level 3 Screening Summary for Candidate Reach 12 (Ag-to-ISF)

Potential Lessors		Potential Lessees	
ID	Historical CU (AFY)	ID	Historical Shortage (AFY)
Div 12-A	165	ISF 12-A	173
Div 13-A	132	ISF 13-A	27,130
Div 13-B	185	Ag 12-A	139
Div 13-C	305	Ag 12-B	3
Div 13-E	776	Ag 12-C	16
Div 13-F	199		
Div 13-G	889		

Table D-5. Level 3 Screening Summary for Candidate Reach 20 (Ag-to-ISF)

Potential Lessors		Potential Lessees	
ID	**Historical CU (AFY)**	**ID**	**Historical Shortage (AFY)**
Div 20-A	213	Ag 20-A	N/A
Div 20-B	122	Ag 20-B	59
Div 20-C	126	ISF 20-A	1,158
Div 20-D	335		
Div 20-E	191		
Div 20-F	283		
Div 20-G	328		

Table D-6. Level 3 Screening Summary for Candidate Reach 22 (Ag-to-Ag)

Potential Lessors		Potential Lessees	
ID	**Historical CU (AFY)**	**ID**	**Historical Shortage (AFY)**
Div 22-H	72	Ag 22-B	20
Div 22-F	465	Ag 22-C	424
Div 22-E	26	Ag 22-D	320
Div 22-I	87	Ag 22-E	80
Div 22-J	166	ISF 22-A	2,595
Div 22-K	116		