Filling the Gap

SECOND IN A SERIES

Meeting Future Urban Water Needs in the Arkansas Basin

WESTERN RESOURCE ADVOCATES

TROUT UNLIMITED

COLORADO ENVIRONMENTAL COALITION
ourcolorado.org

This is the second report in a series that provides a proactive approach to meeting the future water needs of Colorado while protecting the state's economy, environment, and quality of life.

This report is a collaborative effort by Western Resource Advocates (WRA), Trout Unlimited (TU), and the Colorado Environmental Coalition (CEC). The coordinating lead author of the report is Jorge Figueroa (WRA). Mr. Figueroa, John Gerstle (TU), Laura Belanger (WRA), and Dan Luecke (consultant) are the chapter authors. Drew Beckwith (WRA), Drew Peternell (TU), and Becky Long (CEC) are the review editors. Production was facilitated by Nicole Theerasatiankul, Jason Bane, and Anita Schwartz (WRA).

We would like to thank Wayne Vanderschuere, Abby Ortega, and Kevin Lusk from Colorado Springs Utilities; Paul Fanning and Alan Ward from the Pueblo Board of Water Works; and Peter Nichols from Trout, Raley, Montano, Witwer & Freeman, PC for their review. Their experience in Colorado water issues and thoughtful suggestions improved the quality of this report. We are also grateful for the time and information provided by the Pueblo Board of Water Works, Colorado Springs Utilities, High Country Hydrology, the Southeastern Colorado Water Conservancy District, the Lower Arkansas Valley Water Conservancy District, Hunter Industries, and the Center for ReSource Conservation. The authors take full responsibility for any mistake found in this report, and the review of this document by the above entities does not imply their agreement with or endorsement of the concepts, analysis, methodologies, or conclusions of this report.

This work was funded through grants from the David and Lucile Packard Foundation, the Walton Family Foundation, and the Winslow Foundation.

Design by Jeremy Carlson

WESTERN RESOURCE ADVOCATES

TROUT UNLIMITED

COLORADO ENVIRONMENTAL COALITION
ourcolorado.org

After reading *Filling the Gap: Meeting Future Urban Water Needs in the Arkansas Basin*, I am once again impressed with the exceptional work of Western Resource Advocates on issues relating to water in Colorado. They are joined in this effort by Trout Unlimited and the Colorado Environmental Coalition, two other groups that care deeply about the future of Colorado. The report tackles one of the thorniest issues I wrestled with as Governor—how to protect the Arkansas River Basin. Different stakeholders have locked horns over this problem, but answers have been elusive. This report presents real solutions going forward, and everyone who cares about the Arkansas River Basin should pay attention.

—Bill Ritter, Jr.
Former Governor of Colorado

Arkansas headwaters in autumn.

The Smart Principles

Western Resource Advocates, Trout Unlimited, and the Colorado Environmental Coalition recommend that future water supply management and development efforts adhere to a set of basic smart principles. We initially published these principles in 2005 in the *Facing our Future* report, where we used them to evaluate water storage and supply projects at that time proposed for the South Platte and Arkansas Basins. Our 2011 *Filling the Gap* report built on these smart water supply principles to analyze projects proposed for the South Platte Basin. This Arkansas Basin report further refines these principles and offers them as a guide to assure protection of rivers and other natural resources against damage that often results from structural water supply projects. The smart principles are:

1. Make full and efficient use of existing water supplies and reusable return flows before developing new diversion projects.
2. Improve use of existing water supply infrastructure by integrating systems and sharing resources among water users to avoid unnecessary new diversions and duplication of facilities.
3. Recognize the fundamental political and economic inequities and the adverse environmental consequences of new transbasin diversions.
4. Expand or enhance existing storage and delivery before building new facilities in presently undeveloped sites, and expand water supplies incrementally to better utilize existing diversion and storage capacities.
5. Recognizing that market forces now drive water reallocation from agricultural to municipal uses, structure voluntary transfers, where possible, to maintain agriculture and in all cases to mitigate the adverse impacts to rural communities from these transfers.
6. Involve all stakeholders in decision-making processes and fully address the inevitable environmental and socioeconomic impacts of increasing water supplies.
7. Design and operate water diversion projects to leave adequate flows in rivers to support healthy ecosystems under all future scenarios, even if water availability diminishes in the future as a result of climate change or other factors.
8. Seek to develop "multi-purpose projects" to spread project benefits as well as costs.

Contents

Acronyms, Abbreviations, Definitions, and Units

acre-foot	325,851 gallons (the amount of water 2–4 families use in 1 year)
AF	acre-foot or acre-feet
AFY	acre-feet per year
ag/urban	agricultural/urban (in reference to cooperative agreements)
AMR	automated meter reading
APP	Acceptable Planned Project
CEC	Colorado Environmental Coalition
CRWCD	Colorado River Water Conservation District
CSU	Colorado Springs Utilities
CU	consumptive use (water)
CWCB	Colorado Water Conservation Board
DOLA	Colorado Department of Local Affairs
FEIS	final environmental impact statement
firm yield	A measure of dependable water supply that can be expected in most (including dry) years, typically used in municipal water supply planning. Average and wet-year yields can be significantly higher than firm yield.
Fry-Ark	Fryingpan-Arkansas Project
GPCD	gallons per capita per day
IBCC	Interbasin Compact Committee
IPPs	Identified Projects and Processes
ISF	instream flow (water right)
kWh/AF	kilowatt-hours per acre-foot (a measure of energy intensity)
LAVWCD	Lower Arkansas Valley Water Conservancy District
mgl	milligrams per liter
MWh	megawatt-hour (1 million watt hours)
M&I	municipal and industrial
NCNA	Nonconsumptive Needs Assessment subcommittee (a subcommittee of the Arkansas Basin Roundtable)
PBWW	Pueblo Board of Water Works
PPRWA	Pikes Peak Regional Water Authority
PSOP	Preferred Storage Options Plan
RICD	recreational in-channel diversion (water right)
SDS	Southern Delivery System
SECWCD	Southeastern Colorado Water Conservancy District
SFR	single-family residential (water user)
SSI	self-supplied industrial (water user)
SWSI	Statewide Water Supply Initiative
TU	Trout Unlimited
Urban Counties	El Paso and Pueblo counties (Colorado)
U.S.	United States (of America)
VFMP	Voluntary Flow Management Program
WRA	Western Resource Advocates
WWTP	wastewater treatment plant

Preface: Planning for Colorado's Water Future

Folks in Colorado have plenty to be thankful for—and water is right at the heart of it all.

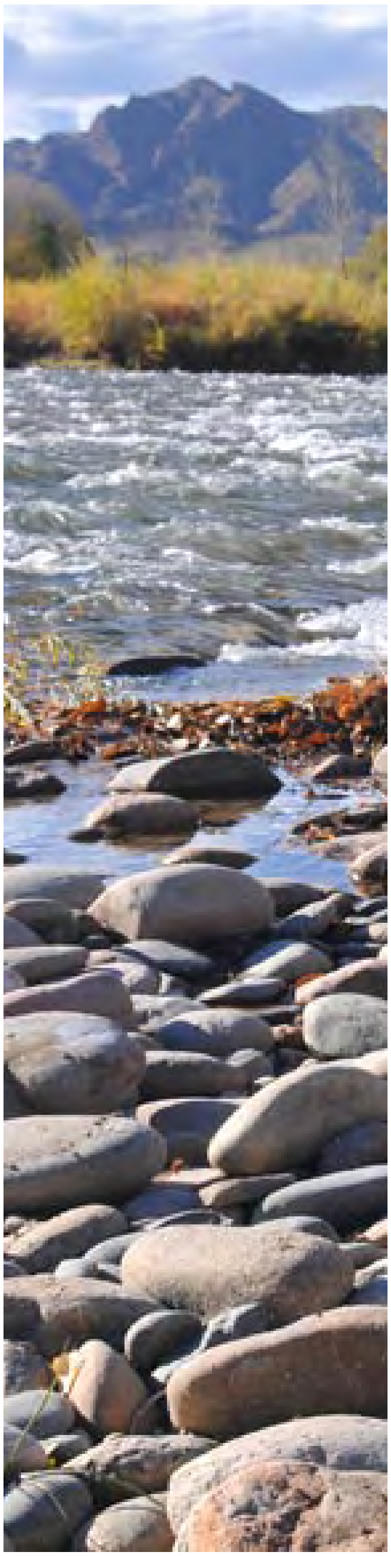
Colorado's millions of people, its landscape, its fish and wildlife, and its farms and businesses all depend on water. Coloradans place great value on this essential resource. Whether it falls from the sky as rain or snow, and whether it ends up as part of an ear of corn, a bottle of beer, or instream habitat for trout, water is essential to Colorado's exceptional quality of life.

Sustaining Colorado's lifestyle and economy demands that we preserve the state's waterways. Healthy rivers and streams support a diversity of fish, wildlife, and ecosystems, and draw residents and visitors to the state's world-famous natural areas. Colorado's rivers provide gold-medal trout fisheries and whitewater recreation, and are focal points for urban greenways in communities from Fort Collins to Durango and from Steamboat Springs to Pueblo. Healthy waterways are key to Colorado's outdoor tourism industry, which injects billions of dollars into the economy each year, and to attracting new businesses to the state. All of this is at risk, however, unless decision-makers in Colorado prioritize innovative, balanced approaches for supplying water to a growing population while sustaining Colorado's rivers and streams.

Colorado is a semi-arid state that receives average annual precipitation of only 16 inches. Many rivers and streams are badly depleted as a result of dams and diversion structures that deliver water to farms, factories, and cities. Developing additional water supplies to provide for a growing population threatens to further stress rivers and streams, preventing them from adequately providing their important environmental and biological functions.

The Colorado Water Conservation Board (CWCB) and Interbasin Compact Committee (IBCC), local communities, and citizens' roundtables at the river basin level are engaged in a water supply planning process known as the Statewide Water Supply Initiative (SWSI). The SWSI effort is intended to answer the important questions of how much water Colorado will need in

Raft on Arkansas River in Buena Vista, Colorado.



Cobbles along the Arkansas River.

the future and how these needs can be met. The most recent SWSI report—titled Colorado's Water Supply Future, Statewide Water Supply Initiative 2010, and hereafter referred to as "SWSI 2010"—forecasts the need to provide an additional 88,000 acre-feet of water by 2050 to the fast-growing municipal and industrial sectors of El Paso and Pueblo counties of the Arkansas River Basin (the "Urban Counties").

Faced with this projected need, the CWCB and IBCC, together with the Arkansas Basin Roundtable, are devising plans for meeting the 2050 demands for the Arkansas Basin. Four strategies are being considered —Identified Projects and Processes (IPPs), increased water conservation, transfer of irrigation water from the agricultural sector to municipalities, and large-scale diversions of water from Colorado's Western Slope to the Front Range. Scenarios for meeting new needs are being developed based on implementation of varying levels of each of the four strategies. Although dams and pipelines and other structural projects will still be valuable in the 21st century—and we have expressed acceptance of some of these projects—too much attention in this planning effort falls on these traditional tools that are often expensive and environmentally damaging.

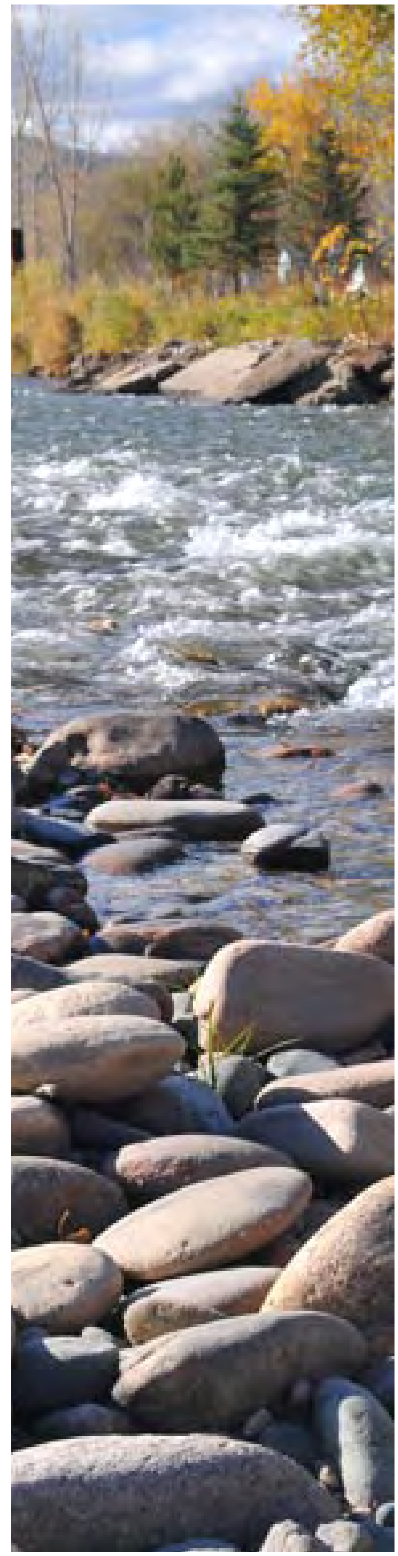
As stakeholders in the planning process, Western Resource Advocates, Trout Unlimited, and the Colorado Environmental Coalition recognize the importance of preparing for our water future. However, we are also concerned that many traditional water supply strategies have resulted in adverse impacts to rivers and streams and their associated environmental, recreational, and economic values. Rather than continuing old patterns, 21st century water development must account for instream flow needs, minimize the adverse environmental impacts of water supply strategies, and even improve stream flows or other environmental conditions on streams that are already depleted. These new challenges require new ways of thinking and new tools.

In a 2005 report called *Facing our Future: A Balanced Water Solution for Colorado*, we articulated a proactive approach for meeting water needs in the South Platte and Arkansas River Basins while protecting Colorado's environment and quality of life. *Facing our Future* highlighted cost-effective and common-sense opportunities for growing municipal areas to meet future water needs through water conservation, reuse, and sharing agreements with irrigators. We laid out a set of principles that should guide decisions regarding new water supply in this state.

In the 2011 report *Filling the Gap: Commonsense Solutions for Meeting Front Range Water Needs* (hereafter referred to as "*Filling the Gap I*"), we built on the smart water supply principles established in Facing our Future and—employing updated and widely accepted data—offered a realistic, balanced water supply portfolio that meets the projected needs in the South Platte Basin's Front Range communities while protecting Colorado's waterways, economy, and quality of life.

This report is a companion volume to *Filling the Gap I*. It demonstrates that by developing select structural water projects, implementing increased water conservation and water reuse projects, and integrating agricultural and municipal water supply systems to allow for increased sharing arrangements, the Urban Counties of the Arkansas Basin can meet their 2050 water needs at a reasonable cost without environmentally damaging water supply developments. **We commend the Urban Counties for working towards implementation of many of the recommendations of this report, and we urge them to pursue fully the strategies we present as soon as possible, as they all have an important role to play in meeting our future water needs.**

Just as we once put down the divining rods and found new ways for providing water supplies, today we must look beyond old ways of thinking and find innovative tools to meet new challenges. The time is now for the state of Colorado and local water providers to embrace new water supply strategies that meet our consumptive water use needs while sustaining the non-consumptive, instream flows that keep our rivers and streams healthy. The methods and ideas laid out in this report should guide choices that are made as we embark on this new era of water supply.



Cobbles along the Arkansas River.

Snow capped Pikes Peak soaring over Garden of the Gods Park after a fresh snowfall near Colorado Springs, Colorado.

While current planning efforts still lean towards traditional measures for supplying water, Colorado can chart a new, innovative path forward that protects our rivers, economies, and local communities.

Executive Summary

Growing Water Demands

Approximately 20% of the population of the state of Colorado lives in the Arkansas Basin.* Most of the population of the Arkansas Basin is concentrated in the Urban Counties of the basin: El Paso and Pueblo counties, which include the cities of Colorado Springs and Pueblo, respectively. Under a medium population growth scenario, the Urban Counties are projected to add 569,000 residents between 2010 and 2050, for a total population of 1.36 million people.

Population increases in the Urban Counties are expected to be the main driver for additional water demands. Accounting for the effects of passive conservation, which occur with more efficient new development and when inefficient appliances and fixtures are replaced over time, water demand for 1.36 million residents and industries in the Urban Counties of the Arkansas Basin will be approximately 314,000 acre-feet (102 billion gallons) in 2050—an increase of 88,000 acre-feet (28.7 billion gallons) in annual demand compared to the 2010 water needs.

It is worth noting that this report relies on the same data used by Colorado's Statewide Water Supply Initiative (SWSI) to project future water demand. The future water demand projections in this report include municipal and industrial (M&I) and self-supplied industrial (SSI) demands. The water demand projections for the energy sector that we use are SWSI's SSI demand projections for the Urban Counties. In addition, South Platte municipal demand on Arkansas Basin water is not considered in our demand calculations. Although they are important considerations, the impact of a potential boom in oil and gas exploration in the basin, and of additional out-of-basin municipal demand, are beyond the scope of this report.

* The following Colorado counties are located in the Arkansas Basin: Baca, Bent, Chaffee, Cheyenne, Crowley, Custer, Elbert, El Paso, Fremont, Huerfano, Kiowa, Lake, Las Animas, Lincoln, Otero, Prowers, Pueblo, and Teller counties.

There is no room for water waste in the Arkansas Basin. The State of Colorado has reported that Arkansas River Compact requirements and existing water uses result in little to no water available for new in-basin uses. Innovative water supply strategies are a must in the Arkansas Basin, and the analysis described below demonstrates that innovative approaches will meet the water needs of the basin without the need to rely solely on traditional large-scale water projects.

Our Water Management Portfolio for Meeting Future Needs

Innovative water supply strategies are a must in the Arkansas Basin.

Mirroring *Filling the Gap I*, this report explores four water supply strategies for the Arkansas Basin—acceptable planned projects, water conservation, reuse, and voluntary water sharing with the agricultural sector. As advocates for the protection of Colorado's rivers and natural heritage, Western Resource Advocates, Trout Unlimited, and the Colorado Environmental Coalition believe it is imperative for water planning to account for instream flow needs and to minimize the adverse environmental impacts of water supply strategies. In the pages that follow, we offer our view of a water supply scenario that more than fills projected needs in the Urban Counties of the Arkansas Basin (Figure ES-1). Importantly, our portfolio meets future needs without new, large, costly, and environmentally damaging transbasin diversions that have been a hallmark of traditional water supply planning.

Acceptable Planned Projects

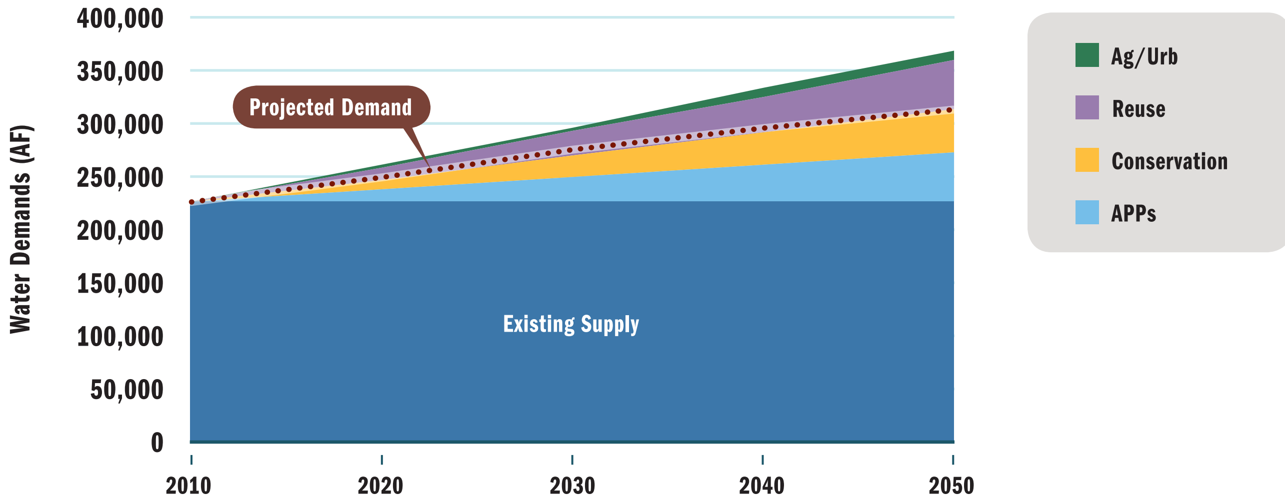
Some of the state's structural Identified Projects and Processes (IPPs) could be acceptable if designed and implemented pursuant to our "smart" principles. In this report, we refer to these projects as "Acceptable Planned Projects" (APPs). The only state-identified structural project selected as an APP in the Arkansas Basin is the Eagle River Joint Use Project. This APP can provide 10,000 acre-feet of new supply annually. The Southern Delivery System (37,000 AFY) is also accounted for in the APP category, rather than as existing supply, because it is a permitted infrastructure project under construction that is not yet operational.

Conservation

Published literature and studies by the Colorado Water Conservation Board (CWCB) indicate that per capita water use can be significantly reduced over

FIGURE ES 1 OUR PORTFOLIO FOR MEETING THE PROJECTED DEMAND OF THE URBAN COUNTIES IDENTIFIED IN SWSI 2010.

Our balanced portfolio more than fills the projected needs of the Urban Counties of the Arkansas Basin while protecting Colorado's environment.



the next 40 years through conservation techniques, practices, and technology. Accounting for both active and passive conservation savings, a 34% reduction in per capita demand—the CWCB's "high" conservation strategy—would result in an annual reduction in water demand of 93,000 acre-feet by 2050.[1] Achieving the conservation savings for a high conservation strategy will require an immediate and sustained investment in conservation programs from utilities and municipalities but no unreasonable or draconian measures. The high conservation strategy requires the implementation of cost-effective programs that are already being implemented in many communities. For purposes of this report, passive conservation savings are included within the calculation of 2050 water demands. If a little more than half of active water conservation savings are dedicated to meeting future needs, 39,000 acre-feet of new water supply will be made available annually by 2050.

Reuse

The Urban Counties have established a strong precedent for reuse in Colorado and intend to increase reuse in the future. Currently, approximately 27,000 acre-feet of water per year in the Urban Counties comes from reuse. SWSI identifies two planned reuse projects in the basin, the El Paso County Water

Authority and Pueblo Board of Water Works reuse projects, which would provide a combined medium range yield of 27,500 acre-feet. Our analysis has found that, in addition to the projects SWSI identified, reuse can provide an additional firm yield of 19,000 acre-feet per year or more to the Urban Counties by 2050, for a total increase in reuse of 46,500 acre-feet by 2050.

Ag/Urban Cooperation

Cooperative agreements between irrigators and municipal suppliers based on rotational land fallowing and temporary water leasing are a central feature of current discussions about future municipal water supply. In fact, with the creation of the Super Ditch, the Arkansas Basin is well on its way to developing the institutions necessary for a broad ag/urban sharing program. Pilot projects are already in place and larger projects are contemplated. The ag/urban sharing concept is premised on agreements that would lease water to municipalities at a price attractive to irrigators, on schedules that are sufficiently reliable for municipal suppliers, and that are established well in advance of actual reallocation of water. We believe that voluntary and compensated ag/urban cooperative water sharing arrangements can provide the Urban Counties of the Arkansas River Basin 9,100 acre-feet of water annually by 2050.

Recommendations

Planning for Colorado's water future is at a critical juncture. The SWSI process presented an abundance of information regarding water supplies, and the basin roundtables and IBCC are engaged in discussions about what the next steps should be.

Sorghum rows in a field ready for harvest.

We believe Colorado can chart an innovative path forward, one that differs from the traditional approach of building large dams and pipelines, to meet the Urban Counties' growing water needs. The portfolio of APPs, conservation, reuse, and ag-urban sharing described in this report, which is based on conservative assumptions, would produce 54,000 acre-feet (17.6 billion gallons) of water in excess of the Urban Counties' 2050 demands. **While each strategy has its individual trade-offs, our portfolio does not require new large-scale, environmentally damaging transbasin diversions from the Western Slope to the Front Range.**

The portfolio of APPs, conservation, reuse, and ag-urban sharing would produce 54,000 acre-feet (17.6 billion gallons) of water in excess of the Urban Counties' 2050 demands.

Based on rigorous data analysis, this report offers several key recommendations that water planners and policy makers should consider carefully in forging Colorado's water future:

- Close the projected Urban County "gap" with balanced strategies that are more cost-effective and environmentally friendly than traditional transbasin diversion projects.

- Protect Colorado's rivers, streams, and lakes as an integral part of any future water development strategy. Non-consumptive uses of water—for fishing, whitewater recreation, and other uses—are worth billions of dollars annually to our state economy and are critical to the quality of life in this state.

- Pursue only those Identified Projects and Processes that can be constructed and operated according to the "smart" principles delineated in this report.

- Implement more aggressive water conservation strategies. Conservation is often the cheapest, fastest, and smartest way to gain "new" water supplies, and Urban County utilities have significant opportunities to boost their existing water conservation efforts.

- Maximize the role of water reuse in meeting the future needs of Colorado's residents, and work to improve public perception and acceptance of reuse projects.

- Cooperate with agriculture on voluntary water sharing agreements that benefit both municipalities and the agricultural community without permanently drying irrigated acres. Alternatives to "buy and dry" transfers present the best opportunities for our future.

By following these recommendations, Colorado can more than meet the future water needs of the Arkansas Basin Urban Counties while minimizing impacts to the state's rivers and streams.

Underwater Rainbow Trout.

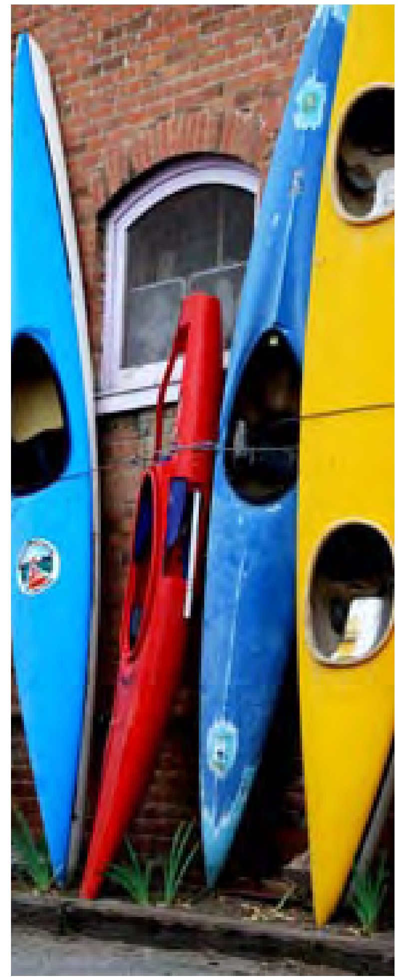
Economic indicators suggest that the environmental services provided by the Arkansas River are integral to the quality of life and economies of Arkansas Basin communities, and the state of Colorado as a whole.

Water, Economy, and the Environment

Humans are just one user of water in the Arkansas River Basin. Water flowing in the Arkansas River and its tributaries also supports invaluable fish communities and riparian ecosystems. Although it might be impossible to capture the intrinsic value of a rainbow trout or a flowing river, the economic indicators described in this report suggest that the environmental services provided by the Arkansas River are integral to the quality of life and economies of Arkansas Basin communities and the state of Colorado as a whole. Unfortunately, there are also indicators showing that some ecosystems in the basin are degraded.

After accounting for existing uses in Colorado and water owed to Kansas under the Arkansas River Compact, there is little to no water availability for new uses in the basin.[2] This report demonstrates that there would be ample supplies of water, not only for future human demands, but also to enhance watershed health in the Arkansas Basin over the next 40 years, if we invest in:

- Proposed "smart" structural water supply projects that minimize adverse impacts to the environment
- Water conservation programs
- Water reuse strategies
- Voluntary agreements between irrigators and municipal suppliers



Colorful kayaks along a wall in Salida, Colorado.

River Flows Are Revenue Flows

Although many of the recreational activities in the Arkansas River occur upstream from the Urban Counties, most of the participants in these activities reside in the Urban Counties — the counties with the highest population. Since most of the recreational equipment is bought where the recreationists live, expenditures on water-based recreation will sustain significant economic activity and jobs in the Urban Counties.[3] Because a direct relationship has been found to exist between river flows and recreational revenue, ensuring appropriate river flows upstream will ensure jobs and revenue flows downstream in the Urban Counties.

Numerous studies have found river recreation to be proportional to stream flow up to some optimum flow.[4,5,6,7] A 2007 study by Colorado State University[8] that includes the Arkansas River found that rafting use and fishing days in Colorado increase with higher stream flows — rafting increases until the river fills its banks, while fishing increases until the river is 70% bankfull. Inversely, the study found that reductions in flow result in reductions in river rafting and fishing activities. Specifically, a 30% reduction in flow results in a statewide reduction of $15 million in expenditures, 700 jobs lost, and $10 million dollars of lost commercial rafting related income annually. Maintaining healthy river flows to support a robust rafting industry is of particular importance to the Arkansas Basin, which holds the largest market share of commercial rafting in the state of Colorado (Figure 1). The income generated per acre-foot of water is comparable for rafting and agriculture (approximately $352 of income generated per acre-foot), and the rafting industry does not consume any water—the water is left in unaltered form for use downstream.[9]

The Arkansas River is the most popular rafting river in the state of Colorado. In 2010, the Arkansas River commercial rafting industry generated a total of 211,150 user days, resulting in approximately $24 million dollars in direct expenditures and an economic impact of $63 million dollars.[10]

The Colorado State University study found the impact between fishing and stream flow even greater than the impact of flow on rafting: statewide, a 30% reduction in flow would result in approximately $23 million less in expenditures, more than 1,000 jobs lost, and $17 million dollars of lost

FIGURE Nº 1 MARKET SHARE OF COMMERCIAL RAFTING USER DAYS IN COLORADO FOR 2010.

42% Arkansas River

36% Colorado River

22% Other Rivers

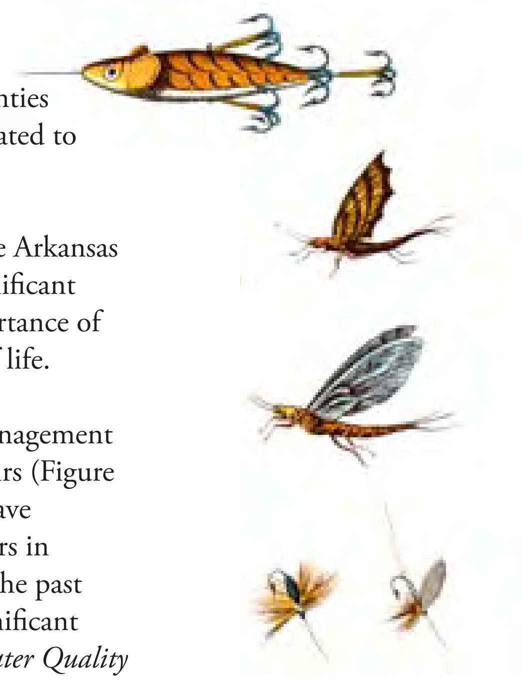
income.[11] Having healthy river flows to support a robust fishing industry is extremely important to the Arkansas Basin, which hosts the most popular fishing destinations in the state of Colorado.[12] Total direct expenditures for fishing in Colorado in 2007 have been calculated at $725 million dollars, with economic impacts on El Paso and Pueblo counties of more than $135 million dollars annually (Table 1).

TABLE № 1 ECONOMIC IMPACT OF FISHING IN PUEBLO AND EL PASO COUNTIES (2007).

County	Colorado Resident	Nonresident	Total
El Paso	$72,820,000	$4,830,000	$77,650,000
Pueblo	$55,860,000	$1,770,000	$57,630,000
TOTAL	**$128,680,000**	**$6,600,000**	**$135,280,000**

Source: BBC Research and Consulting, 2008[13]

As can be seen in Table 1, 95% of the economic impact of fishing in Pueblo and El Paso counties results from fishing related expenditures of Colorado residents. As explained above, because most of the fishing equipment is bought where anglers live, the Urban Counties are expected to make the most money and sustain the most jobs related to fishing.[14]



These rafting and fishing metrics are a good indicator of the role the Arkansas River plays in supporting a rich quality of life in the basin. The significant expenditures on fishing and rafting activities demonstrate the importance of non-consumptive water uses to the region's economy and quality of life.

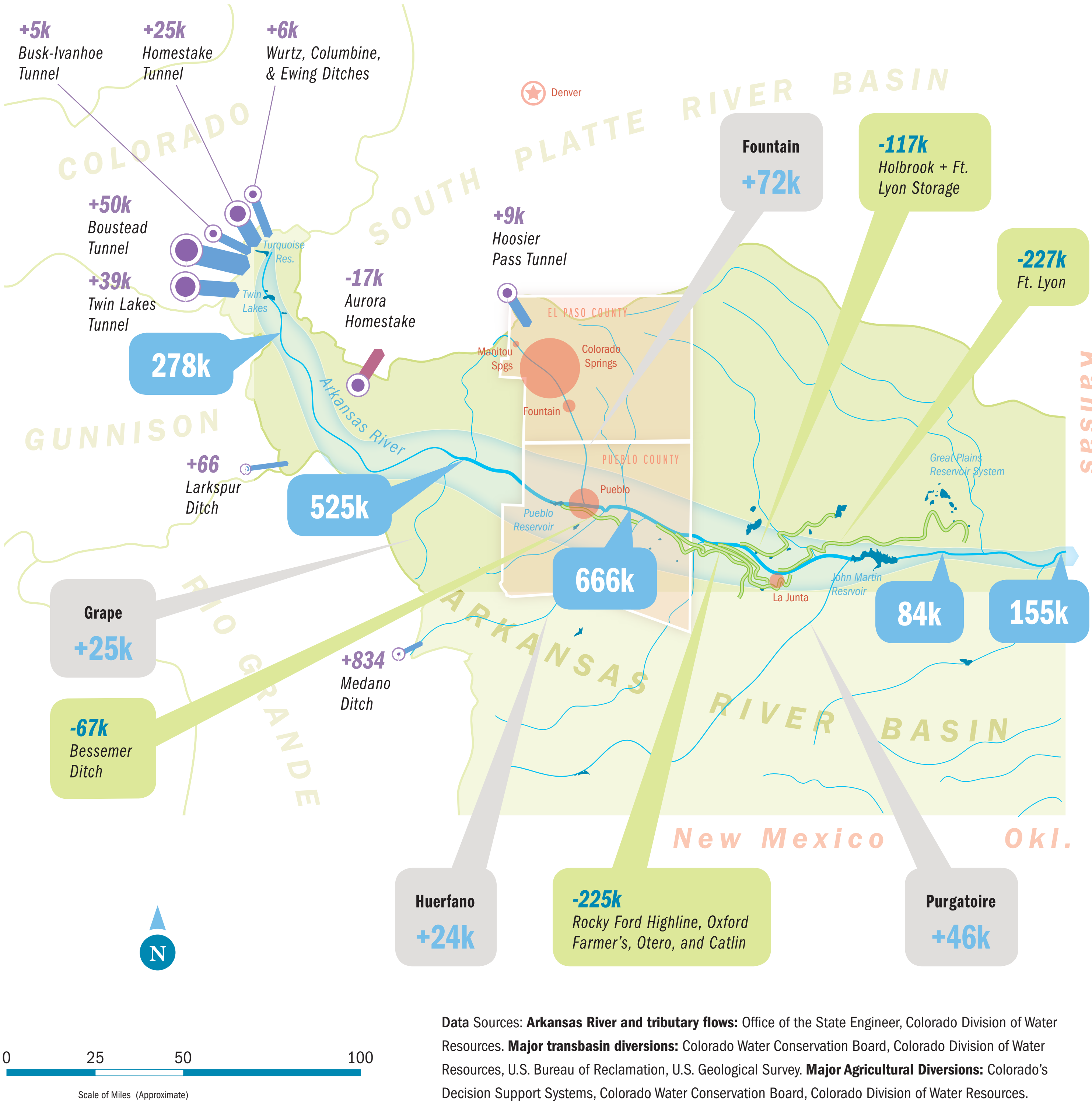
River flows and fisheries in the upper Arkansas are enhanced by management programs, transbasin imports, and re-regulation of flows by reservoirs (Figure 2). On the other hand, activities in the Arkansas River watershed have resulted in the Arkansas River becoming one of the most saline rivers in the United States. Though improvements have been achieved over the past decade, water quality in the lower Arkansas continues to have a significant impact on ecosystems and irrigated agriculture in the basin *(see "Water Quality and Agriculture in the Arkansas River Basin" sidebar, page 38)*. Continuing with the status quo or planning for business-as-usual will ultimately be detrimental to the quality of life supported by the Arkansas River and its tributaries. Any reasonable, balanced water supply portfolio for the Arkansas Basin must therefore not only account for, but also ensure the enhancement of, the environmental health of the Arkansas River and its tributaries.

Planning for the Future

Consumptive and non-consumptive water uses must be integrated in future planning. In accordance with this growing recognition, the Water for the 21st Century Act mandates the Arkansas Basin Roundtable, as part of the ongoing Statewide Water Supply Initiative, to develop an assessment of the environmental and recreational non-consumptive water needs and to propose

FIGURE Nº 2 MAJOR HISTORICAL ANNUAL AVERAGE STREAMFLOWS, TRANSBASIN DIVERSIONS, AND AGRICULTURAL DIVERSIONS OF THE ARKANSAS BASIN IN COLORADO.

All numbers indicate acre-feet per year.



Data Sources: **Arkansas River and tributary flows:** Office of the State Engineer, Colorado Division of Water Resources. **Major transbasin diversions:** Colorado Water Conservation Board, Colorado Division of Water Resources, U.S. Bureau of Reclamation, U.S. Geological Survey. **Major Agricultural Diversions:** Colorado's Decision Support Systems, Colorado Water Conservation Board, Colorado Division of Water Resources.

Map: Jeremy Carlson

structural and non-structural projects and strategies to meet identified needs.* The Nonconsumptive Needs Assessment (NCNA) subcommittee of the Arkansas Basin Roundtable has completed Phase I of its assessment. The main work product of Phase I is a map that identifies local flow-dependent recreational and environmental areas. Phase II of the Arkansas Basin NCNA will include:

- An analysis of the amount of instream flow that may be necessary to maintain water quality, aquatic habitat, scenic values, and recreational activities.

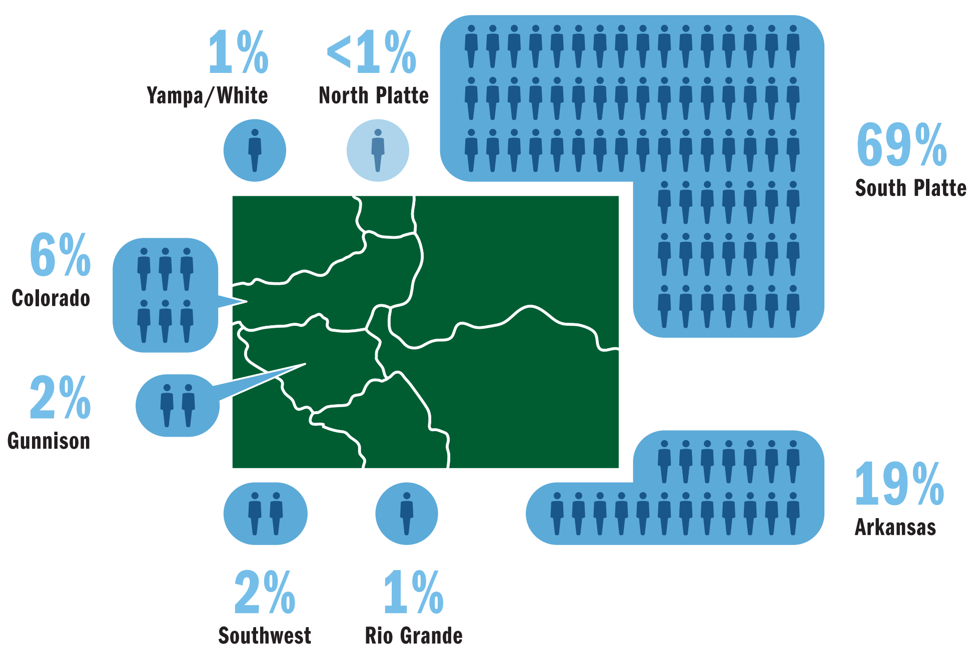
- Identification of projects and methods (both structural and nonstructural) to meet the identified non-consumptive needs of the basin.[15]

The NCNA may become a key planning tool for ensuring that environmental and recreational water demands in the Arkansas Basin are reasonably satisfied

* COLO. REV. STAT § 37-75-104 (2)(c) (2011).

FIGURE Nº 3 2010 POPULATION DISTRIBUTION BY RIVER BASIN.

The vast majority of Colorado's population is concentrated on the eastern side of the state, a trend that is expected to continue through 2050.



many years into the future. Other flow and environment related agreements and projects in the basin include:

- **Voluntary Flow Management Program (VFMP)**—A cooperative agreement implemented by governmental and non-governmental stakeholders to maintain sufficient Arkansas River flows for recreational boating and fisheries management.

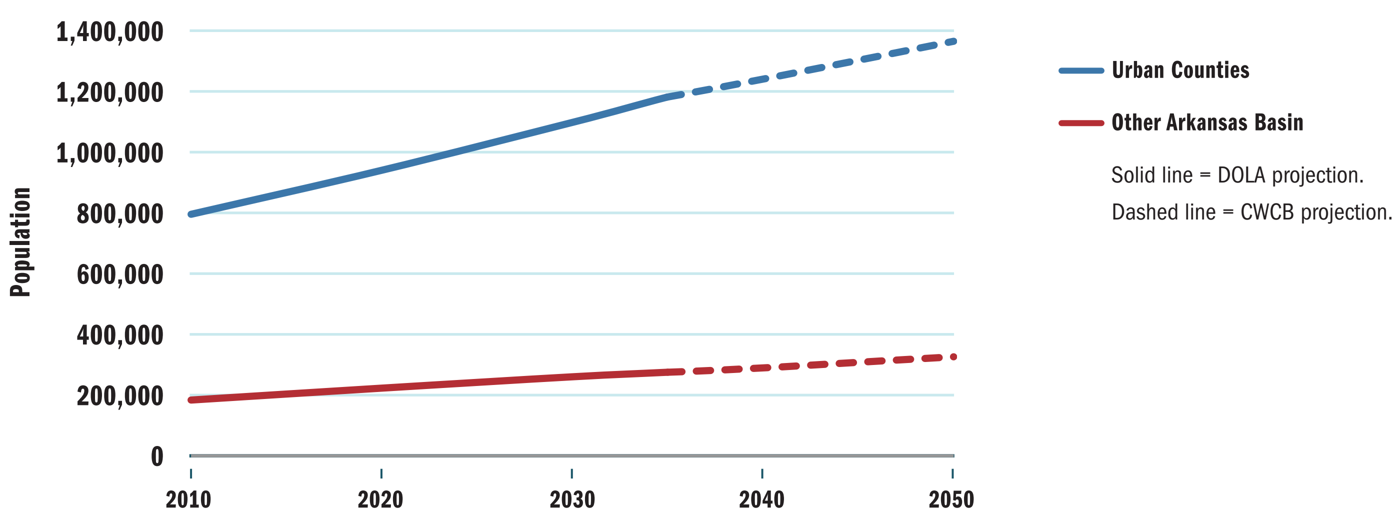
- **Arkansas River Flow Management Program and the City of Pueblo's Arkansas River Legacy Project**—Cooperative efforts, agreed to by Colorado Springs Utilities (CSU), the Pueblo Board of Water Works (PBWW), the City of Aurora, the Southeastern Colorado Water Conservancy District (SECWCD), and the City of Fountain, to provide flows in the river through Pueblo's Arkansas River Corridor Legacy Project.

- **Fountain Creek Master Plan**—A Fountain Creek Watershed, Flood Control, and Greenway District plan to restore and revitalize the 46 miles of Fountain Creek that flows from the southern Colorado Springs city-limit line to the confluence with the Arkansas River in Pueblo.

- **Lower Arkansas River Conservation Corridor Project**—An effort by the Greenlands Reserve to preserve a mile-wide and 140 mile-long portion of Lower Arkansas River corridor through conservation easements.

FIGURE Nº 4 POPULATION PROJECTIONS FOR THE ARKANSAS BASIN.

The population of the Urban Counties of the Arkansas Basin is expected to increase by 70% over the next 40 years under a medium population-growth scenario. To put this growth into perspective, this would be equivalent to adding in the basin a new city the size of Colorado Springs, or five additional cities the size of Pueblo, by 2050.

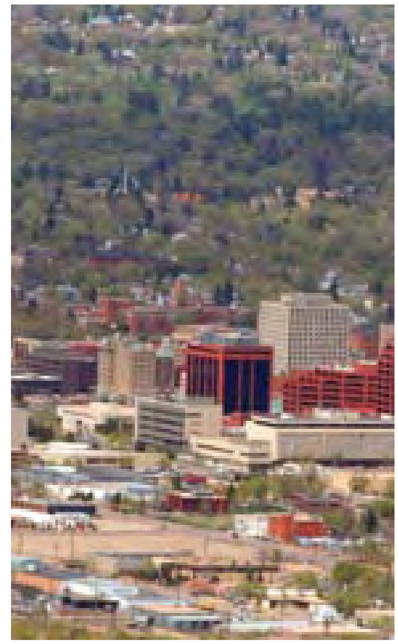


Municipal Water Needs

Population of the Arkansas River Basin

Approximately one-fifth of Colorado's current population lives in the Arkansas Basin.* Most of the population of the Arkansas Basin is concentrated in the Urban Counties of the basin — El Paso and Pueblo counties, which include the cities of Colorado Springs and Pueblo, respectively. Combined with the South Platte Basin, more than 80% of all Coloradans live in the "Front Range" area of the state, which generally extends from immediately east of the Rocky Mountains to Fort Collins and south to Pueblo.

Significant growth is projected for the Arkansas Basin during the first half of the 21st century (Figure 4). According to the Colorado Department of Local Affairs (DOLA), the Urban Counties of the Arkansas Basin — herein defined as the geographical area that encompasses El Paso and Pueblo counties — are expected to increase by 382,000 people between 2008 and 2035, for a total population of 1.18 million residents. The CWCB has produced additional modeling that suggests the Urban Counties' population could increase by approximately 569,000 residents between 2010 and 2050 under a medium population-growth scenario, for a total population of 1.36 million people.[16]



View of Colorado Springs.

Projected Water Demand for the Urban Counties

Significant population increases in the Urban Counties will drive demand for additional municipal water supply. In July 2010, the CWCB released a final report estimating these future demands.[17] This report uses the CWCB's estimates of future demand under a medium-population-growth scenario that includes the effects of passive conservation — conservation resulting from new development and the replacement of inefficient appliances and fixtures

* The Arkansas Basin is located in the following Colorado counties: Baca, Bent, Chaffee, Cheyenne, Crowley, Custer, Elbert, El Paso, Fremont, Huerfano, Kiowa, Lake, Las Animas, Lincoln, Otero, Prowers, Pueblo, and Teller counties.

over time.* The CWCB estimates that demands for the projected 1.36 million residents and industry in the Urban Counties of the Arkansas Basin in 2050 will be approximately 314,000 AFY (Figure 5). This needs projection is for the Urban Counties as a whole, and does not take into account more localized water supply and demand issues (a lack of data precludes more specific analysis).

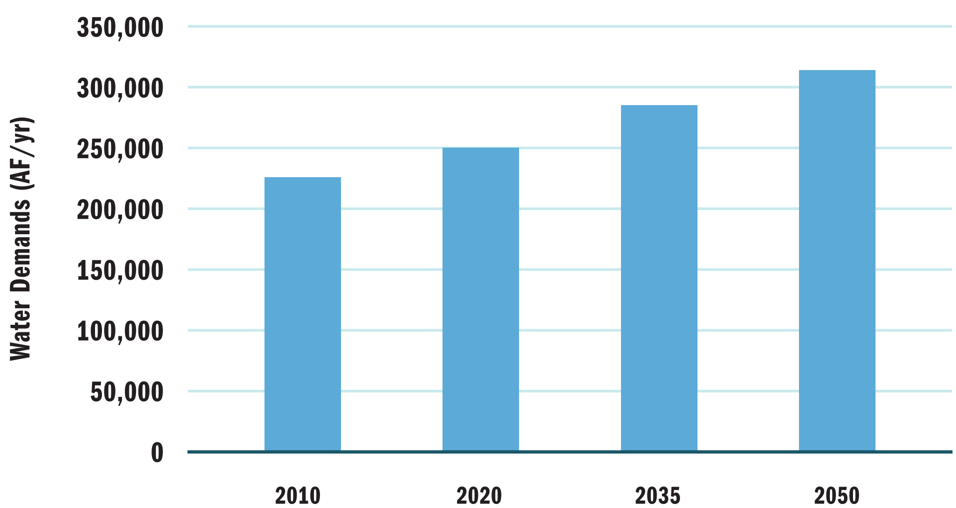
Existing Water Supplies

The Urban Counties obtain municipal water supplies from local surface water and groundwater, as well as through transbasin diversions from the Western Slope and, to a much smaller degree, the South Platte Basin. In the SWSI 2010 report, the CWCB uses 2008 demands as a proxy for existing water supplies. Following this methodology, we used more recent 2010 M&I and SSI demands to represent existing supply, resulting in a current water supply for the Urban Counties (from both local and transbasin sources) of approximately 226,000 AFY.

* The CWCB estimates that passive conservation will reduce per capita demands by 10% between 2008 and 2050. Colorado Department of Natural Resources, Colorado Water Conservation Board. 2011. "Appendix K - SWSI Conservation Levels." In *Colorado's Water Supply Future, Statewide Water Supply Initiative 2010*. Denver, CO. January.

FIGURE Nº 5 PROJECTED URBAN COUNTY WATER DEMANDS.

Projected municipal and industrial (M&I) and self-supplied industrial (SSI) water demands for the Urban Counties under SWSI's medium population-growth scenario.



Pueblo Board of Water Works Purchases Bessemer Ditch Shares

The Pueblo Board of Water Works (PBWW) began purchasing shares of Bessemer Ditch water in 2002, and by 2011 it had accumulated 5,540 shares out of a total of slightly fewer than 20,000. A Bessemer Ditch share is the water needed to irrigate one acre of land. The PBWW estimates that a share will translate into about 1.35 acre-feet of consumptive use, and that the consumptive portion of the Bessemer Ditch shares they have purchased so far will yield 7,500 AF of water.[19] In contrast, the SWSI Portfolio Tool assumes a medium range yield of 6,200 AF for this project.[20]

All the farmers from whom PBWW purchased shares were offered the same deal whereby PBWW agreed to lease the water shares back to the irrigator for a 20-year period, which ends in 2029. In the initial round of leasebacks, farmers could lease the number of shares they sold to PBWW. If not all selling farmers choose to lease their full shares, water would be made available to others. As of the date of this publication, PBWW has leased all of the water.

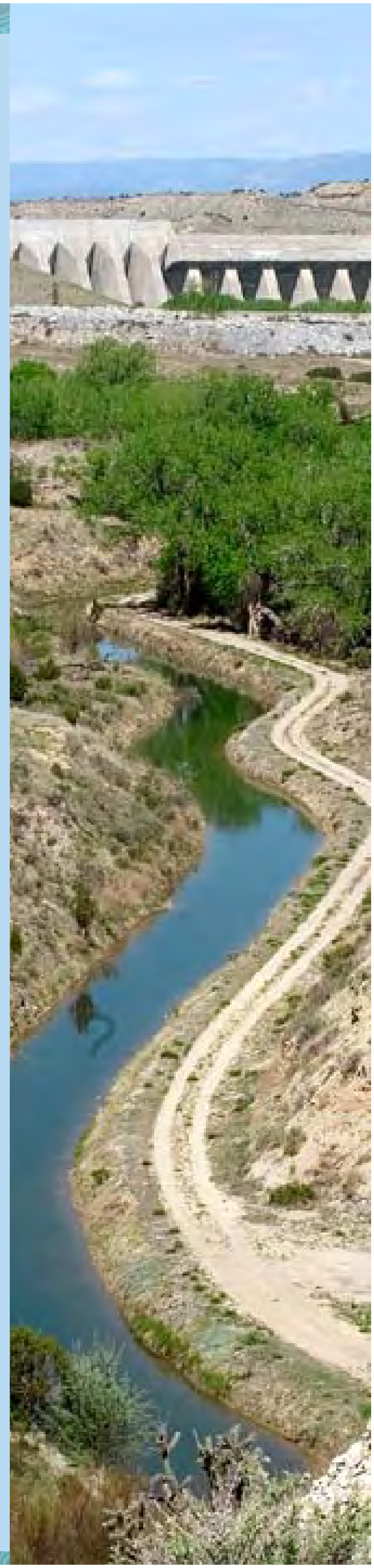
Any farmer who has leased water can cancel the lease with notice, as specified in the lease agreement. In 2029, when the leases expire, PBWW will either renew them or begin using some or all of the water for the city and at the same time start revegetating the land from which the water was taken.

Farmers will continue to own the land from which the water has been removed, but once Pueblo begins revegetation with native grasses, the owners' land use will be limited to activities that do not damage or undermine revegetation efforts.

One seller has a slightly different agreement with PBWW for a rotational fallowing option. He owns 30 acres, has sold 20 Bessemer Ditch shares to PBWW and retained 10 shares, and has negotiated a provision that allows him to rotate the 10-acre units he has under irrigation in any one year.

PBWW paid about $56 million for the shares it has purchased and expects to spend an additional $5 million on engineering and legal issues. It has yet to file change applications on the water or to petition the ditch company for permission to change the use of the shares.

We do not include Pueblo's Bessemer Ditch shares as an existing municipal supply, nor as an example of ag-urban cooperation, as the transfers would result in permanent dry-up. However, we include the supply as potentially available for reuse.



Bessemer Ditch below the Pueblo Dam. Photo: Chris McLean, The Pueblo Chieftain.

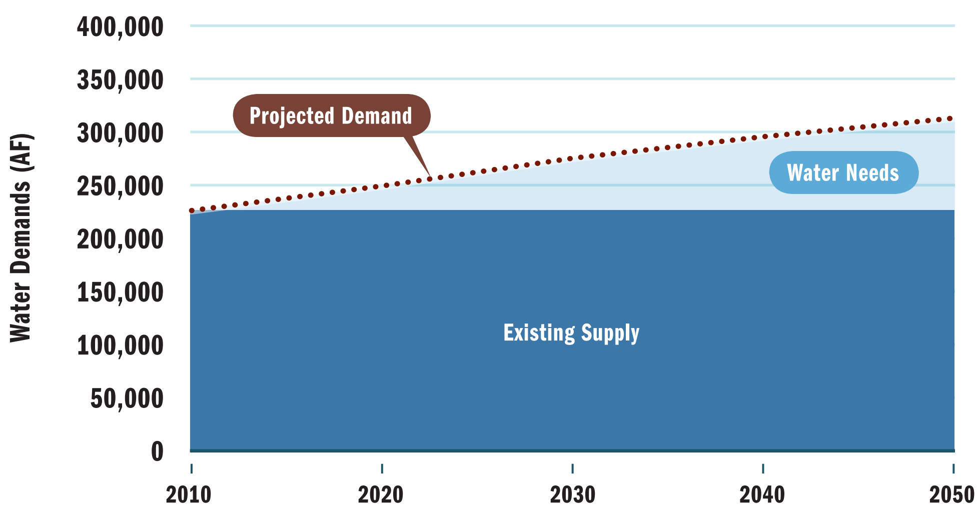
Although we use SWSI's approach to quantify existing demand, it is worth noting that both Colorado Springs Utilities and the Pueblo Board of Water Works have additional supplies for addressing future growth and drought protection that are not accounted for herein. For example, the Pueblo Board of Water Works (PBWW) has purchased approximately 30% of the available shares in the Bessemer Ditch, which is expected to yield 6,200 acre-feet of water supply to the PBWW[18] (see sidebar on Bessemer Ditch). This is not included as an existing water supply in this report.

Future Municipal Water Needs

With existing supplies of 226,000 AFY and projected demands in 2050 of 314,000 AF, we calculate that the Urban Counties will need 88,000 AFY of additional supply by 2050 to meet future demands (Figure 6). As will be detailed in the rest of this report, our portfolio of recommended water supply strategies meets and exceeds these future needs.

FIGURE Nº 6 FUTURE WATER NEEDS OF THE URBAN COUNTIES.

Using the most current CWCB data, we assume the Urban Counties will need an additional 88,000 acre-feet of water by 2050 to fully meet projected demands.



Acceptable Planned Projects

In *Filling the Gap I*, we identified a number of South Platte River Basin water supply projects currently in the planning phases as acceptable, **if designed and implemented pursuant to "smart water supply principles."** These were termed "Acceptable Planned Projects (APPs)."[21] In this section, structural APPs for the Arkansas River Basin are identified. It is estimated that APPs in the Arkansas River Basin could provide approximately 10,000 acre-feet of additional water supply annually by 2050.

The "Smart" Principles

Western Resource Advocates, Trout Unlimited, and the Colorado Environmental Coalition developed the "smart water supply principles" through a series of reports beginning in 2003. These principles, further refined here, are a guide to assure protection of rivers and other natural resources against damage that often results from structural water supply projects. The smart principles are:

- Make full and efficient use of existing water supplies and reusable return flows before developing new diversion projects.
- Improve use of existing water supply infrastructure by integrating systems and sharing resources among water users to avoid unnecessary new diversions and duplication of facilities.
- Recognize the fundamental political and economic inequities and the adverse environmental consequences of new transbasin diversions.
- Expand or enhance existing storage and delivery before building new facilities in presently undeveloped sites, and expand water supplies incrementally to better utilize existing diversion and storage capacities.
- Recognize that market forces now drive water reallocation from agricultural to municipal uses, and structure such transfers, where possible, to maintain agriculture and in all cases to mitigate the adverse impacts to rural communities from these transfers.

- Involve all stakeholders in decision-making processes and fully address the inevitable environmental and socioeconomic impacts of increasing water supplies.

- Design and operate water diversion projects to leave adequate flows in rivers to support healthy ecosystems under all future scenarios, even if water availability diminishes in the future as a result of climate change or other factors.

- Seek to develop "multi-purpose projects" to spread project benefits as well as costs.

These principles are as relevant today as they were nearly a decade ago.

Issues Associated with Structural Projects

Traditional on-stream water storage reservoirs can cause myriad environmental problems, such as blocking fish migration, severely altering stream flow patterns and water temperatures, and inundating aquatic and riparian habitat. As discussed in the *Filling the Gap I* report, water storage reservoirs come with numerous other issues as well, including:

- Reservoirs are costly to build and cannot easily be expanded incrementally in response to growing demands. Often, reservoirs must be paid for and constructed "up front," which increases their financial risk and diminishes their economic feasibility.

- As a basin becomes over-appropriated, additional storage produces diminishing yield, because unappropriated runoff occurs less frequently, with diminished volume available for appropriation and storage. This factor is particularly important for Arkansas River water management because of Colorado's obligations to deliver water downstream to Kansas under the Arkansas River Compact.

- Evaporation losses compound the diminishing yield problem, becoming a major limiting factor in reservoirs' ability to provide water, both over extended drought conditions and during severe droughts that occur every few decades.

- Sedimentation of reservoirs decreases yield and can only be remedied through time-intensive and costly removal projects.

Given the diminishing returns for new storage projects, storage-yield ratios for reservoirs designed to store wet-year water for drought protection are rarely better than 5-to-1. This means that for 100,000 acre-feet of additional firm annual supply, the reservoir would have to store over 500,000 acre-feet, with concomitant large costs and questionable cost-benefit characteristics.

The same problems affect pipeline projects because reservoirs are needed to store water transferred through a pipeline. Pipelines are also extremely costly to build and operate. The CWCB estimates that six potential pipeline proposals being considered today would each cost in the range of $8–10 billion for capital costs alone.[22] Any new pipeline will also require a significant amount of energy to pump water over great distances. Furthermore, pipelines require pumping large quantities of water from remote areas of Colorado or other states, where compact entitlement concerns, water quality issues, relationships with neighboring states, and the local political unpopularity of these projects add to the list of hurdles.

Pueblo Dam diagram.

With these limitations in mind, some water providers are increasingly developing "smart storage"—smaller reservoirs designed to optimize already-developed supplies and to capture unappropriated peak-season runoff. Smart storage is now commonly developed as a means for capturing and re-regulating reusable return flows, increasing the yields of exchange rights and augmentation plans, re-regulating the yields of changed irrigation rights to meet municipal demand patterns, and increasing yields from existing water rights and transbasin diversions. In some cases, existing traditional storage capacity has been re-dedicated to smart storage purposes, with resulting increases in yields.

Acceptable Planned Projects for the Urban Counties

The CWCB refers to water supply projects that are currently in the planning and initial implementation phases as "Identified Projects and Processes" (IPPs). Because some IPPs do not meet our smart principles, this report does not utilize the complete CWCB list of IPPs for the Urban Counties. Instead, we present a subset of the CWCB's Acceptable Planned Projects.

Acceptable Planned Project: Eagle River Joint Use Project

A recent agreement between the Colorado River Water Conservation District (CRWCD), several Eagle River interests, and the cities of Colorado Springs and Aurora allows for the export of an additional 20,000 acre-feet annually from the Eagle River Basin to the Front Range. In connection with this agreement, there are studies underway to examine aquifer management opportunities in the Camp Hale area. For this report, it is assumed that the water would be divided equally between Colorado Springs and Aurora, thus providing 10,000 AF/yr for use in the Arkansas Basin.

Southern Delivery System

The SDS will transport Fryingpan-Arkansas (Fry-Ark) Project water and non-Fry-Ark water from Pueblo Reservoir to Colorado Springs, Fountain, Security, and Pueblo West. The two phases of the project are expected to provide a total firm yield of 37,000 acre-feet per year[23] and include 87,000 acre-feet of storage capacity. The SDS also includes construction of a water treatment plant (WTP) sized to treat up to 100 million gallons of water per day. Initial water deliveries are scheduled to begin in 2016.

The SDS project followed several recommendations outlined in the *Facing Our Future* report, and would minimize its impact to the environment to the extent that it substantially:

- Uses existing storage and delivery infrastructure
- Minimizes reliance on additional transbasin diversions
- Distributes costs and benefits in a single project among several regional water providers and users
- Integrates systems and shares resources, reducing the need for duplication of facilities
- Mitigates its impact on, and enhances the environmental services of, the Fountain Creek watershed
- Honors existing flow agreements in the upper and lower Arkansas River

SDS Issues

Some significant issues related to SDS are briefly discussed below.

1 **Economics**—Phase I and Phase II of the project were initially budgeted at $939 million dollars, combined. Currently, Phase I alone is expected to cost $880 million (in 2009 dollars). With 40-year financing costs and inflation, the total cost of Phase I and Phase II is projected to be $2.3 billion. **To pay for Phase I costs, water rates for Colorado Springs Utilities customers will double from 2010 to 2016.**

2 **Uncertain Need**—The SDS requires a long-term fiscal commitment from project participants, but the immediate need for the project is uncertain. A major justification for the SDS was the proposed Banning Lewis Ranch development in Colorado Springs. The development—which was projected to include 75,000 new residences and house 180,000 people within the next 50 years—is now defunct, though the property may be developed at some uncertain time in the future. Stuck with the SDS financial commitment, CSU customers are experiencing substantial water rate increases to pay for a water supply that is probably not needed in the short or medium term. Although the SDS will provide significant system reliability, the need for SDS could have been delayed with more aggressive reuse and conservation, which represent lower-risk, lower-cost investments for municipal water providers and users.

3 **Energy**—According to the SDS Final Environmental Impact Statement (FEIS), the energy embedded in each unit of SDS water will be 4.63 MWh/AF. This will be an extremely energy-intensive water supply. For reference, seawater desalination is currently considered the most energy-intensive "new" water supply. A proposed desalination plant in Southern California expects to use between 4.66 and 5.12 MWh/AF.[24]

▲ Fountain Creek, Colorado.

The Southern Delivery System has been a controversial project in the Arkansas Basin.

▼ Concrete pipe segments at construction site.

Although it involves transbasin water, the Eagle River Joint Use Project is considered to be acceptable because it involves conjunctive management of surface water and groundwater, is founded on an agreement with parties in the basin of origin, and relies largely on existing physical facilities.

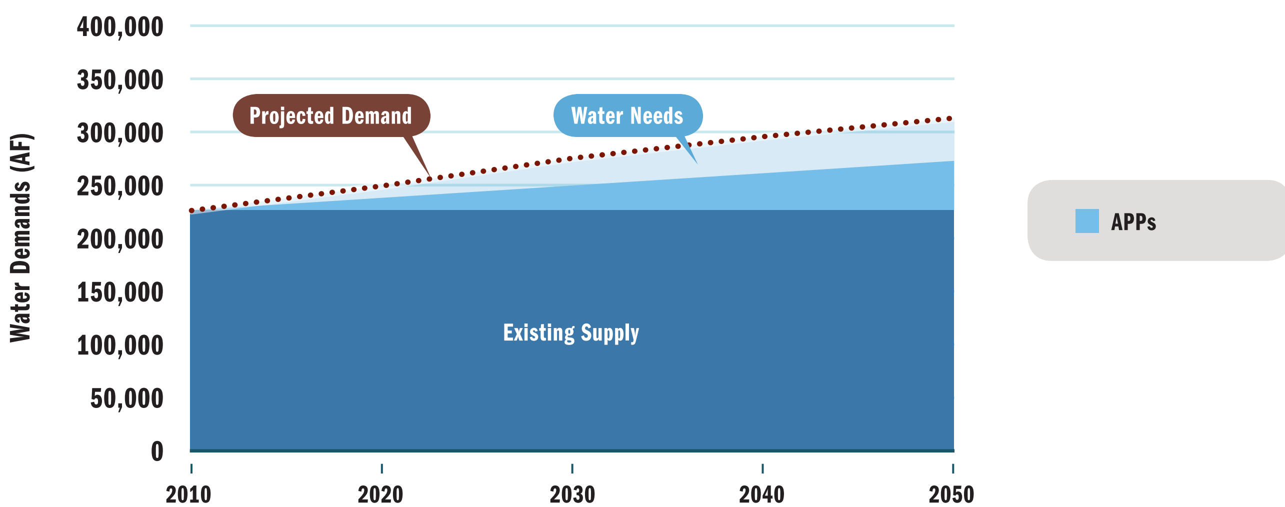
In contrast to the Eagle River Joint Use Project, the Preferred Storage Option Plan (PSOP) has not been clearly defined at this time, and the yield of an acceptable version of PSOP has not been quantified or included as a future supply in this report. Some components of PSOP have the potential to be acceptable, such as the re-operation of existing Fry-Ark Project facilities to increase yield without importing more transbasin water. Depending upon its formulation, PSOP could be an APP if it avoids the construction of new facilities or the importation of additional transbasin water.

The new water supply provided by the Southern Delivery System (SDS) has been included in the APP category. Not all elements of the SDS meet our smart water criteria. Nevertheless, it is a permitted infrastructure project that does not constitute an existing supply, and its yield needs to be taken into account (see "Southern Delivery System" sidebar).

The Eagle River Joint Use Project could produce approximately 10,000 acre-feet of new water supply annually by 2050. Adding the SDS water supply (37,000 acre-feet) to this volume would provide approximately 47,000 acre-feet per year to the Urban Counties by 2050. This is represented by the APP wedge in Figure 7.

FIGURE Nº 7 ESTIMATE OF URBAN COUNTIES' WATER NEEDS INCLUDING THE ACCEPTABLE PLANNED PROJECTS STRATEGY.

APPs and the Southern Delivery System could collectively produce approximately 47,000 acre-feet of new water supply annually by 2050.

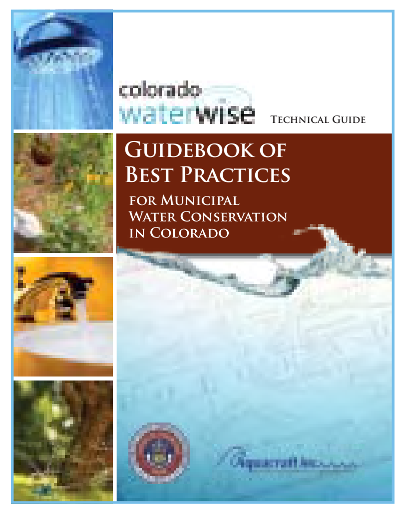


The Conservation Strategy

Water conservation is a no-regrets strategy that represents the cheapest, fastest, most reliable "new supply" for the Urban Counties of the Arkansas Basin. Conservation or demand management programs can delay and downsize the need for infrastructure projects, thereby saving utilities and their customers millions of dollars. Conservation also reduces the demand for the transfer of water from the agricultural to the municipal sector. Water saved through conservation programs may be used to augment instream flow, and water efficiency reduces energy use and greenhouse gas pollution. It is estimated that conservation in the Urban Counties could provide approximately 39,000 acre-feet of additional water by 2050.

Defining Water Conservation

The term "water conservation," as used in this report, refers to a permanent reduction in per capita water usage resulting from long-term implementation of water efficiency practices and technologies. Many of these programs are outlined in the CWCB's WaterWise best practices manual.[25]



Find the handbook at coloradowaterwise.org/BestPractices.

Conservation can be achieved through mandatory or voluntary actions, economic incentives, and education. Conservation programs may target outdoor or indoor water use, and different efficiency technologies may be implemented by the water provider or by the end user (at the single-family residential, multi-family residential, commercial, governmental, and industrial levels). For example, water efficiency can be achieved through water efficient landscapes and water fixture standards. Economic incentives, such as inclining block water rates and high-efficiency toilet rebates, have proved to be an effective driver for conservation. A water provider may achieve significant water savings by reducing system water loss through repair of damaged water lines. Education and outreach programs can also strengthen and invigorate a community's conservation culture. In sum, there is a broad range of available conservation strategies that can be fit to the unique needs of a particular community.

Water Conservation and Energy Use

The state of Colorado and many cities in the region have established goals for reducing energy use or greenhouse gas emissions, and water conservation can play an important role in meeting those goals. In terms of saving energy, not all water conservation measures are created equal—for example, outdoor water conservation measures save the energy used at water utilities' treatment plants and pumping stations, while indoor conservation measures such as installing low flow toilets save energy at utilities' treatment plants, pumping stations, and wastewater treatment plants. Indoor conservation measures that save hot water also save the energy used by the consumer to heat water. This energy demand can be substantial: **According to the U.S. Department of Energy, water heating accounts for 14 to 25% of a home's energy use.**[28] To save the greatest amount of energy, water and energy utilities should focus on measures that save hot water, such as promoting efficient showerheads, clothes washers, and faucets.

Fig. A BREAKDOWN OF TYPICAL WATER USE IN AN AVERAGE (NON-CONSERVING) HOUSEHOLD.

Source: Vickers, 2001[29]

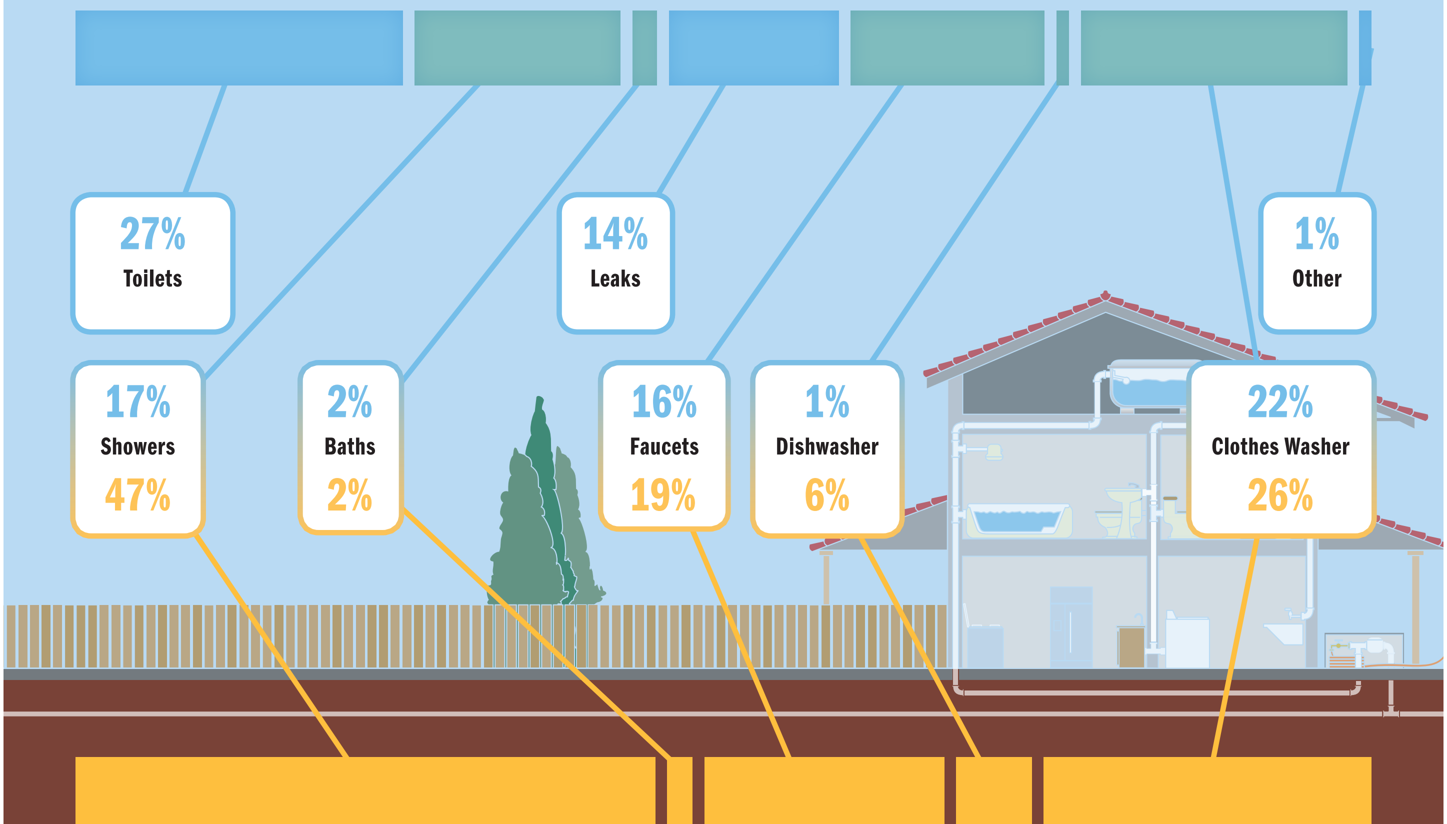
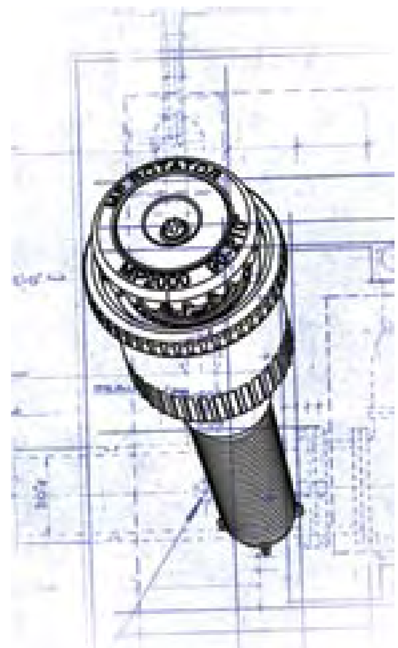


Fig. B WATER-RELATED ENERGY USE IN THE SAME HOUSEHOLD.

Source: Western Resource Advocates

Existing Conservation

Residential/Commercial MP 2000 Rotator Nozzle, Hunter Industries.



In addition to the water savings achieved through passive conservation, water providers in the Urban Counties have reduced water use over the past decades through the implementation of many of the conservation programs and activities described above. From 2000 to 2006, the City of Colorado Springs had the largest drop of single-family residential (SFR) per capita water use among Front Rage water providers (a 32% reduction in its SFR GPCD in 6 years). Colorado Springs' long-term investment in conservation has resulted in one of the lowest single-family residential (SFR) per capita water use rates in the state of Colorado.[26]

Water providers that serve more than 2,000 acre-feet of water annually in Colorado are required by law to adopt a conservation plan, and to submit plan updates to the CWCB within seven-year intervals. The conservation plan must include an estimate of the amount of water that has been saved through a previously implemented conservation plan and an estimate of the amount of water that will be saved through the implementation of the plan.* Water conservation plans must also consider, at a minimum, the following water conservation measures and programs:

- Water-efficient fixtures and appliances, including toilets, urinals, showerheads, and faucets
- Low water use landscapes, drought-resistant vegetation, removal of phreatophytes, and efficient irrigation
- Water-efficient industrial and commercial water-using processes
- Water reuse systems
- Distribution system leak repair
- Public education and outreach regarding water efficiency measures, customer water use audits, and water-saving demonstrations
- Water rate structures and billing systems designed to encourage water use efficiency in a fiscally responsible manner
- Regulatory measures designed to encourage water conservation
- Incentives to implement water conservation techniques, including rebates to customers to encourage the installation of water conservation measures

Outdoor water bills may be reduced to up to one third when conventional sprays are replaced by rotator sprinkler head technology that slowly distributes water evenly and reduces excess runoff.

Below are examples of some of the active conservation programs utilities are implementing throughout the Urban Counties:

- By 2018, the Pueblo Board of Water Works plans to upgrade all 40,191 meters in its system with new ones that utilize automated meter reading (AMR). By the end of 2011, more than 50% of its meters had AMR technology, which alerts customers of costly leaks and is expected to significantly reduce reading errors and missing meter readings.

* Colo. Rev. Stat §§ 37-60-126(1)(b), (4)(d)-(e) (2010).

- The Parks Water Efficiency Pilot Program of the City of Colorado Springs renovated and retrofitted numerous city park irrigation systems. In its first year (2010), it saved 64 AF of water and $91,182 dollars in water expenses. In a five-year period, this program is expected to save the city $398,867 dollars—a 142% return on investment.

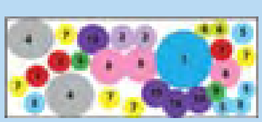
- The Southeastern Colorado Water Conservancy District maintains a website that is dedicated exclusively to promoting xeriscape gardens and providing comprehensive information on the art of low water use landscaping. The District also has a xeriscape demonstration garden at the Pueblo Airport Industrial Park.

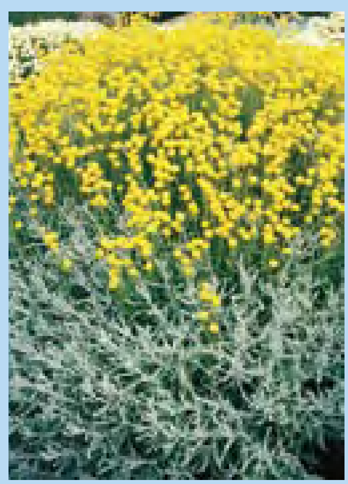
Issues Associated with Conservation

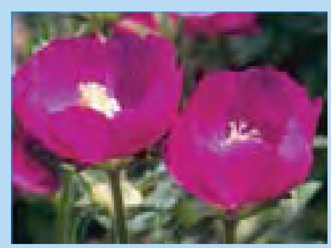
In *Filling the Gap I*, we discussed in detail and dismissed a number of often-repeated arguments for not increasing water conservation. These included demand hardening, permanency of conservation savings, impacts on return flows, and the uniqueness of water providers.[27] In a nutshell, these issues do not represent sound arguments against investing in long-term conservation measures.

Xeric Gardening Made Easy: Garden-In-A-Box

The Center for ReSource Conservation makes xeriscaping easy, fun and affordable with their "Garden-In-A-Box" kits. Every year a selection of water-wise gardens are offered, each featuring a "plant-by-number design" with possible options for different plot shapes, 25-51 xeric perennial plants, and planting and care instructions, all below retail cost. Gardens fit into 50-100 sq. ft. and feature designs for full sun and shade conditions.







Learn more at
conservationcenter.org/water-home/

Future Conservation Estimates

In 2010, Colorado's SWSI conservation study estimated that a "high" conservation strategy could reduce the state's 2008 per capita water demand by 34%. A 34% reduction in per capita demand in the Urban Counties would result in an annual reduction in water demand of 93,000 acre-feet by 2050. This strategy corresponds to a 1% reduction in per capita use per year, with 2008 as the baseline year. Almost one-third of this reduction would be achieved through passive conservation resulting from new development and the replacement of inefficient appliances and fixtures over time (requiring no effort from water providers). The remainder, 66,000 AFY, could be gained through cost-effective, active conservation programs.

Significant reductions in per capita water use are reasonably achievable through existing conservation programs and technologies. **A 1% per year reduction in per capita water use for the next 40 years is a realistic goal that will require a sustained, long-term effort, yet will not entail draconian measures, onerous lifestyle changes, or landscaping modifications beyond those already being implemented in many areas across the Mountain West.** Denver Water has already set a goal to reduce water use by 1% per year or more for this decade. As another example, federal agencies are required to reduce their potable water use consumption by 2% per year through 2020 relative to the baseline water consumption in fiscal year 2007.*

* Exec. Order No. 13,514, 74 Fed. Reg. 52,117, 52,118 (Oct. 5, 2009).

Native plants can provide vibrant, low-maintenance landscapes for the home and business owner.

SWSI's conservation study describes the methodology used to achieve this level of savings, provides extensive documentation for reduction estimates, and uses the Colorado WaterWise best practices manual to provide options for achieving the 34% reduction target. This level of savings is technically achievable even by Colorado Springs, which has one of the lowest SFR per capita use rates in Colorado. But strong leadership and a long-term commitment to conservation will be required to set and reach this target.

In a future in which climate change may create vast uncertainties, conservation represents a low-risk investment. Cities and utilities can quickly adapt a diversified portfolio of conservation programs in response to short-term and medium-term changes in population, development, and precipitation patterns. New pipelines and storage projects, on the other hand, represent significant investments that lock communities into fixed arrangements that generally cannot be adapted to social, economic, and environmental change.

The cheapest water a utility will ever have is the water it already has in the system.[30] By comparison to other new water supply options, conservation is the most cost-effective investment. SWSI estimates that its 34% reduction strategy would cost an average of $8,200 per acre-foot of water saved.[31] A 2010 report by the Natural Resources Law Center of the University of Colorado estimates the cost of conserved water at $5,200 per acre-foot. By comparison, the study found that the lowest-cost option of the Southern Delivery System would provide water to the Urban Counties at $17,400 per acre-foot (Table 2).

TABLE Nº 2 COST OF NEW WATER SUPPLY OPTIONS.

Water Supply Option†	Firm Yield (acre-feet/year)	Average Cost ($/AF)
Southern Delivery System (SDS) Lowest-cost option: Wetland Alternative	74,900	$17,373
Northern Integrated Supply Project (NISP) Lowest-cost option: Glade Reservoir	40,000	$11,473
South Metro Water Supply Authority Master Plan (SMWSA) Lowest-cost option: Arkansas River – Shared Avondale	47,800	$18,358
Average of all 28 options of SDS, NISP, SMWSA	46,918	$20,764
Major water transfers‡ (2005–2009)	7,817	$13,996
Municipal water conservation programs (22 water conservation implementation plans)	63,534	$5,173

† Includes the South Platte and Arkansas basins. Source: Kenney et al., 2010[32]

‡ Firm yield under this option corresponds to total yield. Since most of the transactions involve agriculture to urban transfers within the Colorado-Big Thompson (CBT) project, which benefits from seniority and operational flexibility, it is assumed that total yield would not significantly differ from firm yield.

Colorado Springs Utilities has determined that its residential block rate, commercial seasonal rate, commercial landscape code and policy, and conservation education programs are some of the conservation programs that may save the most water in its service area (Table 3).*

* Colorado Springs Utilities. 2008. *2008–2012 Water Conservation Plan.* Colorado Springs, CO. January 30. A portfolio of water conservation programs of a utility may have more than 20 programs, and therefore the cost of water saved from an individual program may not be representative of the average cost of conserved water from a water conservation portfolio.

TABLE Nº 3 COST OF COLORADO SPRINGS UTILITIES' TOP WATER CONSERVATION PROGRAMS, RANKED BY CONSERVATION SAVINGS.

Program	2017 Annual Savings (AF/yr)	Cost of Water Saved ($/AF)
Residential block rates	1,500	$205
Commercial seasonal rates	1,300	$238
Commercial landscape code and policy	1,200	$12,784
Conservation education	900	$1,348

State-of-the-Art Irrigation Management

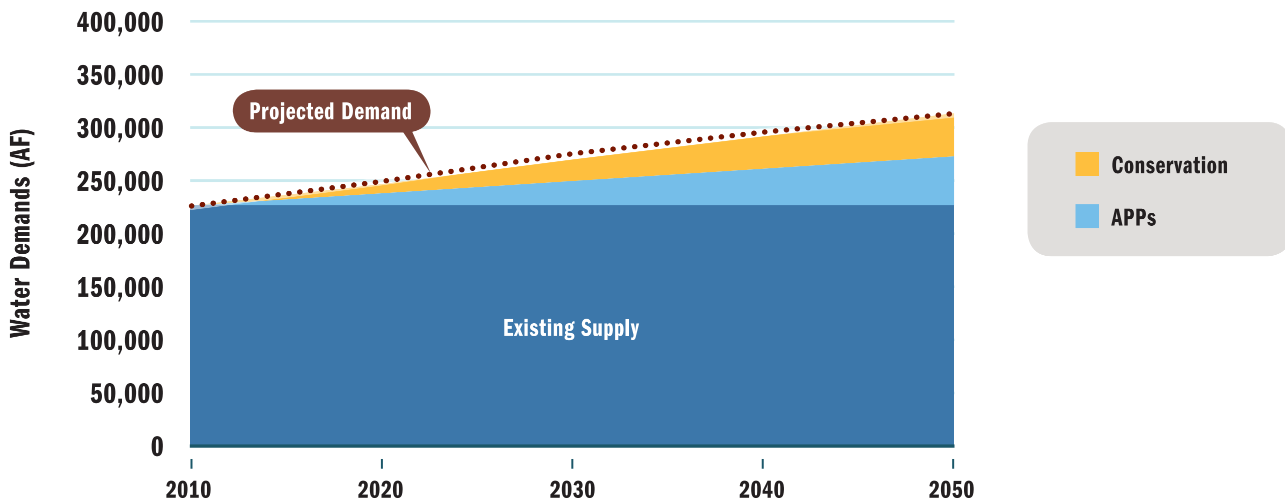
Existing central control technologies can put irrigation managers in complete visual command of their operations, and significantly reduce outdoor water use by automatically adjusting watering times in different irrigation zones based on temperature, precipitation, wind speed, leaks, and breaks.

Irrigation Management and Monitoring Software (IMMS) Central Control System, Hunter Industries.

Generally, water providers do not allocate all conserved water to meeting new demands—a portion of the water saved may be used, for example, to augment instream flows, improve system reliability, or kept in storage as a drought reserve. Assuming that 60% of active conservation savings achieved under the CWCB's "high" conservation strategy are dedicated to growth, 39,000 acre-feet of new water supply will be made available annually in the Urban Counties by 2050 (Figure 8).

FIGURE Nº 8 ESTIMATE OF WATER NEEDS FOR THE URBAN COUNTIES INCLUDING THE ACCEPTABLE PLANNED PROJECTS AND CONSERVATION STRATEGIES.

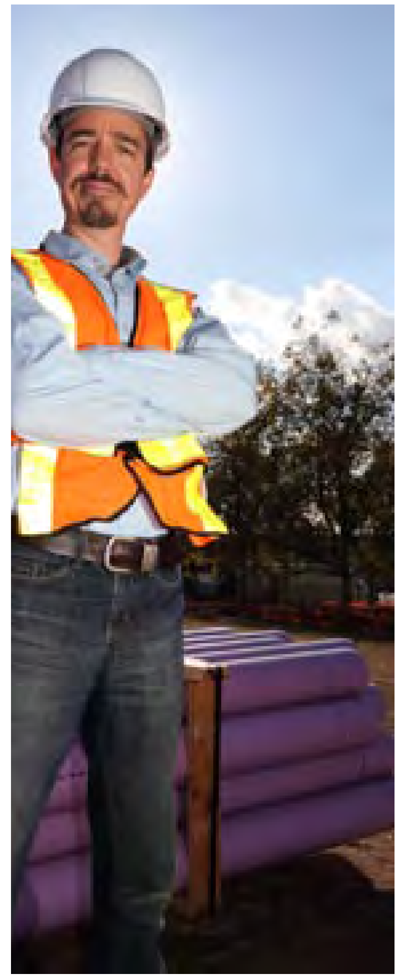
The Urban Counties would have an additional 39,000 acre-feet of annual water supply by 2050 if 60% of active conservation savings are dedicated to meeting new demands.



The Reuse Strategy

As the costs and challenges of developing new water supplies mount, reuse is becoming an important strategy to meet growing demands. In the Urban Counties, approximately 27,000 AFY of reuse currently occurs, and the potential exists for significantly more. The SWSI 2010 report includes an additional 23,000 to 32,000 AFY of reuse in the Urban Counties through planned projects.[33] Our analysis finds that there may be opportunities to increase reuse in the basin by 46,500 AF (including the projects identified in SWSI) to a total of 73,600 AFY or more.

The water amounts we include in this section are based upon reusing supplies that we have identified and accounted for elsewhere in this report. For example, first use of Super Ditch leases is discussed and included as an ag/urban cooperation project, but because these supplies are reusable, we then include additional yield based on reuse of return flows from these supplies here in the "Reuse Strategy" section.



Reusable Water Supplies

Colorado water law is very specific in the types of water that can be reused. These are limited to:

- Non-native water that has been imported into a basin (transbasin diversions)
- The consumptive use portion of agricultural water that has been transferred to another use
- Non-tributary groundwater
- Water diverted under a water right with a decreed reuse right

Some water providers consider reuse to be a conservation measure. In this report, reuse is addressed separately from water conservation because, although it decreases the need for additional supplies, it does not decrease water use. Reuse can be accomplished in two ways:

- **Direct Reuse**—Return flows from reusable supplies can be physically reclaimed for potable and non-potable purposes. For example, a water utility captures reusable treated water leaving its wastewater treatment plant

Reuse will be a crucial strategy to meet growing demands. Our analysis finds significant opportunities to increase reuse in the Urban Counties.

(WWTP) and uses this water again for urban, agricultural, recreational, environmental, or industrial purposes.

- **Indirect Reuse** — Return flows can be reused under substitution or exchange arrangements.[*] An example of indirect reuse is when a water utility lets reusable water leaving its WWTP flow downstream for diversion by an irrigator, and the utility diverts an equivalent amount of water into its system upstream.

The existing 27,000 AFY of reuse in the Urban Counties falls into three general categories: transbasin diversions, consumptive use portion of agricultural transfers, and non-tributary groundwater.

Transbasin Diversions

A significant volume of water is imported into the Urban Counties of the Arkansas Basin from the Colorado River Basin.[†] This water is reusable because it is not part of the basin's native flows, and historical return flows do not need to be maintained. This is the largest share of existing reuse in the Urban Counties.

Consumptive Use Portion of Agricultural Transfers

When an irrigation water right is converted to municipal use, only the historical consumptive use (CU) portion of that right can be transferred. If the decree allows for it, municipalities can reuse this converted CU water. Many Arkansas Basin irrigation water rights have been converted to municipal use.[‡] The most significant existing reusable agricultural transfers are transbasin supplies. In addition, the PBWW has purchased shares of the Bessemer Ditch with an estimated historical consumptive use of 6,200 AF.[34] Though not yet decreed for municipal use, PBWW's Bessemer Ditch supplies will likely be fully reusable. Additional reuse opportunities will also likely emerge as a result of long-term Super Ditch leases.[§]

* An exchange is generally an arrangement in which a junior water user makes water available to a senior water user (e.g., reusable treated effluent) in exchange for permission to use or divert an equivalent amount of water to which the senior would otherwise be entitled. A substitution or augmentation arrangement provides water supplies to replace out-of-priority diversions.

† A very small amount is also imported from the South Platte River Basin as part of the Blue River Pipeline system.

‡ Aurora, located in the South Platte Basin, has also purchased significant Arkansas Basin irrigation rights. Some of this supply is exported to the South Platte Basin and some is currently leased back to Arkansas Basin irrigators.

§ Super Ditch leased water will be the consumptive use portion of agricultural supplies, so it is likely that lessees will be able to use water to extinction.

Non-Tributary Groundwater

Reusable groundwater is limited and is decreasing in the Arkansas Basin. One groundwater reuse project in El Paso County is discussed in the "Acceptable Planned Projects" section. There are no significant additional groundwater reuse projects in place or planned for the Urban Counties.

Issues Associated with Reuse

Establishing a successful reuse project depends on water supply and system specifics. Potential limits to reuse include cost, water quality, infrastructure requirements, instream flow issues, agricultural concerns, and public acceptance. These issues are legitimate and will require effort to resolve. Reuse, however, remains an integral and viable water supply option for the Urban Counties.

Cost

Reuse can range from inexpensive to costly, depending on project specifics. The CWCB has estimated the cost of indirect potable reuse at $13,500 per acre-foot and the cost of direct non-potable reuse at approximately $7,000 per acre-foot, including infrastructure requirements.[35] Direct potable reuse can be much more expensive, ranging from $50,000 to $61,000 per acre-foot of firm yield.[36] Compared to the new project costs shown in Table 2 above, reuse through exchange and non-potable reuse are cost-effective supply options. As exchange potential decreases and costs and technology improve, potable reuse will also likely become a more viable option. According to CSU, "The day will come when recycling wastewater directly into drinking water will make sense for Colorado Springs. But, for now, it's less efficient, more expensive and less environmentally desirable than using the water rights we already own to provide water for our future."[37]

Pipes moving reclaimed water.

Water Quality

Municipal diversions and storm water runoff impact stream water quality. Additionally, more than a century of irrigation in the Lower Arkansas Valley has led to significant water quality concerns in the basin, including high concentrations of salt and minerals, such as selenium and iron (see "Water Quality and Agriculture in the Arkansas River Basin" sidebar).[38] To address these issues, water quality improvement efforts are ongoing in the basin. Increased indirect reuse has the potential to further degrade water quality as upstream water is exchanged for lower quality reusable wastewater return flows. Stored return flows could also create new water quality issues, such as nutrient loading in storage reservoirs. On the other hand, increased direct reuse will capture municipal return flows, decreasing the amount of potentially harmful constituents being discharged to rivers. Due to potential concerns, reuse plans should be evaluated for, and designed to minimize, negative water quality impacts.

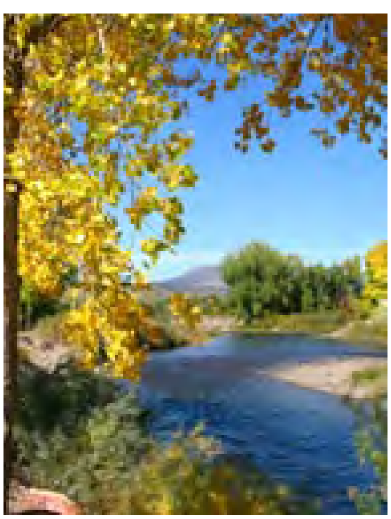
Infrastructure Requirements and Utility Cooperation

In many instances, water storage, infrastructure, and treatment facilities are needed to implement water reuse plans. Such infrastructure requirements are dependent on the level and type of reuse activities, the number of participants involved, and the willingness of the participants to develop shared facilities. Recognizing the benefits of integrated systems, water providers in the Urban Counties already share many facilities.

Stream Flow Issues

Instream flow (ISF) water rights and other flow management agreements and projects* are important to maintaining healthy ecosystems. However, these arrangements and other senior water rights can limit the amount of water that can be exchanged between upstream points of diversion and downstream points of return flow. The Arkansas River Compact must also be considered when evaluating potential reuse projects, and existing senior exchanges, SDS, and the Super Ditch project† will further limit new exchanges to times of higher flows. New storage, such as gravel pits, can provide municipalities with the ability to retime return flows to periods with remaining exchange potential.

Fall foliage along the Arkansas River, Colorado.



* These include the Arkansas River Voluntary Flow Management Program, Pueblo's Arkansas River Legacy Project, and the Fountain Creek Greenway, among others.

† The Super Ditch is discussed in detail in the "Ag/Urban Cooperation" section of this report.

Agricultural Perspective

It is critical to consider the impact on downstream agriculture when looking at increased reuse in the Urban Counties. Downstream irrigators currently lease reusable transbasin supplies from municipal providers. As providers like the PBWW grow into their reusable supplies and increase direct municipal reuse, water available to irrigators will decrease. Impacts on historical agricultural supplies and downstream water quality impacts should be evaluated and planned for.

Public Acceptance of Potable Reuse

Direct potable reuse of municipal return flows is still relatively uncommon in the U.S. but is increasing. This includes the neighboring South Platte Basin, where Aurora's Prairie Waters and the East Cherry Creek Valley Water and Sanitation District's Northern Pipeline projects will both use a combination of natural filtering, advanced water treatment, and blending with other supplies to treat reusable return flows to potable standards. In places where potable reuse has been implemented or seriously considered, public acceptance has been generally favorable, provided that adequate research, education, monitoring, and oversight activities are completed. A key focus of education is explaining the high level of water quality treatment utilized to make the water safe to drink.

Estimate of Urban County Reuse

Existing Reuse

In the Arkansas Basin, there is strong precedent for water reuse. Existing agreements allow municipal water providers to exchange their return flows for native Arkansas River flows or water stored in Pueblo and other reservoirs. CSU has one of the oldest direct reuse systems in the state, having initiated non-potable reuse for irrigation purposes in the early 1960s. Approximately 26% of CSU's demands are currently met via reused water, either directly or through exchanges and augmentation.[39] Table 4 provides a summary of 2002 reuse for the two largest municipal providers in the Urban Counties, CSU and the PBWW. Other providers in the Urban Counties may be using additional reuse water, but those amounts are not quantified here.

Future opportunities may nearly triple the amount of reuse occurring in the Urban Counties.

TABLE Nº 4 EXISTING REUSE IN URBAN COUNTIES.

Current (2002) Reuse*

Utility	Exchanges and Augmentation	Direct	Total
CSU[40]	23,100	3,400	26,500
PBWW[41]	600	–	600
Total	**23,700**	**3,400**	**27,100**

* Dry year 2002 data

Additional Planned Reuse

The Pikes Peak Area Council of Governments' Draft Regional Sustainability Plan,[42] which covers El Paso County and the City of Colorado Springs, includes the notable goal of utilizing 100% of the region's reusable water supplies in order to satisfy 2030 demands with the region's currently owned water supplies. SWSI identifies two planned reuse projects in the basin, the El Paso County Water Authority and PBWW reuse projects, with a combined medium range yield of 27,500 AF.

Further Opportunities

Further reuse opportunities also exist as a result of the following three projects:

- Eagle River Joint Use Project (transbasin diversion APP)
- PBWW's Bessemer Ditch shares (CU portion of agricultural transfer)
- Super Ditch leases (CU portion of agricultural leases)

Table 5 includes yields from existing reuse, additional planned reuse, and further reuse opportunities.

For the purposes of this report, we assume that the Urban Counties will develop and reuse to extinction all available reusable supplies from the Eagle River Joint Use Project, PBWW's Bessemer Ditch shares, and the Super Ditch leases. Accordingly, new reuse in the Urban Counties would reach 46,500 AF by 2050, as represented by the reuse wedge in Figure 9.

TABLE Nº 5 SUMMARY OF PLANS AND ADDITIONAL OPPORTUNITIES FOR REUSE.

Reuse Firm Yield (AFY)	
Current (from Table 4)	27,100
Additional planned†	27,500
Further opportunities‡,§	19,000
Total	**73,600**
Additional	**46,500**

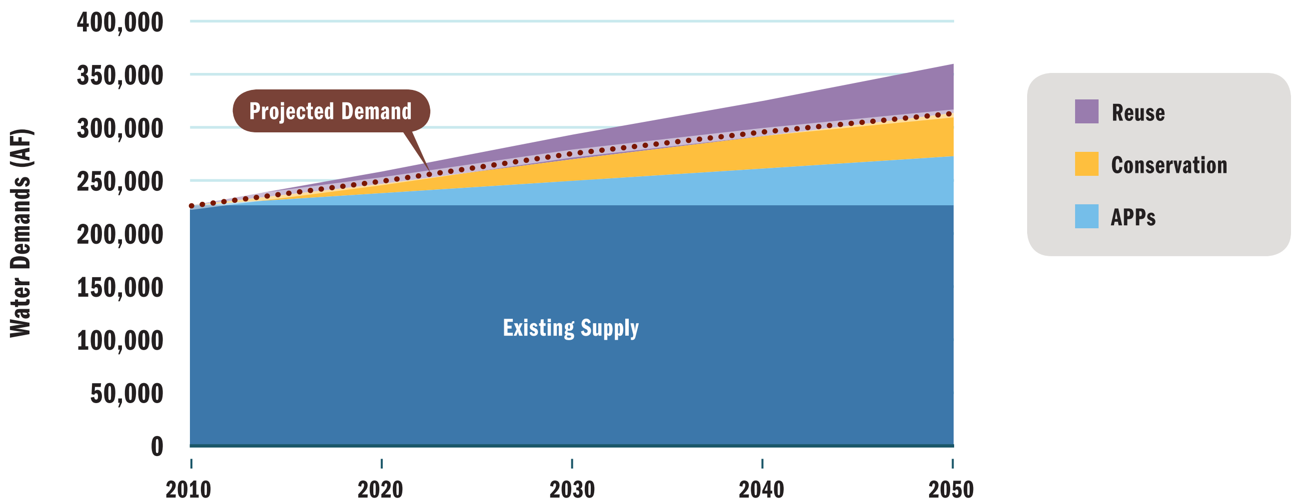
† SWSI, PBWW, and El Paso County Water Authority medium-range reuse project yields

‡ Assumes 0.75 AF of reuse (to extinction) for every 1 AF of reusable supply. The reuse factor of 0.75 is considered reasonable as it is lower than the PBWW's basin-specific factor of .88 (PBWW assumes that 1 AF of reusable supply yields approximately 1 AF of reuse).[43]

§ No additional yield beyond current reuse is assumed here for CSU, though modeling by CSU has indicated that as its demands grow, reuse opportunities will grow.[44] Some of this additional reuse is captured in SDS project yield.

FIGURE Nº 9 ESTIMATE OF WATER NEEDS FOR THE URBAN COUNTIES INCLUDING THE ACCEPTABLE PLANNED PROJECTS, CONSERVATION, AND REUSE STRATEGIES.

New reuse in the Urban Counties could total 46,500 acre-feet of additional annual water supply by 2050.



In the Arkansas River Valley, where a large number of urban and agricultural water users are closely linked, opportunities for agricultural/urban cooperation abound.

Ag/Urban Cooperation in the Urban Counties

The Arkansas River Valley, like the South Platte River Valley, has a mature water economy with a large number of urban and agricultural water users that are closely linked. In this setting, opportunities for agricultural/urban cooperation abound. Such agreements between irrigators and municipal suppliers, based on voluntary rotational land fallowing and temporary water leasing, depend on conditions established well in advance of actual reallocation of water that would lease water, prices that are attractive to irrigators, and delivery that is sufficiently reliable for municipal suppliers. It is estimated that ag-urban cooperation could provide approximately 9,100 acre-feet of additional water per year to the Urban Counties by 2050.

Issues Associated with Ag/Urban Cooperative Agreements

SWSI identifies a number of concerns with temporary ag/urban water transfers:[45]

- Temporary transfers must not be the precursors to permanent transfers.
- Temporary transfers must be protected against claims of abandonment for non-use or in loss of priority.
- A Balance must be struck between the farmers' preference for short-term arrangements and the municipal utilities' interest in long-term security.
- Transfer obligations should be shareable among multiple participating farmers in order to provide flexibility.
- Transfers must not affect the water supplies of nonparticipating farmers or ditch companies.
- Market tiers and associated prices must be established to allow participation by farmers with water of varying reliability.

- The structure, if not the detail, of agreements must be standardized to reduce time and administrative commitments necessary for both their negotiation and implementation.

There are other concerns with transfers as well:

- To the degree that these transfers result in increased diversions at upstream locations, flows in intervening stream reaches would be diminished, which could affect water quality, environmental, and recreational interests.

- Transfer arrangements should be designed so as not to affect the water supplies of nonparticipating farmers. This will require that return flows associated with the supplies of participating farmers be maintained.

> **"Cooperative agreements between irrigators and municipal water departments are the best way to preserve irrigated agriculture in the Arkansas Valley, but these will not be simple or easy to develop. Irrigators must maintain annual contracts for commodities—such as with vegetables and corn silage—or risk losing those markets in the future. Urban water providers need certainty of water availability, and cannot rely on leased water sources over the long term. Rotational fallowing is an option that shows promise, but will be difficult for some irrigators to adopt. Challenges abound, but ag/urban cooperative agreements are possible."**

—Tom Cech
Director of One World One Water Center for Urban Water Education and Stewardship at Metropolitan State College, Denver; former Executive Director of the Central Colorado Water Conservancy District

Large corn field where the irrigation system saves water by approaching the sprinkler as near as possible to the plants.

Super Ditch

The Super Ditch Company, an organization of shareholders from the seven ditches between Pueblo Reservoir and John Martin Reservoir,* was created to address the above concerns and to negotiate and facilitate, on behalf of the farmers, the collective leasing of water to individual municipalities or other water users in southeastern Colorado. The Super Ditch expects to find most of its customers in nonmetropolitan El Paso County. The delivery point for the water is Pueblo Reservoir. Super Ditch's objective is to make leases attractive to potential lessors (irrigators) and lessees by combining lease price, reliability of and access to supply, and long-term conditions that work for all parties. At the present, the Super Ditch is working with lease terms of 40 years at prices for water in the neighborhood of $500 per acre-foot.

Three-Tiered Water

The Super Ditch Company's conceptual market for leasing water is based on a three-tiered approach. Instead of structuring a market in which the lease provides for an entire water supply to customers at a fixed price per unit, its approach anticipates three markets for water, with unique prices corresponding to dry (firm), average, and wet hydrologic conditions. Considering the exchange potential of each ditch, an assumed 65% participation rate and a 25% rate of fallowing, engineering consultants to the Super Ditch calculated the yield of the seven participating ditches for each hydrologic year type.

HDR Engineering, a consultant to Super Ditch, estimated the potential dry-year yield of the lease-fallowing arrangement to be 14,020 acre-feet. When analyzing the hydrologic conditions between 1976 and 2004, there were only two years when all dry-year leases were not satisfied without carryover storage, but nearly 65% could still be delivered, performance that Super Ditch and its consultants consider highly reliable.[46]

The minimum yield available for the average-year market is estimated to be 14,610 acre-feet. Since there would be a greater variability in yield compared to the dry market, average-year leases will be offered at a lower price to consumers and are expected to be more attractive to customers who possess alternative water sources or raw water storage. The average-year market could make full deliveries 16 out of 29 years and make partial deliveries 27 out of 29 years.

Irrigation ditch.

* The seven ditches are: The Catlin Canal Company, the Fort Lyon Canal Company, the High Line Canal Company, the Holbrook Mutual Irrigating Company, the Otero Ditch Company, the Oxford Farmers Ditch Company, and the Bessemer Irrigating Ditch Company.

Approximately 16,770 acre-feet would be available to lease in the wet-year market. These deliveries are less consistent than the average-year market, but would still occur with "some regularity."

Yield estimates assumed that there will be no additional storage in the system beyond that already held by the ditch companies. Any benefit of more storage would depend both on the cost of storage and the price at which water with storage could be leased. In other words, storage must be weighed against its incremental costs to determine any increase in value for the Super Ditch.

The collective leasing of agricultural water, as exemplified by Super Ditch, is a proven path forward in balancing the needs of irrigators and municipalities.

Super Ditch Progress

Municipal acceptance of temporary leasing rather than permanent purchases of water rights remains the principal challenge to fallowing-leasing, but there is progress:

- The Super Ditch is currently implementing a pilot program with the City of Fountain, the City of Security, and other members of the Fountain Valley Authority, by working with farmers on the Catlin Canal to fallow enough acreage to deliver up to 500 AF of water from farmers to the lessees beginning in 2012. This could increase to approximately 8,000 AF in 20 years.

- The Lower Arkansas Valley Water Conservancy District (LAVWCD) and the Super Ditch anticipate that Colorado Springs Utilities (CSU) and Pikes Peak Regional Water Authority (PPRWA) members will continue to work on a carriage agreement(s) for Colorado Springs to deliver leased water from Pueblo Reservoir through the SDS when the pipeline comes online in 2016. If successful, the arrangement could evolve into a long-term lease involving PPRWA members.

- The Super Ditch is also developing a pilot program with the City of Colorado Springs to deliver 2,000 AF of water from farmers on the Catlin and Fort Lyon canals to CSU beginning in 2013. CSU is also interested in securing long-term water leases to cover system emergencies.

Remaining Hurdles

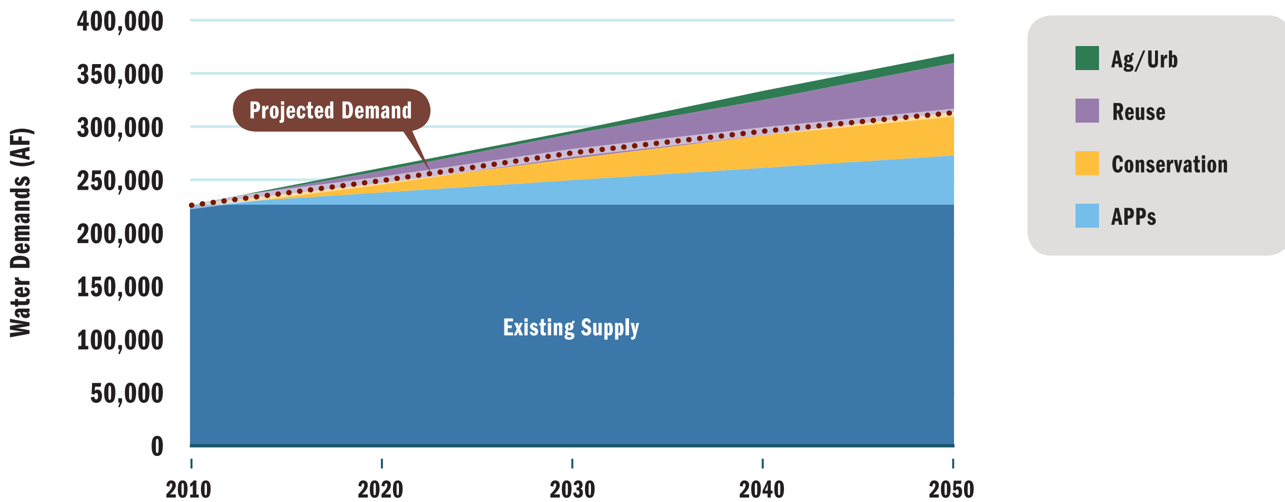
The LAVWCD and Super Ditch are pursuing adjudication of their exchange application in Water Division No. 2 and also working with the Arkansas River Basin Roundtable Task Force to simplify and reduce the cost of fallowing-leasing. This includes developing an "administrative tool" to address historic consumptive use and return flows from fallowing-leasing to simplify implementation of water leases. In addition, LAVWCD is seeking a grant from the CWCB to demonstrate system improvements on the Fort Lyon Canal to regulate return flows and avoid injury to other water rights from fallowing-leasing. Super Ditch is analyzing the potential to make lease water available through the Winter Water Storage Program (a program that allows water typically diverted in the winter to be stored and released during the following irrigation season).[47] Finally, the LAVWCD, the Super Ditch Company, and the Southeastern Colorado Water Conservancy District (SECWCD) are assessing a number of issues related to lease-fallowing agreements, including in-district excess capacity contracting for storage space in the Fry-Ark Project.

Supply from Ag/Urban Cooperative Agreements

Assuming a 65% delivery rate of potential Super Ditch dry yield, temporary agricultural-urban water transfers would provide to the Urban Counties an additional annual supply of 9,100 acre-feet of water by 2050 (Figure 10).

FIGURE Nº 10 ESTIMATE OF WATER NEEDS FOR THE URBAN COUNTIES INCLUDING THE ACCEPTABLE PLANNED PROJECTS, CONSERVATION, REUSE, AND AGRICULTURAL/URBAN COOPERATION STRATEGIES.

Our balanced portfolio more than fills the projected needs of the Urban Counties of the Arkansas Basin while protecting Colorado's environment.



Water Quality and Agriculture in the Arkansas River Basin

Irrigation districts have created, and still sustain, iconic rural landscapes that are integral to the history and cultural heritage of the West. Long-established irrigation systems may create incidental wetlands, open spaces, and rivers that run year-round, attracting wildlife and providing recreational opportunities. Irrigation return flows recharge underground aquifers, and sustain hydrologic and riparian systems downstream. Soil management practices may also contribute to climate change mitigation by increasing vegetation and soil organic carbon, while reducing soil salinity and the use of harmful chemicals.

In addition to irrigated agriculture, the grasslands of working ranches can provide environmental benefits. The dominant land cover in the Arkansas Basin is grassland (67% of total land cover).[48] Appropriately managed grasslands provide wildlife habitat, protect soil from wind and water erosion, and enhance groundwater recharge, among other things.

Nonetheless, while there are environmental benefits to ranching and farming, there may also be environmental problems. The Arkansas River has long sustained a belt of valuable agricultural production, but the Lower Arkansas River Valley may eventually succumb to the ill effects of shallow groundwater tables (waterlogging), excessive salt buildup, and high selenium concentrations, both on the land and in the larger river ecosystem. Excess irrigation and canal seepage in the basin dissolves native salts and selenium in the soils and transports these to the Arkansas River in significant quantities.

The Arkansas River is one of the most saline rivers in the U.S.

Salinity and Waterlogging

The Arkansas River is one of the most saline rivers in the U.S., and the irrigated areas in the Lower Arkansas River Basin are some of the most seriously salt-affected agricultural regions in the U.S. High concentrations of salt in irrigation water and agricultural soils can reduce crop yield by restricting the capacity of the crop to extract water from the soil. Between 2002 and 2005, annual salt loading to the Arkansas River in Colorado from subsurface return flows averaged about 396 pounds per acre per mile along the river upstream of John Martin Reservoir in the vicinity of Rocky Ford and La Junta.[49] Waterlogging, which occurs when shallow groundwater tables deprive the root zone of oxygen as a result of excess water, can also reduce crop yield.[50] Waterlogging and soil salinization have been estimated to cost a total of $5 million annually to Otero County in the Lower Arkansas River Basin.[51]

Center pivot irrigation of a cornfield, eastern Colorado.

Selenium and Environmental Health

Increasing selenium concentrations in the river and its tributaries, derived both from natural and irrigation-induced return flows, also have become a major concern in the basin. At high concentrations, selenium can be toxic to fish, invertebrates, and birds. Selenium may also pose a risk to humans who eat fish and drink water that contains excessive concentrations. Concentrations of selenium in the Arkansas River in Colorado have regularly been found to exceed the nationally recommended aquatic wildlife standard.[52] Preliminary estimates suggest a selenium-loading rate of about 2,200 pounds per year from tributary drainages and from the alluvial aquifer to the 37-mile stretch of the river east of Lamar.[53]

Up to 40% of salt transport to the river and a significant amount of selenium loads may be reduced by improving irrigation efficiency and reducing canal seepage.

Moving Forward

Clearly, salinity and selenium are very serious problems in the Lower Arkansas Valley. Colorado State University estimates that up to 40% of salt transport to the river and a significant amount of selenium loads can be reduced by improving irrigation efficiency and reducing canal seepage. Coordinated strategies that have been developed by Colorado State University and valley stakeholders to improve the current conditions fall within the following categories:

- Reduction of recharge from field irrigation
- Seepage reduction from canals
- Improved drainage options
- Conversion to more salt-tolerant crop varieties
- Phreatophyte removal along the river corridor

These strategies have the potential to decrease water needs and improve water quality. A land fallowing-water leasing program, such as the one proposed by the Super Ditch, is a strategy that could increase municipal water supply and improve water quality by reducing saline return flows.

The John Martin Reservoir Dam. Archive Photo, US Army Corps of Engineeers.

Recommendations

Water is critical to every component of life in Colorado. The high quality of life we enjoy in this state is at risk, however, unless decision-makers in Colorado shift to more innovative, balanced, and cost-effective approaches for supplying water to our growing population while sustaining our rivers and streams. This report lays out a portfolio of water supply strategies for meeting the future water needs of Urban County communities in the Arkansas River Basin without sacrificing the rivers of our majestic headwaters state. We must look beyond old ways of thinking and realize we have many solutions available for meeting future water needs. Today's decisions are critical.

Based on rigorous data analysis, this report offers several key recommendations that water planners and policy makers should consider carefully in forging Colorado's water future:

Historic Arkansas Riverwalk of Pueblo, Colorado.

- Close the projected Urban Counties' "gap" with balanced strategies that are more cost-effective and environmentally friendly than traditional transbasin projects.

- Protect Colorado's rivers, streams, and lakes as an integral part of any future water development strategy. Non-consumptive uses of water—for fishing, whitewater recreation, and other uses—are worth billions of dollars annually to our state economy and are critical to the quality of life in this state.

- Pursue only those Identified Projects and Processes that can be constructed and operated according to the "smart" principles delineated in this report.

- Implement more aggressive water conservation strategies. Conservation is often the cheapest, fastest, and smartest way to gain "new" water supplies, and Urban County utilities have significant opportunities to boost their existing water conservation efforts.

- Maximize the role of water reuse in meeting the future needs of Colorado's residents, and work to improve public perception and acceptance of reuse projects.

- Cooperate with agriculture on voluntary water sharing agreements that benefit both municipalities and the agricultural community without permanently drying irrigated acres. Alternatives to "buy and dry" transfers present the best opportunities for our future.

Duck Pond at Rockledge Ranch, near Colorado Springs.

While the Urban Counties' water providers are already making significant strides in pursuing projects that adhere to our smart principles, by further adopting these recommendations they can more than meet the future water needs of their communities while minimizing impacts to rivers and streams.

A bald eagle on the hunt.

End Notes

1 This calculation uses demands of 2008 as the baseline for the 34% reduction, and assumes that 30% of the total reduction will come from passive conservation. Colorado Department of Natural Resources, Colorado Water Conservation Board. 2011. "Appendix L - SWSI 2010 Municipal and Industrial Water Conservation Strategies." In *Colorado's Water Supply Future, Statewide Water Supply Initiative 2010*. Denver, CO. January.

2 Colorado Department of Natural Resources, Colorado Water Conservation Board. 2006. *Statewide Water Supply Initiative Fact Sheet: Arkansas Basin*. Denver, CO.

3 BBC Research & Consulting. 2008. *The Economic Impacts of Hunting, Fishing and Wildlife Watching in Colorado*. Prepared for the Colorado Division of Wildlife. Denver, CO. September 26.

4 Loomis, J. 2007. *How the Economic Contribution of Angling and Rafting to the Colorado Economy Changes with Variation in Instream Flow*. EDR 07-25. Fort Collins, CO: Colorado State University, Department of Agricultural and Resources Economics. December 10.

5 Walsh, R., R. Ericson, D. Arosteguy, and M. Hansen. 1980. *An Empirical Application of a Model for Estimating the Recreational Value of Instream Flow*. OWRT Project No. A-036-COLO. Fort Collins, CO: Colorado State University, Colorado Water Resources Research Institute. October.

6 Ward, F. 1987. "Economics of Water Allocation to Instream Uses in a Fully Appropriated River Basin: Evidence from a New Mexico Wild River." *Water Resources Research* 23(3):381–392. doi:10.1029/WR023i003p00381.

7 Shelby, B., T. Brown, and J. Taylor. 1992. *Streamflow and Recreation*. General Technical Report RM-209 (revised). Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station.

8 Loomis, J. 2007. *How the Economic Contribution of Angling and Rafting to the Colorado Economy Changes with Variation in Instream Flow*. EDR 07-25. Fort Collins, CO: Colorado State University, Department of Agricultural and Resources Economics. December 10.

9 Ibid.

10 Colorado River Outfitters Association. 2011. *Commercial River Use in the State of Colorado 1988–2010*. January 31.

11 Loomis, J. 2007. *How the Economic Contribution of Angling and Rafting to the Colorado Economy Changes with Variation in Instream Flow*. EDR 07-25. Fort Collins, CO: Colorado State University, Department of Agricultural and Resources Economics. December 10.

12 Policky, G. 2011. "Upper Arkansas River 2011 Fishing Forecast." In *Upper Arkansas River Fish Survey and Management Data*. Salida, CO: Colorado Division of Wildlife, DOW Salida Service Center.

13 BBC Research & Consulting. 2008. *The Economic Impacts of Hunting, Fishing and Wildlife Watching in Colorado*. Prepared for the Colorado Division of Wildlife. Denver, CO. September 26.

14 Ibid.

15 Colorado Department of Natural Resources, Colorado Water Conservation Board. 2010. "Appendix C Nonconsumptive Needs Assessment Focus Mapping Final Report, Appendix D-1: Arkansas Basin Mapping Results." In *Colorado's Water Supply Future, Statewide Water Supply Initiative 2010*. Denver, CO. January.

16 Colorado Department of Natural Resources, Colorado Water Conservation Board. 2011. "Appendix H - State of Colorado 2050 Municipal and Industrial Water Use Projections." In *Colorado's Water Supply Future, Statewide Water Supply Initiative 2010*. Denver, CO. January.

17 Ibid.

18 Colorado Water Conservation Board and Statewide Water Supply Initiative. 2010. "Water Supply Future Portfolio and Trade-off Tool." Available at http://cwcb.state.co.us/technical-resources/portfolio-tool/Pages/main.aspx.

19 Alan Ward, Pueblo Board of Water Works, personal communication to author, January 28, 2012.

20 Colorado Water Conservation Board and Statewide Water Supply Initiative. 2010. "Water Supply Future Portfolio and Trade-off Tool." Available at http://cwcb.state.co.us/technical-resources/portfolio-tool/Pages/main.aspx.

21 Western Resource Advocates, Trout Unlimited, Colorado Environmental Coalition. 2011. *Filling the Gap: Commonsense Solutions for Meeting Front Range Water Needs.* Boulder, CO.

22 Colorado Department of Natural Resources, Colorado Water Conservation Board. 2011. *Colorado's Water Supply Future, Statewide Water Supply Initiative 2010*. Denver, CO. January.

23 Colorado Water Conservation Board and Statewide Water Supply Initiative. 2010. "Water Supply Future Portfolio and Trade-off Tool." Available at http://cwcb.state.co.us/technical-resources/portfolio-tool/Pages/main.aspx.

24 City of Carlsbad, California. 2005. *Precise Development Plan and Desalination Plant Project: Environmental Impact Report for the Proposed Carlsbad Desalination Plan*. December. Available at http://www.carlsbaddesal.com/EIR.asp. See also Park, L. et al. 2008. *The Role of Recycled Water in Energy Efficiency and Greenhouse Gas Reduction*. Study conducted by the California Sustainability Alliance for the California Public Utilities Commission. May 2.

25 Colorado WaterWise and Aquacraft, Inc. 2010. Guidebook of Best Practices for Municipal Water Conservation in Colorado. Denver, CO: Colorado WaterWise. http://coloradowaterwise.org/Resources/Documents/BP%20Project/Best%20Practices%20Technical%20Guidebook%20-%20Oct%2018%202010.pdf.

26 Western Resource Advocates. 2007. *Front Range Water Meter: Water Conservation Ratings and Recommendations for 13 Colorado Communities.* Boulder, CO.

27 Western Resource Advocates, Trout Unlimited, Colorado Environmental Coalition. 2011. *Filling the Gap: Commonsense Solutions for Meeting Front Range Water Needs.* Boulder, CO.

28 U.S. Department of Energy, Energy Efficiency and Renewable Energy. 2012. "Energy Savers: Your Home." Accessed January 5. http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=12760.

29 Vickers, A., 2001. *Handbook of Water Use and Conservation*. Amherst, MA: WaterPlow Press.

30 Hoffman, H.W. 2011. "The Dollar Side of Water Conservation in the CII Sector." Presentation at the WaterSmart Innovations 2011 Conference, Las Vegas, Nevada, October 2–5.

31 Colorado Department of Natural Resources, Colorado Water Conservation Board. 2011. "Appendix L - SWSI 2010 Municipal and Industrial Water Conservation Strategies." In *Colorado's Water Supply Future, Statewide Water Supply Initiative 2010*. Denver, CO. January.

32 Kenney, D., M. Mazzone, and J. Bedingfield. 2010. *Relative Costs of New Water Supply Options for Front Range Cities*. Prepared for the Colorado Water Institute. Boulder, CO: University of Colorado, Natural Resources Law Center. July.

33 Colorado Department of Natural Resources, Colorado Water Conservation Board. 2011. "Appendix L - SWSI 2010 Municipal and Industrial Water Conservation Strategies." In *Colorado's Water Supply Future, Statewide Water Supply Initiative 2010*. Denver, CO. January.

34 Colorado Water Conservation Board and Statewide Water Supply Initiative. 2010. "Water Supply Future Portfolio and Trade-off Tool." Available at http://cwcb.state.co.us/technical-resources/portfolio-tool/Pages/main.aspx.

35 Colorado Department of Natural Resources, Colorado Water Conservation Board. 2011. "Appendix N - Reconnaissance Level Cost Estimates for Strategy Concepts." In *Colorado's Water Supply Future, Statewide Water Supply Initiative 2010*. Denver, CO. January.

36 U.S. Bureau of Reclamation. 2007. "Alternatives Analysis Addendum." For *Southern Delivery System Environmental Impact Statement*, *Great Plains Region*. December.

37 Colorado Spring Utilities. 2009. "Southern Delivery System Reuse." Accessed August 1, 2011. http://www.sdswater.org/env_reuse.asp.

38 Gates T., L. Garcia, and J. Labadie. 2006. *Toward Optimal Water Management in Colorado's Lower Arkansas River Valley: Monitoring and Modeling to Enhance Agriculture and Environment.* Colorado Water Resources Research Institute Completion Report No. 205. Colorado Agricultural Experiment Station Technical Report TR06-10. Fort Collins, CO: Colorado State University. June.

39 Colorado Springs Utilities, email message to author, August 31, 2011.

40 Ibid.

41 Pueblo Board of Water Works, email message to author, September 22, 2011.

42 Pikes Peak Area Council of Governments. 2010. *Pikes Peak Region Sustainability Project, Regional Sustainability Stretch Goals for 2030.* December 6.

43 Pueblo Board of Water Works, email message to author, September 22, 2011.

44 Colorado Springs Utilities, email message to author, October 10, 2011.

45 Colorado Department of Natural Resources, Colorado Water Conservation Board. 2011. "Section 7: Portfolios and Strategies to Address the M&I Gap." In *Colorado's Water Supply Future, Statewide Water Supply Initiative 2010*. Denver, CO. January.

46 HDR Engineering, Inc., 2007. "Appendix 6." In *Rotational Land Fallowing – Water Leasing Program: Engineering and Economic Feasibility Analysis Final Report*. Prepared for Lower Arkansas Valley Water Conservancy District. November.

47 Ibid.

48 Colorado Department of Natural Resources, Colorado Water Conservation Board. 2006. *Water Supply and Needs Report for the Arkansas Basin*. Denver, CO. June.

49 Gates T., L. Garcia, and J. Labadie. 2006. *Toward Optimal Water Management in Colorado's Lower Arkansas River Valley: Monitoring and Modeling to Enhance Agriculture and Environment.* Colorado Water Resources Research Institute Completion Report No. 205. Colorado Agricultural Experiment Station Technical Report TR06-10. Fort Collins, CO: Colorado State University. June.

50 Houk, E., W. Frasier, and E. Schuck. 2004. "The Regional Effects of Waterlogging and Soil Salinization on a Rural County in the Arkansas River Basin of Colorado." Selected paper presented at the Western Agricultural Economics Association Annual Meeting, Honolulu, Hawaii, June 30–July 2.

51 Ibid.

52 Gates T., L. Garcia, and J. Labadie. 2006. *Toward Optimal Water Management in Colorado's Lower Arkansas River Valley: Monitoring and Modeling to Enhance Agriculture and Environment.* Colorado Water Resources Research Institute Completion Report No. 205. Colorado Agricultural Experiment Station Technical Report TR06-10. Fort Collins, CO: Colorado State University. June.

53 Ibid.


Sunset over the Arkansas River.

WESTERN RESOURCE ADVOCATES

2260 Baseline Road, Suite 200
Boulder, CO 80304
Phone: (303) 444-1188
Email: info@westernresources.org

Western Resource Advocates is a nonprofit conservation organization dedicated to protecting the West's land, air, and water.

TROUT UNLIMITED

1320 Pearl St., Suite 320
Boulder, CO 80302
Phone: (303) 440-2937
Email: RScholfield@tu.org

Trout Unlimited's mission is to conserve, protect, and restore North America's coldwater fisheries and their watersheds.

COLORADO ENVIRONMENTAL COALITION
ourcolorado.org

1536 Wynkoop Street, #5C
Denver, CO 80202
Phone: (303) 534-7066
Email: info@ourcolorado.org

Colorado Environmental Coalition works to protect Colorado's environment by educating and mobilizing citizens, providing technical and organizing assistance to environmental organizations and other allies, and uniting and supporting them in coalitions that defend and preserve Colorado's natural heritage and quality of life.

"Clearly, as people who all care about Colorado's tomorrow, it is incumbent upon us to utilize and bring to reality the work given in *Filling the Gap: Meeting Future Urban Water Needs in the Arkansas Basin*. We have always asked more of the Arkansas than it can deliver. The Arkansas, the most over-appropriated river in Colorado, needs help to ensure its future viability. Collectively we must protect and enhance its riparian corridors, its agricultural sustainability, and its non-consumptive stream flows.

I want to thank Western Resource Advocates along with Trout Unlimited and the Colorado Environmental Coalition by urging the adoption of the succinct blueprint provided in the *Filling the Gap* report on the Arkansas Basin."

—John Singletary, Commissioner, Colorado Parks and Wildlife Commission; lifelong farmer, rancher, and resident of the Arkansas River Valley

"Water conservation is a critical way we can protect and preserve one of the West's most precious resources. As our western economies are inextricably tied to clean water and healthy flowing rivers, investments in conservation are essential as part of our efforts to protect our water supply for generations of Coloradans to come."

—Michael F. Bennet, United States Senator for Colorado