6.3 WATER CONSERVATION AND REUSE

GOAL

Colorado's Water Plan promotes technical and financial assistance throughout Colorado, enabling the State to plan and implement long-term water efficiency strategies that meet local and statewide water needs, and to achieve the following statewide long-term goals:

- Reduce overall future water needs through cost-effective water efficiency measures;
- Integrate water efficiency planning and projects into overall water resource management;
- Promote water efficiency ethic throughout Colorado;
- Explore additional water reuse options;
- Further integrate land use and water planning;
- Seek creative options for improving agricultural irrigation conservation and efficiency

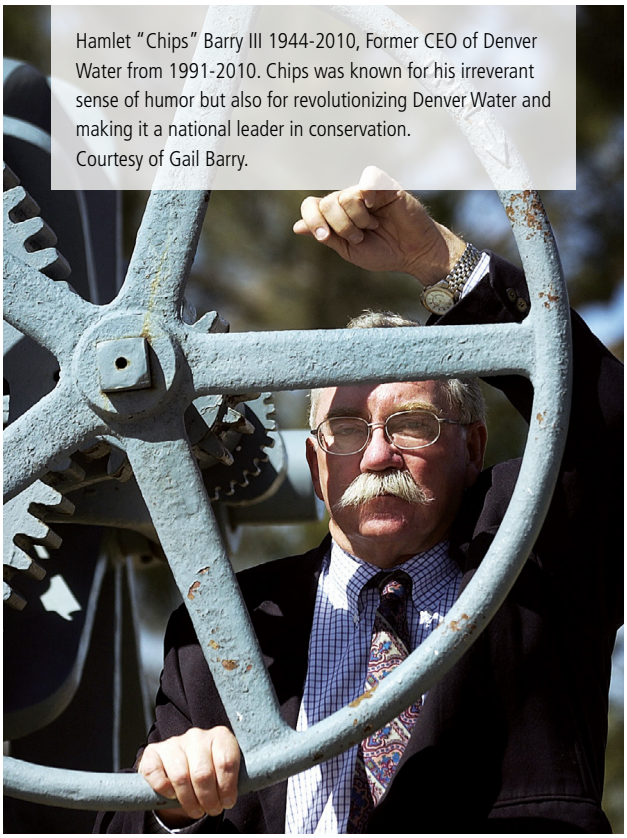
Introduction

Water conservation activities and water reuse will play an important role in balancing the need for additional water supply with strategies to lessen that need. By implementing a comprehensive, statewide approach for water conservation and water-reuse activities, CWCB and other state agencies will strengthen programs from the local to the state level. Much like TMDs, agricultural water transfers, and storage, conservation and reuse are not "silver-bullets;" however, they are critical components of strategies to address future needs. The creation of scalable technical resources, support of local initiatives through financial incentives, and best-practices sharing will bolster conservation and reuse.

This section examines water conservation, reuse, land use, agricultural water conservation, self-supplied industrial (SSI) conservation, and state agency conservation. These water management strategies will help Colorado close the water supply gap while minimizing trade-offs that other solutions might create. Increased conservation, reuse, and better integration of land use and water planning will help maintain a healthy environment, promote livable and sustainable cities, and preserve agricultural production into the future.

Faucet aerators help reduce water consumption. Because the aerator limits the water flow through the faucet, water use is reduced as compared to the same time of flow without an aerator.

6.3.1 MUNICIPAL WATER CONSERVATION



Hamlet "Chips" Barry III 1944-2010, Former CEO of Denver Water from 1991-2010. Chips was known for his irreverant sense of humor but also for revolutionizing Denver Water and making it a national leader in conservation.
Courtesy of Gail Barry.

Governor John Hickenlooper stated that, "Every conversation about water should start with conservation."[136] Municipalities, special water districts, and other water providers have progressed in water conservation over the last decade, as Chapter 5 explains. Building on those efforts, future actions will define the direction Colorado takes to close the supply-and-demand gap.

Benefits of Water Conservation

Water savings resulting from water efficiency activities can reduce water demands and thereby assist providers in avoiding, downsizing, or postponing the construction and operation of water supply facilities and wastewater facilities—as well as eliminating, reducing, or postponing water purchases. In addition to these water supply benefits, Colorado can achieve other societal, political, and environmental benefits, including:[137]

- Reduced wastewater discharges through indoor water savings, which can improve water quality and aquatic habitat.
- Demonstration of a commitment to sustainability.
- The meeting of political and regulatory requirements necessary to obtain permitting for local and regional water supply projects.
- Delay of capital costs for new projects.

Conservation also acts as a management tool to buffer against drought using long-term conservation strategies, and to address shortages by implementing short-term conservation strategies. Water providers can store as a drought reserve the amount of water they realize through long-term water conservation efforts, and use that reserve during periods of shortages. In those cases, more storage may be required to maintain a drought reserve.[138] As with many water management decisions, there may be some disadvantages to water conservation. Some water providers, specifically in the South Platte Basin, are concerned that "indoor conservation measures can reduce the amount of available water for agriculture and environmental and recreational purposes by diminishing return flows the basin relies on."[139] Water conservation programming takes time to implement and water savings can take time to accrue. Long-term water conservation should be viewed as a long-term investment.

The State is wise to invest funds for implementing water conservation activities statewide. These are some of the most inexpensive implementation strategies today, and will allow local water providers to be more efficient with the water resources they already have.

Water Conservation in Colorado

In the past decade, water providers and their customers have done a remarkable job reducing per-capita water needs. Statewide, their efforts amount to just under 20 percent, but some municipalities have reduced their per-capita water use by as much as 30 percent.[140] Most of the largest water providers in Colorado have CWCB-approved water conservation plans, and these approved plans account for most of the M&I statewide demand. According to C.R.S. 37-60-126, covered entities, defined as those entities that deliver more than 2,000 acre-feet of water annually, are required to have a CWCB approved water conservation plan.

Many water providers adopted best practices, including landscape efficiencies, water loss management, and inclining block-rate structures. For example, in the CWCB-approved water conservation plans on file, approximately 85 percent of Front Range and eastern slope water providers, and 77 percent of western slope water providers, have tiered rate structures that increasingly cost customers more if they use more than a base amount of water. These tiered rate structures are called "inclining block-rate structures."[141]

A successful conservation strategy must build on past accomplishments and model in-place examples at the local level across the state. The examples below highlight some of the best efforts to date:

- **Aurora Water:** Aurora Water has implemented landscape and irrigation standards as well as tiered rate structures. Aurora Water also created a customer information system using GIS, an Excel-based water use calculator, and state-of-the-art communication tools to efficiently focus incentives for specific customers and to collaborate with customers more closely. Additionally, Aurora Water has been implementing a successful turf buy-back and landscape-design assistance program since 2007.
- **Douglas County:** All covered entities in Douglas County have CWCB-approved water conservation plans, and the majority of the smaller providers manage water conservation activities under a regional water conservation plan. Of the covered entities, all are implementing water conservation best practices. Specifically, the Town of Castle Rock is a leader in water conservation and is implementing best practices, such as landscape/irrigation ordinances; landscaper certification requirements; landscape incentives, including a turf buy-back program; water budgets based on irrigated landscape area; smart-metering with a customer feedback loop; new construction requirements in relation to water conservation; and customer education.
- **Denver Water:** Over the last eight years, Denver Water has made significant progress through its "Use Only What You Need" campaign. Now Denver Water is customizing water budgets based on irrigated area for its largest commercial customers. Water budgets allow both Denver Water and its customers to know exactly "what they need." As a result of this new program, schools, park districts, and multifamily community associations have already found significant leaks and irrigation-clock malfunctions, and have identified large areas for future conversion to landscaping other than turf.
- **Greeley, Boulder, Highlands Ranch, and Castle Rock:** All of these municipalities adopted water budget rate structures tied to actual water use on a site. Water budgets are rate structures derived from indoor use and from allocated amounts of water per square foot, based on plant requirements and local climate data. Because rates climb steeply if a customer uses more than his or her water budget, these communities use water budgets to manage their summer peak demands while maintaining healthy landscapes.
- **Ute Water/Grand Junction/Clifton:** Starting in 2002, the Grand Valley water providers came together to create a drought response plan called Drought Response Information Project or DRIP. The plan was a success, and is still active. Modeling this effort, the providers came together again to create a regional water conservation plan. Because their systems are interconnected and generally receive the same media, this effort was practical.

- **More Regional Plans:** Statute does not require many communities and water providers to have a CWCB-approved conservation plan due to their small size. These small water providers can, however, come together and create savings that equate to more than the sum of their parts.
  - In the lower Arkansas Valley, 38 small water came together under guidance from Southeastern Colorado Water Conservancy District to create a regional water conservation plan. This plan serves as a roadmap for conservation planning and implementation over the next 50 years. The main impetus of the plan is to ensure that all the water systems are more efficient before connecting to the Arkansas Valley Conduit, thus stretching the new supply further.
  - Steamboat Springs completed a community conservation plan that brought together three water providers under a single community plan in 2010.
  - Five communities in the Roaring Fork Watershed (Aspen, Snowmass Village, Basalt, Carbondale, and Glenwood Springs) have created a regional conservation plan that ties directly into the Roaring Fork Watershed Plan.
- **Other Projects:** Sterling Ranch Rainwater Harvesting Pilot Project
  - In July 2010, CWCB and DWR approved the Sterling Ranch Precipitation Harvesting Pilot Study. The study is currently in its fifth year and is the only pilot project of its kind in Colorado. The legislation that authorized the pilot project study allowed for up to three pilot projects in each river basin, and up to 10 pilot projects across the state.[142] Sterling Ranch is located in Douglas County within the South Platte Basin. Douglas County granted approval to the 3400-acre planned development on July 10, 2013. Sterling Ranch is incorporating precipitation harvesting systems into the first phase of development, which will occur within the next few years. The Sterling Ranch Water Conservation Plan is key to meeting the site's water conservation goals with a substantial, planned reduction in water demands. Preliminary estimates indicate that precipitation harvesting, on average, can supply as much as one-third of the irrigation demand for a typical Sterling Ranch water-wise home, further reducing Sterling Ranch's reliance on non-renewable water supplies.[143]

Social Norming/Behavioral Water Efficiency

Much of water conservation is based—and reliant—on human behavior. It requires constant communication and education to make water conservation a standard community practice (also known as social norming), and to directly influence behavior to achieve water conservation results. At the local water provider level, computer and smart-metering technology have improved greatly in recent years and allow for a direct link between provider and customer. Through this direct link, a water provider can communicate educational messaging about such topics as water consumption targets, water restrictions, and leak detection.

The field of social norming or behavioral water efficiency is becoming standard operating procedure for many water providers in Colorado. Fort Collins, Denver Water, Greeley Water, and City of Brighton are all using technology to provide water consumption goals, current usage statistics, and comparisons between neighbors to elicit more water-efficient behavior change.

The City of Fort Collins and the City of Brighton send water customers a personalized *Home Water Report* that illustrates the customer's consumption and how it compares to neighbors' consumption. The report also suggests customized actions to reduce water use. Equipped with this education, residential customers may change behaviors and can save 5 percent on their water consumption.[144] With Advanced Metering Infrastructure (AMI), feedback can be delivered daily, and even hourly if needed.

These communication links are not limited to water efficiency messaging, and illustrate the changing relationship between water provider and water customer. Continued financial support, technology research, and educational programming are needed for these types of customer relationship and education opportunities, and will be important to Colorado's path toward more efficient water usage and a more water-literate water customer base in the future.

Recent Legislation

Partly in response to the work of the basin roundtables and the IBCC, some recent legislative developments in water conservation have occurred.

In 2014, the Governor Hickenlooper signed legislation that sought to identify and quantify the types of best practices that could enhance municipal outdoor water conservation, and to determine whether further legislation would be needed to facilitate the implementation of those practices. The bill directly refers to the work of the basin roundtables and the IBCC, stating, "As part of the CWCB's statewide water supply initiative and the IBCC and basin roundtable process, a "No/Low Regrets Action Plan" has been developed, an important element of which is to establish and implement conservation strategies to extend the ability of existing water supplies to meet increasing needs and thereby minimize agricultural dry-up."[145]

In 2014, the "fixtures" bill became law.[146] The law phases out less-efficient water-using fixtures, and requires that only WaterSense-specified fixtures may be sold in Colorado. These fixtures carry the EPA WaterSense label, are third-party certified, and are 20 percent more efficient than existing fixtures. Future technology advances could make fixtures even more efficient. In addition, these fixtures do not cost more than their less-efficient counterparts. The bill's proponents estimate that long-term replacement of indoor fixtures will garner approximately 40,000 acre-feet of savings annually by 2050, and will increase the replacement rate of existing fixtures.[147] The bill is consistent with the IBCC's 2010 suggestion to require high-efficiency fixtures.

In 2015, Colorado enacted a law that provides incentives to encourage more participation in the precipitation harvesting pilot program.[148] Incentives include a less burdensome substitute water supply planning process. When calculating required stream replacements to account for captured precipitation, the project proponent would not have to replace the amount of precipitation that would have otherwise been consumed through natural vegetative cover's historical depletion. The proponent may rely on CWCB-established regional factors that specify the amount of precipitation consumed through evapotranspiration of preexisting, natural vegetative cover.

Past Legislation

In 2010, new legislation required most water providers to submit water use and conservation data to the CWCB.[149] This allows water providers to quantify and track water conservation activities and water demand. Implementation of this bill began in 2014 and will provide valuable data to the water plan.

In 2010, additional legislation required the builder of a new, single-family detached residence, for which a buyer is under contract, to offer the buyer a selection of water-saving options, including:

- Toilets, lavatory faucets, and showerheads that are water efficient.
- Dishwashers and clothes washers that meet federal EPA ENERGY STAR program standards if they are financed, installed, or sold as upgrades through the home builder.

The simple things in life, such as a refreshing drink of clean tap water on a warm summer day, cannot be taken for granted.

- Landscape design that follows the green industry's best management practices if landscaping is financed, installed, or sold as upgrades through the home builder and maintained by the homeowner.
- Pressure-reducing valve that limits water pressure to 60 pounds per square inch.[150]

In 2009, the Colorado General Assembly authorized a pilot program that allows for the collection of precipitation from rooftops for non-potable uses. The program can include up to 10 new residential or mixed-use developments. At present, the Sterling Ranch development in Douglas County is the first and only pilot to start, and is at the beginning of its first construction phase.[151]

In 2005, the governor signed legislation that protected water rights owners against abandonment of their water rights if they met certain conditions. Two conditions refer to "a water conservation program approved by a state agency and a water banking program as provided by law." While these conditions do not allow for water sharing, the bill does protect a water rights holder from losing his right if non-use results from water conservation activities.[152]

In 2005, the governor signed legislation that protected homeowners' property rights with regard to installation of xeriscape landscaping. This legislation amended the law that regulated homeowner associations by including a provision that invalidates any new or existing covenant or condition that prohibits or discourages a unit owner from employing xeriscape, or that requires landscaping to consist exclusively or primarily of turf grass.[153]

IBCC Conservation Actions and Goals

In 2010, the IBCC Water Conservation Subcommittee developed a list of water conservation strategies that the IBCC letter to governors included.[154] Among the recommendations were many short-term and longer-term conservation actions, ranging from statewide education campaigns to legislation that addressed indoor and outdoor water use.

In 2013, the IBCC developed the No-and-Low-Regrets Action Plan for water conservation. This strategy outlines the minimum level of water conservation implementation statewide. The IBCC reached consensus on the need to reach low-to-medium levels of water conservation, regardless of the future scenario, and the near-term potential future actions required to achieve that (Table 6.3.1-1).[155]

Three stakeholder processes identified as a goal the minimum amount of water saved through water providers' active conservation efforts. The basin roundtables underwent a process to develop portfolios of water solutions to meet future water needs. The IBCC examined these as part of its No-and-Low-Regrets Action Plan, and determined that it needed low-to-medium conservation levels to address the water supply gap, as the SWSI 2010 defined. The scenario planning process determined that water providers will need to achieve all of low-conservation or half of medium conservation SWSI active conservation levels, or nearly 170,000 acre-feet. Recently, the IBCC achieved consensus onan aspirational goal, known as the "stretch goal." This goal goes beyond the No-and-Low-Regrets actions, and is incorporated into the measurable objectives of Colorado's Water Plan. The goal aims to reduce Colorado's projected 2050 municipal water demands by 400,000 acre-feet through active conservation, while preserving the contribution of urban landscape to vibrancy and sustainability and local flexibility. The language approved by the IBCC is below:

Reduce Colorado's 2050 municipal water demands by 400,000 acre-feet statewide.

- ***Benefits:*** *A stretch goal is in the state's best interest as part of a responsible and sustainable water plan.*
- ***Achieving the Stretch Goal:*** *High levels of customer participation will result from new regulatory mandates, technology innovations, incentives, and changing customer behaviors to reduce Colorado's 2050 water demands by 400,000 acre-feet statewide. This level of conservation includes an additional 60,000 acre-feet of demand reduction beyond the no-and low regrets recommendations. Based on current conservation plans statewide, the committee believes this is achievable.*

- ***Implementation:***
  - ***Accountability:*** *For the goal to be successful, water providers will be encouraged to do comprehensive, integrated water resource planning, geared toward implementing the best practices at the high customer participation levels, as defined in SWSI. This planning will be one of the components that shall be considered to achieve state support for projects, and financial assistance. This planning allows for flexibility by the local water provider to do what is technically, economically, and legally practical for their system as not every conservation practice is appropriate for every community.*
  - ***Best Practice Based:*** *The goal can only be achieved by encouraging the implementation of best management practices at high customer participation levels as defined in SWSI. The best management practices will continue to adapt and evolve over time, incorporating innovative technologies, providing opportunities for contribution to these demand reductions.*
  - ***Maintain Local Control:*** *The goal recognizes the importance of local control and flexibility, while encouraging high levels of conservation and adoption of innovative practices across the state.*
  - ***Monitoring:*** *Tracking demand reductions as part of future SWSI updates will be necessary.*
  - ***Adaptive Management:*** *The goal may need to be adapted based on future demand and other factors and incorporated into the portfolios and scenarios over time.*

BIPs

For 2014, each basin roundtable formulated its own implementation plan. These plans included water conservation goals and activities, in addition to already-planned projects and methods, use of Colorado River water, and alternatives to agricultural water transfers.

TABLE 6.3.1-1 INTERBASIN COMPACT COMMITTEE POTENTIAL FUTURE ACTIONS SUMMARY

1. Improve Tracking and Quantification of Conservation

2. Establish a Statewide Conservation Goal with Intermittent Benchmarks
a. Develop general political support for a statewide conservation goal.
b. Develop statewide agreement tying conservation to new supply development and agricultural transfers.
c. Support local entities in their efforts to outline and report their own approaches to help achieve the statewide goal.
d. Explore best approach to implementation of standards to achieve goal.
e. Develop and implement conservation standards.

3. Continue to Support Local Implementation of Best Practices
a. Continue implementation of state conservation programs.
b. Encourage use of levels framework and best practices guidebook.

4. Promote Enabling Conditions for Use of Conserved Water
a. Maintain and develop storage and infrastructure for the use of conserved water.
b. Promote incentives for the use of conserved water.
c. Identify and, where possible, resolve legal and administrative barriers to the use of conserved water.
d. Identify and explore barriers to sharing conserved water.

5. Develop New Incentives for Conservation
a. Explore funding options in support of the Water Efficiency Grant Program.
b. Develop professional education and certification programs.
c. Develop new eligibility requirements for state grants and loans that include certain conservation levels or indications of commitment to conservation.
d. Develop conservation standards for communities planning to use agricultural transfers or new supplies for future water needs.
e. Develop incentives that incorporate the following concepts: Encourage a base level of conservation; assess issues, benefits, and drawbacks of the current definition of "covered entities;" conservation water markets; small community support; permitting incentives.

6. Explore Legislative Concepts and Develop Support
a. Explore legislative options and support for indoor plumbing-code standards.
b. Explore legislative options and support for outdoor water efficiency standards.
c. Engage in outreach and education efforts to explain the need for legislation; develop political support.

7. Implement Education and Outreach Efforts
a. Track public attitudes through baseline and ongoing surveys.
b. Develop statewide messaging and use focus groups to refine and guide implementation.
c. Develop decision-maker outreach strategies.
d. Pursue a coordinated media campaign.

Arkansas Basin

The Arkansas Basin addressed conservation by stating, "Stakeholders should take all actions required to maintain current water supplies and prevent future water supply gaps from increasing." The Arkansas Basin stated four goals for meeting municipal water needs:

- Meet the municipal supply gap in each county within the basin.
- Support regional infrastructure development for cost-effective solutions to local water supply gaps.
- Reduce or eliminate Denver Basin groundwater dependence for municipal users.
- Develop collaborative solutions between municipal and agricultural users of water, particularly in drought conditions.

To illustrate progress to date, the Arkansas Basin highlighted many of the current water efficiency activities, such as the innovative, regional water efficiency planning efforts of the Southeastern Colorado Water Conservancy District (SECWCD), and the Best Management Practices Toolkit for providers. The regional efficiency planning efforts brought 47 mostly small water providers under one efficiency plan, while using the toolkit to create individual plans for each provider. The toolkit identifies five components as essential areas of water efficiency: Water production and treatment, water distribution, water delivery to customers, customer demand management, and overall water system management. As part of this regional effort, SECWCD will implement triennial system-wide water audits of all participants, and will report annual data to SECWCD.

As a solution for preventing the future increase of water supply gaps while attaining the basin's goals and aligning with the ongoing regional efficiency plan implementation, the basin listed several projects and recommendations related to water conservation. The projects focus on water loss metering and audits. The CWCB identified these as foundational water efficiency activities that every water utility should implement. Activities include master-meter improvements to aid in reliably measuring water flow, and properly accounting for water loss using the internationally accepted American Water Works Association M36 Water Loss Methodology. The BIP related all water efficiency activities that water providers are currently implementing in the Arkansas Basin, such as water loss management, re-evaluation of water rates, landscape water efficiency, adoption of advanced metering infrastructure, indoor fixture and appliance rebates, policies and regulations, and customer education.[156]

Colorado Basin

One of the Colorado Basin's themes is to "Encourage a high level of basin-wide conservation." Two goals specifically related M&I water conservation:

- Improve Colorado water law to encourage efficiency, conservation, and reuse.
- Pursue continued M&I conservation.

Measurable outcomes support these goals, and include revising Colorado water law to allow more flexibility in promoting stream health through conservation, and achieving and sustaining a high level of conservation by all basin water providers. The Colorado Basin identified projects and methods for the implementation of these goals. These include conducting a comparison of Colorado water law and procedures with those of other Western states in order to identify alternative practices and facilitate water transfers and various local water conservation efforts—both today and in the future. Additionally, the Colorado Basin created an extensive section that integrated water conservation with land-use policies. Section 6.3.3 describes this.[157]

Gunnison Basin

The Gunnison Basin BIP promotes high levels of water conservation. The BIP focused on identifying and addressing M&I shortages. As a way of fulfilling this goal the basin stated that it would "Promote the development of voluntary regional water conservation plans to help smaller entities (delivering less than an annual 2,000 acre-feet) achieve water savings and related reductions in expenses related to treatment, distribution, and infrastructure."[158]

To attain this goal, the plan listed two measurable outcomes for water conservation:

- Reliably meet 100 percent of essential municipa water provider system demands in the basin through the year 2050 and beyond.
- Continue the current baseline of covered entities' effective water conservation programs, with a goal to achieve high levels of conservation savings as the SWSI 2010 defined.

The Gunnison Basin also identified statewide principle connecting water efficiency, conservation, and demand management. The most salient of these is Principle 5:

> "Water conservation, demand management, and land-use planning that incorporates water supply should be equitably employed statewide."

The Gunnison Basin Roundtable believes that the best way to promote statewide water conservation—and thereby attain this principle—is by using incentives, not regulatory methods, and by focusing demand-management efforts on covered entities. Additionally, local land-use policies and regulations should discourage sprawl, link water supplies to development, and provide incentives for higher-density developments. Two implementation concepts focus on working with other roundtables to attain this principle, and to promote programs that encourage drought-tolerant vegetation and discourage lawn irrigation.[159]

The Gunnison Basin describes its water conservation planning process for the Upper Gunnison Basin as a means of reaching these measurable outcomes and the goal to address M&I shortages.[160]

MARK MARLOWE

SOUTH PLATTE RIVER BASIN

Mark is the Utilities Director for the Town of Castle Rock, where among other efforts, he spearheads some of the most innovative conservation efforts in the state. Mark is pictured in front of Chatfield Reservoir.

My vision for Colorado's Water Plan is that it brings the citizens of the State together to work towards a secure supply of water for every Coloradan to enjoy a hot shower, a clean bathroom, a cool glass of crystal clear tap water (or a hot cup of Joe), and clean/safe natural water bodies for the pursuit of happiness just as Castle Rock's plan has brought our community together to continually work towards this goal. Castle Rock will continue to be a leader in implementing common sense solutions identified in the state plan as we have already been doing.

I currently serve as the Utilities Director for the Town of Castle Rock. I am responsible for the water, wastewater and stormwater utility…

CONTINUED AT END OF CHAPTER

PROFILE

North Platte Basin

The North Platte Basin focuses mainly on agricultural and environmental water issues, since the municipal need is low due to lack of population. The North Platte Basin Roundtable states that it "supports the extensive water conservation efforts of major Colorado water providers, and encourages further conservation as permitted by technology, economics, and legislation. The North Platte Basin Roundtable supports a wide variety of water conservation methods including municipal conservation programs, strategic growth and development, and landscape limitations. The North Platte Basin Roundtable believes that the best way to promote statewide water conservation is through incentive-based measures as opposed to regulatory methods."[161]

To maximize water savings and avoid an unnecessary burden on smaller, rural water providers, the North Platte Basin Roundtable supports a focus on covered-entity conservation efforts by:

- *Supporting the use of state funding to provide incentives for reaching municipal conservation and efficiency standards.*
- *Working with appropriate entities to ensure that statewide conservation strategies and any related legislation allow flexibility to meet the needs of local governments.*

A measurable outcome for the North Platte Basin Roundtable for this process would be to:

- *Comply with future statewide municipal conservation strategies and any related legislation by 2020 or as appropriate.*

Currently, the North Platte Basin has not identified any proposed projects to address this goal; however, the North Platte Basin Roundtable will remain involved in the IBCC's and the Colorado Water Plan's ongoing processes to support the equitable statewide application of municipal water conservation measures.[162]

Rio Grande Basin

Much like the North Platte Basin, the Rio Grande Basin Roundtable focuses on agricultural water and environmental needs. With that said, the Rio Grande Basin Roundtable does have a goal "to meet new demands for water, to the extent practicable, without affecting existing water rights and compact obligations."[163]

The Rio Grande Basin Roundtable has several measurable outcomes for M&I water conservation:

- *Minimize per capita per day use to a reasonable level.*
- *Inventory existing and expected future M&I and environmental and recreational water needs.*
- *Develop an M&I plan that addresses water needs, availability, and a strategy for meeting the needs for M&I while sustaining agricultural water use and minimizing impacts to other uses.*[164]

South Platte/Metro Basin

The South Platte/Metro Basin has an overarching theme of continuing "its leadership role in efficient use and management of water."[165] It has also identified the following goals and measurable outcomes:

- *Goal: Continue the South Platte River Basin's leadership in wise water use.*
- *MO#1: Further quantify the successes of programs implemented in the past several years throughout the South Platte River Basin and establish a general baseline against which the success of future programs will be assessed.*
- *MO#2: Distribute and encourage adoption of "best management practices" as "guidelines" (not standards) for M&I water suppliers to consider in their "provider-controlled" programs recognizing the substantial differences in climates, cultures and economic conditions throughout the South Platte River Basin.*

It also identified as a nonconsumptive goal:

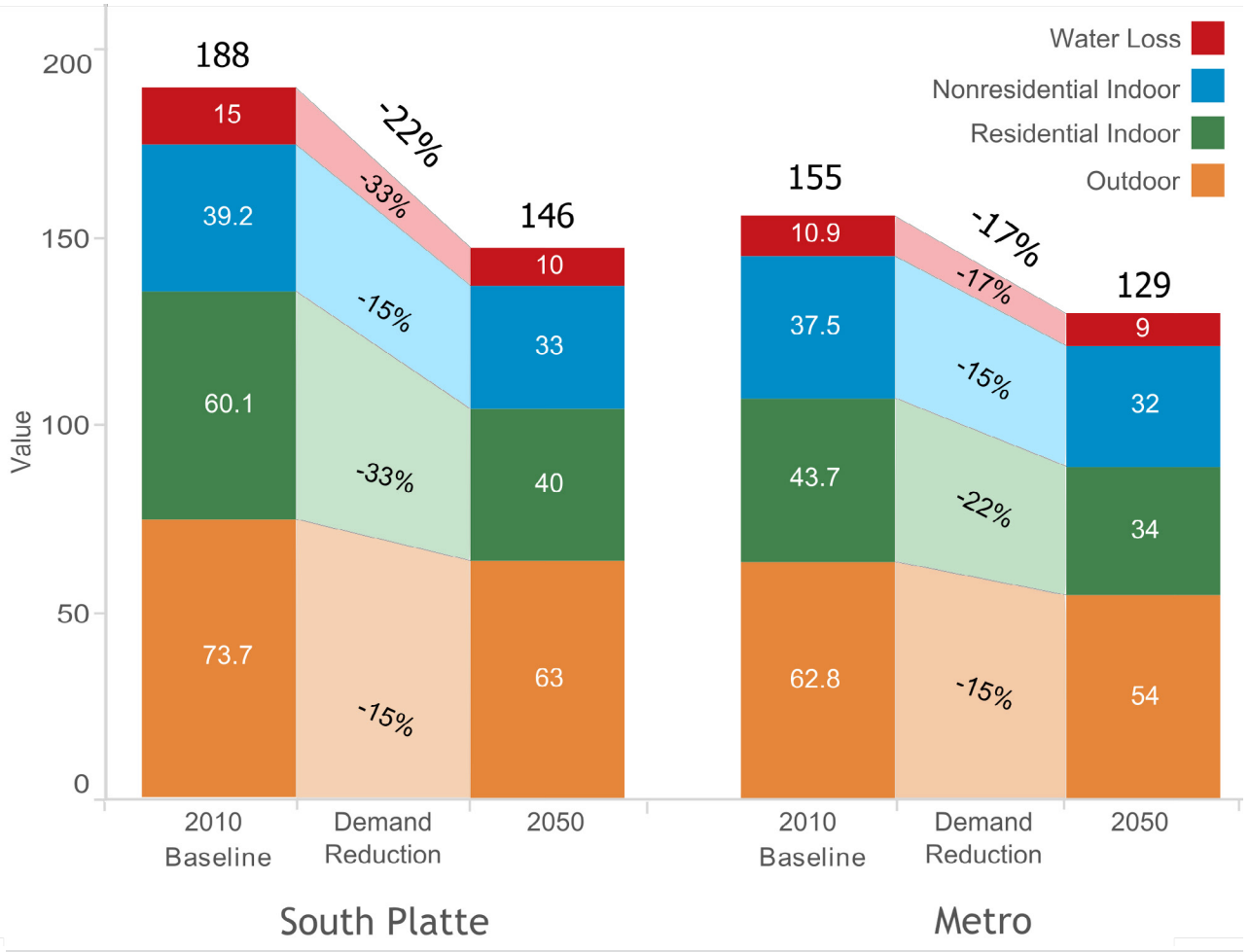
- *NC MO#1: Ensure conservation, reuse and drought management plans take into consider-ation environmental and recreational focus areas and attributes.*

The Metro and South Platte Basin focused on achievable demand reductions based on current trends in water conservation best practices—barring future regulation and major land-use changes. The Metro Basin Roundtable recommends pursuing conservation programs that would reduce per-capita water use from a baseline of 155 gallons per-capita per-day (gpcd) in 2010, to 129 gpcd by 2050. The South Platte Basin Roundtable recommends conservation programs that would reduce per-capita water use from a baseline of 188 in 2010, to 146 gpcd by 2050 (Figure 6.3.1-1). The South Platte Basin Roundtable believes that these goals are aggressive based on the present-day state of conservation best practices and the possible societal changes required to exceed these levels.[166]

The South Platte/Metro Basin shared examples of future work that will help achieve conservation savings. It suggested that "further standardization of the term "per-capita water use" and improvement in the understanding of the factors affecting water consumption rates can help the basin and State better understand the ways that conservation programs and reductions in per-capita water consumption can help meet supply gaps."[167]

Additionally, the South Platte/Metro Basin stated that certain regulatory, rate structure-driven, educational, and incentive-based approaches will assist in achieving conservation goals. "Providers encourage conservation through water rate designs, education, watering schedules, and rebate programs as well as water waste rules. Finding effective methods to strengthen code requirements and enact stronger land-use regulations will be an important factor in building efficiencies through conservation."[168]

FIGURE 6.3.1-1 SOUTH PLATTE AND METRO BASIN CONSERVATION GOALS



Landscaping features that use less water can help to reduce overall demand, and be pleasing to the eye at the same time.

The South Platte/Metro Basin finished with thoughts about ways more water efficiency could occur:

- *Greater savings in outdoor water use would require major changes in landscaping that moves beyond just efficiency measures; this would involve lifestyle considerations about our urban environments. These decisions must be made and implemented at the broader community level, as well as at the water-planner level.*
- *Higher levels of indoor conservation will require broad political and public support.*
- *Land-use planning has the potential to promote densification, growth management, and comprehensive plans to include considerations for impact fees and firm yield.*

The Metro and South Platte Basin Roundtables support ongoing statewide education to address these factors.[169]

Southwest Basin

The Southwest Basin has a "goal of promoting and incentivizing wise and efficient water use through implementation of municipal conservation strategies to reduce overall future water needs."[170] The Southwest Basin supports high conservation levels statewide.

The Southwest Basin stated the following measurable outcomes in its BIP. These outcomes work toward the goal of promoting wise and efficient water use through the implementation of municipal conservation strategies to reduce overall future water needs:

- *Consistently meet 100 percent of residential, commercial, and industrial water system demands identified in SWSI 2010 in each sub-basin, while also encouraging education and conservation to reduce demand.*
- *Change the ratio of in-house to outside treated water use for municipal and domestic water systems (referred to as water providers herein) from the current ratio of 50 percent in-house use and 50 percent outside use, to 60 percent in-house use and 40 percent outside use (60/40 ratio) for southwest Colorado and the entire State by 2030.*
- *The water providers in the state that are using dry up of agricultural land (defined as requiring a water court change case) and/or pursuing a new TMD (as defined by IBCC to be a new western slope to eastern slope diversion project) shall have a higher standard of conservation. The goal for these water providers is a 70/30 ratio by 2030. This is a prerequisite for the roundtable to consider support of a new TMD.*

The Southwest Basin did not develop specific IPPs for all possible management and conservation opportunities; however, overall strategies include:

- *Continue to reduce the amount of water needed for municipal, domestic, and industrial purposes through conservation efforts to meet the goal and measureable outcome herein.*

The Southwest Basin's process identified two project concepts, including: *"1) to work with public water suppliers, including municipalities, to assess their current indoor and outdoor water use ratio and to incentivize the attainment of the 60/40 ratio and; 2) the development of irrigation efficiency program."* No entity is actively pursuing these ideas for projects or processes in the basin yet.[171]

Another area in which the Southwest Basin proposes water conservation action is in the basin's public education and outreach plan. Short term goals "encourage education and conservation to reduce demand, implement information events on water conservation, land-use planning and reuse, and promote wise and efficient use through implementation of municipal conservation strategies to reduce overall future water needs".[172]

Yampa/White/Green Basin

The state demographer projects the Yampa/White/Green Basin population to nearly triple by the year 2050, and expects M&I water usage to nearly double, even with savings from passive conservation. The basin roundtable has identified such strategies as adequate storage, strong municipal conservation measures, and drought plans to address the situation. The Yampa/White/Green Basin identified M&I water conservation as one way to help meet future basin demands. Processes and measurable outcomes include:

- *Identifying specific locations in the basin where M&I shortages may exist in drought scenarios, quantifying the shortages in time, frequency, and duration.*
- *Identifying impacts throughout the basin in the context of water shortages (drought and climate change), wildfire, and compact shortage on M&I demands.*
- *Encourage municipal entities to meet some future municipal water needs through water conservation and efficiency.*[173]

Measurable Outcomes

- *Reliably meet 100 percent of M&I demands in the basin through the year 2050 and beyond.*

The Yampa/White/Green Basin Roundtable identified and quantified one water conservation project in the Yampa/White/Green Basin. The project goal is to reduce projected use by 720 acre-feet by 2035 in Steamboat Springs by reducing per-capita demand by 15 percent in the Steamboat Springs municipal water system. The aim is to achieve this through passive conservation and active conservation, including leak detection programs, fixture rebate programs, and a reduction in landscape irrigation needs.

ACTIONS

The actions below are based on the IBCC's No-and-Low-Regrets Action Plan, the work of the Water Conservation Technical Advisory Group, the basin roundtables, and utility water conservation plans.

1. **Adopt conservation incentives:** Over the next two years, the CWCB will adopt policies stating that water providers must conduct comprehensive, integrated water-resource planning geared toward implementing water conservation best practices at high customer participation levels, as defined in SWSI, as one of the components that shall be considered to achieve State support and financial assistance for water management projects.
2. **Support water management activities for all water providers:** The CWCB will continue to provide funding, technical support, and training workshops to assist water providers in improving the management of their water systems. This will include the use of techniques such as water budgets, smart-metering, comprehensive water loss management programs, savings tracking and estimating tools, and improved data collection on customer water uses. For example, in the next year, the CWCB will fund several regional training workshops about using the American Water Works Association M36 Methodology for Water Audits and Loss Control.
3. **Recommend WaterSense specifications for outdoor irrigation technology:** Through a stakeholder process, the DNR will work with the General Assembly to consider adopting WaterSense specifications for outdoor technology at the retail level. These specifications would create a minimum standard that water providers can easily adapt to accommodate higher-efficiency technologies as they are created and certified.

4. **Explore incentives for outdoor water conservation measures:** As part of a broader funding strategy the CWCB is developing over the next year, the CWCB will work with stakeholders to explore a tax-credit program. The program would incentivize water providers to retrofit higher water-use landscapes with lower water-use landscapes that preserve the environmental and economic benefits of urban landscape and encourage more efficient irrigation systems.

5. **Adopt a stretch goal:** The CWCB supports water providers in their plans to reduce projected 2050 demands by 400,000 acre-feet through active conservation savings. Based on stakeholder work, the CWCB will adopt a "stretch goal" to encourage demand-side innovation that places Colorado at the conservation forefront in a thoughtful way—while recognizing and addressing the effects of conservation. The CWCB will support a stakeholder process that examines various options, including options for local providers to establish targets that are consistent with the IBCC's identified stretch goal. At the same time, CWCB will give appropriate credit to water providers for recent strides they have made in demand reduction.

6. **Water conservation education and outreach:** The CWCB will develop an education and outreach strategy that includes water conservation topics. Section 9.5 offers more detail regarding specific education and outreach recommendations. Section 9.5 outlines education and outreach recommendations that will tie together other actions the section illustrates, and provide the reason for executing these actions. Each BIP will emphasize these efforts, which the roundtable will implement in order to address basin-specific issues. This work will include surveys of public attitudes, and partnerships with water providers and other water educators.

7. **Support local water smart ordinances:** Over the next two years, the CWCB will provide trainings that support local regulatory efforts that shape the ways in which new construction interacts with water use. For example, local jurisdictions could craft landscape and irrigation ordinances, tap fees that reflect actual water uses, education or certification for landscape professionals, green-infrastructure ordinances, and more stringent green-construction codes that include higher-efficiency fixtures and appliances and water-wise landscapes. It is imperative that this action explore the societal and environment benefits of urban landscapes. Section 6.3.3 further explores this action.

8. **Evaluation of barriers to green-building and infrastructure.** CWCB and CDPHE will work together to determine which state agencies govern green infrastructure and green-building, identify barriers, and work with the appropriate agencies to adapt regulations to allow for graywater, green infrastructure, on-site water recycling and other aspects of green developments.

9. **Strengthen partnerships:** The CWCB will create or renew partnerships between the CWCB and the following groups to reach water conservation goals:

    a. Local water providers and local governments to implement water conservation programs to benefit their water systems.

    b. Intra-state government (DOLA, DWR, Department of Regulatory Agencies (DORA), and state facilities) to coordinate and implement incentives.

    c. Green industry (GreenCO, Irrigation Association, Associated Landscape Contractors of Colorado, urban arborists, landscape-related businesses, property management companies) to implement efficient landscape installations and maintenance.

    d. Home building/construction (Home Builders Association, LEED, U.S. Green Building Council) to implement water-smart homes.

    e. Non-governmental organizations (Colorado WaterWise, Alliance for Water Efficiency, Western Resources Advocates, American Water Works Association, Water Research Foundation) to help educate Coloradans and advance conservation innovations and research.

    f. Academia (Colorado State University, CU-Boulder, CU-Denver, One World One Water Center-Metropolitan State) to bring a consortium of businesses, academia, and others together to examine behavioral science and research conservation innovations.

10. **Explore expanding conservation funding:** As Colorado water providers implement more sophisticated and integrated water conservation programs, the CWCB will require annual funding for the Water Efficiency Grant Program beyond the current $500,000 levels, and funding should consistently total $2,000,000 per year. In addition, the CWCB's loaning ability should expand to encompass conservation actions. The DNR will work with the General Assembly to institute these changes over the next two legislative cycles.

11. **Market for conserved, consumptive-use water:** To use conserved, consumptive-use water to the greatest extent possible, the CWCB will identify legal and administrative barriers to the use or sharing of conserved, consumptive-use water through a stakeholder process. If the CWCB can address barriers through acceptable legislative modification, the DNR will work with the Water Resources Review Committee to propose legislative action.

12. **Develop an alternative process for smaller entities to create water conservation plans and report water use data to the CWCB:** The CWCB will provide technical and financial support and will work to formalize the process into the CWCB Municipal Water Efficiency Guidance document.

13. **Continue implementation of state conservation programs:**

    a. The CWCB will continue to review and approve locally adopted water conservation plans to encourage long-term water conservation planning and water savings quantification, and to ensure that water providers document their water conservation goals.

    b. The CWCB will continue to use the Water Efficiency Grant Fund to ensure the implementation of water conservation best practices and to assist water providers in targeting their resources as efficiently as possible.

    c. The CWCB will focus on opportunities for water conservation planning where covered-entities or many small-water providers can create a regional water conservation plan. This will especially be the case when conservation in such communities could help reduce the M&I water supply gap, lessen the need for agricultural dry-up, or affect nonconsumptive values.

6.3.2 REUSE

As Chapter 5 mentioned, various sources of water can be reused to extinction. These sources include water from transbasin diversions, agricultural-municipal water transfers, and nontributary groundwater. Reuse water will affect future demands, and the following section describes future actions that will benefit Colorado. Many innovative reuse projects already exist, and Colorado can learn from several areas in the United States that are exploring future pathways in reuse technologies.

Nationally and internationally, research is focusing on potable reuse systems. In Colorado, most reuse systems have been non-potable in nature. Nonetheless, "de facto" potable reuse in Colorado occurs when one community discharges water to receiving-waters that downstream communities use for potable supply. Water quality standards in the receiving-waters, and Safe Drinking Water Act requirements for potable treatment, control this process (which also drives discharge permits from water reclamation facilities). Intentional, indirect potable reuse (IPR) projects are increasingly common: Aurora's Prairie Waters Project and the Town of Parker use water from their water reclamation facilities to supply Rueter-Hess Reservoir.

Denver Water pioneered direct potable reuse (DPR) through research and its potable-reuse demonstration project in the 1980s. While there continue to be public health and environmental concerns related to brine disposal, it is technically feasible to implement DPR today. However, the public does not fully accept DPR for reuse as drinking water and more research and education may help gain public acceptance.[174] In Colorado, no utilities have seriously pursued DPR.

Widespread development of potable reuse will be an important facet of closing the future water supply-demand gap. Over the last few years, the CWCB funded research into zero-liquid discharge (ZLD). The research focused on assessing the technology for addressing challenges associated with managing residuals from advanced treatment of alternative water supplies from lower-quality water sources. Most recently, the research team selected Brighton and La Junta as pilot sites for investigating the feasibility of technologies to minimize or eliminate brine disposal in a manner suitable for Colorado. The study found that the technology produced excellent water quality and had a very high recovery rate: 96 percent for the La Junta pilot site, and 90 percent for the Brighton site. Although the technology reduced concentrate and increased water recovery rates, the CWCB must conduct more research to understand ways to reduce costs, increase reliability of the technology, and create a more environmentally friendly technology before widespread adoption can occur in Colorado.[175]

The Water Quality Control Commission (WQCC) adopted Regulation 86 which establishes the allowed uses of graywater and prescribes minimum standards for the use of graywater. The bill defines graywater as wastewater collected within a building from sources other than toilets and urinals, kitchen sinks, dishwashers, and non-laundry utility sinks.[176] Once the Colorado Plumbing Board adopts suitable changes, counties and municipalities may adopt local legislation to allow graywater use, subject to water-rights restrictions. Graywater use is limited to subsurface irrigation and toilet-flushing. Once fully approved, graywater reuse should be an important component of

new construction.

In Colorado, reuse water that is used for non-potable uses, such as landscape irrigation, is subject to the requirements of Regulation 84. This regulation establishes standards to protect public health and the environment. Regulation 84 defines reuse water, also known as "reclaimed water," as "domestic wastewater that has received secondary treatment by a domestic wastewater treatment works and such additional treatment as to enable the wastewater to meet the standards for the approved uses."

As Chapter 5 briefly describes, Regulation 84 has adapted over the years to accommodate changes and advances in the science of reuse water. The WQCC promulgated Regulation 84 in 2000, and since then, has amended it four times in order to add new uses. As Colorado plans its reuse future, continued flexibility will be paramount to addressing water resource challenges. To many municipalities, reuse is critical in addressing identifies supply gaps in Colorado. Nonetheless, while reusing wastewater can help close the water supply gap, appropriate public health and environmental protections must remain in place. The CDPHE is committed to working with stakeholders to ensure that health and environment are protected while water reuse expands--but the CDPHE needs additional funding to support expanding safe and environmentally friendly water reuse. Without the ability to expand reuse, the gains that are forecasted to foster permanent growth in the reuse of limited water supplies may not be realistic.

While there is not a specific and defined regulatory pathway for DPR in Colorado, there are currently no regulations prohibiting or limiting a utility's pursuit of this option. At present, Colorado should work through and approve a proposed DPR project. Despite momentum toward more reuse planning and implementation in Colorado, barriers—such as public acceptance of DPR and costs of treatment for lower-quality water sources—are real issues the State must address. With that said, development of any new supplies will face implementation barriers as

The forebay at the Peter D. Binney Purification Facility, part of the Prairie Waters Project. The project is a key component of recycling water, serves Aurora, and will soon provide a renewable source of water to the South Metro Region. Courtesy of Havey Productions.

well. These include infrastructure capacities, losses, supply-and-demand timing, water quality, treatment costs and brine disposal, and regulatory requirements. In addition, the waste product resulting from reverse osmosis has very high salt levels and cannot be discharged into the stream; other disposal options for the waste product are limited. If a municipal provider has higher-quality source water to blend with lower-quality sources, this issue can be avoided. The State must address many, if not all, of these limitations in order to make many of the new water supplies available to meet future demands, whether through TMDs, agricultural transfers, or other methods. These limitations are not unique to reuse projects. In particular, brine disposal is a challenge in treating many lower-quality sources with reverse osmosis (RO), as evidenced by several facilities in Colorado that use RO to treat groundwater supplies for potable use.

Additionally, the issue of reduced return flows concerns many water providers and agricultural users with regard to the downstream effects of increased reuse of water supplies. Like the development of other local supplies through full use of absolute rights or development of conditional water rights, reuse may reduce return flows upon which downstream users have historically relied. Nevertheless, in combination with other water development, reuse can help mitigate the effects. Future research should focus on the possible effects of water reuse on return flows. Concurrently with DPR, Colorado also needs to explore other reuse methods such as, green infrastructure, on site water recycling for non-potable use, use of natural systems, and less energy-intensive treatment methods. The Net Zero Water Initiative is a current project in Colorado that explores many of these aspects of net-neutral water management (Chapter 6.3.3 contains a more detailed explanation of this project).

Recently, the CWCB funded a white paper titled, "Considering the Implementation of Direct Potable Reuse in Colorado," which the Water Environment Research Foundation sponsored and HDR Engineering authored. The draft paper explored the technical, operational, regulatory, and public acceptance challenges related to implementing DPR in Colorado. In alignment with Colorado's Water Plan's grassroots approach, the Water Environment Research Foundation, the Water Research Foundation, and Water Reuse Colorado sponsored a workshop to gather feedback about the white paper and to discuss direct potable reuse as a new water supply. Reuse experts from across the country attended, including first-hand practitioners from Texas, California, and other states. The draft white paper and the workshop elicited the following recommendations:

- *Convene a broad range of experts and interested parties to produce a roadmap to develop potable reuse in Colorado. This would include making policy, regulatory, technical, and operational recommendations.*
- *Sponsor a survey of Colorado utilities and water agencies to determine the extent to which DPR may be considered as a means to augment their water supply portfolios.*
- *Develop a program to educate the public, elected officials, and water utilities about the benefits and safety of DPR.*
- *Partner in research projects that advance the knowledge related to technical challenges associated with DPR including more cost-effective and environmentally acceptable RO concentrate management techniques and the evaluation of non-RO based treatment trains capable of producing water suitable for DPR.*
- *Investigate water quality of de facto reuse situations relative to potable reuse.*
- *Carry out a state funded potable reuse pilot project in Colorado to assess the impacts and benefits of potable reuse.*[177]

The actions below incorporate some of the results of this work.

Reuse Projects

In Colorado, there are 25 entities that treat reuse water and provide nonpotable recycled water. Regulation No. 84 refers to them as "treaters." Most of these water providers are located on the eastern slope along the Front Range. In addition, numerous examples demonstrate indirect reuse through exchange around the state.

As the IBCC's No-and-Low-Regrets Action Plan mentioned, examples of direct and indirect reuse projects in Colorado include:

Colorado Springs Utilities: For more than 50 years, Colorado Springs Utilities has produced reuse water in the form of direct reuse for irrigation and cooling. Irrigation consists of the provision of water to golf courses, parks, campuses, and other properties, while cooling-water is used at the Drake Power Plant's cooling towers. According to Colorado Springs Utilities, direct-reuse water has yielded a savings of 1 billion gallons of drinking water per year.

Aurora Water's Prairie Waters Project: This project employs IPR. Riverbank filtration (RBF) wells extract Aurora's fully reusable water from the South Platte River near Brighton, pump it into aquifer recharge and recovery (ARR) basins, and then pump it back through 34 miles of pipeline and three pumping stations. This provides nearly 1000 feet of lift to the Peter D. Binney Water Purification Facility near Aurora Reservoir. Natural filtration methods in the RBF wells and ARR basins partially treat the water, and then fully treat it at the Binney facility before mixing it with existing water resources and distributing it to Aurora's customers. The current system capacity is approximately10 million gallons per day (mgd), which is expandable to 50 mgd.

Denver Water: Denver Water has an extensive non-potable water reuse system that serves many large customers including Xcel Energy, parks, golf courses, and the Denver Zoo. This recycled water system is a direct reuse system and has a treatment capacity of 30 mgd, expandable to 45 million mgd. With a goal of attaining 17,500 acre-feet per year of recycled water use, Denver Water continues to add sites to its non-potable water distribution network.[178]

IBCC No-and-Low-Regrets Actions

In 2013, the IBCC developed the No-and-Low-Regrets Action Plan for water reuse. This strategy outlines the minimum level of water reuse water providers should implement statewide (Table 6.3.2-1).[179]

BIPs

Several BIPs have featured water reuse, and have stated the following draft goals.

TABLE 6.3.2-1 INTERBASIN COMPACT COMMITTEE NO-AND-LOW-REGRETS ACTIONS

COMPLETED AND ONGOING ACTIONS	POTENTIAL FUTURE ACTIONS
• Continue to support current reuse IPPs. • Continue to incorporate reuse in the state water planning process. • Continue the study of zero liquid discharge reverse osmosis plants through the Water Supply Reserve Account (WSRA) program.	1. Improve Tracking, Quantification, and Planning a. Use SWSI efforts to improve reporting of reuse IPPs b. Develop BIPs that incorporate reuse 2. Establish a Statewide Reuse Goal with Intermittent Benchmarks a. Develop general political support for a statewide reuse goal b. Develop statewide agreement tying reuse to new supply development and agricultural transfers c. Encourage relevant local entities to outline and report their own approaches to help achieve the statewide goal 3. Develop New Incentives for Reuse a. Explore funding options in support of the WSRA grant program b. Pursue breakthroughs in research c. Develop incentives 4. Implement Education and Outreach Efforts a. Track public attitudes through baseline and ongoing surveys

Arkansas Basin

The water conservation section of this plan iterated goals related to meeting municipal water needs; these same goals apply to water reuse. The Arkansas Basin Roundtable has identified the following four goals for meeting municipal water needs:

- *Meet the municipal supply gap in each county within the basin;*
- *Support regional infrastructure development for cost-effective solutions to local water supply gaps;*
- *Reduce or eliminate Denver Basin groundwater dependence for municipal users; and,*
- *Develop collaborative solutions between municipal and agricultural users of water, particularly in drought conditions.*[180]

While reuse projects—including Colorado Springs' Southern Delivery system, and ZLD research in La Junta—are occurring now in the Arkansas Basin, the Arkansas Basin has outlined opportunities and constraints for future reuse development. Opportunities include the creation of additional storage, including the Long-Term Excess Capacity Master Contract space in Pueblo Reservoir, and new reservoirs. New reservoirs may include a lined gravel-pit reservoir below the confluence with Fountain Creek, intended to capture transbasin return flows that are not immediately exchangeable to Pueblo Reservoir. Constraints consisted of the difficulties of reusing more water in the already over-appropriated Arkansas River system. Better management of existing supplies—including transbasin water supplies—will help meet the needs, but achieving better management will require extensive engineering studies and legal support.[181]

Colorado Basin

The Colorado Basin is focused on efforts that include developing water court process recommendations in order to encourage improvements in efficiency, conservation, and reuse.

Measurable outcomes support this goal. The outcomes include revising Colorado water law to allow more flexibility in promoting stream health through conservation, and achieving and sustaining a high level of conservation among all basin water providers. The Colorado Basin identified projects and methods it will need to implement these goals, such as conducting a comparison of Colorado water law and procedures with those of other Western states in order to identify alternative practices and facilitate water transfers and various local water conservation efforts—both today and in the future.[182]

Gunnison Basin

The Gunnison Basin framed its reuse discussion based on criteria for new supply projects using Colorado River Basin water. The criteria represent conservation, land use, and reuse. The Gunnison Basin describes reuse criteria as follows: "Entities must first reuse all legally available reusable water supplies to the maximum extent possible before further development of Colorado River System water."[183]

North Platte and Rio Grande Basin

Neither the North Platte Basin nor the Rio Grande Basin uses reuse as a future strategy to close supply gaps due to relatively minor municipal water use and low population numbers.

South Platte/Metro Basin

The South Platte/Metro Basin has an overarching theme of continuing "its leadership role in efficient use and management of water."[184]

The South Platte/Metro Basin regards reuse water in the context of the Colorado River. Its initial goals state, "A balanced program to plan and preserve options to responsibly develop Colorado River water to benefit both east slope and west slope consumptive and nonconsumptive, environmental and recreational

TABLE 6.3.2-2 SOUTH PLATTE AND METRO PROVIDERS' REUSE OF IDENTIFIED PROJECTS AND PROCESSES

BASIN	PROVIDERS	PROJECT	ESTIMATED YIELD (ACRE-FEET PER YEAR)	ESTIMATED COMPLETION DATE
Metro	Aurora	Prairie Waters Project Expansion and Storage[a]	TBD	2050
Metro	Northglenn	Northglenn Reuse Plan	700	
Metro	Thornton	Thornton Reuse	2,000	2030
Metro	Denver Water	Denver Water Reuse	17,500	2023
Metro	Westminster	Westminster Reclaimed Water		
Metro	Denver Water	Downstream Reservoir Exchanges	12,000	
Metro	Castle Rock	Alternative Northern Water Supply Project	2,500	
Metro	Castle Rock	Plum Creek Diversion and Water Purification Facility Upgrades	4,100	
Metro	Arapahoe County Water and Wastewater Authority	Reuse of ACWWA Flow Project Deliveries	3,250	
Metro	City of Brighton	South Platte and Beebe Draw Well		
Metro	South Metro Water Supply Authority, Denver Water, Aurora	WISE	7,225	2021
South Platte	Erie	Erie Reclaimed Water	5,390	
		TOTAL:	**58,135**	

[a] The yield of PWP expansion depends on the yield of other projects, such as the Eagle River Project, Box Creek and Growth into existing supply, in addition to the future demand scenario used to calculate Aurora's remaining gap.

water uses is needed to assure that the State's plan has equal focus on the other three previously identified strategies including: 1) developing IPPs, 2) municipal conservation and reuse, and 3) agricultural transfers."[185]

The basin also states the following goal and measurable outcomes in relation to reuse: The South Platte River Basin will "enhance current levels of municipal water reuse and consider studies to quantify the effects of: 1) additional municipal water conservation on water available for reuse, 2) additional municipal water reuse in relation to water available for exchanges, and 3) reuse and successive uses of water downstream including effects on agricultural water shortages."[186] In relation to nonconsumptive needs, the basin will ensure that conservation, reuse, and drought management plans consider environmental and recreational focus areas and attributes.[187]

Regional cooperation on reuse projects, such as the WISE project in the Metro area, can help stretch locally available supplies even further. The WISE partners have executed agreements and will begin deliveries in 2016, reaching a full delivery of 10,000 acre-feet per year (on average) by 2021. The project uses available, reusable supplies from Aurora Water and Denver Water, and diverts and delivers it through Aurora's Prairie Waters collection and treatment system. Nevertheless, some municipal supplies, including the Colorado Big Thompson Project, are single-use water supplies and cannot be reused by municipal water users.

The South Platte/Metro Basin raised some concerns about the limitations of reuse and the ways in which reuse affects downstream users. Some of the technical limits of reuse include infrastructure capacities, losses, supply-and-demand timing, water quality, treatment costs and brine disposal, and regulatory requirements.[188] The South Platte/Metro Basin Roundtable does, however, advocate that the State should "direct the Colorado Water Quality Control Commission to look for ways to assist and facilitate reuse."[189]

Southwest Basin

The Southwest Basin has a goal to "support and implement water reuse strategies" using an educational strategy. The basin proposes to implement at least three different informational events around reuse efforts, during which it will highlight tasks, tools, and strategies.[190]

Yampa/White/Green Basin

The Yampa/White/Green Basin considers reuse principally as a pre-condition for TMDs, and not necessarily as a strategy it will undertake firsthand.

The basin states, "Prior to undertaking development of a new trans-mountain diversion, the Front Range must first integrate all other water supply solutions including conservation, reuse, and maximize use of its own native water resources and existing trans-mountain supplies."[191]

ACTIONS

1. **Explore regional and expanded local reuse options:** Over the course of the next three years, the CWCB will conduct a technical review of on-site, local, and regional reuse options and provide grants to support on-site, local, and regional reuse plans and projects.
2. **Improve quantification, planning, and tracking for potential reuse projects:** Over the next two years, the CWCB will examine the quantity of water that is currently being reused, the quantity of water providers plan to reuse, and the potential to increase reuse with regional and local reuse options. As a future planning effort, CWCB should explore regional and local reuse plans and projects. To assess feasibility of potable reuse projects in Colorado, the CWCB will work with partners to map all wastewater and potable infrastructure, water rights, needs, cost, and benefits. In addition, it will examine potential effects on return flows.
3. **Clarify the regulatory environment:** Over the next two years, the CWCB and the CDPHE will work

with stakeholders to examine the application of water quality regulations to reuse water. The aim will be to identify potential change that fosters permanent growth in the reuse of limited water supplies, and that protects public health and the environment.

4. **Provide financial incentives for reuse innovation:** As a research team recommended in the DPR white paper, the CWCB will, over the next year, proactively seek applicants to use WSRA grant funds for expanded research and innovation related to the technical challenges and solutions of reuse. This includes exploring areas such as ZLD, IPR, and DPR; examining regional opportunities; increasing reliability of the technology; exploring on-site reuse of water; examining development of reuse water for food-crop irrigation; inland desalination; and exploring the possibility of sharing reuse water. This research also includes support for the continued development of more cost-effective and environmentally acceptable RO-concentrate management techniques, and the evaluation of non-RO based treatments that are capable of producing water suitable for DPR.[192]
5. **Encourage the Colorado Plumbing Board to adopt the International Plumbing Code to allow for graywater.** The CWCB will encourage the Colorado Plumbing Board to adopt and incorporate the appropriate graywater provisions from the International Plumbing Code to allow for graywater piping within structures.
6. **Expand loan programs:** The CWCB will explore expanding its loan program to include loans for reuse projects. The DNR will work with the General Assembly to institute this modification during the 2016 legislative session.
7. **Support reuse education:** As a research team

recommendations.

8. **Examine mechanisms to improve the ability to market, sell, and share reusable supplies:** Through a stakeholder process, the CWCB will investigate mechanisms to better allow for reuse water to be marketed to water providers outside of a service area, and to make it more desirable to build a reuse project.

6.3.3 LAND USE

As Colorado grows, land-use planning and water planning will become more closely connected through the integration of several principles. Integration does not mean dilution of local control. Connecting these planning disciplines will not diminish private property rights, 1041 powers, and local zoning and development control. Financial incentives, best practices, partnerships, and technical resources can potentially better coordinate and enhance land-use planning and water planning. While density will be a major factor in reducing urban water demand, it is but one facet of creating more water-sensitive land-use decisions.

The manner in which Colorado develops into the future will have a strong influence on Colorado's future water supply gap, and vice versa. This topic is relevant today, as illustrated by the fact that six boards of county commissioners representing both the eastern and western slopes, including Boulder, Denver, Eagle, Grand, Pitkin, and Summit Counties, as well as elected officials from the City and County of Broomfield, collaborated to craft comments about land-use-water integration for Colorado's Water Plan. The importance of water-sensitive land-use planning was stated as, "1. Decrease the water supply gap. As Colorado's population continues to grow, well thought out, effective, sustainable, and predictable land-use planning is essential. 2. Provide low cost alternatives for meeting the Gap. Water sensitive land-use often results in less stress on water systems, indoor and outdoor water savings, and reduction in expensive long-term capital outlay. 3. Protect the values of Colorado, including vibrant economies, agriculture, open space, and recreation. Local land-use planning should be among the first points of consideration to protect and support all of Colorado's values and economic drivers. 4. Create more predictability and reliability as well as reduce risk in water supply planning, in turn creating more sustainability for current and future

> "Every community can do better on water conservation and efficiency via locally determined measures, such as, but not limited to, reinvestment in aging infrastructure, community education, enhanced building codes, and water-sensitive land-use planning." – Guiding statement from county commissioners, as submitted in their input document regarding Colorado's Water Plan.[194]

recommended in the DPR white paper, the CWCB will support stronger education to describe the benefits of reuse water as an integral part of a water supply system. Specific recommendations include sponsorship of a survey of Colorado utilities and water agencies to determine the extent to which they may consider DPR as a means to augment their legally reusable water supply portfolios, and development of a program to educate the public, elected officials, and water utilities about the benefits and safety of DPR.[193] Section 9.5 contains more detail regarding specific education and outreach

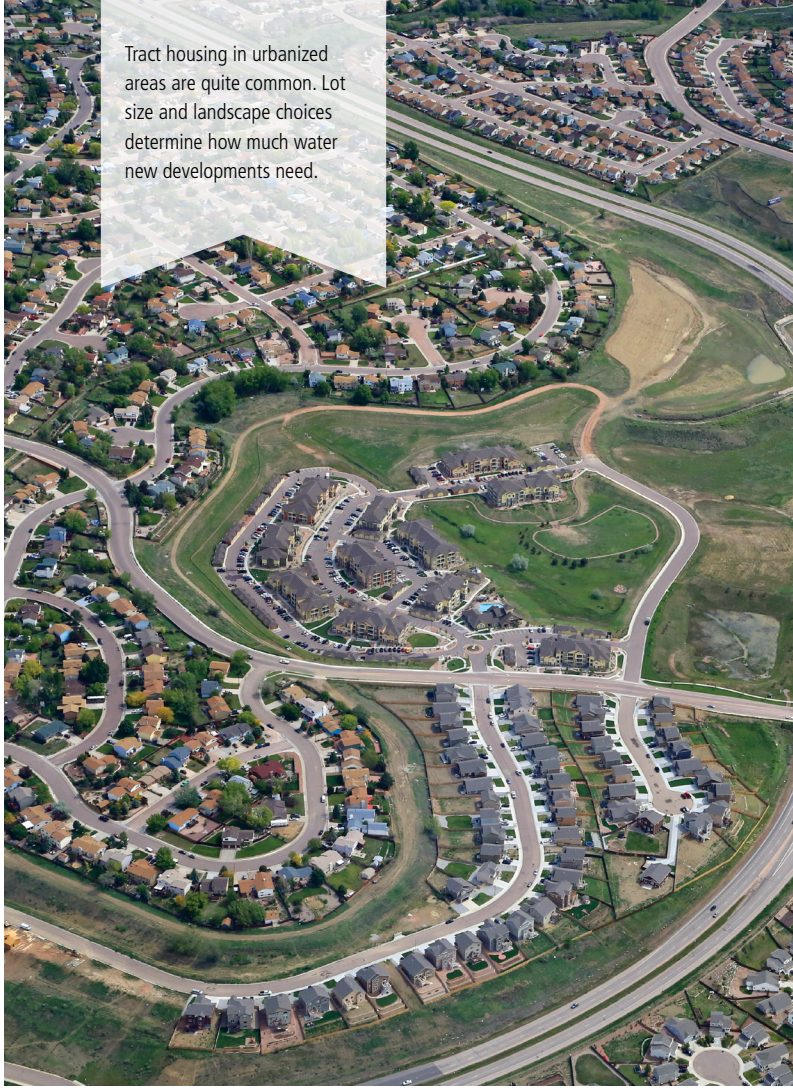
residents. 5. Encourage shared solutions including best management practices, collaborative physical projects and practical land-use models to address water quality and quantity challenges. 6. Result in benefits that reduce infrastructure and service costs, and enhance a community's quality of life."[195]

In 2009, the CWCB began preliminary work in this arena by hosting the *Water and Land Use Planning for a Sustainable Future* conference, and in 2010, it created an associated report and density memo describing several actions that bridge land and water issues.[196] Recently, urban land use has been a major discussion point at the IBCC, which incorporated several options into the Water Conservation No-and-Low-Regrets Action Plan. Additionally, at the July 24, 2013 Joint Front Range Roundtable meeting, 92 percent of participants strongly agreed or agreed with the recommendation that water supply planning and land-use planning should be coordinated. At that same meeting, 55 percent of participants agreed that "coordination of urban land planning and water supply planning" was the most important conservation recommendation to discuss that day.[197]

The following projects and initiatives illustrate these recommendations—and are being pursued in Colorado today.

Net-Zero Water Initiative

The Colorado Water Innovation Cluster is researching net-zero water through a CWCB water efficiency grant, and has assembled a large stakeholder group to create a net-zero water planning template, guidebook, and toolkit.[198] Net-zero water is a water management concept that mitigates effects on water quantity and quality through best practices, which are incorporated into the development or management of a site. While not truly a net-zero strategy, the best practices can result in a water-neutral site. Net-zero water strategies can be applied to a building site or on a more regional scale, and connect water management to land-use planning. The Net Zero Water Planning Template, as well as the guidebook and toolkit, will help users quantify their water footprint, evaluate reduction strategies, and recognize financial and environmental benefits by reducing their effects on water use and water quality.[199]



Tract housing in urbanized areas are quite common. Lot size and landscape choices determine how much water new developments need.

Land Use Leadership Alliance

A recent collaborative effort involving water planners and land-use planners from local jurisdictions is moving the dialogue forward. Pace University School of Law's Land Use Law Center brought its Land Use Leadership Alliance (LULA) training program to Colorado in fall 2013. This training convened land-use and water planners with city managers, city council members, developers, regional government planning groups, and CWCB staff for four all-day sessions focused on the land-use and water planning nexus. These sessions proved very productive in the development of strategies for better integration of land and water planning, and also assisted in the development of relationships between land and water planners within and among municipalities.[200]

This collaboration is a model for integrating local

planning efforts within a local government and with regional planning efforts. The latest LULA trainings took place in May 2015 and involved the participation of five more Front Range municipalities, including Westminster, Lakewood, Commerce City, Broomfield, and Aurora. Additionally, representatives from South Adams Water and Sanitation, Denver Water, Bancroft-Clover Water, and Green Mountain Water and Sanitation attended. The LULA trainings will serve as a template for trainings the CWCB and the DOLA will organize in 2016, as Senate Bill 15-008 outlines.

Denver Regional Council of Government's Metro Vision

The Denver Regional Council of Governments (DRCOG) has also been exploring the nexus between water use and land-use patterns in recent years. Adopted in 2011, the latest *Metro Vision 2035* document, which for the first time includes a section that ties water conservation to land-use planning.

DENVER REGIONAL COUNCIL OF GOVERNMENTS WATER CONSERVATION VISION, GOAL, AND POLICIES

Vision: The Denver metro region will maximize the wise use of limited water resources through efficient land development and other strategies, recognizing that no single strategy will meet the state's water needs and the region will need to pursue a range of strategies concurrently.

Goal: Reduce regional per-capita M&I water use by working with municipalities, counties, water providers, and other stakeholders within the next 6 to 12 months (February 2012) to identify a specific numeric target or measurable benchmark against which to measure progress.

Policies:

1. **Regional Collaboration.** DRCOG will bring together local governments, water providers, and other stakeholders to facilitate collaborative efforts that promote water conservation.
2. **Best Practices.** DRCOG will work to increase understanding of the link between land development and water demand, and to identify best practices for promoting the efficient use of water resources across the region.
3. **Efficient Land Development.** Compact development, infill and redevelopment consistent with DRCOG's urban growth boundary/area and urban centers policies will help reduce water demand and related infrastructure costs.

Source: DRCOG Metro Vision 2035:34

DRCOG has a sustainability goal of increasing housing density by 10 percent between 2000 and 2035.[201] According to DRCOG's most recent analysis, the region has increased in density by 5.3 percent since 2000. These data suggest that the region is well situated to achieve the 10 percent density level by 2035.[202] In the residential housing sector, that 10 percent increase will produce approximately a 5 percent decrease in water use—which equates to 31,000 to 46,000 acre-feet of annual savings for the Denver metro area, depending on population growth (both existing and new). At the medium population growth, this is nearly 42,000 acre-feet of savings annually.[203]

Colorado Water and Growth Dialogue

Through a WEGP grant that addresses the water and growth dilemma, the CWCB is funding a project to estimate demand reductions from various land-use patterns. The Keystone Center secured funding from several grantors (including the CWCB) to complete a two-year dialogue that will bring together water providers, land-use planners and developers, public officials, and other key stakeholders. The goal is to identify meaningful strategies, practices, and policies that will help Coloradans achieve a measurable reduction in the water footprint of new development and redevelopment, and move closer to a long-term balance between water use and growth. To date, the project has produced a draft research report that examines strategies for implementing land-use patterns that reduce water demand. The report identifies four strategies that have the most potential to reduce water demand: Developing smaller residential lots (cluster development), changing from single-family to multi-family development (infill), increasing multi-family development (moving-up), and imposing turf/irrigation restrictions.[204] Additionally, Denver Water and Aurora Water are modeling their service areas' water use patterns on top of existing land-use patterns.

The group will then use DRCOG's UrbanSim model to generate future land-use patterns with the overlay of water use patterns. As the project progresses, it will generate several different exploratory scenarios by 2040. These scenarios could reflect the effects of climate change, economics, market demand, and political will for regulation. In 2016, this water and growth project will create a report and roadmap that describes the most promising strategies for addressing the water and growth dilemma in Colorado, along with specific recommendations for implementing and disseminating the strategies.[205]

Recent Legislation

In 2008, Colorado passed legislation requiring that building permit applications for developments of more than 50 single-family equivalents include specific evidence of an adequate water supply. Adequate water supply is defined as one that is sufficient for the development in terms of quality, quantity, and dependability. Developers must submit proof of adequate supply to the local government through a report from a professional engineer, or from a water supply expert, that identifies the water source and the types of demand management appropriate for the site. Under this law, a local government was permitted to make the adequacy determination only once, at the beginning of the development permit approval process.[206] In 2013, the governor signed legislation that modified the definition of the term "development permit." The new definition clarifies that during the development permit approval process, the local government may grant permits for individual stages, rather than for the entire development.[207]

In 2015, Colorado passed Senate Bill 15-008, which tasks the CWCB and the DOLA with implementing trainings for local water use, water demand, and land-use planners. The topic areas will cover best management practices for water demand management, water efficiency, and water conservation. Additionally, the bill requires that all covered entities' water efficiency plans must evaluate best management practices for water demand management, water efficiency, and water conservation that they may implement through land-use planning efforts.

BIPs

Each basin roundtable is formulating its own implementation plan that will include land-use goals and activities, in addition to already-planned projects and methods. Chapter 6 explores all of these.

Arkansas Basin

The Arkansas Basin did not address land use in an extensive manner in its BIP. The Arkansas Basin did, however, create a policy calling for the integration of land-use and water resource planning.

The Arkansas Basin came to consensus on a policy statement regarding land-use and water resource planning.

- *Policy Statement: The Arkansas Basin Round table supports the integration of land-use and water-resource planning.*[208]

Creating a policy statement for this type of integration is an important first step in the future of demand management in the Arkansas Basin.

Colorado Basin

The Colorado BIP created a theme; set a goal, measurable outcomes, and short- and long-term needs; and identified projects and methods that connect land use with water conservation.

Theme 5 is to "develop local water conscious land use strategies," with a primary goal to "develop land-use policies requiring and promoting conservation." The measurable outcomes associated with this goal include:

- *Developing recommendations for city, county, and state governing bodies promoting water awareness and efficiency in land-use policy.*
- *Developing educational material or opportunities for elected and planning officials on water supply issues and conservation options.*
- *Preserving agriculture by reducing the transfer of agriculture water to municipal use.*[209]

The Colorado Basin established short-term needs, long-term needs, and projects and methods to accomplish this goal. In the short term, it will review existing land-use regulations for water-conscious development requirements and evaluate potential growth in unincorporated areas and water supplies

to those areas. In the long term, it will provide local jurisdictions with financial support to implement water-conscious development requirements, and draft recommended model-basin and statewide land-use planning guidelines that focus on water conservation and water-efficient land-use development. As for projects and methods to accomplish the goal, the Colorado Basin suggests the creation of statewide grant opportunities to enable local jurisdictions to review land-use regulations, conduct public outreach, and implement regulations. Additionally, current governmental council should develop model land-use regulations, and every county and city within the basin should have conservation plans with identified goals. The plan also asks that "the state land-use regulations be evaluated to meet long term exponential state population growth (and water demand) with a limited water supply."[210]

Additionally, the Grand County Region, Summit Region, Eagle River Region, Middle Colorado Region, and Roaring Fork Region all developed specific land-use themes and methods in their needs analysis.

The themes include:

- *Develop local water conscious land-use strategies that focus on growth that affects water supplies and nonconsumptive/environmental needs.*

The methods include:

- *Limit development to within urban boundaries*
- *Promote water conscious growth development through improved land-use policies.*
- *Water providers should work with neighboring entities to provide and plan for growth between boundaries*
- *Implement water provider conservation projects*
- *Review local governments' land-use policies for water-quality and environmental protection standards.*
- *Assess county master plans and codes for improvements in smart growth land-use policies*
- *Ensure new development appropriately incorporates water-related values.*[211]

Gunnison Basin

As with other BIPs, the Gunnison BIP ties land use to water conservation and demand management. The Gunnison Roundtable established goals related to land use and water conservation. Goal 9, which outlines public outreach and education regarding the role of citizens of the Gunnison Basin, identifies land use as a process to achieve this goal: "The GBRT Education Committee will prepare and present annual half-day State of the River seminars for local governments and planning staffs, with the objective of making sure that land-use decisions and new developments are made within the context of the Basin's probable water future." [212]

The Gunnison Basin also identified statewide principles that connect water efficiency, conservation, and demand management.

Principle 5: ***Water conservation, demand management, and land-use planning that incorporates water supply factors should be equitably employed statewide.*** *Demand management strategies supported by the Gunnison Basin include growth only in proximity to existing or planned infrastructure, high density versus urban sprawl, and landscape limitations. Development in proximity to existing infrastructure should be encouraged only in non productive, or the least productive, land to preserve productive agricultural land. The Gunnison Basin believes that land-use policies are essential to promoting both water and land conservation. Local land-use policies and regulations should discourage sprawl, link water supplies to development, and provide incentives for higher density developments."* [213]

Additionally, the Gunnison Basin discusses land use in terms of Colorado River supplies. Under Principle 3: ***Any new supply project from the Colorado River System must have specifically identified sponsor and beneficiaries and meet certain minimum criteria, and "entities must incorporate water supply factors into land-use planning and development.***[214]

North Platte Basin

Due to low population and little municipal use, the North Platte Basin did not address land use in its plan.

Rio Grande Basin

As this chapter stated previously, the Rio Grande Basin has a low population and relatively minor municipal water use. The Rio Grande Basin does not address land use as more urban water basins have, but instead describes the use of conservation easements to manage land development. The conservation easements preserve agricultural land as well as environmental attributes.[215]

South Platte/Metro Basin

According to the South Platte/Metro Basin, municipal water departments are tasked with meeting a large portion of the water supply needs in the South Platte Basin, and are already using programs such as water audits, rebates for efficient water fixtures and appliances, and education to reduce demand. These efforts could be more effective if water departments worked with their respective planning departments to plan and require water-efficient usage and land development within their cities. For instance, a water department may work with its planning department to implement water-efficient landscaping codes, subdivision regulations, zoning requirements, and master plans.[216]

Nevertheless, many water utilities' current roles are generally limited to providing for water needs within their service areas, with little cross-over to land-use authority. The South Platte/Metro Basin discusses current land-use authority and water provider authority, opportunities for collaboration, and examples of current work in this arena. The plan describes the issue that has made collaboration between water and land-use planning difficult in the past. The South Platte/Metro Basin states, "The primary responsibility held by water utilities is to provide for water needs within communities. Coordinating or integrating the land-use and water planning process is a relatively new area being explored for reducing municipal water use. Increasing awareness of limited future water supply opportunities and the potential effects of climate change helps to spur this integration of planning."[217]

The South Platte/Metro Basin indicates that there are opportunities for closer collaboration and reduction in water use through more integrated land-use planning. These include:

- *Updates to Comprehensive Plans,*
- *Changes to zoning requirements,*
- *Revising water/land-use subdivision regulations, and*
- *Using the direction provided by the State Water Engineer and recent legislation.*[218]

With regard to opportunities, the plan states that "increasing residential density has the potential to significantly improve water use efficiency and will continue to result in reduced effects on natural resources. The highly urbanized areas of the Front Range corridor have many opportunities to redevelop lands for higher population densities."[219]

Projects the South Platte/Metro Basin highlighted include the Keystone Center Land Use Study and LULA. The Keystone Center project will identify land-use patterns across the metro area and find ways to more closely integrate land and water planning. The LULA training program "focuses on finding land-use solutions to the challenges posed by growing Front Range populations and Colorado's limited water resources. The LULA program is designed to help local land-use and water leaders create new networks of support, identify successful land-use techniques, and develop implementable local strategies that will enable a more 'water-smart' future for the region."[220]

The South Platte/Metro BIP ends with a land-use recommendation in the section *Recommendation for Additional SP-BIP Analysis and Refinements.* This recommendation is:

Further Analysis of Planning Coordination— *The South Platte and Metro Roundtables recommend further investigation into options for increased coordination between water utilities and land-use planners to better plan for water-efficient growth.*[221]

Southwest Basin

The Southwest Basin identified a need to organize informational events about water conservation, land-use planning and water reuse efforts, tools and strategies. "One strategy to achieve the short-term goals of conservation, land-use planning (which will include coverage and discussion of the 60/40 and 70/30 ratios referenced above), and water reuse is to implement a pilot conservation and land-use planning session in 2015. Initially it is anticipated that this would be a two to four hour workshop for local decision makers and water utility personnel." If successful, the basin could host the session throughout the basin (for example, in Cortez, Telluride, Pagosa Springs, and other locations) as with the Water 101 Seminar.[222]

Yampa/White/Green Basin

The Yampa/White/Green Basin did not describe projects or plans for land use in its BIP.

ACTIONS

One objective of Colorado's Water Plan is that by 2025, 75 percent of Coloradans will live in communities that have incorporated water-saving actions into land-use planning. Ten communities have completed land-use and water trainings through the LULA process, and in order to reach the 75 percent population objective, a total of 80 communities and water providers will need to have participated in similar trainings by 2025. The trainings will support approximately 80 water providers and communities statewide to incorporate land-use practices into their water conservation plans. To facilitate the use of local land-use tools to reduce water demands for municipalities and urbanization of agricultural lands, the State will work with partners to pursue the following actions.

1. **Encourage the use of local development tools:** Through voluntary trainings in 2016, the CWCB and DOLA will encourage local governments to incorporate best management practices for water demand management, water efficiency, and water conservation into land-use decisions.

   Trainings may cover the following topics:

   - Expediting permitting for high-density buildings and developments that incorporate certain water efficiency measures, such as efficient irrigation systems (with plan-check and install-check).
   - Including water supply and demand management in comprehensive plans.
   - Installing climate-appropriate landscapes.
   - Understanding the societal and environmental benefits of urban landscapes
   - Using appropriate amounts of soil amendments.
   - Incentivizing maximum-irrigable-area or WaterSense-certified landscapes.
   - Instituting tax incentives for incorporating certain water efficiency measures for high-density developments, such as cluster developments.
   - Establishing structured impact (tap) fees designed to promote water-wise developments and in-fill.
   - Developing water-budget rate structures to help maintain initial projected water budgets for a site.
   - Introducing landscape and irrigation ordinances.
   - Exploring the environmental and farmland benefits of water sensitive urban land-use planning.
   - Creating more stringent green-construction codes that include higher-efficiency fixtures and appliances and more water-wise landscapes.
   - Exploring landscape-oriented professional education or certification programs.
   - Examining opportunities to reduce agricultural urbanization and fragmentation.[223]

2. **Examine barriers in state law for implementing the above local development tools:** Over the next 18 months, the CWCB will examine barriers local jurisdictions may face while implementing local development tools.

3. **Incorporation of land-use practices into water conservation plans:** Over the next 18 months, the CWCB, through partnerships, will develop new guidance for water conservation plans that requires

the incorporation of land-use practices. This is an addition to C.R.S. 37-60-126.

4. **Strengthen partnerships:** To be successful in integrating land-use and water planning, the CWCB will need to partner with many different agencies and groups. Within the next year, the CWCB will establish meetings with various agencies to map out ways in which the CWCB and other agencies can work together on these issues.

    - Local municipalities, local water providers, and county governments will implement water and land-use plans. Without their partnership and support of new ideas, comprehensive water and land planning will not succeed. In addition to partnering with local entities, the CWCB will partner with the Colorado Municipal League, Colorado Counties Incorporated and the Special District Association to ensure successful integrated water and land-use planning.
    - The DOLA is involved in the land-use in the local government arena. Like the CWCB, the DOLA can also leverage its grant funding for water and land-use planning initiatives, such as incentives for incorporating water supply into comprehensive land-use planning.
    - The DORA regulates professionals in various industries and works to create a fair market place. The CWCB will work with the DORA to focus on the landscape and irrigation industry or the property management industry, and to consider developing certifications for these industries to conserve water.
    - Home-building and construction organizations, such as the Home Builders Association, LEED, and the U.S. Green Building Council, will be building communities that have a direct influence on water demand. They must be involved in crafting the vision for future water-sensitive developments.
    - Non-governmental organizations, such as Keystone Center, Alliance for Water Efficiency, Western Resources Advocates, American Planning Association, and economic development councils, can advance land-use and water integration innovation and research.
    - Academic institutions, such as Colorado State University, University of Colorado Boulder, University of Colorado Denver, One World One Water Center-Metropolitan State, and Rocky Mountain Land Use Institute, can advance land-use and water-integration innovation and research.
    - LULA brings an innovative training model that could change the way Colorado looks at this subject by breaking down institutional silos. The CWCB will work with LULA, or another local group, to create a Colorado-specific training model for the integration of sustainable, long-term, land, and water planning.
    - Councils of governments make connections between the local and state government levels. Councils of governments can be strong allies in trainings and research about the land-water nexus.

5. **Funding:** The CWCB should use the WEGP funds and Water Supply Reserve Account grant funds to fund aspects of the land-use and water planning nexus. The CWCB will work with the basin roundtables to proactively seek applicants to use WSRA funds for larger regional efforts that tie more directly into the basin roundtables. It will use the WEGP funds for smaller, more localized efforts.

6.3.4 AGRICULTURAL CONSERVATION, EFFICIENCY, AND REUSE

Introduction

This section seeks to assist Colorado's agricultural industry in becoming more efficient and resilient, and to reduce non-beneficial water consumption and diversions without affecting statewide agricultural productivity and the environment. It also explores opportunities to stretch water supplies to help meet future needs. Discussions about agricultural water use often become confounded by imprecise use of terms and an incomplete understanding of agricultural water systems. This section presents a basis for an analysis using a common understanding of terms.

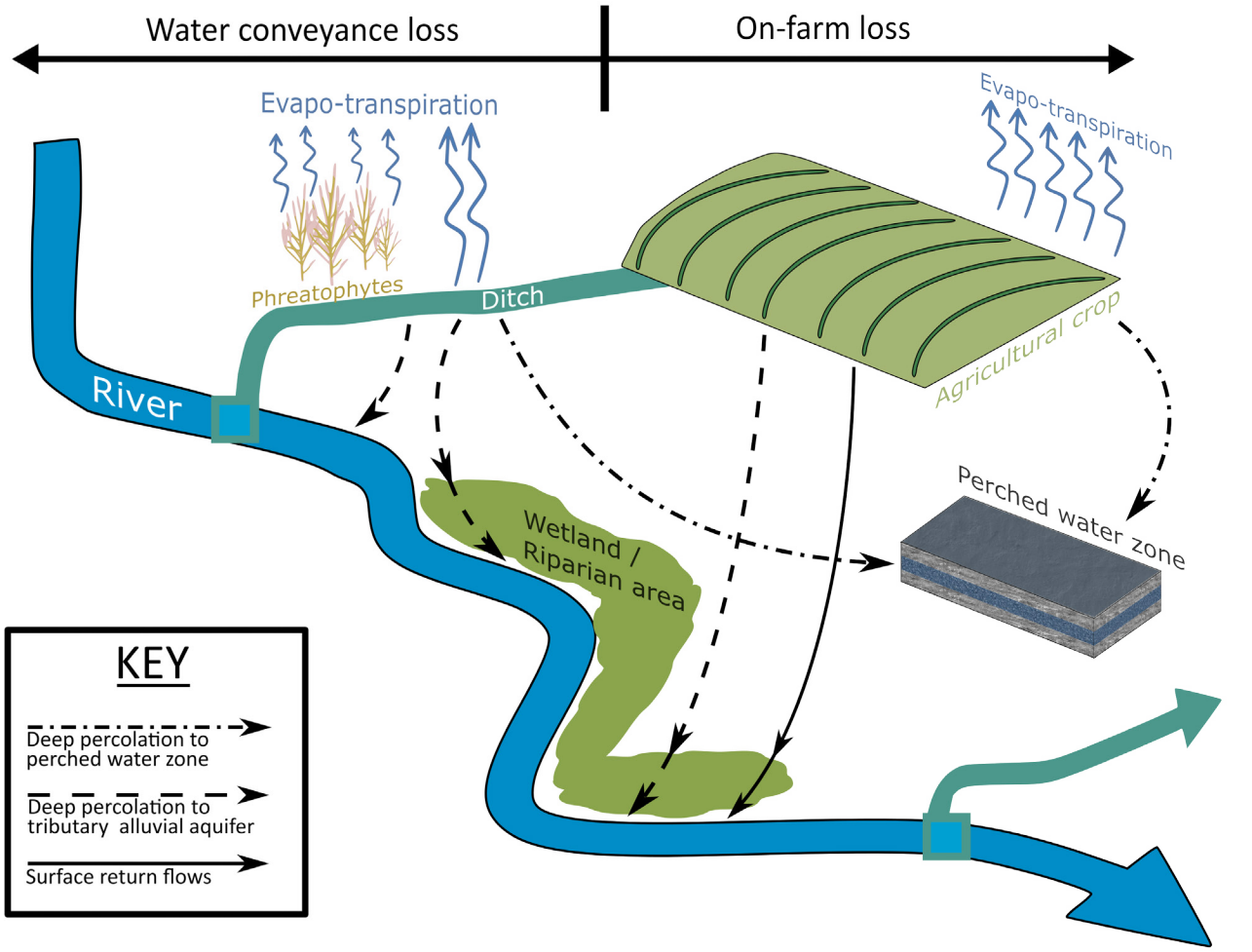
Background on Agricultural Water Use and Losses

Where rainfall is insufficient to meet crop needs, crop irrigation is a requirement. Figure 6.3.4-1 illustrates the irrigation process and its associated consumptive use (CU) and water losses. In some cases, a deep-rooted crop may withdraw water directly from shallow groundwater areas through a natural process known as sub-irrigation.

During the process of irrigation, water conveyance loss occurs when some of the water diverted via ditch or canal never reaches the crop. These losses can occur due to ditch or canal seepage, when the water either returns to the stream via seepage into the local groundwater system through deep percolation, or via non-beneficial consumptive use by phreatophytes.[223] Ditch or canal seepage is considered nonconsumptive because the water returns as surface flows in the river system, and is available for other users. Some conveyance loss is permanent, in which case it is frequently referred to as non-beneficial consumptive use.[224] For example, this loss can take the form of evaporation from exposed water or soil surfaces of ditches and canals and the unintentional growth of phreatophyte vegetation with no agricultural value. Colorado State University estimates that as much as 10 percent of the water lost during irrigation is a result of these types of non-beneficial consumptive use. Nevertheless, some of these unintended uses provide environmental benefits by creating wetlands and enhancing riparian corridors.

Once the water reaches the field, either the plant uses it as a CU, or the water becomes part of on-farm losses. Irrigation provides water to the crop's root zone to meet crop CU, which occurs through transpiration from the growing plants and evaporation from adjacent soil surfaces. The combined effect of transpiration and evaporation is call evapotranspiration (ET). Plants transpire water during photosynthesis while also incorporating a small portion of the water into the plant tissue. The water ET consumes is permanently removed from the local hydrologic system.[225] Since ET represents the water used by a plant, the beneficial consumptive use of an irrigation water right is measured by the amount of crop ET. Crop ET is not easily measured. Rather, theoretical or potential ET (the maximum amount of water a crop can consume) is calculated based on the factors that influence ET, such as crop type, growing season, and daily climatic conditions. Crop ET is measured at a specific location by adjusting for the amount of water applied to the crop.[226]

FIGURE 6.3.4-1 AGRICULTURAL WATER USE AND LOSSES



On-farm losses occur when water is applied to fields at a rate that exceeds the soil's capacity to retain the water. This results in deep percolation or surface runoff. Deep percolation into underlying groundwater systems raises the local groundwater table, thereby returning water to the surface system through stream accretions.[227] In locations where the amount of deep percolation exceeds the capacity of an aquifer to quickly transmit water back to the stream, groundwater storage occurs and produces lagged return flows. In some cases, deep percolation collects in perched zones that are not connected to the regional groundwater system, and is permanently lost to the river system as a type of non-beneficial CU. Surface runoff, on the other hand, occurs when the rate at which water is applied to a field exceeds the rate at which water infiltrates a given soil type. Surface runoff is returned to the surface water system via waste ditches and drainage works.

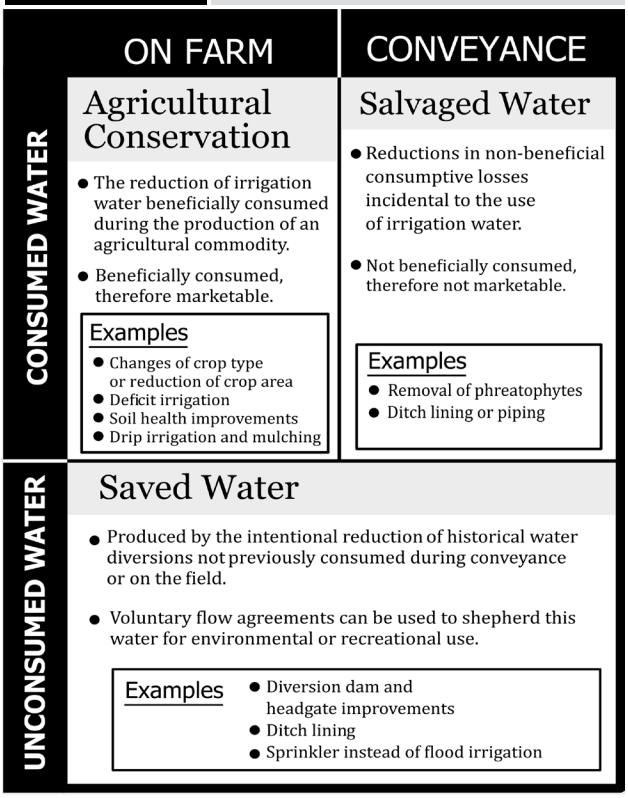
Collectively, the majority of water that is diverted, but not consumed, creates return flows to the stream.[228] Return flows are a critical component of the agricultural water balance, and Colorado water law rigorously protects them for the benefit of other users on the system.[229] Diversion of water in the stream as a result of return flows is a fundamental element of the water supply in Colorado. A portion of each subsequent diversion provides new return flows for users further downstream, allowing multiple diversions of the same water within a basin.[230] In over-appropriated basins, an individual molecule of water will be diverted several times before it leaves the state or is finally consumed.[231]

Terminology Related to Irrigation Efficiency

Several terms and phrases frequently arise in discussions related to irrigation efficiency. The following definitions, in conjunction with Figure 6.3.4-2, provide clarity to this complex topic.

- **Irrigation efficiency:** Irrigation efficiency is the ratio of the total amount of water diverted for an irrigation use to the volume of water the crop beneficially consumes through ET. Irrigation efficiency may be further refined by looking at the specific water losses that occur before and after the water is applied to the crop. There are often separate calculations of delivery efficiencies and on-farm efficiencies. Since irrigation efficiency is a ratio, it may be increased by practices that either reduce the amount of water consumed, or reduce the amount of water that is diverted but not consumed. As a result, "irrigation efficiency" is used as a general term to refer to agricultural conservation and efficiency practices on the farm, and it is associated with conveyance.
  - **Water-conveyance (delivery) efficiency:** Delivery efficiency reflects seepage, evaporation, and ET losses that occur in the canals, ditches, and laterals between the point of diversion and the turnout to the farm field.[232]
  - **On-farm efficiency:** On-farm or application efficiency reflects the losses that occur, after the farm turnout, as water is applied to a crop. These losses include deep percolation, evaporation, and field runoff.[233] Flood and furrow are application methods that have higher losses than more direct methods (such as sprinklers and drip).[234] However, sprinkler and drip irrigation may allow crops to better use the water applied and increase total beneficial consumptive use.[235]
- **Agricultural water conservation:** "Agricultural water conservation" describes the water resulting from on-farm practices that reduce the amount of beneficially consumed irrigation water during the production of an agricultural commodity. The amount of such water can be measured as a reduction in historical consumptive use.[236] Examples of non-structural, agricultural water conservation practices include changes in crop type, reduction of crop area, deficit irrigation, and soil health improvements that reduce evaporative loss. Because agricultural water conservation is a reduction in historical consumptive use, it is the only irrigation efficiency practice that can be marketed to other beneficial uses. However, there may be challenges associated with administering these water-rights transfers.

FIGURE 6.3.4-2 IRRIGATION EFFICIENCY OUTCOMES



- **Salvaged water:** Salvaged water is the recovery of water that is lost due to consumptive use or to permanent loss of water that does not provide a beneficial use. These losses are incidental to the use of irrigation water. For example, phreatophytes or deep percolation to a perched zone may result in ET. In all cases, water is lost or consumed, although not beneficially. Efficiency improvements that eliminate or prevent losses of water that would have otherwise been consumed can produce salvaged water.[237] For example, removing invasive phreatophytes, and ditch-lining or piping water, could yield salvaged water.
- **Saved Water:** Saved water is produced by intentionally reducing the unconsumed portion of water diversions that otherwise would have provided a portion of historical return flows. Such saved water can be the result of either on-farm or conveyance efficiency practices that reduce losses that were not previously consumed, such as historical return flows.[238] Such water can be left in the stream, but it may not provide a benefit to environmental or recreational values without a voluntary flow agreement. Headgate improvements, ditch-lining or piping, and other efficiency improvements can produce saved water.
- **Reuse:** Capturing and reusing irrigation water for crop use on the same ground—provided it complies with the underlying water right—is common. Because this water is also consumed, it does not result in agricultural water conservation, although it may reduce the total amount of water that is diverted. When reuse is not consistent with the terms of a water right (such as reuse on acres not described in a decree), it is considered an "expanded use," which is prohibited.[239]

On the other hand, the irrigator may potentially reduce irrigation diversions by reusing treated M&I water as an additional source of agricultural supply. Section 6.3.2 more fully explores reuse.

- **Waste:** Waste is a term that is often used pejoratively to refer to water that is diverted but not beneficially consumed.[240] People frequently use it in expressions such as, "By eliminating agricultural waste we can meet future needs," or "One man's waste is another man's water supply." Legally defined, "beneficial use" is the amount of water that is reasonable and appropriate, under reasonably efficient practices, to accomplish without waste the purpose for which the appropriation is lawfully made.[241] The DWR has the authority to curtail truly wasteful practices, and little waste is occurring in agricultural water use. Some elements of water use that might otherwise be considered waste are important to agricultural production. For instance, water is occasionally diverted into ditches and immediately returned to the stream in order to sluice sediments from diversion and conveyance works. Also, through intentional, deep percolation into the underlying water table, excess water is sometimes applied to fields to leach harmful salts from the crop root zone. In areas with limited availability of water storage and highly variable surface flows, some irrigators, in an effort to store the excess water in the soil profile, divert more water than a crop can use at that time. While this is a highly inefficient method of storage, for many irrigators, it is the only option for mitigating future supply shortages. The State does not consider this practice to be wasteful or unreasonable under the circumstances.
- **"Use it or lose it":** The common usage of this phrase is associated with the (incorrect) belief that by maximizing the amount of water diverted, one can enhance or preserve the magnitude of a water right. This notion is incorrect, since the true measure of the water right is actual historical, beneficial CU; in the case of an irrigation right, this is crop ET.[242] Thus, there is no real legal incentive to divert more irrigation water than the crop will eventually consume. In addition, a water right can be abandoned or lost due to non-use for a long period of time, but only if the non-use is indicative of an actual intent to permanently give up the water right.[243] One aspect of the "use it or lose it" perception does bear further consideration. Under current law, the determination about historical consumptive use is based on the amount of water the crop actually consumes—which is the lesser amount

Efficient irrigation methods do a better job of delivering water to crops than older methods. This often increases crop yield due to more even water delivery.

of the water actually applied to the crop or the maximum amount a given crop could potentially consume. Thus, engaging in deficit-irrigation for a period of time could reduce the transferable yield in a future change-of-water-right case, which is a disincentive to adopting these new practices. The legislature provided partial relief to this problem in Western Colorado via C.R.S. 37-92-305(c), of the Colorado Revised Statutes, which allows for CU reductions without affecting historical CU calculations, provided the water user is under a conservation plan.

Benefits of Irrigation Efficiency

Irrigation efficiency can increase crop production, enhance flows for environmental and recreational needs, and increase opportunities for water marketing through water-sharing practices. This section and Section 6.4 discuss water-sharing practices.

Increased crop production: A large segment of agriculture in Colorado operates at a water deficit.[244] This means that the available supply at some periods during the growing season is less than the amount needed to fully satisfy crop-irrigation water requirements (consumptive needs) at that time. Thus, for a producer that is making efficiency improvements, the primary incentive is to satisfy a crop's water consumption by eliminating conveyance and on-farm losses, ultimately increasing crop yields. The intention of this practice is to increase crop production through increased consumptive use. It does not create the availability of new water supplies for other users.

Reduced vulnerability to drought: Many existing irrigation systems were constructed 80 to 100 years ago and could be operated more efficiently - particularly in western Colorado where average irrigation efficiencies are low. These systems operate with a water deficit, in part because their inefficiencies prevent them from conveying available water from the river to the farm gate, or turnout. These issues may be exacerbated under climate change projections if water supply variabilities increase, drought becomes more common and extreme, and runoff patterns change. Efficiency improvements will help shield irrigators from some of these impacts by allowing them to reduce or eliminate conveyance losses and better manage demands in conjunction with upstream storage.

Enhanced flows for the environment & recreation: Refurbishing a headgate, building a diversion dam, or reducing diversions can increase flows below the water structure, potentially benefiting recreation and

the environment. Even though this water cannot be transferred, local instream flow benefits accrue from saved water left in the reach of the stream between the historic point of diversion and the downstream headgate. This is limited to the location where return flows previously entered the stream. Environmental benefits of refurbished agricultural infrastructure present an opportunity for state, federal, and foundation programs to contribute funding toward the costs of efficiency changes. A voluntary flow management program or agreement negotiated with downstream water users can enhance and protect environmental and recreational benefits.

Improved water quality: One benefit of improved irrigation efficiency is improved water quality. The process of deep percolation results from delivering more water into the root zone than the soil can retain for eventual crop consumption. This water migrates into the groundwater system, often dissolving natural salts, uranium, and selenium, and it also leaches manmade fertilizers and pesticides from the soil. These contaminant-loads eventually reach the stream system, and in some cases, seriously degrade surface water quality.[245] Recognition of water-quality benefits results in substantial amounts of federal funding for irrigation efficiency improvements. Over the past several decades, this funding has rapidly accelerated the historically slow trend toward improved irrigation efficiency.

Water sharing: While there are numerous reasons and methods for improving irrigation efficiency, there are limited opportunities for true agricultural water conservation that creates marketable supplies for other users. These methods rely on either crop-ET reduction, or soil moisture evaporation. The methods can be achieved by:

- Switching crop types to those with lower ET requirements.[246] The variation in ET needs among crops can be large. For instance, beans and small grains require 20 inches or less per year, while corn, beets, and alfalfa need 30 or more inches.
- Using deficit irrigation to intentionally supply less water to a given crop than its historical irrigation requirement. Deficit irrigation must result in lower crop yields in order to generate any salvaged water. [247]
- Reducing soil evaporative losses through improved cultivation methods, including mulching, drip irrigation, and "soil health" practices. [248]
- Temporarily and entirely removing a crop from the ground through fallowing.[249]
- Permanently and entirely removing a crop from the ground through land retirement.[250]

Addressing Barriers to Irrigation Efficiency

While irrigators have used these techniques in Colorado to address specific situations, legal, technical, and financial barriers often prevent long-term new water supplies. Section 6.4 discusses ways in which irrigators can use some of these techniques as alternatives to traditional, permanent dry-up of irrigated lands.

With the exception of phreatophyte removal, which the water court has expressly prohibited as a source of a transferable right, the transfer of salvaged water has not yet been tested in water court or addressed by the legislature. The volume of water resulting from any individual efficiency improvement is relatively small, and it is difficult to precisely quantify since it cannot be measured directly. This makes reliable management and administration of exchanges and transfers of salvaged water extremely complex and time-consuming for DWR personnel. Irrigators cannot use or market saved water to reliably provide water to the environment or recreation. There is little direct advantage for irrigators to shepherd this water downstream, and few legal mechanisms exist to support it. The generation of water using agricultural conservation practices, such as deficit irrigation, rotational fallowing, or a transition to cool-season crops, is the subject of ATMs. Section 6.4 of Colorado's Water Plan explores this further.

Examples of recent cases in which agricultural producers in Colorado have improved efficiencies and overcome barriers provide context to the descriptions of these agricultural efficiency concepts:

- The Uncompahgre Valley Water Users Association converted portions of its open-ditch delivery system to pipelines through the Colorado River Basin Salinity Control Program.[251] This reduced seepage and delayed storage releases to better meet late-season crop needs. It also created the added benefits

of reducing salt-loading to and salinity of the Colorado River, and improving downstream water quality. This is an example of a regional approach to irrigation efficiency using state and federal funding as incentives.

- Farmers in the Arkansas Basin converted thousands of acres from furrow and flood irrigation methods to sprinkler and drip application methods through the U.S. Department of Agriculture's Environmental Quality Incentives Program (EQIP). In doing so, they were able to stretch limited water supplies in a severely over-appropriated basin. They also achieved water-quality benefits through the reduction of deep percolation and associated salt-loading. A word of caution applies to efficiency programs in the Arkansas River basin due to the unique terms of Article IV.D of the Arkansas River Compact, which expressly prohibits any improvements to irrigation systems that cause increased depletions at the state line. Because crops in Colorado typically do not receive the full amount of water they are capable of consuming, most irrigation efficiency practices increase CU. Thus, producers who installed sprinklers and drip systems in the Arkansas Basin are required to fully replace the increased depletions with augmentation water.
- The Grand Valley near Grand Junction is an area with adequate senior water rights, and crops generally have a full supply throughout the growing season. Through federal programs, farmers were able to modernize their headgates and delivery systems, which produced saved water through reduced diversions. This action provided enhanced flows in the Colorado River for endangered fish species while simultaneously reducing saline return flows.
- The Rio Grande and Republican River Basins use alternate crops and fallowing to maintain a sustainable agricultural community in light of an imbalance between legally available groundwater supplies and current levels of water use.
- The City of Aurora and the Rocky Ford High-line Canal have made drought-driven, temporary-lease fallow arrangements.
- The CWCB's Alternative Agricultural Water Transfer Methods Program supports pilot projects such as the Colorado River Water Bank Working Group.[252] This group is notably exploring options for reducing irrigation demands through deficit irrigation, temporary forbearance, or other means in order to avoid, delay, or limit the likelihood or negative effects of a Colorado River compact curtailment. Section 6.4 further describes the work of the Water Bank Working Group.
- Implementation of soil health practices, such as low tillage, mulching, and cover crops (a crop planted to protect the soil), have improved the water-holding capacity of the soil and have reduced soil surface evaporation in many locations. These practices can reduce non-beneficial consumptive losses as well as make more available for crop CU. One example that demonstrates the potential of these techniques is in the Rio Grande Basin. The basin used soil health techniques to both reduce water consumption and increase specialty potato-crop quality and yield. Rockey Farm replaced a barley crop rotation with a permanent cover crop, which uses less water, reduces soil moisture loss through evaporation, and adds organic matter to the soil. This, in turn, leads to increased soil moisture for the potato crop planted the following year.[253] The Rio Grande Basin's education and tour program to promote soil health and other irrigation efficiency practices showcases this work.

Recent Legislative Actions Related to Irrigation Efficiency

There are some existing legislative exceptions to the aforementioned limitations to agricultural conservation and efficiency. These exceptions apply in narrow instances, such as:

SB 05-133 provides that the State will not deem a western slope water-rights holder to have abandoned his or her water rights if the water-rights holder has met certain conditions. Two conditions include "a

Spring peach orchard near Palisade. Many orchards in the Grand Valley are becoming more efficient through the use of diversion structures and drip irrigation.

water conservation program approved by a state agency and a water banking program as provided by law." These conditions don't allow water sharing, but they do stipulate that a water-rights owner won't lose the rights if non-use stems from water conservation activities.[254]

HB 13-1130 allows a water-rights owner with an interruptible water supply agreement (IWSA) to request up to two additional 10-year periods for the IWSA. IWSAs enable water users to transfer a portion of their water rights, called historical consumptive use, to another water user on a temporary basis, without permanently changing the water rights.[255]

SB 13-019 restricts a water judge from determining a water user's historical consumptive use based on water-use reductions that result from enrollment in a federal land-conservation program, participation in certain water conservation programs, participation in an approved land-fallowing program, provision of water for compact compliance, or participation in a water-banking program. Some water users may wish to reduce their water consumption in order to limit the effects of drought on streamflows. However, under current law, there is a disincentive that penalizes appropriators that decrease their consumptive use of water. This legislation seeks to mitigate that disincentive.[256]

SB15-183 allows court discretion in determining the appropriate period of record to use when calculating historical consumptive use in change-of-water-rights cases.[257]

HB 15-1006 establishes a two-year grant program for invasive phreatophyte control, and provides $2 million each year for administration and distribution through the CWCB.[266]

Basin Implementation Plans and Irrigation Efficiency

For 2015, each basin roundtable is formulating its own implementation plan. Several plans include agricultural water conservation and efficiency goals and activities.

Most of the roundtables' BIP goals indicate that the basins plan on increasing efficiencies and modernizing agricultural infrastructure. Several examples are below:

- Arkansas Basin Roundtable: Provide increased quantities of augmentation water to comply with Division 2 rules regulating increased farm efficiencies.[259]
- Colorado Basin Roundtable: Improve agricultural efficiency, preservation, and conservation.[260]

Irrigating potatoes in the San Luis Valley. Efficient irrigation methods do a better job of delivering water to crops than older methods. This often increases crop yield due to more even water delivery.

- Gunnison Basin Roundtable: Restore, maintain, and modernize critical water infrastructure, including hydropower.[261]
- North Platte Basin Roundtable: Continue to restore, maintain, and modernize critical water infrastructure to preserve current uses and increase efficiencies.[262]
- Rio Grande Basin Roundtable: Operate, maintain, rehabilitate, and create necessary infrastructure to the basin's long-term water needs, including storage.[263]
- South Platte/Metro Basin Roundtable: Meet agriculture goals with an intent to "support strategies that reduce traditional permanent dry-up of irrigated acreage through implementation of other solutions including conservation, reuse, successful implementation of local IPPs, successful implementation of ATMs, and development of new Colorado River supplies" and "support strategies to address agricultural water shortages through IPPs, new multipurpose projects and innovative measures to maximize use of available water supplies."[264]
- Southwest Basin Roundtable: Implement efficiency measures to maximize beneficial use and production.[265]
- Yampa/White/Green Basin Roundtable: Restore, maintain, and modernize water storage and distribution infrastructure.[266]

Interbasin Compact Committee No-and-Low-Regrets Actions

As part of the IBCC's ongoing work, the IBCC is recommending that "Colorado will continue its commitment to improve conservation and reuse." It has developed recommendations for agricultural conservation and efficiency improvements for current and future agriculture. The actions below incorporate those recommendations.

ACTIONS

The following actions will support Colorado's agricultural industry to make it more efficient, resilient, and capable of reducing water consumption without affecting agricultural productivity.

1. **Agricultural water incentive education program:** Over the next two years, the CWCB will work in partnership with the basin roundtables, Colorado Energy Office, the Colorado Department of Agriculture, Natural Resources Conservation Service, and Colorado State University's extension program to develop a strategic education plan. In addition to the topics Section 6.5 discussed with regard to the education and assistance program, the plan will cover the following topics:
   a. **Agricultural water conservation:** Outreach to the agricultural community about available agricultural water conservation techniques and incentives.
   b. **Soil health:** Begin a soil health education and tour program to help growers examine ways to increase net revenues while decreasing water inputs, and in some cases water consumption.
2. **Continue to support the rehabilitation of diversions and ditches:** The CWCB will continue to provide grants, loans, and technical support to refurbish diversions and ditches. This action will generate saved water and reduce losses where there are benefits to recreation, the environment, and other consumptive water uses.
3. **Voluntary flow agreements:** Over the next two years, the CWCB and the DWR will work with agricultural and environmental partners to develop model language for voluntary flow agreements paired with irrigation efficiency practices. CWCB will also provide funding, facilitation, and technical support to encourage these agreements.
4. **Removal of invasive phreatophytes:** The CWCB will support the management and removal of invasive phreatophytes through grant-funding House Bill 15-1006 provides.
5. **Explore additional incentives:** The CWCB will explore additional incentives to assist basins in implementing, where appropriate, irrigation efficiency practices, and in changing crop type to a lower water-use crop.228F The CWCB should first explore these incentives through conservation demonstration and pilot projects.
6. **New agricultural lands:** The CWCB will encourage newly developed agricultural lands (currently identified in the North Platte, Yampa, and Southwest Basins) to either be very efficient or provide direct and measurable benefits to the environment.
7. **Administrative tracking:** Over the next three years, the CWCB will work with the DWR to explore the development of administrative means to track and administer agricultural conserved water for the purposes of marketing these waters.
8. **Watershed scale planning and improved river basin predictive models and computational tools:** The CWCB and DWR will work with stakeholders to explore the development of tools and models that can serve as an approved common baseline, upon which water court litigants and parties to administrative change cases can rely, for conservative estimates of consumptive water use, return flows, and injury.
9. **Efficiency and conservation innovation:** The CWCB will continue to work with research institutions in Colorado to advance agricultural conservation and efficiency.

6.3.5 SELF-SUPPLIED INDUSTRIAL CONSERVATION AND REUSE

Introduction

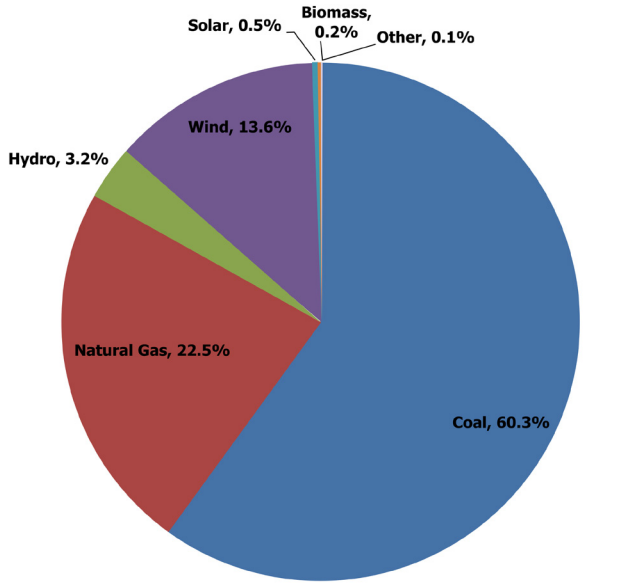
SSI water users describes industrial users that have developed their own, independent water supplies. Users include beer producers, power plants, mining-industry companies, and the ski industry, which uses water for snowmaking purposes. This section, however, will focus on the thermoelectric generation and energy extraction sectors within SSI. While SSI represents a small proportion of the water used statewide, it can represent a substantial amount of water in some local areas—including communities that are home to thermoelectric power generation plants or that have a significant energy-extraction presence, as these are the two major SSI water-user sectors. As a result, SSI water use is often included in the energy-water nexus. "The water-energy nexus is a term used to describe the interaction and interdependencies between water and energy resources. Understanding the dependencies, synergies, conflicts, and trade-offs between these two critical resources is necessary to identify and implement mutually beneficial strategies for their management and use."[267]

Water Use in Energy Production and Extraction

Electricity Generation

Electricity generation in Colorado totaled 53,524,000 megawatt-hours (MWh) in 2013. The demand for power requires an annual consumptive use of slightly more than 55,000 acre-feet, which represents 1 percent of Colorado's consumptive use (Colorado Energy Office calculations are based on utility resource plans). Overall, electricity demand has slowed over the past half-century; gains in energy efficiency have largely offset increased demand. Currently, the U.S. Energy Information Administration estimates a relatively flat electricity load-growth over time, at 0.9 percent per year nationally.[268]

FIGURE 6.3.5-1 COLORADO'S 2012 ELECTRICITY PORTFOLIO[269]



Thermoelectric Power

In 2012, thermoelectric facilities generated more than 85 percent of Colorado's electricity. Thermoelectric power generation heats water to produce steam, which in turn powers turbines to create electricity. While facilities can use a variety of fuel types to heat the water in thermoelectric power generation, the primary fuel sources in Colorado are coal and natural gas. Additionally, water is used to condense steam

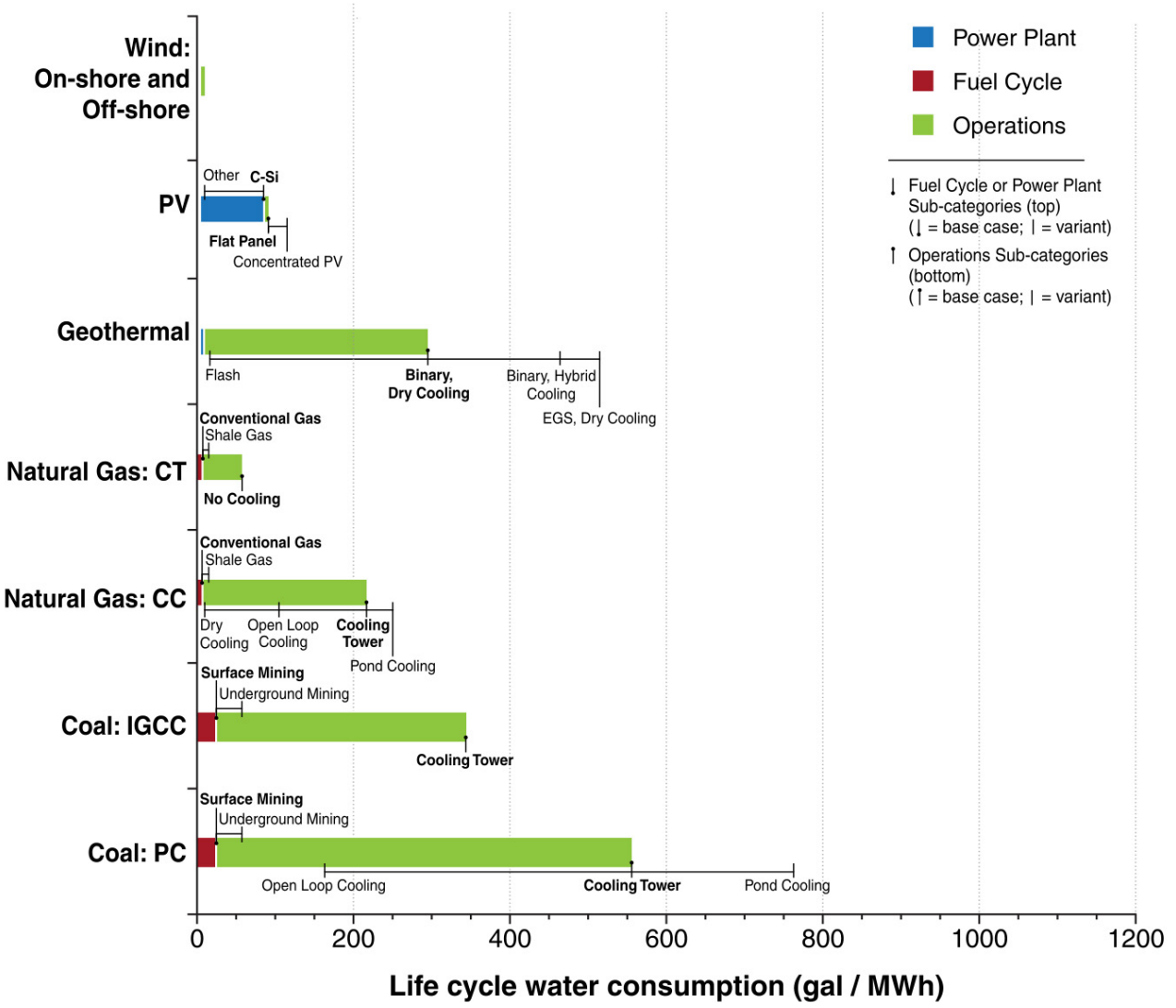
for reuse or discharge. The cooling process accounts for 95 percent of the consumptive use in electricity generation.[270]

Facilities can use a variety of cooling techniques in plant design, depending on process efficiency and an economic cost-benefit analysis. These techniques include once-through cooling, closed-loop, hybrid methods, and dry-cooling.

Once-through cooling systems typically require the greatest withdrawal, but have lower consumptive use because the water passes through a singular cooling process that absorbs heat and is then discharged. Historically, this has often been the least expensive and the most-used method nationwide, but it can have greater effects on the ecosystem because of warm-water discharge. Facilities in Colorado do not use once-through cooling systems.

Alternatively, closed-loop cooling systems use cooling towers to condense the steam. This requires comparatively lower withdrawal, but because of recirculation, it has a higher consumptive-use rate. Many of Colorado's electric generating units use this method, including Xcel's Arapahoe Station, Comanche Station Units 1 and 2, Cherokee Station, and Tri-State G&T's Craig Station.[271] Some facilities minimize freshwater consumption by using treated closed-

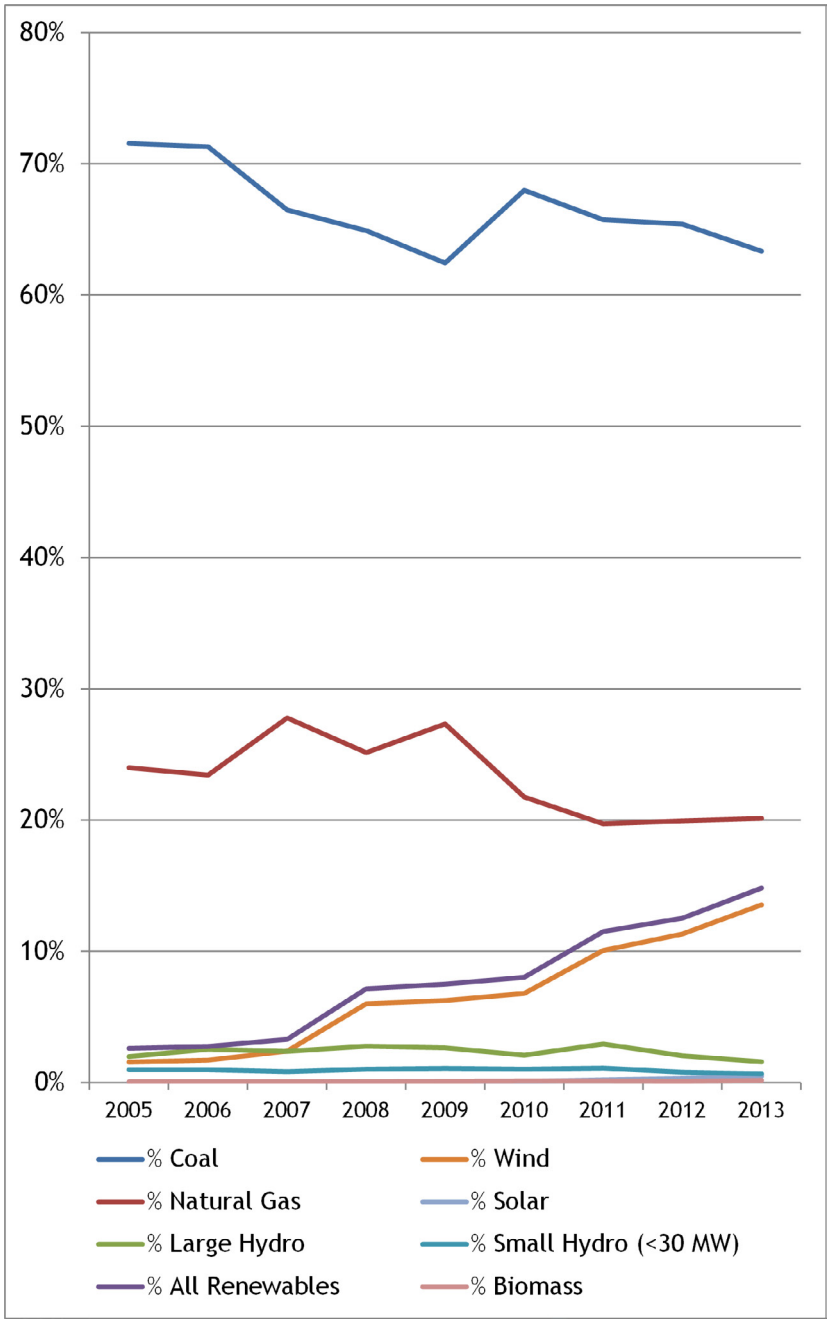
FIGURE 6.3.5-2 LIFECYCLE WATER CONSUMPTION FOR VARIOUS METHODS OF ENERGY PRODUCTION[272]



loop systems. For example, the Platte River Power Authority's Rawhide coal generator relies on 87 percent treated effluent water, and its natural gas turbines use closed-loop glycol cooling systems.

Facilities are researching and employing two other cooling systems in an effort to reduce water consumption. These systems use ambient air-cooling called dry-cooling. Dry-cooling uses only ambient air to condense steam, has lower plant efficiency, has a greater land footprint, and requires a higher electric load, which increases the expense of this method. Nevertheless, hybrid air and water systems that employ both techniques in concert—such as Xcel's Unit 3 at the Comanche Station—are becoming more prevalent.

FIGURE 6.3.5-3 COLORADO'S ELECTRICITY PORTFOLIO (NET-GENERATION)



Coal and natural gas are the primary fuel sources for electricity generation in Colorado, and accounted for 65 percent and 20 percent in 2012, respectively (Figure 6.3.5-1, page 6-102). Each source requires different amounts of water for its process (Figure 6.3.5-2, page 6-103). On average, coal plants consume roughly 40 percent more water per MWh produced when compared to combined-cycle natural gas plants (controlling for all cooling system types).[273] Nevertheless, the cooling techniques each facility employs are the primary source of consumption, regardless of the fuel source.

Beyond the electricity generation requirements, both fuel types also require minimal amounts of water to extract and deliver the resource to the plant.

Renewable energy generation can have consumptive water use depending on the technology, but overall, renewable energy requires substantially less water than fossil-fuel generation. In 2004, Colorado voters passed Amendment 37, which established a Renewable Electricity Standard. The standard required utilities to generate a portion of their electricity from renewable sources. Among other public policy goals, the legislative declaration for Amendment 37 specifically included language indicating that the measure would "minimize water use for electricity generation."[274] Currently, Colorado's renewable electricity standard requires 30 percent generation for investor-owned utilities, 20 percent for co-ops, and 10 percent for municipal utilities—all by 2020.

Additionally, in 2010, Colorado's legislature passed the Clean Air Clean Jobs Act, which sought to reduce emissions from power plants by retiring, retrofitting, or repowering some power plants that Xcel Energy and Black Hills Energy own. Because of these state-level policies, a variety of EPA regulations, and increasingly competitive wind and solar prices, Colorado is likely to reduce water use in electricity generation as Colorado's generation portfolio trends toward a larger mix of natural gas and renewable generation. In fact, generation from wind has grown the fastest of any fuel source as a percentage of the overall portfolio. That growth reached more than 12 percent between 2005 and 2012, and represents both the state's largest renewable energy generation source and the utility-scale source of electricity with the least consumptive use of water.

Public Disclosure and Resource Planning

Colorado's investor-owned utilities, Xcel Energy and Black Hills Energy, report their water consumption when filing resource plans with the Public Utilities Commission (PUC). The PUC is also allowed to consider water use in addition to fuel costs, construction costs, conventional operating costs, and transmission costs when evaluating resource selection. Investor-owned utilities in Colorado are also permitted to use water consumption as a factor when prioritizing and evaluating competitive solicitations for renewable energy.[275] Tri-State G&T provides water-consumption data to the PUC as part of its public resource-planning process.

Hydroelectric Power Generation

Currently, hydropower provides approximately 4 percent of Colorado's electricity, which is generated from more than 60 hydropower facilities throughout the state. With a combined installed capacity of 1162 megawatts (MW), hydroelectric facilities produce roughly 1 million MWh of electricity annually. Colorado's hydro plants range in size from 5 kilowatts to 300 MW, and include three pumped-storage facilities. While Colorado has an arid climate, the state has potential to further develop hydroelectric resources.

Colorado categorizes its hydroelectric resources into three areas: Large-hydro, small-hydro, and agricultural-hydro. Each project category has unique characteristics and affects water consumption in different ways. Typically, larger hydroelectric projects (with large

generating capacity) have larger evaporative losses due to the need for sizable dams and reservoirs. While Colorado has classified six projects as large-hydro (over 30 MW), these projects are still relatively small in size compared to others around the country. While there is no widely accepted definition of "small-hydro," small-hydro projects in Colorado are typically 2 MW or smaller in size.

Agricultural-hydro projects include a variety of system types, including pressurized irrigation systems. There are roughly 2.7 million acres of land under irrigation in Colorado. A Colorado Department of Agriculture (CDA) analysis found that 7 percent of these lands, representing approximately 175,000 acres, are candidates for pressurized irrigation systems. Of those candidate lands, 13 percent are already sprinkler-irrigated and would incur the lowest development cost. The remaining 87 percent are predominantly flood- or furrow-irrigated and would incur a higher cost for agricultural-hydro development due to necessary redesign and retrofits.[276]

Gravity-pressurized irrigation systems, or center-pivot sprinklers, have the potential to generate electricity if there is either excess flow or excess pressure available—or if the center-pivot system currently relies on diesel generators or the electrical grid. The hydroelectric generating potential (in excess of the power needed to pressurize the irrigation systems themselves) of Colorado's pressurized irrigation systems is estimated at 30 MW. Depending on the situation on a given parcel, excess hydroelectric power could help offset other electrical loads or mechanically drive the sprinkler system itself.[277]

A variety of organizations, including federal agencies, have explored the hydropower potential of existing agricultural dams. Colorado features more than 2000 dams, and a large number of those dams are very small or only hold water for a very short period of time. A CDA study of the use of small dams excluded dams that were not related to agriculture, were on federal lands, or were so small that they were very unlikely to hold potential. The CDA study found 102 small dams with the technical potential to generate hydroelectricity. The study determined that 23 sites would be economically feasible and could break-even within 20 years. Those 23 economically feasible sites total approximately 40 MW of capacity—25 MW of which are currently under development via six projects. That leaves about 15 MW of untapped, economically feasible potential statewide.[278]

Opportunities for additional large-hydro projects in Colorado are limited, as most of the ideal sites have already been developed. Nevertheless, small-hydro and agricultural-hydro systems have better outlooks for future growth. According to the BOR, Colorado currently has more than 30 potential hydropower sites at reclamation facilities, which could potentially produce more than 105,000 MWh annually.[279] A U.S. Department of Energy report estimates an additional 11 potential sites with the potential to produce more than 632,000 MWh annually.[280] Between these two studies, Colorado's estimated untapped, hydropower energy potential is more than 737,975 MWh annually.[281] If Colorado were to use this full potential, it could power more than 65,000 homes a year using new hydropower.

Oil and Gas Production

In Colorado, there are more than 52,000 active oil and gas wells. Oil and gas development accounts for less than one-tenth of 1 percent of the overall water usage in the state. The primary uses for water occur during the drilling and completion phases. Usage and processes include cooling the drill bit, bringing drill-cuttings to the surface, and hydraulic fracturing (fracking). During hydraulic fracturing, water mixed with sand and chemicals is pumped under high pressure down the wellbore to create tiny fractures in the rock, releasing oil and gas. Water usage for oil and gas operations varies, depending on the type and location of the well and whether or not the well is

hydraulically fractured. Vertical and directional wells use less water than horizontal wells, because they are not as long and they require lower pressure. Vertical and directional wells typically use between 100,000 and 1,000,000 gallons of water, depending on the depth of the well. Horizontal wells typically use between 2,000,000 and 5,000,000 gallons, depending on the depth and length of the well.

In June 2012, the Colorado Oil and Gas Conservation Commission (COGCC) began requiring oil and gas operators to report the volume of fluids used in hydraulic fracturing. That year, operators used approximately 7.3 billion gallons of water for 2294 well starts, including 664 horizontal wells. Of that total volume, operators reported about 3.8 billion gallons (53 percent) as recycled fluids. In 2014, approximately 4.2 billion gallons of water were used for 1609 well starts, including 1081 horizontal wells. Of this total volume, operators reported about 1.2 billion gallons (29 percent) as recycled fluids.[282]

COGCC does not formally track reuse of produced water. Anecdotally, the most significant reuse of produced water is for hydraulic fracturing. Since the produced water contains chemicals and naturally occurring hydrocarbons, COGCC and CDPHE regulations tightly control its use off of the well site. Operators are currently testing and implementing new treatment technologies to allow for the reuse and recycling of produced water for other purposes.

Coal Extraction

There are nine actively producing coal mines in Colorado. Most of the water in coal extraction is used for mining, washing, and transporting coal, as well as dust-suppression efforts. Consumptive water use at these coal mines ranges from 26 to 320 acre-feet per year, with an average of 165 acre-feet (1,000,000 gallons = 3 acre-feet).[282] A few mines are implementing water efficiency measures. For example, the West Elk Mine in Delta County uses a closed-loop system. It pumps all surface runoff into the mine for use in its wash plant and dust-suppression efforts. The mine only rarely pumps water from the North Fork of the Gunnison River, and discharges back to the river have been minimal and rare.

Energy Use in Water Conveyance

The other piece of the water-energy nexus is the energy that is required for water conveyance, water treatment, water distribution, and wastewater treatment. The 2009 study, titled, "Water Conservation = Energy Conservation: A Report for the CWCB," stated that, "Energy is embedded in water. Water utilities use energy to pump groundwater, move surface water supplies, treat raw water to potable standards, and distribute it to their customers. Customers use energy to heat, cool, and pressurize water; and wastewater treatment plants use energy to treat wastewater before discharging it (Figure 6.3.5-4, page 6-109)."[283]

Concerning domestic water, the water-energy nexus is centered on water conservation measures utilities can employ to lessen the energy intensity of water use. Water supplies carry vastly different energy intensities, depending on the point at which they originate and the manner in which they are conveyed. Some water supplies are almost purely conveyed using gravity, while other supplies are very energy-intensive and require a large amount of electricity to pump water from deep underground.

Water conservation and energy efficiency can play synergistic roles in lessening the effects of each other. Through more efficient changes in water treatment, distribution, and end-use, energy use can be made more efficient and vice versa. This extends back to saving energy in the SSI area of energy production, resulting in saving water that would normally go into the process of producing this energy.

Energy and Water Efficiency Tools

Many of Colorado's efficiency programs involve energy savings that also result in water savings. Although reducing water use alone can save energy, Colorado's efficiency programs generally focus on improving water efficiency and energy efficiency during a complete facility renovation.

Energy performance contracting is a tool that allows public facilities to finance capital improvements, including upgrades to efficient equipment. The tool allows facilities to contract an energy service out to company to conduct investment-grade audits to facilities, as well as obtain prioritized lists of facility improvement measures. By pursuing those measures through a performance contract, energy

Wind energy production in Limon. Water conveyance requires energy, and energy production requires water. Renewable energy generation typically consumes substantially less water than fossil fuel generation.

FIGURE 6.3.5-4 ENERGY IS USED TO PUMP, TREAT, DISTRIBUTE, AND USE POTABLE WATER, AND TO TREAT WASTEWATER[284]

service companies guarantee that their facilities will realize energy, water, and associated operations and maintenance savings as a result of the proposed improvements. In Colorado, facilities have used energy performance contracting to finance $447.4 million in facility investments. Those investments provide guaranteed annual savings of 141.8 million kWh of electricity, 9.95 million therms of heating fueling, 467,200 kgal of water, and $30.9 million.

The Colorado Energy Office also manages an Energy Savings for Schools Program, which helps K-12 school districts lower energy use, water use, and costs while improving building performance and comfort. This program's services and resources are designed to cover the variety of energy efficiency and energy management needs of schools. High energy costs particularly affect Colorado schools located in rural or lower-income districts, and these schools are therefore a high priority for the Colorado Energy Office's energy efficiency programs.

There is also significant potential for efficiency savings among Colorado's agricultural communities. The CDA is working with agricultural producers to reduce energy and water costs. Some of these efforts also reduce thermoelectric energy use with concomitant water savings. Projects include locally sited micro-hydro, solar, and wind-power generation.[285] In addition, the Colorado Energy Office developed an agricultural efficiency pilot with dairy farmers. This pilot focused on energy efficiency improvements, but the State could further develop the program to include water efficiency measures.

Through Senate Bill 14-171, the Colorado Legislature expanded another energy efficiency program to include water use savings last year. Commercial Property-Assessed Clean Energy Bonds previously allowed commercial building owners to arrange financing, secured by a lien, for the installation of energy efficiency improvements. Senate Bill 14-171 allows water conservation fixtures to be included in the improvements, so that buildings can benefit from both energy and water efficiency.

ACTIONS

1. Examine the feasibility of water-energy nexus programs that conserve both water and energy. Some concepts to further explore include:
    a. Joint water and energy home or commercial audits.
    b. Joint rebate programs, which combine water and energy utility rebates to most effectively incentivize customers to purchase a specific energy- or water-efficient appliance.
    c. Treat water utilities as a large customer of the energy utility and explore system-wide water- and energy-reducing measures, such as reduction of distribution system leaks.
2. When exploring new water supply projects, consider opportunities for renewable energy to meet the increased demands.
3. Conduct outreach to energy companies to encourage and promote the most water-efficient technologies for energy extraction.

4. Ensure that the Colorado Energy Office continues to support energy saving associated with on-farm agricultural practices that also reduce water use.
5. Ensure that the CWCB works with the Colorado Energy Office and local agricultural producers to financially and technically support a pilot that combines renewable energy development with an alternative agricultural transfer. Such a pilot would aim to lessen the potential economic effects on the local community.
6. Ensure that the CWCB encourages energy companies to continue collaborating with agricultural and environmental interests when managing their water portfolio.
7. Ensure that the State helps to protect critical infrastructure by working with power providers to identify areas of their systems that are prone to failure or impact during water shortages and natural disasters.
8. Ensure that the State works with power providers to mitigate the possibility of curtailment in severe droughts, and to diversify their water rights portfolio.
9. Encourage demand-side management:
    a. Continue support of research into innovative ways to reuse produced water.
    b. Decrease vulnerability during times of water shortages.
10. Encourage technologies that reduce water use in energy extraction processes.

6.3.6 STATE AGENCY CONSERVATION

The State of Colorado plans to increase conservation efforts within state facilities to help demonstrate the ability to save water. The Colorado Energy Office has been facilitating the Greening Government initiative since Governor Bill Ritter issued Executive Orders D 0011 07 and D 0012 07. The Greening Government Leadership Council recently generated a new draft goal for water demand reduction at state facilities. The state will achieve this goal by 2020 with a baseline of 2015, and will normalize the goal for weather and other external factors.

Water goal: *Collectively, all executive state agencies and departments shall reduce potable water consumption by a minimum of 1 percent annually (normalized for weather) and at least 7 percent by FY 2020, relative to an FY 2015 baseline.*

State agencies reduce their water consumption by various methods, including installation of efficient plumbing fixtures, use of advanced lawn irrigation controls, and use of reuse water.

The 2012 Greening Government Annual Report Card provided the following information.[286] The state saw an increase of 8.4 percent (112.5 million gallons of water) in water use. Each agency provided the following data, and the data reflects that agency's best attempt to record all water purchases between FY'06-FY'12 in EnergyCAP. Water usage has not been normalized for the increase in state employees, increasingly hot weather, or new water-intensive industries. Of the 14 agencies and departments that own square footage, six reduced their water use by more than 10 percent, four reduced their water use by less than 10 percent, and four increased their water use.[287]

Exemplary State Agency Projects

1. The CDPHE has decreased its water use by 11 percent since 2005. It replaced two acres of bluegrass lawn with xeric grass species, an action that is saving more than 2.5 million gallons per year. It also replaced high-flushing urinals with 0.5 gallons-per-flush urinals, and installed waterless urinals.
2. Capitol Complex facilities personnel conducted some notable efforts over the last few years. They worked with Denver Water to audit all cooling towers for the Capitol Complex, and have the capacity to reduce consumption by almost 500,000 gallons per year. Additionally, facilities personnel can now take advantage of Denver Water incentives. In an example that this annual report did not capture, a landscape transformation initiative is taking place on the Capitol grounds. A collaborative group from the Governor's Office, CWCB, Denver Water, the Denver Botanic Gardens, Colorado Nursery and Greenhouse Association, and Capitol Complex Facilities is working on plans to reduce water consumption and demonstrate the benefits of water-wise landscaping on the Capitol building grounds. This high-profile project will highlight to the public what can be done with Colorado-appropriate landscapes.

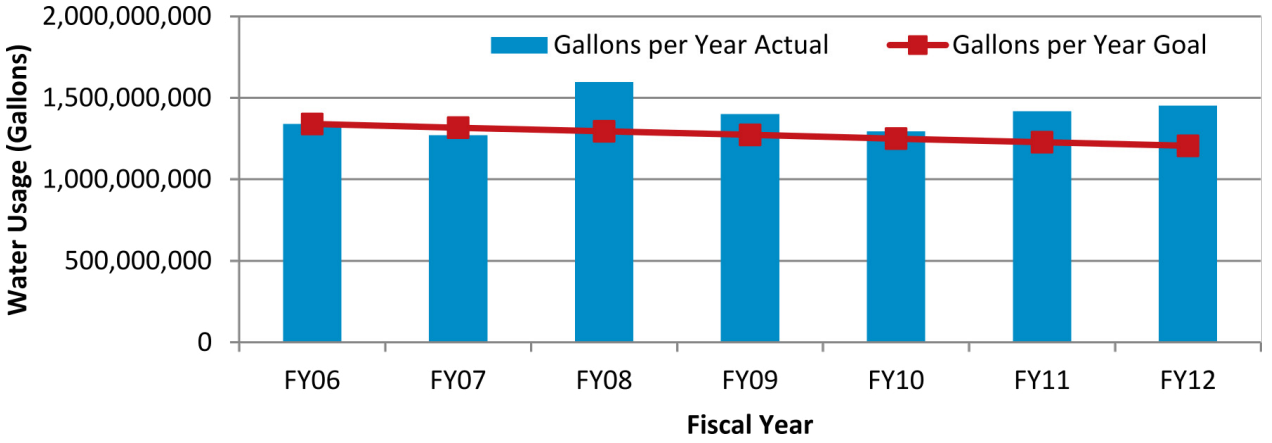
State agencies have been working for years, under greening government policies, to help reduce water and energy use in State facilities and are committed to doing so in the future.

Recommendations from Annual Report Card

- *Continue requiring water reductions by all state agencies.*
- *Require agencies to take advantage of free or reduced cost water audits by their water utility, if applicable.*
- *Look into bulk purchasing of water efficient appliances for state agencies.*
- *Continue educating Council about the water-energy nexus.*
- *Research and identify alternative ways to provide sufficient funding for water efficiency.*
- *Continue encouraging agencies to use their water rights.*[288]

This type of water use is an important standard to pursue in that the State of Colorado should lead by example in its own facility water use. This idea ties back to the SWSI Levels Framework philosophy that water providers should prioritize their foundational activities first, and then focus on what they have direct control over within their own facilities. While state facilities have accomplished much, better tracking and quantification could help normalize the data for weather, number of employees, and any new intensive uses that have been introduced.

FIGURE 6.3.6-1 WATER USE (ACTUAL AND GOAL) THROUGH TIME



ACTION

The CWCB will provide grants and technical support to state agencies for the installation of high-efficiency toilets and urinals, replacement of turf grass with plants that use less water, and improvement of cooling towers.

State agencies are working collaboratively with the Denver Botanic Gardens, shown here, and other organizations on plans to reduce water consumption and demonstrate the benefits of water-wise landscaping. One goal of this partnership is to educate the public on Colorado-appropriate landscapes.