Basin Report Objectives

This report is designed to provide a local perspective on the Statewide Water Supply Initiative 2010 (SWSI 2010) report. This basin report was prepared in consultation with the local Basin Roundtable established by House Bill 05-1177 and some sections of the report were directly produced by basin roundtable members. As such, the report not only summarizes basin-specific data from SWSI 2010, but also seeks to document progress, problems, and a path forward from the basin's perspective. The State of Colorado fully supports the basin roundtable process, yet the substantive conclusions of this report are those of the basin roundtable and are not necessarily endorsed by the State of Colorado.

This report is intended to provide reconnaissance-level data that employs consistency in data collection and forecast methodology across the state while maximizing available data. The methods utilized in this approach are for the purpose of general statewide and basinwide planning and are not intended to replace the efforts of local entities for project-specific purposes.

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Acronyms

AF	acre-feet
AFY	acre-feet per year
AHRA	Arkansas Headwaters Recreation Area
AVC	Arkansas Valley Conduit
AwwaRF	American Water Works Research Foundation
BOR	U.S. Bureau of Reclamation
CBEF	Center for Business and Economic Forecasting
CDOW	Colorado Department of Wildlife
CDPHE	Colorado Department of Public Health and Environment
CDSS	Colorado Decision Support System
CRWAS	Colorado River Water Availability Study
CSU	Colorado Springs Utilities
CU	consumptive use
CU&L	Consumptive Uses and Losses
CWCB	Colorado Water Conservation Board
DMRP	Drought Mitigation and Response Plan
DNR	Department of Natural Resources
EIS	Environmental Impact Statement
Enterprise	Southeastern Colorado Water Activity Enterprise
EPA	U.S. Environmental Protection Agency
Fry-Ark	Fryingpan-Arkansas
GIS	geographic information system
gpcd	gallons per capita per day
HB	House Bill
HI	Hydrologic Institute
HUC	Hydrologic Unit Code
IBCC	Interbasin Compact Committee
IPP	identified projects and processes
ISAM	Irrigation Systems Analysis Model
ISF	instream flows
IWR	Irrigation Water Requirement
LAVWCD	Lower Arkansas Valley Water Conservancy District
M&I	municipal and industrial
NCNA	Nonconsumptive Needs Assessment
NEPA	National Environmental Policy Act
NHD	National Hydrography Dataset
PBWW	Pueblo Board of Water Works
PRWCD	Purgatoire River Water Conservancy District
PSOP	Preferred Storage Option Plan
RICDs	recreational in-channel diversions
RO	reverse osmosis
SB	Senate Bill
SDO	State Demographer's Office
SDS	Southern Delivery System
SRGAP	Southwest Regional Gap Analysis Project
SSI	self-supplied industrial
SWSI	Statewide Water Supply Initiative
UAWCD	Upper Arkansas Water Conservancy District

USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
WateReuse	WateReuse Foundation
WSL CU	Water Supply Limited Consumptive Use
WSRA	Water Supply Reserve Account
WTP	water treatment plant

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Arkansas Basin Roundtable Executive Summary

Overview

This report summarizes the Arkansas Basin Roundtable's Consumptive and Nonconsumptive Needs Assessment as required by House Bill 05-1177, or the Colorado Water for the 21st Century Act. This act states "Using data from the Statewide Water Supply Initiative [SWSI] and other appropriate sources and in cooperation with the ongoing Statewide Water Supply Initiative, develop:

- An assessment of consumptive water needs (municipal, industrial, and agricultural)
- An assessment of nonconsumptive water needs (environmental and recreational)
- An assessment of available water supplies (surface and groundwater) and an analysis of any unappropriated waters
- Proposed projects or methods to meet any identified water needs and achieve water supply sustainability over time"

Through this process, the basin roundtable has identified the following priorities:

- Maintain agricultural viability in the lower basin
- Provide for in-basin augmentation in the upper basin
- Provide for adequate water quality to meet all needs
- Ensure adequate water for future needs including municipal and industrial (M&I), agricultural, recreational, and environmental purposes

To help meet their water supply needs, the Arkansas River Basin has identified the following major water supply projects—the Southern Delivery System (SDS), the Arkansas Valley Conduit (AVC), the Preferred Storage Option Plan (PSOP), and the Super Ditch Rotational Fallowing project.

This executive summary summarizes the basin's nonconsumptive needs, consumptive needs, and summarizes the projects and methods to meet the basin's future needs. Examination of water supply availability in the Arkansas Basin was completed as part of the SWSI 1 and this effort found water availability in the basin to be limited and therefore water availability is not discussed in this executive summary. Water Availability is discussed in Section 6 of the report.

Nonconsumptive Needs

To examine its nonconsumptive needs, the Arkansas Basin Roundtable developed a unique map (**Figure ES-1**) showing focus areas with nonconsumptive environmental and recreational water needs. The Arkansas Basin identified nine environmental and recreational subcategories as shown on the map. Areas with the most overlap of subcategories are shown in the darkest color and are primarily concentrated in three areas—1) the mainstem Arkansas River upstream of Pueblo, 2) the Fountain Creek watershed, and 3) in the areas around major reservoirs on the Lower Arkansas River between Las Animas and Eads.

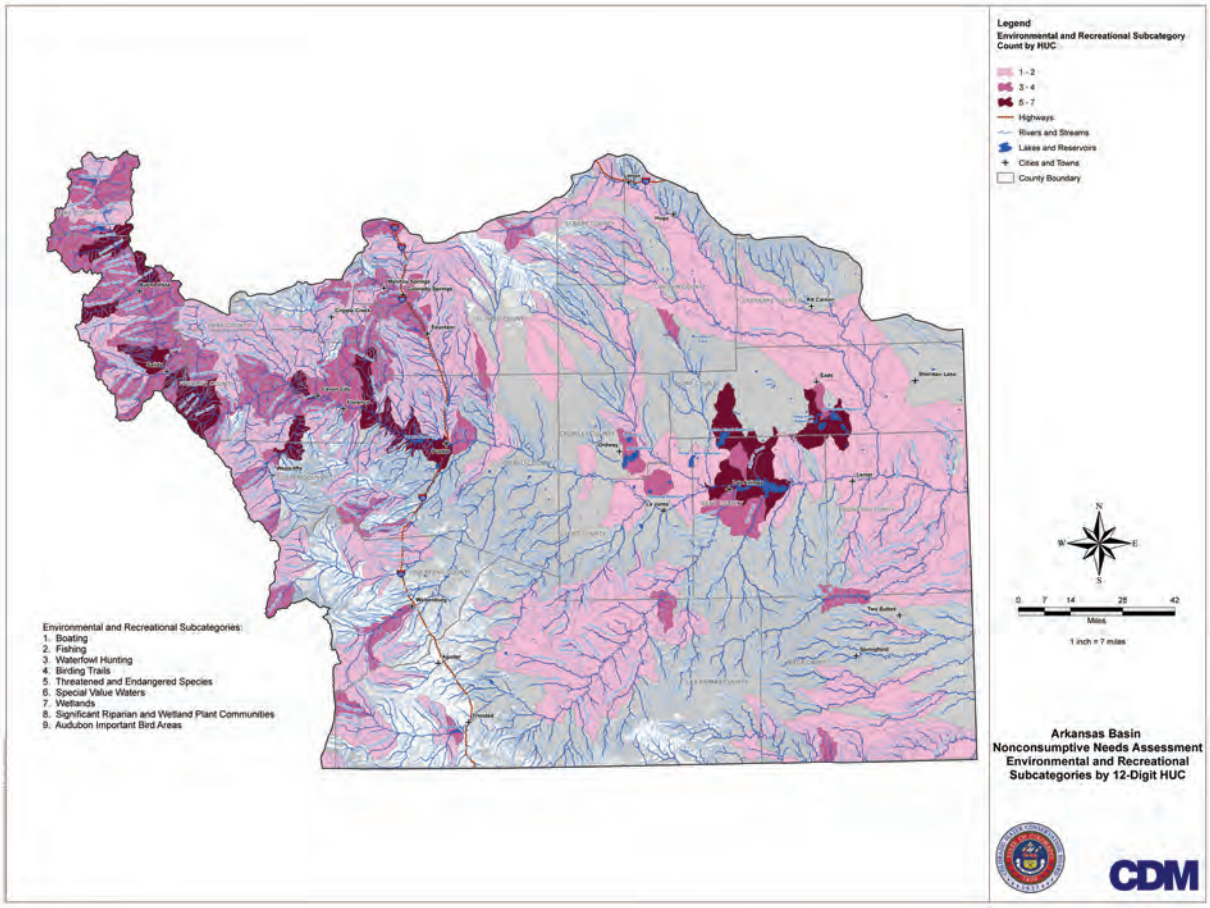


Figure ES-1 Arkansas Basin Environmental and Recreational Focus Areas

Consumptive Needs

The driving factor behind M&I water demands between now and 2050 is population growth. **Figure ES-2** shows how population growth will vary throughout the Arkansas Basin at the county level. Under medium economic development assumptions, the Arkansas River Basin population is projected to increase by about 78 percent between 2008 and 2050; El Paso County will account for much of the growth and will remain the largest population center in that basin. Household basic jobs, tourism jobs, and regional and national service jobs will be the drivers of growth in the basin by 2050.

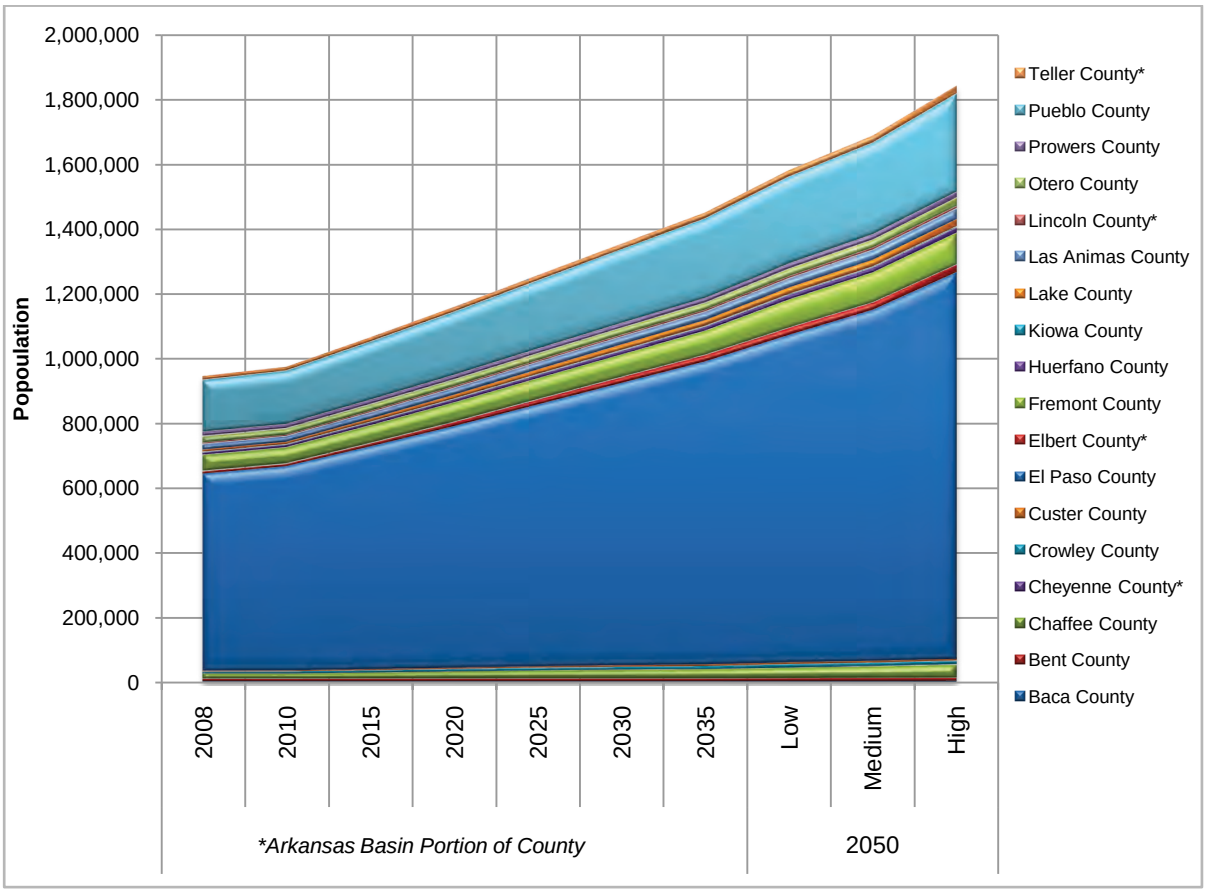


Figure ES-2 Arkansas Basin Population Projections through 2050

Figure ES-3 shows the M&I and self-supplied industrial (SSI) demands for the Arkansas Basin. Current demands in the basin are approximately 250,000 acre-feet per year (AFY) and are expected to increase to between 350,000 AFY and 425,000 AFY by 2050.

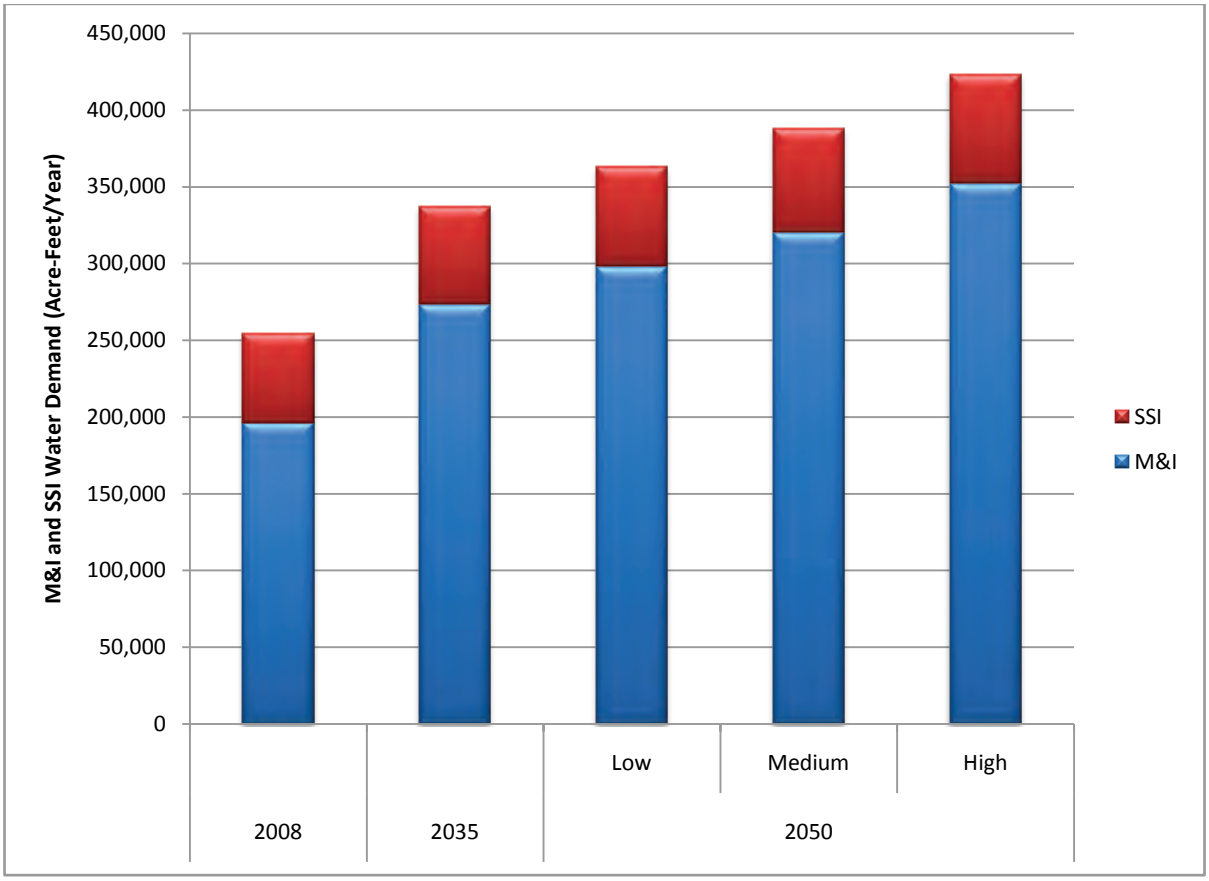


Figure ES-3. Arkansas Basin M&I and SSI Water Demands

Figure ES-4 shows water demands for irrigated agriculture across the state. The Arkansas Basin has the third highest agricultural water demand behind the South Platte and Rio Grande Basins. By 2050, the Arkansas Basin is expected to lose 35,000 to 73,000 irrigated acres due to urbanization and transfer of agricultural water for M&I uses.

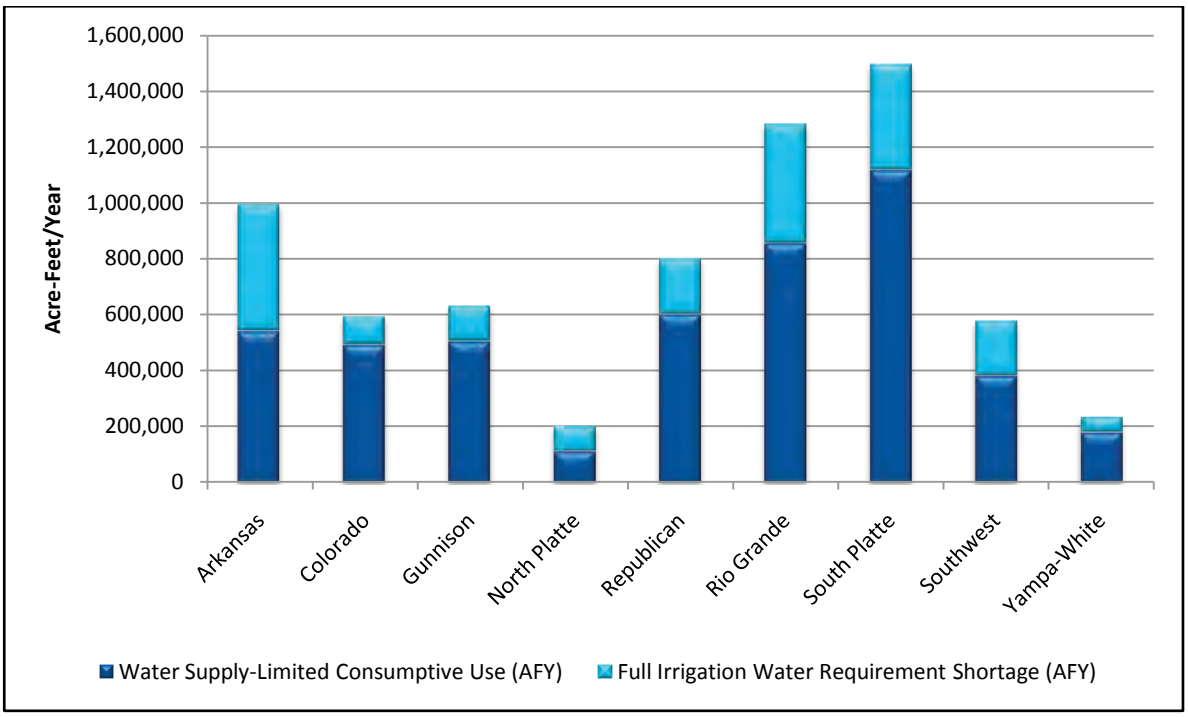


Figure ES-4 Current Agricultural Demands and Shortages

Projects and Methods to Address Needs

The Colorado Water Conservation Board (CWCB) has collected information across the state regarding projects and methods to address nonconsumptive and consumptive needs. **Figure ES-5** is a summary of the nonconsumptive projects and methods developed to date by CWCB and represents the spatial information for all nonconsumptive projects and methods that are planned, ongoing, or completed in the Arkansas Basin. This map contains all nonconsumptive projects and methods including—1) CWCB interviews and workshops, 2) CWCB watershed restoration projects, 3) Water Supply Reserve Account grants, 4) Instream Flows, 5) United States Geological Survey Southwest Regional Gap Analysis Project information, and 6) Colorado Division of Wildlife projects. This map includes projects and methods inside the designated focus areas to spatially display the full extent of any project collected by CWCB.

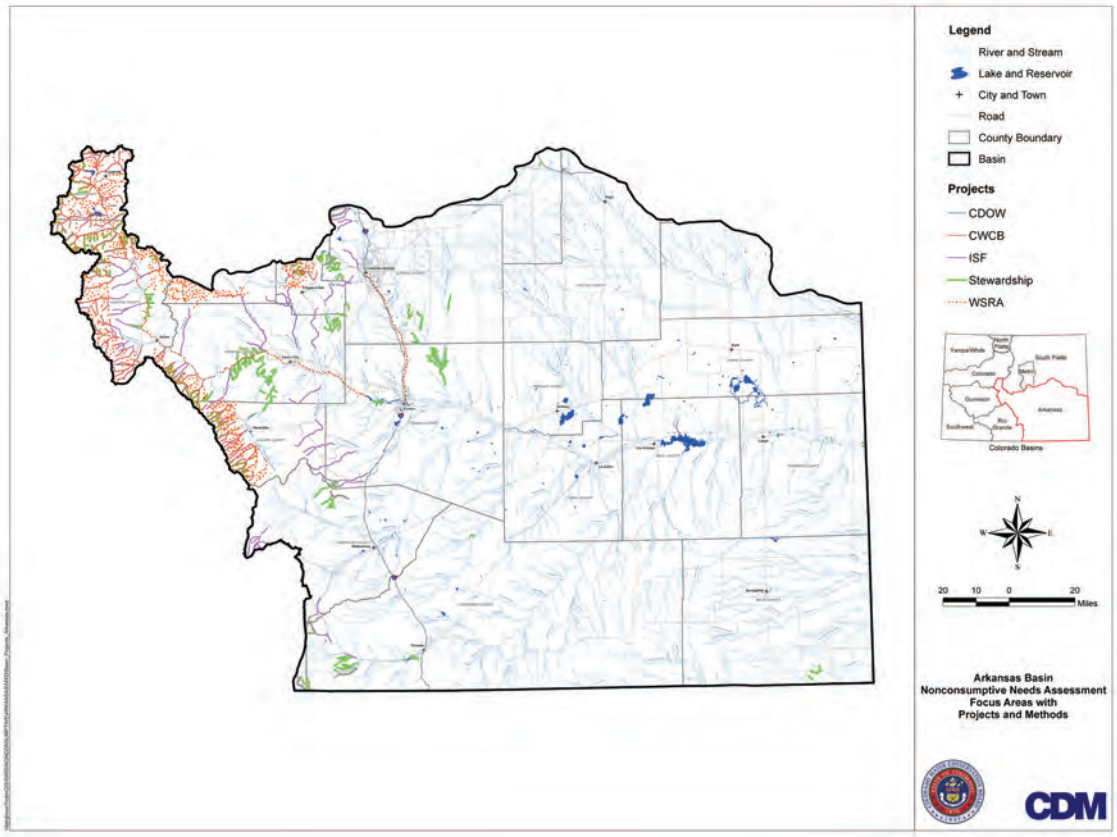


Figure ES-5 Nonconsumptive Projects and Methods

In addition to the nonconsumptive projects and methods, CWCB also worked with the basin roundtables to summarize consumptive projects and methods or Identified Projects and Processes (IPPs). The IPPs for the Arkansas Basin are summarized in **Table ES-1** below. In the Arkansas Basin, most of the major M&I water providers reported that they will be able to meet all or part of 2050 needs through existing supplies, projects underway, and planned projects. Reuse is being pursued by most providers that have reusable supplies. In most cases in Colorado, reuse is limited to nonnative water such as transbasin diversions, nontributary groundwater, and the unused first use portion of the consumptive use (CU) portion of transfers of agricultural rights. Most of the entities that are planning reuse projects in the Arkansas Basin anticipate using one or more of the following components:

- Augmentation plans
- Exchanges
- Nonpotable use for irrigation of parks and golf courses
- Groundwater recharge
- Gravel lake storage to regulate consumable return flows for exchange or nonpotable reuse

Table ES-1 Arkansas Basin IPP Summary at 100% Success Rate

Region or County	Agricultural Transfer (AFY)	Reuse (AFY)	Growth into Existing Supplies (AFY)	Regional In-Basin Project (AFY)	New Transbasin Project (AFY)	Firming In-Basin Water Rights (AFY)	Firming Transbasin Rights (AFY)	Total IPPs at 100% Success Rate (AFY)
Eastern Plains	0	0	1,600 – 1,900	0	0	0	100	1,700 – 2,000
Eastern Plains IPPs • Nontributary groundwater • AVC								
Lower Arkansas	0	0	0	0	0	800 – 2,000	0	800 – 2,000
Lower Arkansas IPPs • AVC								
Southwestern Arkansas	600	0	700	0	0	600	0	1,900
Southwestern Arkansas IPPs • Existing water rights • Augmentation plans • Agricultural transfers								
Upper Arkansas	3,600	0	0	0	0	4,700	3,600	11,900
Upper Arkansas IPPs • Upper Arkansas Water Conservancy District Augmentation plan • Other augmentation plans • Agricultural transfers • Use of Fry-Ark M&I allocation directly or for augmentation								
Urban Counties	5,000 – 7,200	23,000 – 32,000	0	37,000	0	0	6,500 – 6,900	71,500 – 83,100
Urban Counties IPPs • Agricultural transfers • Reuse plans • Groundwater • SDS • Eagle River Joint Use Project • Blue River Conditional Storage Development • AVC								
Total[1]	**9,200 – 11,000**	**23,000 – 32,000**	**2,300 – 2,600**	**37,000**	**0**	**6,100 – 7,300**	**10,000 – 11,000**	**88,000 – 100,000**

[1] Aggregated basin total values rounded to two significant digits to reflect increased uncertainty at larger geographic scales.

Colorado Springs Utilities (CSU) and the Pueblo Board of Water Works (PBWW) both indicated in recent interviews with CWCB that they have adequate existing water rights or are pursuing new projects to meet 2050 demands and beyond. Their "surplus" supplies in excess of 2050 demands are not available for permanent use by others, since these supplies will eventually be needed by CSU and PBWW. Given the lack of developable new supplies in the Arkansas Basin, agricultural transfers throughout the basin will continue via purchases, developer donations, and development of irrigated lands.

Providers in the Southeastern Colorado Water Conservation District, including entities in the Upper Arkansas, Urban Counties, and Lower Arkansas regions, are relying heavily on future Fryingpan-Arkansas (Fry-Ark) Project allocations. The Eastern Plains region will rely on nontributary groundwater and the Southwestern Arkansas region will rely on augmentation, existing water rights, and agricultural transfers.

Many providers are planning on maximizing the use of their existing transbasin and other fully consumable supplies. Even though there is very little potential for additional new water development in the Arkansas Basin, storage is needed throughout the basin to regulate existing and future supplies, firm the yield of agricultural transfers, provide for augmentation releases, and to capture return flows.

Funding for the AVC, which would improve drinking water quality and reduce transit losses for the Lower Arkansas Basin communities, has been authorized by the federal government. Pre-National Environmental Policy Act (NEPA) studies for the project, funded through a State and Tribal Assistance Grant, were completed in 2010. The towns along the mainstem of the Arkansas River downstream of the City of Pueblo divert from alluvial wells, nontributary deep wells, or from tributary surface water supplies. In addition to local water rights, these towns also have access to Fry-Ark Project allocations and return flows from the use of project water. Stream transit losses are assessed from Pueblo Reservoir to the downstream location and water quality is impacted by minerals and salts in the river channel and return flows as the water flows down the Arkansas River.

Fountain and Security are both participating in the SDS with CSU to help meet their future demands. The SDS is a regional project to deliver water from the Arkansas River that is stored in Pueblo Reservoir. Major components of the project include—1) a connection to the North Outlet Works of Pueblo Dam; 2) 62 miles of underground raw and treated water pipeline; 3) three pump stations; and 4) a 50-million-gallons-per-day treatment plant. A final environmental impact statement for the project has been published by the U.S. Bureau of Reclamation (BOR), and a Record of Decision was issued in March 2009. Major construction activity is scheduled to begin in 2011.

The Upper Arkansas Water Conservancy District (UAWCD), which provides augmentation for wells in a portion of the upper basin, will be challenged to develop the CU water rights and storage required to meet additional augmentation requirements in the upper basin. The upper basin, like many headwater areas throughout the state, is projected to experience high growth rates. Augmentation to existing or proposed environmental and recreation water rights, such as CWCB instream flow rights and recreational in-channel diversions and senior agricultural and M&I rights, will likely require the construction of storage in upper areas of tributaries. Economies of scale are generally not present in small reservoir construction and the engineering, permitting, and construction costs will tax the ability to provide for augmentation water at a reasonable cost. The acquisition of agricultural rights will likely be part of the augmentation supplies for the UAWCD due to limits on the availability of Fry-Ark allocations.

In addition to the IPPs described above, the PSOP is an important method for meeting the basin's future water needs. PSOP would enlarge Pueblo Reservoir by 75,000 acre-feet (AF) and Turquoise Reservoir by 19,000 AF. In addition, PSOP would allow for utilization of excess capacity contracts (up to 90,000 AF) from the BOR.

The IPP information provided above was utilized to conduct a M&I gap assessment. The gap analysis provides a summary of increased M&I and SSI demands, the amount of IPP yield, and the volume of M&I and SSI gap for each region in the Arkansas Basin for the low, medium, and high gap scenarios. The baseline existing M&I and SSI water supply for the Arkansas Basin is 255,000 AFY and is assumed to remain constant through 2050; however, there may be a decline in the existing supply over time due to the current use of nonrenewable groundwater in some areas of the Arkansas Basin. The estimated basinwide gaps for 2050 are as follows:

- Low gap (IPPs at 100 percent success) = 36,000 AFY
- Medium gap (IPPs at 90 percent success) = 64,000 AFY
- High gap (IPPs at 75 percent success) = 110,000 AFY

The gaps for the Urban Counties, and thus the entire basin, include an additional 13,500 AFY for the replacement of nonrenewable groundwater.

Recommendations

Following are the Arkansas Basin Roundtable's recommendations for future consideration by the Basin Roundtable:

- Implementation of the Arkansas Basin's IPPs is critical to meeting future M&I demands as outlined in the roundtable's Resource Document: Projects & Methods to Meet the Needs of the Arkansas Basin Roundtable. The roundtable recognizes the importance of the following IPPs in addressing the Basin's M&I needs: PSOP, AVC, and SDS.

- The Arkansas Basin agrees with the IBCC's recommendations of needing the "four legs of the stool" to meet future M&I demands. The Arkansas Basin Roundtable defines the four legs of the stool to include: active and passive conservation, implementation of all the IPPs, alternative agricultural transfers, and development of Colorado River supplies.

- Storage is essential to meeting all the basin's consumptive and nonconsumptive needs. The roundtable has recognized the importance of the PSOP for meeting the basin's future needs. In addition, Aquifer Storage and Recovery should be considered when examining future storage options. Also, storage is an important element to make the "four legs of the stool" successful and minimizes the risk associated with each leg of the stool.

- Development of portfolios to meet the basin's future needs and associated trade-offs can inform development of risk management strategies.

- A critical gap that needs to be addressed in the future in the basin is replacement of nonrenewable groundwater and the sustainability of designated groundwater basins.

- The basin roundtable recognizes that there are many advocates for M&I demands in the basin. However, environmental, recreational, and agricultural interests are important in the basin and the issues related to the needs of these interests need to continue to be supported by the roundtable.

- The basin roundtable's nonconsumptive committee has identified focus areas in the basin. The committee plans to continue prioritizing environmental and recreational areas in the basin and also to identify areas for further quantification.

- It is equally important to determine the agricultural water need gap as well as the M&I gap. Agriculture is integral to the economic and social fabric of the basin and the roundtable recommends that further effort be considered by the roundtable in defining an agricultural "gap" for the basin. The roundtable recommends that this gap be a production based gap and build upon other efforts the roundtable has conducted through the CWCB's Alternative Agricultural Transfer Grant program.
- With respect to future agricultural to urban transfers, the basin roundtable recommends that the framework developed in their *Considerations for Agriculture to Urban Water Transfers* report, included as Appendix D to this report, be utilized.

Section 1
Introduction

1.1 Arkansas Basin Roundtable

The Arkansas Basin has seen robust growth over the past decade. Home to two large cities – Colorado Springs and Pueblo – the Arkansas Basin has seen an increase in competition for scarce water resources. As a result of this urban growth, there has been an increase in the transfer of water from agricultural use to municipal and industrial (M&I) uses.

The Arkansas Basin has recently approved a report describing the basin's significant efforts towards implementing the requirements set forth in the Colorado Water for the 21st Century Act. Since the Arkansas Basin Roundtable first convened in September 2005, the basin roundtable has worked to determine its consumptive and nonconsumptive water supply needs, examined water supply availability and identified projects or methods to meet those needs. This resource document, *Projects and Methods to Meet the Needs of the Arkansas Basin* (November 2009 and Appendix A), details the work of the basin roundtable's three major subcommittees—transfer guidelines, consumptive, and nonconsumptive. The basin roundtable completed the *Arkansas Basin Consumptive Use Water Needs Assessment: 2030* (July 2008 and Appendix B). This report updated the analysis of the Statewide Water Supply Initiative (SWSI) and re-examined the "gap" and the identified projects and processes (IPPs) contemplated by the major providers. Through a series of basin roundtable meetings, they identified the projects and methods to meet their needs and then individually scored each project or method on how well it was deemed viable, bearable, or equitable. The basin is currently involved in Phase 2 of the nonconsumptive needs assessment and determining how to best support and/or implement the projects and methods identified in their resource document. Through this process, the basin roundtable has identified the following priorities:

- Maintain agricultural viability in the lower basin
- Provide for in-basin augmentation in the upper basin
- Provide for adequate water quality to meet all needs
- Ensure adequate water for future needs including M&I, agricultural, recreational, and environmental purposes

To help meet their water supply needs, the Arkansas River Basin has identified the following major water supply projects—the Southern Delivery System, the Arkansas Valley Conduit, the Preferred Storage Option Plan, and the Super Ditch Rotational Fallowing project.

1.2 Overview of the Water for the 21st Century Act

In 2005, the Colorado General Assembly passed the Colorado Water for the 21st Century Act (House Bill [HB] 05-1177). This legislation set up a framework that provides a permanent forum for broad-based water discussions, and it created two new structures—1) the Interbasin Compact Committee (IBCC), a statewide committee that addresses issues between basins; and 2) the basin roundtables, which were established in each of the state's eight major river basins plus the Denver Metro area. The purpose of the basin roundtables is to facilitate discussions on water issues and encourage locally-driven collaborative solutions. The broad-based, collaborative nature of this process is reflected in the basin roundtable membership.

To help the basin roundtables accomplish their major responsibility of developing basinwide needs assessments, they have relied on groundwork completed during the SWSI Phase 1 study. To further develop their needs assessments, support water activities in each of the basins, and implement identified water projects and methods, it was clear that the basin roundtables needed staff support as well as technical and financial assistance. Using resources provided through HB 06-1400, the Colorado Water Conservation Board (CWCB) provides staff support and technical assistance to the basin roundtables and the IBCC for the ongoing implementation of the Colorado Water for the 21st Century Act. The basin roundtables were also provided financial resources through Senate Bill (SB) 06-179, which established the Water Supply Reserve Account (WSRA). The WSRA appropriates money to the CWCB to help implement the consumptive and nonconsumptive water supply projects and methods identified by the basin roundtables. These bills and other relevant legislation are summarized below. The purpose of this report is to summarize the results of the Arkansas Basin Roundtable's needs assessment that have been completed to date.

Basin roundtables are legislatively required to be made up of a diverse set of stakeholders, including representatives from counties, municipalities, water conservancy districts, the environmental and recreational communities, agriculture, and industry. The responsibilities of the basin roundtables can be grouped into three categories—procedural, substantive, and public involvement. Each basin roundtable adopted bylaws that include the basin roundtable's goals, objectives, and operating procedures. These bylaws reflect the specific needs of the basin roundtable and reflect the uniqueness of each basin. Each basin roundtable developed procedures and selected two members of the IBCC.

SB03-110 authorized SWSI 1, which implemented a collaborative approach to water resources issues by establishing SWSI roundtables. SWSI 1 focused on using a common technical basis for identifying and quantifying water needs and issues.

HB05-1177 or The Colorado Water for the 21st Century Act provides a permanent forum for broad-based water discussions. It creates two new structures: 1) the IBCC, and 2) the basin roundtables. There are nine basin roundtables based on Colorado's eight major river basins and the Denver Metro area.

SB06-179 created the WSRA. Throughout SWSI and Colorado Water for the 21st Century Act processes, there has been a clear recognition that financial assistance is needed to address the water challenges in our state. This legislation funds the WSRA, which directs the State Treasurer to annually transfer $10 million from the Operational Account of the Severance Tax Trust Fund to the WSRA. These monies are available to the basin roundtables to fund water activities.

HB06-1385 created the CWCB's Intrastate Water Management and Development Section, which implements SWSI, the WSRA, develops reconnaissance level water supply alternatives, and tracks and supports water supply projects and planning processes. This section is now called the Water Supply Planning Section.

HB06-1400 appropriated money to the CWCB to fund staffing of the Water for the 21st Century Act process and monies for a contractor to technical assistance the basin roundtables.

SB09-106 authorized the funding of the WSRA in perpetuity.

The most extensive substantive responsibility assigned to each basin roundtable is to develop a basinwide water needs assessment. This is performed in cooperation with local governments, area water providers, and other stakeholders. The Colorado Water for the 21st Century Act states: "Using data from the Statewide Water Supply Initiative and other appropriate sources and in cooperation with the ongoing Statewide Water Supply Initiative, develop:

- An assessment of consumptive water needs (municipal, industrial, and agricultural)
- An assessment of nonconsumptive water needs (environmental and recreational)
- An assessment of available water supplies (surface and groundwater) and an analysis of any unappropriated waters
- Proposed projects or methods to meet any identified water needs and achieve water supply sustainability over time"

Equally important to selecting members of the IBCC and developing a basinwide water needs assessment, the basin roundtables serve as a forum for public involvement. The basin roundtable activities are required by law to be open, public meetings. The basin roundtable process creates an expanded foundation for public involvement.

This SWSI 2010 Report was largely based on basin roundtables' water needs assessments. This report is a summary of the Arkansas Basin Roundtable's needs assessment results that were utilized in the SWSI 2010 Report and that were chosen by the basin roundtable to be included in this Arkansas Basin Roundtable Needs Assessment Report.

1.3 Overview of the SWSI 2010 Report

The last decade brought many changes to the State of Colorado's water supply outlook. Despite the recent economic recession, the state has experienced significant population growth, and Colorado's population is expected to nearly double within the next 40 years. Colorado needs to provide an adequate water supply for its citizens and the environment, yet Colorado is transitioning from an era of undeveloped resources to an era of managing a more developed resource. Meeting the state's municipal, industrial, agricultural, environmental, and recreational water needs will involve implementing a mix of local water projects and processes, conservation, reuse, agricultural transfers, and the development of new water supplies, all of which should be pursued concurrently. Ultimately, the future of Colorado—both its vibrancy and its beauty—is dependent on how our water resources are sustained, used, and developed.

To help understand and address these trends, the CWCB undertook a number of important initiatives. The CWCB is statutorily charged to conserve, protect, manage, and develop Colorado's water resources for current and future generations. In advancing this mission, the CWCB helps ensure that water is utilized to meet the needs of Colorado's citizens while protecting the environment.

In the last few years, state leaders and resource management agencies have increasingly focused on helping ensure that Colorado has an adequate water supply for its citizens, agriculture, and the environment. In 2003, the Colorado General Assembly recognized the critical need to understand and better prepare for our long-term water needs and authorized the CWCB to implement the SWSI. SWSI 1, approved by the CWCB Board in 2004, was a comprehensive identification of Colorado's current and future water needs, and it examined a variety of approaches Colorado could take to meet those needs. SWSI 1 implemented a collaborative approach to water resource issues by establishing "basin roundtables"—diverse groups of individuals representing water interests who provide input on water issues.

This was followed by SWSI 2, which established four technical roundtables—Conservation, Alternative Agricultural Water Transfers, Environmental and Recreational Needs, and Addressing the Water Supply Gap. The overall goal of SWSI 2 was to develop a range of potential solutions that would help water providers, policymakers, and stakeholders gain a deeper understanding of the relative role that water efficiency, agricultural transfers, and new water development can play in meeting future needs and the trade-offs associated with these solutions.

In 2005, the legislature reaffirmed the need to prepare for a future in which water resources are increasingly limited by passing the Colorado Water for the 21st Century Act. This legislation institutionalized nine basin roundtables and created a voluntary, collaborative process to help the state address its water challenges. This process is based on the premise that Coloradoans can work together to address the water needs within the state.

Figure 1-1 illustrates the nine basin roundtables, which were organized to represent Colorado's eight major river basins and a separate basin roundtable for the Denver Metro area. The Yampa-White, Colorado, Gunnison, and Southwest Basin Roundtables are all based on tributaries to the Colorado River. The North Platte, Metro, and South Platte Basin Roundtables represent watersheds tributary to the Platte River. The Arkansas and Rio Grande Basin Roundtables are the headwaters of these river systems.

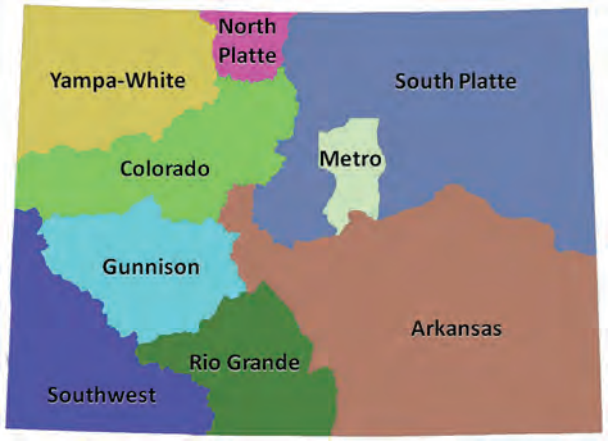


Figure 1-1 Colorado's nine basin roundtables provide a voluntary and collaborative process to help the state address its water challenges

In addition to the nine basin roundtables, the Colorado Water for the 21st Century Act established the 27-member IBCC to facilitate conversations between basins and to address statewide issues. The IBCC established its charter in 2006, which was soon ratified by Colorado's General Assembly. The charter outlines the roles of the IBCC—to provide a "framework that creates incentives for successful deliberations, agreements, and their implementation." To help advance this role, the IBCC embarked on a visioning process, through which the IBCC, CWCB, and basin roundtables agreed to evaluate water demand and supply strategies that could help address Colorado's water supply future.

1.4 SWSI 2010 Report Recommendations

With the completion of the SWSI 2010 Report, CWCB has updated its analysis of the state's water supply needs and recommends Colorado's water community enter an implementation phase to determine and pursue solutions to meeting the state's consumptive and nonconsumptive water supply needs. This will be accomplished through the following recommendations.

These recommendations do not necessarily represent a statewide consensus. The CWCB has deliberated on the information contained in SWSI 2010 and has put forth its view of how to move forward.

1. Actively encourage projects to address multiple purposes, including municipal, industrial, environmental, recreational, agricultural, risk management, and compact compliance needs.

2. Identify and utilize existing and new funding opportunities to assist in implementing projects and methods to meet Colorado's consumptive and nonconsumptive water supply needs.

3. Continue to lead the dialogue and foster cooperation among water interests in every basin and between basins for the purpose of implementing solutions to Colorado's water supply challenges.

4. Support water project proponents and opponents in resolving conflict and addressing concerns associated with implementing IPPs that will reduce the M&I water supply gap. Identify IPPs that could be implemented by 2020.

5. Support meeting Colorado's nonconsumptive water needs by working with Colorado's water stakeholders to help:

    - Promote recovery and sustainability of endangered, threatened, and imperiled species in a manner that allows the state to fully use its compact and decreed entitlements.
    - Protect or enhance environmental and recreational values that benefit local and statewide economies.
    - Encourage multi-purpose projects that benefit both water users and native species.
    - Pursue projects and other strategies, including CWCB's Instream Flow Program, that benefit consumptive water users, the riparian and aquatic environments, and stream recreation.
    - Recognize the importance of environmental and recreational benefits derived from agricultural water use, storage reservoirs, and other consumptive water uses and water management.

6. Help meet Colorado's agricultural water supply needs by incorporating agricultural water needs into the development of water supply portfolios and supporting the implementation of multi-purpose agricultural water supply projects.

7. In order to determine the appropriate combination of strategies (IPPs, conservation, reuse, agricultural transfers, and the development of new water supplies) and portfolios to meet the water supply needs, CWCB will identify what it considers is achievable for each portfolio element and how those portfolio elements could be implemented.

8. Evaluate multi-purpose projects or packages of projects to develop new water supplies for use on the West Slope and the Front Range.

9. Develop and support risk management strategies so that Colorado can fully use its compact and decree entitlements to best balance Colorado's diverse water needs.

10. Support, encourage, and incentivize water providers in planning for and implementing M&I active conservation best management practices and other demand management strategies.

11. Work with water providers to identify opportunities where additional water could be made available by increased regional cooperation, storage, exchanges, and other creative opportunities.

12. Continue the evaluation of Colorado's water supply availability in all basins to help provide water users with viable analysis tools.

13. Help safeguard Colorado's water supply during times of drought by incorporating drought mitigation and response in statewide and local water supply planning.

14. Support local water supply planning.

15. The CWCB, in consultation with other state agencies, shall develop and implement a plan to educate and promote stewardship of water resources that recognizes water's critical role in supporting the quality of life and economic prosperity of all Coloradoans.

16. Establish a 6-year planning cycle for assessing Colorado's long-term consumptive and nonconsumptive water needs and support the implementation of projects and methods to meet those needs.

1.5 Arkansas Basin Roundtable Needs Assessment Report Overview

This report presents the information utilized in the SWSI 2010 Report and needs assessment information developed by the basin roundtable that is specific to the Arkansas Basin. Following is a description of the contents of this Basin Needs Assessment Report:

- **Section 2** is a summary of the **Arkansas Basin Nonconsumptive Needs Assessment** that have been completed to date. The roundtable has completed an extensive inventory of its environmental and recreational attributes and has summarized this information in focus area mapping.

- **Section 3** provides an overview of **Arkansas Basin Nonconsumptive Projects and Methods** that have been gathered by the CWCB and a summary of this information as requested by the basin roundtable.

- **Section 4** summarizes the basin's M&I and agricultural water demands into a basinwide look at the **Arkansas Basin Consumptive Needs Assessment**. The consumptive demands utilize a planning horizon of 2050.

- In **Section 5**, projects and methods to meet consumptive needs are considered. As part of the summary, the **Consumptive Projects and Methods and the M&I Gap** are described at a regional level.

- The CWCB recently developed the draft Colorado River Water Availability Study (CRWAS). In **Section 6, Water Availability** is considered statewide including a summary of the analyses considered in CRWAS as well as water availability information developed by the Basin Roundtables as part of their basinwide needs assessments and during SWSI 1.

- **Section 7** is an overview of the **Arkansas Basin Implementation and Recommendations** to address Consumptive and Nonconsumptive Needs as well as the basin roundtable's recommended next steps.

Section 2
Arkansas Basin Nonconsumptive Needs Assessment

2.1 Overview of Nonconsumptive Needs Assessments

As discussed in Section 1, the basin roundtables are required to complete Nonconsumptive Needs Assessments (NCNAs). This effort has included an extensive inventory, analysis, and synthesized mapping effort that built upon the Statewide Water Supply Initiative (SWSI) 2 environmental and recreational attribute mapping as a common technical platform for the basin roundtables. **Figure 2-1** shows the process that was utilized by the Colorado Water Conservation Board (CWCB) and basin roundtables in completing their NCNAs. The basin roundtables have utilized environmental and recreational mapping to identify where the nonconsumptive focus areas are in their basins. In addition, the Arkansas Basin has utilized Water Supply Reserve Account funding to further quantify environmental needs for John Martin Wetlands and Nee Noshe Reservoir. The basin roundtables' nonconsumptive focus areas and further study efforts are intended to facilitate the identification of projects and methods to address environmental and recreational water needs. The Arkansas Basin nonconsumptive identified projects and methods are summarized in Section 3 of this report.

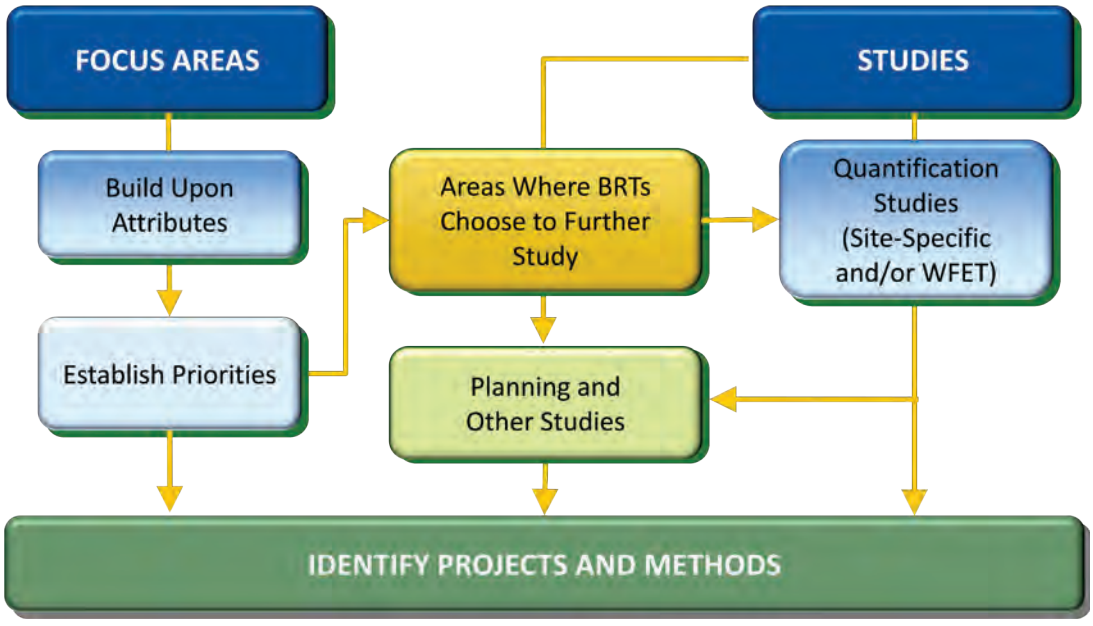


Figure 2-1 Nonconsumptive Needs Assessment Methodology

The focus area maps developed by each basin roundtable are based on a common set of environmental and recreational attributes and represent where Colorado's important water-based environmental and recreational attributes are located. The maps are reflective of stakeholder input for the focus areas and also reflect stream reaches and subwatersheds with higher concentrations of environmental and recreational qualities. These maps were generated to provide information to the basin roundtables on important environmental and recreational areas in their basins but were not intended to dictate future actions. It should be noted, and as will be shown in this section, that this effort has not identified all streams as important. The NCNAs are not intended to create a water right for the environment and will not diminish, impair, or cause injury to existing absolute or conditional water rights. The CWCB and basin roundtable developed the environmental and recreational focus area mapping for the following purposes:

- The maps are intended to serve as a useful guide for water supply planning so that future conflicts over environmental and recreational needs can be avoided.
- The maps can assist in identifying environmental and recreational water needs status, such as where needs are being met, where additional future study may need to take place, or where implementation projects in the basin are needed.
- The maps can help basins plan for the water needs of species of special concern so that they do not become federally-listed as endangered or threatened in the future.
- The maps can provide opportunity for collaborative efforts for future multi-objective projects.

2.2 Focus Area Mapping Methodology

Underlying the work done by the basin roundtables is a common technical platform, which builds off SWSI 2, as described above. This common technical platform approach recognizes the need for each basin roundtable to utilize the technical work in the most effective manner for the stakeholders and concerns within the basin. For example, some basins that were focused on wetlands or bird habitat issues used a watershed approach, while others focused on instream habitat.

Overall, the basin roundtables used three methods to identify their focus areas as shown in **Figure 2-2**. After the basin roundtables gathered additional data layers beyond existing SWSI 2 geographic information system (GIS) data layers, they each developed a summary map that highlighted environmental and recreational focus areas for their basin. The Arkansas Basin Roundtable utilized Method 1, which employed GIS software to summarize information at a watershed level (U.S. Geological Survey [USGS] 12-digit Hydrologic Unit Code [HUC] watershed). The basin roundtable had many data layers that they summarized into "categories," such as threatened and

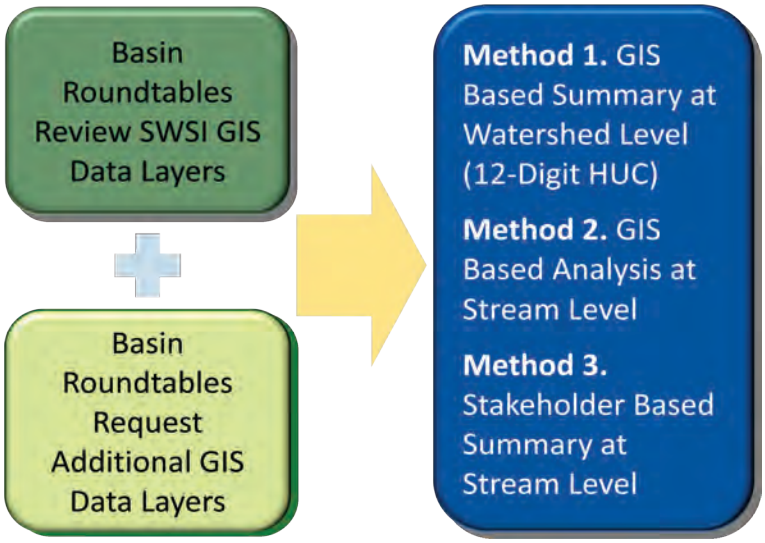


Figure 2-2 Basin Roundtable Focus Area Mapping Methodology

endangered species, riparian communities, and recreational boating areas. Using GIS software, the number of categories in each watershed was counted, and using varying color scales, GIS watersheds with a higher number of categories were highlighted in a darker color.

GIS software was used to organize the data layers for environmental and recreational attributes associated with nonconsumptive water needs for each basin. The term "data layer" refers to geographic data that represents a specific type of feature or attribute (e.g., wetlands or species habitat) and can also be referred to as a shapefile. Multiple data layers, organized collectively, are referred to as a dataset. The environmental and recreational data layers for each basin were selected using the SWSI 2 GIS data layers as a starting point. The basin roundtables reviewed the available data layers compiled during SWSI 2 and then suggested and contributed additional data layers as deemed appropriate for each basin. The SWSI 2010 Report's Appendix C contains the *Nonconsumptive Needs Assessment Focus Mapping Final Report* that provides the detailed methodology utilized by each basin roundtable in developing their focus area map.

2.2.1 SWSI 2 GIS Data Layers

The Environmental and Recreational Technical Roundtable that was formed under SWSI 2 developed a list of select environmental and recreational GIS data layers that could potentially be used by decisionmakers to determine areas of focus for environmental and recreational water needs. The complete list of SWSI 2 GIS data layers is shown in **Table 2-1**.

Table 2-1 SWSI 2 Environmental and Recreational Data Layers

Arkansas Darter	Gold Medal Trout Streams
Audubon Important Bird Areas	Greenback Cutthroat Trout
Bluehead Sucker	Greenback Cutthroat Trout
Bonytail Chub	Humpback Chub
Boreal Toad Critical Habitat	Rafting and Kayak Reaches
Colorado Department of Public Health and Environment Water Quality Control Division 303(D) Listed Segments	Rare Riparian Wetland Vascular Plants
Colorado Pikeminnow	Razorback Sucker
Colorado River Cutthroat Trout	Recreational In-Channel Diversions
CWCB Instream Flow Rights	Rio Grande Cutthroat Trout
CWCB Natural Lake Levels	Rio Grande Sucker
CWCB Water Rights Where Water Availability had a Role in Appropriation	Roundtail Chub
Flannelmouth Sucker	Significant Riparian/Wetland Communities
Gold Medal Trout Lakes	

In addition to the SWSI 2 environmental and recreational GIS data layers, the basin roundtables requested the attainment and development of other important environmental and recreational GIS data layers. Some of the additional GIS data were received directly from state and federal agencies, nongovernmental organizations and municipalities, or downloaded from their official websites. Other additional GIS data were digitized from available information, lists, or maps provided by basin roundtables, specialists (biologists, recreation guides), and other stakeholders. **Table 2-2** contains a list of additional environmental and recreational data layers that were collected based on a statewide basis from basin roundtable input.

Table 2-2 Additional Statewide Environmental and Recreational Data Layers Based on Basin Roundtable Input

Additional Fishing	National Wetlands Inventory
Additional Greenback Cutthroat Trout Waters	Northern Leopard Frog Locations
Additional Paddling/Rafting/Kayaking/Flatwater Boating	Northern Redbelly Dace
Additional Rio Grande Sucker and Chub Streams	Osprey Nestsites and Foraging Areas
Bald Eagle Winter Concentration	Piping Plover
Bald Eagle Active Nestsites	Plains Minnow
Bald Eagle Summer Forage	Plains Orangethroat Darter
Bald Eagle Winter Forage	Preble's Meadow Jumping Mouse
Brassy Minnow	River Otter Confirmed Sightings
Colorado Birding Trails	River Otter Overall Range
Colorado Outstanding Waters	Rocky Mountain Biological Laboratory (scientific and educational reaches)
Common Garter Snake	Sandhill Crane Staging Areas
Common Shiner	Southwestern Willow Flycatcher
Ducks Unlimited Project Areas	Stonecat
Educational Segments	Waterfowl Hunting Areas
Eligible/Suitable Wild and Scenic	Wild and Scenic Study Rivers
Grand Mesa, Uncompahgre, and Gunnison Wilderness Waters/Areas	Wildlife Viewing
High Recreation Areas	Yellow Mud Turtle
Least Tern	

2.2.2 Categorization of Data Layers

Once the basin roundtables identified the focus environmental and recreational data layers in their basins, the data layers were grouped into subcategories representing a collective environmental or recreational category. This method had two advantages—1) it moderated redundancy among comparable, geographically overlapping individual data layers, and 2) it allowed for a more comprehensible presentation of the GIS data. For example, Colorado pikeminnow, razorback sucker, humpback chub, and bonytail chub and federal critical habitat individual data layers were all grouped under the subcategory "Federally Endangered Fish," which was included in the overarching environmental category. The Arkansas Basin's subcategories are shown as an example below in **Figure 2-3**.

2.2.3 GIS Analysis of Data Layers

The Arkansas Basin chose to use 12-digit HUC watersheds as the basis for their GIS tool development. The HUC is a hierarchical, numeric code that uniquely identifies hydrologic units. Hydrologic units are subdivisions of watersheds nested from largest to smallest areas and are used to organize hydrologic data. HUCs are identifiers as assigned to basin polygons by the USGS. The USGS creates the digital data for HUCs, which are available for download through the USGS website. Twelve-digit HUCs are the smallest subdivision of hydrologic data available to-date in Colorado, with an average of 33 square miles.

For the Arkansas Basin Roundtables, each environmental and recreational data layer was categorized as described in Section 2.2.2. Using GIS software, the categories of data layers were intersected with the 12-digit HUCs to create HUC-based environmental and recreational category areas. These HUC-based environmental and recreational categories areas were then overlaid on one another using GIS software to create a density or number of environmental and recreational categories in a given 12-digit HUC. Detailed procedures for this analysis are described in Appendix C of the SWSI 2010 Report.

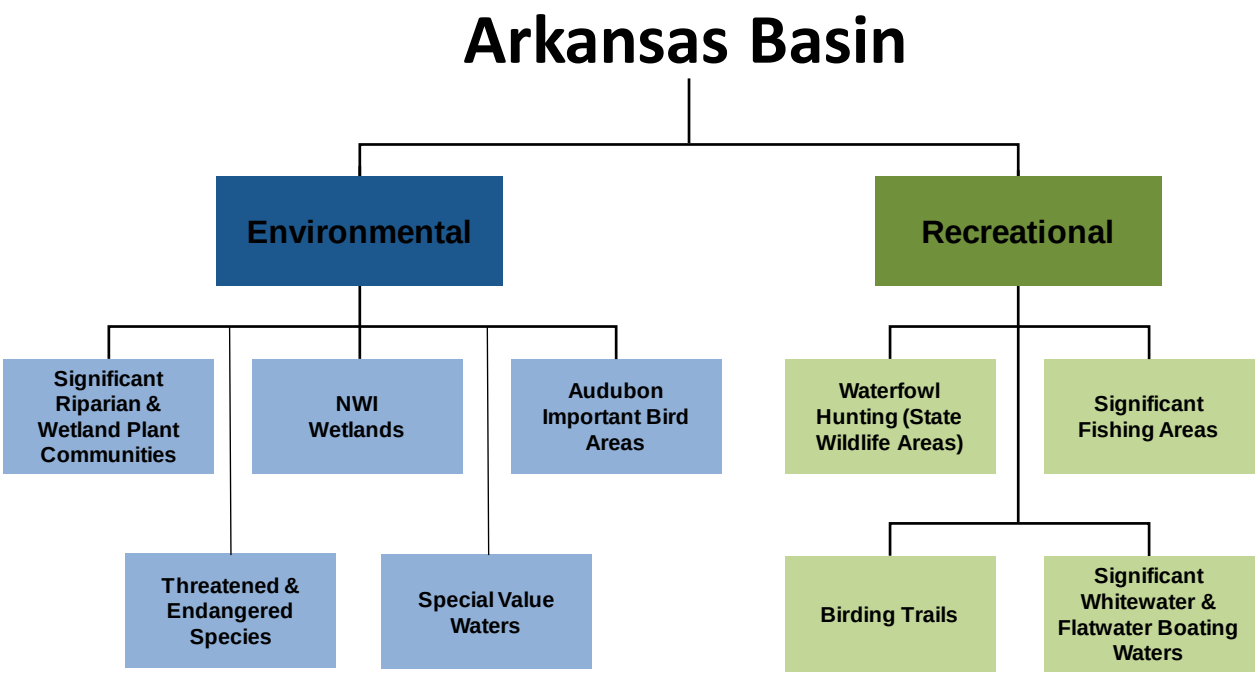


Figure 2-3 Arkansas Basin Environmental and Recreational Subcategories

2.3 Nonconsumptive Focus Area Mapping Results

Using the methodologies and techniques outlined above, the Arkansas Basin developed a unique map showing focus areas with nonconsumptive environmental and recreational water needs. The basin map was created as a Geospatial PDF file, or GeoPDF, to allow the user the ability to "click" areas of the map and view characteristics of that portion of the map such as what attribute subcategories are present for a given HUC or stream segment. In addition, the presence of specific attributes (e.g., Arkansas darter, trout, kayaking, etc.) is also summarized as well as information designated by the basin roundtable through creation of tables associated with their map. **Figure 2-4** at the end of this section can be used as GeoPDFs in the electronic version of this report. To utilize the maps interactively, select the tools dropdown list, then select the analysis tools arrow and then click on the "object data tool." Using this tool, triple click a reach for additional information that will appear on the left side. Figure 2-4 shows the environmental and recreational focus mapping for the Arkansas Basin. The figure was developed as a GeoPDF that enable the viewer to select a 12-digit HUC focus area and view the environmental and recreational attributes for that HUC. The Arkansas Basin identified nine environmental and recreational subcategories as shown on the map. Areas with the most overlap of subcategories are shown in the darkest color and are primarily concentrated in three areas—1) the mainstem Arkansas River upstream of Pueblo, 2) the Fountain Creek watershed, and 3) in the areas around major reservoirs on the Lower Arkansas River between Las Animas and Eads.

2.4 Summary of John Martin Reservoir Wetlands and Nee Noshe Reservoir Nonconsumptive Quantification

The general approach for both study sites began with the development of an understanding of the environmental and recreational resources at each location. Data available for the areas were used to identify the sources of water to, and the total acreage of, the wetlands complex at John Martin Reservoir. Available data were also used to estimate the existing shorebird habitat available at Nee Noshe Reservoir with relation to the reservoir levels at the site. Once the water sources and wetland area at John Martin Reservoir and the habitat/lake level relationship at Nee Noshe Reservoir were established, the information was used to support development of the overall water budgets or water balance at each location. A water budget is "the scientific method for measuring the amount of water entering, stored within, and leaving a watershed, and it is also called a hydrologic budget or a water balance." A water budget was used to determine the interactions between the water inputs and outputs of both systems.

The full study report is located in Appendix C of this report.

2.4.1 John Martin Reservoir Wetland Complex Water Budget

A water budget was constructed for the John Martin Reservoir wetlands to provide relative quantification of existing sources of supply to the wetlands. Historical aerial photographs showed that the wetlands were present in the area during reservoir construction and maintained a similar footprint regardless of reservoir levels. Because of this historical evidence, there were two major components of the analysis for the John Martin Reservoir wetlands: one focused on surface water dynamics and the other on subsurface dynamics. The water budgets were used to determine that the ultimate source of supply for these wetlands is shallow groundwater (subsurface) supported by agricultural return flows.

2.4.2 Nee Noshe Reservoir Water Budget

The Nee Noshe Reservoir is an off-channel reservoir that currently receives surface water diversions only sporadically during periods of high flow due to the junior priorities of the storage rights for the Great Plains Reservoirs. As a result of this condition, the water budget for the reservoir is mainly based on direct precipitation and evaporation. Since, on an annual basis, evaporative losses are higher than direct precipitation to the reservoir, the reservoir generally loses water.

2.4.3 Results

2.4.3.1 John Martin Reservoir Wetlands

Data were used to estimate that the wetlands at John Martin Reservoir cover approximately 6,300 acres. The final wetlands water budget results (both annual and monthly) were then calculated using the available data. The water budget showed that the wetlands are maintained by approximately 32,000 acre-feet of water per year (AFY), which is supplied primarily by regional irrigation return flows to the sub-surface. Results also demonstrate that, on an annual basis, the Arkansas River gains flow through the study reach. On a monthly basis, this analysis shows significant fluctuations in inflows and outflows to the system, most likely as a result of changes in Arkansas River hydraulics. Results indicate large inflows to the sub-surface system in the spring and early summer, consisting primarily of river seepage and irrigation returns. During this period (May and June), the calculations indicate that the water table below the wetlands is rising. The results imply that the system changes in later summer and fall to a losing system, as river levels subside. During this period, a net loss of water was quantified from the sub-surface pool,

primarily in the form of gains to the river. Based on this information, it is likely that the water table drops during this time.

2.4.3.2 Nee Noshe Reservoir Bird Habitat

Using historical data, the current habitat at Nee Noshe Reservoir and reservoir size were characterized. Nee Noshe Reservoir currently covers 300 acres and holds 3,500 acre-feet (AF) of water. There are approximately 80 acres of habitat available to the bird species at this reservoir size. Although habitat exists at the reservoir, least tern and piping plover have not been observed at the site since 2004. Because current conditions at Nee Noshe Reservoir do not support the bird populations, quantification of water needs were analyzed for three scenarios:

- Maintenance of current conditions;
- Maintenance of the dead pool capacity; and
- Maintenance of 2004 reservoir levels.

The additional scenarios were analyzed because if reservoir levels could be maintained at the dead pool capacity, it would provide the best opportunity for downstream use of any available water and least terns were last observed at Nee Noshe Reservoir in 2004.

Annual water budgets for both current and hypothetical scenarios were calculated using available data. A deficit of 1,000 AFY was quantified for the current system based on the available historical data used to develop the water budget. Therefore, an average of 1,000 AFY of surface water is needed to maintain current levels of storage. Due to canal losses (approximately 45 percent), this is the equivalent of 1,800 AFY diverted at the canal headgate.

A seasonal investigation was also performed for the dead pool scenario and revealed high river diversion requirements, early in the water year, were needed to maintain targeted pool levels. These autumn and early winter diversions would provide the habitat inundation required to prevent vegetation encroachment. The sharp drop in diversion water in subsequent months (spring through summer) would allow for the desired drop in lake levels during the nesting and foraging seasons.

A previously established area-capacity curve was also used to estimate the capacity of Nee Noshe Reservoir in 2004 when least terns were last observed nesting on the shores. It is estimated that Nee Noshe Reservoir held 25,000 AF in 2004. For this scenario, a headgate diversion requirement of 12,300 AFY was calculated to maintain the 2004 reservoir level on an annual basis.

Legend

Environmental and Recreational Subcategory Count by HUC

- 1 - 2
- 3 - 4
- 5 - 7
- Highways
- Rivers and Streams
- Lakes and Reservoirs
- Cities and Towns
- County Boundary

N
W E
S

0 7 14 28 42
Miles

1 inch = 7 miles

Environmental and Recreational Subcategories:
1. Boating
2. Fishing
3. Waterfowl Hunting
4. Birding Trails
5. Threatened and Endangered Species
6. Special Value Waters
7. Wetlands
8. Significant Riparian and Wetland Plant Communities
9. Audubon Important Bird Areas

Figure 2-4
Arkansas Basin
Nonconsumptive Needs Assessment
Environmental and Recreational Subcategories by 12-Digit HUC

COLORADO WATER CONSERVATION BOARD
STATE OF COLORADO
1876 1937

CDM

Section 3
Arkansas Basin Nonconsumptive Projects and Methods

3.1 Nonconsumptive Projects and Methods Overview

Section 2 of this report summarizes the nonconsumptive needs in the Arkansas Basin. As discussed in Section 1, the Water for the 21st Century Act requires the basin roundtables to identify projects and methods to meet their consumptive and nonconsumptive needs. For consumptive projects and methods, the Colorado Water Conservation Board (CWCB) worked with water providers and the basin roundtables to update the Statewide Water Supply Initiative (SWSI) 1 identified projects and processes (IPPs) from a planning horizon of 2030 to 2050. This effort is summarized in Section 5 of this report. For nonconsumptive needs, the CWCB has conducted an analogous outreach effort with the environmental and recreational community and the basin roundtables to identify nonconsumptive projects and methods similar to the municipal and industrial (M&I) consumptive IPPs. CWCB digitized the project information into geographical information system (GIS) and compared this information with the nonconsumptive focus areas summarized in Section 2. With this information, CWCB was able to preliminarily identify nonconsumptive focus areas with and without projects and methods. It is important to note that if a focus area does not have an associated project and method it does not mean that the area needs protective projects and methods. It is also important to note that CWCB did not judge the sufficiency of the projects and methods in each reach; rather, as with the M&I IPPs, CWCB did not judge the merits of the nonconsumptive projects and methods being pursued by local organizations. This information gathered was intended to assist the basin roundtables in addressing the following questions:

1. Are there existing protections/efforts for environmental and recreational focus areas?
2. Are there areas without protections that need further study?
3. What strategies are needed to support nonconsumptive priority areas?
4. Are there areas where new flow or water level quantification is appropriate?
5. Are there areas where a project, whether structural (e.g., river restoration) or nonstructural, can be identified and implemented?
6. Are there areas where no action is needed at this time?

Section 3.2 describes the methodology used to gather nonconsumptive projects and methods across the state. Section 3.3 summarizes the methodology used to analyze the project and method information.

3.2 Nonconsumptive Projects and Methods Methodology

In January 2010, CWCB developed a survey to collect information on where there are existing or planned nonconsumptive projects, methods, and studies. Studies were included since they may recommend or inform the implementation of projects or methods that will provide protection or enhancement of environmental and recreational attributes. This survey was distributed through CWCB's basin roundtable and e-mail database. On February 10, 2010, CWCB conducted a workshop in Silverthorne, Colorado to discuss the Phase II efforts and to collect information on nonconsumptive projects, methods, and studies from the workshop attendees. At the workshop, information on 116 stream segments and 209 projects, methods, or studies was provided to CWCB. In addition, CWCB also gathered information on individuals and organizations to follow up with the data collection effort. Since the February 2010 meeting, an additional 57 meetings have occurred to gather data on additional projects, methods, and studies. **Table 3-1** below summarizes the number of individuals or organizations contacted since the February 2010 meeting; the number of follow-up meetings held; and the number of projects, methods, and studies identified to date for each basin. Table 3-1 details the number of projects, methods, and studies that are in the focus areas and the number of projects outside of the focus areas. In total, 648 projects were identified from the outreach effort. Examples of the types of projects collected during this outreach effort include:

- Habitat restoration projects such as bank stabilization projects or instream habitat restoration such as pool and riffle development. Another example of habitat restoration area projects that focus on the maintaining connectivity for fish passage such as fish ladders.
- Flow protection projects such as voluntary flow agreements, instream flow (ISF) donations, or voluntary re-operation of reservoirs for releases for environmental or recreational needs.

Table 3-1 Summary of Meetings to Collect Nonconsumptive Project and Methods Information

Basin Roundtable	No. of Individuals or Organizations Contacted	No. of Meetings	No. Projects and Methods in Focus Areas	No. Projects and Methods Outside Focus Areas	Total No. Projects and Methods
Arkansas	**7**	**5**	**40**	**0**	**40**
Colorado	21	12	168	35	203
Gunnison	9	4	44	15	59
Metro	See South Platte	See South Platte	See South Platte	See South Platte	See South Platte
North Platte	1	1	41	7	48
Rio Grande	10	5	59	0	59
South Platte	17	14	54	53	107
Southwest	17	12	84	10	94
Yampa-White	9	4	22	16	38
TOTAL	91	57	512	136	648

In addition, there is a great deal of information gathered from divisions within the Colorado Department of Natural Resources (DNR) that have been integrated into the projects and methods database. For instance, **Table 3-2** summarizes CWCB's ISFs for each basin roundtable. Decreed ISFs have been confirmed by the water court. Pending ISFs have been approved by the CWCB Board and are going through the water court process. Recommended ISFs include those areas submitted to CWCB as a recommendation, but not yet approved by the CWCB Board at this time.

Table 3-2 Summary of CWCB Instream Flows and Natural Lake Levels

Basin Roundtable	Natural Lakes	ISF Decreed	Pending ISF	Recommended ISF
Arkansas	**86**	**171**	**11**	**8**
Colorado	150	404	12	6
Gunnison	82	259	15	2
Metro	0	24	0	0
North Platte	31	45	1	3
Rio Grande	49	141	0	0
South Platte	31	208	2	2
Southwest	50	151	4	6
Yampa-White	150	175	7	5
TOTAL	**494**	**1,578**	**52**	**32**

The CWCB's Watershed Protection and Flood Mitigation section oversees the agency's watershed restoration efforts. In addition, many of the Water Supply Reserve Account (WSRA) grants fully or partially address nonconsumptive needs. **Table 3-3** shows the funding programs implemented by CWCB and project type associated with each program. The table shows the status of the projects; pending in this case means that either the contract has not yet been signed, but has CWCB approval, or that applicants have applied, but are not yet approved by the CWCB.

Table 3-3 Summary of CWCB's Watershed Restoration and Nonconsumptive WSRA Projects

Funding Source	Type	Complete	On-going	Pending	Total
Colorado Healthy Rivers Fund	Report	19	9	3	31
Colorado Healthy Rivers Fund	Restoration Project	15	7	6	28
Colorado Watershed Restoration Program	Report	1	3	0	4
Colorado Watershed Restoration Program	Restoration Project	2	9	1	12
Fish and Wildlife Resources Fund	Restoration Project	2	2	0	4
Multi-Objective Watershed Protection Plan	Report	5	0	1	6
Multi-Objective Watershed Protection Plan	Restoration Project	6	0	4	10
WSRA Nonconsumptive Related Grants	Report	8	15	3	26
WSRA Nonconsumptive Related Grants	Restoration Project	13	12	4	29
TOTAL		**71**	**57**	**22**	**150**
Total Restoration Projects	**Restoration Project**	**38**	**30**	**15**	**83**
Total Reports	**Report**	**33**	**27**	**7**	**67**
TOTAL CWCB Dollars Spent/Encumbered		$14,499,625			
TOTAL Estimated Match Dollars		$34,323,697			
TOTAL Approximate Expenditures		**$ 48,823,322**			

In addition to CWCB's efforts, the Colorado Division of Wildlife (CDOW) is mandated by statute to manage the state's fishery and wildlife resources for the benefit of the citizens and visitors to the State of Colorado. The CDOW Aquatic Section takes the lead for fishery management for the agency, and to this end has mapped every waterbody, stream, or river segment in Colorado and associated a water management classification relating back to fishery objectives for that waterbody. The CDOW has participated in the basin roundtable processes throughout the state in order to provide data and information on basin fisheries, indicate fishery management priorities, and also to communicate where the most significant threats are currently located. CDOW recognizes that human uses of water will often conflict directly or indirectly with the ability to manage fisheries to meet these objectives. CDOW anticipates that as water resources are more intensively managed in the future, that pre-emptive coordination between water developers and conservation interests can minimize and in some cases improve their ability to meet fishery objectives in Colorado.

Finally, CWCB included the Southwest Regional Gap Analysis Project (SRGAP), coordinated by U.S. Geological Survey (USGS) into the projects and methods database. The SRGAP created detailed, seamless GIS data layers of land cover, all native terrestrial vertebrate species, land stewardship, and management status values. The management status values quantify the relationship between land management and biodiversity throughout the State of Colorado. Four management status values are as described below:

- Status 4 lands are where there are no known public or private institutional mandates or legally recognized easements or deed restrictions held by the managing entity to prevent conversion of natural habitat types to anthropogenic habitat types. The area generally allows conversion to unnatural land cover throughout.
- Status 3 lands comprise areas having permanent protection from conversion of natural land cover for the majority of the area, but subject to extractive uses of either a broad, low-intensity type (e.g., logging) or localized intense type (e.g., mining). It also confers protection to federally-listed endangered and threatened species throughout the area.
- Status 2 lands are areas having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a primarily natural state, but that may receive uses or management practices that degrade the quality of existing natural communities, including suppression of natural disturbance.
- Status 1 lands include areas having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a natural state within which disturbance events (of natural type, frequency, intensity, and legacy) are allowed to proceed without interference or are mimicked through management.

For this effort, CWCB include areas with a status between 1 and 2.5 as a project and method in the nonconsumptive projects database.

3.3 Nonconsumptive Projects and Methods GIS Mapping and Analysis Methodology and Results

The project and method information collected by CWCB, as described in Section 3.2, was spatially digitized in GIS. Each project was digitized separately using an existing stream database called National Hydrography Dataset (NHD) 12-digit segments. The average length of an NHD segment is 1.5 miles. Depending on the length of the project, multiple NHD segments could represent one project. Also, depending on the project location, multiple projects could exist on the same NHD segment. A unique Project Identification and Segment Identification were given to all surveyed and interviewed projects within the Nonconsumptive Needs Assessment database. In addition, the WSRA grant project locations were digitized in a similar fashion. The CWCB ISFs and natural lake levels, CWCB restoration projects, and the USGS SRGAP information had previously been summarized using GIS; therefore, this data did not have to be digitized. The USGS SRGAP information was analyzed further to calculate a weighted management status value for each NHD segment. This value was calculated in GIS for each NHD 12-digit HUC by a weighted average of each land management status within the HUC.

Following are the assumptions used in digitizing the nonconsumptive projects and methods:

- No NHD segment was edited (i.e., if the project was smaller than an NHD segment, the whole NHD segment was used to represent the project location).

- Projects were digitized based on hand-drawn locations and/or brief descriptions. This information is still under review by the basin roundtables.

Following are the types of information included in the GIS geodatabase for each project:

- Project or Method Name
- Project or Method Type (i.e., study, flow protection, or restoration project)
- Project or Method Location
- Comments
- Project or Method Status (i.e., ongoing, planned, or completed)
- Project or Method Identification Number
- Project or Method Contact Name
- Project or Method Contact Identification Number

Figure 3-1 is a summary of the projects and methods developed to date by CWCB and represents the spatial information for all nonconsumptive projects and methods that are planned, ongoing, or completed in the Arkansas Basin. This map contains all nonconsumptive projects and methods including—1) CWCB interviews and workshops, 2) CWCB watershed restoration projects, 3) WSRA grants, 4) ISFs, 5) USGS SRGAP information, and 6) CDOW projects. This map includes projects and methods inside the designated focus areas to spatially display the full extent of any project collected by CWCB. This information is also summarized in **Table 3-4** at the end of this section. This table summarizes the project name, location, type, and status. In addition, it summarizes the attributes located within the project boundary and also summarizes information about the type of protections the project provides as defined below.

In addition to identifying the spatial extent and status of the identified projects and methods, CWCB also examined what type of protection the project or method may provide to a given environmental or recreational attribute. CWCB has classified the projects as having direct or indirect protections based on a given environmental or recreational attribute. The definitions used for direct and indirect protections are as follows:

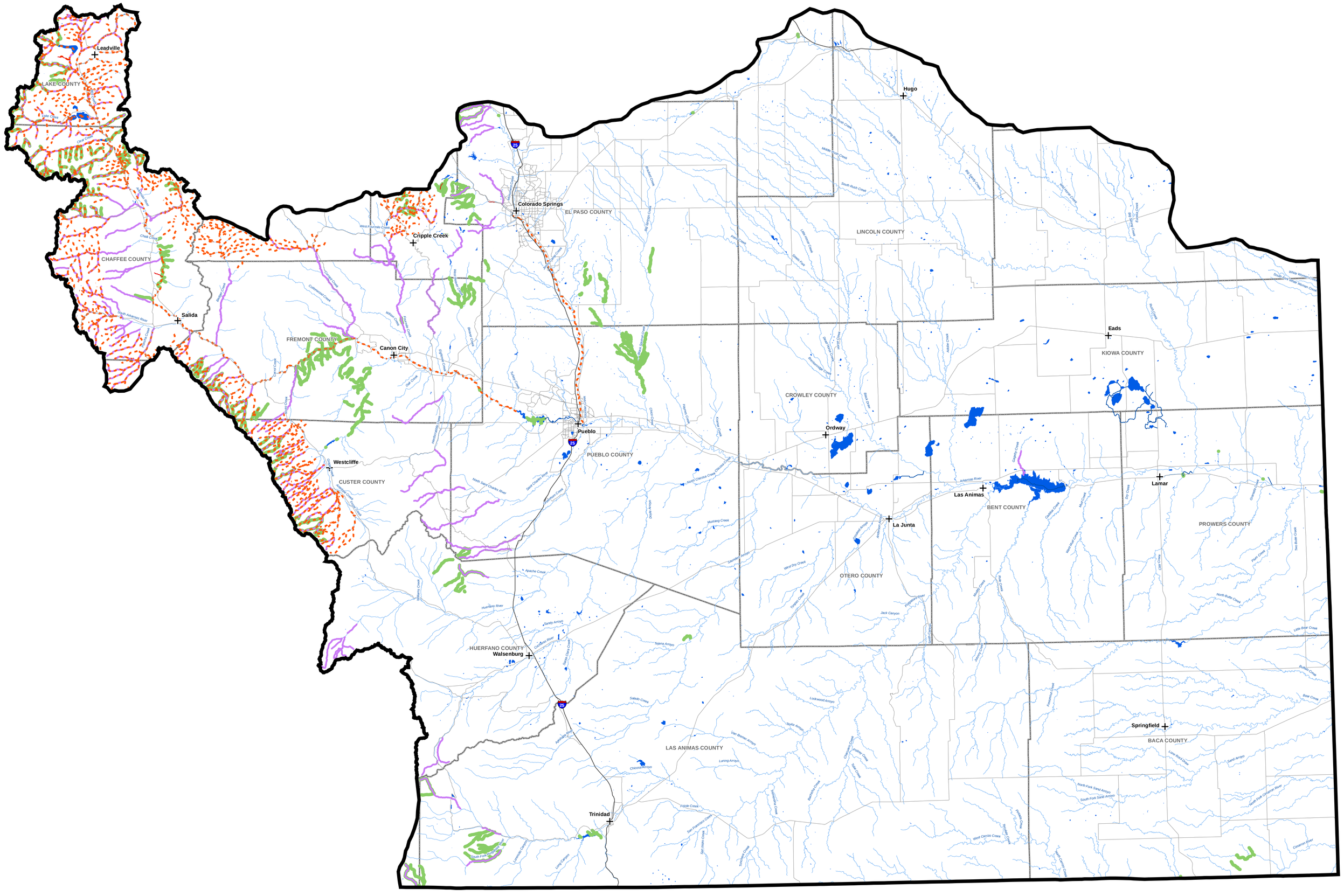
- **Direct Protection** – Projects and methods with components designed intentionally to improve a specific attribute. For example, ISFs have direct protection of fish attributes. Additionally, restoration of a stream channel would also provide direct protections for aquatic species.

- **Indirect Protection** – Projects and methods with components that were not designed to directly improve the specific attribute but may still provide protection. For example, flow protection for a fish species may also indirectly protect riparian vegetation that is located in the area of the flow protection. Another example includes protective land stewardship or a wetland or bank stabilization effort that could indirectly protect aquatic species.

The projects and methods identified through interviews were individually evaluated and compared to the environmental and recreational attributes gathered by the basin roundtables during their focus area mapping effort. This information is included in Table 3-4 above. CWCB examined the various attributes summarized by the roundtables in their focus area mapping efforts (Section 2) and indentified if these areas have projects and methods that provide direct or indirect protections. The interviewed projects and methods, ISFs, and stewardship information were assigned direct or indirect protections based on roundtable attribute. In the Arkansas Basin, the basin roundtable identified 14,030 miles of water bodies as focus areas. For these focus areas, 22 percent have an associated project or method. **Table 3-5** below summarizes the project and method protections identified for the Arkansas Basin. In the attribute column of Table 3-5, the environmental and recreational attributes collected by the basin roundtable are summarized. Several of the attribute categories are attribute specific such as Arkansas Darter, Greenback Cutthroat Trout, Piping Plover, and Least Tern. The recreation attribute category includes attributes from whitewater and flatwater boating. Important Riparian and Wetland Areas category includes significant riparian areas, Audubon important bird areas, and rare plant communities. Finally, the fishing attribute category includes streams and identified lakes as fishing areas.

Table 3-5 Summary of Protections for Arkansas Basin Environmental and Recreational Attributes

Attribute Category	Percent of Attribute Length with Direct Protections	Percent of Attribute Length with Indirect Protections	Percent of Attribute Length with Direct and Indirect Protections	Total Percent of Attribute Length with Protections
Arkansas Darter	1%	2%	0%	3%
Fishing	23%	3%	3%	29%
Greenback Cutthroat Trout	36%	3%	8%	47%
Important Riparian and Wetland	1%	13%	0%	14%
Piping Plover and Least Tern	17%	0%	0%	17%
Recreation	0%	2%	0%	2%
Waterfowl Hunting/ Viewing	0%	7%	0%	7%

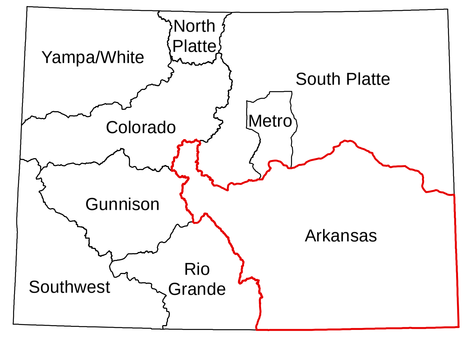


Legend

- River and Stream
- Lake and Reservoir
- City and Town
- Road
- County Boundary
- Basin

Projects

- CDOW
- CWCB
- ISF
- Stewardship
- WSRA



Colorado Basins

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Figure 3-1
Arkansas Basin
Nonconsumptive Needs Assessment
Focus Areas with
Projects and Methods

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Table 3-4 Arkansas Basin Nonconsumptive Identified Projects and Processes Summary

Project Location	Project Name	Project Type	Project Status	Basin Roundtable Attributes Identified	Project Protections
Arkansas Headwaters to Pueblo Reservoir	Pueblo Flow Program	Project	Ongoing	Additional Wilderness Areas and Wilderness Study Areas, Arkansas Headwaters Recreation Areas, Arkansas State Wildlife Areas and State Fishing Units, Arkansas Wilderness Areas, Birding Trails, Boreal Toad, Colorado Outstanding Waters, CWCB instream flow water rights, CWCB natural lake level water rights, Flatwater Boating, Gold Metal Trout Lakes, Gold Metal Trout Streams, Greenback Cutthroat Trout, National Wetlands Inventory, Recreational In-Channel Diversion Structures, Significant Riparian/Wetland Communities, Waterfowl Hunting / Viewing, Whitewater Boating, Wilderness Area Waters	Arkansas Headwaters Recreation Areas-D, Arkansas State Wildlife Areas and State Fishing Units-D, Birding Trails-I, Durango Natural Studies-D, Greenback Cutthroat Trout-D, High Recreation Lakes and Reservoirs -D, High Recreation Rivers -I, Pueblo Fishing-D, Rare Plants-D, Reservoir and Lake Fishing -D
Arkansas Basin	Fountain Creek Issues and Projects	Project	Ongoing	Arkansas Darter, Arkansas State Wildlife Areas and State Fishing Units, Audubon important bird areas, Birding Trails, Colorado Outstanding Waters, CWCB instream flow water rights, Greenback Cutthroat Trout, National Wetlands Inventory, Significant Riparian/Wetland Communities	
Arkansas Basin	Local Watershed Recreational Uses Project	Project	Ongoing	Arkansas Darter, Arkansas State Wildlife Areas and State Fishing Units, Audubon important bird areas, Birding Trails, Colorado Outstanding Waters, CWCB instream flow water rights, Greenback Cutthroat Trout, National Wetlands Inventory, Significant Riparian/Wetland Communities	
Arkansas Basin	Pueblo & Arkansas Flow Management Program	Project	Ongoing	Arkansas Darter, Arkansas State Wildlife Areas and State Fishing Units, Audubon important bird areas, Birding Trails, Colorado Outstanding Waters, CWCB instream flow water rights, Greenback Cutthroat Trout, National Wetlands Inventory, Significant Riparian/Wetland Communities	Arkansas Headwaters Recreation Areas-D, Arkansas State Wildlife Areas and State Fishing Units-D, Birding Trails-I, Durango Natural Studies-D, Greenback Cutthroat Trout-D, High Recreation Lakes and Reservoirs -D, High Recreation Rivers -I, Pueblo Fishing-D, Rare Plants-D, Reservoir and Lake Fishing -D
Arkansas Basin	Southern Delivery System	Project	Ongoing	Arkansas Darter, Arkansas State Wildlife Areas and State Fishing Units, Audubon important bird areas, Birding Trails, Colorado Outstanding Waters, CWCB instream flow water rights, Greenback Cutthroat Trout, National Wetlands Inventory, Significant Riparian/Wetland Communities	
Arkansas Basin	Stocking Agreements	Project	Ongoing	Arkansas Darter, Arkansas State Wildlife Areas and State Fishing Units, Audubon important bird areas, Birding Trails, Colorado Outstanding Waters, CWCB instream flow water rights, Greenback Cutthroat Trout, National Wetlands Inventory, Significant Riparian/Wetland Communities	
Arkansas Headwaters	Arkansas River Water Needs Assessment	Information	Completed		Additional Wilderness Areas and Wilderness Study Areas, Arkansas Darter, Arkansas Headwaters Recreation Areas, Arkansas State Wildlife Areas and State Fishing Units, Arkansas Wilderness Areas, Birding Trails, Colorado Outstanding Waters, CWCB instream flow water rights, CWCB natural lake level water rights, Flatwater Boating, Gold Metal Trout Lakes, Gold Metal Trout Streams, Greenback Cutthroat Trout, National Wetlands Inventory, Recreational In-Channel Diversion Structures, Significant Riparian/Wetland Communities, Waterfowl Hunting / Viewing, Whitewater Boating, Wilderness Area Waters
Arkansas Headwaters	Diversion Structure Replacement Plans #1	Project	Completed		Additional Wilderness Areas and Wilderness Study Areas, Arkansas Darter, Arkansas Headwaters Recreation Areas, Arkansas State Wildlife Areas and State Fishing Units, Arkansas Wilderness Areas, Birding Trails, Colorado Outstanding Waters, CWCB instream flow water rights, CWCB natural lake level water rights, Flatwater Boating, Gold Metal Trout Lakes, Gold Metal Trout Streams, Greenback Cutthroat Trout, National Wetlands Inventory, Recreational In-Channel Diversion Structures, Significant Riparian/Wetland Communities, Waterfowl Hunting / Viewing, Whitewater Boating, Wilderness Area Waters
Arkansas Headwaters to John Martin Reservoir	Aurora Decrees & Exchanges	Flow Protection	Ongoing	Additional Wilderness Areas and Wilderness Study Areas, Arkansas State Wildlife Areas and State Fishing Units, Arkansas Wilderness Areas, Birding Trails, CWCB instream flow water rights, Flatwater Boating, National Wetlands Inventory, Significant Riparian/Wetland Communities	
Arkansas River	Rocky Mountain Fen Research Program	Information	Planned	Additional Wilderness Areas and Wilderness Study Areas, Arkansas Darter, Arkansas Headwaters Recreation Areas, Arkansas State Wildlife Areas and State Fishing Units, Arkansas Wilderness Areas, Audubon important bird areas, Bald Eagle Sites, Birding Trails, Colorado Outstanding Waters, CWCB instream flow water rights, CWCB natural lake level water rights, Flatwater Boating, Gold Metal Trout Lakes, Gold Metal Trout Streams, Greenback Cutthroat Trout, Least Tern, Lesser Prairie Chicken, National Wetlands Inventory, Piping Plover, Pueblo Fishing , Recreational In-Channel Diversion Structures, Significant Riparian/Wetland Communities, Waterfowl Hunting / Viewing, Whitewater Boating, Wilderness Area Waters	
Bear Creek	Bear Creek - Pikes Peak	Project	Planned	Colorado Outstanding Waters, Greenback Cutthroat Trout, National Wetlands Inventory, Significant Riparian/Wetland Communities	Arkansas Headwaters Recreation Areas-I, Arkansas State Wildlife Areas and State Fishing Units-I, Durango Natural Studies-I, Greenback Cutthroat Trout-I, High Recreation Lakes and Reservoirs -I, Pueblo Fishing-I, Rare Plants-I

Table 3-4 Arkansas Basin Nonconsumptive Identified Projects and Processes Summary

Project Location	Project Name	Project Type	Project Status	Basin Roundtable Attributes Identified	Project Protections
Arkansas Headwaters	Diversion Structure Replacement Plans #2	Project	Planned	Additional Wilderness Areas and Wilderness Study Areas, Arkansas Darter, Arkansas Headwaters Recreation Areas, Arkansas State Wildlife Areas and State Fishing Units, Arkansas Wilderness Areas, Birding Trails, Colorado Outstanding Waters, CWCB instream flow water rights, CWCB natural lake level water rights, Flatwater Boating, Gold Metal Trout Lakes, Gold Metal Trout Streams, Greenback Cutthroat Trout, National Wetlands Inventory, Recreational In-Channel Diversion Structures, Significant Riparian/Wetland Communities, Waterfowl Hunting / Viewing, Whitewater Boating, Wilderness Area Waters	Arkansas Headwaters Recreation Areas-D, Arkansas State Wildlife Areas and State Fishing Units-D, Birding Trails-I, Durango Natural Studies-D, Greenback Cutthroat Trout-D, High Recreation Lakes and Reservoirs -D, High Recreation Rivers -I, Pueblo Fishing-D, Rare Plants-D, Reservoir and Lake Fishing -D
Canon City	Canon City Kayak Park and Fishing Restoration	Project	Completed		Arkansas Darter, Arkansas Headwaters Recreation Areas, Birding Trails, Whitewater Boating
South Colony Creek	South Colony Watershed	Project	Planned	Additional Wilderness Areas and Wilderness Study Areas, Arkansas Wilderness Areas, CWCB instream flow water rights, CWCB natural lake level water rights, National Wetlands Inventory	Arkansas Headwaters Recreation Areas-I, Arkansas State Wildlife Areas and State Fishing Units-I, Durango Natural Studies-I, Greenback Cutthroat Trout-I, High Recreation Lakes and Reservoirs -I, Pueblo Fishing-I, Rare Plants-I
Gulch near Leadville	California Gulch Superfund Project	Project	on-going	Arkansas Headwaters Recreation Areas, Arkansas State Wildlife Areas and State Fishing Units, Arkansas Wilderness Areas, Birding Trails, CWCB instream flow water rights, Gold Metal Trout Lakes, Gold Metal Trout Streams, Significant Riparian/Wetland Communities	Durango Natural Studies-I, Greenback Cutthroat Trout-I, Rare Plants-I
Jackson Creek (b/t I-25 and West Baptisto Rd.)	Jackson Creek wetlands project	Project	Completed		National Wetlands Inventory, Significant Riparian/Wetland Communities
North Crystal Creek	North Crystal Creek Erosion Control	Project	Completed		Arkansas State Wildlife Areas and State Fishing Units, Flatwater Boating
Cache Creek	Stream channel and restoration project	Project	Ongoing	Additional Wilderness Areas and Wilderness Study Areas, Arkansas Headwaters Recreation Areas, Arkansas Wilderness Areas, Colorado Outstanding Waters, CWCB instream flow water rights, Flatwater Boating, Gold Metal Trout Streams, Significant Riparian/Wetland Communities, Waterfowl Hunting / Viewing, Whitewater Boating	High Recreation Lakes and Reservoirs -D, Pueblo Fishing-D
Glen Cove Creek	Glen Cove sediment trap	Project	Planned	Arkansas State Wildlife Areas and State Fishing Units, Flatwater Boating	Arkansas Headwaters Recreation Areas-I, Arkansas State Wildlife Areas and State Fishing Units-I, Durango Natural Studies-I, Greenback Cutthroat Trout-I, High Recreation Lakes and Reservoirs -I, Pueblo Fishing-I, Rare Plants-I
Sugarloaf Gulch at Dinero Tunnel	Dinero and Nelson Tunnel	Project	on-going	Arkansas Headwaters Recreation Areas, Arkansas State Wildlife Areas and State Fishing Units, Arkansas Wilderness Areas, Birding Trails, CWCB instream flow water rights, Gold Metal Trout Lakes, Gold Metal Trout Streams, Significant Riparian/Wetland Communities	Durango Natural Studies-I, Greenback Cutthroat Trout-I, Rare Plants-I
Upper Arkansas River	Arkansas River Watershed Invasive Plants Plan	Information	Completed		Additional Wilderness Areas and Wilderness Study Areas, Arkansas Darter, Arkansas Headwaters Recreation Areas, Arkansas State Wildlife Areas and State Fishing Units, Arkansas Wilderness Areas, Birding Trails, Colorado Outstanding Waters, CWCB instream flow water rights, CWCB natural lake level water rights, Flatwater Boating, Gold Metal Trout Lakes, Gold Metal Trout Streams, Greenback Cutthroat Trout, National Wetlands Inventory, Recreational In-Channel Diversion Structures, Significant Riparian/Wetland Communities, Waterfowl Hunting / Viewing, Whitewater Boating, Wilderness Area Waters
Upper Arkansas River	Arkansas Water Transfer Study	Information	Planned	Additional Wilderness Areas and Wilderness Study Areas, Arkansas Darter, Arkansas Headwaters Recreation Areas, Arkansas State Wildlife Areas and State Fishing Units, Arkansas Wilderness Areas, Birding Trails, Colorado Outstanding Waters, CWCB instream flow water rights, CWCB natural lake level water rights, Flatwater Boating, Gold Metal Trout Lakes, Gold Metal Trout Streams, Greenback Cutthroat Trout, National Wetlands Inventory, Recreational In-Channel Diversion Structures, Significant Riparian/Wetland Communities, Waterfowl Hunting / Viewing, Whitewater Boating, Wilderness Area Waters	
Upstream Hecla just above confluence	Arkansas River Hecla Junction Restoration Project	Project	on-going	Additional Wilderness Areas and Wilderness Study Areas, Arkansas Headwaters Recreation Areas, Flatwater Boating, Gold Metal Trout Streams, Significant Riparian/Wetland Communities, Whitewater Boating, Wilderness Area Waters	Durango Natural Studies-I, Greenback Cutthroat Trout-I, Rare Plants-I
West Beaver Creek	West Beaver Creek	Project	Planned	CWCB instream flow water rights	Arkansas Headwaters Recreation Areas-I, Arkansas State Wildlife Areas and State Fishing Units-I, Durango Natural Studies-I, Greenback Cutthroat Trout-I, High Recreation Lakes and Reservoirs -I, Pueblo Fishing-I, Rare Plants-I
Fountain Creek - Memorial Park	Fountain Creek - Memorial Park	Project	Planned	Birding Trails, CWCB instream flow water rights, National Wetlands Inventory	Arkansas Headwaters Recreation Areas-D, Arkansas State Wildlife Areas and State Fishing Units-D, High Recreation Lakes and Reservoirs -D, Pueblo Fishing-D

Table 3-4 Arkansas Basin Nonconsumptive Identified Projects and Processes Summary

Project Location	Project Name	Project Type	Project Status	Basin Roundtable Attributes Identified	Project Protections
Colorado Gulch, near Leadville	Colorado Gulch Restoration near Leadville Colorado, Mt. College, Kato Dee Project - bioreactor system design	Project	on-going	Arkansas Headwaters Recreation Areas, Arkansas State Wildlife Areas and State Fishing Units, Arkansas Wilderness Areas, Birding Trails, CWCB instream flow water rights, Gold Metal Trout Lakes, Gold Metal Trout Streams, Significant Riparian/Wetland Communities	Durango Natural Studies-I, Greenback Cutthroat Trout-I, Rare Plants-I
Glen Cove Wetland	Glen Cove Wetland	Project	Completed		Arkansas State Wildlife Areas and State Fishing Units, Flatwater Boating
Fountain Creek along State Highway 24	Fountain Creek erosion and mine tailings pollution control project	Project	Completed		Birding Trails, CWCB instream flow water rights, National Wetlands Inventory
Fountain Creek at Shryver Park Reach	Shryver Park Reach	Project	Completed		Birding Trails, CWCB instream flow water rights, National Wetlands Inventory
Fountain Creek at Soda Springs Park Reach	Soda Springs Park Reach	Project	Completed		Birding Trails, CWCB instream flow water rights, National Wetlands Inventory
Fountain Creek between Colorado Springs and Pueblo City Line	Fountain Creek Dam Improvements	Information	Planned	Arkansas Darter, Arkansas State Wildlife Areas and State Fishing Units, Audubon important bird areas, Birding Trails, Colorado Outstanding Waters, Greenback Cutthroat Trout, National Wetlands Inventory, Pueblo Fishing , Significant Riparian/Wetland Communities, Whitewater Boating	
Fountain Creek between Colorado Springs and Pueblo City Line	Fountain Creek Wetlands Improvement	Project	Planned	Arkansas Darter, Arkansas State Wildlife Areas and State Fishing Units, Audubon important bird areas, Birding Trails, Colorado Outstanding Waters, Greenback Cutthroat Trout, National Wetlands Inventory, Pueblo Fishing , Significant Riparian/Wetland Communities, Whitewater Boating	Arkansas Headwaters Recreation Areas-D, Arkansas State Wildlife Areas and State Fishing Units-D, Birding Trails-D, High Recreation Lakes and Reservoirs -D, High Recreation Rivers -D, Pueblo Fishing-D, Significant Plant Communities-D
Fountain Creek just above confluence with Arkansas in Pueblo	Fountain Creek Fish Egg Dredge Sieve	Information	Planned	Arkansas Darter, Arkansas Headwaters Recreation Areas, Arkansas State Wildlife Areas and State Fishing Units, Arkansas Wilderness Areas, Birding Trails, CWCB instream flow water rights, Gold Metal Trout Lakes, Gold Metal Trout Streams, Pueblo Fishing , Significant Riparian/Wetland Communities, Whitewater Boating	
Four-Mile Creek	Four-Mile Creek / Denver Water Channel Reconstruction #2	Project	Completed		Additional Wilderness Areas and Wilderness Study Areas, Arkansas Headwaters Recreation Areas, Arkansas Wilderness Areas, Boreal Toad, CWCB instream flow water rights, Flatwater Boating, Significant Riparian/Wetland Communities, Whitewater Boating
California Gulch	Upper Arkansas River Watershed Restoration Plan - California Gulch	Project	Planned	Arkansas Darter, Arkansas Headwaters Recreation Areas, Arkansas State Wildlife Areas and State Fishing Units, Arkansas Wilderness Areas, Birding Trails, CWCB instream flow water rights, Gold Metal Trout Lakes, Gold Metal Trout Streams, Pueblo Fishing , Significant Riparian/Wetland Communities, Whitewater Boating	Arkansas Headwaters Recreation Areas-I, Arkansas State Wildlife Areas and State Fishing Units-I, Greenback Cutthroat Trout-I, High Recreation Lakes and Reservoirs -I, Pueblo Fishing-I, Rare Plants-I
0	Acquire additional pond and lake resources for habitat and fisheries	Flow Protection	on-going	Additional Wilderness Areas and Wilderness Study Areas, Arkansas Darter, Arkansas Headwaters Recreation Areas, Arkansas State Wildlife Areas and State Fishing Units, Arkansas Wilderness Areas, Audubon important bird areas, Bald Eagle Sites, Birding Trails, Colorado Outstanding Waters, CWCB instream flow water rights, CWCB natural lake level water rights, Flatwater Boating, Gold Metal Trout Lakes, Gold Metal Trout Streams, Greenback Cutthroat Trout, Least Tern, Lesser Prairie Chicken, National Wetlands Inventory, Piping Plover, Pueblo Fishing , Recreational In-Channel Diversion Structures, Significant Riparian/Wetland Communities, Waterfowl Hunting / Viewing, Whitewater Boating, Wilderness Area Waters	Arkansas Headwaters Recreation Areas-D, Arkansas State Wildlife Areas and State Fishing Units-D, Birding Trails-I, Durango Natural Studies-D, Greenback Cutthroat Trout-D, High Recreation Lakes and Reservoirs -D, High Recreation Rivers -I, Pueblo Fishing-D, Rare Plants-D, Reservoir and Lake Fishing -D
0	Arkansas Minimum Flows agreement	Flow Protection	on-going	Additional Wilderness Areas and Wilderness Study Areas, Arkansas Darter, Arkansas Headwaters Recreation Areas, Arkansas State Wildlife Areas and State Fishing Units, Arkansas Wilderness Areas, Audubon important bird areas, Bald Eagle Sites, Birding Trails, Colorado Outstanding Waters, CWCB instream flow water rights, CWCB natural lake level water rights, Flatwater Boating, Gold Metal Trout Lakes, Gold Metal Trout Streams, Greenback Cutthroat Trout, Least Tern, Lesser Prairie Chicken, National Wetlands Inventory, Piping Plover, Pueblo Fishing , Recreational In-Channel Diversion Structures, Significant Riparian/Wetland Communities, Waterfowl Hunting / Viewing, Whitewater Boating, Wilderness Area Waters	Arkansas Headwaters Recreation Areas-D, Arkansas State Wildlife Areas and State Fishing Units-D, Birding Trails-I, Durango Natural Studies-D, Greenback Cutthroat Trout-D, High Recreation Lakes and Reservoirs -D, High Recreation Rivers -I, Pueblo Fishing-D, Rare Plants-D, Reservoir and Lake Fishing -D
0	Rehabilitate Skaguay Reservoir	Project/Flow Protection	Proposed		Additional Wilderness Areas and Wilderness Study Areas, Arkansas State Wildlife Areas and State Fishing Units, Flatwater Boating, Significant Riparian/Wetland Communities, Wilderness Area Waters
0	Re-operate CDOW storage rights in DeWeese Reservoir	Flow Protection	Proposed		Additional Wilderness Areas and Wilderness Study Areas, Arkansas State Wildlife Areas and State Fishing Units, Arkansas Wilderness Areas, Flatwater Boating, Significant Riparian/Wetland Communities, Waterfowl Hunting / Viewing, Whitewater Boating, Wilderness Area Waters

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Section 4
Arkansas Basin Consumptive Needs Assessment

4.1 Overview of Consumptive Needs Assessment Process

Water in Colorado is managed to meet the needs of Colorado's citizens, agriculture, and environment. Colorado's economy, quality of life, recreational opportunities, and the environment are all dependent on water. The broad diversity of water uses in Colorado is indicative of the many ways in which we are affected by the water that is available to us and our environment, and how we choose to use it. Severe and continuing drought conditions throughout the state in the early 2000s in conjunction with rapid economic growth and concern over interstate compact obligations have brought focus to the constraints on our state's water resources and the challenges associated with meeting multiple objectives and needs.

The objectives of the consumptive needs part of this Arkansas Basin Needs Assessment Report is to:

- Update population projections and extend them to 2050
- Update municipal and industrial (M&I) per capita estimates including passive conservation
- Extend the Statewide Water Supply Initiative (SWSI) 1 consumptive water use projections to 2050 for the M&I sector
- Update the self-supplied industrial (SSI) sector forecast to 2050
- Update the current tally of irrigated acres throughout Colorado and forecast irrigated acres in 2050
- Update current agricultural demands and shortages
- Update the consumptive demand forecast to 2050 for the agricultural sector

The analyses summarized in this section use a water forecast horizon of 2050 for a number of reasons. The Colorado Water Conservation Board (CWCB) determined that the forecast horizon for the water demand projections needed to be extended to the year 2050 to better represent the long-term water needs that the state will face.

The following sections provide an overview of the methods used in determining reconnaissance level consumptive water use projections for 2050, and the results of those analyses. Sections 4.2.1 and 4.2.2 describe the methods and results of projecting M&I demands, including population forecasting, estimation of per capita water use, and the application of passive conservation measures. The methods used to estimate SSI demands, and the results thereof, are presented in Section 4.2.3. Section 4.2.4 summarizes the statewide results of the M&I and SSI demand projections. Section 4.3 summarizes the same for agricultural demands. Detailed descriptions of these methodologies and results are available in Appendices H and I of the SWSI 2010 Report.

4.2 M&I and SSI Consumptive Needs

Standard methods were used for projecting future M&I and SSI water demands in the Arkansas Basin. The objectives were to develop a reconnaissance level water use forecast that employs consistency in data collection and forecast methodology across the state and maximizes available data. The methods utilized in this approach are for the purpose of general statewide and basinwide planning and are not intended to replace demand projections prepared by local entities for project-specific purposes.

The M&I water demands forecast takes on a "driver multiplied by rate of use" approach. This is a commonly accepted forecast methodology that accounts for changes in water demand resulting from changes in the driver. County and statewide population projections are the most accepted predictor of future growth for the state. Therefore, the driver for the M&I water demands forecast is population and the rate of use is gallons per capita per day, or gpcd.

4.2.1 Future Population Projections

Population projections were estimated using the forecasting process and models utilized by the Colorado State Demographer's Office (SDO). Because of the uncertainty in projecting economic conditions and employment levels in 2050, low, medium, and high scenario population projections were developed. A detailed analysis of the population projections is included in Appendix H of the SWSI 2010 Report.

4.2.1.1 2050 Population Projection Methodology

The first step in developing 2050 population projections was to identify a population forecasting methodology that could meet the needs of the 2050 water demand projections. To be suitable, the water demand projections would need to satisfy the following criteria:

- The forecasting methodology must be valid and widely acceptable, both by users of the results and demographic forecasting practitioners.
- The forecasting approach must be transparent and understandable to the extent possible.
- The projections must be replicable.
- In keeping with state-of-the-art practices employed by the SDO, the projections must be economically based and then linked to demographic factors in an integrated manner.
- The projections must be able to produce population forecasts for each county to the year 2050 under high, medium, and low economic development assumptions.

It was determined that the forecasting process and models utilized by the SDO, in conjunction with its consultant, the Center for Business and Economic Forecasting (CBEF), met all of those criteria. Therefore, the SDO forecasting process was adopted for the 2050 effort.

As of 2010, the SDO/CBEF projections are available through the year 2035. It was determined that the forecasting models, equations, and algorithms could be extended or adjusted as needed from 2035 to 2050. To adjust the models from 2035 to 2050, assumptions regarding national and international driving forces behind Colorado's basic economic sectors were developed.

Basic economic sectors include those activities that bring money and economic stimulus into a geographic area. Employment was projected for each of Colorado's basic economic sectors on the basis of the assumptions for the driving forces behind those basic sectors. With projections of basic employment, industry-specific employment multipliers were applied to arrive at total Colorado jobs.

Because of the uncertainty in projecting economic conditions and employment levels in 2050, low, medium, and high employment scenarios were developed for each key employment sector, leading to low, medium, and high population projections. Each of the scenarios reflects unique assumptions for the economy and for each employment sector. These assumptions are detailed in Appendix H of the SWSI 2010 Report. Additionally, populations for counties that lie within two or more basins were allocated to the respective basins based on estimates from known population centers within each basin.

4.2.1.2 2050 Population Projection Results

Between the years 2008 and 2050, the State of Colorado is projected to grow from approximately 5.1 million people to between 8.6 million and 10 million people. Under low economic development assumptions, state population is projected to grow to about 8.6 million people, or by about 71 percent. Under high economic development assumptions, including a 550,000 barrel per day oil shale industry, the state's population is projected to grow to just over 10 million people, or by 98 percent, as compared to Colorado's 2008 population. On average, statewide population projections from 2008 forward indicate an increase of about 1.4 million people every 15 years.

Table 4-1 shows how population growth will vary across the state during the next 40 years. Based on these projections, the Arkansas, Metro, and South Platte Basins will continue to have the largest population in the state. However, the West Slope will continue to grow at a faster rate than the Front Range of Colorado. **Figure 4-1** shows how population growth will vary throughout the Arkansas Basin at the county level. Under medium economic development assumptions, the Arkansas River Basin population is projected to increase by about 78 percent between 2008 and 2050; El Paso County will account for much of the growth and will remain the largest population center in that basin. Household basic jobs, tourism jobs, and regional and national service jobs will be the drivers of growth in the basin by 2050.

Table 4-1 Population Projections by River Basin

Basin	2008	2035	Percent Change 2008 to 2035	Percent Average Annual Growth Rate	2050			Percent Change 2008 to 2050	Percent Average Annual Growth Rate
					Low	Medium	High		
Arkansas	**948,000**	**1,451,000**	**53**	**1.6**	**1,581,000**	**1,688,000**	**1,841,000**	**67-94**	**1.2-1.6**
Colorado	307,000	558,000	82	2.2	661,000	725,000	832,000	115-171	1.8-2.4
Gunnison	105,000	184,000	75	2.1	206,000	220,000	240,000	96-129	1.6-2.0
Metro	2,513,000	3,622,000	44	1.4	4,018,000	4,144,000	4,534,000	60-80	1.1-1.4
North Platte	1,500	1,800	20	0.7	2,000	2,200	2,500	33-67	0.7-1.2
Rio Grande	50,000	68,000	36	1.2	74,000	80,000	87,000	48-74	0.9-1.3
South Platte	977,000	1,622,000	66	1.9	1,808,000	1,902,000	2,065,000	85-111	1.5-1.8
Southwest	105,000	185,000	76	2.1	204,000	224,000	249,000	94-137	1.6-2.1
Yampa-White	45,000	81,000	80	2.2	94,000	117,000	153,000	109-240	1.8-3.0
TOTAL	**5,051,500**	**7,772,800**	**54**	**1.6**	**8,648,000**	**9,102,200**	**10,000,000**	**71-98**	**1.3-1.6**

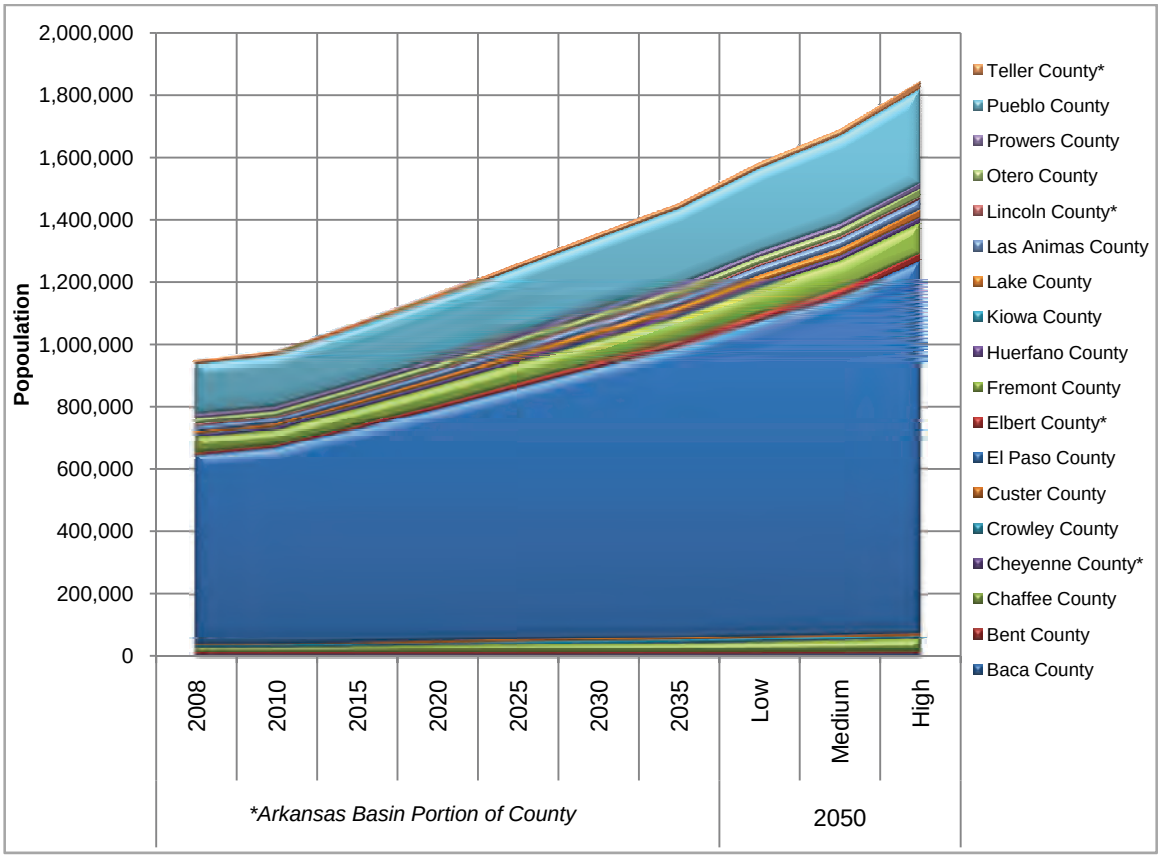

Figure 4-1 Arkansas Basin Population Projections through 2050

4.2.2 Future M&I Water Demands

The M&I demand forecast is aimed at capturing the water needs of an increased population. M&I demands are the water uses typical of municipal systems, including residential, commercial, light industrial, non-agricultural related irrigation, non-revenue water, and firefighting. For the current effort, the M&I demand forecast also captures households across the basin that are self-supplied and thus not connected to a public water supply system. **Table 4-2** contains the definitions of the M&I demand terms used throughout this report.

Table 4-2 Definition of M&I Demand Terms

Demand Terminology	Definition
M&I Demand	All the water uses of typical municipal systems, including residential, commercial, industrial, irrigation, and firefighting
SSI Demand	Large industrial water uses that have their own water supplies or lease raw water from others
M&I Demand and SSI Demand	The sum of M&I and SSI demand

The updated demands presented in this document include both baseline demands (without passive conservation) and baseline demands minus passive conservation. It is important to note that the M&I demand forecasts do not include potential increases in demand due to climate change or potential decreases in demand due to active conservation programs.

4.2.2.1 2050 M&I Water Demands Methodology

The methodology used for the M&I water demands forecast in this update is nearly identical to the methodology employed in SWSI 1. The method is based on a sample of water providers throughout the state as described in this section. The estimated per capita water use rates for each county were multiplied by the projected population of each county to estimate current and future municipal water demand (i.e., the residential, commercial, and industrial water use) of each county.

It is critical to note that the methods utilized in this approach are for the purpose of general basinwide and statewide planning and are not intended to replace demand projections prepared by local entities for project-specific purposes. County and statewide population projections are the most accepted predictor of future growth for the state. Therefore, it was determined the SWSI 1 methodology was most appropriate. The methodology employed is a commonly accepted forecast methodology for statewide water supply planning purposes, but is not appropriate for project-specific purposes or for direct comparisons between basins or counties.

Estimates of Per Capita M&I Water Use

The M&I water demands forecast is developed by multiplying the population projections outlined in Section 4.2.1 by a rate of use. The rate of use is systemwide gpcd. Numerous factors affect per capita water use rates, and through the course of SWSI 1 and the current SWSI 2010, differences in the water use components that are included or excluded from individual entities' per capita estimates clearly affected the resulting values. Per capita water use rates are in large part a function of:

- Number of households
- Persons per household
- Median household income
- Mean maximum temperature
- Total precipitation
- Total employment
- Ratio of irrigated public land areas (e.g., parks) to population in service area
- Mix of residential and commercial water use and types of commercial use
- Level of tourism and/or second homes
- Ratio of employment by sector (e.g., agriculture, commercial, industrial)
- Urban/rural nature of county

Provider water use and service population data were gathered from various sources and organized to create a database. The database built upon existing information from 254 water providers gathered for SWSI 1. Efforts were made to update the data for these providers as part of analyses completed in 2009 and 2010. The CWCB also worked with water providers and basin roundtables across the state through the first part of 2010 to collect additional data. Based on these efforts, updated per capita estimates were collected for 214 water providers covering 87 percent of the population in Colorado. A systemwide gpcd estimate was calculated for each participating local water provider by dividing the total water deliveries by the service area population.

Because 2050 population projects were developed at the county level, the systemwide gpcd values needed to be aggregated from the water provider level to the county level. A weighting process was applied to develop a county average systemwide gpcd based upon the portion of the county population serviced by each water provider. Once the county level M&I demand forecast was developed, basin level M&I water use rates were calculated for the nine basin roundtable areas. Basin M&I demands were aggregated from the county demands based on the portion of the county within the basin. For four counties (Cheyenne, Lake,

Saguache, and San Juan), no provider-level data were obtained. For these counties, the weighted basin average was assigned.

The population estimates developed for this update and the gpcd values determined through data collection are multiplied to estimate county demands. The population estimates represent permanent populations of each county; thus the water use rates are based on total water use divided by the permanent population. The resulting gpcd water use rates incorporate water used by tourists, students, and other transient populations in that the water used by the transient population is indexed to the permanent population along with the water use of the permanent population. The resulting gpcd also incorporates commercial and light industrial water use supplied by the water provider. For statewide planning purposes, this is a consistent approach to account for water use by transient populations, commercial, and light industry. Comparisons of gpcds between counties and basins should not be made directly, since differences in the amount of industry, tourism, and outdoor water use varies significantly between geographic regions.

Passive Water Conservation Savings

The methodology for the M&I water demands projections outlined above develops baseline water demand estimates. In addition, CWCB has updated the passive conservation analysis, and these water savings are subtracted from the baseline estimates. This section provides an overview of passive water conservation savings, which chiefly relate to the water demand reductions associated with the impacts of state and federal policy measures and do not include active conservation measures and programs sponsored by water providers. A detailed description of this analysis is provided in the *SWSI Conservation Levels Analysis* report.

Several pieces of key federal and state legislation were considered in the development of the passive conservation savings estimates, including the 1992 National Energy Policy Act, the 2002 California Energy Commission Water Efficiency Standards, and the 2007 California Assembly Bill 715.

For this analysis, passive water savings were calculated to occur as a result of retrofitting housing stock and businesses that exist prior to 2016 through the replacement of washing machines, toilets, and dishwashers. Future water demand reductions associated with passive savings were calculated for each year beginning in 1996, which was when benchmark toilet flushing volume data from Denver was available. The calculations used to estimate future demand reductions from passive conservation were developed for minimum and maximum scenarios based on the assumptions related to the retrofit of existing housing and commercial construction with high-efficiency toilets, clothes washers, and dishwashers.

The calculations based on these assumptions were used to estimate a range of future passive water savings in each county for each year starting in 2000 and continuing until 2050. The total range of savings expected from passive conservation through 2050 is 19 to 33 gpcd. The upper range of these savings were applied to the county level baseline estimates described above to assess what the 2050 demands would be on a low, medium, and high basis with passive conservation. As stated in the *SWSI Conservation Levels Analysis* report there are three major reasons for applying the high passive conservation savings:

1. Water and energy savings will become increasingly important to water customers as water and fuel costs rise. As water customers seek more efficiency in their homes and businesses, high efficiency fixtures and appliances will become increasingly efficient as technology improves and customers strive to reduce their variable costs related to water and energy.

2. The potential exists to realize substantial permanent water demand reductions in the future if appropriate regulations and ordinances are developed to address water use in existing and new construction.

3. The impact of commercial retrofits (e.g., restaurants, motels, ski area condominiums, centralized laundries, commercial laundries, bars, etc.), is not well captured in the passive savings analyses since information regarding numbers of and ages of individual types of commercial properties were not available.

4.2.2.2 2050 M&I Water Demands Results

Colorado's population is projected to nearly double by the year 2050. Because the major driver for water use is population growth, M&I water usage is also expected to nearly double, even with savings from passive conservation. Statewide municipal water demands are estimated to increase from 975,000 acre-feet per year (AFY) to 1.36 million AFY by 2035 requiring an additional 383,000 AFY of water to meet Colorado's municipal water needs in 2035.

Based on the population projections discussed in Section 4.2.1, total statewide 2050 M&I water demands with passive conservation could range from 1.5 to 1.8 million AFY. By 2050, Colorado will need between 538,000 and 812,000 AFY of additional water to meet M&I demands. Passive conservation savings will result in approximately 154,000 AFY reduction statewide or just over 8 percent decrease in M&I water demands by 2050 for the medium demand scenario.

Table 4-3 and **Figure 4-2** illustrates the M&I water demand projections with passive conservation savings for each of the counties in the Arkansas Basin.

Table 4-3 M&I Forecast by River Basin

County	Water Demand (AF)	Baseline Water Demands (AFY)				Water Demands with Passive Conservation (AFY)			
	2008	2035	2050 Low	2050 Medium	2050 High	2035	2050 Low	2050 Medium	2050 High
Baca County	1,600	1,600	1,700	1,800	1,900	1,500	1,600	1,700	1,800
Bent County	800	880	950	980	1,000	720	780	810	850
Chaffee County	5,900	9,700	11,000	12,000	13,000	9,200	10,000	11,000	13,000
Cheyenne County-Arkansas Basin Portion	86	100	110	120	130	89	94	110	120
Crowley County	1,000	1,400	1,600	1,600	1,700	1,200	1,400	1,400	1,500
Custer County	1,100	2,200	2,400	2,600	2,700	2,100	2,300	2,400	2,600
El Paso County	120,000	180,000	190,000	210,000	230,000	160,000	180,000	190,000	210,000
Elbert County-Arkansas Basin Portion	2,500	7,100	7,800	8,000	8,300	6,900	7,500	7,700	8,100
Freemont County	12,000	18,000	21,000	23,000	24,000	17,000	20,000	21,000	23,000
Huerfano County	1,400	2,100	2,400	2,600	2,800	1,900	2,200	2,400	2,500
Kiowa County	550	630	670	710	760	590	620	660	720
Lake County	1,800	4,200	4,500	4,700	4,900	3,800	4,200	4,300	4,500
Las Animas County	4,200	6,300	7,000	7,500	8,200	5,900	6,500	7,000	7,700
Lincoln County-Arkansas Basin Portion	480	600	670	730	800	560	630	690	750
Otero County	4,000	4,500	4,800	5,100	5,400	4,000	4,300	4,500	4,800
Prowers County	3,600	4,000	4,200	4,400	4,700	3,700	3,900	4,100	4,400
Pueblo County	37,000	56,000	62,000	65,000	70,000	52,000	57,000	60,000	65,000
Teller County-Arkansas Basin Portion	1,000	1,600	1,700	1,900	2,000	1,400	1,500	1,700	1,900
Total	**200,000**	**300,000**	**320,000**	**350,000**	**380,000**	**270,000**	**300,000**	**320,000**	**350,000**

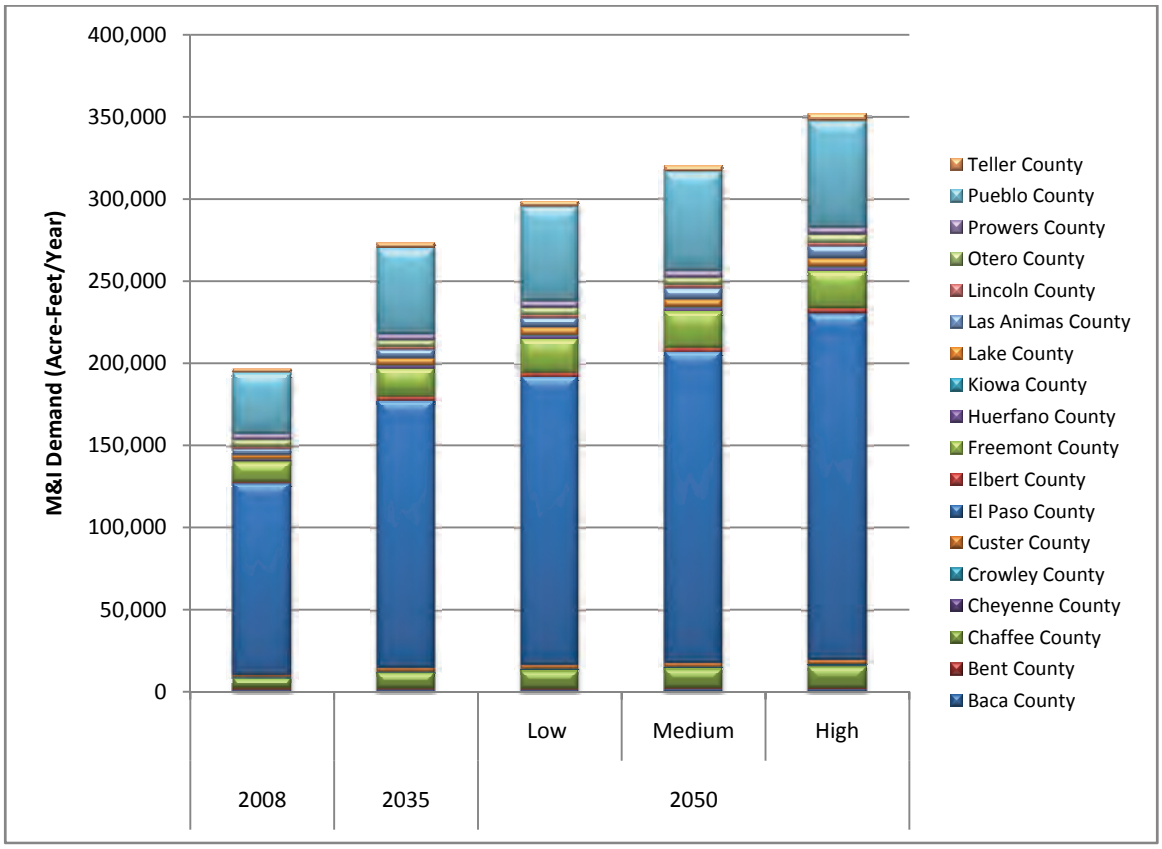

Figure 4-2 Arkansas Basin M&I Water Demands

4.2.3 SSI Water Demands

Standard methods were adapted for use in SWSI 1 for estimating future SSI water demands throughout Colorado. SSI water demands include water use by self-supplied and municipal provided large industries. The subsectors that are included in SSI are:

- Large industries, including mining, manufacturing, brewing, and food processing
- Water needed for snowmaking
- Thermoelectric power generation at coal- and natural gas-fired facilities
- Energy development, including the extraction and production of natural gas, coal, uranium, and oil shale

These industries represent economic growth within the state and the availability of water resources is imperative to their growth. Because of the diversity of the SSI subsectors, this section is organized to summarize each subsector separately, including data collection efforts and results. Detailed discussions of data sources, methodologies, and results are provided in Appendix H of the SWSI 2010 Report.

4.2.3.1 Large Industry

The goal of this subsector is to identify large self-supplied industries in Colorado with significant consumptive water demands. These include Colorado Steel Company in Pueblo County. The sources of information used to develop the SSI estimates for large industry are detailed in Appendix H of the SWSI 2010 Report. Results of the large industry subsector water demands forecast are provided in **Table 4-4**. No low, medium, and high growth scenarios are considered for this subsector.

Table 4-4 Large Industry Demands (AFY)

County	2008	2035/2050
Pueblo	49,400	49,400

4.2.3.2 Thermoelectric Power Generation

Water use at coal-fired and natural gas power facilities is included in the SSI water demands estimates. In 2006, nearly 95 percent of Colorado's electricity was produced from coal (71 percent) and natural gas (23 percent). Although Colorado's General Assembly has adopted a state renewable electricity standard that requires 20 percent of the state's electric portfolio to be from renewable resources of energy by 2020, demand for coal-fired and natural gas energy production will remain significant into the future. Generation facilities using fossil fuels require cooling systems to condense steam turbine exhaust. Cooling water is the most economical method to condense steam.

For SWSI 1, estimates of current and future water use at various power generation facilities in Colorado were obtained from power producers. For this update, SWSI 1 baseline estimates were assumed to stay constant until 2035. To extend 2035 projections to 2050 for Pueblo County percent increases were assumed for the low, medium, and high scenarios, respectively, as follows—5 percent, 25 percent, and 50 percent. These percentages were based on expected population increases throughout the state. **Table 4-5** provides the estimates of thermoelectric water demands with 2050 low, medium, and high scenarios.

Table 4-5 Estimated Thermoelectric Power Generation Water Demands (AFY)

			2050		
County	2008	2035	Low	Med	High
Pueblo	9,000	14,700	15,400	18,400	22,100

4.2.3.3 Arkansas Basin SSI Summary

The Arkansas Basin SSI summary is summarized in **Figure 4-3**.

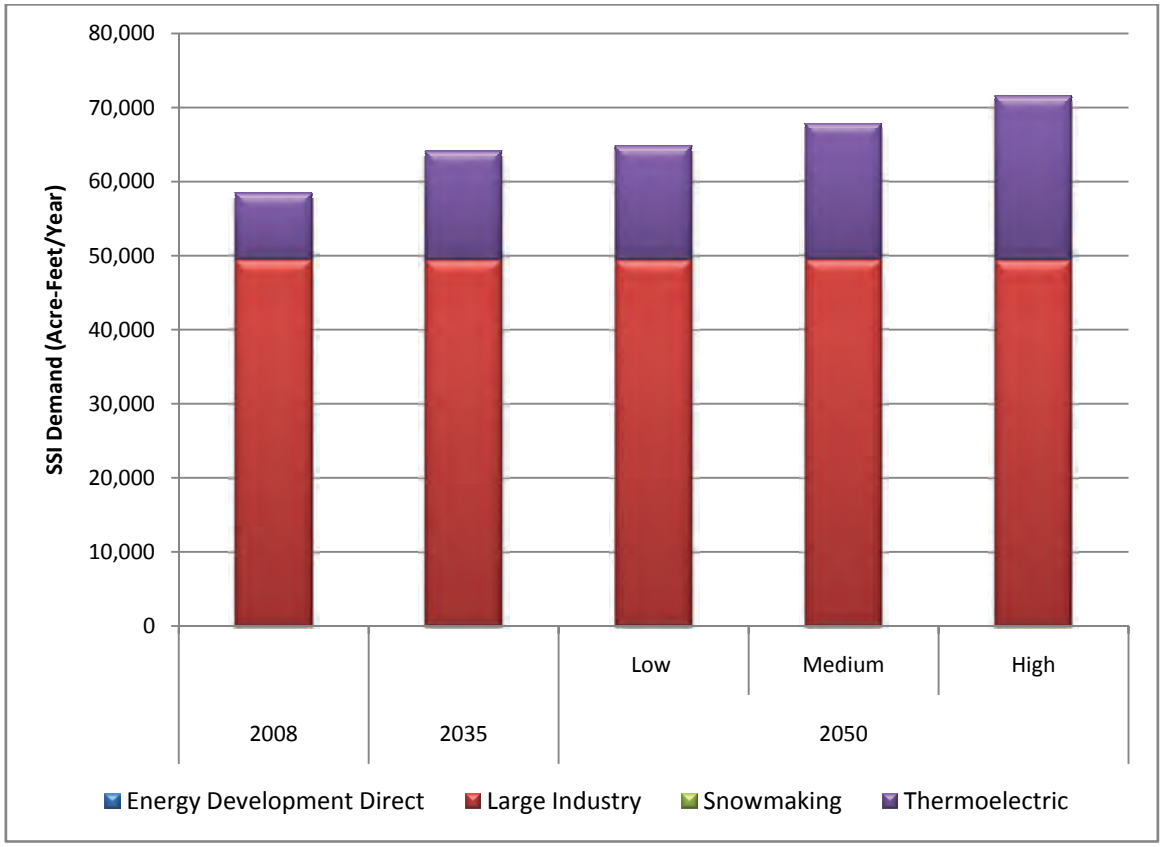

Figure 4-3 Arkansas Basin SSI Water Demands

4.2.4 Statewide 2050 M&I and SSI Consumptive Needs Summary

Of the many factors affecting M&I water use, the projected increases in population clearly drive the increases in M&I use from 2000 to 2050. **Table 4-6** and **Figure 4-4** summarize the Arkansas Basin's M&I and SSI water use for 2008 and projections including reductions as a result of passive conservation measures for 2035 and the 2050 low, medium, and high scenarios. Total statewide 2035 water demands are projected to be nearly 1.6 million AFY. 2050 water demands are projected to range from approximately 1.75 million AFY to nearly 2.1 million AFY. Figure 4-4 also shows that M&I water demands are estimated to exceed SSI demands for all of the future projections.

Table 4-6 Summary of M&I and SSI Demands for Arkansas Basin (AFY)

Basin	Demand Type[1,2]	2008	2035	2050 Low	2050 Med	2050 High
Arkansas	M&I	196,000	273,000	298,000	320,000	352,000
	SSI	58,400	64,100	64,800	67,800	71,500
	Total	254,400	337,100	362,800	387,800	423,500
Statewide	M&I	974,500	1,357,600	1,512,700	1,607,700	1,786,800
	SSI	187,760	235,990	235,890	261,490	322,090
	Total	1,162,260	1,593,590	1,748,590	1,869,190	2,108,890

[1] M&I demands for 2035 and 2050 include passive conservation savings.
[2] SSI demands include energy development, large industry, snowmaking, and thermoelectric.

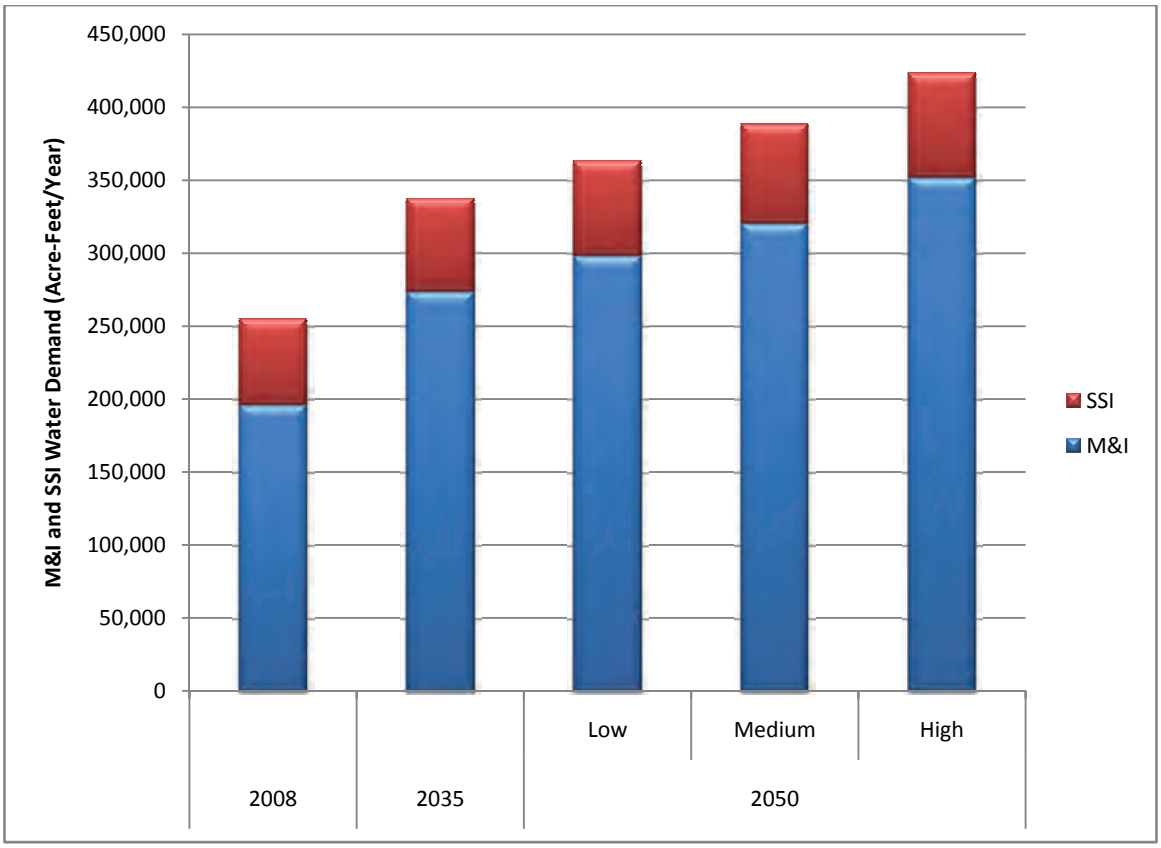

Figure 4-4. Arkansas Basin M&I and SSI Water Demands

4.3 Agricultural Consumptive Needs

This section provides information about the methodologies utilized to develop a current tally of irrigated acres and summarizes how 2050 irrigated acres were estimated. In addition, this section provides an overview of existing and 2050 agricultural demands.

4.3.1 Agricultural Demand Methodology

This section describes the methods used to estimate the water needed to support Colorado's agriculture, both currently and in 2050. The estimates include consumptive use (CU) water only—rather than the generally larger volumes of water pumped or diverted—both for the irrigation of crops and for livestock production. CU includes the amount of diverted water that is used by plants through evapotranspiration processes, as well as water that is "lost" to soil evaporation or deep percolation into the groundwater aquifer. A portion of the total diverted amount returns to the stream through surface runoff or lagged groundwater return flows and therefore is not consumptively used.

Colorado's water needs for irrigation are characterized in this analysis by the Irrigation Water Requirement (IWR), Water Supply Limited Consumptive Use (WSL CU), and the difference between these two numbers. CU modeling was executed using a recent decade of climate and water supply information. The objective was not to simulate what occurred over the past 10 years, but to estimate IWR and WSL CU for today's agricultural conditions and a plausible sample of climate and hydrology, exemplified by the recent decade. Future irrigation demand was examined by assuming that historical climate conditions will

continue. The analysis assumed that agricultural demand is directly and linearly related to the number of acres irrigated.

In addition to the crop consumption described above, Colorado's agricultural demand includes three other types of CU that are associated with agricultural activity:

- Livestock CU
- Stockpond evaporation
- Losses incidental to delivering irrigation water

In the Arkansas Basin, where a Colorado Decision Support System (CDSS) program does not exist, CDSS procedures were generally applied if data were available to support the method. The following subsections provide an overview of the methodologies used to estimate current and future irrigated acres and agricultural water demands and the results. A detailed description of these methodologies and results is in Appendix I of the SWSI 2010 Report.

4.3.1.1 Current Irrigated Acres Methodology

The CDSS program has produced irrigated lands mapping and crop CU models in the Arkansas Basin. The maps are available as spatial databases, and include crop types, irrigation practices, and association with diversion structures or wells. The structure identifier associated with the irrigated land indicates the location of the headgate that serves the land. Irrigated acres are assigned to the water district where the diversion is located, which may not be where the irrigated acreage lies. Dates of the irrigated lands information varied with the basins including the number of years information was collected.

CDSS has not been implemented in the Arkansas Basin so information had to be gathered from other sources or developed within this project. Groundwater irrigated acreage for the Republican River Basin was obtained from the Republican River Compact Administration accounting spreadsheets for 2007. Precise information on surface water irrigated lands in the Republican River Basin is not available, but according to the State Engineer's Office, the total amount is believed to be no more than 1,000 acres.

The Arkansas Basin can be divided into three areas, in terms of the irrigated acreage data available:

- The Lower Arkansas Basin, the area covered by the Hydrologic Institutional (HI) model that Colorado must use for compact accounting, pursuant to settlement of the *Kansas v. Colorado* litigation, comprising irrigated lands under Arkansas River canals from Pueblo Reservoir to the state line
- The Purgatoire River Water Conservancy District (PRWCD) in Water District 19
- All other irrigated land in the basin, including the Upper Arkansas Basin, tributaries above Pueblo Reservoir, and the Southern High Plains Designated Basin

For the Lower Arkansas region, irrigated acreage based on 2008 data was obtained from the Irrigation Systems Analysis Model (ISAM), developed by Division 2 as a refinement of the HI Model to the individual farm level. Five small ditches within the HI Model domain were excluded from the acreage data in ISAM, so acreage for those structures was taken from 2003 imagery associated with the HI Model.

Division 2 recently completed an irrigated lands assessment of the PRWCD, a geographic information system (GIS) product based on 2008 imagery, which provided the necessary acreage data for this area of the Arkansas Basin. For the remainder of the Arkansas Basin, multiple scenes spanning the 2009 growing season were obtained from the Landsat 5 Thematic Mapper archive and analyzed. A vegetative index map

was derived, indicating areas of vigorous plant growth, and additional analyses were performed to distinguish irrigated farmland from non-agricultural lands such as riparian areas and irrigated urban parks.

4.3.1.2 2050 Irrigated Acres Methodology

Using the most current irrigated acres for each basin as defined in the previous section as a baseline, estimates of 2050 irrigated acres were based on the following factors:

- Urbanization of existing irrigated lands
- Agricultural to municipal water transfers
- 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

The first three factors (urbanization of existing irrigated lands, agricultural to municipal water transfers, and water management decisions) were quantified based on future growth estimates, municipal water demand gaps that will be met by 2050, and interviews with water management agencies across the state. The remaining factors were qualitatively addressed based on information provided by the CWCB and the Colorado Department of Agriculture.

The urbanization of existing irrigated lands was established using 2050 population projections, estimation of future urban area size, and the current irrigated acres as described in the previous section. As discussed above, current irrigated acres in each administrative water district were determined from GIS data sources. However, certain types of data (e.g., future population forecasts) were only available on a county basis. Therefore, future losses of irrigated acres were calculated first for each county, and then re-distributed by water district. The methodology is described in detail in Appendix I of the SWSI 2010 Report.

The M&I gap analysis (described in Section 5) was used as the basis for the analysis of irrigated acreage changes associated with agricultural to municipal water transfers. For each of Colorado's major river basins the amount of the M&I gap was summarized in AFY on a low, medium, and high basis. For the purposes of predicting future irrigated acres it was assumed that 70 percent of M&I gap would be met from agricultural to municipal transfers. This percentage is a conservative estimate based on the assumption of 100 percent yield success rate for IPPs (see Section 5). Therefore, it does not take into account the projects or methods that may not be successful in meeting Colorado's future M&I demands; if IPPs are unsuccessful, it is likely that M&I water providers will turn to increased agricultural transfers to meet future demands. The following equation was used to estimate irrigated acres that would be needed for agricultural to municipal transfers to address M&I gaps:

Irrigated Acres Transferred = M&I Gap ÷ Transferrable Consumptive Use x (1 – Safety Factor)

A safety factor of 25 percent was applied to account for the additional amount of irrigated acres that may be needed to provide the transferred water on a firm yield basis.

For the remaining factors (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), CWCB identified trends that are expected to occur within each area

over the next 40 years and then developed a qualitative assessment on whether each factor would cause a negative or positive impact on irrigated agriculture by 2050. A detailed description of this qualitative assessment is available in Appendix I of the SWSI 2010 Report.

4.3.1.3 Current Agricultural Demand Methodology

Current irrigation demand for water in Colorado can be defined as the average amount of water consumptively used by crops on land currently under irrigation. Typically, water supply is plentiful early in the irrigation year, crop CU is not limited and is equal to the crop IWR. As the irrigation season continues, the available water supply generally decreases, becoming less than the crops' uptake capacity, and CU is limited by supply. In order to quantify crop CU, one must have credible estimates or measurements of the crops' average capacity to use irrigation water, referred to as IWR, as well as the average water supply. The minima of these two values over a series of time increments (typically months) is the WSL CU.

For this analysis, both average IWR and average WSL CU are reported. The latter may be considered to be the current agricultural demand; that is, the water required to sustain current levels of farming. IWR provides perspective on the amount of water that would be used, if it was physically and legally available. It is an upper limit on consumption by current agriculture, and a reminder that Colorado is a dry state with over-appropriated streams.

IWR estimation requires time series of climate information, particularly precipitation and temperature, over the study period; WSL CU estimation requires information about the time-varying water supply available to the crop. For this analysis, a recent 10-year study period was used in each basin, although the exact decade differed from basin to basin depending on available data. The 10-year period allowed for estimation of average conditions with respect to both climate and hydrology. IWR and WSL CU were calculated assuming that the most current estimate of number of irrigated acres, and most recent information on crop types, prevailed during each year of the study period. The results show demand for "today's" agricultural conditions in Colorado, based on a 10-year sample of climate and hydrology.

Where applicable, CDSS methodologies were applied to estimate non-irrigation agricultural consumptive demands (e.g., livestock and stockpond evaporation) as well. Livestock CU is estimated by multiplying the number of cattle, sheep, and hogs located within a basin by their corresponding per capita use. Stockpond evaporation is based on net evaporation rates and stock pond surface area estimates. Details differ among the basins, but in general, the method estimates net reservoir evaporation by subtracting average monthly effective precipitation from the estimated gross monthly free water surface evaporation.

Lastly, incidental losses may include, but are not limited to, vegetative CU that occurs along canals and in tailwater areas. The CDSS program, in preparing Consumptive Uses and Losses (CU&L) Reports for the state, has adopted 10 percent as the factor for computing incidental losses associated with irrigation CU. The value is in the middle of the range of factors (5 percent to 29 percent) used by the U.S. Bureau of Reclamation in their parallel CU&L accounting throughout the upper basin states.

4.3.1.4 2050 Agricultural Demand Methodology

Following the techniques described in Section 4.3.1.2, changes in numbers of acres irrigated have been developed for each water district. Since this study intentionally avoids identifying specific water rights or ditches for change of use, there is no basis for calculating the structure-specific CU by which a water district's irrigation demand will change. CU per irrigated acre varies from structure to structure, and depends on available supply, seniority of a water right, and system efficiency. The variability of these factors makes it impossible to predict future losses of irrigated land on a structure-by-structure basis.

Consequently, simplifying assumptions were made such that irrigation demand was considered directly proportional to number of acres irrigated. To derive future irrigation demand, current irrigation demand for each water district was scaled by the ratio of future irrigated acreage to current irrigated acreage.

Similarly, non-irrigation demand was estimated as being in proportion to irrigated acres. The relationship between losses incidental to irrigation and number of acres irrigated is proportional. With respect to stockponds and stock watering, it is assumed that predicted changes in irrigated acreage will be accompanied by similar changes in stock raising activities. To derive future non-irrigation demand, current non-irrigation demand was scaled by the ratio of future irrigated acreage to current irrigated acreage.

4.3.2 Agricultural Demand Results

The following sections describe the results of the current and future agricultural demand analyses, which were performed based on the methodologies described above. These analyses included assessments of both irrigated acreage and associated agricultural consumptive water demands. Maps are included to identify the locations of existing irrigated lands across the state, as well as to show the range of irrigated acreage losses anticipated in each basin by 2050.

4.3.2.1 Current Irrigated Acres Results

Information developed for this effort was generated at the water district level. **Figure 4-5** shows the locations of Colorado's water districts and the spatial distribution of current irrigated acres in Colorado based on the methods presented previously. Note that spatial information was not available for the irrigated lands in the Republican River water districts.

Table 4-7 presents the number of irrigated acres in each river basin and the percentage of total that each basin represents. Colorado currently has 3,466,000 acres of irrigated farmland across the state. The South Platte River Basin has the highest percentage of irrigated acres followed by the Rio Grande Basin and the Republican River Basin.

Table 4-7 Current Irrigated Acres by River Basin

Basin	Irrigated Acres	Percentage of Colorado's Irrigated Acres
Arkansas	**428,000**	**12%**
Colorado	268,000	8%
Gunnison	272,000	8%
North Platte	117,000	3%
Republican	550,000	16%
Rio Grande	622,000	18%
South Platte	831,000	24%
Southwest	259,000	7%
Yampa-White	119,000	3%
Statewide Total	**3,466,000**	**100%**

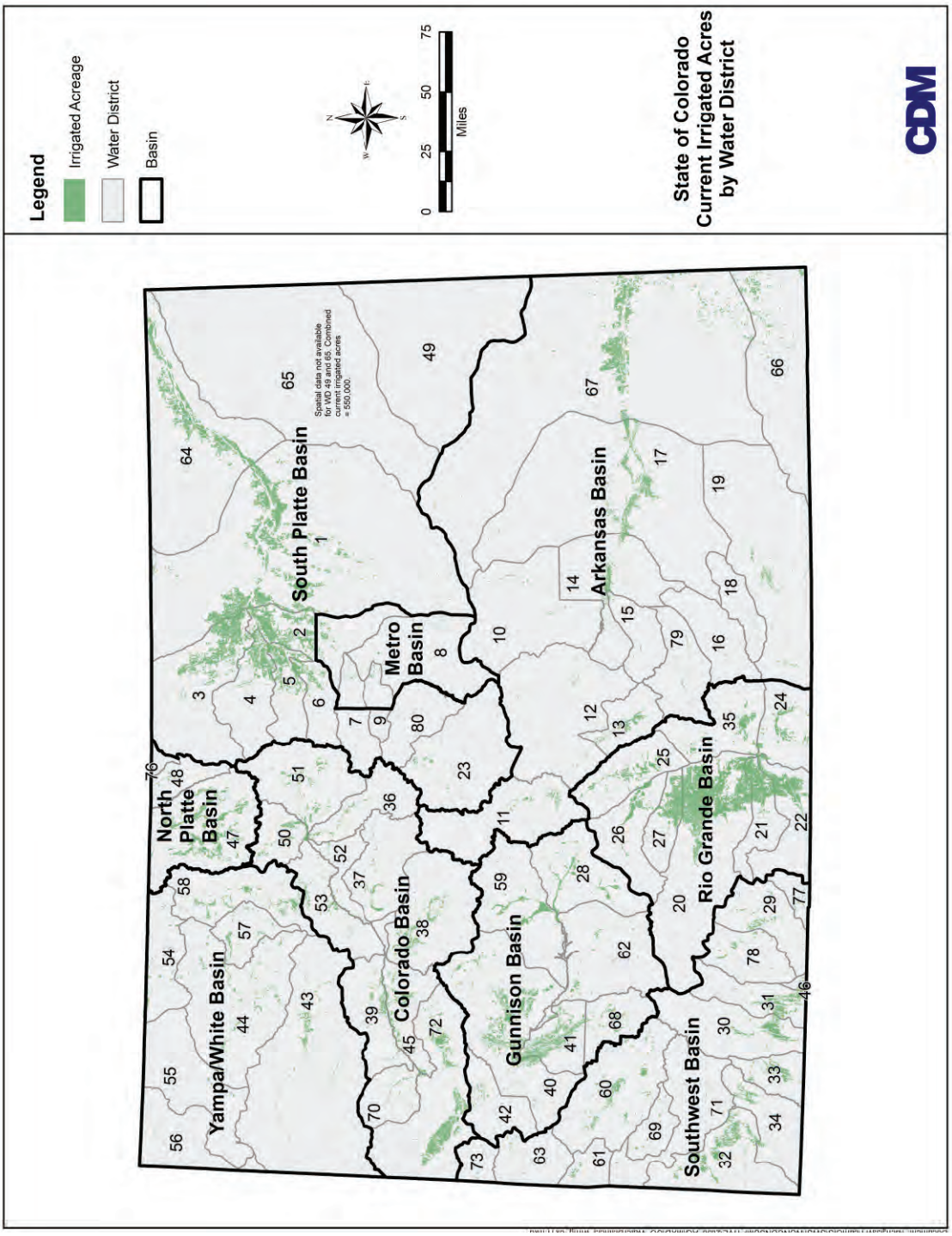

Figure 4-5 State of Colorado Current Irrigated Acres by Water District

4.3.2.2 Future Irrigated Acres Results

Table 4-8 shows the results of future irrigated acres analysis. Future irrigated acres in Colorado may decrease by 115,000 to 155,000 acres due to urbanization alone, under low and high population growth scenarios, respectively. The basins with largest expected loss of irrigated acres due to urbanization are the South Platte, Colorado, and Gunnison Basins.

Finally, Table 4-8 identifies approximately 26,000 acres that will be dried-up in the Arkansas, Colorado, and South Platte River Basins as a result of planned agricultural to municipal transfers. Additional transfers that may be required to meet M&I gaps are expected to decrease irrigated acreage from 160,000 acres to 334,000 acres statewide.

Overall, the future irrigation analysis shows that Colorado may lose about 500,000 to 700,000 acres of its irrigated lands by 2050 due to all factors combined. These acreages represent 15 to 20 percent of the current total irrigated lands. **Figure 4-6** shows the range of potential changes by basin. **Figure 4-7** shows the comparison between current irrigated acres and 2050 irrigated acres as both numbers of acres and percent change. Note that the basin with the highest percent change (Yampa-White, 34,000 acres, 29 percent) is not the same as the basin with the highest change in total acres (South Platte, 224,000 acres, 27 percent).

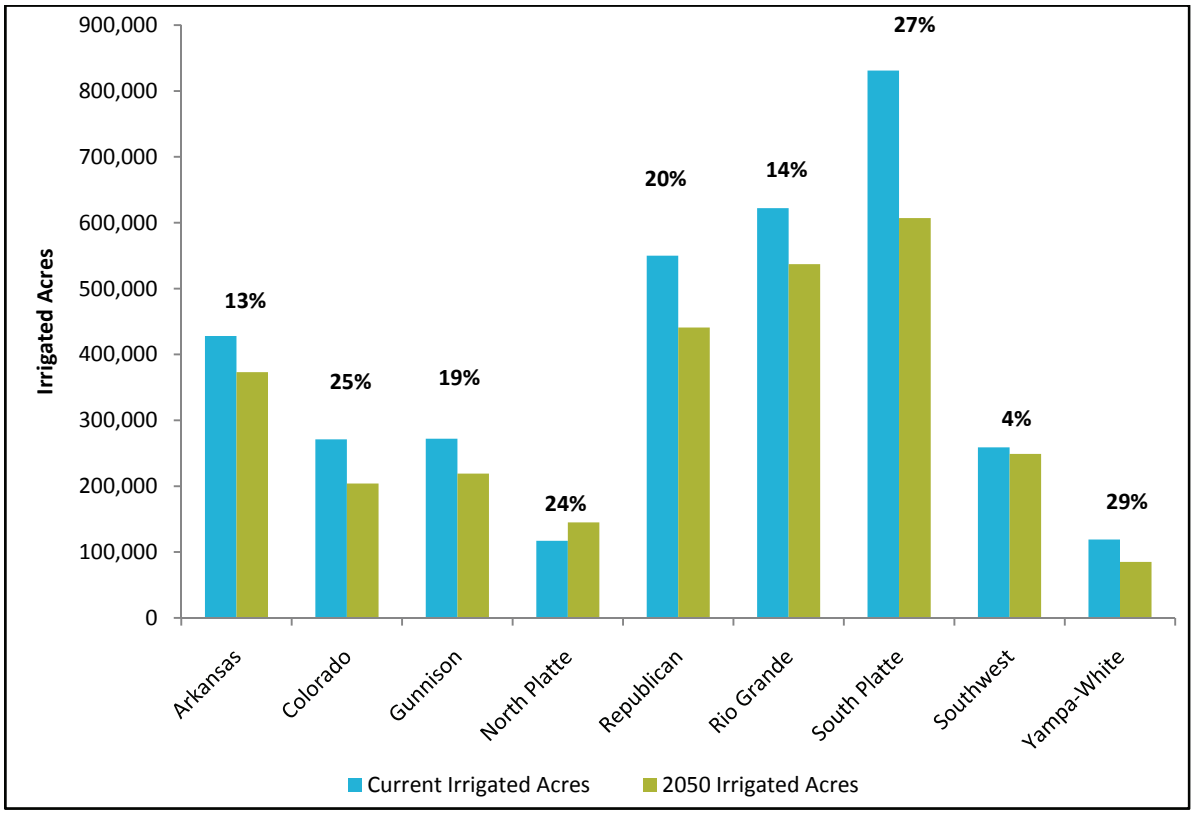

Figure 4-7 Comparison of Current and 2050 Irrigated Acres

Table4-8 Future Irrigated Acres by River Basin

Basin	Current Irrigated Acres	Decrease in Irrigated Acres Due to Urbanization		Decreases in Irrigated Acres Due to Other Reasons	Decreases in Irrigated Acres from Planned Agricultural to Municipal Transfers	Decreases in Irrigated Acres from Agricultural to Municipal Transfers to Address M&I Gap		Estimated 2050 Irrigated Acres	
		Low	High			Low	High	Low	High
Arkansas	**428,000**	**2,000**	**3,000**	**—**	**7,000**	**26,000**	**63,000**	**355,000**	**393,000**
Colorado	268,000	40,000	58,000	—	200	11,000	19,000	190,800	216,800
Gunnison	272,000	20,000	26,000	—	—	1,000	2,000	244,000	251,000
North Platte	117,000	—	—	—	—	—	—	117,000	117,000
Republican	550,000	300	600	109,000	—	—	—	440,400	440,700
Rio Grande	622,000	800	1,000	80,000	—	2,000	3,000	538,000	539,200
South Platte	831,000	47,000	58,000	14,000	19,000	100,000	176,000	564,000	651,000
Southwest	259,000	4,000	6,000	—	—	3,000	7,000	246,000	252,000
Yampa-White	119,000	1,000	2,000	—	—	3,000	64,000	53,000	115,000
Statewide Total	**3,466,000**	**115,100**	**154,600**	**203,000**	**26,200**	**146,000**	**334,000**	**2,748,200**	**2,975,700**

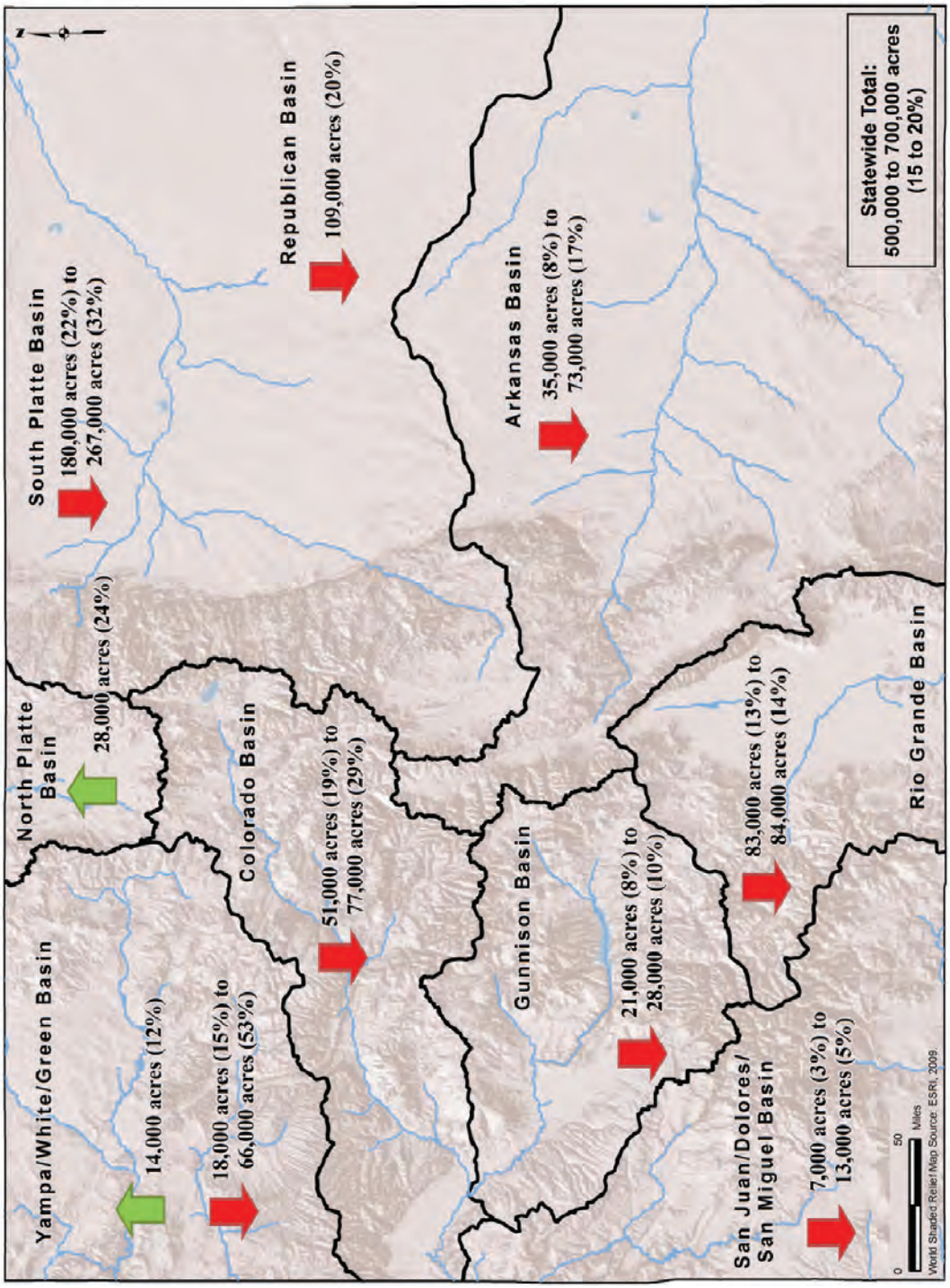

Figure 4-6 Potential Changes in Irrigated Acres by 2050

4.3.2.3 Current Agricultural Demand Results

Table 4-9 summarizes results of the average annual current agricultural demand by basin. It shows irrigated acres, IWR, WSL CU, and shortage (difference between IWR and WSL CU). Non-irrigation demand is also shown by basin. **Figures 4-8** and **4-9** show the current WSL CU and shortage amounts by basin. Basins with the highest agricultural water demand include the South Platte, Rio Grande, and Republican.

Table 4-9 Estimated Current Agricultural Demand by Basin

Basin	Irrigated Acres	Irrigation Water Requirement (AFY)	Water Supply-Limited Consumptive Use (AFY)	Shortage (AFY)	Non-Irrigation Demand (AFY)
Arkansas	**428,000**	**995,000**	**542,000**	**453,000**	**56,000**
Colorado	268,000	584,000	485,000	100,000	51,000
Gunnison	272,000	633,000	505,000	128,000	54,000
North Platte	117,000	202,000	113,000	89,000	12,000
Republican	550,000	802,000	602,000	200,000	67,000
Rio Grande	622,000	1,283,000	855,000	428,000	45,000
South Platte	831,000	1,496,000	1,117,000	379,000	115,000
Southwest	259,000	580,000	382,000	198,000	46,000
Yampa-White	119,000	235,000	181,000	54,000	24,000
Statewide Total	**3,466,000**	**6,819,000**	**4,791,000**	**2,028,000**	**470,000**

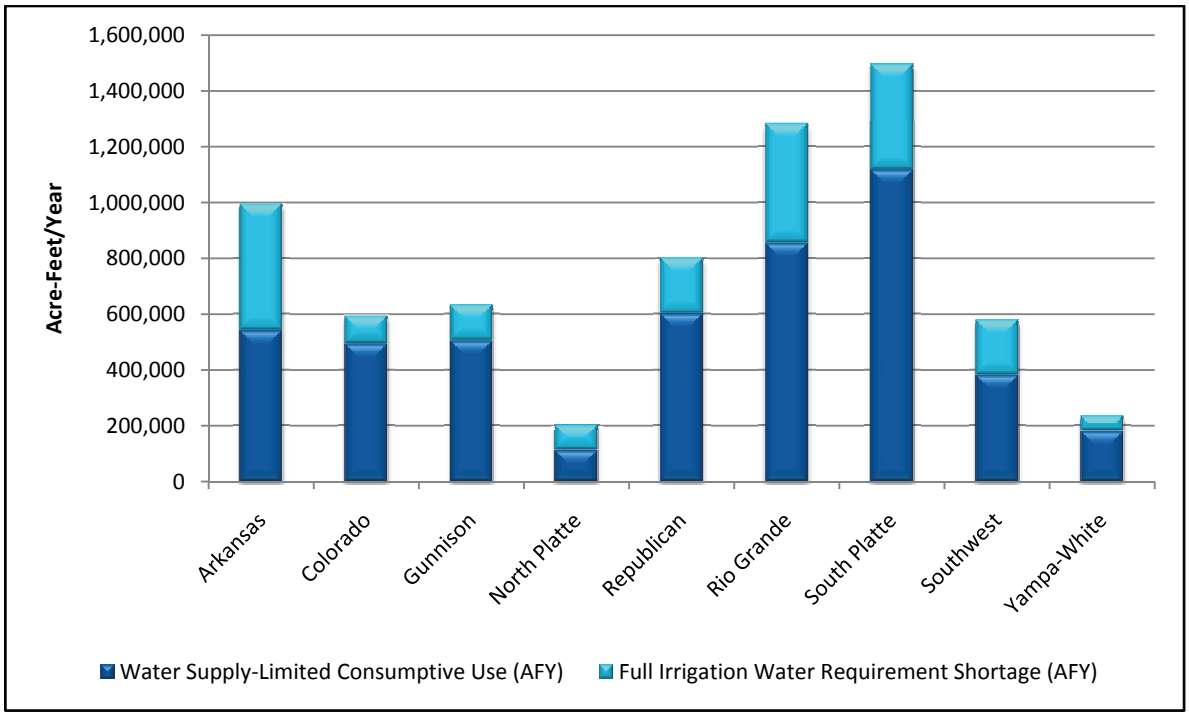

Figure 4-9 Current Agricultural Demands and Shortages

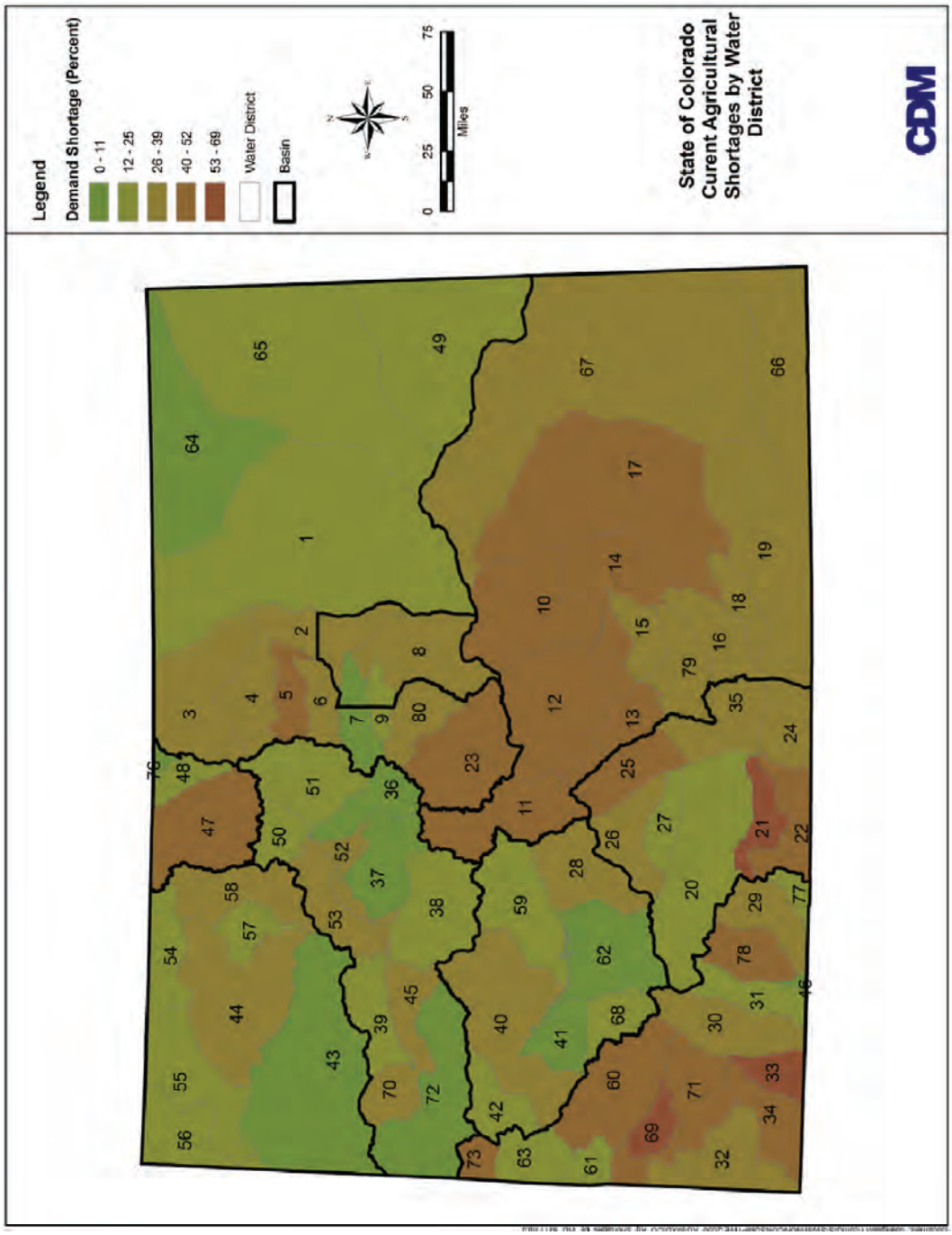

Figure 4-8 State of Colorado Current Agricultural Shortages by Water District

4.3.2.4 Future Agricultural Demand Results

Table 4-10 summarizes the estimated average annual agricultural demand by basin for the year 2050, assuming that historical climate and hydrology continue into the future. It shows irrigated acres, IWR, WSL CU, shortage, and non-irrigation demand. **Figure 4-10** shows the WSL CU and shortages by basin for the 2050 irrigated acres. Consistent with the projected decline in irrigated acres, declines in both irrigation and non-irrigation agricultural water demands are anticipated to occur in all basins except for the North Platte.

Table 4-10 Estimated 2050 Agricultural Demand by Basin

Basin	Irrigated Acres	Irrigation Water Requirement (AFY)	Water Supply-Limited Consumptive Use (AFY)	Shortage (AFY)	Non-Irrigation Demand (AFY)
Arkansas	**373,000**	**862,000**	**476,000**	**386,000**	**49,000**
Colorado	204,000	443,000	366,000	77,000	38,000
Gunnison	219,000	573,000	457,000	116,000	48,000
North Platte	145,000	250,000	140,000	110,000	14,000
Republican	441,000	640,000	480,000	160,000	5,000
Rio Grande	537,000	1,108,000	739,000	369,000	38,000
South Platte	607,000	1,094,000	820,000	274,000	84,000
Southwest	249,000	558,000	367,000	191,000	44,000
Yampa-White	85,000	209,000	170,000	39,000	17,000
Statewide Total	**2,860,000**	**5,737,000**	**4,015,000**	**1,722,000**	**337,000**

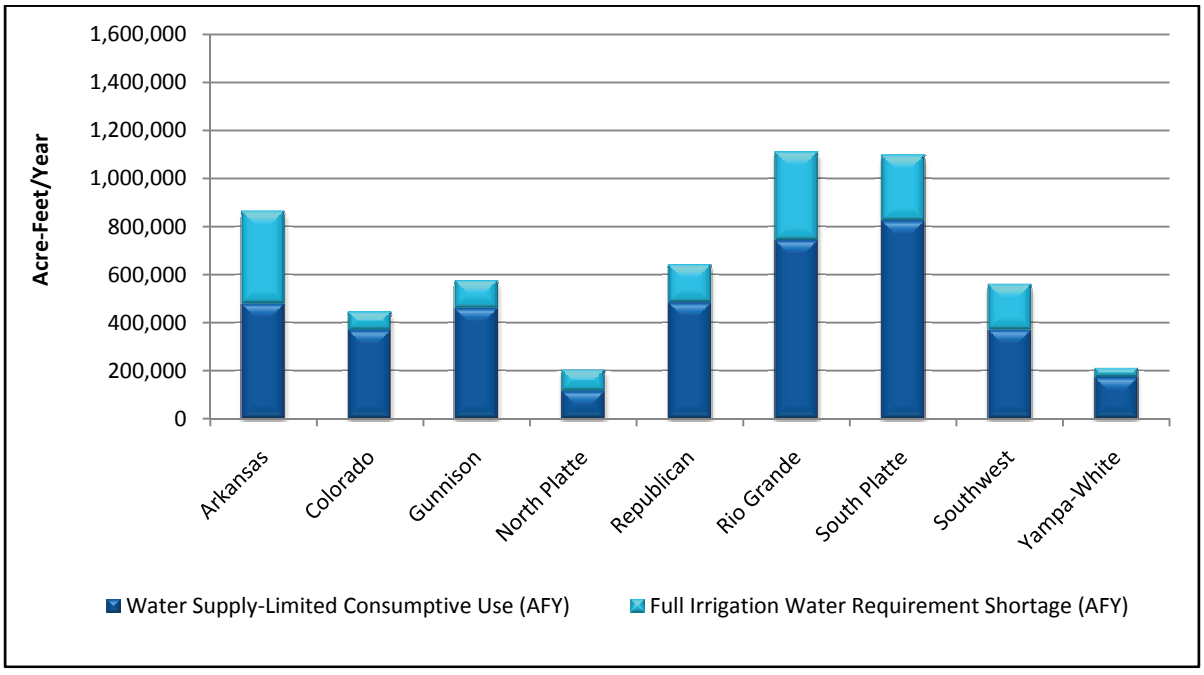

Figure 4-10 2050 Agricultural Demands and Shortages

Section 5
Arkansas Basin Consumptive Projects and Methods and the M&I Gap

5.1 Projects and Methods to Address the M&I Gap Overview

Section 4 of this report summarizes the consumptive water needs across the State of Colorado and the Arkansas Basin. As discussed in Section 1, the Colorado Water for the 21st Century Act requires the basin roundtables to identify projects and methods to meet their consumptive needs.

Section 5.2 summarizes the major projects and methods identified to meet future municipal and industrial (M&I) consumptive needs; Section 5.3 documents the resulting assessment of M&I gaps.

In order to identify M&I projects and methods, the Colorado Water Conservation Board (CWCB) worked with water providers and the basin roundtables to update the Statewide Water Supply Initiative (SWSI) 1 identified projects and processes (IPPs). This information was used to estimate a low, medium, and high 2050 M&I gap corresponding to the M&I demand projections summarized in Section 4 and different IPP success rates. To be clear, an M&I "gap" in the context of this study is not indicative of a future water supply shortfall; rather, it is a future water supply need for which a project or method to meet that need is not presently identified.

It is important for the reader to recognize that the analyses documented in this section are intended for the purpose of "big picture" statewide planning. While data and other information were collected from individual water providers, the results presented herein are for the purpose of general statewide and basinwide planning and are not intended to be used for individual provider planning, site-specific analysis, or project-specific purposes.

5.2 Projects and Methods to Meet M&I Consumptive Needs

Water providers throughout Colorado are pursuing water supply projects and planning processes to help meet future water demands. These IPPs, if successfully implemented, have the ability to meet some, but not all of Colorado's 2050 M&I water needs. IPPs are defined as projects and methods local water providers are counting on to meet future water supply needs. Future M&I water supply needs that are not met by an IPP are considered an M&I water supply gap. The estimation of future M&I water supply gaps is dependent upon several factors, including current water use, forecasted future water use, and water provider predictions of new water supply that will be developed through IPPs.

Statewide, these analyses were performed on a countywide basis and aggregated by basin roundtable area. For the Front Range counties in the Arkansas, Metro, and South Platte Basins, the county results were aggregated to a regional subbasin level for presentation in this report and consistency with SWSI 1. The majority of population growth over the next 40 years is expected to occur in these basins.

5.2.1 Identified Projects and Processes Methodology

The first part of the M&I gap analysis is to calculate 2050 total new M&I water needs, which is described in Section 4. The second part of the 2050 M&I and SSI gap analysis is to calculate the anticipated yield from the water providers' 2050 IPPs, assuming 100 percent success rate. For counties with more than one surveyed water provider, all relevant information was compiled to create the most complete picture of projected water supplies in the county. This IPP yield is then subtracted from the 2050 net new water needs (i.e., demand increases above existing supplies) at the county level. Where the total water provider IPP yield in a county exceeded the projected county demand for the low, medium, or high scenarios, the extra water was assumed to not be available for redistribution to other counties unless otherwise noted.

Information on water providers' IPPs was obtained from the following sources:

- CWCB interviews and data collected from water providers throughout the state in 2009–2010
- Section 6 of the SWSI 1 report (published 2004, data based on projections to 2030)
- Basin roundtable updates (e.g., Arkansas 2008 report, June 2010 presentation by Applegate)

CWCB staff conducted outreach interviews in 2010 with most municipal water providers delivering 2,000 acre-feet per year (AFY) or more, including the top three water providers in each basin, where possible. Not every water provider responded; however, with significant basin roundtable assistance, many water providers submitted data in addition to the original list. This outreach was used to determine what projects and methods water providers are pursuing to meet their future needs along with confirmation of water demand data. In an effort to obtain more detailed data on providers' IPPs than was available for SWSI 1, interviewed entities were asked to delineate IPPs into the following categories:

- Agricultural water transfers
- Reuse of existing fully consumable supplies
- Growth into existing supplies
- Regional in-basin projects
- New transbasin projects
- Firming in-basin water rights
- Firming transbasin water rights

Passive and active conservation measures are not included in the categorized IPPs. Passive conservation is already factored into the 2050 M&I demand forecasts presented in Section 4. As requested by the Conservation Technical Advisory Committee and for the purposes of this analysis, active conservation is considered a strategy for meeting the M&I gap and is described in Section 7.

The categorized IPP data presented in this section is based on information provided by the interviewed water providers on what their firm treated water deliveries will be for each category of IPP. While some IPPs include features that could be applied across more than one category, CWCB relied upon the water providers' data to assign the various projects and methods to the single most appropriate category. For example, although not explicitly quantified herein, it is likely that the true yield anticipated from agricultural water transfers is higher, but many water providers have captured agricultural transfers in IPPs falling in other categories such as regional in-basin projects or firming in-basin water rights. Some entities may also own agricultural water rights that are presently being leased back to agricultural water users; future M&I use of these supplies may be considered by some water providers to be growth into

existing supplies. Based on these efforts IPP data were updated for 75 providers covering approximately 80 percent of the population in Colorado. Many of the quantified IPPs specified by the interviewed M&I water providers are identified in Appendix J of the SWSI 2010 Report.

The interview summary provided by CWCB identified and quantified many of the water providers' IPPs associated with each category. Where IPP information was derived from other sources, professional judgment was used to assign predicted yield to the most appropriate category. This approach was primarily applied to IPP data from the SWSI 1 report, which tallied IPPs by county or subbasin, but generally did not categorize yields from specified types of IPPs.

Because of the need for flexibility, reliability, and future uncertainty, many water providers design projects to meet needs based on planning numbers, which are often greater than current per capita water usage rates. Some specific reasons include—1) ensuring water supply if another system fails, 2) planning for drought or climate change, 3) an expected increase in commercial water use, or 4) concerns that one or more planned project will not be successfully implemented. Furthermore, many water rights limit the use of water to the specific water right holder, causing legal barriers to sharing water supplies. For these reasons, where the total potential volume of IPPs exceeded either the 2050 total water needs or the 2050 total water needs minus any provider-specified gaps, a pro-rata share reduction was applied to each IPP category relevant to that county or subbasin. For example, total quantified IPPs for the interviewed providers in a particular county exceed 50,000 AFY, but IPPs required to meet 2050 net new water needs range from 18,000 AFY to 30,000 AFY. A percentage of the total 50,000 AFY yield from IPPs is associated with each of the seven categories of IPPs, but since less IPP yield is actually needed to meet demands, the same category distribution percentages were applied to the lesser need. In other words, the amount of yield from each IPP category is reduced such that only the amount actually necessary to meet 2050 new water needs is applied.

Note, however, that this methodology and data presentation does not in any way preclude water providers from developing IPPs in excess of their 2050 needs. Rather, it is beyond the scope of this gap analysis to present data for individual water providers whose demand projections, planning horizon, and system reliability may differ from the regional analysis presented here. Any excess IPP volume quantified for a particular county is assumed to not be available to meet water supply gaps in other counties, unless specified otherwise. Likewise, there was no intention of implying intra-county sharing among water providers, unless specifically noted. By proportionally scaling back each entity's 2050 IPP yields when the sum of all entities' IPPs in a particular county exceed the forecasted 2050 net new water needs for that county—and explicitly accounting for provider-specified gaps—it is CWCB's intention to avoid implying that any one provider's excess yield would be used to meet the shortfall (i.e., gap) of another water provider.

5.2.2 Estimation of 2050 IPP Yield by Basin

A broad range of water management solutions with varying levels of supply are planned for each of the basins. The following sections summarize the yields of IPPs statewide and for each county or region in each basin at the 100 percent success rate. As described above, due to the number of counties and distinct areas in the Arkansas, Metro, and South Platte Basins, those basins are summarized by region, whereas each of the other basins is discussed at a county level. Because of the overall volume of demand and the size of the projected gaps in the South Platte and Arkansas Basins, those basins' IPPs lists are more populated than the other basins' lists.

Many water providers are pursuing multiple projects and will need to pursue all of these identified projects to meet their increased demand by the year 2050. This is due to the reality that each of the IPPs has associated risk and may not yield all of the anticipated water supply. Alternate IPP yield success rates (i.e.,

less than 100 percent) are addressed subsequently in Section 5.3.2. The results of calculations based on the alternate IPP success rates are incorporated into the gap analysis presented in Section 5.3.3. Additionally, many of these IPPs will benefit multiple beneficiaries and therefore address a number of objectives concurrently. However, challenges exist in determining funding sources and acquiring water rights to support the multiple uses. In addition to quantified IPP yields, the tables for each basin also include a general summary of the major projects and other IPPs in each county or region.

5.2.2.1 Statewide

Statewide, the new water supplies needed for M&I and self-supplied industrial (SSI) use by the year 2050—above and beyond all existing supplies—are estimated to range from about 600,000 AFY to nearly 1 million AFY (see Section 4). This range reflects the uncertainty associated with forecasting water demands 40 years into the future, in particular SSI demands associated with energy development and other market-driven commodities. Based on extensive interviews with water providers, input from basin roundtable and Interbasin Compact Committee (IBCC) members, and a thorough review of other pertinent information, IPPs have been identified that will meet a significant portion of these future new demands.

Applying the general methodology for assessing IPPs described in Section 5.2.1, the IPPs were grouped into seven primary categories. **Table 5-1** identifies the anticipated range of yield from each category for each basin. For this and many of the subsequent tables, values are presented as a range, with the low and high yield values shown. Where the yield values do not change from low to high, a single value is shown rather than a range. Although the interviewed water providers generally provided demand and IPP data for a 2050 medium growth scenario, the ranges presented herein derive from the use of low, medium, and high population and demand levels for 2050 for the various analyses associated with SWSI 2010.

As shown in Table 5-1, quantified IPPs at 100 percent yield success would provide approximately 430,000 AFY, or about 72 percent of the new demands under the low growth scenario. At the high end, again assuming 100 percent success rate, IPPs would total about 580,000 AFY and represent approximately 58 percent of the high demand increase. The largest categories of IPP yields by volume are projected to be regional in-basin projects (150,000 AFY to 170,000 AFY) and growth into existing supplies (100,000 AFY to 160,000 AFY). **Figure 5-1** depicts the data graphically; for the individual basins that follow.

Table 5-1 Major Categories of Identified Projects and Processes by Basin (Yields at 100% Success Rate) [1]

Basin	Agricultural Transfer (AFY)	Reuse (AFY)	Growth into Existing Supplies (AFY)	Regional In-Basin Project (AFY)	New Transbasin Project (AFY)	Firming In-Basin Water Rights (AFY)	Firming Transbasin Rights (AFY)	Total IPPs at 100% Success Rate (AFY)
Arkansas	**9,200 – 11,000**	**23,000 – 32,000**	**2,300 – 2,600**	**37,000**	**0**	**6,100 – 7,300**	**10,000 – 11,000**	**88,000 – 100,000**
Colorado	2,900 – 8,000	500	14,000 – 28,000	13,000 – 15,000	0	11,000 – 19,000	0	42,000 – 70,000
Gunnison	400 – 500	0	1,100 – 1,700	11,000 – 15,000	0	900	0	14,000 – 18,000
Metro	20,000 – 33,000	14,000 – 21,000	55,000 – 86,000	34,000 – 39,000	13,000 – 23,000	900 – 1,400	3,500 – 4,800	140,000 – 210,000
North Platte	0	0	100 – 300	0	0	0	0	100 – 300

Table 5-1 Major Categories of Identified Projects and Processes by Basin (Yields at 100% Success Rate) [1] (continued)

Basin	Agricultural Transfer (AFY)	Reuse (AFY)	Growth into Existing Supplies (AFY)	Regional In-Basin Project (AFY)	New Transbasin Project (AFY)	Firming In-Basin Water Rights (AFY)	Firming Transbasin Rights (AFY)	Total IPPs at 100% Success Rate (AFY)
Rio Grande	0	0	2,900 – 4,300	0	0	3,000 – 4,300	0	5,900 – 8,600
South Platte	19,000 – 20,000	5,000 – 7,000	20,000 – 30,000	37,000 – 39,000	0	22,000 – 26,000	18,000 – 21,000	120,000 – 140,000
Southwest	0	0	5,200 – 7,300	9,000 – 13,000	0	0	0	14,000 – 21,000
Yampa-White	0	0	3,500 – 4,900	6,600 – 9,000	0	0	0	10,000 – 14,000
Total	**51,000 – 73,000**	**43,000 – 61,000**	**100,000 – 160,000**	**150,000 – 170,000**	**13,000 – 23,000**	**44,000 – 58,000**	**32,000 – 37,000**	**430,000 – 580,000**

[1] Aggregated basin total values rounded to two significant digits to reflect increased uncertainty at larger geographic scales.

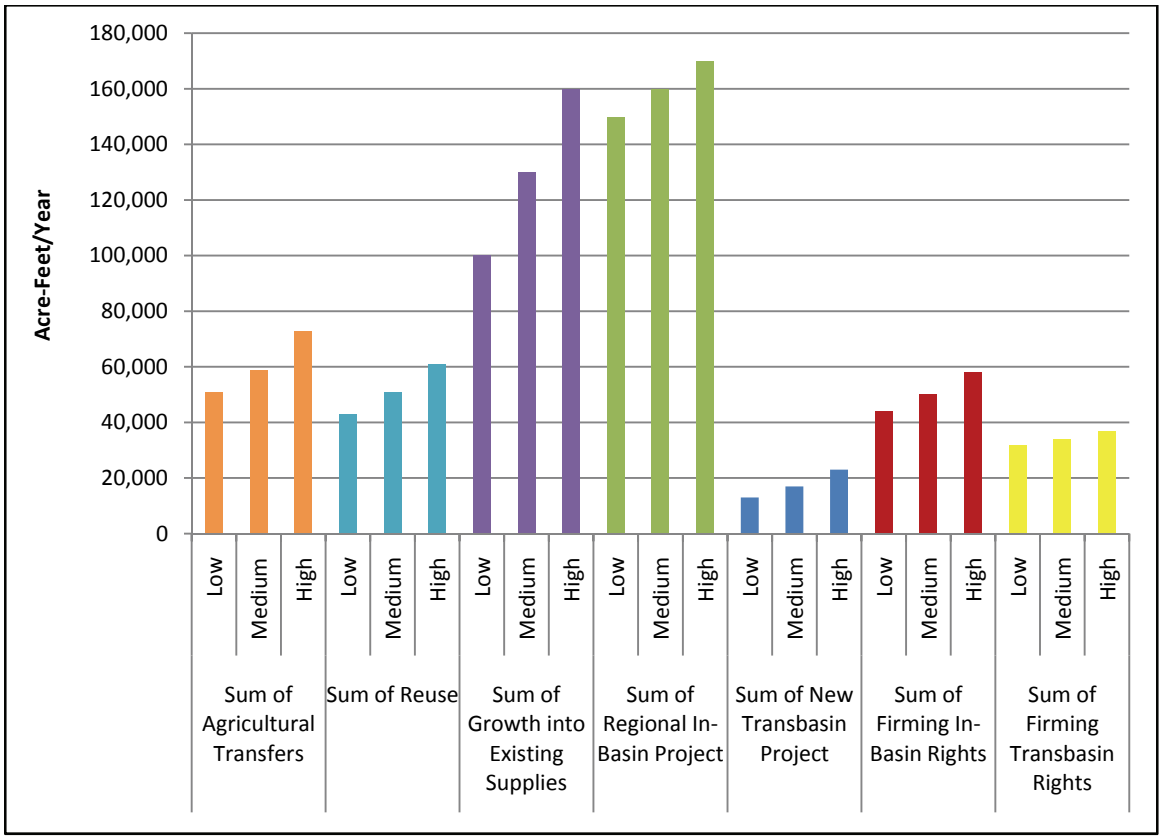

Figure 5-1 Statewide Summary of Yield for IPP Categories at 100% Success Rate

5.2.2.2 Arkansas Basin

For consistency with SWSI 1, the IPP and gap analysis updates for the Arkansas Basin were performed by aggregating county results to a regional subbasin level. The Arkansas Basin regions described below were defined in SWSI 1 and are illustrated in **Figure 5-2**.

- Upper Arkansas (Chaffee, Custer, Fremont, Lake, Teller)
- Urban Counties (El Paso, Pueblo)
- Lower Arkansas (Bent, Crowley, Otero, Prowers)
- Eastern Plains (Baca, Cheyenne, Elbert, Kiowa, Lincoln)
- Southwestern Arkansas (Huerfano, Las Animas)

Note that several counties (Cheyenne, Elbert, Lincoln, and Teller) are split between two basins, with a pro-rata share of current and future demands accounted for in each basin. This approach is consistent with the South Platte and Metro Basin needs assessment work.

In the Arkansas Basin, most of the major M&I water providers reported that they will be able to meet all or part of 2050 needs through existing supplies, projects underway, and planned projects. Reuse is being pursued by most providers that have reusable supplies. In most cases in Colorado, reuse is limited to nonnative water such as transbasin diversions, nontributary groundwater, and the unused first use portion of the consumptive use (CU) portion of transfers of agricultural rights. Most of the entities that are planning reuse projects in the Arkansas Basin anticipate using one or more of the following components:

- Augmentation plans
- Exchanges
- Nonpotable use for irrigation of parks and golf courses
- Groundwater recharge
- Gravel lake storage to regulate consumable return flows for exchange or nonpotable reuse

Colorado Springs Utilities (CSU) and the Pueblo Board of Water Works (PBWW) both indicated in recent interviews with CWCB that they have adequate existing water rights or are pursuing new projects to meet 2050 demands and beyond. Their "surplus" supplies in excess of 2050 demands are not available for permanent use by others, since these supplies will eventually be needed by CSU and PBWW. Given the lack of developable new supplies in the Arkansas Basin, agricultural transfers throughout the basin will continue via purchases, developer donations, and development of irrigated lands.

Providers in the Southeastern Colorado Water Conservation District, including entities in the Upper Arkansas, Urban Counties, and Lower Arkansas regions, are relying heavily on future Fryingpan-Arkansas (Fry-Ark) Project allocations. The Eastern Plains region will rely on nontributary groundwater and the Southwestern Arkansas region will rely on augmentation, existing water rights, and agricultural transfers.

Many providers are planning on maximizing the use of their existing transbasin and other fully consumable supplies. Even though there is very little potential for additional new water development in the Arkansas Basin, storage is needed throughout the basin to regulate existing and future supplies, firm the yield of agricultural transfers, provide for augmentation releases, and to capture return flows.

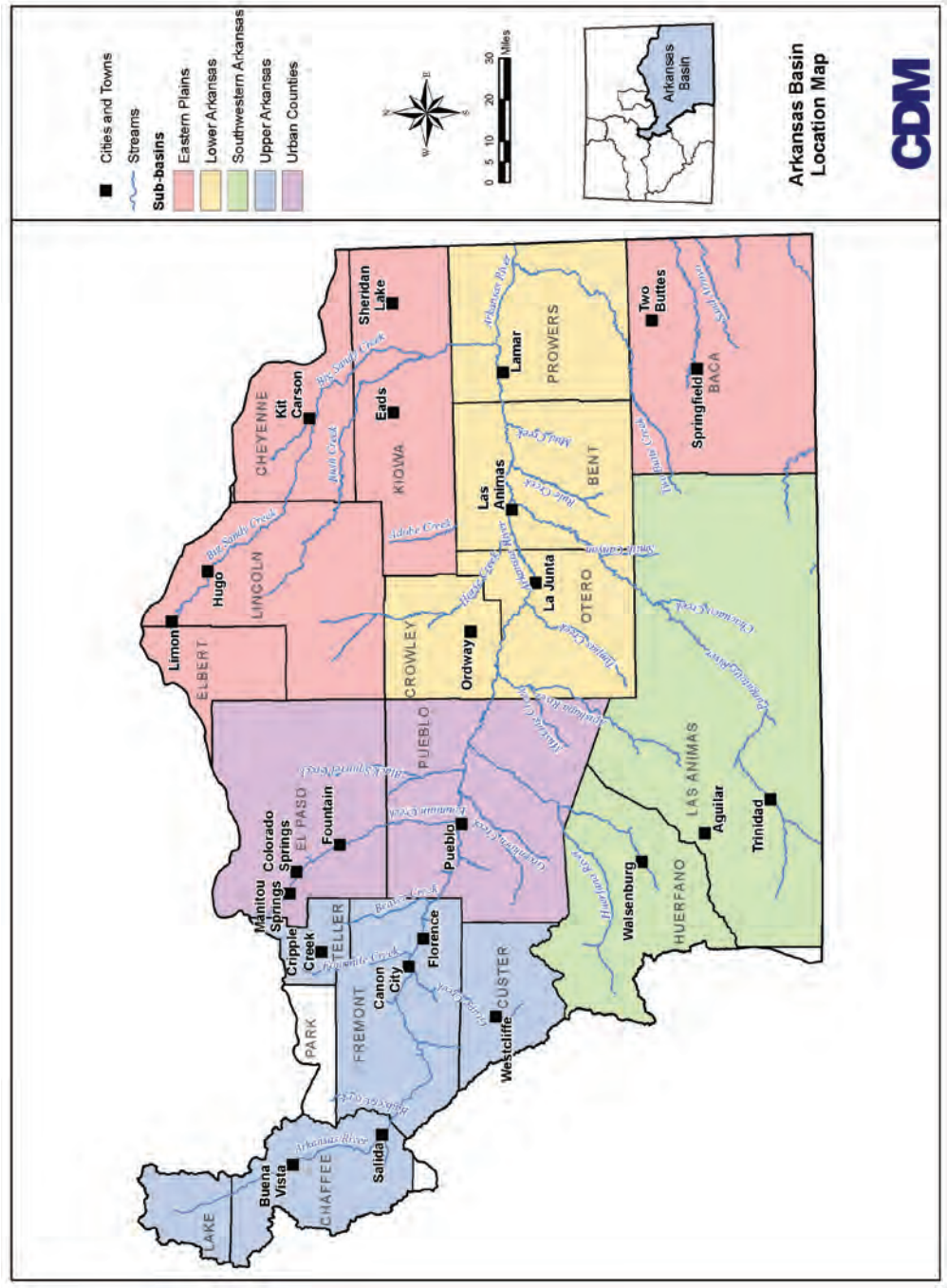

Figure 5-2 Arkansas Basin Location Map

Funding for the Arkansas Valley Conduit (AVC), which would improve drinking water quality and reduce transit losses for the Lower Arkansas Basin communities, has been authorized by the federal government. Pre-National Environmental Policy Act (NEPA) studies for the project, funded through a State and Tribal Assistance Grant, were completed in 2010. The towns along the mainstem of the Arkansas River downstream of the City of Pueblo divert from alluvial wells, nontributary deep wells, or from tributary surface water supplies. In addition to local water rights, these towns also have access to Fry-Ark Project allocations and return flows from the use of project water. Stream transit losses are assessed from Pueblo Reservoir to the downstream location and water quality is impacted by minerals and salts in the river channel and return flows as the water flows down the Arkansas River.

Fountain and Security are both participating in the Southern Delivery System (SDS) with CSU to help meet their future demands. The SDS is a regional project to deliver water from the Arkansas River that is stored in Pueblo Reservoir. Major components of the project include—1) a connection to the North Outlet Works of Pueblo Dam; 2) 62 miles of underground raw and treated water pipeline; 3) three pump stations; and 4) a 50-million-gallons-per-day treatment plant. A final environmental impact statement (EIS) for the project has been published by the U.S. Bureau of Reclamation (BOR), and a Record of Decision was issued in March 2009. Major construction activity is scheduled to begin in 2011.

The Upper Arkansas Water Conservancy District (UAWCD), which provides augmentation for wells in a portion of the upper basin, will be challenged to develop the CU water rights and storage required to meet additional augmentation requirements in the upper basin. The upper basin, like many headwater areas throughout the state, is projected to experience high growth rates. Augmentation to existing or proposed environmental and recreation water rights, such as CWCB instream flow rights and recreational in-channel diversions and senior agricultural and M&I rights, will likely require the construction of storage in upper areas of tributaries. Economies of scale are generally not present in small reservoir construction and the engineering, permitting, and construction costs will tax the ability to provide for augmentation water at a reasonable cost. The acquisition of agricultural rights will likely be part of the augmentation supplies for the UAWCD due to limits on the availability of Fry-Ark allocations.

In addition to the IPPs described above, the Preferred Storage Option Plan (PSOP) is an important method for meeting the basin's future water needs. PSOP would enlarge Pueblo Reservoir by 75,000 acre-feet (AF) and Turquoise Reservoir by 19,000 AF. In addition, PSOP would allow for utilization of excess capacity contracts (up to 90,000 AF) from the BOR.

Anticipated yields from each category of IPPs at 100 percent success rate are summarized for the Arkansas Basin in **Table 5-2**.

Table 5-2 Arkansas Basin IPP Summary at 100% Success Rate

Region or County	Agricultural Transfer (AFY)	Reuse (AFY)	Growth into Existing Supplies (AFY)	Regional In-Basin Project (AFY)	New Transbasin Project (AFY)	Firming In-Basin Water Rights (AFY)	Firming Transbasin Rights (AFY)	Total IPPs at 100% Success Rate (AFY)
Eastern Plains	0	0	1,600 – 1,900	0	0	0	100	1,700 – 2,000
Eastern Plains IPPs • Nontributary groundwater • AVC								
Lower Arkansas	0	0	0	0	0	800 – 2,000	0	800 – 2,000
Lower Arkansas IPPs • AVC								

Table 5-2 Arkansas Basin IPP Summary at 100% Success Rate (continued)

Region or County	Agricultural Transfer (AFY)	Reuse (AFY)	Growth into Existing Supplies (AFY)	Regional In-Basin Project (AFY)	New Transbasin Project (AFY)	Firming In-Basin Water Rights (AFY)	Firming Transbasin Rights (AFY)	Total IPPs at 100% Success Rate (AFY)
Southwestern Arkansas	600	0	700	0	0	600	0	1,900
Southwestern Arkansas IPPs • Existing water rights • Augmentation plans • Agricultural transfers								
Upper Arkansas	3,600	0	0	0	0	4,700	3,600	11,900
Upper Arkansas IPPs • UAWCD Augmentation plan • Other augmentation plans • Agricultural transfers • Use of Fry-Ark M&I allocation directly or for augmentation								
Urban Counties	5,000 – 7,200	23,000 – 32,000	0	37,000	0	0	6,500 – 6,900	71,500 – 83,100
Urban Counties IPPs • Agricultural transfers • Reuse plans • Groundwater • SDS • Eagle River Joint Use Project • Blue River Conditional Storage Development • AVC								
Total[1]	**9,200 – 11,000**	**23,000 – 32,000**	**2,300 – 2,600**	**37,000**	**0**	**6,100 – 7,300**	**10,000 – 11,000**	**88,000 – 100,000**

[1] Aggregated basin total values rounded to two significant digits to reflect increased uncertainty at larger geographic scales.

5.3 M&I Gap Analysis

The IPPs being pursued by local water providers represent significant quantities of water and the implementation of these local projects and plans is critical to meeting Colorado's future water supply needs. However, even with the implementation of the IPPs, there are still remaining M&I and SSI consumptive water supply gaps that will need to be satisfied. As stated previously, the calculated gaps do not necessarily represent a future water supply shortage, but the gaps do demonstrate where additional work is needed to identify projects and methods to meet those future needs. The following sections summarize the calculations and results of the 2050 M&I and SSI gap analysis. As described previously, this analysis includes 2050 low, medium, and high gap values to account for the inherent uncertainty in long-range population, demand, and water supply forecasting. Future M&I and SSI demands were assessed in Section 4 of this report.

Section 5.3.1 presents the M&I and SSI gap calculation methodology generally, followed by details on the variations that occur within the calculations for each basin. The calculations as described in Section 5.3.1 are based on the assumption of 100 percent success rate for the development of IPP yield. Section 5.3.2 describes alternate (i.e., less than 100 percent) IPP yield success rates for each basin as they are applied to estimate the 2050 medium and high gaps. Section 5.3.3 summarizes the results of the gap analysis at the statewide level and for each of the nine basin roundtable areas.

The results of the gap analysis presented in this report are based on the estimated firm yield of IPPs. Furthermore, the demand values that are integral to the gap calculations are based on water providers' treated water deliveries and do not account for losses during raw water collection, treatment, and distribution, which are highly variable depending on, among other things, water source, types of treatment processes, and age and condition of distribution system. Additionally, there are many future uncertainties

such as the potential for climate change, drought, infrastructure failure, and other factors. Therefore, raw water needs are very likely to be greater than the gap values presented in this report.

Note that current and future agricultural consumptive demands and shortages were assessed in Section 4 of this report. Calculated irrigation shortages are based on available water supply being less than the ideal amount required for meeting the CU requirements of a particular crop. Changes in these calculated results for 2050 relative to 2008 are generally driven by the anticipated loss of irrigated land to development and other factors. The discussions that follow apply only to the M&I and SSI consumptive gap analysis.

5.3.1 M&I Gap Analysis Methodology

For the purpose of this study, the M&I and SSI water supply gap is defined as follows:

M&I and SSI Water Supply Gap = 2050 Net New Water Needs – 2050 IPPs

where:

2050 Net New Water Needs = (2050 low/medium/high M&I baseline demands – high passive conservation - current M&I use) + (2050 low/medium/high SSI demands – current SSI use)

2050 IPPs = Water Provider Anticipated Yield from: Agricultural Transfers + Reuse + Growth into Exiting Supplies + Regional In-basin Projects + New Transbasin Projects + Firming In-basin Water Rights + Firming Transbasin Water Rights

If the available IPPs exceeded the 2050 water needs for a particular county, the IPPs were reset equal to the 2050 water needs. As stated previously herein, this calculation effectively scales back the yield of each IPP in a pro-rata fashion in order to present only the amount of yield necessary to meet water supply needs at the 2050 planning horizon. Sometimes this occurs for all three growth scenarios, sometimes for only low or low and medium. It is generally assumed that one county's surplus IPPs would not be reallocated to another county and that one provider's surplus would not be specifically allocated to meet another provider's gap. This approach was applied in all basins, unless specified otherwise.

The 2050 M&I and SSI gap is referred to in the results tables (see Section 5.3.3) as the "information/real" gap. The "real" gap is based on known numerical data from the Demands to 2050 Report (see Section 4 and Appendix H of the SWSI 2010 Report), water provider interviews and data, SWSI 1, and other sources. Based on this information, 2050 M&I and SSI demand forecasts exceed the anticipated yields of water providers' IPPs and the result is a real, defined gap. An "information" gap arises due to a lack of numerical data to support more detailed gap quantification for some water providers or even counties and subbasins.

The preceding description represents the general approach to the M&I gap analyses, with the yields of IPPs based on the 100 percent success rate. However, the process was modified as necessary for each county and basin based on the available source data. The following sections outline variations to the methodology in each basin. These are general descriptions and do not necessarily capture every variation for every county; however, additional details about the calculations for each county or region are provided in Appendix J of the SWSI 2010 Report.

5.3.1.1 Arkansas Basin

Following are the assumptions used to revise the gap calculations for the Arkansas Basin:

- The 2050 total water needs were calculated based on the Demands to 2050 Report, as described in the general approach.
- The July 2008 Arkansas Basin Roundtable update presents data consistent with SWSI 1, i.e., current conditions = 2000, future conditions = 2030. The gap analysis in the basin roundtable update was based on meeting 2030 demands.
- Provider-specified gaps were identified in SWSI 1 and the basin roundtable updates. In most cases, this information was retained as a "real" gap.
- For outlying areas of the Arkansas Basin where specific IPP data was not available from interviewed providers, IPPs were generally calculated as 2030 demand minus 2000 demand (both values from SWSI 1) minus specific provider gaps identified in SWSI 1 and the 2008 and 2010 basin roundtable updates. Thus, in these areas of limited data, IPPs are applied toward meeting 2030 demands, and increases in demand above 2030 levels were assumed to result in a gap.
- Additional provider-specific IPPs were identified and/or quantified based on CWCB interviews and data collection. Details are provided in Section 5.2.2.2.
- After accounting for known IPPs, the information/real gap was generally calculated as 2050 net new water needs minus IPPs (for low/medium/ high growth scenarios).

Additionally, unincorporated northern El Paso County needs renewable sources to meet future demands as it is currently 100 percent on nonrenewable, nontributary groundwater. If that area's existing nontributary sources fail or become technically or economically infeasible to continue to use as well yields decline, the amount needed (the gap between supply and demand) will become significantly larger in the northern portion of the basin. The El Paso County gap values therefore include an additional 13,500 AFY due to the necessary replacement of nonrenewable groundwater sources.

5.3.2 Gap Analysis with Alternate IPP Yield Scenarios

The assumptions and calculations described in Section 5.3.1 above evaluate the gap based on a 100 percent success rate for IPP yield development. To assess the full range of the 2050 M&I and SSI Gap, CWCB developed three potential scenarios to bracket the range of the M&I and SSI gap for low to high scenarios. Each scenario has a variable IPP yield success rate applied as a percentage of total IPP yield. For the low gap scenario, it was assumed that 100 percent of the IPPs (see Section 5.2.1) could be applied to the 2050 net new water needs.

For the medium and high gap estimates, the yield of the IPPs was assumed to be varied based on discussions from the IBCC, CWCB, and basin roundtables. For the medium gap scenario, it was assumed that the IPP yield would be reduced based on percent success rates discussed by IBCC in their scenario discussions for the alternative portfolio (see Section 7). IPP yield for the high gap scenario is assumed to be reduced based on the percent success rates as defined in the status quo portfolio that has been discussed by the IBCC. The percentage success rates for IPP yields for the medium and high scenarios are presented in **Table 5-3**. For the medium and high statewide analyses, the success rates in Table 5-3 are applied to each basin prior to calculating the overall gaps on an aggregate basis.

Table 5-3 IPP Success Rates for the Medium and High Gap Scenarios

Basin	IBCC Alternative Portfolio IPP Yield Success Rates	IBCC Status Quo Portfolio IPP Yield Success Rates
Arkansas	**90%**	**75%**
Colorado	90%	90%
Gunnison	90%	90%
Metro	60%	50%
North Platte	90%	90%
Rio Grande	90%	90%
South Platte	60%	40%
Southwest	75%	75%
Yampa-White	90%	90%

5.3.3 2050 M&I and SSI Gap Analysis Results

The water supply gaps resulting from the assumptions and calculations defined in Section 5.3.1 and Section 5.3.2 are summarized in the following sections, first statewide, then for each basin by subbasin (region) or county. The full set of gap results implies nine total gap scenarios based on low, medium, and high M&I demands and three IPP yield scenarios (100 percent success rate, an alternative success rate, and a status quo success rate). For the purpose of discussion, however, the results are reduced to three scenarios in the tables presented in the following sections. These three scenarios encapsulate the full range of anticipated M&I and SSI water supply gaps in 2050, from the lowest low gap scenario (lowest demands with 100 percent IPP success rate) to the highest high gap scenario (high demands with status quo IPP success rates).

5.3.3.1 Statewide

Colorado faces a significant M&I water supply gap in 2050. Under the low gap scenario (low demands and 100 percent IPP success rate), the statewide gap is 190,000 AFY. Under the medium gap scenario (medium demands and an alternative IPP success rate), the statewide gap is about 390,000 AFY. Under the high gap scenario (high demands and status quo IPP success rate), the statewide gap is about 630,000 AFY. By 2050, Colorado's M&I gap could be between 32 percent and 66 percent of new M&I demands.

Table 5-4 provides a summary of each basin's increased M&I and SSI demands relative to current conditions (defined for this study as 2008), the amount of that increase met by the IPPs, and the results of the gap calculations. In general, the low IPPs plus the low remaining M&I and SSI gap equal the low increase in M&I and SSI demand, with some minor variability due to rounding at the county or regional level. The same is true for the medium and high values. The Arkansas and Metro Basins are exceptions to this rule due to the inclusion of additional gap volumes associated with the replacement of existing nonrenewable groundwater sources.

Table 5-4 Statewide M&I and SSI Gaps in 2050[1]

Basin	Increase in M&I and SSI Demand (AFY)			Estimated Yield of Identified Projects and Processes (AFY)			Estimated Remaining M&I and SSI Gap after Identified Projects and Processes (AFY)		
				100% IPP Success Rate	Alternative IPP Success Rates	Status Quo IPP Success Rates	Gap at 100% IPP Success Rate	Gap at Alternative IPP Success Rates	Gap at Status Quo IPP Success Rates
	Low	Med	High	Low	Med	High	Low	Med	High
Arkansas[2]	**110,000**	**140,000**	**170,000**	**88,000**	**85,000**	**76,000**	**36,000**	**64,000**	**110,000**
Colorado	65,000	82,000	110,000	42,000	49,000	63,000	22,000	33,000	48,000
Gunnison	16,000	19,000	23,000	14,000	14,000	16,000	2,800	5,100	6,500
Metro[3]	180,000	210,000	280,000	140,000	97,000	100,000	63,000	130,000	190,000
North Platte	100	200	300	100	200	300	0	20	30
Rio Grande	7,700	9,900	13,000	5,900	6,400	7,700	1,800	3,600	5,100
South Platte	160,000	180,000	230,000	120,000	78,000	58,000	36,000	110,000	170,000
Southwest	20,000	25,000	31,000	14,000	13,000	15,000	5,100	12,000	16,000
Yampa-White	34,000	48,000	95,000	10,000	11,000	13,000	23,000	37,000	83,000
Total	**590,000**	**710,000**	**950,000**	**430,000**	**350,000**	**350,000**	**190,000**	**390,000**	**630,000**

[1] Aggregated basin total values rounded to two significant digits to reflect increased uncertainty at larger geographic scales.
[2] Arkansas gaps include additional 13,500 AFY for Urban Counties replacement of nonrenewable groundwater supplies.
[3] Metro gaps include additional 20,850 AFY for South Metro replacement of nonrenewable groundwater supplies.

Colorado faces immediate M&I water supply needs. **Figure 5-3** illustrates the timing of the statewide M&I and SSI gap for the medium gap scenario. The statewide existing supply is 1,161,000 AFY and is assumed to remain constant through 2050, except for the replacement of nontributary groundwater in Douglas and El Paso counties. Under the medium gap scenario Colorado's immediate M&I water supply needs are met with the successful implementation of the IPPs. The associated yield of the IPPs increases steadily from 2010 through 2020, then at a higher rate of growth through 2030. Under the medium gap scenario, the IPPs are fully implemented by 2030 and yield about 350,000 AFY. Without the successful implementation of additional IPPs, increases in demand after 2030 are assumed to be gap, leading to a 2050 M&I gap of approximately 390,000 AFY for the medium gap scenario.

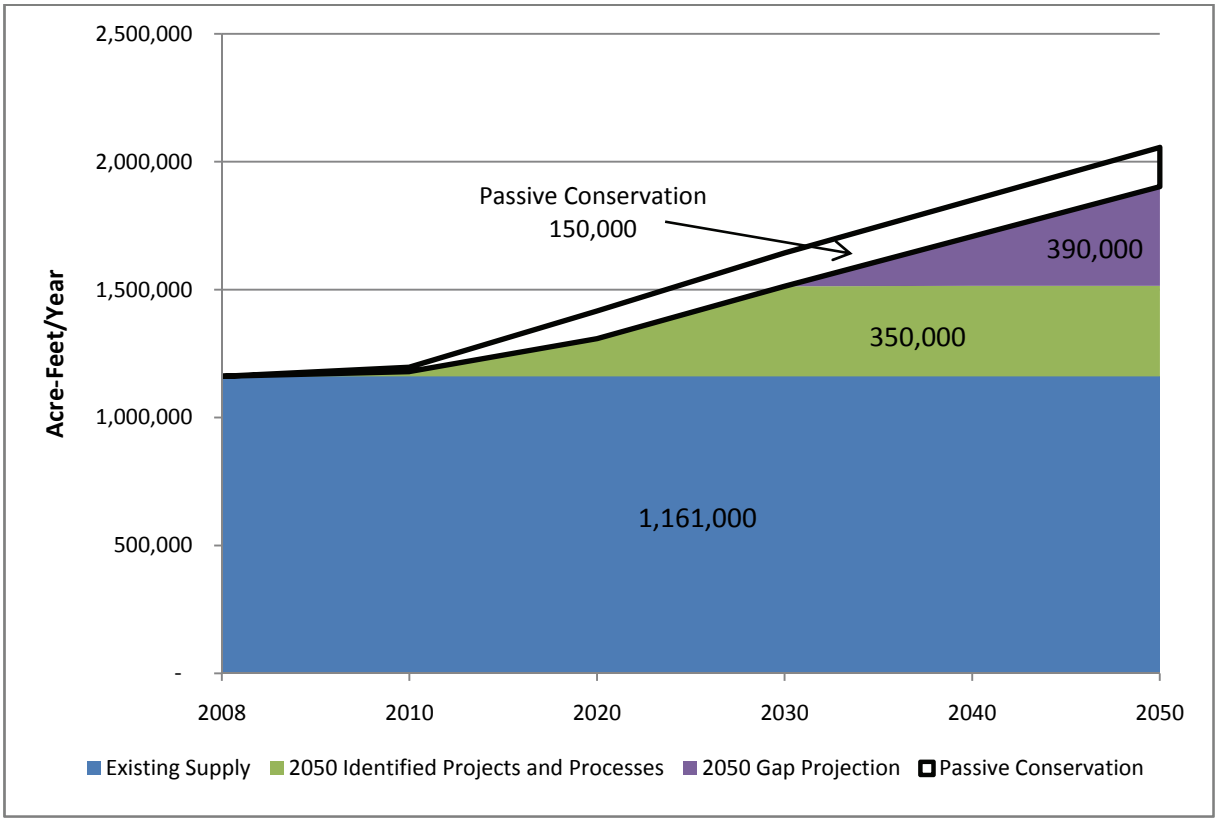

Figure 5-3 Statewide M&I and SSI Gap Summary Medium Scenario (IPPs at 70% Success Rate)

Note that while this plot does illustrate the temporal evolution of existing supplies, IPPs, and the gap, it is not intended to serve as a definitive timeline for the development of these parameters. A level of uncertainty remains for most components of this analysis; demand increases may come sooner or later than projected and IPPs may have more or less success than anticipated in these calculations. Thus, the figure functions as a representation of the interrelated nature of IPPs and the gap. At any given point in time, the sum of existing supplies, IPPs, and gap are equal to demands. The figure illustrates that the need for successful implementation of the IPPs is immediate. As long as the development of IPPs keeps pace with demands, the gap will be minimal. However, if demands continue to increase beyond the development of presently identified IPPs or if successful IPP yield development occurs at a lower rate, the gap will continue to grow in magnitude and will appear at an earlier point in time. It is also important to note the spatial variability of the M&I gap. Some areas of the state will have an M&I gap sooner than others. Plots illustrating the low and high gap scenario statewide and the low, medium, and high gap scenarios for all basins are included in Appendix J of the SWSI 2010 Report.

Figure 5-4 illustrates the relative percentages of 2050 net new water needs occupied by IPPs and the gap for each basin for the medium gap scenario. The pie chart shown on the map for each basin is scaled to represent the magnitude of the 2050 medium demand. IPP success rates are defined as shown for the "Alternative Portfolio" in Table 5-3; at the statewide level, the overall IPP success rate is approximately 70 percent for the medium gap scenario.

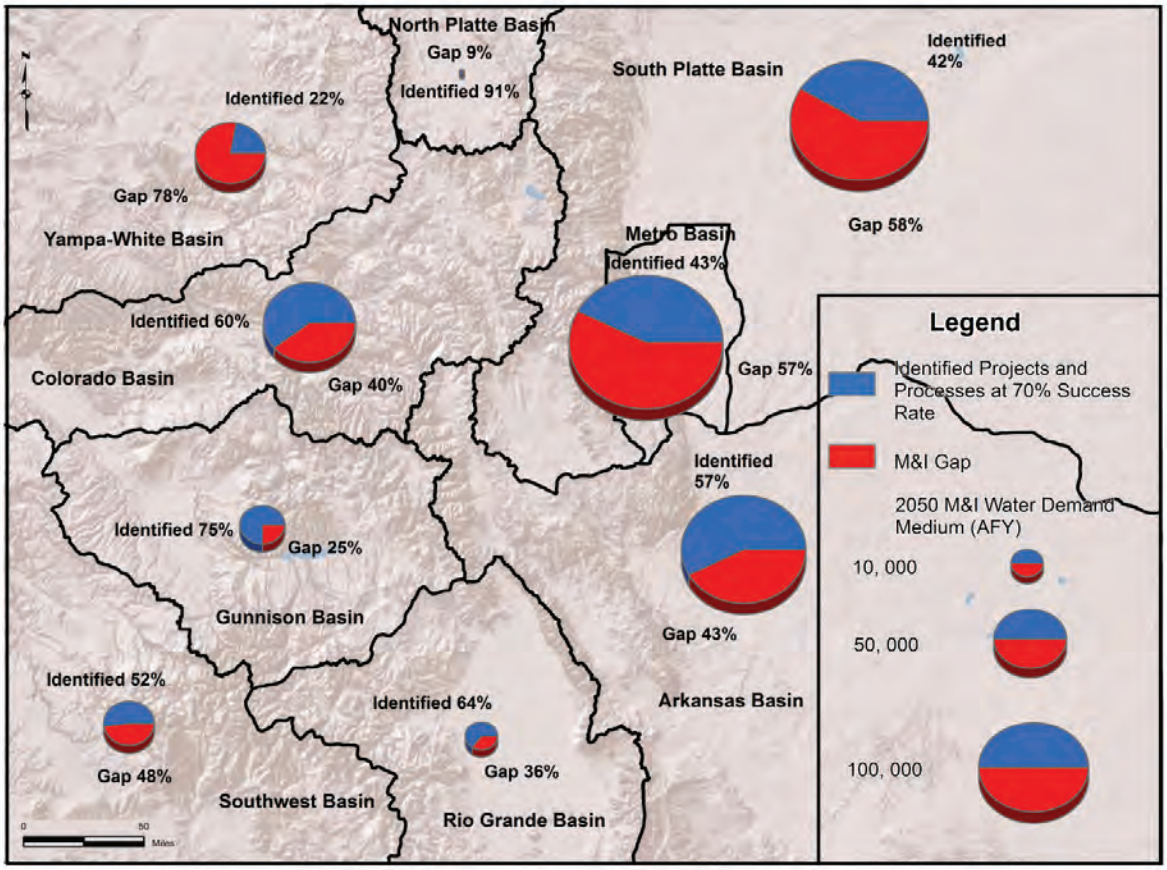

Figure 5-4 2050 M&I and SSI Gap Analysis – Medium Gap Scenario

For the Arkansas, Colorado, Gunnison, North Platte, and Rio Grande Basins, IPPs (illustrated as the blue part of the pie charts) meet 50 percent or more of the 2050 medium demand as a result of 90 percent IPP yield success rate in these basins. Southwest Basin IPPs also exceed 50 percent of 2050 medium demand despite a success rate of only 75 percent. The Yampa-White Basin has a 90 percent IPP yield success rate for the medium gap scenario, but the high yet uncertain demands associated with future SSI uses result in a very large water supply gap (78 percent, illustrated in red) in 2050. Future M&I and SSI water supply gaps for the South Platte and Metro Basins exceed 50 percent due to significantly reduced IPP yield success rates, at 60 percent. For these basins in particular, and also in the Arkansas Basin, a significant reduction in the success of yield development from planned projects and processes identified by Front Range water providers will likely lead to much greater increases in agricultural transfers as a means to meet future demands (see Section 4).

It must be clearly understood that the low, medium, and high gap scenarios evaluated in this study are based on assumptions about the implementation of IPPs made for the purposes of conducting the analyses. In reality, both demand growth and the development of IPPs will be impacted by various factors that will likely cause them to fall somewhere between the low and high values highlighted above. However, it remains highly probable that there will be some level of gap regardless of the level of IPPs development, and a portfolio of solutions will be needed to meet Colorado's future M&I water needs.

Of particular importance will be the implementation of new projects and sources of water in the event that not all IPPs currently undergoing NEPA review receive permits for project construction from the

jurisdictional federal agency (BOR or U.S. Army Corps of Engineers for most ongoing EIS projects). The list of these projects includes high-yield regional projects such as Northern Integrated Supply Project, Windy Gap Firming Project, SDS, the Moffat Collection System Project, Chatfield Reallocation, and others.

The significance of the yield that would be provided by IPPs currently or soon to be engaged in the NEPA process—particularly in the South Platte, Metro, and Arkansas Basins—is illustrated in **Figures 5-5** and **5-6**. For the medium growth scenario and assuming 100 percent IPP success rate, South Platte Basin and Metro IPPs in NEPA represent 115,000 AFY of potential yield, or about 40 percent of the total IPP yield for the combined basins. Likewise, NEPA IPPs in the Arkansas Basin total nearly 49,000 AFY, or roughly 51 percent of overall IPP yield for the medium growth scenario. Note that in Figures 5-5 and 5-6 the new demand values also include the replacement of nonrenewable groundwater.

The following section provides additional results of the gap analysis for each basin roundtable area.

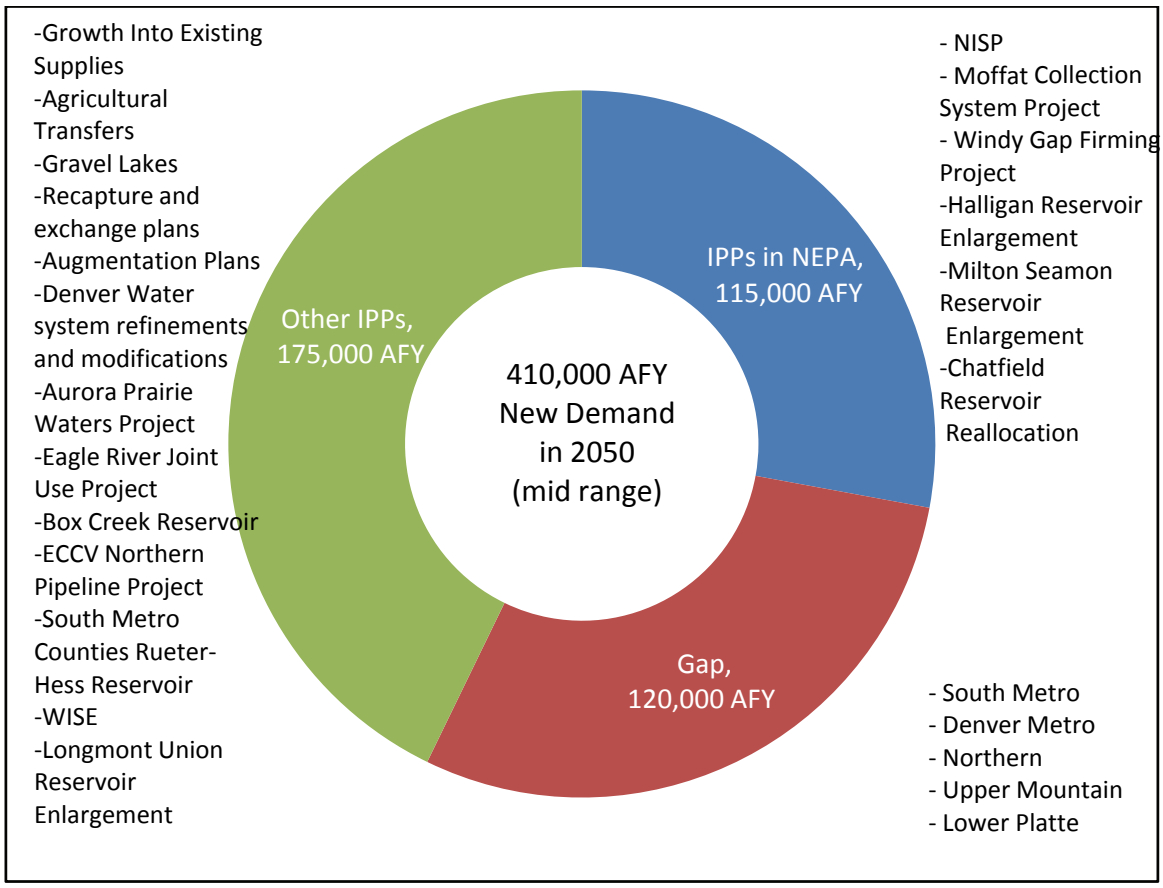

Figure 5-5 Potential Yield of NEPA Projects Relative to 2050 New Demands, Other IPPs, and Gap in South Platte and Metro Basins

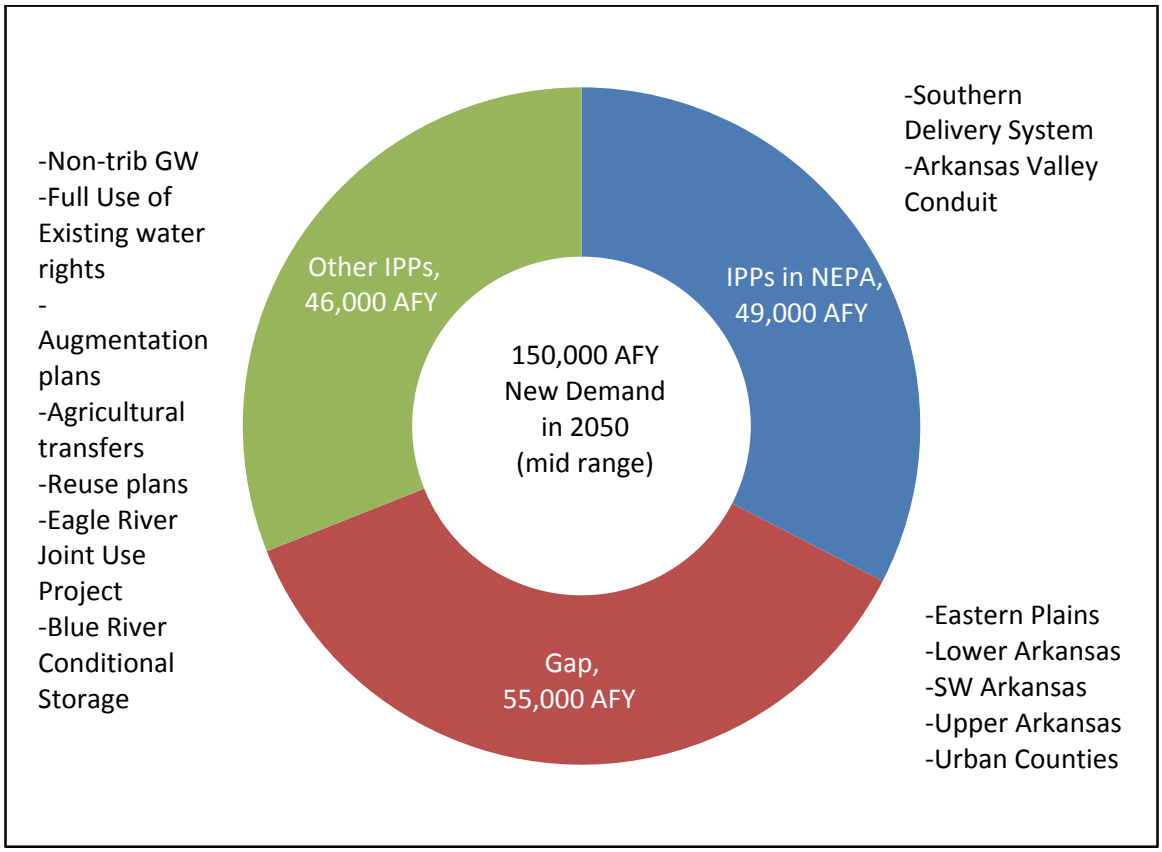

Figure 5-6 Potential Yield of NEPA Projects Relative to 2050 New Demands, Other IPPs, and Gap in Arkansas Basin

5.3.3.2 Arkansas Basin

Table 5-5 provides a summary of increased M&I and SSI demands, the amount of IPP yield, and the volume of M&I and SSI gap for each region in the Arkansas Basin for the low, medium, and high gap scenarios. The baseline existing M&I and SSI water supply for the Arkansas Basin is 255,000 AFY and is assumed to remain constant through 2050; however, there may be a decline in the existing supply over time due to the current use of nonrenewable groundwater in some areas of the Arkansas Basin. After applying the alternative and status quo IPP success rates in Table 5-3, the estimated basinwide gaps for 2050 are as follows:

- Low gap (IPPs at 100 percent success) = 36,000 AFY
- Medium gap (IPPs at 90 percent success) = 64,000 AFY
- High gap (IPPs at 75 percent success) = 110,000 AFY

Table 5-5 Arkansas Basin M&I and SSI Gaps in 2050

Region or County	Increase in M&I and SSI Demand (AFY)			Estimated Yield of Identified Projects and Processes (AFY)			Estimated Remaining M&I and SSI Gap after Identified Projects and Processes (AFY)		
				100% IPP Success Rate	Alternative IPP Success Rate (90%)	Status Quo IPP Success Rate (75%)	Gap at 100% IPP Success Rate	Gap at Alternative IPP Success Rate (90%)	Gap at Status Quo IPP Success Rate (75%)
	Low	Med	High	Low	Med	High	Low	Med	High
Eastern Plains	2,300	2,700	3,200	1,700	1,600	1,500	600	1,100	1,700
Lower Arkansas	900	1,400	2,100	800	1,200	1,500	100	200	600
Southwestern Arkansas	3,000	3,700	4,600	1,900	1,700	1,400	1,100	2,000	3,200
Upper Arkansas	19,000	22,100	25,900	11,900	10,700	8,900	7,200	11,500	17,000
Urban Counties[1]	85,200	105,500	135,000	71,500	70,100	62,300	27,200	48,900	86,200
Total[2]	**110,000**	**140,000**	**170,000**	**88,000**	**85,000**	**76,000**	**36,000**	**64,000**	**110,000**

[1] Urban Counties Gap includes an additional 13,500 AF for replacement of nonrenewable groundwater.
[2] Aggregated basin total values rounded to two significant digits to reflect increased uncertainty at larger geographic scales.

The gaps for the Urban Counties, and thus the entire basin, include an additional 13,500 AFY for the replacement of nonrenewable groundwater. The importance of achieving success for projects currently undergoing NEPA evaluation was discussed in Section 5.3.3.1. Graphical illustrations of the temporal development of IPPs and the gap are included below in **Figures 5-7, 5-8,** and **5-9**.

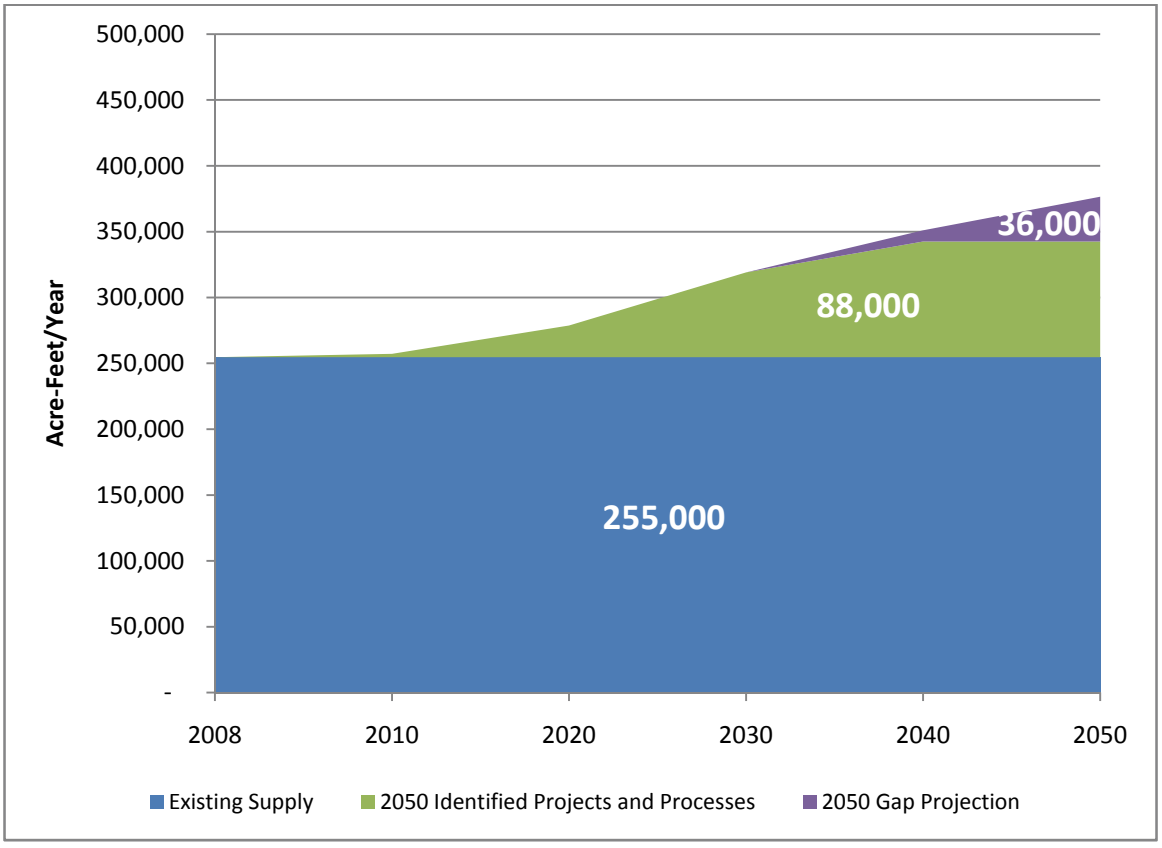

Figure 5-7 Arkansas Basin M&I and SSI Gap Summary Low Scenario (IPPs at 100% Success Rate)

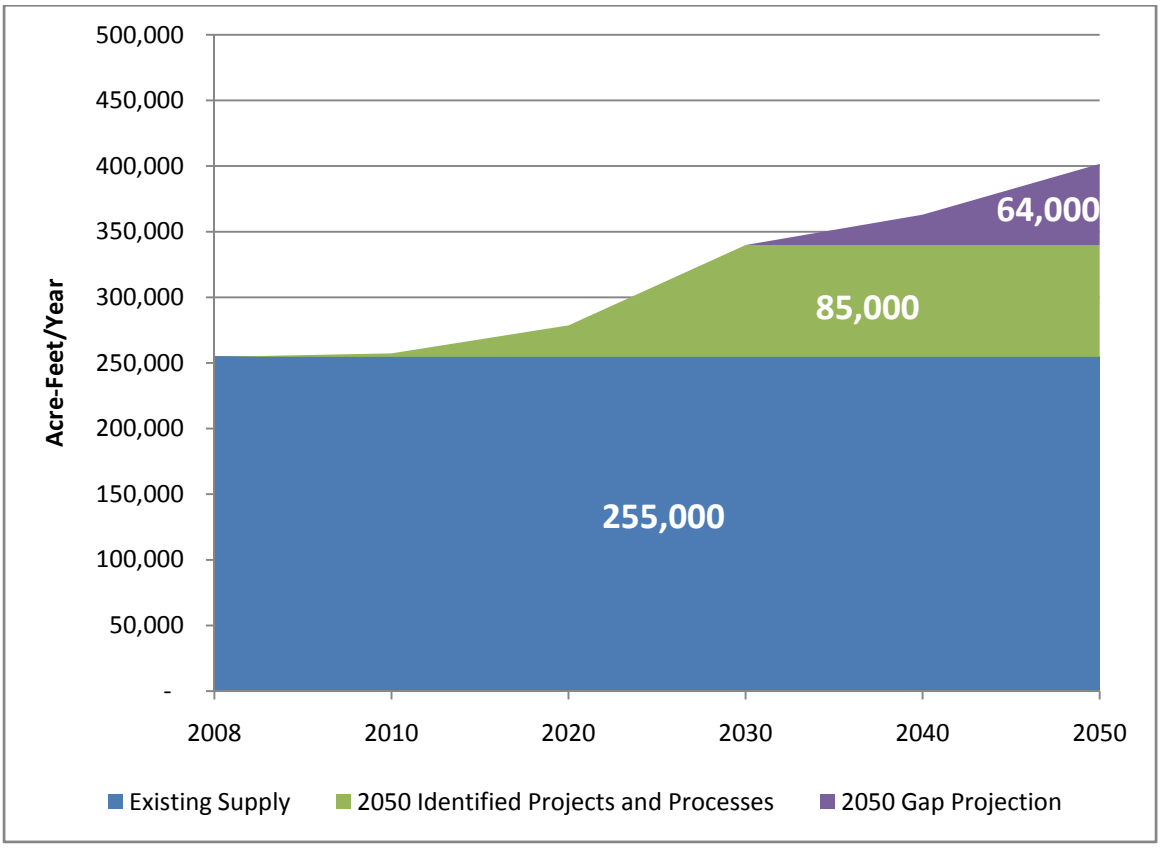

Figure 5-8 Arkansas Basin M&I and SSI Gap Summary Medium Scenario (IPPs at 90% Success Rate)

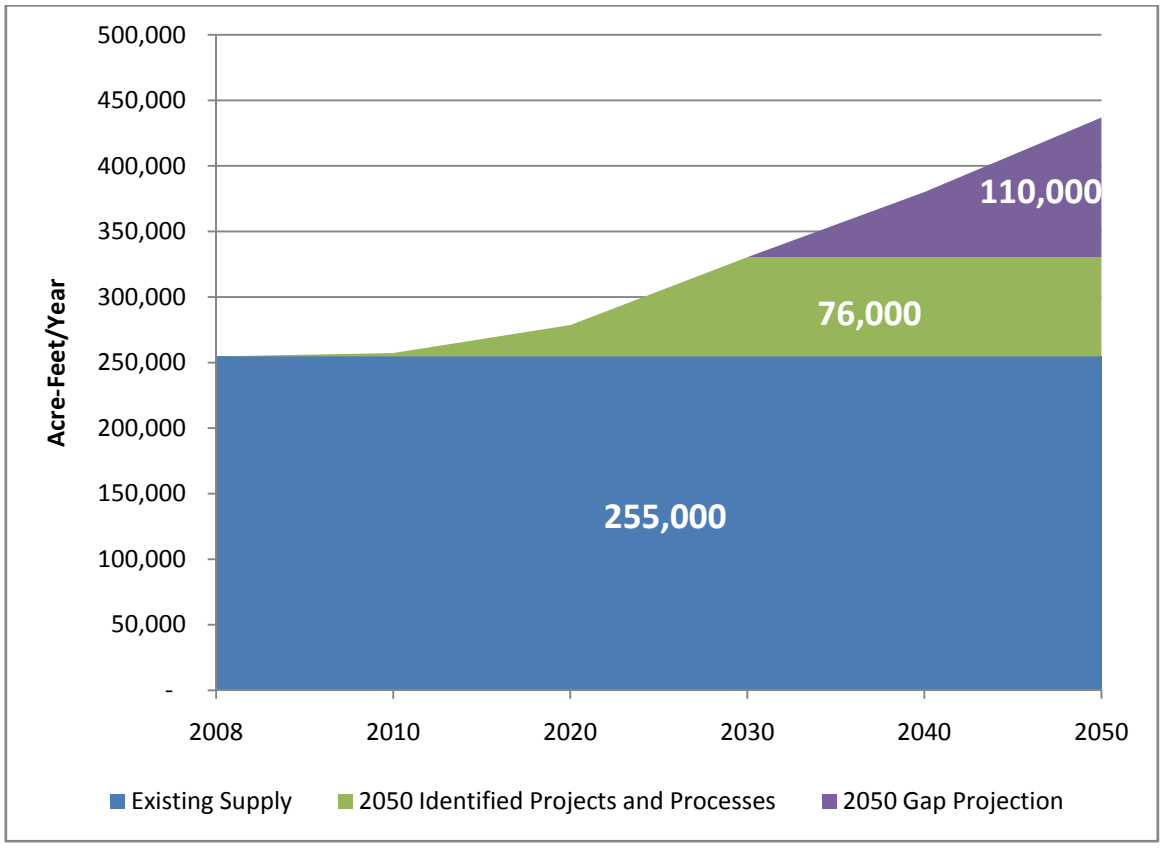

Figure 5-9 Arkansas Basin M&I and SSI Gap Summary High Scenario (IPPs at 75% Success Rate)

Section 6
Arkansas Basin Water Availability

6.1 Water Availability Overview

Justice Gregory J. Hobbs of the Colorado Supreme Court has stated "The 21st Century is the era of limits made applicable to water decisionmaking. Due to natural western water scarcity, we are no longer developing a resource. Instead, we are learning how to share a developed resource." These words of wisdom should serve as guidance for all parties interested in Colorado water. The amount of water available for use within the state is finite.

The Statewide Water Supply Initiative (SWSI) 2010 analyzes Colorado's water availability based on recent work by the Colorado Water Conservation Board (CWCB) and the basin roundtables. SWSI 2010 finds that unappropriated water in the South Platte, Arkansas, and Rio Grande Basins is extremely limited, and reliance on nonrenewable, nontributary groundwater as a permanent water supply creates reliability and sustainability concerns, particularly along the Front Range. It also finds that Colorado River compact entitlements are not fully utilized and that water in the Colorado River system may be available to meet future needs. However, in order to develop new water supplies in the Colorado River system, projects and methods will be needed to manage the risks of additional development.

6.2 Methodology to Evaluate Surface Water Supply Availability

This section provides a summary of statewide surface water and groundwater availability. This update summarizes work to date completed by the CWCB and the basin roundtables through the development of their basinwide water needs assessments. A comprehensive analysis of water availability for each basin was completed in SWSI 1 and is only partially updated. Future SWSI updates will provide updated water availability analysis in each basin based on additional Colorado Decision Support System (CDSS) modeling tools.

In addition to the analysis of water availability in SWSI 1, the SWSI 2010 update specifically includes an updated analysis for the basins within the Colorado River system as part of CWCB's Colorado River Water Availability Study (CRWAS), which is summarized here. Updated information is also included for the South Platte Basin based on results of analysis directly associated with the South Platte Basin Roundtable Task Order.

In another effort related to water availability, statewide drought planning has occurred through the preparation and implementation of the Colorado Drought Mitigation and Response Plan (DMRP). In 2010, the CWCB conducted a comprehensive revision of the DMRP. The updated plan provides a blueprint for how the state will monitor, mitigate, and respond to drought.

The potential effects of climate change are quantified in the CRWAS, and provided at various locations throughout the Colorado River basins. Reliable climate change analyses are not yet available for the other basins and are not included in this update.

6.3 Water Availability

The purpose of this section is to summarize the available data and studies indicating the level of water availability in each basin and the location of opportunities for further new water supply development.

Table 6-1 below summarizes the findings from SWSI 1 related to water supply development potential under interstate compacts and U.S. Supreme Court decrees. Colorado has entered into and is affected by nine interstate compacts, two equitable apportionment decrees, and one international treaty.

Table 6-1 Major Interstate Compacts, Decrees, and Endangered Species Programs by Basin

River Basin	Flows Legally Available under Compact or Decrees for Future Development	Interstate Compacts, Equitable Apportionment Decrees and Endangered Species Recovery Programs	Year of Compact or Decree
Arkansas		Arkansas River Compact	1948
		Kansas vs. Colorado	1995
Colorado	✓	Colorado River Compact	1922
		Upper Colorado River Basin Compact	1948
		Upper Colorado River Endangered Fish Recovery Program	—
		Rio Grande, Colorado, and Tijuana Treaty between United States and Mexico	1945
Dolores/San Juan/ San Miguel (Southwest)	✓	Colorado River Compact	1922
		La Plata River Compact	1922
		Upper Colorado River Basin Compact	1948
		Animas-La Plata Project Compact	1969
		San Juan River Basin Recovery Implementation Program	—
		Rio Grande, Colorado, and Tijuana Treaty between United States and Mexico	1945
Gunnison	✓	Colorado River Compact	1922
		Aspinall Unit Operations	—
		Upper Colorado River Basin Compact	1948
		Upper Colorado River Endangered Fish Recovery Program	—
		Rio Grande, Colorado, and Tijuana Treaty between United States and Mexico	1945
North Platte/ Laramie	✓	Nebraska vs. Wyoming	1945
		Wyoming vs. Colorado	1957
		Platte River Recovery Implementation Program	—

Table 6-1 Major Interstate Compacts, Decrees, and Endangered Species Programs by Basin, continued

River Basin	Flows Legally Available under Compact or Decrees for Future Development	Interstate Compacts, Equitable Apportionment Decrees and Endangered Species Recovery Programs	Year of Compact or Decree
Rio Grande		Rio Grande River Compact	1938
		Costilla Creek Compact (amended)	1963
		Rio Grande, Colorado, and Tijuana Treaty between United States and Mexico	1945
South Platte	✓	South Platte River Compact	1923
		Republican River Compact	1942
		Platte River Recovery Implementation Program	—
Yampa/White/Green	✓	Colorado River Compact	1922
		Upper Colorado River Basin Compact and Yampa River Portion	1948
		Upper Colorado River Endangered Fish Recovery Program	—
		Rio Grande, Colorado, and Tijuana Treaty between United States and Mexico	1945

These agreements establish how water is apportioned between Colorado and downstream states as well as between the United States and Mexico. Each agreement has a significant effect on the development of future water supplies in Colorado.

SWSI 1 found there are no reliable additional water supplies that can be developed in the Arkansas and Rio Grande Basins, except in very wet years. The North Platte Basin has the ability to increase both irrigated acres and some additional consumptive uses, consistent with the North Platte Decrees. The South Platte Basin has water that is legally and physically available for development in wet years, although unappropriated water is extremely limited.

Compact entitlements in the Colorado River Basins are not fully utilized and those basins (Colorado, Gunnison, Southwest, and Yampa-White) have water supplies that are legally and physically available for development given current patterns of water use.

During SWSI 1, it was documented that there are no reliable available surface water supplies for development in the Arkansas Basin except in very wet years. During these high flow years, water could be placed into storage or developed for use in a conjunctive use (e.g., aquifer recharge and recovery) project where nontributary groundwater could be used as a primary supply. In addition, the 1948 Arkansas River Compact plays a major role in limiting supply availability in the basin by restricting water use by post-1948 diversions to times when there would be no depletions to usable stateline flows. These times would only occur under high flows when John Martin Reservoir is spilling. The compact apportions the storage in John Martin Reservoir from the Arkansas River between Colorado (60 percent) and Kansas (40 percent), as administered by the Arkansas River Compact Administration. John Martin Reservoir does not spill very often, with the last spill occurring in 1999. It did not spill between 1965 and 1985.

In addition to infrequent surface water availability, some of the use of nontributary groundwater in the basin will need to be replaced. Currently, 13,350 acre-feet per year (AFY) of nontributary and nonrenewable groundwater is relied upon by water users in unincorporated El Paso County and the Town of Monument (*Arkansas Basin Consumptive Use Water Needs Assessment 2030*, CWCB 2008; included as Appendix B of this report). The Arkansas Basin Roundtable identified that this 13,350 AFY of nontributary groundwater will need to be replaced. This replacement of nontributary groundwater was accounted for and discussed in Section 5 of this report in the municipal and industrial (M&I) gap section.

Unappropriated water in the Arkansas Basin is extremely limited.

Section 7
Arkansas Basin Implementation and Recommendations

7.1 Implementation and Recommendations Overview

This section summarizes the Arkansas Basin Roundtable's Water Supply Reserve Account (WSRA) grants that have been funded to date implement portions of their needs assessment as well as the basin roundtable's recommendations for topics to be discussed, studied, or implemented by the roundtable in the future.

7.2 Recommendations

Following are the Arkansas Basin Roundtable's recommendations for future consideration by the basin roundtable:

- Implementation of the Arkansas Basin's identified projects and processes (IPPs) is critical to meeting future municipal and industrial (M&I) demands as outlined in the roundtable's Resource Document: *Projects & Methods to Meet the Needs of the Arkansas Basin Roundtable* (included as Appendix A to this report). The roundtable recognizes the importance of the following IPPs in addressing the basin's M&I needs: Preferred Storage Option Plan (PSOP), Arkansas Valley Conduit (AVC), and Southern Delivery System.
- The Arkansas Basin agrees with the Interbasin Compact Committee's (IBCC's) recommendations of needing the "four legs of the stool" to meet future M&I demands. The Arkansas Basin Roundtable defines the four legs of the stool to include: active and passive conservation, implementation of all the IPPs, alternative agricultural transfers, development of Colorado River supplies.
- Storage is essential to meeting all the basin's consumptive and nonconsumptive needs. The roundtable has recognized the importance of the PSOP for meeting the basin's future needs. In addition, Aquifer Storage and Recovery should be considered when examining future storage options. Also, storage is an important element to make the "four legs of the stool" successful and minimizes the risk associated with each leg of the stool.
- Development of portfolios to meet the basin's future needs and associated trade-offs can inform development of risk management strategies.
- A critical gap that needs to be addressed in the future in the basin is replacement of nonrenewable groundwater and the sustainability of designated groundwater basins.
- The basin roundtable recognizes that there are many advocates for M&I demands in the basin. However, environmental, recreational, and agricultural interests are important in the basin and the issues related to the needs of these interests need to continue to be supported by the roundtable.

- The basin roundtable's nonconsumptive committee has identified focus areas in the basin. The committee plans to continue prioritizing environmental and recreational areas in the basin and also to identify areas for further quantification.
- It is equally important to determine the agricultural water need gap as well as the M&I gap. Agriculture is integral to the economic and social fabric of the basin and the roundtable recommends that further effort be considered by the roundtable in defining an agricultural "gap" for the basin. The roundtable recommends that this gap be a production based gap and build upon other efforts the roundtable has conducted through the Colorado Water Conservation Board's (CWCB's) Alternative Agricultural Transfer Grant program.
- With respect to future agricultural to urban transfers, the basin roundtable recommends that the framework developed in their *Considerations for Agriculture to Urban Water Transfers* report be utilized (Appendix D to this report).

7.3 Water Supply Reserve Account Grant Summaries

Following are summaries of the WSRA grants that the Arkansas Basin Roundtable has funded to date.

Arkansas Valley Conduit

APPLICANT: Southeastern Colorado Water Activity Enterprise

APPROVED: March 2007

STATUS: In Progress

WSRA FUNDS: $200,000 (Statewide Account)

MATCHING FUNDS: $212,000 (plus past study cost of up to $140,000)

DESCRIPTION:

The AVC was incorporated as an original component of the Fryingpan-Arkansas (Fry-Ark) Project, but never constructed due to the inability of the local constituents to pay 100 percent of the costs as required by the U.S. Bureau of Reclamation. The Southeastern Colorado Water Conservancy District, which manages the Fry-Ark Project, has created the Southeastern Colorado Water Activity Enterprise (Enterprise) in part to help construct the AVC. The AVC is designed to bring higher quality water to the communities east of Pueblo that have had growing issues with water quality since the inception of the project. Currently, 13 of these entities are under Active Enforcement Orders from the Colorado Department of Public Health and Environment (CDPHE). The AVC will provide for the delivery of 12 percent of Fry-Ark water that is dedicated to these communities (an average of about 6,202 acre-feet [AF]). The Enterprise is seeking to leverage the WSRA funds along with local matching funds to secure $675,000 of U.S. Environmental Protection Agency funding for the AVC's pre-design development work.

Long-term Management of Non-native Phreatophyte Trees and Mapping Project (Tamarisk)

APPLICANT: Southeastern Colorado Water Conservancy District

APPROVED: March 2007

STATUS: Complete

WSRA FUNDS: $50,000 (Statewide Account)

MATCHING FUNDS: $17,000 cash and in-kind

DESCRIPTION:
Southeastern Colorado Water Conservancy District is developing a Strategic Plan for the Long-Term Management of Non-Native Phreatophyte Trees that includes the completion of a mapping project to inventory the infestation level in the basin. Non-native phreatophyte trees (Tamarisk, Russian olive, and Siberian elm) have infested much of the riparian lands and are moving into the upland areas causing serious impacts to the limited water resources in the Arkansas River Basin (currently estimated at almost 60,000 AF). The planning and mapping project is designed to develop a comprehensive basinwide approach, without which control efforts will be largely ineffective. A specific goal is to develop a strategic long-term management plan to efficiently and effectively implement control, riparian restoration, monitoring, and maintenance measures. To compliment the Plan a comprehensive database will be developed to assist property owners and land managers in determining proper control, restoration, monitoring, and long-term maintenance methods for a particular infestation level and land situation. This database will be available on a website enabling the district and other entities to track the progress of the plan's implementation.

Upper Black Squirrel Creek Aquifer Recharge Investigation

APPLICANT: El Paso County Water Authority

APPROVED: March 2007

STATUS: Complete

WSRA FUNDS: $45,200 (Basin Account)

MATCHING FUNDS: $70,000

DESCRIPTION:
This project evaluates and refines the existing knowledge of the alluvial aquifer system in the Upper Black Squirrel Creek Designated Groundwater Basin to assess the potential for aquifer recharge and storage implementation. Existing municipal supply systems could access recharged water, representing a substantial cost savings over new construction. Agricultural interests could be restored, enhanced, and/or sustained by thoughtful management of the recharge and recovery administration. Geographic, geologic, hydrologic, and water quality data was collected and analyzed to evaluate the recharge potential, storage capacity, and water quality impacts in the study area. Previous studies have identified sizable storage potential due in part to a significant drawdown of the aquifer. The project's second phase further details a select site or sub-basin for potential pilot project implementation. The project also sought to validate the potential for significant non-evaporative storage in order to justify infrastructure development to deliver agricultural water generated from rotational fallowing.

Groundwater Aquifer Recharge Conference

APPLICANT: El Paso County Water Authority

APPROVED: March 2007

STATUS: Complete

WSRA FUNDS: $24,721 (Basin Account)

MATCHING FUNDS: None

DESCRIPTION:
This project was originally included as a part of the Upper Black Squirrel Aquifer Recharge Investigation Project detailed above. Due to CWCB concerns that the conference was not adequately included in the original scope of work, it was divided into a separate project. The project consists of a policy conference to review the economic and legal issues affecting the use of alluvial aquifers for underground storage in Colorado. Conjunctive use of surface and groundwater has long been recognized by water resource experts as technically feasible. Aquifer recharge programs are becoming increasingly common in Colorado. However, depending on the geology and designation of the groundwater system and various administrative considerations, a number of economic and legal issues have not been fully explored. This conference sought to examine those and other issues.

Fountain Creek Vision Task Force

APPLICANT: Pueblo and El Paso Counties

APPROVED: May 2007

STATUS: Complete

WSRA FUNDS: $75,000 (Basin Account)

MATCHING FUNDS: $43,800

DESCRIPTION:
The Fountain Creek Vision Task Force is the creation of El Paso County and Pueblo County, with the help of the Lower Arkansas Valley Water Conservancy District (LAVWCD) and the El Paso County Water Authority. The Task Force consists of over 200 members from various entities and communities in the watershed that represent a wide range of interests. This project seeks to develop a detailed "Strategic Plan for Fountain Creek Watershed," which identifies consumptive and nonconsumptive water needs in the basin along with methods and projects for addressing those needs. The plan leverages existing studies into specific solutions to meet the needs and problems in the watershed. It is a consensus-based document, agreed to by the diverse members of the Consensus Committee, and includes projects both within jurisdictions as well as several that cross jurisdictions. The Strategic Plan was vetted and improved by members of the affected and invested communities and will become the shared community roadmap for the future of Fountain Creek.

Round Mountain Water & Sanitation District Water System Improvements Project

APPLICANT: Round Mountain Water and Sanitation District

APPROVED: May 2007

STATUS: Complete

WSRA FUNDS: $120,000 (Basin Account)

MATCHING FUNDS: $150,000 (Applicant) and $380,000 (DOLA Grant)

DESCRIPTION:
A recent evaluation of the public water system for the Towns of Silver Cliff and Westcliffe, served by the Round Mountain Water & Sanitation District, identified major shortcomings that demand immediate attention. Shortcomings include water pressure below state guidelines, insufficient fire flow, inadequate chlorine contact time, and critically low system storage during peak times. System improvements are necessary to not only provide for the health, safety, and welfare of the citizens of these towns, but also to allow for expansion. The project includes drilling a new water supply well with a new pump, electrical supply, treatment building and equipment, and chlorine contact chamber. The district also installed a new water main from the well site to the existing system to create a new pressure zone. The new zone has a variable frequency booster pump station, a generator back up and electrical supply, new water line looping, and an additional water storage tank.

Rotational Land Fallowing - Water Leasing Program - Lower Arkansas Super Ditch Company

APPLICANT: Lower Arkansas Water Conservancy District

APPROVED: January 2008

STATUS: Complete

WSRA FUNDS: $150,000 (Basin Account)

MATCHING FUNDS: $68,735

DESCRIPTION:
The LAVWCD was created in 2002 to serve the Lower Arkansas River Basin from above Pueblo Reservoir to the Kansas State line. The Rotational Land Fallowing and Water Leasing Program is designed to create an alternative to the traditional acquisition and transfer of water rights by M&I water providers seeking to meet increasing demands. The nonstructural project is an entirely voluntary program that links irrigators desiring to lease water with municipalities and other water users with unmet demands. The program also seeks to acquire and hold for agricultural, municipal, and other uses, water rights that might otherwise be sold and permanently transferred out of the Basin. The flexibility of the program ultimately seeks to maintain land in irrigation that might otherwise be dried up while operating entirely within existing Colorado water law and absent injury to any vested, conditional, or contractual water rights. As such the program seeks to maximize the short- and long-term value of irrigation water in the valley by providing a viable alternative to conventional "buy and dry" projects. To implement the program irrigators will create an independent "Super Ditch Company" to lease water made available by the fallowing of irrigated land. Irrigators between Pueblo and John Martin Reservoirs may participate at their discretion. Land irrigated by participants may be fallowed on a rotational basis to match hydrology with lease demands.

Upper Big Sandy Water Balance

APPLICANT: Upper Big Sandy Ground Water Management District

APPROVED: January 2008

STATUS: Complete

WSRA FUNDS: $45,000 (Basin Account)

MATCHING FUNDS: $5,000

DESCRIPTION:
This project quantifies the use and supply of alluvial groundwater within the Upper Big Sandy Ground Water Management District and creates a water balance to assist the District in developing long-term management policies, especially in regard to well pumping and maximum levels of sustainable pumping (safe yield). The Water Balance provides the district with a technical basis upon which they can approve or deny new well permits, and therefore allow the district to plan for the current and future use of the alluvial groundwater. Additionally, this project could lead to a dynamic groundwater model to help planning efforts for future droughts. The study assesses consumptive and nonconsumptive water needs and compares the needs against the available water supply via a water balance assessment approach. The study also examines how a lowered water table may affect threatened species, wetlands, and other environmental or recreational amenities. The project compares the needs with the annual recharge to determine sustainability and will compare the water in storage to determine if water table lowering is expected.

Model Transfers - Agriculture to Urban, Arkansas Basin

APPLICANT: Southeastern Colorado Water Conservancy District

APPROVED: January 2008

STATUS: Complete

WSRA FUNDS: $23,860 (Basin Account)

MATCHING FUNDS: None

DESCRIPTION:
This project is designed by the Water Transfers Committee of the Arkansas Basin Roundtable to develop a portfolio of prototypes to address issues and mutual benefits associated with transfers of water from agriculture. The Water Transfers Committee members represent a wide swath of Arkansas Basin Roundtable agricultural and urban interests. The Committee identified specific transfer alternatives and mitigation options to enhance rural economic viability and agricultural modernization. Outside advisors assisted as needed for input and review, reporting periodically to the roundtable. The project includes work sessions led by a facilitator, interim reports, and a final report. The reports outline a broad range of alternatives considered by the committee resulting in a matrix categorizing the alternatives, listing positive and negative aspects, measures to mitigate negative aspects, and identification of the best alternatives for subsequent experimentation, demonstration, and/or academic research.

Arkansas Headwaters Diversion Structure Improvement Project

APPLICANT: Greater Arkansas River Nature Association

APPROVED: March 2008

STATUS: Complete

WSRA FUNDS: $57,954.50 (Statewide Account)

MATCHING FUNDS: $59,804

DESCRIPTION:
Water-based recreation within the Arkansas Headwaters Recreation Area has been recognized as a critical nonconsumptive water need in the Arkansas Basin. This engineering study provides design guidelines and structural analysis of four existing diversion structures to improve water delivery efficiency, boater safety, fisheries management, and the recreational experience of visitors to the Arkansas Headwaters Recreation Area. The four water diversion structures are located between the Towns of Granite and Canon City and include: the Granite Water Diversion Structure, the Helena Water Diversion Structure, the Hydraulic Water Diversion Structure, and the Oil Creek Water Diversion Structure. Updating these structures will create more efficient water delivery for the intended water users at all water levels, improve the public safety of recreational boaters, and improve the fishery by allowing safe passage aquatic species both up and down the river corridor during critical time periods such as the spawning season. The design drawings, modeling, and design reports provide the background necessary to ultimately reconstruct these diversions.

City of Las Animas Water System Improvements

APPLICANT: City of Las Animas

APPROVED: March 2008

STATUS: Complete

WSRA FUNDS: $300,000 ($100,000 - Basin Account; $200,000 - Statewide Account)

MATCHING FUNDS: $2,022,000 ($400,000 Applicant, $1,622,000 Grants)

DESCRIPTION:
The water treatment plant (WTP) of the City of Las Animas will be stretched beyond its capacity with the doubling in size of the local correctional facility. Furthermore, the city needs to have the facilities in place to develop the raw water it is entitled to in addition to conveying said raw water to its WTP. To address these needs, the City of Las Animas conducted a comprehensive Preliminary Engineering Report to evaluate its water system. The report identified a number of necessary improvements including: the addition of a third reverse osmosis (RO) train in the WTP, re-drilling of an existing well, and installation of a new parallel transmission line to convey raw water to the WTP. The facilities will: provide the city additional WTP capacity required to meet demands; eliminate old, brittle, and failing piping throughout the distribution system; and enable the city to operate and maintain their water system more cost effectively. This will bring an economic boost to an area suffering from years of natural disasters, economic hardship, and the transfer of water rights out of the basin.

Colorado State Parks Zebra Mussel Response

APPLICANT: Colorado State Parks

APPROVED: March 2008

STATUS: Complete

WSRA FUNDS: $1,000,000 (Statewide Account)

MATCHING FUNDS: Over $3,000,000

DESCRIPTION:
The goal of this project is to minimize the spread of zebra mussels in Colorado. Zebra mussels were confirmed by the Division of Wildlife to be present and reproducing in Lake Pueblo in January 2008. These invasive mussels have caused dramatic ecological changes and economic impacts in other states and other countries. They are small bi-valve (two shelled) mollusks like a clam, but with the unique ability to firmly attach to hard substances underwater, including pipes and conduits. They reproduce sexually and release microscopic larvae by the millions. Since zebra mussels are extremely difficult to eradicate, efforts around the country focus on containment in infested water bodies and prevention in water bodies not yet affected. Modeled after successful programs in other states, the State Parks program at Lake Pueblo includes: public education, revised boating policies, comprehensive boat inspections, boat decontamination, intensive sampling, and modeling. Expedited financial assistance defrayed the costs of additional staffing to implement the program in time for the 2008 boating season.

Geospatial Decision Support System for Integrated Water Management in the Arkansas River Basin

APPLICANT: Colorado State University

APPROVED: September 2008

STATUS: In Progress

WSRA FUNDS: $600,000 ($100,000 - Basin Account; $500,000 - Statewide Account)

MATCHING FUNDS: Unknown

DESCRIPTION:
This project furthers the Arkansas Basin Roundtable's needs assessment by providing technical studies, assistance, and analysis of water quality issues within the Arkansas River Basin. This data collection and analysis will potentially be used when the Arkansas Decision Support System is implemented by the CWCB in the near future. As such, the applicants have amended the scope of work to develop a product that would maximize benefits to the water users and future CWCB Decision Support System efforts in the basin. The project includes: assessing data needs for stream-aquifer system modeling in the basin, identifying and compiling existing data, gathering select new data, developing a database and geographic information system-based webpage, complete descriptive analysis of data gathered, and final recommendations on outstanding data needs for system characterization and model support.

Telemetry Data Collection Platforms at Six Reservoirs Plus Flow Control Equipment and Gauging at Six Reservoir Outlet Channels and Nine Streams Within the Upper Arkansas River Basin

APPLICANT: Upper Arkansas Water Conservancy District

APPROVED: September 2008

STATUS: In Progress

WSRA FUNDS: $285,332 ($75,000 - Basin Account; $210,332 - Statewide Account)

MATCHING FUNDS: $529,884

DESCRIPTION:

The Upper Arkansas Water Conservancy District proposes to install telemetry data collection platforms at six reservoirs and flow control equipment and related gages at 15 locations, which include the outlet channels for the six reservoirs and nine other locations in the Upper Arkansas Basin. The structural water activity will generate data that will be used to better manage water within the district's 2-million-acre service area at the headwaters of the Arkansas River. Many of the locations are remote and difficult to access during the winter. The telemetry platforms will allow data collection at times that otherwise would be very difficult or impossible. Additionally, there are very few existing gaging stations in the district. The additional gaging stations installed for this project will give the district much needed information to better manage its resources, as well as information that will be useful to many other entities, including the CWCB.

Demonstration of Membrane Zero Liquid Discharge Process for Drinking Water Systems

APPLICANT: Colorado Department of Public Health and Environment - Water Quality Control Division (Fiscal Agent: Water Environment Research Foundation)

APPROVED: September 2008

STATUS: Contracting

WSRA FUNDS: $800,000 - Joint Application:
- $25,000 - Arkansas Basin Account
- $25,000 - South Platte Basin Account
- $50,000 - Metro Basin Account
- $700,000 - Statewide Account

MATCHING FUNDS: $325,000

DESCRIPTION:

Membrane treatment for municipal drinking water supply (including RO and nanofiltration) is the best technology for producing potable water from lower quality/impacted sources that will meet, and often exceed, regulatory requirements. Currently, many sources of water in the Arkansas and South Platte River Basins exceed the regulatory water quality requirements and/or have high levels of total dissolved solids that are unacceptable to consumers. Due to the uncertainty about the availability of feasible disposal options for the membrane concentrate in Colorado many utilities have been reluctant to undertake membrane projects. Zero liquid discharge is a sustainable disposal option that represents a long-term solution to concentrate disposal for utilities that need membrane treatment to produce safe drinking water. The proposed project includes two pilot projects at two sites (Brighton and La Junta) with two different water quality issues (nitrate and selenium, respectively). The pilot projects will develop site-specific cost and performance data to help alleviate current technical and financial uncertainties. Deliverables include various technical memorandum, an experimental plan, design drawings, pilot plant equipment, capital and operating costs under multiple conditions, analysis of water samples, analysis of solids sampling, process

schematics and water and energy balances, and a final report. Though the CDPHE was the original applicant, the application specified that the contracting entity and project management would be provided by the non-profit American Water Works Association Research Foundation (AwwaRF) in addition to $100,000 of matching funds. Due to AwwaRF's funding problems, they are no longer able to participate in the project or provide matching funds. In its place the CDPHE has secured an identical commitment of participation and matching funds from the WateReuse Foundation (WateReuse). WateReuse is an educational, nonprofit public benefit corporation (501(c)(3)) that conducts applied research on behalf of the water and wastewater community for the purpose of advancing the science of water reuse, recycling, reclamation, and desalination.

John Martin Wetlands and Neenoshe Reservoir Nonconsumptive Needs Quantification

APPLICANT: Lower Arkansas Water Conservancy District

APPROVED: May 2009

STATUS: In Progress

WSRA FUNDS: $148,975 (Basin Account)

MATCHING FUNDS: $43,250

DESCRIPTION:
The LAVWCD seeks to further quantify nonconsumptive needs within the basin. The objectives of the nonconsumptive needs quantification are to: 1) identify flow needs to support wetlands west of John Martin Reservoir that support critical environmental and recreational bird habitat; 2) identify lake levels needed to support habitat of federally listed shore birds, Least Tern and Piping Plover, near Neenoshe Reservoir; and 3) under a separate scope of work prepare a river restoration plan for 44 miles of Fountain Creek. This scope of work includes the development of the appropriate methodologies that will be most useful to quantify the needed water for objectives one (1) and two (2). Historical data will be collected, including hydrologic and hydraulic data available from USGS, NWIS, and other sources, wetland studies, and wildlife species data. Applicant will then conduct a gap analysis to help determine data collection needs. Project will focus on surveys of habitat, plant species, soil type, wildlife, and hydrology indicators. GPS data and photo documentation will also be collected.

UAWCD Hydrologic Water Balance Study

APPLICANT: Upper Arkansas Water Conservancy District

APPROVED: September 2009

STATUS: In Progress

WSRA FUNDS: $180,000 (Statewide Account)

MATCHING FUNDS: Approximately $200,000

DESCRIPTION:
This study seeks to quantify the surface water and groundwater components of the water budget (especially groundwater recharge) and to characterize the interaction between surface and groundwater. Study results can be used to estimate the effects in water use changes on the availability and sustainability of groundwater resources. The major tasks of the project include data compilation, data collection, data analysis, and reporting. Due to growth pressures in the upper basin a better understanding of the connection between the ground and surface water hydrology will allow better management of the basin's water.

Bedload/Sediment Collection and Removal Technology - Fountain Creek

APPLICANT: City of Pueblo

APPROVED: September 2009

STATUS: In Progress

WSRA FUNDS: $190,000 ($40,000 - Basin Account; $150,000 - Statewide Account)

MATCHING FUNDS: $5,000

DESCRIPTION:
This project will install and monitor the success of a Bedload Monitoring Collector system to be placed in Fountain Creek approximately 1/2-mile upstream of the confluence with the Arkansas River. The project will assess changes in the water quality and any reductions in downstream sediment deposition as well as the creek's ability to manage high flow conditions. The improvements involve the placement of a pre-cast concrete sediment collector within the bed of the creek. The collector will serve as a research tool to gage the transport rates of sediment captured by a large-scale collector and to verify the system's ability to remove and classify by granule size the sediment for the beneficial re-use by the City of Pueblo. This demonstration project will be conducted for a one-year period with monitoring and testing completed at specific times and a variety of flow conditions. The project includes monitoring to assess the success of the project in relationship to establishing sediment transport modeling criteria, removal of contaminants from Fountain Creek, impacts to sediment and potential benefits in reduction of erosion, and the re-establishment of a stable creek channel.

Flaming Gorge Project Task Force Assessment

APPLICANT: El Paso County Water Authority

APPROVED: May 2010

STATUS: In Progress

WSRA FUNDS: $40,000 - Joint Application:
$20,000 - Arkansas Basin Account
$20,000 - Metro Basin Account

MATCHING FUNDS: None

DESCRIPTION:
This project assesses the viability of forming a task force, similar to the Fountain Creek Vision Task Force, to inform a Flaming Gorge Project. The assessment will review constituent agendas, supply alternatives, demand management, environmental impacts, and project development strategies to determine if a collaborative task force model is viable. Keystone Center will prepare a written Assessment Summary, including a recommendation whether to proceed to the convening of a task force. If the recommendation is not to convene, the summary will identify the obstacles to a successful convening or suggest alternatives to a task force approach. If the recommendation is favorable, Keystone Center will develop a protocol for the task force and convene the preliminary Task Force session.

Stakeholder's Cooperative Management Analysis for the Upper Arkansas River Basin

APPLICANT: Southeastern Colorado Water Conservancy District

APPROVED: July 2010

STATUS: In Progress

WSRA FUNDS: $33,600 (Basin Account)

MATCHING FUNDS: $8,400

DESCRIPTION:
The Voluntary Flow Management Program developed in 1990 for the Upper Arkansas is considered a model throughout Colorado and the country and has allowed for Colorado's most vibrant rafting economy. After 15 years of operating, the addition of Chaffee County's recreational in-channel diversion, and other water management agreements and objectives, many stakeholders believe that flows could be managed better to meet the needs of many stakeholders. This project is a stakeholder supported investigation of past and current river operations in the upper Arkansas River Basin. This analysis will identify historic management strategies used during high, average, and low river flow years and assess the impacts of those strategies. Then, based on stakeholder inputs, a limited number of new management strategies to enhance impacts on fishery, recreational, agricultural, and landowner components will be developed and assessed. The study will focus on water supplies in the upper Arkansas River Basin, especially as it relates to the operations involving transmountain diversions, municipal upstream exchanges from Pueblo Reservoir and Fountain Creek, releases from Turquoise and Twin Lakes Reservoirs, and storage levels in Pueblo Reservoir. Input from the stakeholders will be analyzed in the context of a river operations analysis that identifies the legal and institutional framework in which all management alternatives must be considered.

Fountain Creek Fish Marking and Monitoring Study

APPLICANT: Fountain Creek Watershed Greenway and Flood Control District

APPROVED: September 2010

STATUS: Contracting

WSRA FUNDS: $35,000 ($8,000 - Basin Account; $28,000 - Statewide Account)

MATCHING FUNDS: None

DESCRIPTION:
This project involves the study of the movement of the Flathead Chub, which is state species of special concern. Colorado Springs Utilities received a nonconsumptive statewide WSRA grant for the design and planning of a fish passage for an 8-foot diversion structure located on Clear Springs Ranch, a Colorado Springs Utilities owned property in El Paso County. This application will fund the study of this fish, specifically where it is and how it moves up and down Fountain Creek in relation to the fish passage. It will aid in the planning of the fish passage design and the future monitoring of Colorado Springs Ranch diversion structure as well as other impediments along Fountain Creek.

Trinidad/Purgatoire River Reach 4 Demonstration Project

APPLICANT: Purgatoire River Water Conservancy District

APPROVED: January 2011

STATUS: Contracting

WSRA FUNDS: $75,000 (Arkansas Basin Account)

MATCHING FUNDS: $20,000 cash match; $68,980 in-kind match

DESCRIPTION:
The goal of this project is to improve the aquatic habitat and riparian areas of approximately 1/2-mile of the Purgatoire River in downtown Trinidad, Colorado. Improvements will provide velocity shelter, cover, and quality usable habitat for resident trout during the high flow summer months through the installation of in-channel habitat features. A new handicap accessible trail will be constructed along the river to provide fishing access for persons with disabilities. Three handicap accessible river fishing sites will be constructed adjacent to newly installed habitat features in the project reach.

Helena Diversion Structure/BV Boat Chute Demonstration Project

APPLICANT: Arkansas Headwaters Recreation Area (AHRA)

APPROVED: March 2011

STATUS: Contracting

WSRA FUNDS: $325,000 ($290,000 - Statewide Account; $35,000 - Arkansas Basin Account)

MATCHING FUNDS: $35,000 Basin Funds and $25,320 Stakeholder Match

DESCRIPTION:
The Helena Diversion Structure at Buena Vista is owned and operated by the Colorado Department of Corrections and local land owners. The structure is currently navigated by both private and commercial boaters. It is extremely dangerous because portions of the structure have shifted over time. The shift created an unpredictable spillway that has lead to a boating fatality in the summer of 2007. The structure also prohibits the safe passage of aquatic species both up and down the river during the spawning season. AHRA plans to use statewide and Arkansas Basin funding to engineer and construct a new structure that will allow for safe recreational boat passage and improved fish migration. The new structure will also improve water delivery efficiency at all water levels.

Raising Awareness in 2012: A Statewide Celebration of Colorado Water

APPLICANT: Colorado Foundation for Water Education

APPROVED: March 2011

STATUS: Contracting

WSRA FUNDS: $30,515 (Statewide Account)

MATCHING FUNDS: $26,670 Cash Match; $25,400 In-kind Match

DESCRIPTION:
The year 2012 is a milestone for Colorado water. What started as an anniversary celebration of several Colorado Water organizations (e.g., Colorado Water Conservation Board, Northern Colorado Water Conservancy District, Colorado River Water Conservation District, and Southwest Colorado Water Conservation District) has grown into a statewide celebration of the uses and values of water. In 2012, all corners of Colorado will host events that educate Coloradoans on water's history and science. The purpose of this grant is to provide support for these organizations by developing and education outreach plan.

Super Ditch Delivery Engineering

APPLICANT: Lower Arkansas Valley Water Conservancy District

APPROVED: March 2011

STATUS: Contracting

WSRA FUNDS: $225,837 (Statewide Account)

MATCHING FUNDS: $56,460 Cash/In-kind Match

DESCRIPTION:
This project is an extension of the previous work performed by and for the LAVWCD to advance the Super Ditch fallowing project. The LAVWCD and the Super Ditch Company seek to preserve irrigated agriculture in the Lower Arkansas Basin with temporary water transfers and other methods than can benefit both the municipal interests and those of the local agricultural based economy. This additional engineering work will enable a better understanding of the water resources in the Lower Arkansas Basin and better modeling of the operations. The key objectives of the project follow: analysis of reservoir operations in the lower Arkansas Basin, analysis of Pueblo Reservoir operations, analysis of the Winter Water Storage Program, recovery of non-exchangeable supplies, system calibration and optimization, and engineering and economic integration.

The Use of Excess Storage Capacity in Blue Mesa Reservoir to Avoid or Reduce the Impact of a Colorado River Compact Curtailment in Colorado

APPLICANT: Southeastern Colorado Water Conservancy District and the Upper Gunnison River Water Conservancy District

APPROVED: March 2011

STATUS: Contracting

WSRA FUNDS: $245,000 ($196,000 from Statewide Account; $24,500 from Gunnison Account; $24,500 from Arkansas Account)

MATCHING FUNDS: $49,000 Cash Match (Basin Funds)

DESCRIPTION:

The objectives of this project are to assess the effectiveness of using excess capacity storage in Blue Mesa Reservoir to avoid, forestall, and/or mitigate the magnitude and duration of potential Colorado River Compact curtailment in Colorado. A principle objective is to evaluate the use of Blue Mesa Reservoir as a potential storage location for a Colorado water bank. The analysis may also consider and use the potential output of the Water Banking Study (partially funded by the CWCB through the ATM grant program) to be conducted by the Water Bank Group as input reflecting the likely available supplies (e.g., pre-1922 consumptive use credits) that might be deposited in a water bank. The project will contribute to better understanding of circumstances surrounding a potential curtailment of Colorado River diversions in Colorado and the effectiveness of utilizing excess storage capacity in Blue Mesa Reservoir as a water bank. The project will provide a draft report that will include conclusions and recommendations based upon the findings.

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