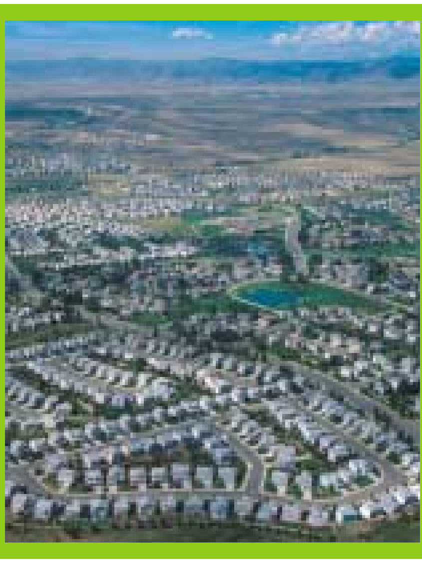
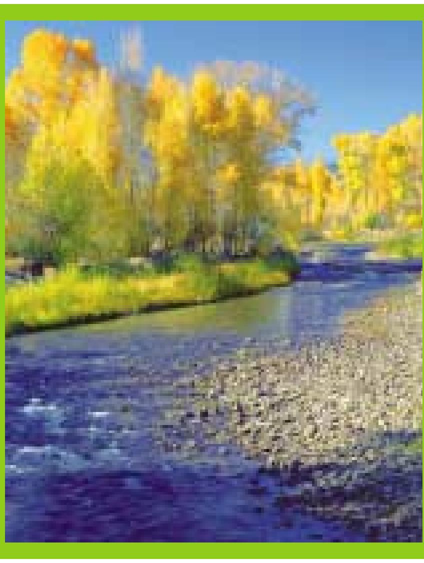
Facing Our Future





A Balanced Water Solution for Colorado

[This report conveys the vision of members of the Colorado conservation community for meeting the water needs of Colorado's Front Range for the next 25 years.]

Key Components

Conservation **Efficient Supply** **Storage**

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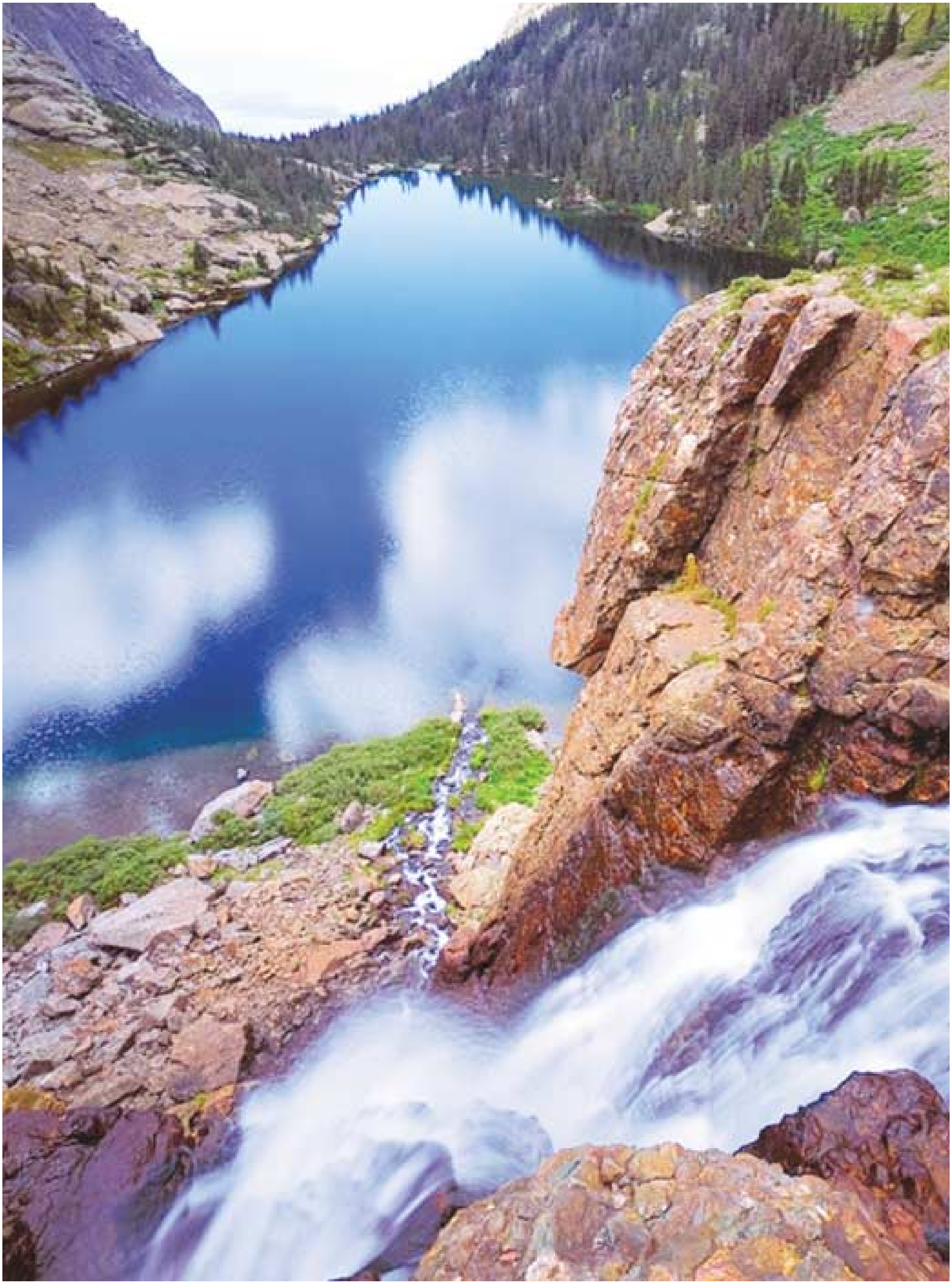


Willow Lake Waterfall. Photo by John Fielder

Introduction

Facing Our Future: A Balanced Water Solution for Colorado offers a broad-based, vision for satisfying the growing demands for water along Colorado's Front Range.

A key feature of Facing Our Future is its recognition that some new storage facilities will be necessary to increase and improve management of water supplies. However, this report asserts that improving conservation and efficiency, and investing more in reuse and water "sharing" between cities and farmers, are even higher priorities. These strategies increase supply faster, with less harm to Colorado's famous environmental values, and with much less controversy.

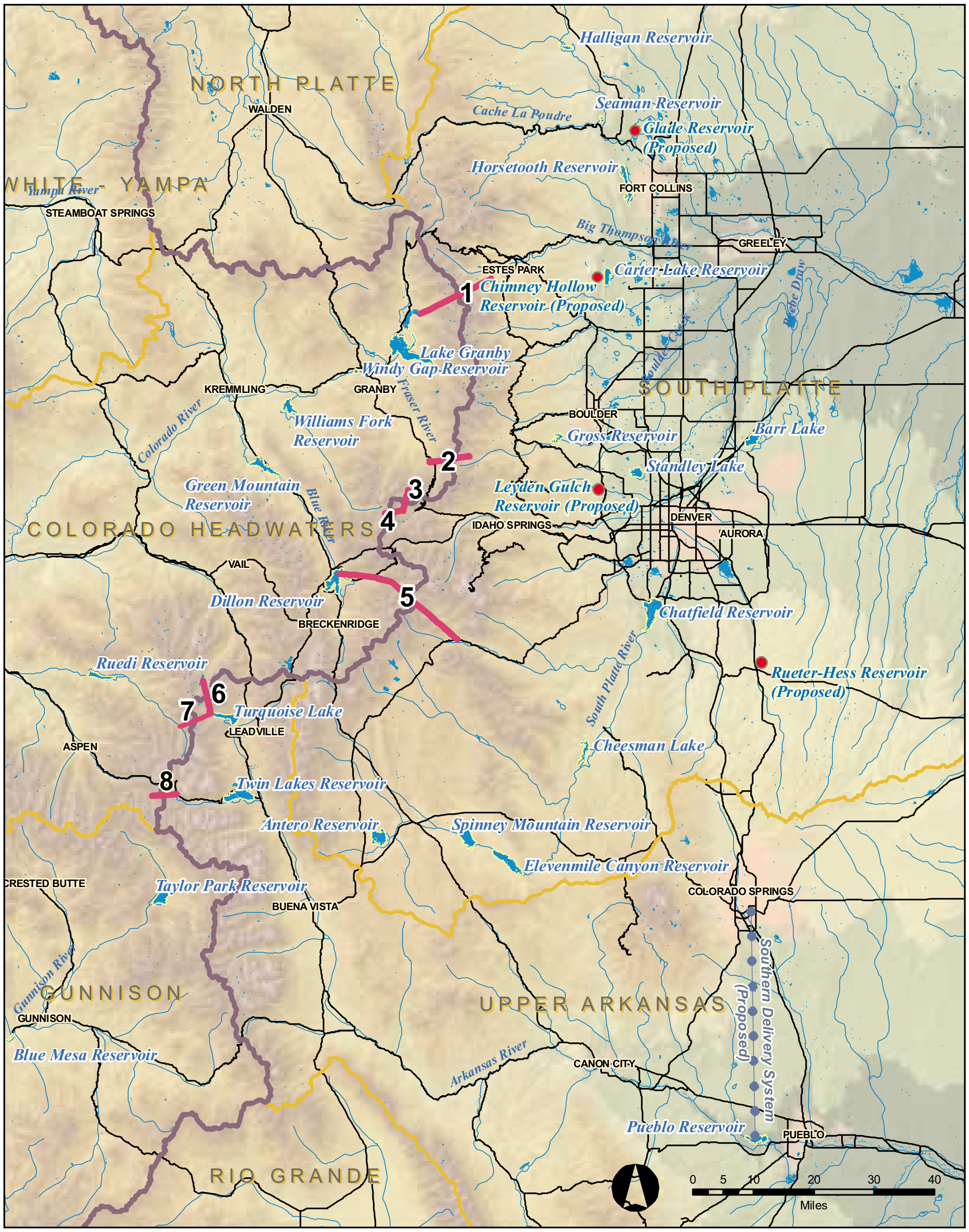
This solution is based on the premise that a diverse portfolio of strategies must be employed to meet future Front Range water needs. No single strategy will provide enough "new" water to achieve this objective. Some of these strategies have already been implemented by water utilities and districts, or are under consideration or development. Collectively, these strategies will provide a sustainable water supply (even in periods of drought), help the state's growing water-based recreation economy, protect the environment, and minimize adverse effects on communities whose water resources also provide water for out-of-basin users.

This report is, in part, a response to the Final Report of the recent Statewide Water Supply Initiative (SWSI). That process highlighted various means of increasing Colorado's water supply, and making this supply more reliable. Although members of the conservation community participated in SWSI, they felt strongly that the process did not prioritize meeting instream water needs, as opposed to those needs that require water to be diverted out of a river or stream channel. This report addresses that shortcoming by analyzing projects, programs, and policies that satisfy all water needs and could be fully supported by the conservation community.

In the past, the conservation community often resisted new water storage or diversion projects, as these undertakings would have caused too much harm to the environment and failed to promote the kind of change in the culture of water use and management in Colorado that will allow us to do more with less and have confidence in our supplies even in dry years.

The conservation groups responsible for this report would like to move beyond that dynamic; we expect to support the initiatives described here once they are modified to meet the "smart" storage criteria. Furthermore, the conservation groups represented in this report pledge to work closely with water providers and conservation districts to achieve higher levels of water conservation and efficiency, to ensure that the new or enhanced water projects described herein fulfill their potential to be smart, and to facilitate the subsequent approval and development of these projects.

Water Resources near the Front Range



Map created by Connor Bailey

Legend

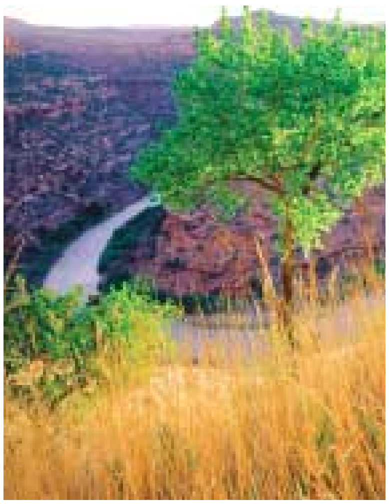
- Tunnels
- Continental Divide
- Watersheds
- Lakes & Reservoirs
- Rivers
- Highways
- Cities

Tunnels

1 Alva B. Adams
2 Moffat
3 Vazquez
4 Gumlick
5 Roberts
6 Homestake
7 Twin Lakes

Executive Summary

Colorado is a semi-arid state, and drought cycles are a common characteristic of our climate. While the severity of the current drought has intensified Colorado's focus on water issues, the sustainability of water supplies in this region has been an issue since the Anasazi abandoned their lands in the 14th century.



Dolores River oxbow
Photo by John Fielder

Colorado has always experienced drought. What is different now is that the state has millions more people living here, who expect water to satisfy a wider variety of needs. A century ago, the primary demands for water were for agriculture, mining and industry, and cities. Today, there are additional demands for water—to conserve and restore the environment; to support fishing, kayaking, and other water-based recreation; to make snow for ski areas; and to generate power, to name a few.

Colorado has experienced a dramatic increase in its population, especially in the last 20 years. Population projections indicate the number of residents will increase by 65 percent over the next 25 years. A full 88 percent of Colorado's present population resides along the Front Range, and the vast majority of new residents will live in Front Range cities and suburbs.

Recent events, including the state's water supply initiative process and the ballot-box defeat in 2003 of a $2 billion state bonding authority for unspecified water projects, revealed current trends and public convictions that should be factored into water planning in the near future:

- **Coloradans support water efficiency goals and programs.**
- **Coloradans believe it is important to conserve the environment and to leave enough water in rivers to support fish, wildlife and recreation, both for their quality-of-life benefits and because of their economic value.**
- **Coloradans want water planning to remain primarily a local exercise, albeit through processes that allow for participation of both beneficiaries and those adversely affected.**
- **Coloradans want solutions that are cost-effective.**

Colorado's Front Range has experienced—and will continue to experience—major changes in the characteristics of its water demand. The way water providers address these changes will affect water management and use, both locally and statewide. For this reason, it is important to have consistency in the criteria and conditions used to evaluate, approve, and build new water supply and storage projects at any and all levels of water planning.

A "Smarter" Vision

This report, Facing Our Future: A Balanced Water Solution for Colorado, conveys the vision of members of the Colorado conservation community for meeting the water needs of Colorado's Front Range for the next 25 years. Water suppliers are studying the feasibility of a number of proposed water supply and storage projects, or are in the process of obtaining necessary permits. Facing Our Future looks at these projects with the goal of improving their chances for success.

Facing Our Future offers a strategic model that will help satisfy the competing demands for water along the Front Range, including those of the environment and river-based recreation, while minimizing reliance on large new dams and projects that divert more water from the West Slope. This strategic model is distinguished from other water management approaches in two primary aspects: (1) it places a higher priority on boosting rates of water conservation and efficiency in water use and management; and (2) it incorporates protection—and even improvement—of environmental values into any and all actions that would boost water supplies.

Photo by John Fielder

Some new storage facilities will be necessary to increase and improve management of water supplies. However, this report asserts that boosting conservation and efficiency, investing more in reuse, and water "sharing" are even higher priorities. These strategies can increase supplies faster, more affordably, with greater protection for Colorado's environmental values, and with much less controversy. Where new water storage projects are needed, it is vitally important to ensure that they are as "smart" as possible—that is, that they satisfy the broadest possible range of stakeholder needs and concerns, are cost-effective, and minimize harm to local communities, the economy, and environmental quality.

Colorado's West Slope has a huge stake in the outcome of present and future water planning. New supplies to meet the needs for Front Range municipal growth—beyond what the Front Range gains from conservation, reuse, groundwater, more efficient water sharing, and transfers from agriculture—are likely to come from the West Slope. Outdoor recreation and irrigated agriculture are important components of the economies of many West Slope communities. As the proposed water projects analyzed in this report have the potential to cause significant, perhaps irreparable impacts to West Slope rivers, agriculture, and communities' future growth, cooperation and collaboration between the Front Range and the West Slope on new water projects is critical.

There is no single, simple solution for meeting Colorado's future water needs. In addition to using our water more efficiently through conservation and developing or improving some new water storage projects, other water management tools will be necessary to supply water to Colorado's growing urban centers while supporting our diverse economy and environment. These include:

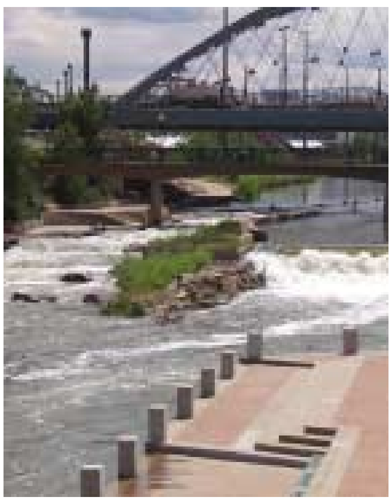
- **More "sharing" of water between existing users—for example, between farmers and cities;**
- **More cooperation between water providers, including the joint maintenance or operation of water supply infrastructure;**
- **More reuse of already developed water supplies;**
- **More expansion or rehabilitation of existing dams, reservoirs, and diversion structures.**

Together, these strategies constitute a "smart," balanced portfolio of alternatives that can achieve a workable water solution for all of Colorado.

The Case for Urban Efficiency

Coloradans take justifiable pride in our state's famous environmental values, chief among them scenic landscapes and flowing rivers. These characteristics of the Centennial State contribute significantly to our quality of life; increasing numbers of Coloradans participate in and enjoy Colorado's vast range of outdoor recreation opportunities. We need not sacrifice these values to satisfy our water needs.

With the population of the Front Range expected to increase by 65 percent by 2030 (from 3.8 million to 6.2 million), conservation is one of the most important strategies for meeting Colorado's water needs, because saving water can produce immediate results in terms of "new" water supplies. Most water that can be saved through systemic measures that improve efficiency can be used to meet growing demands or to improve the reliability of our water supply systems. Water savings through such efficiency measures should therefore be considered functionally equivalent to development of "new" supply sources.



South Platte River, Confluence Park, Denver. Photo by Amy Livingston

Saving water also saves money over the long-run—for water providers, consumers, and the state as a whole. "New" supplies gained from conservation may cost less, can be delivered more quickly, and have fewer adverse consequences for Colorado's environment than new supplies gained from other sources, such as storing and diverting water that now sustains our rivers.

Equally important, water conservation is the counterpoint to water waste. Water waste is unacceptable in a state as dry and with as many competing demands for water as ours. Surveys consistently show that Coloradans support greater conservation and efficiency in the use of water. Waste can be dramatically reduced through the installation and use of new technologies, new public policy (regulations and economic incentives), public education, and other strategies, without eliminating any particular uses of water or imposing restrictions that cause hardships for water consumers.

The potential for greater conservation and efficiency in the use of water in Colorado is so large that if it were fully or mostly realized, few if any new dams or transbasin diversions would be needed in the coming decades, even taking into account the expected growth in the state's population and economy.

Most Front Range water providers have implemented modest water conservation programs, but few have effectively integrated conservation savings into their water supply planning strategy. Many viable and cost-effective water saving measures acceptable to consumers remain underutilized or undeveloped.

Indoor Use

Estimates of Potential Water Savings from Single Family Residential Indoor Use

The success of any effort to increase efficiency in the use of water for indoor purposes is highly dependent on the policies and programs of municipalities and water utilities (e.g., rebate programs, public education campaigns, building code amendments).

This report bases its residential indoor conservation estimates on indoor water use dropping to 45 gallons per capita per day (gpcd) when water-efficient appliances and fixtures are installed throughout the household and as indoor leak detection and repair improves. These estimates do not factor in the potential effect of human behavioral changes regarding indoor water use, changes that can result in even greater water savings.

The 45-gpcd target figure may seem ambitious, given today's levels of use. But this report is not about today—its planning horizon is 2030. If the City of Aurora can reduce its in-home consumption by 10 percent (from 66 to 60 gpcd) in just three years, imagine the potential for reductions over a 20-year period. What's more, the 45-gpcd figure is based on 2001 technology. **Innovation in water conservation is every bit as dynamic as in other technology fields, and this innovation, coupled with progressive water policies and programs, will facilitate the conversion to greater efficiency of both new and older homes. It is worth noting that the City of Boulder, which includes both older and newer homes, is already at 57 gpcd for residential indoor use, one of the lowest usage numbers in the state.**

Photo by American Water Works Association

To compensate for uncertainty in the pace and breadth of more-efficient appliance installation and retrofitting, a high-low range is provided. In addition, these estimates factor in the indoor use differences between existing residents (as of 2000) and future residents (i.e., the net gain in population) since future residents in new developments will already have many water-efficient appliances in place. Explanations of these variables are found in the Technical Appendix.

The figures below apply only to single-family residences. Substantial additional savings are available in other water use sectors (e.g., multi-family, commercial, industrial, institutional).

Indoor Savings Potential

Existing and Future Single-Family Residents by 2030

Measured in acre-feet per year	
South Platte River Basin:	48,131–106,314
Arkansas River Basin:	10,920–23,910
Total Front Range:	59,051–130,224

Outdoor Use

Estimates of Potential Water Savings from Single Family Residential Outdoor Use

Over half of all residential water use in most Front Range cities is for urban landscape irrigation (watering lawns and gardens), so there is huge potential for water savings in this area. Tens of thousands of acre-feet can be saved as single-family residential (SFR) property owners make their gardens and lawns less water-needy and improve their landscape irrigation efficiency.

Achieving significant savings in outdoor water use does not preclude turfgrass landscaping. A very large amount of water can be saved, even with turfgrass, if a customer:

- Replaces a portion of the turfgrass coverage with low-water-use vegetation (particularly the areas that are less-used and/or difficult to water); and/or
- Waters the areas that remain turfgrass in a more efficient manner.

These outdoor savings estimates assume that all SFR lots in future developments and in existing developments hold the potential for improvements in water efficiency, whether through Xeriscaping, irrigation upgrades, or both. Since additional outdoor conservation savings can be achieved in other consumer sectors (primarily multi-family, commercial, and institutional), the noted savings estimates are just a fraction of potential Front Range outdoor water savings. For example, municipalities have an important leadership role in implementing efficient watering on city parks and regionally appropriate landscaping on other city properties.

Xeriscaped Yard
Photo by David Winger, Denver Water

Outdoor Savings Potential

*Single-Family Residential, Existing and Future Residents by 2030; Limited to Moderate Xeriscaping; Consumer Participation from 20% To 50% **

Measured in acre-feet per year	
South Platte River Basin:	19,969–112,323
Arkansas River Basin:	4,711–26,501
Total Front Range:	24,680–138,824

* See Technical Appendix for further explanation

Water and the Environment

We should conserve, protect, and restore streamflows to protect and promote recreational and ecological values.

Colorado's rivers and streams are renowned for their scenic qualities—and for the extraordinary recreational opportunities they provide. Many Colorado communities depend heavily on healthy streamflows for their economic well-being and future growth, especially in the mountains and on the West Slope.

A three-pronged strategy to conserve, protect, and restore our rivers and streams will help prevent chronically low flows or dewatering from damaging the ecological and recreational values of presently healthy river segments, and will repair and rehabilitate damaged waters.

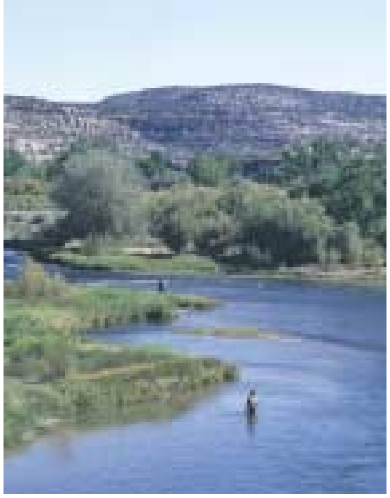


Photo by Jeff Widen

1. Conserve

Maintain the health of rivers that have consistently good water quality and streamflows.

Strategies:

- Encourage the Colorado Water Conservation Board (CWCB) to acquire senior water rights to protect or improve the environment, and to appropriate new instream flow water rights
- Encourage the CWCB to accept more donations and loans of water
- Recognize legitimate local government need for water rights to protect recreational investments and economy
- Encourage existing water rights holders to share water through interruptible supply agreements, fallowing, and leases

Priority River Segments:

- Gold Medal and wild trout fisheries designated by Division of Wildlife (DOW)
- Intact instream flow (ISF) reaches
- Priority streams for Great Outdoors Colorado, The Nature Conservancy, or the Colorado Water Trust
- Streams originating or passing through protected federal and state lands
- Other streams known for their environmental and/or recreational quality

2 Protect

Maintain/improve the condition of mostly healthy rivers threatened by low flows or poor water quality.

Strategies (in addition to those described above):

- Improve or maintain streamflows at critical times of the year through conditions in new water storage facility permits
- Improve or maintain streamflows through new water management agreements (e.g., those that may derive from processes such as "UPCO" in Summit and Grand Counties)

Priority River Segments:

- All streams that would be affected by projects identified in the Statewide Water Supply Initiative

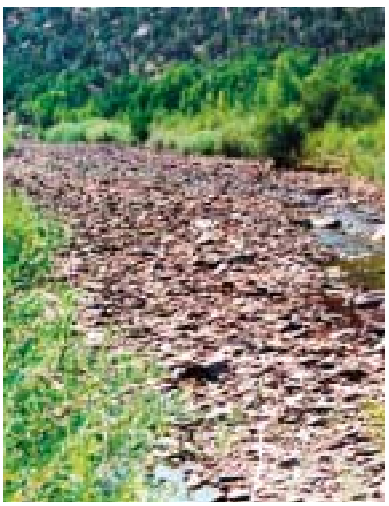


Photo: TU Archives

3. Restore

Improve the condition of rivers that currently suffer from low flows, dewatering, or poor water quality.

Strategies (in addition to those described above):

- Improve streamflows through re-operation of water storage and transmission facilities
- Improve streamflows through system-wide lining of ditches

Priority River Segments:

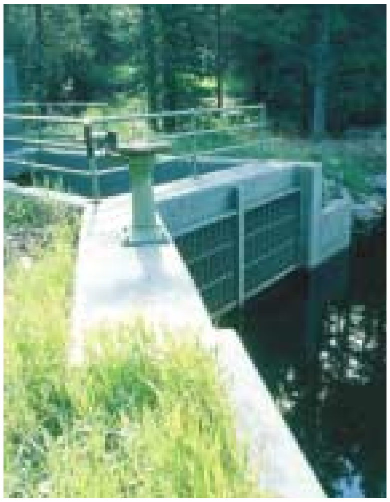
- Streams with truncated ISF water rights, e.g., where the ISF water right on a tributary does not extend to its confluence with the mainstem
- Streams with ISF water rights where the original appropriation was less than DOW recommended due to a lack of available water
- Streams critical to endangered, threatened, or sensitive species
- Stream reaches identified in Colorado Water Trust maps, including those from Trout Unlimited's 2002 report, Dry Legacy

Principles of "Smart" Water Supply and Storage

"Smart" water storage and supply projects—those that fully integrate public opinion and economic, financial, environmental, and recreational needs into the planning and development process—are the better way to provide for a secure water future. Some proposed new water projects for the South Platte and Arkansas River Basins have certain "smart" characteristics. Not all smart principles apply to every new water project.

However, a project that does not incorporate all relevant smart principles is unlikely to be smart overall. An indisputably smart water supply or storage project will satisfy each of the following principles that is relevant:

- Make full, efficient use of existing in-basin and imported water supplies, and reusable return flows, before increasing transbasin diversions.
- Invest in the most cost-effective and least environmentally damaging water supply options first. All costs should be considered in this analysis, including those borne by people or landscapes not served by the project ("externalities").
- Fully integrate conservation, water reuse, and demand management into the water supply planning process.
- Ensure that new and refurbished water projects do not increase the risk of extinction of native species nor adversely modify designated critical habitat for species protected under the Endangered Species Act.
- Before taking more water out of rivers, adopt interruptible supply agreements (where feasible) between agricultural water users and other water users, including those seeking to conserve, protect, or restore instream flows, and minimize any undesirable consequences of the reallocation of water from agricultural to municipal use.
- Improve use of existing water supply infrastructure and sharing of resources between water users to avoid unnecessary new diversions and duplication of facilities.
- Ensure public involvement—especially for non-traditional stakeholders directly affected by new water projects—in the planning process to ensure that project developers understand and minimize environmental and socioeconomic impacts.
- Use incremental approaches to providing new water supplies, to facilitate adding, changing, ending, accelerating, or delaying new supply strategies as demands change.
- Expand or enhance existing storage and delivery before building new facilities in presently undeveloped sites.
- Ensure that new projects provide multiple benefits and satisfy the greatest possible range of needs (including those for instream recreation and the environment), and use the most effective methods for minimizing environmental damage during construction/maintenance.



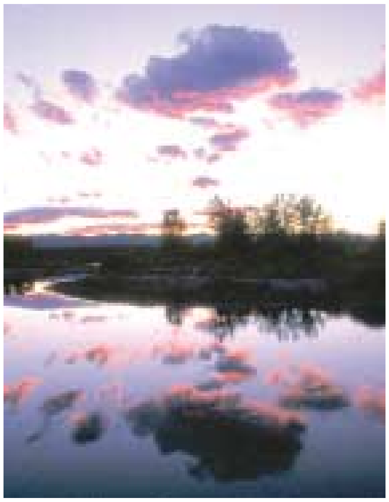
Fraser Intake
Photo by Ken Neubecker

Analysis of Proposed Water Supply Options

1. South Platte River Basin Options

The South Platte River Basin drains the northeast quarter of Colorado. Twenty-two counties, and some three million people (over 68 percent of the state's total population), depend on its water. With the population of this basin projected to grow to nearly five million people by the year 2030, municipal and industrial water needs are expected to grow by as much as 409,700 acre-feet, if cities do not incorporate significant water demand management, i.e., urban conservation.

To meet these needs, municipal water providers are pursuing a wide range of water supply development options that reflect the varying conditions and existing infrastructure in the basin's different regions. Many of these providers are successfully planning and implementing projects to increase the yield and reliability of their water supply systems.



Sunset over South Platte River
Photo by John Fielder

The recent Statewide Water Supply Initiative (SWSI) concluded that, of the over 400,000 acre-feet of new supply that might be needed to satisfy projected South Platte Basin demands, projects currently in the planning stage would satisfy at least 78 percent of this need.

Since SWSI was generous in its estimates of demand, but quite conservative in estimating potential savings through urban efficiency programs, it is likely that many water providers in the South Platte River Basin will be able to supply their customers for at least the next generation without having to bring online large new supplies other than those already planned.

2. Arkansas River Basin Options

The Statewide Water Supply Initiative calculates water demand shortfall in the Arkansas River Basin by the year 2030 to be only 5,500 acre-feet, mostly due to anticipated increases in urban demand. The shortfalls identified by SWSI, if considered in the context of the total existing demands in the Arkansas River Basin, are relatively small. **Even a modestly increased level of municipal and urban conservation would probably be sufficient to satisfy the needs identified by SWSI (this would still be the case in the event that several of the new water projects currently in the planning stage are not completed with the yield projected).**

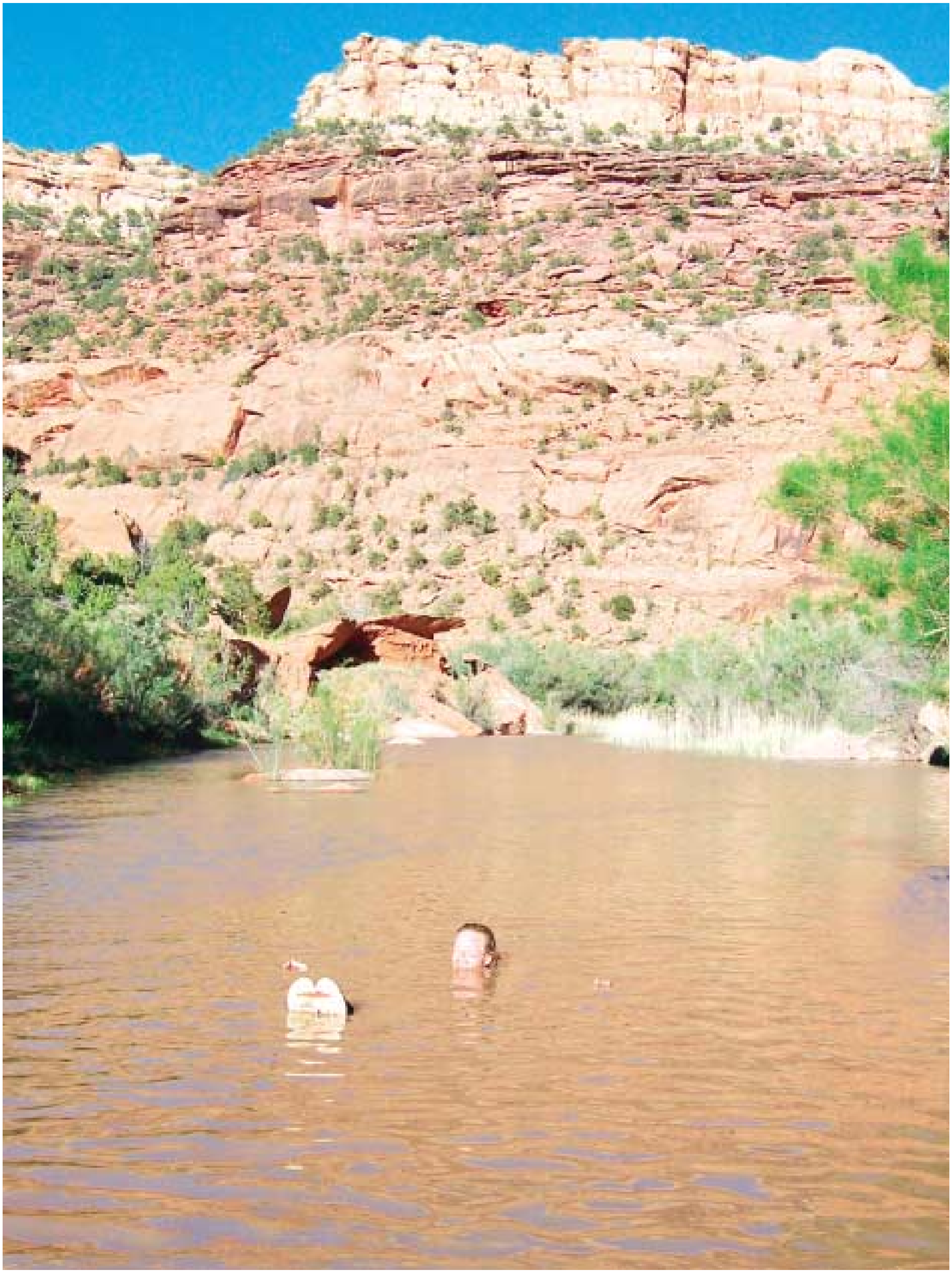
The possibility of increased water transfers out of the Arkansas River Basin to the South Platte River Basin is, due to their relative magnitudes, likely to be of much greater significance to Arkansas River Basin water management and socio-economic development than the SWSI-identified shortages. Many of the water supply alternatives identified by SWSI could ultimately be of primary benefit to those seeking to export water from the Arkansas River Basin.

Analysis of South Platte River Basin Supply Options

Project Name/Description (Beneficiary)	Potential Yield (acre-feet/year, rounded to nearest thousand)	Issues To Be Resolved
Water Conservation (all cities)	68,000–219,000	• Improve implementation by water providers • Gain wider public acceptance and endorsement • Offset effects on water provider revenue
Temporary Transfers (all cities)	Up to 190,000	• Address legal/institutional barriers • Mitigate/minimize impacts, especially to agricultural communities • Construct storage and delivery facilities • Assess highest value/most flexible transfers
Reuse (all cities with reusable rights)	Up to 120,000	• Assess cost of reuse for potable water, and adjust planning and consumer expectations accordingly • Assess and minimize potential adverse impacts to instream flows and water quality • Encourage public/water provider acceptance
System Refinements (Denver Water)	13,000	
Chatfield Reservoir Enlargement (Denver Water, other central South Platte water suppliers)	7,000	• Assess and minimize impacts of reservoir fluctuation on recreational facilities, wetlands, and bird habitats
Halligan/Seaman Reservoir Enlargement (Fort Collins, Greeley, others)	~ 20,000	• Ensure that project beneficiaries become more water efficient before the projects are initiated • Protect and enhance Pondre River and tributary flows
Standley Reservoir Enlargement (Northglenn, FRICO, Westminster)	6,000	• Gain additional, paying beneficiaries • Avoid/offset impacts to bald eagle habitat
Antero and Eleven Mile Reservoir Enlargements (Denver, Aurora)	Antero: 8,000 ElevenMile: 5,000	• Avoid or mitigate adverse instream flow issues in all affected stream reaches • Protect flows where possible
Barr Lake/Beebe Draw (Multiple Denver metro area suppliers)	10,000–100,000	• Minimize adverse effects of possible diminished flows below confluence of Beebe Draw and S. Platte mainstem • Assess potential for groundwater to be contaminated by agricultural fertilizers, and counteract this effect
South Metro Conjunctive Use (11 Douglas County water suppliers)	19,000–38,000	• Evaluate further the non-tributary aquifer to establish recharge potential • Maximize use of in-basin (South Platte) surface water supplies and reuse prior to use of additional West Slope water
Gross Reservoir Enlargement / Leyden Reservoir (Denver)	18,000	• Implement urban efficiency measures first • Avoid/offset impacts to Fraser River instream flows • Protect flows where possible
Windy Gap Firming (Northern Colo. WCD's Municipal Subdistrict)	30,000 plus storage	• Implement urban efficiency measures first • Avoid/offset impacts to Colorado River flows • Restore flows where possible

Analysis of Arkansas River Basin Supply Options

Project Name/Description (Beneficiary)	Potential Yield (acre-feet/year, rounded to nearest thousand)	Issues To Be Resolved
Water Conservation (all cities)	16,000–50,000	• Improve implementation by water providers • Gain wider public acceptance and endorsement; need consistent incentives to increase participation • Offset effects on water provider revenue
Temporary Transfers (all cities)	Initial rough estimate: 15,000 available	• Address legal/institutional barriers • Mitigate/minimize impacts, especially to agricultural communities • Construct storage and delivery facilities • Assess highest value/most flexible transfers
EPCWA Water Report— Development of Groundwater Resources (El Paso County, Colorado Springs)	4,000	• Address potential for aquifer renewal/recharge • Address potential for, and offset impacts associated with, future surface water diversions to supply Northern El Paso County
Reuse (all cities with reusable rights)	4,000	• Assess cost of reuse for potable water, and adjust planning and consumer expectations accordingly • Assess and minimize potential adverse impacts to instream flows and water quality • Encourage public/water provider acceptance
Arkansas River Water Bank Program	Large potential, but no way to quantify at this time	• Adopt/improve incentives to boost current low rate of participation • Analyze potential for benefit to broader base of users (not just users below Pueblo Reservoir)
SE Colorado Water Conservancy District Preferred Storage Option Plan	70,000 in additional storage; yield to be determined	• Offset impacts on Arkansas River flows and existing users • Address adverse impacts of potential demand for increased transbasin diversions into and out of Arkansas River Basin
Colorado Springs Southern Delivery System	51,000 average	• Address impacts on Fountain Creek water quality and stream channel • Maintain streamflows below Pueblo Reservoir; address other impacts on downstream users



Delores River Tributary. Photo by Amy Livingston

How We Achieve Results

Colorado has enough water to meet its needs, now and in the future. The state's future water needs can be satisfied through a variety of strategies: water conservation, reuse, enlargement of existing reservoirs and water supply systems, development of a few strategically located new reservoirs, and cooperative water supply management actions. Conservation and greater efficiency in the use and management of water, while not the entire solution, are unmatched in their potential to improve Colorado's usable water supplies relatively quickly and affordably—and without diminishing Colorado's quality of life.

Some Colorado water users will need to build new water storage facilities to satisfy growing needs in the next 25 years. Where proponents have demonstrated a real need for these facilities, it is vitally important to ensure that they satisfy the broadest possible range of stakeholder needs and concerns, are cost-effective, and minimize harm to local communities, the economy, and environmental quality.

The state has a role to play in the process of identifying, analyzing, and developing workable and affordable solutions to Colorado's water challenges. But the recent Statewide Water Supply Initiative found that most local and regional water providers have adequate water supplies for meeting current demands and are doing a commendable job of planning and implementing measures to meet future demands. The SWSI process also proved that construction of large new transbasin diversion systems or large new state-sponsored water development projects is not necessary to guarantee a reliable and sustainable water supply in 2030 and beyond. As a result, going forward the state's role in water supply planning and development will continue to be most effective when it focuses on facilitating communication and cooperation between water providers, Front Range and West Slope interests, and conservation groups.

The state has also played, and should continue to play, an important role in coordinating efforts to address endangered species issues, facilitating collaboration between water providers and the federal government, and providing technical resources and information. In addition, the state can help water users and others identify or develop sources of funding to ensure that projects conserve, protect, and restore rivers.

When Colorado's water laws were written, there was far greater value placed on removing water from rivers and streams for irrigation and industrial use than keeping water in-channel. Today, the value of water has shifted significantly. The volume of demand is greater, and traditional supplies have not increased as rapidly as this demand. In many areas, it is now a higher priority to keep as much water as possible in a river bed, and the cost of water for residential and municipal purposes is much higher than for agriculture.

It is more important today than ever before to ensure that any new water project—particularly one that would take water from a West Slope river basin—must consider and account for this shift in values. The state, its water providers, and its residents are equally responsible for making sure that this is accomplished, so that we can be confident in Colorado's water future. Future planning at all levels must focus significant efforts on improved efficiency, incorporate principles of "smart" supply and storage, and address the environmental, economic, and social needs of the originating river basins.

“...Colorado has experienced a dramatic increase in its population, especially in the last 20 years... and population projections indicate the number of residents will increase by 65 percent by 2030.”

The Challenge

Colorado has enough water to meet its anticipated needs for at least the next 25 years. Moreover, most water providers in Colorado are engaged in responsible planning—refining and updating future water demand projections and developing strategies to satisfy them. That's the good news.

The bad news is that a combination of outdated water policies, drought, institutional resistance to change, and factors that discourage efficient use of water makes it difficult to address Colorado's water challenges in ways that are both cost-effective and sensitive to our landscapes and rivers—a unique and varied natural heritage that most state residents and visitors treasure. Thus, what are often the most sensible strategies for cities—conservation and efficiency programs—are de-emphasized in state and local water planning, even though they can deliver "new" water faster and with less controversy than other options.

Conservation =
Reduction of water demand through water pricing incentives, landscape ordinances, indoor appliance upgrades, public awareness, irrigation system upgrades, technological advancements, and other means.

Efficient Supply =
Modifications to and integrations of existing water collection and delivery systems that allow more economical use of current water supplies.

For example, in the South Platte and Arkansas River Basins (the most populous basins in the state), even modest reductions in single-family residential urban water use—both indoors and outdoors—could save enough water to satisfy as much as 25 percent of the state's anticipated growth in municipal and industrial water needs by the year 2030. Substantially more water could become available with more comprehensive and committed efforts in demand reduction across all cities and all customer sectors. This potential can also be applied across Colorado.

There is no single, simple solution for meeting Colorado's future water needs. In addition to conserving water so that we use it more efficiently, and developing or improving some new water storage projects, we should increase our efforts to implement other water management tools to supply water to Colorado's growing urban centers while supporting our diverse economy and environment. These include:

- More "sharing" of water between existing users—for example, between farmers and cities.
- More cooperation between water providers, including the joint maintenance or operation of water supply infrastructure.
- More reuse of already developed water supplies.
- Greater efforts toward water loss reduction (including leak detection and repair).
- More expansion or rehabilitation of existing dams, reservoirs, and diversion structures.

Together, these strategies constitute a balanced portfolio of alternatives that can achieve a balanced water solution for all of Colorado.

Recent events, including the state's water supply initiative process and the ballot-box defeat in 2003 of a $2 billion state bonding authority for unspecified water projects, revealed current trends and public convictions that should be factored into water planning in the near future:

- Coloradans support more rigorous water efficiency goals and programs.
- Coloradans believe that it is important to conserve the environment and to leave enough water in rivers to support fish, wildlife, and recreation, both for their quality-of-life benefits and because of their economic value.
- Coloradans want water planning to remain primarily a local exercise, albeit through processes that allow for participation of both beneficiaries and those adversely affected.
- Coloradans want solutions that are cost-effective and that consider all costs (including federal, state, and local permitting, potential litigation, and impacts on the basins of origin).

Conservation and greater efficiency in the use and management of water are not the entire answer to the question of how we best supply enough water to meet our state's growing needs without sacrificing key elements of life in Colorado. However, the potential of conservation and efficiency to improve Colorado's water supplies reliably, substantially, and relatively quickly is unmatched by any other viable strategy.

This report is a product of collaboration among members of Colorado's conservation community. Its authors intend to present a forward-thinking, cost-effective, and readily achievable proposal regarding water supply and demand in Colorado to the year 2030 and beyond.

Xeriscaped Yard. Photo by David Winger, Denver Water

Background

In recent years, Colorado has suffered from the effects of drought—in many aspects, the most severe on record. Although the drought has focused attention on water issues in the state as never before, these issues are neither new nor unexpected. But the severity of the current drought, particularly in 2002, has raised new concerns about the long-term reliability of our water supply and our ability to continue to meet growing demands.

One reason for this heightened concern is the expansion in types of demand for water. A century ago there were fewer demands for water in Colorado: the primary needs were for agriculture, mining and industry, and cities. Today, there are additional demands for water—to conserve and restore the environment; to support fishing, boating, and other river-based recreation; to make snow for ski areas; and to generate power, to name a few.

Perhaps more importantly, Colorado has experienced a dramatic increase in its population, especially in the last 20 years. There are simply more people living in the Centennial State than ever before (approximately 4.34 million as of 2004)—and population projections indicate the number of residents will increase by 65 percent by 2030. A full 88 percent of Colorado's present population resides along the Front Range, and the vast majority of new residents will live in Front Range cities and suburbs. Much of this growth occurred during the relatively wet years of the 1980s and 1990s; but levels of precipitation in the past six years appear to be more consistent with this drought-prone region's long-term averages.

These factors have contributed to an animated public debate about how best to address Colorado's water challenges, both in periods of drought and in periods of plenty. Some Front Range politicians and water providers argue that large new transbasin diversions, dams, and storage facilities are needed, while conservation groups and some West Slope communities and their legislators counter that other strategies should be pursued before committing to the enormous funding and time-consuming permitting process required to build large new transbasin diversions—the taking of yet more water from one natural river basin and exporting it to another.

One outcome of this debate was Referendum A, a 2003 ballot measure that would have provided some $2 billion for new water storage projects around the state. Despite the drought and drought-related water use restrictions in many areas, Colorado residents voted two-to-one against the measure. The promise of additional water supplies from new projects was not enough to offset concerns about where and how such projects would be completed, and how much they would really cost consumers.

Meanwhile, local and regional water providers had been planning (some for many years) to meet the growth in water demands associated with the projected population increase. The recently completed Statewide Water Supply Initiative (SWSI), conducted by the Colorado Water Conservation Board, documented that most water providers are doing a good job of planning to meet their future needs. Significantly, SWSI also determined that the gap between estimated water demands in 2030 and supplies likely to be available at that time is relatively small. SWSI proved that the development of, planning for, and management infrastructure of Colorado's water supply is quite mature and functioning effectively, and that there are many opportunities for water providers to work together on cooperative solutions.

Water planning is evolving in its scope and focus, from its traditional emphasis on single-purpose projects to more comprehensive and integrated strategies. Because of changes over time in the relative value of water, evolution of new types of demand, and expansion of the number of "stakeholders" in water issues, the importance of this more systematic planning cannot be overstated.

Colorado's Front Range has experienced—and will continue to experience—major changes in the characteristics of its water demand. The way water providers address these changes will affect water management and use, both locally and statewide. For this reason, it is important to have consistency in the criteria and conditions used to evaluate, approve, and build new water supply and storage projects. Water suppliers are studying the feasibility of a number of proposed new water supply and storage projects, or they are in the process of obtaining necessary permits. Facing Our Future looks at these projects with the goal of improving their chances for success.

The West Slope's Stake

Front Range diversion of water from West Slope headwater counties
(by percent of natural flows)

Grand County 60%
Summit County 25%
Pitkin County 50%

Total average annual diversion > 600,000 acre-feet

Source: Rocky Mountain News, October 2, 2004

Colorado's West Slope has a huge stake in the outcome of present and future water planning. New supplies to meet the needs for Front Range municipal growth—beyond what the Front Range gains from conservation, reuse, groundwater, more efficient water sharing, and transfers from agriculture—are likely to come from the West Slope. Water-based recreation and irrigated agriculture are important components of the economies of many West Slope communities. The natural beauty and recreational opportunities of the West Slope are clearly of interest and value to all Colorado citizens. As the proposed water projects analyzed in this report have the potential to cause major, perhaps irreparable impacts to West Slope rivers, agriculture and future growth, cooperation and collaboration between the Front Range and West Slope on new water projects is critical.

West Slope headwaters counties already deliver over 600,000 acre-feet of water per year to the Front Range. This considerable amount of water is made available by diverting 60 percent of the natural flows in Grand County, 25 percent of natural flows in Summit County, and 50 percent of natural flows in Pitkin County. New storage projects under consideration could increase these diversions by 100,000 acre-feet or more annually.

West Slope water currently supplies over 50 percent of Denver's use. Denver already diverts 50 percent of the Fraser River headwater flows and plans to divert an additional 10 percent. The Fraser's future as a viable river, both ecologically and aesthetically, is in serious doubt. The Northern Colorado Water Conservancy District's current diversions from, and conditional water rights in, the Colorado River above the Williams Fork result in much the same dynamic.

As a result of diversions by Denver, Colorado Springs, and others, the Blue River now flows consistently from Dillon Reservoir at only a minimum flow level during much of the year. The Eagle River—already tapped by Colorado Springs and Aurora—would lose even more of its flows if new planned diversions come online. The Roaring Fork and Fryingpan Rivers presently relinquish as much as 50 percent of their flows to transbasin diversions for southeastern Colorado water users.

Water management and operating plans are as important to West Slope interests as the amount of water diverted to the Front Range. Many headwaters counties depend heavily upon the economic benefits of healthy rivers. Outdoor recreation generates hundreds of millions of dollars in West Slope communities every year. This industry is based substantially on lakes and rivers, from on-the-water activities like fishing and boating to activities such as hiking and camping, since scenic landscapes and rewarding cross-country travel depend on clean and aesthetic water sources. Visitors from around the world value the West Slope's unique water-based resources.

The health of any river depends not only on the quantity of flowing water, but on seasonal variation of flow, associated river habitat, and water quality. Smarter solutions thus must satisfy one of the key "demands" of the West Slope: that enough good quality water flow in streams, at the right times, not only to protect but to strengthen the vibrant recreation-based economy. Any new water project that would divert more water from the West Slope should incorporate the health of donor streams into its operation and management.

Like cities along the Front Range, a critical issue for West Slope communities is their need for adequate, dependable water supplies to satisfy future growth and economic development. Ironically, while the headwater counties are the state's most productive sources of water, they are effectively trapped in a water rights desert—senior downstream rights on the Colorado River, transmountain diversions, and requirements to maintain instream flows all limit the ability of these counties to procure new water. In fact, traditional options for meeting new water needs in the headwaters counties are limited primarily to transfers from West Slope agriculture, or the development of expensive new junior storage reservoirs. Thus, in planning to meet future water needs in this region, water efficiency, reuse, and cooperative planning among West Slope water providers will be just as important as it will be to the Front Range.

Projected increase in water needs for Colorado River headwater counties by 2030

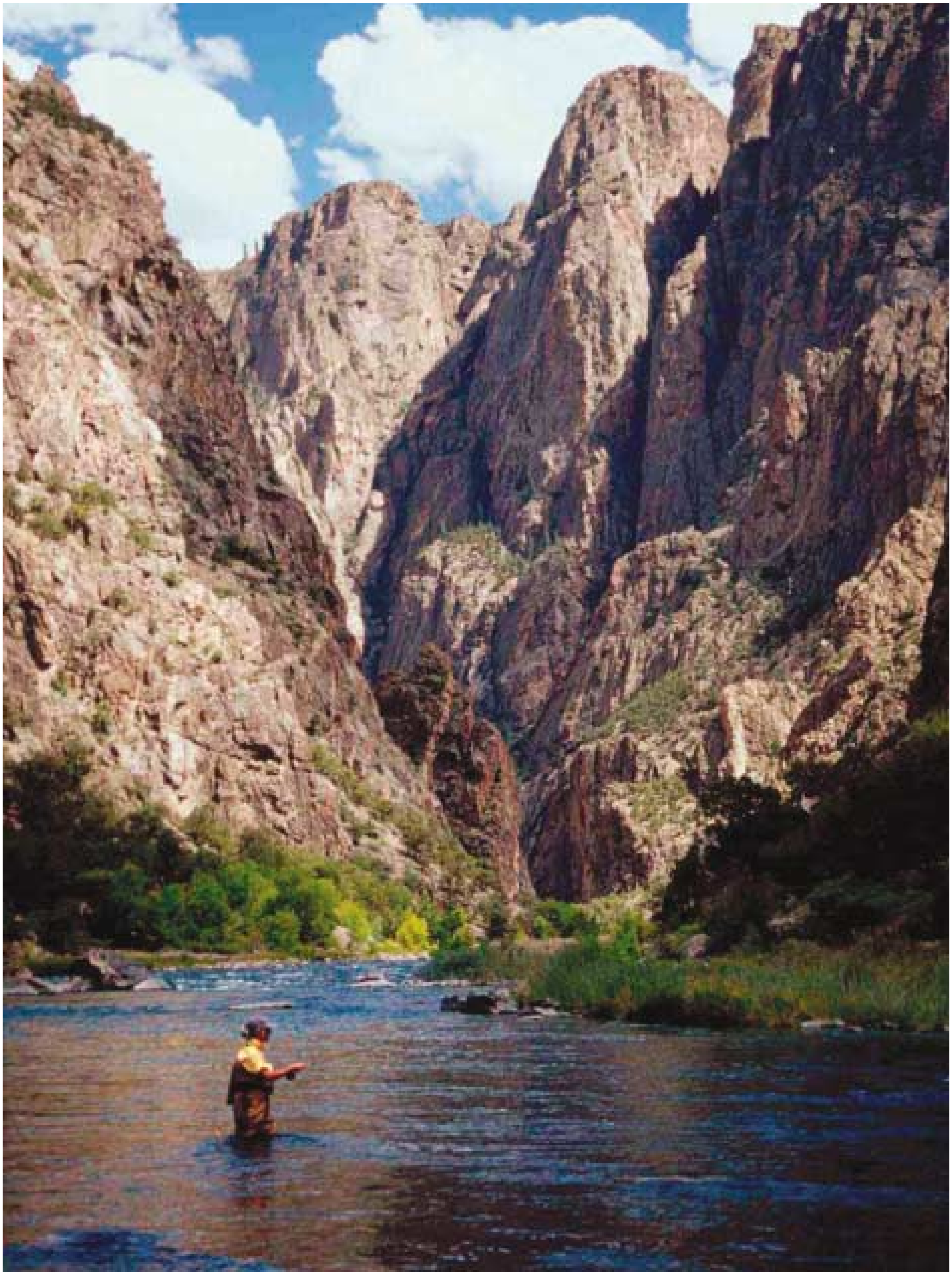
Grand County 93%
Summit County 92%
Eagle County 87%
Pitkin County 60%

Source: Upper Colorado River Basin Study, Phase II Final Report, April 2003

Historically, the West Slope has been less attentive to in-basin water conservation than the Front Range, but conservation and efficiency are growing concerns on the West Slope as well. As areas of the West Slope grow and become more urban, they frequently have difficulty securing adequate water supplies. Moreover, some West Slope communities are often not well-informed about water scarcity and other water issues, especially in areas with significant resort and second home populations.

High-end second homes in some resort towns use many times more water just for landscaping—while unoccupied—than is used for the average full-time residential home. West Slope water providers have begun to adopt more conservation strategies and do more water education; the conservation community will assist in the expansion of these activities. For example, conservation activists will continue to speak out in support of local decisions to adopt metering and tiered rate structures that are becoming the standard for West Slope communities.

West Slope residents feel strongly that the Front Range should maximize use of its "home" water supplies before withdrawing more from the West Slope. In order to reduce the likelihood of more intra-state conflict, plus further delays and greater costs associated with delivery of new supplies, Front Range water providers and consumers are well-advised to demonstrate their commitment to using (and reusing) every available drop of in-basin water. A large-scale and well-publicized emphasis on improving conservation and efficiency in the transport, sharing, and use of Front Range water will help convince the West Slope that additional transbasin diversions, if necessary, will not simply replace water that is wasted or mismanaged.



Angler in Black Canyon. Photo by Mark Lance

“Conservation and greater efficiency in the use and management of water, while not the entire solution, are unmatched in their potential to improve Colorado’s usable water supplies...”

A Balanced Solution

Every gallon of water that runs from our household taps or lawn sprinklers originates from a natural river system or underground aquifer. The daily use of water in our homes, institutions, and businesses thus is linked directly to the long-term preservation of Colorado's natural heritage.

The Case for Urban Efficiency

Coloradans take justifiable pride in our state's famous environmental values, chief among them scenic landscapes, flowing rivers, and outdoor recreation. These values do not have to be sacrificed to satisfy our water needs.

With the population of the Front Range expected to increase by 65 percent by 2030 (from 3.8 million to 6.2 million)[1], conservation—a critical sub-part of overall system efficiency—is one of the most important strategies for meeting Colorado's water needs, because saving water can produce immediate results in terms of "new" water supplies. Most water that can be saved through conservation can be used to meet growing demands or to improve the reliability of our water supply systems. Water savings through such efficiency measures can therefore be thought of as functionally equivalent to development of "new" supply sources.

Saving water also saves money over the long run—for water providers, consumers, and the state as a whole. "New" supplies gained from conservation may cost less, can be delivered more quickly, and have fewer adverse consequences for Colorado's environment than new supplies gained from other sources, such as storing and diverting water that is now sustaining our rivers.

Equally important, water conservation is the counterpoint to water waste. Water waste is unacceptable in a state as dry and with as many competing demands for water as ours. Surveys have consistently shown that Coloradans support greater conservation and efficiency in the use of water. Colorado should be doing everything possible to minimize water waste. Waste can be dramatically reduced through the installation and use of new technologies, new public policy (regulations and economic incentives), public education, and other strategies, without eliminating any particular uses of water or imposing restrictions that cause hardships for water consumers.

Some water providers are resistant to raising levels of conservation because they claim high levels of current use enable water use restrictions to save water in drought years. This argument is unconvincing on several counts. First, even with a significant increase in conservation, the predominant residential landscape along the Front Range will continue to be bluegrass for many years to come; the fact that bluegrass can survive for extended periods with little water provides a sizeable water "buffer" in times

[1] Rounded from figures available at Colorado Department of Local Affairs, Demography Office (www.dola.state.co.us, accessed on July 20, 2004). See data in Technical Appendix for breakdown of demographic data and forecasts for each metropolitan district along the Front Range.

of drought. Second, other supply options (including dry-year leases and exchange agreements) can provide water to cities in extremely dry years, often at a fraction of the cost of new storage projects. Third, it's simply not good public policy to discourage efficient use of any limited resource–especially since Colorado's rivers, recreation economy, and many West Slope communities depend on more efficient use of water. Until there are unequivocal data proving that higher levels of water use now are, paradoxically, required to ensure that Colorado residents and businesses have enough water during future droughts, we should encourage Coloradans to "do more with less."

The potential for non-structural alternatives—greater conservation and other forms of efficiency in the use of water in Colorado—to enhance water supply is so large that if it were fully or mostly realized, few if any new dams or transbasin diversions would be needed in the coming decades, even taking into account the expected growth in the state's population and economy. Most Front Range water providers have implemented modest water conservation programs, but few have effectively integrated conservation savings into their water supply planning strategy. Many viable and cost-effective water saving measures acceptable to consumers remain underutilized or undeveloped.

Becoming as Water-Efficient as Possible: How Do We Get There?

The more efficient we are in our collective conservation efforts, the more water we will save. Both municipal water utilities and their customers share the responsibility to become more water efficient.

Although consumers, or end users, ultimately determine how much water they use, the cities, districts, and other utilities that supply the water also play an integral role that directly affects customer use patterns because they establish water conservation policies, programs, and incentives. For example, water rate structures, landscaping ordinances, appliance rebate programs, turf replacement rebates programs, public education campaigns, and large user water audits all encourage consumers to use water more efficiently. In the future, technological advancements in water-efficient appliances, fixtures, and irrigation devices will further contribute to the water savings derived from a joint commitment by consumers and suppliers to become more water efficient.

Conservation is critical to becoming more water-efficient. From a residential consumer's perspective, the two primary categories of urban water conservation are:

- Indoor water savings derived from installation of water-efficient appliances and fixtures, and from water-efficient behavior; and
- Outdoor water savings derived from water-efficient urban landscaping and irrigation.

Water suppliers have considerable authority and influence to convince their customers to increase water savings, by implementing comprehensive conservation strategies that target both indoor and outdoor water use. Since each water supplier deals with unique water use patterns and community attributes, conservation strategies must be customized to the needs and values of each city.

To ensure that conservation strategies have a meaningful impact on the water use and water savings of each consumer, each Front Range municipal water provider should address all four of the following general program and policy categories:

- **Water rate/pricing structures**
- **Rebate and retrofit programs**
- **Education**
- **Regulations and ordinances**

Some effective examples of these conservation programs and policies are listed on the following pages.

(1) Water Rate/Pricing Structures

Definition:

Adjusting retail water rates to provide a price incentive for consumers to use water more efficiently and to support rebates and other programs.[2]

Examples:

Increasing block rate structures reward customers who conserve with low unit prices, and fairly allocate higher costs of water to customers whose use places the highest burden on supply (via a significant unit price increase for using excessive volumes of water).

Water budget rate structures—a version of increasing block rates—provide an equitable way of charging for water by assigning a unique rate structure to each customer account, based on each customer's water needs.

Photo by Jeff Widen

Water Budget Rate Structures

Boulder recently decided to join the growing number of Colorado cities (including Aurora and Highlands Ranch) that use a water budget rate structure on city water bills. A "budget" rate structure is a kind of increasing block rate that establishes an individual allocation for each property owner and business. Each customer account is assigned a monthly allotment of water based on the customer's lot size, irrigable area, climate conditions, and occupancy.

The monthly budget provides enough water for each customer to satisfy normal indoor uses and actual landscape irrigation needs. If customers exceed their monthly budget, the excess use is charged at a notably higher rate. This structure can provide incentives to conserve water year-round—it rewards water savings yet does not penalize large-lot owners and businesses, as long as they make concerted efforts to be efficient. A water budget also becomes a unique tool for drought management: in times of shortage, the budget for all customers can be lowered proportionately, so that reductions are shared equitably.

Cities that have implemented water budgets in Colorado and elsewhere have seen dramatic decreases in water use. Irvine Ranch (California) adopted a water budget program in the mid-1990s and saw a 20 percent reduction in demand within two years. Aurora's (Colorado) budget program led to dramatic use reductions in 2003 and 2004. Citizens, armed with a better understanding of how much water they actually need, are able to maintain their quality of life while using considerably less water.

(2) Rebate and Retrofit Programs

Definition:

Incentive programs that provide customers with free retrofits of water-efficient indoor and outdoor fixtures, and/or provide monetary rebates to customers who voluntarily replace their indoor and outdoor water appliances or fixtures.

Examples of Rebates:

- Installation of ultra-low-flow (ULF) toilet
- Use of new water-efficient dishwasher
- Use of landscape irrigation controller
- Installation of new rainfall sensor

[2] Note that the effectiveness of an increasing block rate structure is wholly dependent on the way it is designed. Not all increasing block rate structures are effective in promoting efficient use.

Snowmass Creek Ranch
Photo by John Fielder

Aspen Manages Demand Through Efficiency Improvements

A growing number of cities around the state use better water management, rather than new supply sources, to meet new water demands. The City of Aspen is a good example.

Just a decade ago, over half of the water Aspen treated for domestic use went unaccounted for, lost through a combination of leaks, faulty metering, and poor record-keeping. In the mid-1990s, the city began an aggressive program to upgrade water meters and repair leaks (especially on main water lines). The result: unaccounted for water now constitutes less than five percent.

Over the past 10 years, the number of accounts served by Aspen has increased by 40% (10,000 equivalent capacity units (ECUs) to 14,000 ECUs). But, during that time, water efficiency programs have kept Aspen's peak and average monthly demands steady, avoiding the need to seek out new supplies. Indeed, many cities are discovering that conservation is, in itself, a valuable source of supply.

Source: Phil Overinder, Aspen Water Manager

- Use of soil moisture content sensor
- Use of evapo-transpiration sensor/controller
- Use of new high-efficiency clothes washing machine
- Conversion of landscaping from water-intensive to water-efficient (e.g., replacing turfgrass with Xeriscaping)

Examples of Retrofits:

- Low-flow showerhead retrofit
- Faucet aerator retrofit

Other:

- Toilet self-check kits

(3) Education

Definition:

Programs that improve public awareness of water use, teach how to become more water-efficient, and explain the relationship between water efficiency and protecting natural river systems and aquifers. To be broadly effective, such programs should address such basic questions as: **(1)** Why is conservation important? **(2)** What's at stake if we don't conserve? and **(3)** How do we conserve water, both indoors and outdoors?[3]

Examples:

- Print and audio-visual media campaigns to boost public awareness
- Outreach and education in local schools and public forums
- Classes in Xeriscape design and planting
- Expanded water utility Web site functionality—comprehensive news, notices, conservation tips, etc.
- Inclusion of the public in water task force meetings, water planning hearings, etc.
- Indoor and outdoor water use audits in homes, businesses, and institutions (particularly large-volume customers)

[3] Water-use audits in homes and businesses are an "active," more specific form of educating consumers on how they can be more water-efficient.

(4) Regulations

Definition:

Water utility and municipality policies that improve efficiency in water use for both existing customers and future landscape designs.

Examples:

- Water-efficient landscaping ordinances for all new development (requiring more low-water-use plants, improved landscape design criteria, and more efficient irrigation system design)
- Watering restrictions that prohibit watering during daytime hours
- Water waste ordinances that prohibit excessive or wasteful use of water
- Municipal plumbing code updates that require water-efficient fixtures and appliances (beyond that of the 1992 Energy Policy Act)
- Abolishment of residential covenants that require turfgrass lawns
- Higher land use densities (and less irrigable land area), as outlined by zoning ordinance
- Ordinances that require water fixture and/or appliance upgrades upon building permit application or property sales, thus accelerating the replacement of inefficient appliances and fixtures

Estimates of indoor and outdoor water savings potential that can result from the above conservation strategies are discussed below and more extensively in the Technical Appendix.

Estimates of Potential Water Savings from Single Family Residential Indoor Water Use

The success of any effort to increase efficiency in the use of water for indoor purposes is highly dependent on the policies and programs of municipalities and water utilities (e.g., rebate programs, public education campaigns, building code amendments). In addition, federal regulations play a large role in the pace and extent to which conservation measures, such as new fixtures and leak repair, are implemented. Continuing improvement in technology will further increase indoor water savings.

The estimates shown below are based on residential indoor water use dropping to 45 gallons per capita per day (gpcd) when water-efficient appliances and fixtures are installed throughout the household, and as indoor leak detection and repair improves. In 2001, most Front Range indoor use rates were higher than this (57 to 69 gpcd). These savings estimates do not factor in the potential effect of human behavioral changes regarding indoor water use, changes that can result in even greater water savings.


Photo by Jeff Widen

The 45-gpcd target figure may seem ambitious, given today's levels of use. But this report is not about today—its planning horizon is 2030. If the City of Aurora can reduce its in-home consumption by 10 percent (from 66 to 60 gpcd) in just three years, imagine the potential for reductions over a 20-year period. What's more, the 45-gpcd figure is based on 2001 technology. **Innovation in water conservation is every bit as dynamic as in other technology fields, and this innovation, coupled with progressive water policies and programs, will facilitate the conversion to greater efficiency of both new and older homes. It is worth noting that the City of Boulder, which includes both older and newer homes, is already at 57 gpcd for residential indoor use, one of the lowest usage numbers in the state.**

To compensate for uncertainty in the pace and breadth of more efficient appliance installation and retrofitting, a high-low range is provided. In addition, these estimates factor in the indoor use differences between existing residents (as of 2000) and future residents (i.e., the net gain in population) since future residents in new developments will already have many water-efficient appliances in place. Explanations of these variables and assumptions are found in the Technical Appendix.

The figures below apply only to single-family residences. Substantial additional savings are available in other water use sectors (e.g., multi-family, commercial, industrial, institutional).

Indoor Savings Potential
Existing and Future Single-Family Residents by 2030
Measured in acre-feet per year

South Platte River Basin	48,131–106,314
Arkansas River Basin	10,920–23,910
Total Front Range	59,051–130,224

Estimates of Potential Water Savings from Single Family Residential Outdoor Use

Over half of all residential water use in most Front Range cities is for urban landscape irrigation (watering lawns and gardens), so there is huge potential for water savings in this area. Tens of thousands of acre-feet can be saved as single-family residential (SFR) property owners make their gardens and lawns less water-needy and improve their landscape irrigation efficiency.

To generate savings in urban outdoor irrigation, many variables must be weighed—including community landscaping history and aesthetic preferences. The savings figures represented here are based on assumptions related to average lot size ranges, average single-family residential household occupancy rates, ratio of SFR housing to total housing, population forecasts, various urban landscaping alternatives, and average net evapo-transpiration rates for these alternatives. (The sources and reasoning behind this analysis, as well as the full range of potential savings from various participation scenarios and full Xeriscaping, can be found in the Technical Appendix.)

Photo from Colorado Springs Utlilites

Colorado Springs Utilities Promotes Xeriscaping —Expects Water Conservation and Efficiency to Make Significant Contribution in Meeting Future Demand

Colorado Springs Utilities (CSU) opened its Xeriscape Demonstration Garden in 1991. This garden is considered to be one of the finest in the country, receiving a national award from the US Bureau of Reclamation in the mid-1990s. In 2004, approximately 22,400 customers visited the Xeriscape Demonstration Garden, while in the first four months of 2005 the garden attracted nearly 5,000 customers. In order to maintain the garden, twenty-five volunteers contribute over 2500 volunteer hours per year.

By 2040, Colorado Springs Utilities (CSU) expects to meet 24% of its future forecasted demand through conservation and efficiency measures, which is based on the success of their existing conservation and efficiency measures resulting in comparably low per capita use and delaying the need to expand large, costly water projects.

Source: Colorado Springs Utilities

Achieving significant savings in outdoor water use does not preclude turfgrass landscaping. A very large amount of water can be saved, even with turfgrass, if a customer:

- Replaces a portion of the turfgrass coverage with low-water-use vegetation (particularly the areas that are less-used and/or difficult to water); and/or
- Waters the areas that remain turfgrass in a more efficient manner.

The following outdoor water conservation estimates characterize one sub-set of potential savings if Front Range residents take advantage of opportunities to become more water-efficient in outdoor water use at various levels of participation. The outdoor savings estimates noted below assume that all SFR lots in future developments and in existing developments hold the potential for improvements in water efficiency, whether through Xeriscaping, irrigation upgrades, or both.

Since additional outdoor conservation savings can be achieved in other consumer sectors (primarily multi-family, commercial, and institutional), the savings estimates are just a fraction of potential Front Range outdoor water savings. Municipalities, businesses, and state institutions also play important roles in implementing efficient watering. Cities, in particular, can play an important leadership role in implementing efficient watering on city parks and city-owned golf courses, and can convert to more regionally appropriate landscaping on other city properties.

Urban landscape choice is a social issue intertwined with community aesthetic preferences. Therefore, we present these outdoor water savings potentials as hypothetical scenarios to provide Front Range residents with a basic framework for considering the water volume tradeoffs between their particular landscaping choices and the natural heritage of Colorado's river basins.

Ultra-Low-Flow Toilet
Photo by the American Water Works Association

Denver's Summer Rebate Program a Success

In 2004, Denver Water implemented a summer rebate program. As reported in the Rocky Mountain News, this program provided rebates for homeowners who became more efficient in their indoor and outdoor water usage, through installation of low-flush toilets, and water-efficient clothes washers and landscape materials. This program will save more than 773 acre-feet of water annually—enough water for the annual needs of over 4,000 residents. The cost per acre-foot is approximately $4,060, well below the cost of water derived from large new dams or water diversion projects.

Single-Family Residential Outdoor Savings Potential
Existing and Future Residents by 2030
Measured in acre-feet per year

	Customer Participation Scenarios (percentage participating)			
	20%	**30%**	**40%**	**50%**
South Platte River Basin				
• Limited Xeriscaping -or- Full coverage of efficiently watered bluegrass	19,969	29,953	39,938	49,922
• Moderate Xeriscaping (50% of irrigable area in low-water-use plants)	44,929	67,394	89,859	112,323
Arkansas River Basin				
• Limited Xeriscaping -or- Full coverage of efficiently watered bluegrass	4,711	7,067	9,423	11,778
• Moderate Xeriscaping (50% of irrigable area in low-water-use plants)	10,600	15,901	21,201	26,501
Total Front Range				
• Limited Xeriscaping -or- Full coverage of efficiently watered bluegrass	24,680	37,020	49,361	61,700
• Moderate Xeriscaping (50% of irrigable area in low-water-use plants)	55,529	83,295	111,060	138,824

Water and the Environment

We should conserve, protect, and restore streamflows to protect and promote recreational and ecological values. Colorado's rivers and streams are renowned for their scenic qualities—and for the extraordinary recreational opportunities they provide. River- and stream-based recreation is a key component of the state's diverse economy, and this economic sector is growing rapidly. Many Colorado communities depend heavily on healthy streamflows for their economic well-being, especially in the mountains and on the West Slope.

Many Colorado rivers and streams, including waters famous for their recreational values, such as the San Miguel River, the Cache La Poudre River, and the South Arkansas River, suffer from chronically low flows or are completely dry at times. A three-pronged strategy to conserve, protect, and restore our rivers and streams will help prevent such injury to other rivers, and will repair and rehabilitate damaged waters.

1. Conserve

(Maintain the health of rivers that have consistently good quality and streamflows.)

Strategies:

- Encourage the Colorado Water Conservation Board (CWCB) to acquire senior water rights to protect or improve the environment, to appropriate new instream flow water rights, and to enforce these rights when in place.
- Encourage the CWCB to accept more donations and loans of water.
- Recognize legitimate local government need for water rights to protect recreational investments and the local economy.
- Encourage existing water rights holders to share water through interruptible supply agreements, fallowing, and leases.

Priority River Segments:

- Gold Medal and wild trout fisheries designated by Division of Wildlife (DOW)
- Intact instream flow (ISF) reaches.
- Priority streams for Great Outdoors Colorado, The Nature Conservancy, or the Colorado Water Trust.
- Streams originating or passing through protected federal and state lands.
- Other streams known for their environmental and/or recreational quality.

2. Protect

(Maintain/improve the condition of mostly healthy rivers threatened by low flows or poor water quality.)

Strategies (in addition to those described above):

- Improve or maintain streamflows at critical times of the year through conditions in new water storage facility permits.
- Improve or maintain streamflows through new water management agreements (e.g., those that may derive from processes such as "UPCO" in Summit and Grand Counties).

Priority River Segments:

- All streams that would be affected by projects identified in the Statewide Water Supply Initiative.

3. Restore

(Improve the condition of rivers that currently suffer from low flows, dewatering, or poor water quality.)

Strategies (in addition to those described above):

- Improve streamflows through re-operation of water storage and transmission facilities.
- Improve streamflows through system-wide lining of ditches.

Priority River Segments:

- Streams with truncated ISF water rights, e.g., where the ISF water right on a tributary does not extend to its confluence with the mainstem.
- Streams with ISF water rights where the original appropriation was less than DOW recommended due to a lack of available water.
- Streams critical to endangered, threatened, or sensitive species.
- Stream reaches identified in Colorado Water Trust maps, including those from Trout Unlimited's 2002 report, Dry Legacy.

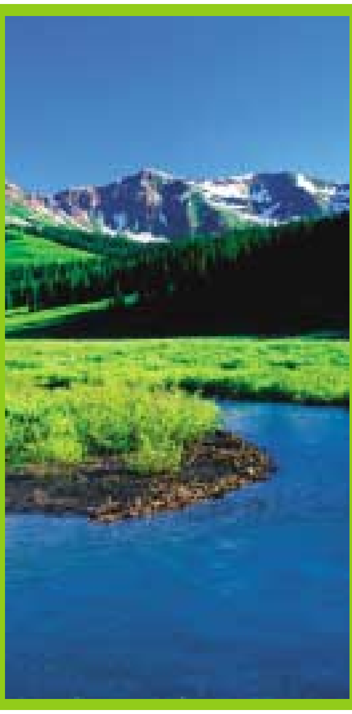


Photo by John Fielder

Donation of Water Rights Conserves Instream Flows

In the 1990s, the City of Boulder donated water rights to the Colorado Water Conservation Board (CWCB) to supplement existing instream flow rights on Boulder Creek and North Boulder Creek. As a result, the lower reach of Boulder Creek that previously dried up by July now has water running through it all year long.

The donation of the water rights required close collaboration between Boulder, CWCB, the local water commissioner, and other water experts. The CWCB designated Boulder as its agent to monitor and administer the Boulder Creek instream flows—a water right that is, except in extremely dry years, ushered down the creek past several diversion structures.

"The process proved that instream flow water rights are fully compatible with Colorado's way of administering water, demonstrating that streams can be kept wet without adversely impacting water use or water development," says Carol Ellinghouse, Boulder's Water Resources Coordinator. "The tradeoff for Boulder in donating its senior water rights is having a beautiful stream running through the town for the enjoyment of its citizens."

The donation of water for instream flows also smoothed the progress of Boulder's negotiation with the U.S. Forest Service concerning permitting and bypass flow requirements for Boulder's pipeline facilities on federal land. The USFS accepted Boulder's joint efforts with the CWCB on instream flows in Boulder Creek as meeting all USFS requirements.

Source: Colorado Water Conservation Board (www.cwcb.state.co.us/isf/Newsletter/inst0701.pdf)

Principles of "Smart" Water Supply and Storage

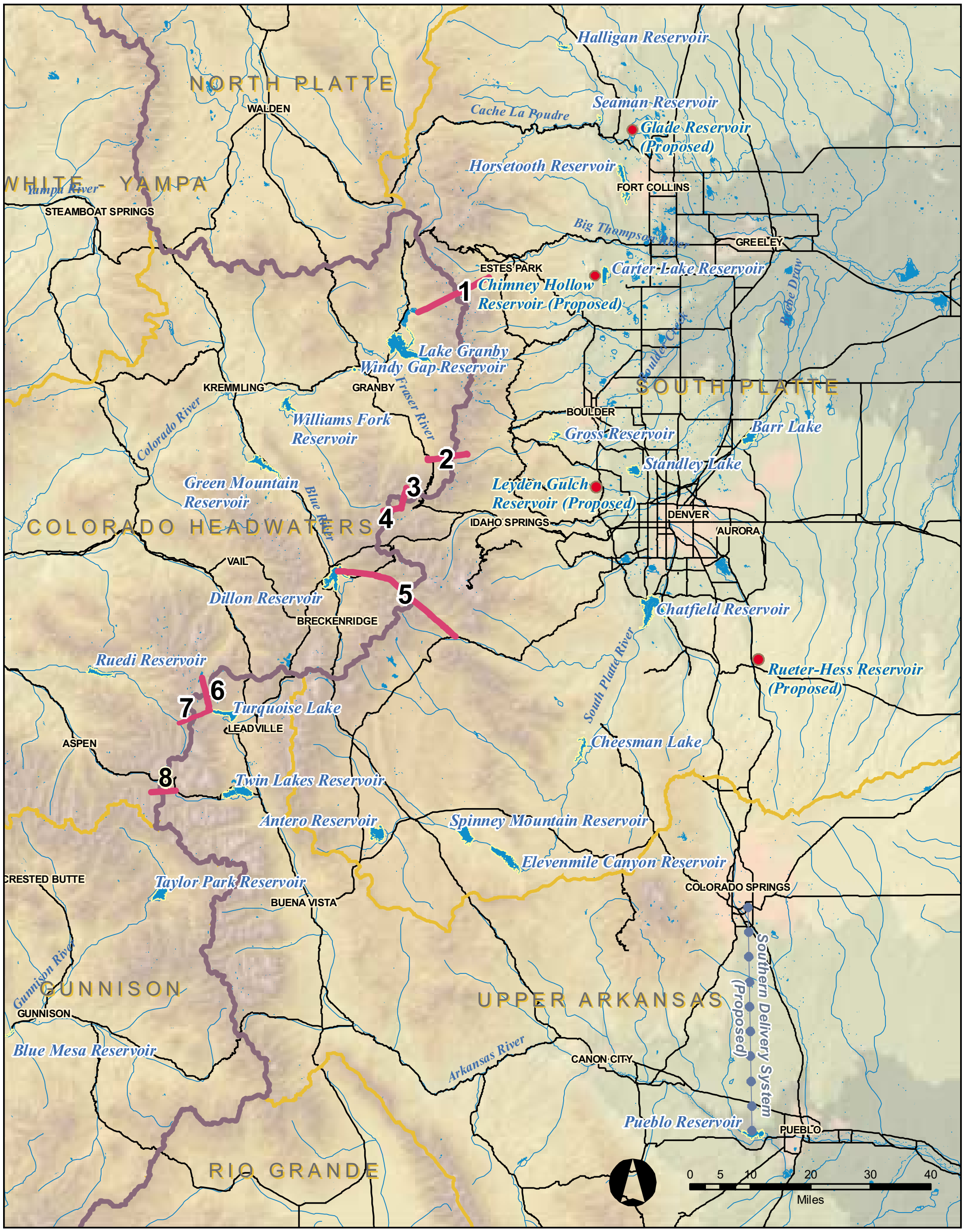
Colorado's growth is fueling new and greater demands for water. "Smart" water storage and supply projects—those that fully integrate public opinion and economic, financial, environmental, and recreational needs into the planning and development process—are the better way to provide for a secure water future.

Some proposed new water projects for the South Platte and Arkansas River Basins have certain "smart" characteristics. Not all smart principles apply to every new water project. However, a project that does not incorporate all relevant smart principles is unlikely to be smart overall. An indisputably smart water supply or storage project will satisfy each of the following principles that is relevant:

- Make full, efficient use of existing in-basin and imported water supplies, and reusable return flows, before increasing transbasin diversions.
- Invest in the most cost-effective and least environmentally damaging water supply options first. All costs should be considered in this analysis, including those borne by people or landscapes not served by the project ("externalities").
- Fully integrate conservation, water reuse, and demand management into the water supply planning process.
- Ensure that new and refurbished water projects do not increase the risk of extinction of native species nor adversely modify designated critical habitat for species protected under the Endangered Species Act (ESA).
- Before taking more water out of rivers, adopt interruptible supply agreements (where feasible) between agricultural water users and other water users, including those seeking to conserve, protect, or restore instream flows, and minimize any undesirable consequences of the reallocation of water from agricultural to municipal use.
- Improve use of existing water supply infrastructure and sharing of resources between water users to avoid unnecessary new diversions and duplication of facilities.
- Ensure public involvement—especially for non-traditional stakeholders directly affected by new water projects—in the planning process to ensure that project developers minimize environmental and socioeconomic impacts.
- Use incremental approaches to providing new water supplies, to facilitate adding, changing, ending, accelerating, or delaying new supply strategies as demands change.
- Consider expanding or enhancing existing storage and delivery infrastructure before building new facilities in presently undeveloped sites.
- Ensure that new projects provide multiple benefits, satisfy the greatest possible range of needs (including those for instream recreation and the environment), and use the most effective methods for minimizing environmental damage during construction/maintenance.

Cheesman Canyon. Photo by Marc Lance

Water Resources near the Front Range



Map created by Connor Bailey

Legend

- Tunnels
- Continental Divide
- Watersheds
- Lakes & Reservoirs
- Rivers
- Highways
- Cities

Tunnels

1 Alva B. Adams
2 Moffat
3 Vazquez
4 Gumlick
5 Roberts
6 Homestake
7 Twin Lakes

Analysis of Proposed Water Supply Options

1. South Platte River Basin Options

The South Platte River Basin drains the northeast quarter of Colorado. Twenty-two counties, and some three million people (over 68 percent of the state's total population), depend on its water. The South Platte Basin encompasses a diverse geography: towering mountains, extensive pine forests, river canyons, agricultural lands on the eastern plains, and the foothills of the Front Range. With the population of this basin projected to grow to nearly five million people by the year 2030, annual municipal and industrial water needs are expected to grow by as much as 409,700 acre-feet, although these expectations do not incorporate significant water demand management, i.e., urban conservation. Thus, a more accurate tally of new demands is actually significantly lower.

To meet these needs, municipal water providers are pursuing a wide range of water supply development options that reflect the varying conditions and existing infrastructure in the basin's different regions. Many of these providers are successfully planning and implementing projects to increase the yield and reliability of their water supply systems.

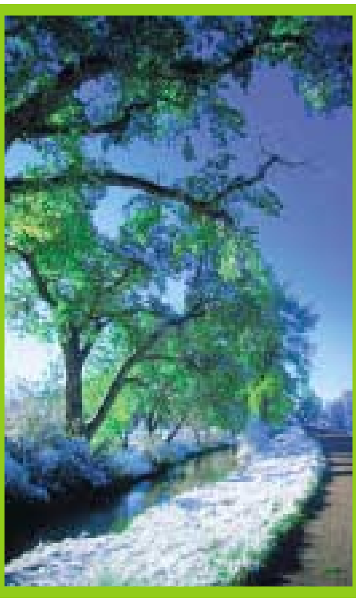
The recent Statewide Water Supply Initiative (SWSI) concluded that, of the over 400,000 acre-feet of new supply that might be needed to satisfy projected South Platte Basin demands, projects currently in the planning stage would satisfy 78 percent of this need. Since SWSI was generous in its estimates of demand but quite conservative in estimating potential savings through urban efficiency programs, it is likely that many water providers in the South Platte Basin will be able to supply their customers for at least the next generation without having to bring on-line large new supply projects beyond those already planned.

Agricultural-Municipal Transfers

The transfer of valuable senior agricultural water rights to municipal uses is an important water supply option that first came into play several decades ago, although the use of this strategy has grown most rapidly in recent years. For example, in the Northern Colorado Water Conservancy District, the ownership of Colorado-Big Thompson Project shares by municipal and industrial interests has increased from 15 percent in 1957 to 61 percent in 2004.

Institutional hurdles are being removed and will speed future transfers. New state laws give cities more flexibility to lease agricultural water on a temporary basis (i.e., through interruptible supply arrangements), which has the advantage of compensating farmers during dry years, but not taking their lands permanently out of irrigated agricultural production. Another example of this type of arrangement is the City of Boulder, where surrounding lands acquired by the city for open space have been leased back to farmers, with the city reserving the right to used irrigation water during drought conditions. And "fallowing" arrangements, in which a group of farmers agree to rotate some acreage out of production (and, therefore, make available a certain quantity of water) are likely to become much more common in the future. The increasing reliance on these options is driven by the disparity between the value of water for municipal versus agricultural uses, drought crises, and the simple fact that, for many cities, their cheapest new supply is agricultural water.

Temporary transfers result in water being diverted from the system upstream of where the historical diversion occurred. Thus, some reaches with temporary transfers will lose flows, and in particular, cleaner dilution flows. This may adversely affect resident aquatic resources and water quality. However, there may also be instances where less, or more efficient, agricultural use of water will benefit a river's water quality because there will be fewer of the pollutants associated with agricultural practices reaching the river. Those interested in specific transactions will need to evaluate water quality impacts and should counteract adverse effects.



Highline Canal in Spring
Photo by John Fielder

Aurora, High Line Canal Agree to Water Lease

Cities are coming up with creative, non-traditional options for meeting water needs. For example, the City of Aurora agreed in 2004 to a $5.5 million, two-year deal to lease up to 12,600 acre-feet annually—over four billion gallons—of High Line Canal Company water.

Under this arrangement, leased water will be delivered through exchange agreements with the Bureau of Reclamation and the city of Pueblo. The water is held in the Twin Lakes Reservoir high in the Arkansas River watershed, discharged to the Otero Pump Station, and then directed to Spinney Mountain Reservoir. High Line superintendent Dan Henrichs says the two-year lease will potentially fallow about 36 percent of the 22,500 acres irrigated by the canal. The rest will remain in full or partial production.

"It's one of those things where the sun and moon and stars lined up and everybody came away from the table with what they needed," says Aurora Director of Utilities Peter Binney. Aurora Mayor Paul Tauer also praised the agreement that he says demonstrates how cities and agriculture can work together. "We all win—farmers, small communities in the Arkansas Valley, and Aurora residents," says Tauer.

Source: www.cfwe.org/headwaters/headwaters4.pdf

Groundwater and "Conjunctive" Use

The Denver Basin aquifers that underlie much of the Denver metropolitan area have, for the last two decades, provided an increasingly large portion of supply, especially in the fast-growing southern reaches of the basin. Since these underground reservoirs store billions of gallons of water, they are an attractive supply source. While the natural recharge of this groundwater is limited, it is unimpaired by surface water droughts and therefore represents excellent drought-year insurance. However, areas of Douglas County that rely heavily on these aquifers for annual supply are already finding that they are being drawn down at alarmingly rapid rates, and cannot be used as a permanent water supply on a yearly basis. (While the aquifers are not in danger of "running out" any time soon, the costs of extracting the water are growing significantly as more energy is required for pumping, and eventually, of course, the supply would be fully depleted.)

Nevertheless, cities that have not previously tapped these aquifers, such as Aurora and Denver, are now considering development of their own Denver Basin groundwater resources for limited use during periods of drought. Through conjunctive use and recharge, these aquifers can be managed to provide a long-term, sustainable supply resource. Some Douglas County water providers are working with Denver and West Slope interests to develop a project whose purpose would be to reduce the rate of groundwater mining and replenish these aquifers by injecting surface water underground during wetter-than-normal years.

Conservation

Water policy in Colorado, historically, has not encouraged real efficiency in the management and use of water. Unfortunately, this trend continues. For example, the final SWSI report projects relatively little savings from water efficiency programs over the next 25 years, even though the potential for increasing supply through this option is substantial. Improving urban water efficiency through indoor and outdoor conservation would allow already-developed water supplies to be dedicated to meeting much of the demand associated with the Front Range's projected growth.

Still, certain water utilities have made progress in promoting effective conservation measures. For example, in 2001 (one year prior to the height of the current drought), Boulder's system-wide per capita consumption was at 180 gallons per day—considerably less than most northern Colorado towns. And in Highlands Ranch, the Centennial Water and Sanitation District has adopted an innovative water budget rate structure that has significantly contributed to the district's 32 percent reduction in overall demand since its implementation in 2002.

There are significant opportunities for Colorado cities, both small and large, to expand their adoption of programs and policies that boost efficiency. Consider the success of Albuquerque, New Mexico, in so doing. Although Albuquerque's rate of population growth is similar to that of cities along Colorado's Front Range, Albuquerque's per capita water use is declining at a pace sufficient to offset the additional demands of new households. Albuquerque's program includes indoor and outdoor conservation rebates, a landscaping ordinance, and a comprehensive education program.

Denver Zoo Achieves Dramatic Water Savings Through City's Largest Water Conservation Project

The Denver Zoo has built a new recirculated water wetland in its flamingo pond that reduces water usage by more than 90 percent, from 20 million gallons a year to 1.6 million. This water is clean and clear, and reusing it saves the Zoo $20,500 annually—enough to feed the polar bears, seals, and sea lions for an entire year. The project cost about $50,000.

The zoo's improved 250,000 gallon flamingo pond recirculates water at 35 gallons per minute through the new wetland and uses a timer and valve to replace water lost to evaporation. This conserves much more water than the previous system, which passed water through the pond only once.

This project's success has prompted the Denver Zoo to seek other ways to save water. The zoo's master plan includes use of recirculated water and filtration systems that conserve water throughout the facility, and the zoo plans to use Denver Water's recycled water extensively in the future.

Source: Denver Zoo

Photo c/o Colorado Division of Wildlife

Reuse

Another supply option that some cities are developing involves the reuse of municipal and industrial water, subject to certain water rights restrictions. There are three water sources that cities can usually tap for reuse programs: non-tributary groundwater, water that has been diverted from other river basins, and consumptive-use water converted from agriculture. In some instances, notably Denver's diversions from the Blue River, court decrees actually impose a duty to reuse. Even though reuse is potentially expensive, public acceptance of this use is on the rise, and cities both large and small are looking at reuse as a feasible and reliable source of water for some uses. For instance, in addition to the large projects Aurora and Denver are pursuing, Broomfield and other communities in the Big Dry Creek drainage will soon complete a non-potable water reuse project.

Aurora provides a good example of how reuse can contribute to water supplies. Over 90 percent of Aurora's existing water supply is reusable; thus, the city is examining options for capturing and re-regulating its reusable return flows downstream of Denver and delivering these supplies to its service area for non-potable and potable uses.

Denver has nearly completed development of its non-potable reuse project to deliver water from Chatfield Reservoir directly to the Denver system. This project will utilize over 17,000 acre-feet of reusable return flows to provide non-potable water for industrial, commercial, and municipal irrigation uses, including those of the Cherokee power plant, Denver International Airport, and Stapleton redevelopment. Denver is also in the process of securing the reusable portion of its lawn irrigation return flows to increase its legally reusable supplies, and is considering several potable water supply projects that would more fully utilize Denver's reusable return flows.

Structural Projects, Facilities Integration, and Exchanges

Many of the water supplies deriving from the sources discussed above will require new infrastructure to operate. South Platte water providers already have built or are planning to build new reservoirs, reservoir expansions, or other new infrastructure. These storage sites will fill with water rights that are now conditional (rights for which cities have obtained water court decrees, but which have not yet been used because the necessary infrastructure is unavailable—or because the demand for this water is low or non-existent).

In the central South Platte region, for example, Denver is actively pursuing an expansion of its north end supply system that will involve expansion of Gross Reservoir on South Boulder Creek and/or construction of a new, off-channel reservoir at Leyden Gulch. Leyden Gulch could be used simply as a storage alternative to Gross Reservoir enlargement or it could be used in conjunction with one of Denver's potable reuse schemes for storage and for blending of raw and reused water. In addition, to maximize use of water rights that both Denver and Aurora own, Denver is considering expansion of both Antero and Eleven Mile Reservoirs. Finally, Denver is considering a number of refinements to its system that will increase its water supplies, from storage of water in former gravel pits, to transfers of agricultural water from ditches.

Other central South Platte water providers are also considering new projects. Several cities, including Denver, are storing or planning to store additional water in gravel pits, both along the South Platte and Clear Creek. The entities that receive Standley Lake water—FRICO and the cities of Thornton, Northglenn, and Westminster—are planning its enlargement. Consolidated Mutual recently completed Welton Reservoir.

At the southern end of the South Platte service area, 11 Douglas and Arapahoe County water providers have banded together to consider a set of water projects that will allow the area to rely more on surface water and less on non-renewable ground water. In addition, Parker has recently obtained all necessary permits to construct Reuter-Hess Reservoir, to supply drinking water to its residents.

There is also considerable activity at the north end of the South Platte system. Lafayette is developing a pipeline at 75th Street to deliver Boulder Creek water to its residents. The recently completed Pleasant Valley Pipeline now delivers water from the Poudre River out of Horsetooth Reservoir to the Munroe Canal so as to increase water supplies for Greeley, Fort Collins, and several other water suppliers. Greeley and Fort Collins are also considering a project that would expand two of their reservoirs—Halligan and Milton Seaman—in a manner that may have environmental benefits as well as allow the cities and several rural water districts to increase both drinking water and agricultural water supplies.

Finally, the Northern Colorado Water Conservancy District has several large new projects on the drawing board, including two that involve major new reservoirs. The Windy Gap Firming Project would increase Northern's ability to capture Colorado River water for use on the Front Range, and would involve construction of a new Front Range reservoir, as well as potentially a second reservoir on the West Slope. Other Northern projects would capture excess return flows in the South Platte downstream of Greeley, regulate acquired irrigation rights for municipal uses, capture unappropriated South Platte tributary peak flows, and facilitate exchanges of existing water rights to allow their use elsewhere in Northern's service area.

A Workable Set of Policies and Projects for the South Platte River Basin

Below, we propose a set of non-structural and structural options that can collectively meet the identified water supply needs for the South Platte River Basin. While the four mostly non-structural options do not require permits to achieve, cities would have to adopt more significant water efficiency programs, take more initiative to pursue some of the transactional arrangements now available, and investigate more seriously the potential for reuse. However, similar to most of the smaller projects mentioned in the preceding section, these projects are not likely to cause significant adverse environmental effects.

The eight structural projects described here all carry some degree of risk with respect to degrading environmental values. However, each project has at least some "smart" elements, such that its proponents could make it truly "smart" without sacrificing significant yield or causing significant environmental damage. These project proponents must work with local governments, communities, businesses, and water rights holders in the areas from which water will be diverted, the conservation community, and other interested parties to ensure that the projects ultimately incorporate adequate environmental protection.

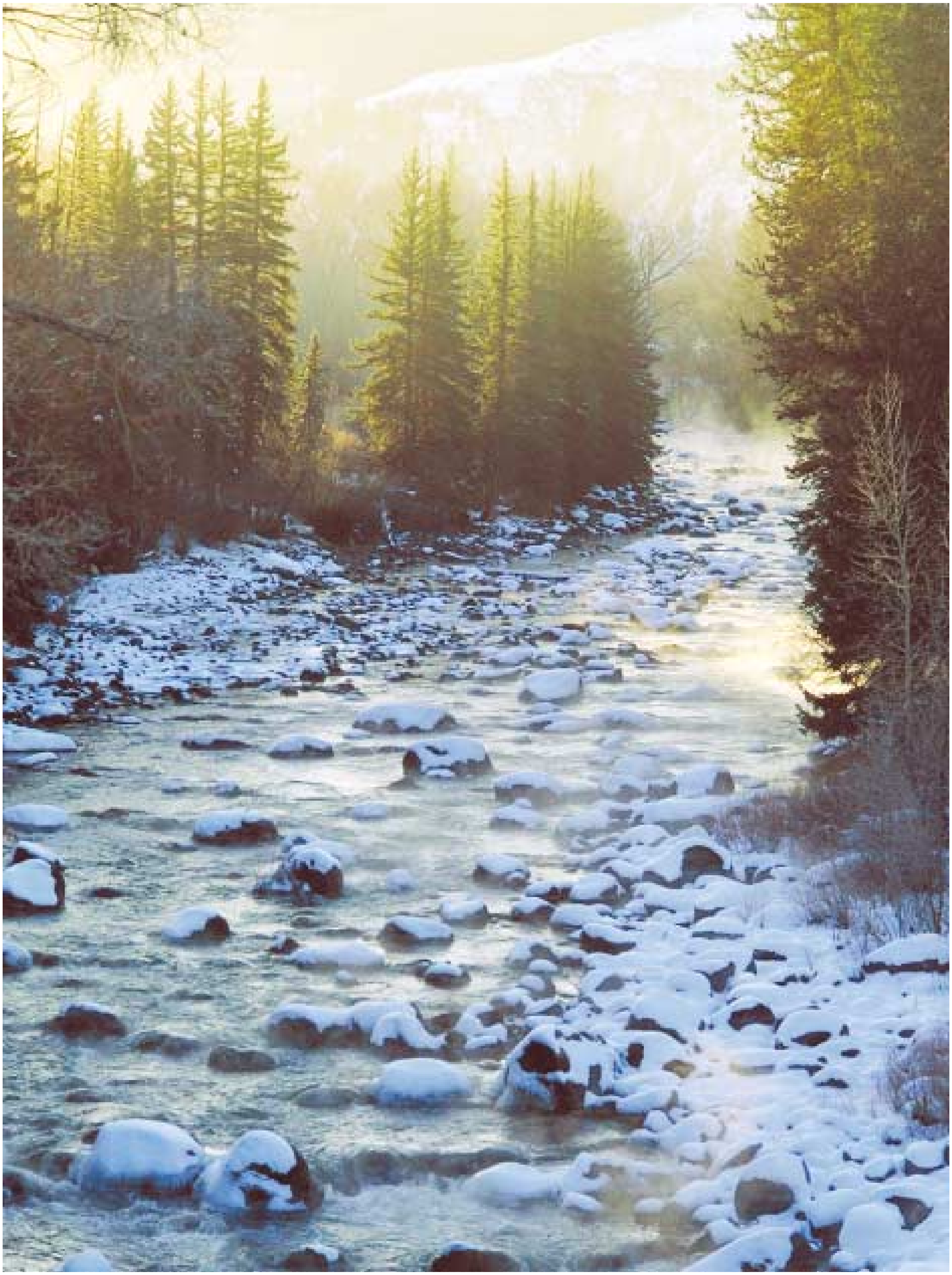
Analysis of South Platte River Basin Supply Options

Project Name (Beneficiary)	**Description**	**Potential Yield** (acre-feet/year)	**Timeframe**	**Issues To Be Resolved**
Water Conservation (all cities)	Rate structures Retrofit programs Xeriscaping Incentive rates Irrigation efficiency Landscape ordinances Zoning Public awareness Technology upgrades	68,000–219,000	Ongoing	• Improve implementation by water providers • Gain wider public acceptance and endorsement • Offset effects on water provider revenue
Temporary Transfers (interruptible supply) (all cities)	Cooperative arrangements between municipal, industrial and agricultural water users	Up to 190,000	Ongoing	• Address legal/institutional barriers • Mitigate/minimize impacts, especially to agricultural communities • Construct storage and delivery facilities • Assess highest value/most flexible transfers
Reuse (all cities with reusable rights)	Cities' non-potable and indirect potable reuse of wastewater and lawn irrigation return flows	Up to 120,000	Mid- and long-term	• Assess cost of reuse for potable water, and adjust planning and consumer expectations accordingly • Assess and minimize potential adverse impacts to instream flows and water quality • Encourage public/water provider acceptance

continues on next page

Analysis of South Platte River Basin Supply Options *(continued)*

Project Name (Beneficiary)	**Description**	**Potential Yield** (acre-feet/year)	**Timeframe**	**Issues To Be Resolved**
System Refinements (Denver Water)	Improvements in system efficiency	13,000		
Chatfield Reservoir Enlargement (Denver Water, other central South Platte water suppliers)	Modify structures, reallocate 20,600 acre-feet of storage for flood control to urban use	7,000	Near-term	• Assess and minimize impacts of reservoir fluctuation on recreational facilities, wetlands, and bird habitats
Halligan/Seaman Reservoir Enlargement (Fort Collins, Greeley, others)	Increase storage in two reservoirs by a combined 69,000 acre-feet	~ 20,000	Halligan by 2020; Seaman by 2030	• Ensure that project beneficiaries become more water efficient before projects are initiated • Protect and enhance Poudre River and tributary flows
Standley Reservoir Enlargement (Northglenn, FRICO, Westminster)	Enlarge spillway and reservoir capacity by 18,000 acre-feet	6,000	Mid-term	• Gain additional, paying beneficiaries • Avoid/offset impacts to bald eagle habitat
Antero and Eleven Mile Reservoir Enlargements (Denver, Aurora)	Structural modifications to enlarge reservoir capacities by 65,000 acre-feet at Antero and 17,800 acre-feet at Eleven Mile	Antero: 8,000 Eleven Mile: 5,000	Long-term	• Avoid or mitigate adverse instream flow issues in all affected stream reaches • Protect flows where possible
Barr Lake/ Beebe Draw (multiple Denver metro area suppliers)	Use of Beebe Draw alluvium for storage with pipeline and treatment plant for delivery of potable water	10,000–100,000	Near- and mid-term	• Minimize adverse effects of possible diminished flows below confluence of Beebe Draw and S. Platte mainstem • Assess potential for groundwater to be contaminated by agricultural fertilizers, and counteract this effect
South Metro Conjunctive Use (11 Douglas County water suppliers)	Surface/non-tributary groundwater conjunctive use and water reuse and conservation	19,000–38,000	Mid- and long-term	• Evaluate further the non-tributary aquifer to establish recharge potential • Maximize use of in-basin (South Platte) surface water supplies and reuse prior to use of additional West Slope water
Gross Reservoir Enlargement / Leyden Reservoir (Denver)	Reservoir enlargement and/or construction of new reservoir	18,000	Near-term	• Implement urban efficiency measures first • Avoid/offset impacts to Fraser River instream flows • Protect flows where possible
Windy Gap Firming (Northern Colorado WCD's Municipal Subdistrict)	New reservoir to capture Windy Gap water in more years	30,000 plus storage	Near-term	• Implement urban efficiency measures first • Avoid/offset impacts to Colorado River flows • Restore flows where possible


Eagle River in Winter. Photo by John Fielder

Water Conservation

See pages 7-9 and 27-35 the Technical Appendix for a complete discussion of potential yield from this source of supply.

Temporary Transfers

Description

In many areas of the northern and southeastern Front Range, the water rights associated with agriculture are mostly senior to the water rights held by cities. This fact tends to limit the water yield available to municipalities during dry periods. Interruptible supply involves the voluntary, temporary transfer of water, in almost all cases, from agricultural use to meet municipal needs. One of the primary goals of this type of arrangement is to protect agricultural water rights from acquisition by and permanent transfer to municipalities and industry, and from the adverse impacts on agricultural communities that can be associated with such permanent transfers.

Under interruptible supply arrangements with agriculture, farmers would continue to use all or a portion of the subject water most of the time (i.e., 9 out of every 10 years) and would remain the primary users of the water. During times of short supply, all or a portion of the water would be transferred to municipal uses. By comparison, under fallowing arrangements, a group of farmers agree to rotate some acreage out of production and, collectively, make available a certain reliable quantity of water for use by a city each year. If such temporary transfers include provisions that prevent significant adverse impacts on the affected areas, they can be beneficial to both the agricultural community and municipalities. Where these programs proceed, if done in conjunction with increased agricultural efficiency, such as the City of Aurora has done by installing drip irrigation systems on the Highline Canal, there will be an increased benefit in terms of yield.

Interruptible supply and fallowing arrangements can occur under direct arrangements between the parties, or through the establishment of a water bank or other intermediary to facilitate communication between buyers and willing sellers.

Potential Yield

190,000 acre-feet.
[Source: *Metropolitan Water Supply Investigation*, Hydrosphere Resource Consultants, pp. 80-109]

Timing

Near-term to long-term, depending upon the circumstances of the parties involved, such as infrastructure needed to implement the transfer.

Status

Several Front Range cities have purchased agricultural water rights and lands with leaseback agreement with farmers. During the 2002 drought, some providers canceled these leases or entered into short-term interruptible supply arrangements with farmers. Different forms of interruptible supply arrangements were also used to facilitate exchanges making water available to individual systems that could not otherwise have been directly deliverable.

However, no one has investigated the potential for systematic implementation of interruptible supply arrangements in the South Platte River Basin. The greatest potential for these arrangements lies in the sub-basin tributaries to the north of Denver, including Boulder Creek, plus the St. Vrain, Big Thompson, and Cache La Poudre Basins.

Impacts

There are concerns about the potential social, environmental, and economic impacts of interruptible supply arrangements and fallowing arrangements. These include:

- A strong desire exists to protect and maintain agricultural communities and heritage.
- Temporary transfers are sometimes seen as precursors to permanent transfer of agricultural water to municipal uses, resulting in the drying-up of agricultural lands.
- Farmers are concerned that long-term arrangements can become encumbrances that limit their options in the future.
- Interruptible supply and fallowing agreements can have adverse economic impacts on local communities, including job losses and loss of revenues for businesses that support agricultural activities.
- Temporary removal of irrigation water may impact wetland and habitat for migratory birds and other species.
- Temporary interruption of instream flows can result in impacts to aquatic ecosystems that may take several years to recover.
- Construction of new delivery systems with their own environmental impacts may be necessary to implement interruptible supply and fallowing arrangements.

Make It Smart!

Interruptible supply and fallowing agreements should be an important source of supplemental water supplies, provided that arrangements with farmers are structured to be mutually beneficial and to address the issues identified above. In the negotiation of these agreements, it is important to provide the resources and expertise necessary to understand the potential social, economic, and environmental impacts and to identify mechanisms and strategies for minimizing those impacts.

Reuse

Description

Most cities and suppliers of municipal water have several kinds of water rights in their portfolios. Some of these rights allow the city a single use, but there are three kinds of water rights that cities can use "to extinction," which means that they can use and reuse the water without having to return any to the stream. There are three principal sources of reusable rights.

- **Water diverted from a different basin is reusable. In fact, Denver has decrees from the Blue River that require it to make reasonable reuse of the water it takes.**
- **Water extracted by well from ground water aquifers that are not tributary to surface water streams, i.e., will not affect the volume of surface water flows in 100 years, is reusable.**
- **Water that the city acquired, or whose use the city changed where the city obtained a water right for a specific quantity of consumptive use, is reusable.**

Urban water use, especially use other than lawn irrigation, is typically not highly consumptive. Indoor residential use is only about 5 percent consumptive. So, a city can potentially use its water multiple times before it is used up "to extinction."

Cities can recycle this reusable water if they can satisfy two conditions: (1) economically recapture it physically and move it back to the start of their distribution system, i.e., their raw water treatment facility, and (2) demonstrate to their customers that the recycled water will be of high water quality. The first condition will require a demonstration of the appropriate quantity that is available as well as pipelines and potentially storage capacity. The second will require public education, and often will mean that a city limits its recycling to less than what it could do with available water rights. For example, the public tends to be more accepting of recycled water for irrigation or industrial purposes than as drinking water.

Potential Yield

Up to 120,000 acre-feet. This figure is conservative, to avoid double-counting of supply derived from other options.

[Source: Metropolitan Water Supply Investigation, Hydrosphere Resource Consultants, pp. 67-89]

Timing

Varies from city to city, from near-term to long-term.

Status

Denver has recently opened a reuse facility; the cities in the Big Dry Creek drainage, including Broomfield, will open such a facility soon. Aurora, Westminster and Colorado Springs all have existing reuse facilities.

Impacts

- Potential loss of instream flows or water quality degradation below points for re-diversion of water for reuse could occur.
- Additional water conveyance and storage facilities may be needed which could cause related environmental impacts.

Make It Smart!

It will be necessary to minimize and offset the impacts described above, to the extent required by law. However, the biggest barriers to reuse are related to public skepticism and the potential costs for some municipalities for recovering and recycling this source of water.

Chatfield Reservoir Storage Reallocation

Description

Central South Platte water suppliers are asking the Army Corps of Engineers to reallocate up to 20,600 acre-feet of storage in Chatfield Reservoir—currently allocated to the flood control pool—for a number of other purposes, including:

- Augmentation of the Central Colorado Water Conservancy District's out-of-priority depletions for irrigation;
- Maintenance of instream flow target levels in the South Platte River through Littleton and Denver; and/or
- Municipal and industrial uses in the South Metro area, including surface water s upplies for conjunctive use of surface and groundwater.

The proposed project would involve minor modifications to the Chatfield Dam and spillway, increases in the level of water stored in the reservoir, and modification in recreational facilities to accommodate higher water levels and increases in reservoir fluctuations.

"Smart" storage elements include expanded utilization of an existing facility, potential cooperative project, and possible environmental and recreational benefits associated with instream flow enhancement.

Potential Yield

Up to 7,000 acre-feet.

Timing

Near-term.

Status

Army Corps of Engineers initiated a feasibility study and National Environmental Policy Act scoping to guide preparation of an environmental impact statement (EIS) in October of 2004. Currently, the Corps intends to complete the draft feasibility study and EIS for release to the public in the winter of 2005, and to release the final report in the fall of 2006.

Impacts

- Reservoir fluctuations may adversely affect reservoir recreational facilities associated with Chatfield State Park, depending upon reallocation and operational alternatives.
- Proposed increases in the reservoir surface elevation and storage fluctuations may adversely affect wetlands and wildlife habitat, including migratory bird habitat and nesting areas.

Make It Smart!

The EIS process should thoroughly address potential impacts associated with all of the proposed reallocation and operational scenarios. Preliminary investigations indicate that various operation scenarios could result in increases in storage pool elevations and associated impacts. The EIS process should provide the information necessary to evaluate the differences in the environmental impact of these and other options, including combinations of uses. The EIS should investigate alternatives that avoid and minimize impacts as well as identify opportunities for mitigation of impacts.

Halligan/Seaman Reservoir Enlargement

Description

The proposed enlargement of Halligan Reservoir, located on the North Fork of the Poudre River, would increase its storage capacity from 6,428 acre-feet to about 40,000 acre-feet. Milton Seaman Reservoir, located on the North Fork downstream of Halligan Reservoir, would be enlarged from 5,000 acre-feet to about 43,000 acre-feet. The primary project sponsors are Fort Collins and Greeley, with secondary participation by the City of Evans, the East Larimer County Water District, the North Weld County Water District, the Fort Collins-Loveland Water District, and the North Poudre Irrigation Company.

Halligan would store water from the North Fork of the Poudre River, while Seaman would store water from the North Fork and water diverted from the mainstem of the Poudre through an existing raw water diversion facility.

While the operations of the enlarged reservoirs have yet to be defined, the project sponsors have suggested they could operate the reservoirs in an integrated manner to meet the participants' water supply needs while providing benefits to the environment—specifically, that the reservoirs could be operated to help improve fall and winter season instream flows on both the mainstem Poudre and on the North Fork of the Poudre.

The Halligan and Seaman Reservoir enlargements represent a reasonably sized project that involves a cooperative approach with multiple water providers, the potential for integration of supply and demand management strategies, and the potential for multi-purpose benefits, including the restoration of instream flows on the mainstem and tributaries of the Poudre. The project also would enlarge and replace existing facilities in areas that have already been impacted by water supply infrastructure development.

Potential Yield

Approximately 20,000 acre-feet.

Timing

Halligan by 2010; Seaman by 2020.

Status

In the fall of 2004, the cities of Fort Collins and Greeley signed an intergovernmental agreement that proposed the enlargement of Halligan and Milton Seaman reservoirs. The cities also submitted a Letter of Intent to federal oversight agencies indicating their desire to expand these reservoirs and identifying the project proponents and participants. The Army Corps of Engineers has begun the process of selecting an independent third-party consultant to prepare the environmental impact statement required for the proposed action. If approved, the Halligan enlargement could be completed and operational by 2010 and Seaman by 2020.

Halligan/Seaman Reservoir Enlargement (continued)

Impacts

- Reservoir operations would alter stream flows in the North Fork downstream from Halligan Reservoir and in the mainstem Poudre downstream of its confluence with the North Fork.
- Expansion of reservoir surface area and volume could inundate wildlife habitat or otherwise affect sensitive areas.

Make It Smart!

Use the expansion of Seaman Reservoir to restore fall and winter season flows in the Poudre and its tributaries above the confluence with the North Fork. Manage operations to maintain environmentally healthy flows downstream of both reservoirs. Ensure that flooding of habitat or sensitive areas is minimized or counteracted.

Standley Reservoir Enlargement

Description

Standley Lake is an existing 42,380 acre-feet reservoir that serves the cities of Northglenn, Thornton, and Westminster, and the Farmers Reservoir and Irrigation Company (FRICO). Northglenn eventually needs this project (or an alternative) to firm up its supply. This project would enlarge the existing reservoir for Northglenn's benefit by raising the dam height to create 18,000 acre-feet of additional storage. Water to fill the new storage would come from Clear Creek using existing diversion infrastructure.

Yield

6,000 acre-feet.

Timing

Mid-term to long-term (more than 10 years).

Status

Northglenn is developing this proposal, but is looking for partners in the north Denver metropolitan area to make the project economically feasible.

Impacts

- Construction activities in the vicinity of reservoir enlargement area could affect bald eagle nesting.

Make It Smart!

Need to ensure that displaced bald eagles have an alternative nesting site. Determine if Ute ladies'-tresses orchids would be affected and, if so, transplant them to another location. Additionally, this project should investigate the potential for greater cooperation between water providers who benefit from it. For example, Denver Water is seeking additional storage in the north end of its service area. Recently the utility entered into an agreement with Consolidated Mutual to share storage in Fortune Reservoir. It may be possible, and advantageous, to develop a similar arrangement with Standley Reservoir.

Photo by John Fielder

Antero and Eleven Mile Reservoir Enlargement

Description

Denver and Aurora are examining the merits of a joint use project that would enlarge two existing reservoirs. Expanding Antero Reservoir would enhance the supplies of both cities and increase their operational flexibility. Denver's present water supply yield from Antero is relatively small because of the reservoir's size and its junior water rights. However, Aurora's water imports from the Colorado and Arkansas Rivers, which are potentially quite large and vary considerably from year to year, could be delivered to and stored in Antero Reservoir if it were bigger. The proposed expansion of Antero would secure another 65,000 acre-feet of storage, while the proposed expansion of Eleven Mile would add 17,810 acre-feet. Although this project would allow the suppliers to store more water only in wet years, due to the variability of Aurora's imports, its synergistic potential is considerable.

Potential Yield

8,000 acre-feet at Antero; 5,000 acre-feet at Eleven Mile.

Timing

Long-term (not before 2025).

Status

Denver Water's Integrated Resource Plan identifies these enlargements as potential long-term options, but neither Denver nor Aurora is working actively on this project at this time.

Impacts

- Enlargement of Antero could affect the largest breeding population of mountain plover in Colorado (and possibly range-wide), either through expansion of the reservoir footprint or through disturbance from construction/maintenance.
- In drought years, Antero's once-excellent fishery might be preserved since it would probably not be completely dewatered, as in 2002.
- The expansion of Eleven Mile would inundate existing riparian areas, and might alter recreational opportunities (e.g., it might flood the campground).
- Peak (flushing) flows could be reduced down the South Platte, both between these two reservoirs and downstream of Eleven Mile.

! Make It Smart!

Avoid or minimize impacts to the mountain plover and rich fen environments in the area (habitat for rare species like Porter's feathergrass). Denver historically has used its supplies at Antero as "drought contingency"—this water is drawn down only in very dry periods. For Aurora to have access to its additional supplies, the two cities would have to cooperate more extensively in the operation of these reservoirs and their water transportation infrastructure. This cooperation would need to extend to the provision of flushing flows when possible, and the preservation of the fisheries in Antero, the Gold Medal water of the Dream Stream (between Spinney and Eleven Mile), and Cheesman Canyon below Eleven Mile.

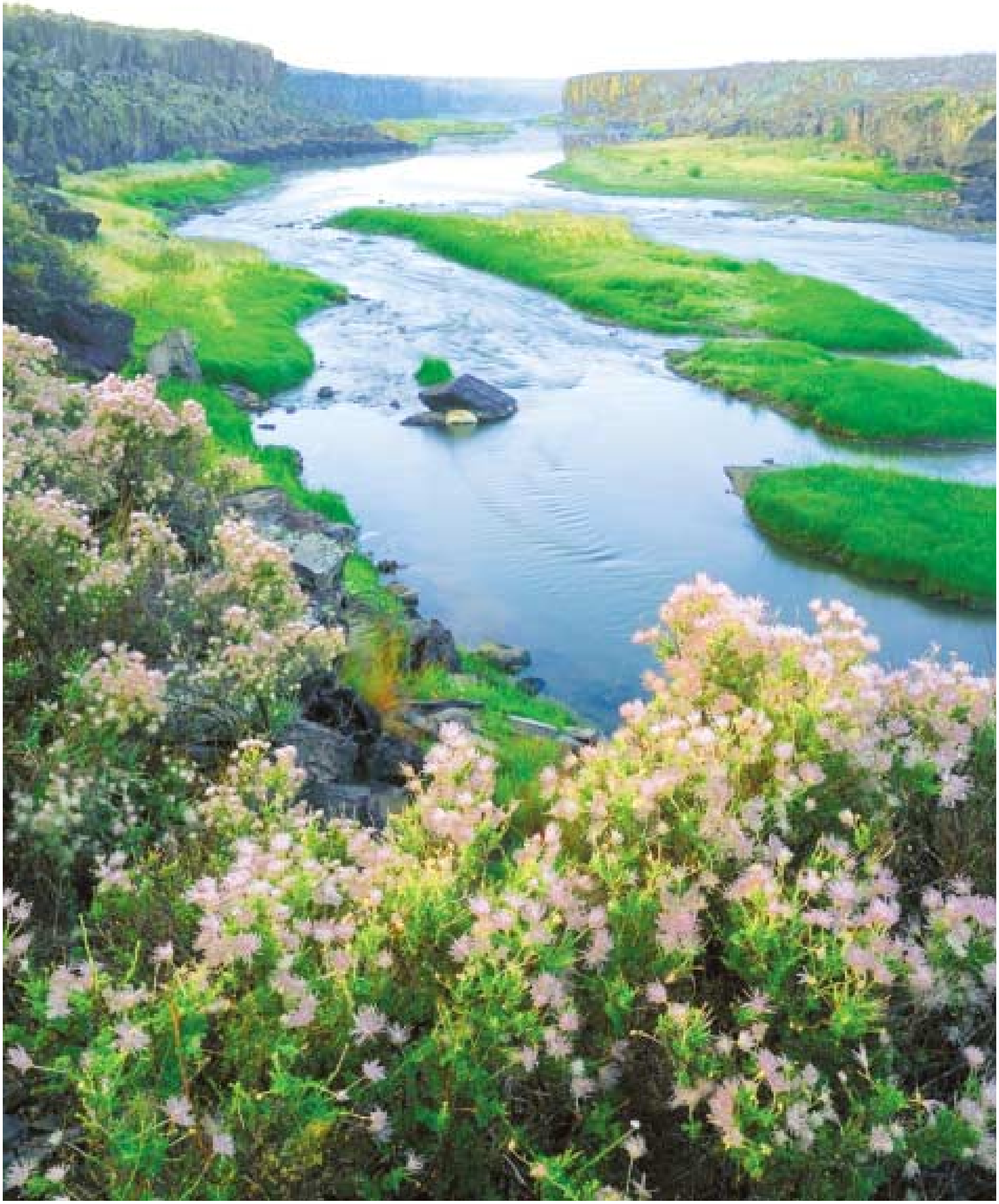


Photo by John Fielder

Barr Lake and Beebe Draw Surface/Groundwater Conjunctive Use, Storage, and Reuse Options

Description

Barr Lake and Beebe Draw are located a short distance northwest of Denver International Airport, and are associated with the extensive water storage and delivery system operated by the Farmers Reservoir & Irrigation Company (FRICO), the Burlington Ditch & Reservoir Company, and the Henrylyn Irrigation District. The water in Barr Lake (capacity of 32,000 acre-feet) and Beebe Draw currently is used for irrigation.

This project concept would manage Beebe Draw groundwater resources in combination with the surface water rights presently used for irrigation in this area to provide water for urban or suburban use. The project could serve many locations in the Denver metropolitan area, although most of the interest in this project comes from water suppliers in the South Metro area.

The concept for this project is based on the "conjunctive" use of surface and ground water. During wet years, suppliers would inject surface water into the Beebe Draw ground water aquifer for storage, while in dry years, they would withdraw water from the aquifer for use. In addition, the concept includes the "first use" of senior water rights by urban water suppliers, with subsequent reuse by irrigators. New wells and plumbing would be installed in Beebe Draw, whose geohydrological characteristics are well-suited for ground water storage.

This project would be complementary to the South Metro Project (SMP), as it could be one potential source of in-basin water for the SMP.

This project appears quite promising. It could supply a lot of water, both for continued irrigation and for municipal use; it would rely on active water and wastewater management, without construction of a new dam or reservoir; and the associated environmental impacts would likely be minimal.

Potential Yield

10,000–100,000 acre-feet.

Timing

Short-term to mid-term (5-10 years).

Status

A company, United Water, has been formed to develop this project. United Water is actively working to recruit water providers to make the project economically viable. There is significant interest from a number of Denver Metro area water suppliers.

Impacts

- Possible adverse impacts could occur to one of the last remaining breeding populations of burrowing owls along the Front Range.
- Possible adverse impacts related to diminished flows downstream of the confluence of Beebe Draw and the South Platte mainstem could occur.
- Possible contamination of some groundwater in Beebe Draw by agricultural products, especially nitrates, could occur.

Barr Lake and Beebe Draw Surface/Groundwater Conjunctive Use, Storage, and Reuse Options (continued)

Make It Smart!

This supply project has several "smart" elements, including its reuse of water, cooperation between agricultural water users and municipal interests, and cooperation among water providers. As the project's sustainability will probably be linked to the area's land use, it could be developed as part of an agricultural land use and open space arrangement. A smart solution would ensure that the burrowing owl population near Barr Lake would not be compromised. The project also would need to ensure that stream flows in the South Platte below its junction with Beebe Draw are not significantly reduced. Finally, prior to end use, the raw water will need treatment, as it is unlikely to meet drinking water standards.

South Metro Conjunctive Use

Description

The proposed South Metro Conjunctive Use project links and coordinates the operation of at least eleven local water suppliers' surface water rights and infrastructure with their non-renewable ground water systems. The goal is to use surface water sources more fully in average and wet years, while reserving non-renewable groundwater supplies for dry years. In wet years, the project beneficiaries would use surface water to recharge the groundwater, currently being depleted at an unsustainable rate. This project would also involve extensive reuse of the consumable return flows available after the beneficiaries' first use of non-tributary groundwater.

The surface water supplies that participants are considering as potential sources for both recharge and wet- and average-year use include both South Platte and new Blue River water rights, and the transfer of agricultural water supplies from the Beebe Draw area to the north of Barr Lake. Regardless of the ultimate source of the surface water, implementation of this project will require construction of pipelines, pumping stations, treatment plants, and storage reservoirs.

There are at least eleven local water suppliers in Douglas County who would benefit from this project. Beneficiaries are currently working with Denver Water and West Slope interests to design a project that will integrate the beneficiaries' existing infrastructure as well as their supply and demand management operations. Preliminary capital cost estimates range from $1.1 billion to $2.3 billion.

Potential Yield

19,000 to 36,000 acre-feet, depending on surface water supply source. With Denver's South Platte and Blue River systems, yield would be 26,000 acre-feet.

Timing

Near-term to mid-term.

Status

Centennial Water & Sanitation District, the City of Parker, and other entities are already planning and implementing some components of the infrastructure for this project. These include the Rueter-Hess Reservoir, planning for reallocation of storage in Chatfield Reservoir, and testing of recharge potential. Negotiations between Denver Water, Douglas County Water providers, and the West Slope are currently underway.

South Metro Conjunctive Use (continued)

Impacts

Potential increased transbasin diversions through Denver Water system could occur that would eliminate peak flows on the Blue Rivers in most, if not all, years if Denver does not rely exclusively on water from the South Platte River Basin.

Increased South Platte diversions in average and wet years could occur.

Localized effects of infrastructure construction could occur.

Make It Smart!

Effective implementation of reuse and conservation is needed, as conjunctive use alone will not be sufficient to achieve sustainable use of non-tributary ground water. Maximize use of in-basin (South Platte) surface water supplies and reuse, with use of additional West Slope water from the Blue River only as a last resort.

Denver Water Moffat Collection System Project

Description

Denver's "North End" project is designed to address raw water delivery needs associated with its Moffat collection system. Moffat Tunnel runs under the Continental Divide from the Fraser River valley (near Winter Park) to the headwaters of South Boulder Creek. Denver's West Slope collection system takes water from both Fraser and William Fork River tributaries. Denver currently needs to deliver more raw water for drinking water use than the system is capable of handling, particularly in severe drought periods. Thus, Denver is considering a 20,000–71,000 acre-feet enlargement of Gross Reservoir, an existing 43,065 acre-feet reservoir located on South Boulder Creek. Another storage reservoir that Denver is considering building as an alternative, or in addition to the Gross Reservoir enlargement, would be off-channel at Leyden Gulch. This reservoir could be sized between 31,300–60,200 acre-feet. Denver could use Leyden Gulch simply as a storage alternative to Gross enlargement or it could be used in conjunction with its potable reuse strategy for blending raw and reused water. Either option would increase Denver's northern storage capacity so that it could increase its Moffat collection system diversions in wet years into Front Range storage, ultimately for use in dry periods.

Other options under consideration include reuse from Denver's metropolitan wastewater treatment system to Ralston or Leyden Reservoirs that would capture some of Denver's reusable return flows for non-potable or indirect potable reuse in the northern part of the Denver service area. This option is associated primarily with the Leyden Gulch reservoir because of its proximity to effluent sources. Denver may allow participation by other East and West Slope providers in its North End project in order to address water supply and instream flow deficiencies in the Fraser River and Boulder Creek Basins.

As Denver considers its options, it is also engaged in discussions with affected West Slope entities through the Upper Colorado River Study Project (UPCO). UPCO is examining ways that Front Range diverters could make the diversions to which they are entitled, while still protecting West Slope environmental and recreational interests.

Potential Yield

18,000 acre-feet, assuming 72,000 acre-feet of new reservoir storage.

Timing

Near-term for a reservoir; mid-term or longer for potable reuse.

Status

While the Army Corps of Engineers completed its scoping process under the National Environmental Policy Act in the fall of 2003, Denver Water was unable to complete its data collection during the summer of 2004. Thus, they have delayed the release of a draft environmental impact statement until March 2006.

Denver Water Moffat Collection System Project
(continued)

Impacts

- Diminished flows downstream of the Moffat Tunnel collection system on the Fraser and Colorado Rivers could occur.
- Inundation of areas associated with Gross Reservoir Expansion and/or Leyden Reservoir could occur.
- Potential increased flows in South Boulder Creek below an expanded Gross Reservoir could occur.

! Make It Smart!

Demonstrate that Denver has pursued all reasonable urban efficiency measures before proceeding with increased transbasin diversions.

Avoid or offset environmental impacts (including those arising from flow reductions), in both the South Platte and Colorado River Basins, especially in the Fraser River and its tributaries.

Where feasible, integrate Denver's system with other transbasin diverters out of the Upper Colorado and Front Range water suppliers to decrease total diversion, both now and in the future, and create opportunities to restore healthy flows on the Fraser River and elsewhere.

Windy Gap Firming Project

Description

The purpose of this project is to give the Northern Water Conservancy District Municipal Subdistrict the storage it needs to capture Colorado River water to which it is legally entitled, but which it currently cannot use because it lacks sufficient storage capacity. It would increase diversions under existing Windy Gap water rights.

The existing Windy Gap Project consists of a diversion dam, located on the Colorado River below the mouth of the Fraser River, a pumping station, and a pipeline that conveys water to Lake Granby. From Lake Granby, the water is delivered through the U.S. Bureau of Reclamation's Colorado-Big Thompson Project (C-BT) to participating entities located on the Front Range within the municipal subdistrict of the Northern Colorado Water Conservancy District. Some, but not all of Windy Gap's participants have immediate needs for additional water. Those beneficiaries that do not have immediate needs expect to have increased needs in the future.

Windy Gap Firming proponents cite three primary reasons for this project: (1) Windy Gap is limited by senior rights holders in dry years; (2) Windy Gap is limited in some other years by lack of storage and pipeline capacity in the C-BT project; and (3) Windy Gap's junior water rights mean that even in wet years, there is no storage under its priority in the C-BT system. Thus, at present, Northern is not able to divert all of the water to which it is entitled. To capture this water, Northern needs to build at least one reservoir on the Front Range and possibly a reservoir on the West Slope as well. While the project would use existing facilities and could potentially integrate Windy Gap and Colorado-Big Thompson operations, as currently envisioned it would also significantly lower flows in the Upper Colorado River during peak runoff months. The Bureau of Reclamation is considering five reservoir storage sites:

Reservoir Site	Storage Capacity (acre-feet)
Chimney Hollow	44,500–110,000
Little Thompson	110,000
Cactus Hill	112,000
Rawhide	13,000
Jasper North (West Slope)	36,500–79,000

Alternatives also could include a combination of new reservoirs and/or changes in the operations of the C-BT system to enhance the yield of the Windy Gap Project.

Potential Yield

30,000 acre-feet, assuming 110,000 acre-feet of new storage.

Timing

Near-term to mid-term.

Status

The National Environmental Policy Act scoping process was completed Fall, 2003. A draft environmental impact statement is expected in September, 2005.

Windy Gap Firming Project (continued)

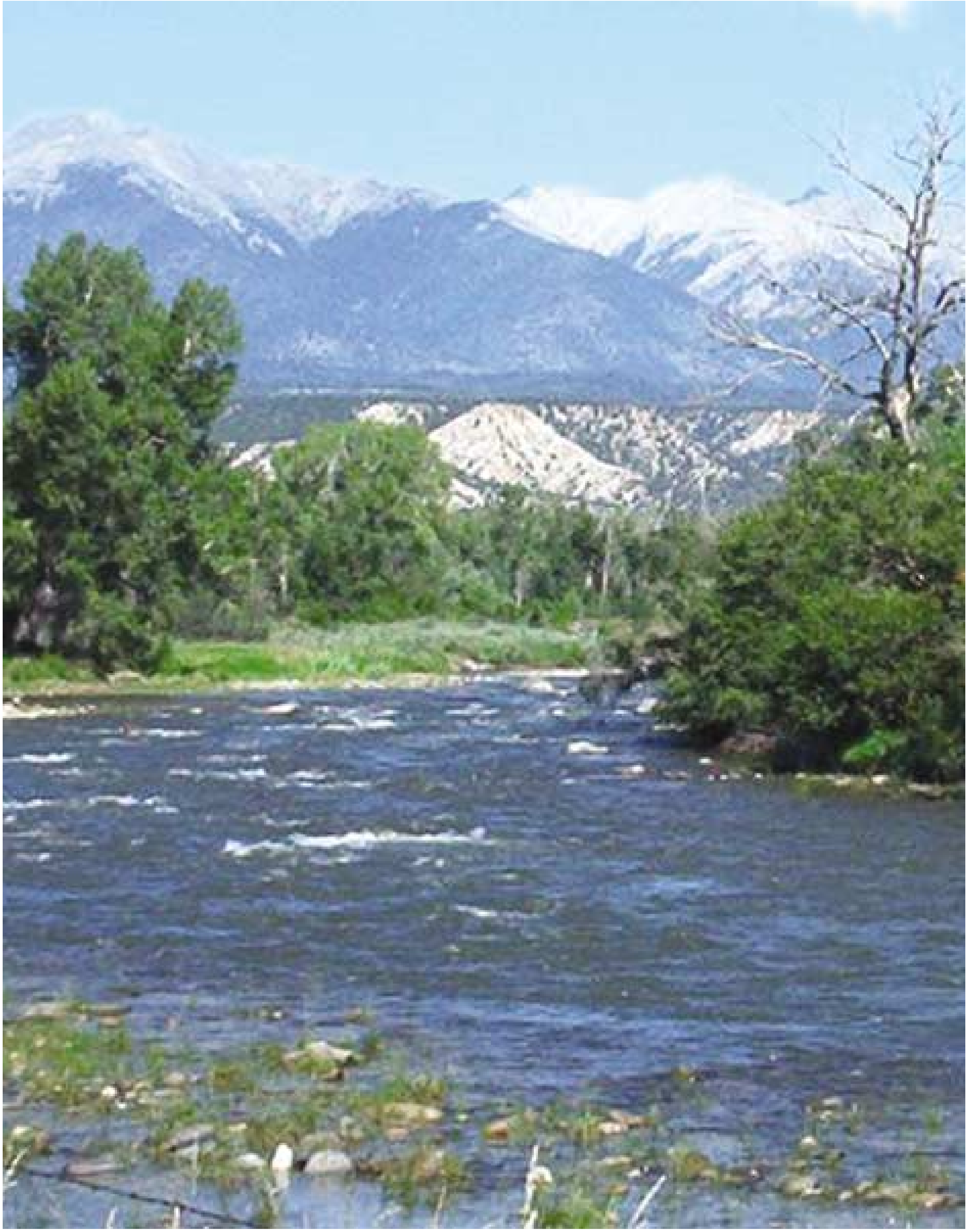
Impacts

- Diminished flows in the Colorado River downstream of Windy Gap and C-BT storage facilities could occur.
- Inundation of land at location of selected reservoir site on Eastern Slope could occur.
- Potential adverse effects could occur on bald eagles recorded in the Jasper North area; boreal toads in the Chimney Hollow area; swift fox along Rawhide Creek; and tallgrass prairie remnant north of the Little Thompson River.

Make It Smart!

Implement urban efficiency program to delay and reduce the "need" for the project. Ensure that rare or sensitive species will not be compromised. Minimize adverse environmental effects, including flow regimes, in all affected reaches of the Colorado and South Platte River Basins. Avoid or counteract adverse effects to Colorado River Basin recreational interests. Integrate Windy Gap and C-BT facilities to the maximum extent possible, including modifications to C-BT operations that could firm Windy Gap rights with fewer adverse effects. Implement an alternative consisting of small-capacity elements, non-structural options, conservation, and project phasing to meet a revised project purpose focused on meetings demands, not land use plans. Commit to begin integration of Northern's and Denver's systems so as to minimize diversions from the Upper Colorado River Basin now and in the future.

Photo by Jeff Widen



Arkansas River
Photo by Jeff Widen

2. Arkansas River Basin Options

While most of the water usage in the Arkansas River Basin today is agricultural, the Fountain Creek Basin (El Paso and Pueblo Counties) is a fast-growing municipal area, and cities in both the Arkansas and South Platte River Basins are looking to transfer Arkansas irrigation water to municipal use. In addition, the Upper Arkansas River Basin (Lake, Chaffee, Custer, Teller, and Fremont Counties) is becoming increasingly urbanized.

The Statewide Water Supply Initiative calculates water demand shortfall in the Arkansas River Basin by the year 2030 to be only 5,500 acre-feet, mostly due to anticipated increases in urban demand. The shortfalls identified by SWSI, if considered in the context of the total existing demands in the Arkansas River Basin, are relatively small. Even a modestly increased level of municipal and urban conservation would probably be sufficient to satisfy the “gap” that SWSI identified. This would still be the case in the event that several of the new water projects currently in the planning stage are not completed with the yield that is projected.

The possibility of increased water transfers out of the mainstem Arkansas River to the Fountain Creek drainage or out of the Arkansas River Basin generally to the South Platte River Basin is, due to their relative magnitudes, likely to be of much greater significance to Arkansas River Basin water management and socio-economic development than the SWSI-identified gap. Many of the water supply alternatives identified by SWSI may ultimately benefit these exporters more than existing in-basin users.

Since the 1996 adoption of its Water Resource Plan, Colorado Springs Utilities (CSU) has made or is currently finalizing improvements to its water operations systems. These cumulative improvements will result in a supply yield of nearly 25,000 acre-feet. The SWSI final report suggests that as much as 30,000 acre-feet of supply could be gained by improvements to Colorado Springs’ water systems. While over 80% of this goal has been realized through CSU’s current improvements, more improvements may be possible and would yield some additional supply.

Southeastern Water Conservancy District recently established a water bank in the Arkansas River Basin to facilitate short-term, temporary water transfers on the Arkansas River in Pueblo Reservoir and downstream. Although the water bank has completed few, if any, transactions to date, it could address many of the demand shortfalls identified by SWSI, including many of those from El Paso County, if Colorado Springs constructs its planned Southern Delivery System.

Analysis of Arkansas River Basin Supply Options

Project Name (Beneficiary)	**Description**	**Potential Yield** (acre-feet/year, rounded to nearest thousand)	**Timeframe**	**Issues To Be Resolved**
Water Conservation (all cities)	Indoor and outdoor	16,000–50,000	Ongoing	• Improve implementation by water providers • Gain wider public acceptance and endorsement; need consistent incentives to increase participation • Offset effects on water provider revenue
Temporary Transfers (Interruptible Water Supply Agreements) (all cities)	Contracts for cities to use agricultural water in dry years (e.g., Aurora, Rocky Ford)	Initial rough estimate: 15,000 available	Ongoing	• Address legal/institutional barriers • Mitigate/minimize impacts, especially to agricultural communities • Construct storage and delivery facilities • Assess highest value/most flexible transfers
EPCWA Water Report (El Paso County, Colorado Springs)	Development of groundwater resources	4,000	Long-term	• Address potential for aquifer renewal/recharge • Address potential for, and offset impacts associated with, future diversions from Gunnison River basin to supply Northern El Paso County
Reuse (all cities with reusable rights)		4,000	Mid- and long-term	• Assess cost of reuse for potable water, and adjust planning and consumer expectations accordingly • Assess and minimize potential adverse impacts to stream flows, water quality • Encourage public/water provider acceptance
Arkansas River Water Bank Program	Facilitate short-term water exchange	Large potential, but no way to quantify at this time	Short-term (authorized only through 2007)	• Adopt/improve incentives to boost current low rate of participation • Analyze potential for benefit to broader base of users (not just users below Pueblo Reservoir)
SE Colorado Water Conservancy District Preferred Storage Option Plan	Pueblo and Turquoise Reservoirs Enlargement	70,000 in additional storage; yield to be determined	Short-term	• Offset impacts on Arkansas River flows and existing users • Address adverse impacts of potential demand for increased transbasin diversions into and out of Arkansas River Basin
Colorado Springs Southern Delivery System	Pipeline from Pueblo Reservoir to Colorado Springs	51,000 average	Mid-term	• Address impacts on Fountain Creek water quality and stream channel • Maintain streamflows below Pueblo Reservoir; address other impacts on downstream users

Water Conservation

See pages 27-35 and the Technical Appendix for a complete discussion of potential yield from this source of supply.

Temporary Transfers

See page 41 for the brief analysis of the potential yield from this source of supply.

Reuse

See page 44 of this report for a description of this source of supply. The figure for potential yield from reuse in the Arkansas Basin comes from the El Paso County Water Authority Water Report and the Colorado Springs Utilities Water Resource Plan.

El Paso County Water Authority Water Report

Description

This draft report was issued in 2002. It reviews alternatives for the provision of interim and long-term water supplies to various El Paso County water providers, including individual wells, community-type wells, regional water supply systems with sources, including imports of water from other basins (the Gunnison, Rio Grande and South Platte), Colorado Springs Utilities, conversion of Arkansas River Basin agricultural water rights, and conjunctive management of surface and groundwater resources.

Potential Yield

Although the report draws no firm conclusions regarding the quantity of water available from the alternatives examined, the Water Supply Options catalogue used in the SWSI process indicates there could be 2,551 acre-feet available from groundwater and an additional 2,480 acre-feet available from increased water reuse practices.

Timing

The timing of these options has not yet been determined. Several of the alternatives could be arranged in the medium-term, but, given the institutional and physical challenges involved, most of the alternatives should be regarded as long-term options.

Status

The report is under review.

Arkansas Water Bank

Description

The Arkansas River Water Bank has the potential to ensure that water in the Arkansas River Basin is used to best advantage. The water bank allows water-rights holders to forgo (temporarily) use of their water and sell it to other water users seeking additional short-term supplies. Transactions are limited to water that can be stored in Pueblo Reservoir, and contract duration may not go beyond 2007, the last year for which the water bank is authorized to operate.

Although the Arkansas River Water Bank has been in operation for two years, no transactions have been consummated. The water bank's restrictions on deals leading to the transfer of water outside of the basin prevent many of the parties with the greatest potential interest in leasing water from doing so. Because the demand for Arkansas River water is greatest upstream of Pueblo Reservoir and outside of the Arkansas River Basin, many potential lessees of water are not able to take advantage of the program.

Potential Yield

Although the level of activity could potentially be on an order of magnitude of several hundred thousand acre-feet (limited by the volume of water stored in Pueblo Reservoir), it is unlikely to reach this level. The record to date indicates that the yield associated with this program is unlikely to be large without significant revision to some of the water bank's constraints and/or operating procedures.

Timing

The water bank procedures have been designed to allow transfers to occur on a relatively quick basis, so that transactions can occur within a fast timeframe.

Status

The water bank is authorized to operate through 2007.

Impacts

- Unknown, but few are likely.

Make It Smart!

The Arkansas River Water Bank is potentially an effective and "smart" water supply arrangement, because it could assist in allowing water to be used in the most efficient manner for the most highly valued purposes. Revisions that would make it more useful include removal of some of the restrictions on participation and water use, enhancing the physical facilities of the irrigation canal companies to allow more precise and efficient water management, and a shorter approval process by authorities to allow transactions to proceed efficiently.

Colorado Springs Utilities - Southern Delivery System

Description

The Southern Delivery System (SDS) includes a new, 43-mile long, 66-inch diameter pipeline from Pueblo Reservoir to Colorado Springs capable of diverting 87,000 acre-feet of water annually to supply additional water for Colorado Springs' municipal system, including Fountain, Security, and Pueblo West. Wastewater from this project will be returned to the Arkansas River via Fountain Creek. Related, future elements of SDS include two new off-channel storage reservoirs, pump stations, and treatment capacity for the Colorado Springs municipal water supply system. While it is not absolutely necessary to increase the storage capacity of Pueblo Reservoir (described under the analysis for the Preferred Storage Options Plan) in order for Colorado Springs to build the Southern Delivery System, there would be an advantage to the utility were PSOP also built.

Cost

Total = $939 million. Phase I (pipeline) = $539 million; Phase II (Jimmy Camp Creek reservoir) and Phase III (Williams Creek Reservoir) = $400 million (both exclusive of the costs of Pueblo Reservoir expansion).

Potential Yield

87,000 acre-feet.

Timeframe

Phase I from 2010-2011; Phase 2 from 2012-2015; Phase III from 2020 to 2030.

Status

NEPA scoping complete. Draft EIS expected June, 2006.

Impacts

- SDS would reduce mainstem Arkansas River flows through Pueblo from Pueblo Reservoir to the confluence with Fountain Creek at certain times of the year.

- Increased effluent discharges and return flows to Fountain Creek from SDS will exacerbate channel erosion problems and degrade water quality.

- Although SDS does not itself develop or use "new" water, it would increase Colorado Springs' use of its existing water rights, potentially leading to increased depletions.

- Pueblo Reservoir expansion would affect habitat for sensitive endemic plant species, such as the dwarf milkweed, golden blazing star, round-leaf four-o'clock, Barnaby's feverfew, Pueblo goldenweed, and Arkansas Valley evening primrose.

  – Increased Fryingpan River and Roaring Fork diversions to the Arkansas River could occur as Colorado Springs actually diverts all of the water to which it is legally entitled, resulting in depleted flows in the Fryingpan and Roaring Fork

Colorado Springs Utilities - Southern Delivery System
(continued)

and contributing to lower flows in the Colorado River system, potentially affecting listed Colorado River fish and their critical habitat).

- Increased exchanges of water up the Arkansas River mainstem could occur, potentially further degrading water quality.

Make It Smart!

Delay or even eliminate the need for SDS with more aggressive reuse of Colorado River water and conservation, especially in the construction of new residential developments. Move diversion point downstream to Fountain Creek confluence to mitigate low flows through Pueblo and the Arkansas River Legacy Project reach. Ensure that plants species of special concern are protected.

Preferred Storage Options Plan (PSOP)

Description

The Preferred Storage Options Plan (PSOP) is the result of a multi-year planning process, including an environmental impact review that Southeastern Colorado Water Conservancy District (Southeastern) undertook to ensure that it would provide for the needs of its member communities, as well as Aurora. The PSOP consists of three parts: (1) potential expansion of the two East Slope reservoirs that are part of the Bureau of Reclamation's Fryingpan-Arkansas Project (Pueblo and Turquoise); (2) storage of "non-project" water in these bureau facilities (i.e., water under water rights not associated with the Fryingpan-Arkansas project); (3) revisions to reservoir operations; and (4) a water conservation program intended to reduce demand for water storage. The increased storage available from the PSOP could accommodate increased transbasin diversions from the Fryingpan and Roaring Fork Rivers to the Arkansas River under existing water rights that have not been exercised because of a lack of storage.

Potential Yield

69,625 additional acre-feet of storage; yield to be determined.

Status

Federal legislation required.

Timing

10-15 years.

Impacts

- Lower flows in Arkansas River mainstem from Pueblo Reservoir to Fountain Creek could occur.
- Increased Fryingpan River and Roaring Fork diversions to the Arkansas River could occur (depleted flows in the Fryingpan and Roaring Fork contribute to lower flows in the Colorado River system, potentially affecting listed Colorado River fish and their critical habitat).
- Increased exchanges of water up the Arkansas River mainstem could occur, potentially further degrading water quality.
- Pueblo Reservoir expansion would affect habitat for sensitive endemic plant species, such as the dwarf milkweed, golden blazing star, round-leaf four-o'clock, Barnaby's feverfew, Pueblo goldenweed, and Arkansas Valley evening primrose.

! Make It Smart!

Certain aspects of PSOP could be regarded as having the potential for classification as "smart" supply. Water conservation is an important element of smart supply, and the focus on expansion of existing reservoirs (Pueblo and Turquoise) is, in principle, more desirable than construction of new reservoirs. If PSOP is formulated to enhance the operations of the Arkansas River Water Bank, this could lead to increased efficiency of water use and management. PSOP should ensure that sensitive or ESA-listed plant, fish, and wildlife species and their habitat would not be compromised.

“The state, its water providers, and its residents are equally responsible for making sure that this is accomplished, so that we can be confident in Colorado’s water future.”

How We Achieve Results

Washington Park, Denver
Photo by Amy Livingston

Animas Rafting
Photo by Jeff Widen

Agricultural Irrigation
Photo by American Water Works Association

Colorado has enough water to meet its needs, now and in the future. The state's future water needs can be satisfied through a variety of strategies: water conservation, reuse, enlargement of existing reservoirs and water supply systems, development of a few strategically located new reservoirs, and cooperative water supply management actions. Conservation and greater efficiency in the use and management of water, while not the entire solution, are unmatched in their potential to improve Colorado's usable water supplies relatively quickly and affordably—and without diminishing Colorado's quality of life.

Some Colorado water users will need to build new water storage facilities to satisfy growing needs in the next 25 years. Where proponents have demonstrated a real need for these facilities, it is vitally important to ensure that they satisfy the broadest possible range of stakeholder needs and concerns, are cost-effective, and cause the least possible harm to local communities, the economy, and environmental quality.

The state has a role to play in the process of identifying, analyzing, and developing workable and affordable solutions to Colorado's water challenges. But the recent Statewide Water Supply Initiative found that most local and regional water providers have adequate water supplies for meeting current demands, and are doing a commendable job of planning and implementing measures to meet future demands. The SWSI process also proved that construction of large new transbasin diversion systems or large new state-sponsored water development projects is not necessary to guarantee a reliable and sustainable water supply in 2030 and beyond.

As a result, going forward the state's role in water supply planning and development will continue to be most effective when it focuses on facilitating communication and cooperation between water providers, Front Range and West Slope interests, and conservation groups. When the state acts in a non-partisan manner to support water negotiations, innovative water supply initiatives can result, such as the South Metro Conjunctive Use proposal and the Upper Colorado River Basin Study. These initiatives are designed to increase water supplies in ways that address the needs and concerns of all stakeholders in the water equation.

The state has also played, and should continue to play, an important role in coordinating efforts to address endangered-species issues, facilitating collaboration between water providers and the federal government, and providing technical resources and information. Examples of the results of this role include:

- The Platte River Cooperative Agreement and EIS process
- The Chatfield Reservoir Reallocation Feasibility Study
- The U.S. Forest Service's South Platte Wild & Scenic Study and associated negotiations
- Development of river basin decision support systems

The authors believe that, in most cases, those who benefit from water development should pay its costs, including the costs of mitigating environmental damage. However, to conserve, protect and restore Colorado's rivers, there will be opportunities and costs not associated with new water supply projects. In these situations, the state can play an important role in helping water users and river advocates identify and develop sources of funding that will provide needed water for the environment.

When Colorado's water laws were written, there was far greater value placed on removing water from rivers and streams for irrigation and industrial use than keeping water in-channel. Today, the value of water has shifted significantly. The volume of demand is greater, and traditional supplies have not increased as rapidly as this demand. In many areas, it is now a higher priority to keep as much water as possible in a river bed, and the cost of water for residential and municipal purposes is much higher than for agriculture.

We recognize increased urban efficiency may, in some cases, reduce municipal return flows and affect downstream water quality issues. Water planners face similar issues for other options as well. Indeed, there is a need to address water quality issues related to all plans for meeting future water demands

It is more important today than ever before to ensure that any new water project—particularly one that would take water from a West Slope river basin—must consider and account for this shift in values. The state, its water providers, and its residents are equally responsible for making sure that this is accomplished, so that we can be confident in Colorado's water future.

Photo by John Fielder

Technical Appendix

Water use data and population statistics are the basis for potential water-conservation savings estimates for existing and future residents of Colorado's Front Range. The authors of this report gathered population data from the U.S. Census Bureau and the Colorado Department of Local Affairs (DOLA). We also used per capita water use data from documents generated by the American Water Works Association Research Foundation (AWWARF)[4] and Amy Vickers, a nationally recognized water conservation specialist and author of *Handbook of Water Use and Conservation*.[5] Jim Knopf, landscape architect, and publications by DOLA's Office of Smart Growth provided additional information regarding landscaping water needs.

The Front Range population data are broken down into various metropolitan statistical areas (MSAs), as defined by the U.S. Census Bureau and DOLA. Collectively, the following four MSAs make up the vast majority of the Front Range population base.

South Platte River Basin

- Denver-Boulder-Greeley MSA
- Fort Collins-Loveland MSA

Arkansas River Basin

- Colorado Springs MSA
- Pueblo MSA

	South Platte River Basin		Arkansas River Basin	
	Denver-Boulder-Greeley MSA	**Fort Collins-Loveland MSA**	**Colorado Springs MSA**	**Pueblo MSA**
Counties included in MSA	Denver, Boulder, Adams, Weld, Arapahoe, Douglas, Jefferson, Broomfield	Larimer	El Paso	Pueblo
2000 census population [Source: www.census.gov, accessed on July 18, 2004]	2,581,506	251,494	516,929	141,472
2030 DOLA projected population [Source: www.dola.state.co.us, accessed on July 20, 2004]	4,185,720	441,904	801,721	226,311
Net population gain from 2000 to 2030	1,604,214	190,410	284,792	84,839
Percent of 2000 population in "urban" area	93.7%	86.5%	90.5%	87.2%
2000 population in single-family homes (detached)	1,751,509	177,862	360,949	108,145
SFR percent of all residence types in 2000 (by population)	69%	73%	72%	79%
Single-family residential household occupancy rates in 2000 (people/household)	2.79	2.55	2.79	2.51

4 Peter Mayer and William DeOreo, Residential End Uses of Water Study (REUWS), American Water Works Association Research Foundation (AWWARF), 1999.
5 Amy Vickers, Handbook of Water Use and Conservation, WaterPlow Press, 2001, at 23-133.

Indoor Conservation Potential Estimates

The first step in assessing indoor conservation potential is to establish a range of current indoor water use along the Front Range. Average per capita indoor water use varies across communities. However, with few exceptions, the variation is not nearly as large as for outdoor water use. Indoor per capita water use is quite similar from household to household across the country. In recent years, the following indoor water use rate examples have been documented:

- Average U.S. indoor use[6] = 69 gpcd (gallons per capita per day)
- Denver Water indoor use[7] = 69 gpcd
- City of Boulder indoor use[8] = 57 gpcd

A conservative assumption is that most cities along the Front Range currently average between 57 and 69 gpcd, with only small deviations above or below this range. Therefore, the authors have applied this indoor use range to the estimates for existing Front Range residents.

Second, we must designate a realistic target indoor use rate by the year 2030. Research indicates that household use could drop to 45 gpcd if all indoor water fixtures and appliances are retrofitted with water-efficient appliances and if improved leak detection/repair is accomplished[9]. As consumer awareness and technology advance, even lower per capita indoor use rates may be possible. However, for the sake of these savings estimates and to maintain a conservative approach, we designate 45 gpcd as the target per capita use rate. This 45-gpcd target indoor use estimate is based on: (1) water usage rates of water-efficient fixtures and appliances that are currently available on the market, as identified by Amy Vickers, and (2) indoor water use patterns identified in the AWWARF *Residential End Uses of Water* study[10]. In addition to a notable reduction in indoor leaks, this target indoor use rate assumes the installation of the following appliance and fixture ratings[11]:

- Toilets (1.6 gallons per flush)
- Showerheads (2.5 gallons per minute at 80 psi)
- Faucets (2.0 gallons per minute at 80 psi)
- Clothes washers (27 gallons per load)
- Dishwashers (7.0 gallons per load)

Water-efficient toilets, showerheads, and faucets are already required for new urban and suburban development, and a "natural replacement" of these appliances and fixtures will occur over time for existing structures. In addition, other water-efficient fixtures and appliances, such as clothes washers and dishwashers, are likely to continue to gain popularity as they become more affordable. Mandatory sales/use of water-efficient washing machines is likely in the relatively near future.

Third, this Front Range indoor water savings estimation must be separated into two components: potential savings from existing residents and potential saving from new residents (born in or immigrating to Colorado's Front Range between now and 2030). Since many of the new residents will move into new developments/structures with more efficient toilets, showerheads, and faucets, their average per capita indoor use will generally be lower than that of existing residents who might still be using older, less efficient fixtures and appliances. We create a range of potential savings to account for the statistical error that may be introduced by these assumptions.

Since it is uncertain how fast or how extensive indoor conservation measures will be incorporated over the next 30 years, the authors calculate a range of potential water savings. A low-high range of potential indoor savings is presented for the existing Front Range population and for the future (net gain) Front Range population (from now until 2030). These two low-high ranges will be summed to generate an overall potential savings range for Colorado's Front Range, broken down into the Arkansas and South Platte River Basins.

Chosen per capita indoor savings ranges for existing residents as of 2000:

- Minimum savings estimate by 2030:
  From 57 gpcd to 45 gpcd = 12 gpcd savings
- Maximum savings estimate by 2030:
  From 69 gpcd to 45 gpcd = 24 gpcd savings

Chosen savings ranges for net gain in residents from present to 2030 (averaged over 25 years):

- Minimum savings estimate by 2030:
  From 50 gpcd to 45 gpcd = 5 gpcd savings
- Maximum savings estimate by 2030:
  From 60 gpcd to 45 gpcd = 15 gpcd savings

[6] Mayer and DeOreo, AWWARF, at p. 90.
[7] Water For Tomorrow: An Integrated Resource Plan, Denver Water, 2002.
[8] City of Boulder Utilities Department.
[9] Vickers, at 17-19.
[10] Mayer and DeOreo, AWWARF, at 86-88.
[11] Vickers, at 18-19.

South Platte River Basin

Existing Front Range Residents: South Platte Basin (2,833,000 in 2000)
MGA = million gallons annually
AFA = acre-feet annually

Assuming minimum savings:
For every 1,000,000 existing residents =
4,380 MGA saved (13,442 AFA saved)

Total minimum potential indoor savings from existing Front Range residents:
2.833000 million X 4,380 MGA) =
12,408 MGA saved 38,080 AFA saved

Assuming maximum savings:
For every 1,000,000 existing residents =
8,760 MGA saved (26,883 AFA saved)

Total maximum potential indoor savings from existing Front Range residents:
(2.833000 million X 8,760 MGA) =
24,817 MGA saved 76,161 AFA saved

Forecasted Net Gain in Front Range Residents: South Platte Basin
(from present until 2030) = 1,794,624 by 2030

Assuming minimum savings:
For every 1,000,000 new residents = 1,825 MGA saved (5,601 AFA saved)

Total minimum potential indoor savings from new Front Range residents:
(1.794624 million X 1,825 MGA) =
3,275 MGA saved 10,051 AFA saved

Assuming maximum savings:
For every 1,000,000 new residents =
5,475 MGA saved (16,802 AFA saved)

Total maximum potential indoor savings from new Front Range residents:
(1.794624 million X 5,475 MGA) = 9,826 MGA saved 30,153 AFA saved

Arkansas River Basin

Existing Front Range Residents: Arkansas Basin (658,401 in 2000)
MGA = million gallons annually
AFA = acre-feet annually

Assuming minimum savings:
For every 1,000,000 existing residents =
4,380 MGA saved (13,442 AFA saved)

Total minimum potential indoor savings from existing Front Range residents:
(0.658401 million X 4,380 MGA) =
2,884 MGA saved 8,850 AFA saved

Assuming maximum savings:
For every 1,000,000 existing residents =
8,760 MGA saved (26,883 AFA saved)

Total maximum potential indoor savings from existing Front Range residents:
(0.658401 million X 8,760 MGA) = 5,768 MGA saved 17,700 AFA saved

Forecasted Net Gain in Front Range Residents: Arkansas Basin
(from present until 2030) = 369,631 by 2030

Assuming minimum savings:
For every 1,000,000 new residents = 1,825 MGA saved (5,601 AFA saved)

Total minimum potential indoor savings from new Front Range residents:
(0.369631 million X 1,825 MGA) = 674 MGA saved 2,070 AFA saved

Assuming maximum savings:
For every 1,000,000 new residents =
5,475 MGA saved (16,802 AFA saved)

Total maximum potential indoor savings from new Front Range residents:
(0.369631 million X 5,475 MGA) = 2,024 MGA saved 6,210 AFA saved

Outdoor Conservation Potential Estimates
(Single-Family Residential Lots Only)

The first step in the assessment of outdoor water use and potential savings is to establish a range for single-family residential (SFR) lot irrigable areas in the Front Range. According to a recent American Water Works Association Research Foundation study sampling, the average SFR irrigable area per lot for Denver and Boulder is:[12]

- Average SFR irrigable area in Boulder = 6,512 sq. ft.
- Average SFR irrigable area in Denver = 7,726 sq. ft.

From the above data, we assume 7,000 sq. ft. as the average irrigable area for SFR lots in Front Range communities. Using this irrigable area will generate a relatively conservative savings potential since suburban lots tend to be larger than the urban lot sizes representative of Boulder and Denver. Much of the existing Front Range population and a majority of the future net gain Front Range population (by 2030) will be in suburban areas. This irrigable area assumption also factors in the effect of non-irrigated areas on larger SFR lots.

Second, we must factor in single-family household occupancy rates in the Front Range in order to attain water use estimates on a per capita basis. According to the 2000 U.S. Census data, the SFR household occupancy rates for the various MSAs in the Front Range are:[13]

South Platte River Basin
- Denver-Boulder-Greeley MSA avg. SFR occupancy rate = 2.79 ppl/hh
- Fort Collins-Loveland MSA avg. SFR occupancy rate = 2.55 ppl/hh
- South Platte Basin MSA average SFR occupancy rate = 2.77 ppl/hh[14]

Arkansas River Basin
- Colorado Springs MSA avg. SFR occupancy rate = 2.79 ppl/hh
- Pueblo MSA avg. SFR occupancy rate = 2.51 ppl/hh
- Arkansas Basin MSA average SFR occupancy rate = 2.72 ppl/hh[15]

Since the SFR household occupancy rates for these two basins are quite similar, and since this slight variation will yield negligible results in per capita water use calculations, we use 2.76 ppl/hh as the weighted average Front Range SFR household occupancy rate.

Third, we can derive potential water savings by estimating the difference in yearly water needs for various landscaping and irrigation alternatives (ranging from 100 percent high-water-use landscape to full Xeriscaping). Although evapo-transpiration (ET) rates vary from city to city along the Front Range (i.e. from Pueblo to Fort Collins), the average ET of Denver provides a reasonable representation of landscaping water needs and savings potential for the region as a whole. Areas with more arid conditions than Denver could expect somewhat higher savings potentials than are listed in this analysis, and vice versa.

The potential outdoor conservation estimates are based on the following "net ET" data. A "net ET" rate refers to the net difference between the vegetation water needs and average natural precipitation (i.e., the amount of water needed for landscape irrigation). We derive savings volumes by considering the difference between a "baseline" bluegrass landscape average and the average water needs of three more efficient landscape alternatives.

Note that many Front Range residents apply excessive amounts of water to their bluegrass lawns, well beyond the listed baseline irrigation rate for a bluegrass landscape. Therefore, the use of the following irrigation rate for the baseline landscape builds a significant conservative assumption into the overall savings estimates.

Average irrigation for "baseline" Front Range landscape:
- Thoroughly watered bluegrass yard:[16]
  18-20 gal./sq. ft./yr. [29"-32" per year]

Average irrigation needs for three "alternative" choices of more water-efficient landscapes:[17]
- Limited Xeriscaping -or- Full coverage of efficiently-watered bluegrass:
  15 gal./sq. ft./yr. [24" per year]
- Moderate Xeriscaping:
  10 gal./sq. ft./yr. [16" per year]
- Substantial/full Xeriscaping:
  3 gal./sq. ft./yr. [5" per year]

The Colorado Department of Local Affairs model landscape ordinance uses the 15 gal./sq. ft./yr. target. This target also is consistent with landscape irrigation information posted on Denver Water's Web site[18]. This amount of irrigation could sustain a bluegrass lawn if watering is accomplished efficiently, and is thus a realistic and reasonable expectation for Front Range residents. In other words, notable outdoor water savings are achievable even if a customer's landscape is still dominated by turfgrass. However, the watering needs of alternative landscapes listed above further illustrate that outdoor water savings potential expands significantly when Xeriscape techniques are incorporated into an urban landscape.

12 Mayer and DeOreo, AWWARF, at p.118.
13 www.census.gov (accessed on July 18, 2004).
14 ppl/hh = people per SFR household. Figure has been weighted with respect to SFR population ratio of both MSAs.
15 Id.
16 Colorado Department of Local Affairs, Office of Smart Growth, "Water Wise Landscaping Best Practices Manual: A Companion Guide to Water Efficient Landscape Design," 2004, p. 13. These water need estimates are based on the net ET for Denver.
Note: Gal./sq. ft./yr. = gallons per square foot of irrigable area per year
17 Id.
18 See www.denverwater.org (accessed on August 4, 2004). Web posting graphic indicates that average bluegrass water needs (net ET) for Denver customers is approximately 26 inches per growing season in additional to natural precipitation. This water amount translates to roughly 16 gal/sq. ft./yr., which is very comparable to the first level alternative listed in the tables.

Next, we need to translate these irrigation rates to a per capita basis. This can be done by applying the above-listed irrigation needs to in the estimated Front Range SFR irrigable area (7,000 sq. ft.) and average SFR household occupancy (2.76 ppl/hh). The following table lists the resulting per capita water usage for irrigating each landscape type. The table also lists the net irrigation need difference (per capita) between the three alternatives and the "baseline" landscape.

The authors base our calculation of savings potential for the alternatives on the assumption that all residents maintain a bluegrass landscape (with the "baseline" watering rates associated with it). Of course, this is not the case in most Front Range communities, where many residents use some form of low-water-use landscaping on portions of their yards. However, since statistics on existing landscaping choices are not available in most communities, these savings estimates must be based on the baseline bluegrass coverage assumption. This baseline bluegrass assumption is counterbalanced by the many conservative assumptions we have built into these savings estimates (e.g., relatively small average irrigable area, relatively low net ET rates, disregarding the existence of excessively-watered bluegrass landscapes). In any case, we can evaluate the potential for significant water savings by assessing the differences between other alternatives and establishing a potential range of savings.

Single-Family Residential Landscape Irrigation Needs (Net ET) Per Capita

Based on a 7,000 sq. ft. SFR Irrigable Area Yard
and a 2.76 ppl/hh SFR Occupancy Rate

Measured in gallons per capita per year

	Annual Per Capita Irrigation Needs	Net Difference Between Alternatives and Baseline
"Baseline" Scenario:		
Thoroughly-watered bluegrass landscape	48,188	—
"Alternative" Scenarios:		
Limited Xeriscaping -or- Full coverage of efficiently-watered bluegrass	38,043	10,145
Moderate Xeriscaping	25,362	22,826
Substantial/full Xeriscaping	7,609	40,579

We can easily convert the net differences in per capita irrigation rates to potential annual water savings volumes per million SFR residents.

Total Single-Family Residential Outdoor Water Savings Potential

For Every 1,000,000 SFR Residents

Measured in acre-feet per year per 1,000,000 SFR residents

	Savings Potential per 1,000,000 SFR Residents
Limited Xeriscaping -or- Full coverage of efficiently-watered bluegrass	31,134
Moderate Xeriscaping 70,050	
Substantial/full Xeriscaping	124,532

Figures are based on a 7,000 sq. ft. irrigable area SFR yard, with an average SFR household occupancy rate of 2.76 ppl/hh.

Since all communities and all SFR residents may not behave in the same manner by the year 2030 with respect to landscaping and/or irrigation choices, we apply a range of "participation percentages" to the above outdoor savings potential estimates. These participation percentages allow us to derive water savings estimates for the different landscape alternatives as well as different scenarios of participation.

Total Single-Family Residential Outdoor Water Savings Potential

Based on Participation Scenarios for Every 1,000,000 SFR Residents
Measured in acre-feet per year per 1,000,000 SFR residents

	Participation Scenarios (percentage participating)					
	20%	30%	40%	50%	75%	100%
Limited Xeriscaping -or- Full coverage of efficiently-watered bluegrass	6,227	9,340	12,454	15,567	23,351	31,134
Moderate Xeriscaping	14,010	21,015	28,020	35,025	52,538	70,050
Substantial/full Xeriscaping	24,906	37,360	49,813	62,266	93,399	124,532

The authors derive the above outdoor savings potential volumes by assuming a baseline of 100 percent bluegrass landscaping for all residents. However, with the participation percentage breakdown, we can establish potential water savings scenarios by noting the differences between alternative landscape types and participation levels.

Next, to generate basin-wide and Front-Range-wide potential outdoor savings, the above SFR outdoor savings rates need to be multiplied by the forecasted SFR population for these geographic areas. Estimates for SFR population forecasts can be derived by multiplying the total 2030 population forecasts by a SFR population: total population ratio from 2000 U.S. Census data. Although future ratios may fluctuate from the 2000 ratio, this estimate should provide a reliable representation of the 2030 SFR population.

South Platte River Basin

- 2030 population forecast: 4,627,624
- 2000 ratio of SFR population to total population: 69.3% (weighted)
- Estimated 2030 SFR population: 3,206,943

Arkansas River Basin

- 2030 population forecast: 1,028,032
- 2000 ratio of SFR population to total population: 73.6%
- Estimated 2030 SFR population: 756,632

Total Front Range

- 2030 population forecast: 5,655,656
- Estimated 2030 SFR population: 3,963,575

Finally, to arrive at outdoor conservation savings potential amounts for both the South Platte River Basin and the Arkansas River Basin, we multiplied the above 2030 SFR population estimates by the per 1,000,000 SFR residents savings estimates shown in the above tables. The following table lists the resulting SFR outdoor savings potential volumes:

Single-Family Residential Outdoor Savings Potential

Existing and Future Residents by 2030

Measured in acre-feet per year

	Customer Participation Scenarios (percentage participating)					
	20%	30%	40%	50%	75%	100%
South Platte River Basin						
Limited Xeriscaping -or- Full coverage of efficiently-watered bluegrass	19,969	29,953	39,938	49,922	74,885	99,845
Moderate Xeriscaping	44,929	67,394	89,859	112,323	168,486	224,646
Substantial/full Xeriscaping	79,873	119,810	159,747	199,684	299,525	399,367
Arkansas River Basin						
Limited Xeriscaping -or- Full coverage of efficiently-watered bluegrass	4,711	7,067	9,423	11,778	17,668	23,557
Moderate Xeriscaping	10,600	15,901	21,201	26,501	39,752	53,002
Substantial/full Xeriscaping	18,845	28,267	37,690	47,112	70,669	94,225
Total Front Range						
Limited Xeriscaping -or- Full coverage of efficiently-watered bluegrass	24,680	37,020	49,361	61,700	92,553	123,402
Moderate Xeriscaping	55,529	83,295	111,060	138,824	208,238	277,648
Substantial/full Xeriscaping	98,718	148,077	197,437	246,796	370,194	493,592

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